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BUMHS QUETTA

BUMHS Quetta MDCAT 2024 Official Paper

Official Annual Full-Length Practice Examination (FLP) · Complete Solved Paper

Official Admitting Board: Bolan University of Medical and Health Sciences Quetta Archive Code: BEAMBE-FLP-BUMHS-2024 Duration: 200 Minutes (3h 20m)

200
TOTAL QUESTIONS

200m
OFFICIAL DURATION

+1 / 0.00
ZERO NEGATIVE MARKING

200
MAXIMUM MARKS

EXAMINATION BLUEPRINT & SUBJECT WEIGHTAGE

English
18 MCQs
9.0% weight

Biology
68 MCQs
34.0% weight

Chemistry
56 MCQs
28.0% weight

Physics
52 MCQs
26.0% weight

Logical Reasoning
6 MCQs
3.0% weight

ENG SECTION: ENGLISH

Questions 1 to 18 (18 MCQs)

Q1. ENG

We are about _____ at the place where we can set up our tents.

- (A) To arrive
- (B) Arriving
- (C) Be arriving
- (D) To have arriving

Q2. ENG

Choose the word which is similar in meaning to REIGN:

- (A) Damp
- (B) Tussle
- (C) Rule
- (D) Prime

Q3. ENG

It is common knowledge to anyone who studies science, that the earth _____ on its own axis once every 24 hours.

- (A) Revolves
- (B) Revolve
- (C) Has revolved
- (D) Has had revolved

Q4. ENG

"To abscond" means:

- (A) To create a secret hiding place
- (B) To do something without telling anyone
- (C) To go away secretly and hide
- (D) To do something ahead of deadline

Q5. ENG

There was a surprising story in the newspaper about the _____ car was stolen.

- (A) Man which his
- (B) Man whose his
- (C) Man that his
- (D) Man whose

Q6. ENG

When I _____ him, Rauf _____ cricket.

- (A) Was, playing
- (B) Saw, is playing
- (C) Saw, was playing
- (D) Saw, played

Q7. ENG

Identify the correct option for this sentence:

Many modern architects insist on _____ materials native to the region that will blend into the surrounding landscape.

- (A) Use
- (B) To use
- (C) The use
- (D) Using

Q8. ENG

We are committed to providing excellent customer service, _____ ensuring a positive experience for all our clients.

- (A) Thereby
- (B) Therefore
- (C) Because
- (D) Since

Q9. ENG

Read the following passage to answer the given question:

As adults, we may be able to convey our mood by a mere twist of the lips, but the infant throws much more into the battle. When smiling at full intensity, it also kicks and waves its arms about, stretches its hands out towards the stimulus and moves them about, produces babbling voices, tilts back its head, protrudes its chin, leans its trunk forward or rolls it to one side.

Which statement is true?

- (A) Babies rarely smile and often it is difficult to judge their smiles
- (B) A baby's smile is more vigorous than an adult's
- (C) In comparison to adults, a baby smiles more quietly
- (D) Babies make babbling noises before they smile

Q10. ENG

Use an appropriate article:

Danube is _____ Austria's longest river.

- (A) A
- (B) An
- (C) The
- (D) No Article

Q11. ENG

Fill in the blank with appropriate preposition:

He isn't good _____ French.

- (A) At
- (B) In
- (C) To
- (D) Of

Q12. ENG

Romans _____ a unique system of the Roman alphabet.

- (A) Improved
- (B) Developed
- (C) Persuaded
- (D) Exchanged

Q13. ENG

Read the following passage to answer the given question:

All walked in from a world of darkness and left in the fullness of light - blind or partially blind patients who received the gift of sight through cornea transplants of eyes.

Who are being referred to?

- (A) People from dark regions
- (B) Those interested in gifts
- (C) People with healthy eyesight
- (D) Those who sought eye transplants

Q14. ENG

Identify the correct option for this sentence:

Unless a student _____ with the university regulations, he can be removed from the university.

- (A) Complies
- (B) Complied
- (C) Had complied
- (D) Will comply

Q15. ENG

Antonym of HEGEMONY is:

- (A) Lack of energy
 - (B) Lack of precision
 - (C) Lack of authority
 - (D) Lack of confidence
-

Q16. ENG

What is the opposite of CHAOTIC:

- (A) Immersive
 - (B) Orderly
 - (C) Hectic
 - (D) Steady
-

Q17. ENG

Under ethical guidelines recently adopted by the National Institutes of Health, human genes are to be manipulated only to correct diseases for which _____ treatments are unsatisfactory.

- (A) Similar
 - (B) Most
 - (C) Dangerous
 - (D) Alternative
-

Q18. ENG

Identify the correct option for this sentence:

If _____ the match, I will go to Lahore to meet the sports board chairman.

- (A) I win
 - (B) I will win
 - (C) I shall win
 - (D) I wins
-

BIO SECTION: BIOLOGY

Questions 19 to 86 (68 MCQs)

Q19. BIO

The soluble shield of macromolecules that surrounds bacteria is called:

- (A) Pili
- (B) Slime
- (C) Capsule
- (D) Flagella

Q20. BIO

The following form of circular double-stranded, self-replicating DNA molecules present in many bacteria, in addition to the chromosomes, are not essential for bacterial growth and metabolism:

- (A) Nucleoid
- (B) Plasmids
- (C) Mesosomes
- (D) Nuclear region

Q21. BIO

Most fungi are:

- (A) Autotrophs
- (B) Heterotrophs
- (C) Photosynthetic
- (D) All of the given options

Q22. BIO

The life cycle during alternation of generation has the following feature:

- (A) Zygote undergoes meiosis
- (B) Zygote develops into gametophyte
- (C) Sporophyte generation produces haploid spores
- (D) Gametophyte generation produces diploid gametes

Q23. BIO

During high temperatures, plants usually remain cool by the loss of water from their bodies through:

- (A) Guttation
- (B) Transpiration
- (C) Photosynthesis
- (D) Osmosis

Q24. BIO

What is/are the element(s) of the nervous system that help in nervous coordination?

- (A) Neurons
- (B) Receptors
- (C) Effectors
- (D) All of the given options

Q25. BIO

The _____ system aids in defending the human body against foreign invaders.

- (A) Reproductive
- (B) Digestive
- (C) Lymphatic
- (D) All of the given options

Q26. BIO

Which of the following is / are the characteristics of the enzymes?

- (A) All enzymes are globular proteins
- (B) They lower the activation energy of reactions
- (C) They are sensitive to minor changes in substrate concentration
- (D) All of the given options

Q27. BIO

The first step of the central dogma is the transfer of information from:

- (A) DNA to Protein
- (B) DNA to mRNA
- (C) RNA to Protein
- (D) DNA to tRNA

Q28. BIO

_____ is a type of connective tissue.

- (A) Nail
- (B) Hair
- (C) Ligament
- (D) Jaw bone

Q29. BIO

The detachable _____ is called as an activator, if it is an inorganic ion.

- (A) Substrate
- (B) Product
- (C) Co-factor
- (D) None of these

Q30. BIO

Highly condensed proteins of chromatin are called:

- (A) Homochromatin
- (B) Heterochromatin
- (C) Semi-heterochromatin
- (D) Semi-homochromatin

Q31. BIO

Hemoglobin has the following characteristics, except:

- (A) Gives red color to blood
- (B) Can carry molecular oxygen
- (C) Is an iron-containing protein
- (D) Important component of bile pigment

Q32. BIO

The hereditary material is:

- (A) DNA
- (B) Protein
- (C) Both DNA and Protein
- (D) Neither DNA nor Protein

Q33. BIO

In artificial selection, we develop desired characteristics in _____ offspring to create from variants:

- (A) New males
- (B) New females
- (C) New breeds
- (D) New organs

Q34. BIO

There are types of reduction used for treating bone fractures.

- (A) Two
- (B) Three
- (C) Four
- (D) Five

Q35. BIO

The conversion of lysogenic cycle to lytic cycle is called:

- (A) Conduction
- (B) Production
- (C) Induction
- (D) None of the given options

Q36. BIO

Movement can be lost in the _____ due to Sciatica.

- (A) Neck
- (B) Hand toes
- (C) Hand-arm
- (D) Foot-ankle

Q37. BIO

Endomycorrhizae may enter the outer cells of the plant root and cause

- (A) Swelling
- (B) Minute branching
- (C) Both Swelling and Minute Branching
- (D) None of the given options

Q38. BIO

Water contributes _____% of total mammalian cell weight

- (A) 40
- (B) 50
- (C) 60
- (D) 70

Q39. BIO

Which of the following is not true regarding the phenomenon of aging?

- (A) Cells undergo mitosis as a part of growth of the body
- (B) After a number of cell divisions, cells become differentiated
- (C) After maximum metabolic activity, cells in the body start deteriorating
- (D) The resistance to negative environmental factors remains the same throughout life

Q40. BIO

Symptoms of Hepatitis are:

- (A) Loss of immunity
- (B) Loss of T helper cells
- (C) Blood cancer
- (D) None of the given options

Q41. BIO

Hemichordata belongs to:

- (A) Deuterostomes
- (B) Protostomes
- (C) Both (a) and (b)
- (D) None of the given options

Q42. BIO

Which one of the following is not an enzyme?

- (A) Pepsin
- (B) Insulin
- (C) Sucrase
- (D) Catalase

Q43. BIO

Which of the following is not true regarding the Dihybrid cross breeding as observed in experiments on plants:

- (A) Some new plants, which are different from the parental plants, are produced
- (B) Genes for different traits, like the color and shape of seeds, always stay together
- (C) A dihybrid cross follows the law of independent assortment
- (D) Dominant traits of color and shape of seed appeared in the F1 generation

Q44. BIO

In binomial nomenclature, the first name refers to the:

- (A) Species
- (B) Genus
- (C) Family
- (D) Order

Q45. BIO

The vital functions of the colon are the following:

- (A) Storage of fecal matter
- (B) Absorption of water and salts
- (C) Synthesis of vitamins
- (D) Breakdown of cellulose in herbivores

Q46. BIO

Poliomyelitis mostly occurs in:

- (A) Childhood
- (B) Adulthood
- (C) In old age
- (D) Difficult to say

Q47. BIO

If the sequence of bases in DNA is TAGG, the sequence of bases in RNA will be:

- (A) ATCG
- (B) AUCC
- (C) TAGC
- (D) None of the above

Q48. BIO

A disadvantage of animal cloning is

- (A) Rapid growth
- (B) Rapid aging
- (C) Identical offspring
- (D) Absence of mitosis

Q49. BIO

Which of following is true about Triploblastic animals?

- (A) Their body consists of two layers
- (B) They have non-cellular mesoglea present
- (C) They have a great degree of specialization in cells
- (D) They have radial symmetry

Q50. BIO

In humans, the ability of regeneration is restricted to the following organ

- (A) Bones
- (B) Skin
- (C) Nerve tissue
- (D) Muscles

Q51. BIO

Ribose is an example of sugar:

- (A) Pentose
- (B) Hexose
- (C) Heptose
- (D) Tetrose

Q52. BIO

The psychological disorder in which a patient stops eating due to fear of being obese is called:

- (A) Dyspepsia
- (B) Anorexia nervosa
- (C) Bulimia nervosa
- (D) None of the given options

Q53. BIO

Permit exchange of materials with the tissue:

- (A) Veins
- (B) Arteries
- (C) Capillaries
- (D) All of the given options

Q54. BIO

Persons can bleed to death from small cuts or bruises in:

- (A) Typhoid
- (B) Dysentery
- (C) Hemophilia
- (D) Color blindness

Q55. BIO

The part of the small intestine which connects with the large intestine is known as:

- (A) Ileum
- (B) Jejunum
- (C) Duodenum
- (D) Appendix

Q56. BIO

In lichens, _____ protects its symbiotic partner from desiccation.

- (A) Fungi
- (B) Algae
- (C) Bacteria
- (D) Viruses

Q57. BIO

Lactose, maltose, and sucrose are important type of following carbohydrates in living organisms:

- (A) Monosaccharides
- (B) Disaccharides
- (C) Triaccharides
- (D) Polysaccharides

Q58. BIO

Viruses can be classified on the basis of:

- (A) Shape
- (B) Nucleic acid
- (C) Envelope
- (D) All of these

Q59. BIO

In diploid parthenogenesis, the eggs produced by female developed into:

- (A) Males
- (B) Females
- (C) Hermaphrodite
- (D) None of the above

Q60. BIO

Parazoa are:

- (A) Multicellular
- (B) Radially symmetrical
- (C) Bilaterally symmetrical
- (D) Asymmetrical

Q61. BIO

A tetrad is also known as:

- (A) Bivalent
- (B) Duplicated chromosome
- (C) Paired homologous chromosomes
- (D) Homologous and thickened chromosome

Q62. BIO

Developing seeds are a rich source of:

- (A) Estrogen
- (B) Cytokinins
- (C) Auxins
- (D) Both Cytokinins and Auxins

Q63. BIO

The following is not present in the cytoplasm of the cell:

- (A) Nucleolus
- (B) Glycolysis
- (C) Presence of organelles
- (D) Storage of vital chemicals

Q64. BIO

Changes in rate of base substitution in DNA cause:

- (A) Osmotic pressure
- (B) Hydraulic pressure
- (C) Air pressure
- (D) Mutation pressure.

Q65. BIO

Which organism uses pseudopods for the purpose of locomotion?

- (A) Amoeba
- (B) Euglena
- (C) Plasmodium
- (D) Paramecium

Q66. BIO

Which one is Monera?

- (A) Nostoc
- (B) Both 'E. coli' and 'Nostoc'
- (C) None of the given options
- (D) E. coli

Q67. BIO

Some genetic diseases are caused due to abnormal number of?

- (A) Nucleotides
- (B) Genes
- (C) Chromosomes
- (D) All of the above

Q68. BIO

Dinoflagellates are known to change the colour of water to:

- (A) Yellow
- (B) Green
- (C) Brown
- (D) All of the given options

Q69. BIO

Archaeobacteria are most likely to occur in:

- (A) Soil
- (B) Ice caps
- (C) Freshwater
- (D) Hydrothermal vents

Q70. BIO

Photosynthesis is

- (A) Reduction process
- (B) Oxidation process
- (C) Redox process
- (D) None of the given options

Q71. BIO

RNA is associated with:

- (A) Lysosome
- (B) Centrosome
- (C) Ribosomes
- (D) Golgi bodies

Q72. BIO

Which of the following kingdoms, the eukaryotic multicellular autotrophs are classified?

- (A) Plantae
- (B) Animalia
- (C) Monera
- (D) Protista

Q73. BIO

Typical protozoa include the following except:

- (A) Euglena
- (B) Paramecium
- (C) Proterospongia
- (D) Amoeba

Q74. BIO

Following are the products of photosynthesis:

- (A) Glucose and water
- (B) Oxygen and glucose
- (C) Oxygen, glucose, and water
- (D) None of the given options

Q75. BIO

Examples of Psilopsida are:

- (A) Psilotum
- (B) Lycopodium
- (C) Both Psilotum and Lycopodium
- (D) None of the given options

Q76. BIO

What is the other name for resting membrane potential in the neural membrane?

- (A) Polarized state
- (B) Depolarized state
- (C) Hyperpolarized state
- (D) All of the above

Q77. BIO

In prokaryotes, the genetic material is without:

- (A) RNA
- (B) DNA
- (C) Membrane
- (D) Cell membrane

Q78. BIO

Followings are the visible parts of Angiosperm .

- (A) Spores
- (B) Capsule
- (C) Gametophyte
- (D) None of these

Q79. BIO

Which one of the following is a derivative of indole acetic acid or its variant?

- (A) Auxins
- (B) Cytokinins
- (C) Cytochrome
- (D) Absciscic acid

Q80. BIO

In most animals, the principal effectors are the muscles and:

- (A) Nodules
- (B) Tubules
- (C) Glands
- (D) Ganglia

Q81. BIOIf the cell does not enter the G₀ -phase then there is / are ____ phase(s) between anaphase and G₂ -phase?

- (A) 1
- (B) 2
- (C) 4
- (D) None of these

Q82. BIO

Which one of the following is part of the digestive system?

- (A) Lungs
- (B) Pharynx
- (C) Esophagus
- (D) Both (b) and (c)

Q83. BIO

Vernalisation serves the following purpose(s):

- (A) Discourages cross-pollination
- (B) Ensures reproduction at suitable times
- (C) Ensures that all species flower at the same time
- (D) Both (b) and (c)

Q84. BIO

An enzyme and its substrate react with each other through a _____ of enzyme.

- (A) Active site
- (B) Uncharged site
- (C) Both Active site and Uncharged site
- (D) Definitive charge-bearing site

Q85. BIO

The condition in which babies are born with a small skull is called:

- (A) Malaria
- (B) Microcephaly
- (C) Turner's syndrome
- (D) Klinefelter's syndrome

Q86. BIO

The change in allelic frequency of small population, purely by chance is called:

- (A) Genetic drift
- (B) Continental drift
- (C) Mutation
- (D) Gene pool

CHEM SECTION: CHEMISTRY

Questions 87 to 142 (56 MCQs)

Q87. CHEM

Which of the following food product has lower energy per gram?

- (A) Milk
- (B) Ghee
- (C) Butter
- (D) Glucose

Q88. CHEM

The sign of heat "q" is positive for a system when:

- (A) The temperature of system drops
- (B) Heat flows from surrounding to system
- (C) Heat flows from system to surrounding
- (D) No flow of heat between system to surrounding

Q89. CHEM

Which of the following is used for galvanizing iron sheet?

- (A) Tin
- (B) Zinc
- (C) Aluminum
- (D) Copper

Q90. CHEM

Water is:

- (A) Weak electrolyte
- (B) Strong electrolyte
- (C) Very strong electrolyte
- (D) Moderate electrolyte

Q91. CHEM

Which of the following elements react rapidly with water at room temperature?

- (A) Cu (Copper)
- (B) Na (Sodium)
- (C) Fe (Iron)
- (D) Al (Aluminum)

Q92. CHEM

Natural gas consists mainly of:

- (A) Butane
- (B) Propane
- (C) Methane
- (D) Ethane

Q93. CHEM

The IUPAC name for formaldehyde is:

- (A) Ethanal
- (B) Methanal
- (C) Butanal
- (D) Propanal

Q94. CHEM

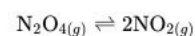
What change in oxidation number of Cu takes place in the following reaction:



- (A) 0 to -1
- (B) 0 to +1
- (C) 0 to -2
- (D) 0 to +2

Q95. CHEM

Suppose the following system has reached equilibrium at a certain temperature:

Adding N_2O_4 to the system will:

- (A) Start forward reaction
- (B) Start the reverse reaction
- (C) Not disturb the equilibrium
- (D) Raise the temperature of the system

Q96. CHEM

5 calories are equivalent to _____ Joule.

- (A) 4.184
- (B) 10.26
- (C) 20.92
- (D) 25.65

Q97. CHEM

Which one of the following statements is NOT correct?

- (A) Formaldehyde is a gas at room temperature
- (B) Formaldehyde is a liquid at room temperature
- (C) Oxidation of methyl alcohol can produce formaldehyde
- (D) Dry distillation of calcium formate can produce formaldehyde

Q98. CHEM

Select the correct one:

- (A) Only electrons of atoms get shuffled during chemical reaction
- (B) All the sub-atomic particles of an atom take part in chemical reaction
- (C) Protons of an atom spearhead chemical reaction
- (D) Protons and neutrons of an atom collectively make chemical reactions possible

Q99. CHEM

Le Chatelier's principle does NOT give information about the effect of the following on the equilibrium

- (A) Time
- (B) Pressure
- (C) Temperature
- (D) Concentration

Q100. CHEM

Conversion of Fahrenheit to Celsius scale by:

- (A) $^{\circ}\text{C} = \frac{5}{9}(^{\circ}\text{F} + 32)$
- (B) $^{\circ}\text{C} = \frac{9}{5}(^{\circ}\text{F} - 32)$
- (C) $^{\circ}\text{C} = \frac{5}{9}(^{\circ}\text{F} - 32)$
- (D) $^{\circ}\text{C} = \frac{9}{5}(^{\circ}\text{F} + 32)$

Q101. CHEM

Having knowledge of the bond energies of alkyl halides; the most reactive one is the

- (A) Iodo-compound
- (B) Bromo-compound
- (C) Chloro-compound
- (D) Fluoro-compound

Q102. CHEM

Amino acids, which are not synthesized by the human body are:

- (A) Non-essential amino acids
- (B) Essential amino acids
- (C) Dietary amino acids
- (D) Synthetic amino acids

Q103. CHEM

Transition metal compounds containing unpaired electrons are:

- (A) Always diamagnetic
- (B) Attracted by the magnet
- (C) Not attracted by the magnet
- (D) Repelled by the magnet

Q104. CHEM

Which of the following is NOT the state of matter:

- (A) Plasma
- (B) Liquids
- (C) Gases
- (D) Ether

Q105. CHEM

In organic chemistry, a nucleus liking agent, rich in electrons, is defined as:

- (A) nucleotide
- (B) A nucleophile
- (C) An electrophile
- (D) Electron affluent

Q106. CHEM

The term 'Transition Temperature' is used for the temperature:

- (A) At which one crystalline form of a substance changes into another
- (B) At which liquid crystals are formed in a liquid
- (C) Within which the habit of a crystal remains the same
- (D) Showing a sharp change in the anisotropic properties of a crystal

Q107. CHEM

The non-protein part of an enzyme is called:

- (A) Activator
- (B) Co-enzyme
- (C) Substrate
- (D) Apoenzyme

Q108. CHEM

The concentration of rectified spirit is:

- (A) 85%
- (B) 90%
- (C) 95%
- (D) 100%

Q109. CHEM

Alkyl halides can yield ethers when heated in the presence of the metallic compound:

- (A) AgO
- (B) CuO
- (C) Cu₂O₂
- (D) FeO

Q110. CHEM

The lipids which have a tetracyclic compound are called Steroids.

The tetracyclic compound is:

- (A) Benzene
- (B) Tetracyclic
- (C) Cyclopentane
- (D) Phenanthrene

Q111. CHEM

The equilibrium constant has no units if the number of moles of products is:

- (A) Less than reactants
- (B) More than reactants
- (C) Equal to reactants
- (D) Half of the reactants

Q112. CHEM

Which statement is NOT correct for cathode rays?

- (A) Have consist of moving material particles
- (B) Have definite mass
- (C) Have definite velocity
- (D) Travel with the velocity of light

Q113. CHEM

Sodium nitrate (NaNO₃), on heating, decomposes forming:

- (A) Na₂O and NO₂
- (B) NaNO₂ and O₂
- (C) Na, NO₂ and O₂
- (D) Na₂O, NO₂ and O₁

Q114. CHEM

A molecule of ethane has _____ bonds.

- (A) four
- (B) five
- (C) six
- (D) seven

Q115. CHEM

The only group of lines occurring in the visible region of the hydrogen spectrum is labeled as the

- (A) Paschen series
- (B) Pfund series
- (C) Balmer series
- (D) Lyman series

Q116. CHEM

Electric current in solutions is carried by:

- (A) Ions
- (B) Canal rays
- (C) Free protons
- (D) Free electrons

Q117. CHEM

In alkane series, all the linkages between carbon atoms is / are _____ bond(s).

- (A) single
- (B) double
- (C) triple
- (D) quadruple

Q118. CHEM

In a chemical reaction, a limiting reactant is that:

- (A) Which is present in excess
- (B) Which is not in excess
- (C) Which acts as catalyst
- (D) Which is not taking part in the reaction but its presence is helpful in completion of the reaction

Q119. CHEM

Units of change in enthalpy of a system are

- (A) cc
- (B) °C
- (C) J
- (D) Pa

Q120. CHEM

Electrically diamond is a:

- (A) Good conductor
- (B) Non-conductor
- (C) Semi-conductor
- (D) None of these

Q121. CHEM

Which of the following food product has lower energy per gram?

- (A) Milk
- (B) Ghee
- (C) Butter
- (D) Glucose

Q122. CHEM

Which of the following is used for galvanizing iron sheet?

- (A) Tin
- (B) Zinc
- (C) Aluminum
- (D) Copper

Q123. CHEM

On heating acetic acid in the presence of P_2O_5 , dehydration occurs with the formation of

- (A) Acetamide
- (B) Octyl acetate
- (C) Methyl acetate
- (D) Acetic anhydride

Q124. CHEM

One picometer (pm) = ?

- (A) 10^{-6} m
- (B) 10^{-8} m
- (C) 10^{-10} m
- (D) 10^{-12} m

Q125. CHEM

Isotopes differ from each other on the basis of:

- (A) Number of electrons
- (B) Mass number
- (C) Electronic configuration
- (D) Crystal lattice

Q126. CHEM

Carbon atom is used to measure relative:

- (A) Atomic size
- (B) Atomic number
- (C) Atomic mass
- (D) Atomic volume

Q127. CHEM

_____ is regarded as the simplest and the parent member of aromatic class of compounds.

- (A) Methanol
- (B) Acetylene
- (C) Benzene
- (D) Acetic acid

Q128. CHEM

The procedure for the preparation of ethers in which an alcohol is first allowed to react with metallic sodium is called:

- (A) Tollen's synthesis
- (B) Fehling's Synthesis
- (C) Williamson's synthesis
- (D) Grignard's synthesis

Q129. CHEM

Inter molecular repulsive forces in gases are due to

- (A) Ionic bonding
- (B) Vander Waal's forces
- (C) Dipoles
- (D) Covalent bonding

Q130. CHEM

The polymer formed from a single type of monomer is called:

- (A) Terpolymer
- (B) Copolymer
- (C) Homopolymer
- (D) Thermosetting polymer

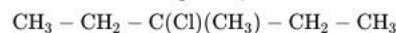
Q131. CHEM

When a hydrogen atom of an alkane is removed, the resulting group is called:

- (A) Aryl
- (B) Alkyl
- (C) Alkenyl
- (D) Phenyl

Q132. CHEM

The IUPAC name of the following compound is:



- (A) Hexylchloride
- (B) 3-chloromethylhexane
- (C) 3-chloro-3-ethylbutane
- (D) 3-chloro-3-methylpentane

Q133. CHEM

The early chemists never succeeded in synthesizing organic compounds, and their failure led them to believe that organic compounds could be manufactured:

- (A) With pure reagents
- (B) By and within living things
- (C) With pure organic solvents
- (D) At very high temperature and pressure

Q134. CHEM

Oxidation number of Mn in K_2MnO_4 is:

- (A) +4
- (B) +5
- (C) +6
- (D) +7

Q135. CHEM

Which of the following compound is not an alcohol:

- (A) C_3H_7OH
- (B) C_4H_9OH
- (C) $C_4H_8CH_3OH$
- (D) None of the given options

Q136. CHEM

Benzene when reacts with chlorine, in presence of sunlight gives an additional product i.e

- (A) HCl
- (B) Chloroform
- (C) Hexachlorobenzene
- (D) Polyvinyl chloride (PVC)

Q137. CHEM

The sum of pH and pOH for pure water at $25^\circ C$ is

- (A) 10
- (B) 10^{-14}
- (C) 14
- (D) 25

Q138. CHEM

An electron in an atom is completely described by its _____ quantum numbers.

- (A) Eight
- (B) Six
- (C) Five
- (D) Four

Q139. CHEM

Which of the following is not a result of capillary action?

- (A) Rise of water from soil to plant
- (B) Movement of blood in veins
- (C) Absorption of water by the cotton
- (D) Spreading of ink on blotting paper

Q140. CHEM

When potassium chromate is treated with an acid, it produces:

- (A) Water
- (B) Sodium chloride
- (C) Potassium sulfate
- (D) Potassium dichromate

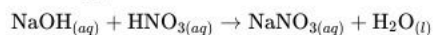
Q141. CHEM

Compounds attracted into a magnetic field are called:

- (A) Paramagnetic
- (B) Diamagnetic
- (C) Polymagnetic
- (D) Ferrimagnetic

Q142. CHEM

The change in enthalpy for the reaction:



is

- (A) Heat of combustion
- (B) Heat of neutralization
- (C) Heat of decomposition
- (D) Heat of formation

PHY SECTION: PHYSICS

Questions 143 to 194 (52 MCQs)

Q143. PHY

Ohm's law states that the electric current through a conductor is proportional to the applied voltage provided:

- (A) Electric current is constant
- (B) Electric field is constant
- (C) Resistance is constant
- (D) Electric charge is constant

Q144. PHY

The electric potential at a point in an electric field is the amount of work done to move:

- (A) Any amount of charge from infinity to that point
- (B) A unit positive charge from infinity to that point
- (C) Any amount of charge from any position to that point
- (D) A unit negative charge from infinity to that point

Q145. PHY

When a gas is expanded at constant temperature then it

- (A) Absorbs heat
- (B) Releases heat
- (C) Neither absorbs nor releases heat
- (D) None of the given options

Q146. PHY

A spherical liquid drop has a diameter of 2cm and is given a charge of 1mC. The potential at the surface of the drop is:

- (A) 9 MV
- (B) 900 MV
- (C) 0.45 MV
- (D) 4.5 MV

Q147. PHY

Photoelectron emission depends upon the:

- (A) Intensity of incident light
- (B) Color of the body
- (C) Frequency of incident light
- (D) Shape of the body

Q148. PHY

The direction of induced EMF can be determined by:

- (A) Faraday's law
- (B) Lenz's law
- (C) Galvanometer
- (D) Fleming's right-hand rule

Q149. PHY

Magnetic field lines set up in the surrounding of current carrying wire will be:

- (A) Circular
- (B) Radially outward
- (C) Along the current
- (D) Opposite to current

Q150. PHY

Velocity V of an electron revolving around the nucleus is _____ to the radius r of the orbit.

- (A) Acute angle
- (B) Obtuse angle
- (C) Right angle
- (D) Supplementary angle

Q151. PHY

A stone is dropped from a cliff. The graph (Position or velocity versus time) which best represents motion when it falls:

- (A) curved graph with increasing slope (Position vs. Time)
- (B) A straight-line graph with a positive slope (Velocity vs. Time)
- (C) A straight-line graph with a constant slope (Position vs. Time)
- (D) A curved graph with an increasing slope (Velocity vs. Time)

Q152. PHY

Let five resistors, each of 10 ohm, are connected in parallel and the combination is then connected with a battery of 50V. The current through each resistor will be:

- (A) 5A
- (B) 10A
- (C) 25A
- (D) 50A

Q153. PHY

Let two current carrying wires are placed near a conducting loop such that loop is midway between wires as shown below. If i_1 and i_2 are decreasing at the same rate, induced current in the loop will be:



- (A) Zero
- (B) Clockwise
- (C) Anticlockwise
- (D) Sometimes clockwise, sometimes anticlockwise

Q154. PHY

Gravitational mass of a body is:

- (A) F/a
- (B) Fa
- (C) W/g
- (D) Wg

Q155. PHY

Electrons of mass m and charge e are accelerated through a potential difference V and strike the target. The maximum speed of these electrons is:

- (A) $\sqrt{\frac{e^2}{m}}$
- (B) $\frac{eV}{m}$
- (C) $\frac{eV^2}{m}$
- (D) $\sqrt{\frac{2eV}{m}}$

Q156. PHY

The induced EMF in a 100 turns coil if change in flux through the coil is 2×10^4 Wb in 0.02 sec:

- (A) 1.0 V
- (B) -1.0 V
- (C) 10 V
- (D) 1×10^8 V

Q157. PHY

No current flows between two charged bodies when connected, if they have the same:

- (A) Charge
- (B) Potential
- (C) Capacity
- (D) Density

Q158. PHY

Which of the following is NOT a basic operation of Boolean variables:

- (A) YES operation
- (B) NOT operation
- (C) AND operation
- (D) OR operation

Q159. PHY

Let an electron beam be accelerated by adjustable potential V. If we decrease potential V, the wavelength of the matter wave associated with the electron will:

- (A) increase
- (B) decrease
- (C) remain the same
- (D) sometimes increase sometimes decrease

Q160. PHY

Which of the following methods can be used to vary induced EMF in a coil?

- (A) Alternating magnetic field
- (B) Moving the coil in the magnetic field
- (C) Changing the shape of the coil
- (D) All of the above

Q161. PHY

A dielectric for a capacitor can be: I. polar II. non-polar

- (A) I only
- (B) II only
- (C) both I and II
- (D) neither I nor II

Q162. PHY

A set of coordinate axes in which measurements are made is called

- (A) Cartesian coordinates
- (B) Rectangular coordinates
- (C) Spherical coordinates
- (D) Frame of reference

Q163. PHY

Carnot cycle consists of

- (A) Isothermal steps only
- (B) Adiabatic steps only
- (C) Both adiabatic and isothermal steps
- (D) Neither adiabatic nor isothermal

Q164. PHY

Which of the following set of frequencies can have constructive interference

- (A) 20Hz and 21Hz
- (B) 100Hz and 110Hz
- (C) 1000Hz and 2000Hz
- (D) None of the given options

Q165. PHY

Mass number of an atom represents the number of

- (A) Proton
- (B) Neutron
- (C) Neutron plus proton
- (D) Proton plus electron

Q166. PHY

The potential energy due to gravitational field near the surface of the Earth at a height h is given by

- (A) $\frac{1}{2}mg/h$
- (B) mgh
- (C) mg/h
- (D) gh/m

Q167. PHY

A slow neutron will cause fission in ?

- (A) ^{234}U
- (B) ^{235}U
- (C) ^{236}U
- (D) ^{237}U

Q168. PHY

Sounds wave are not polarized in air because:

- (A) They are longitudinal waves
- (B) They are transverse waves
- (C) They need media for its propagation
- (D) They have shorter wave lengths

Q169. PHY

Which of the following statements is correct: I. nuclear radiation with the least penetrating power has the most ionization power II. nuclear radiation with the most penetrating power has the least ionization power

- (A) I only
- (B) II only
- (C) Both I and II
- (D) neither I nor II

Q170. PHY

A battery has an emf of 6.0V and an internal resistance of 0.4 Ω . It is connected to a 2.6 Ω resistor through a switch. When the switch is open, the potential difference across the switch is:

- (A) 0V
- (B) 6.0 V
- (C) 2.6 V
- (D) 5.2 V

Q171. PHY

Let T be the half-life of a certain radioactive element and N_0 be the number of atoms present in the sample at $t=0$. After time $3T$, what percent of atoms present at $t=0$ will have decayed?

- (A) 12.5%
- (B) 50%
- (C) 87.5%
- (D) 100%

Q172. PHY

If a force of one Newton acts on a body and displaces it through a distance of one meter in the direction of the force then the work done is one:

- (A) Joule
- (B) Dyne
- (C) Erg
- (D) Watt

Q173. PHY

The distance between consecutive crest and trough of water waves is:

- (A) λ
- (B) $\lambda/2$
- (C) $\lambda/4$
- (D) none of these

Q174. PHY

In the photo-electric effect, electrons are emitted on incidence of light upon certain material surfaces:

- (A) Below a certain frequency
- (B) Beyond a certain wavelength
- (C) Above a certain frequency
- (D) None of the given options

Q175. PHY

Electrical measuring instruments convert electrical energy into:

- (A) Chemical
- (B) Mechanical
- (C) Nuclear
- (D) Thermal

Q176. PHY

Let an inductor be connected with a battery. If EMF induced in the inductor opposes the EMF of the battery, then the electric current through the circuit is:

- (A) Decreasing
- (B) Increasing
- (C) Constant
- (D) Alternating

Q177. PHY

A 40kg body starting from rest falls through a vertical distance of 125cm to the ground. The velocity of the body just before it hits the ground is:

- (A) 250 m/s
- (B) $(250)^{1/2}$ m/s
- (C) 25 m/s
- (D) 5 m/s

Q178. PHY

Which of the following believed in absolute time?

- (A) Newton
- (B) Galileo
- (C) Both Newton and Galileo
- (D) Neither Newton nor Galileo

Q179. PHY

If a force of 1N acts upon a body as it moves through a displacement of 0.5 m, at an angle of 60° with the direction of force then the work done W is:

- (A) 0.25 J
- (B) 0.5 J
- (C) 10 J
- (D) 4 J

Q180. PHY

If heat equal to 0.1 J is provided to the gas contained in a cylinder and it expands through 0.1 m^3 at 1 N/m^2 then its internal energy:

- (A) Increases
- (B) Decreases
- (C) Remains the same
- (D) Decreases by 0.1 J

Q181. PHY

Which of the following forces gives rise to ocean tides?

- (A) Frictional force
- (B) Gravitational force
- (C) Earth's magnetic force
- (D) Nuclear force

Q182. PHY

A body of mass m moving in a circle of radius r is executing a uniform circular motion. If the mass of the body is doubled then the centripetal force acting upon the body is:

- (A) Reduced to half
- (B) Remains same
- (C) Doubled
- (D) None of the given options

Q183. PHY

A person's life was saved in a car accident due to airbags system. During that car accident, airbags expanded in front of head of that person. If that car was not equipped with airbags then movement of head would be stopped by windshield in much faster time. Airbags saved life because it:

- (A) Causes much greater force for longer time
- (B) Causes much greater force for smaller time
- (C) Causes much smaller force for longer time
- (D) Causes much smaller force for smaller time

Q184. PHY

The circuit required for change of AC voltage to DC voltage is called:

- (A) Rectifier
- (B) Amplifier
- (C) Detector
- (D) Emitter

Q185. PHY

When placed in light which of the following can generate an output voltage across its electrodes?

- (A) P-N diode
- (B) Light emitting diode
- (C) Photo diode
- (D) All of these

Q186. PHY

Which of the following isotope of hydrogen is unstable?

- (A) H^1
- (B) D^2
- (C) T^3
- (D) All of these

Q187. PHY

A current-carrying conductor of length 'L' and current 'I' is lying at an angle of 90 degrees to the direction of a uniform magnetic field 'B'. If its length L is rotated clockwise through an angle of 90 degrees and current through it is reduced to two-thirds then magnetic force on it becomes:

- (A) 2/3 times
- (B) 1/3 times
- (C) 4/3 times
- (D) Zero

Q188. PHY

Which of the following statements is absolutely correct: I. Forces can stop or make objects move faster II. Forces can change the direction of movement

- (A) I
- (B) II
- (C) Both I and II
- (D) Neither I nor II

Q189. PHY

Compression is that portion of the longitudinal wave where pressure is:

- (A) High
- (B) Low
- (C) Zero
- (D) All of these

Q190. PHY

If the rate of change of current I_p in the primary coil is increased by one half then emf induced in the secondary coil becomes:

- (A) Half
- (B) Double
- (C) 2/3 times
- (D) 3/2 times

Q191. PHY

Which of the following is a vector quantity?

- (A) Electric Flux
- (B) Work done
- (C) Electric Potential Energy
- (D) None of the given options

Q192. PHY

Which of the following condition must be true for transfer of energy from an object at temperature T_1 to another object at temperature T_2 ?

- (A) $T_1 = T_2$
- (B) $T_1 < T_2$
- (C) $T_1 > T_2$
- (D) None of these

Q193. PHY

Resistance is the measure of:

- (A) Current
- (B) Voltage
- (C) Motion of charges
- (D) Opposition to the motion of charges

Q194. PHY

A particle is executing uniform circular motion in a circle of radius 100 mm. If its speed is 10 cm/s then its angular velocity is:

- (A) 10 rad/s
- (B) 0.1 rad/s
- (C) 10 revolutions/s
- (D) None of the given options

LOGIC SECTION: LOGICAL REASONING

Questions 195 to 200 (6 MCQs)

Q195. LOGIC

Statement: The vegetable traders feel that the prices of onion will again go up.

Courses of Action:

I. The Government should purchase and store sufficient quantity of onion in advance to control prices.

II. The Government should make available network of fair price shops for the sale of onions during the period of shortage.

- (A) Only I follows
- (B) Only II follows
- (C) Both I and II follow
- (D) Neither I nor II follows

Q196. LOGIC

Five cities P, Q, R, S and T are connected by different modes of transport as follows:

P and Q are connected by boat as well as by rail

S and R are connected by bus and by boat

Q and T are connected only by air

P and R are connected only by boat

T and R are connected by rail and by bus

Which mode of transport would help one to reach R starting from Q but without changing mode of transport?

- (A) Boat
- (B) Rail
- (C) Bus
- (D) Air

Q197. LOGIC

Statement 1: A is the brother of B.

Statement 2: B is the daughter of C.

Based on these statements, how is A related to C?

- (A) Brother
- (B) Son
- (C) Father
- (D) Daughter

Q198. LOGIC

If the first two statements are true, the third statement is:

I. Maria runs faster than Amna.

II. Laiba runs faster than Maria.

III. Amna runs faster than Laiba.

- (A) True
- (B) False
- (C) Uncertain
- (D) None of these

Q199. LOGIC

Statements:

I. The university authority has instructed all the colleges under its jurisdiction to ban use of all phones inside the college premises.

II. Majority of the teachers of the colleges signed a joint petition to the university complaining the disturbances caused by cell phone ring-tones inside the classrooms.

Which of the following is correct?

- (A) Statement I is the cause and statement II is its effect
- (B) Statement II is the cause and statement I is its effect
- (C) Both statements are independent causes
- (D) Both statements are effects of independent causes

Q200. LOGIC

Statements:

I. Kenya has surpassed the value of tea exports this year due to an increase in demand for quality tea in the Foreign market.

II. There is an increase in demand of coffee in the local market during the last two years.

Which of the following is correct?

- (A) Statement I is the cause and statement II is its effect
- (B) Statement II is the cause and statement I is its effect
- (C) Both statements are independent causes
- (D) Both statements are effects of independent causes

OFFICIAL VERIFIED ANSWER KEY

BUMHS Quetta MDCAT 2024 Official Paper - Rapid Self-Grading Grid

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Q#	KEY	SUB	Q#	KEY	SUB	Q#	KEY	SUB	Q#	KEY	SUB	Q#	KEY	SUB
1	A	ENG	41	A	BIO	81	B	BIO	121	A	CHEM	161	C	PHY
2	C	ENG	42	B	BIO	82	D	BIO	122	B	CHEM	162	D	PHY
3	A	ENG	43	B	BIO	83	B	BIO	123	D	CHEM	163	C	PHY
4	C	ENG	44	B	BIO	84	A	BIO	124	D	CHEM	164	A	PHY
5	D	ENG	45	B	BIO	85	B	BIO	125	B	CHEM	165	C	PHY
6	C	ENG	46	A	BIO	86	A	BIO	126	C	CHEM	166	B	PHY
7	D	ENG	47	B	BIO	87	A	CHEM	127	C	CHEM	167	B	PHY
8	A	ENG	48	B	BIO	88	B	CHEM	128	C	CHEM	168	A	PHY
9	B	ENG	49	C	BIO	89	B	CHEM	129	B	CHEM	169	C	PHY
10	D	ENG	50	B	BIO	90	A	CHEM	130	C	CHEM	170	B	PHY
11	A	ENG	51	A	BIO	91	B	CHEM	131	B	CHEM	171	C	PHY
12	B	ENG	52	B	BIO	92	C	CHEM	132	D	CHEM	172	A	PHY
13	D	ENG	53	C	BIO	93	B	CHEM	133	B	CHEM	173	B	PHY
14	A	ENG	54	C	BIO	94	D	CHEM	134	C	CHEM	174	C	PHY
15	C	ENG	55	A	BIO	95	A	CHEM	135	D	CHEM	175	B	PHY
16	B	ENG	56	A	BIO	96	C	CHEM	136	C	CHEM	176	B	PHY
17	D	ENG	57	B	BIO	97	B	CHEM	137	C	CHEM	177	D	PHY
18	A	ENG	58	D	BIO	98	A	CHEM	138	D	CHEM	178	C	PHY
19	B	BIO	59	B	BIO	99	A	CHEM	139	B	CHEM	179	A	PHY
20	B	BIO	60	A	BIO	100	C	CHEM	140	D	CHEM	180	C	PHY
21	B	BIO	61	A	BIO	101	A	CHEM	141	A	CHEM	181	B	PHY
22	C	BIO	62	D	BIO	102	B	CHEM	142	B	CHEM	182	C	PHY
23	B	BIO	63	A	BIO	103	B	CHEM	143	C	PHY	183	C	PHY
24	D	BIO	64	D	BIO	104	D	CHEM	144	B	PHY	184	A	PHY
25	C	BIO	65	A	BIO	105	B	CHEM	145	A	PHY	185	C	PHY
26	D	BIO	66	B	BIO	106	A	CHEM	146	B	PHY	186	C	PHY
27	B	BIO	67	C	BIO	107	B	CHEM	147	C	PHY	187	D	PHY
28	C	BIO	68	D	BIO	108	C	CHEM	148	B	PHY	188	C	PHY
29	C	BIO	69	D	BIO	109	A	CHEM	149	A	PHY	189	A	PHY
30	B	BIO	70	C	BIO	110	D	CHEM	150	C	PHY	190	D	PHY
31	D	BIO	71	C	BIO	111	C	CHEM	151	B	PHY	191	D	PHY
32	A	BIO	72	A	BIO	112	D	CHEM	152	A	PHY	192	C	PHY
33	C	BIO	73	C	BIO	113	B	CHEM	153	A	PHY	193	D	PHY
34	B	BIO	74	B	BIO	114	D	CHEM	154	C	PHY	194	D	PHY
35	C	BIO	75	A	BIO	115	C	CHEM	155	D	PHY	195	C	LOGIC
36	D	BIO	76	A	BIO	116	A	CHEM	156	D	PHY	196	A	LOGIC
37	C	BIO	77	C	BIO	117	A	CHEM	157	B	PHY	197	B	LOGIC
38	D	BIO	78	D	BIO	118	B	CHEM	158	A	PHY	198	B	LOGIC
39	D	BIO	79	A	BIO	119	C	CHEM	159	A	PHY	199	B	LOGIC
40	D	BIO	80	C	BIO	120	B	CHEM	160	D	PHY	200	D	LOGIC

SUBJECT-WISE PERFORMANCE BREAKDOWN

SUBJECT	MAX	YOUR SCORE	ACCURACY
English	18		----- %
Biology	68		----- %
Chemistry	56		----- %
Physics	52		----- %
Logical Reasoning	6		----- %
TOTAL	200	-----	----- %

PMDC PROVINCIAL MERIT FORMULA

Official Weightage Law:

- MDCAT Component (50%): (Your Score / 200) × 50
- FSc / HSSC Component (40%): (FSc Marks / 1100) × 40
- Matric / SSC Component (10%): (Matric Marks / 1100) × 10

Estimated Provincial Merit Aggregate: ----- %

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1

Key: (A)

ENGLISH

04. Subject-Verb Agreement, Tenses & Conditionals

We are about _____ at the place where we can set up our tents.

CORE CONCEPT & DERIVATION

The semi-auxiliary phrasal structure 'be about to' expresses an event intended or expected to happen in the immediate future.

Formula / Rule / Reaction:

Subject + be + about + to-infinitive (base verb)

Solution:

- The sentence contains the subject 'We' followed by the auxiliary 'are' and adjective 'about'.
- In standard English, 'be about' requires a full infinitive ('to' + base form of the verb) to complete the idiom indicating immediate future action.
- Therefore, 'To arrive' is the grammatically correct completion.

Why other options are incorrect:

- Option B:** 'Arriving' is a present participle; 'about arriving' would function as a preposition with a gerund, which alters the standard idiom of imminent occurrence.
- Option C:** 'Be arriving' lacks the required particle 'to' and forms an ungrammatical double bare verb structure.
- Option D:** 'To have arriving' is an ungrammatical fusion of a perfect infinitive and a present participle.

Question #3

Key: (A)

ENGLISH

04. Subject-Verb Agreement, Tenses & Conditionals

It is common knowledge to anyone who studies science, that the earth _____ on its own axis once...

CORE CONCEPT & DERIVATION

Universal truths, scientific axioms, and habitual physical phenomena are strictly expressed using the simple present tense.

Formula / Rule / Reaction:

Third-person singular subject (the earth) + base verb + -s/-es

Solution:

- The movement of the Earth on its axis is a perpetual scientific fact occurring once every 24 hours.
- The grammatical subject is 'the earth', which is a third-person singular noun requiring a singular verb ending in '-s'.
- Consequently, the simple present singular form 'revolves' is required.

Why other options are incorrect:

- Option B:** 'Revolve' is the plural base form and violates subject-verb agreement with the singular noun 'the earth'.
- Option C:** 'Has revolved' is in the present perfect tense, incorrectly implying a completed action rather than a perpetual scientific reality.
- Option D:** 'Has had revolved' is an ungrammatical, non-existent compound tense construct.

Question #2

Key: (C)

ENGLISH

01. Vocabulary, Synonyms, Antonyms & Spelling

Choose the word which is similar in meaning to REIGN:

CORE CONCEPT & DERIVATION

Vocabulary evaluation requires identifying the exact synonym based on semantic denotation in political and sovereign governance.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The noun/verb 'reign' denotes the exercise of sovereign power or the period during which a monarch governs.
- The verb/noun 'rule' denotes the exercise of authoritative control or governing authority over a state or people.
- Thus, 'Rule' is the exact synonymous match.

Why other options are incorrect:

- Option A:** 'Damp' means slightly wet or moisture-laden, having no semantic relationship to sovereign power.
- Option B:** 'Tussle' signifies a vigorous struggle, fight, or scuffle.
- Option D:** 'Prime' denotes of first importance, primeval, or the best possible stage.

Question #4

Key: (C)

ENGLISH

01. Vocabulary, Synonyms, Antonyms & Spelling

"To abscond" means:

CORE CONCEPT & DERIVATION

Lexical definitions in legal and general registers define 'abscond' as departure in a sudden and secret manner, typically to avoid arrest or prosecution.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The etymology of 'abscond' originates from Latin 'abscondere' (to stow away or hide away).
- In standard English, to abscond means to depart secretly and withdraw into hiding, often to evade legal consequences.
- This corresponds directly to 'To go away secretly and hide'.

Why other options are incorrect:

- Option A:** Absconding refers to the act of the person fleeing, not physical construction of a hiding facility.
- Option B:** Performing an action covertly without fleeing does not meet the definition of abscondence.
- Option D:** Completing tasks early pertains to efficiency or punctuality, entirely unrelated to clandestine flight.

Question #5 Key: (D)ENGLISH
06. Punctuation, Capitalization & Reading Comprehension

There was a surprising story in the newspaper about the _____ car was stolen.

CORE CONCEPT & DERIVATION

Relative clauses denoting possession utilize the relative possessive determiner 'whose', replacing personal possessive adjectives without redundancy.

Formula / Rule / Reaction:

Antecedent (Noun) + whose + possessed noun

Solution:

- The sentence requires a relative clause that connects the antecedent 'man' to the possessed object 'car'.
- The possessive relative pronoun 'whose' correctly stands for 'the man's'.
- Redundant co-occurrence of possessive pronouns (such as 'whose his') is grammatically impermissible.
- Therefore, 'man whose' provides the correct antecedent and relative pronoun.

Why other options are incorrect:

- **Option A:** 'Which' cannot serve as a personal relative pronoun for human antecedents, and the construction with 'his' is redundant.
- **Option B:** 'Whose his' introduces an ungrammatical double possessive redundancy.
- **Option C:** 'That his' incorrectly attempts to replace a possessive relative with a restrictive relative pronoun plus personal pronoun.

Question #6 Key: (C)ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

When I _____ him, Rauf _____ cricket.

CORE CONCEPT & DERIVATION

When a continuous background past action is interrupted by a discrete, single event in the past, the past continuous tense pairs with the simple past tense.

Formula / Rule / Reaction:

When + Simple Past (interruption), Past Continuous (ongoing event)

Solution:

- The ongoing background action in the past was Rauf playing cricket (requires past continuous: 'was playing').
- The interrupting, point-in-time past event was seeing him (requires simple past: 'saw').
- Combining these gives: 'When I saw him, Rauf was playing cricket.'

Why other options are incorrect:

- **Option A:** 'Was, playing' leaves the dependent time clause incomplete without an appropriate main lexical verb.
- **Option B:** 'Is playing' mismatches tenses by pairing a past simple subordinate clause with a present continuous main clause.
- **Option D:** 'Saw, played' depicts two consecutive completed actions rather than an action in progress during an observation.

Question #7 Key: (D)ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

Identify the correct option for this sentence: Many modern architects insist on _____ material...

CORE CONCEPT & DERIVATION

Prepositions in English must govern noun phrases, pronouns, or gerunds (-ing forms), never base form verbs or to-infinitives.

Formula / Rule / Reaction:

Verb + Preposition ('on') + Gerund (verb-ing)

Solution:

- The phrasal verb 'insist on' features the preposition 'on'.
- Any verb directly following a preposition must take the gerund form to serve as the object of that preposition.
- 'Using' is the gerund form that takes 'materials' as its direct object.

Why other options are incorrect:

- **Option A:** 'Use' is a bare infinitive and cannot follow the preposition 'on'.
- **Option B:** 'To use' is an infinitive phrase, which cannot function as the object of the preposition 'on'.
- **Option C:** The use would require a subsequent preposition ('insist on the use of materials') to be grammatically complete.

Question #8 Key: (A)ENGLISH
05. Active-Passive Voice, Reported Speech & Syntax

We are committed to providing excellent customer service, _____ ensuring a positive experience...

CORE CONCEPT & DERIVATION

The adverb 'thereby' introduces a participial result clause indicating that an outcome happens as a direct consequence of the action just stated.

Formula / Rule / Reaction:

Clause+, +thereby + Present Participle (-ing)

Solution:

- The clause 'ensuring a positive experience' is an adverbial participial phrase expressing result.
- 'Thereby' means 'by that means' or 'as a result of that' and characteristically modifies participial phrases without requiring a full finite clause.
- Hence, 'thereby' seamlessly and correctly connects the action to its result.

Why other options are incorrect:

- **Option B:** 'Therefore' is a conjunctive adverb that coordinates finite independent clauses, typically requiring a subject and finite verb ('therefore we ensure').
- **Option C:** 'Because' is a subordinating conjunction requiring a finite subject-verb clause ('because we ensure'), not an isolated participle.
- **Option D:** 'Since' is a causal/temporal conjunction requiring a complete finite subordinate clause.

Question #9 **Key: (B)**ENGLISH
06. Punctuation, Capitalization & Reading Comprehension

Read the following passage to answer the given question: As adults, we may be able to convey our...

CORE CONCEPT & DERIVATION

Reading comprehension requires direct textual inference based solely on explicit statements and contrasts delineated in the prompt.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The passage explicitly contrasts an adult's smile ('a mere twist of the lips') with an infant's smile ('throws much more into the battle... kicks and waves its arms about... leans its trunk forward').
- These descriptions demonstrate that an infant's smile engages broad, vigorous whole-body motor activity compared to an adult.
- Thus, statement B accurately reflects the text.

Why other options are incorrect:

- **Option A:** The passage does not claim babies rarely smile or that their smiles are hard to judge.
- **Option C:** The passage explicitly states that babies produce 'babbling voices' and kinetic movements, refuting the claim that they smile more quietly.
- **Option D:** The passage states babbling occurs concurrently 'when smiling at full intensity', not prior to smiling.

Question #10 **Key: (D)**ENGLISH
03. Parts of Speech, Prepositions & Modifiers

Use an appropriate article: Danube is _____ Austria's longest river.

CORE CONCEPT & DERIVATION

In English grammar, a noun phrase modified by a possessive noun phrase (genitive determiners like 'Austria's') cannot simultaneously take a definite or indefinite article.

Formula / Rule / Reaction:

Subject + be + $\emptyset$ + Possessive Noun ('s) + Superlative + Noun

Solution:

- The blank directly precedes the possessive noun 'Austria's'.
- A possessive determiner fully specifies the reference of the noun phrase 'longest river'.
- Preceding a possessive determiner with an article ('the Austria's' or 'a Austria's') is ungrammatical; zero article (No Article) is strictly required.

Why other options are incorrect:

- **Option A:** 'A' cannot precede a genitive determiner and violates phonetic rules when preceding a vowel sound.
- **Option B:** 'An' cannot co-occur with a possessive determiner in standard English determiner syntax.
- **Option C:** 'The' cannot immediately precede 'Austria's longest river' because double determination in noun phrases is syntactically invalid.

Question #11 **Key: (A)**ENGLISH
03. Parts of Speech, Prepositions & Modifiers

Fill in the blank with appropriate preposition: He isn't good _____ French.

CORE CONCEPT & DERIVATION

The adjective 'good' takes specific dependent prepositions: 'good at' indicates competence, skill, or proficiency in a domain, discipline, or language.

Formula / Rule / Reaction:

To be + good + at + Noun/Discipline

Solution:

- When referencing proficiency or academic/linguistic performance, English uses the idiomatic collocation 'good at'.
- Therefore, 'He isn't good at French' is the standard grammatical construction.

Why other options are incorrect:

- **Option B:** 'In' is used with participation or health states, not with the adjective 'good' to denote competence in a subject.
- **Option C:** 'Good to' expresses kindness or benevolence directed toward a recipient (e.g., 'He was good to me').
- **Option D:** 'Good of' is used in evaluations of an action (e.g., 'It was good of you to come').

Question #12 **Key: (B)**ENGLISH
03. Parts of Speech, Prepositions & Modifiers

Romans _____ a unique system of the Roman alphabet.

CORE CONCEPT & DERIVATION

Verb selection requires choosing the term that accurately denotes the historical creation, evolution, and systematization of an orthographic script.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The historical act of bringing a structured writing system into an established form over time is denoted by the verb 'develop'.
- 'Developed' conveys the deliberate creation and refinement of the Roman alphabet system.

Why other options are incorrect:

- **Option A:** 'Improved' implies merely enhancing an already finished system rather than generating the specific system identified.
- **Option C:** 'Persuaded' means convinced someone to do something, which cannot govern an inanimate orthographic system.
- **Option D:** 'Exchanged' implies trading one object for another, failing to describe system origination.

Question #13 **Key: (D)**ENGLISH
06. Punctuation, Capitalization & Reading Comprehension

Read the following passage to answer the given question: All walked in from a world of darkness...

CORE CONCEPT & DERIVATION

Metaphorical expressions in expository texts must be interpreted in direct conjunction with the explicit appositive explanations provided by the author.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The clause 'All walked in from a world of darkness and left in the fullness of light' is directly defined by the appositive phrase: 'blind or partially blind patients who received the gift of sight through cornea transplants'.
- This identifies the subjects as patients with impaired vision who sought and received surgical cornea transplants.

Why other options are incorrect:

- Option A:** 'World of darkness' is a metaphor for corneal blindness, not a geographical or environmental region.
- Option B:** 'Gift of sight' is a figurative idiom for restored vision, not a material present or souvenir.
- Option C:** The patients were blind or partially blind upon entry, not individuals with healthy vision.

Question #14 **Key: (A)**ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

Identify the correct option for this sentence: Unless a student _____ with the university regu...

CORE CONCEPT & DERIVATION

In first conditional sentences introduced by 'unless' (meaning 'if not'), the subordinate conditional clause takes the simple present tense to describe future potential conditions.

Formula / Rule / Reaction:

Unless + Present Simple (Subject + Verb-s), Subject + modal (can/will) + base verb

Solution:

- The main clause contains the modal present potential 'he can be removed'.
- The subordinate condition is introduced by 'Unless', requiring the simple present tense.
- Since the subject 'a student' is third-person singular, the verb takes the '-s/-es' inflected form: 'complies'.

Why other options are incorrect:

- Option B:** 'Complied' is simple past, creating an improper mixed-tense conditional with the present modal 'can'.
- Option C:** 'Had complied' is past perfect, which is reserved for third conditional constructions with 'would have'.
- Option D:** 'Will comply' violates the rule that conditional time clauses cannot take modal future markers ('will').

Question #15 **Key: (C)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

Antonym of HEGEMONY is:

CORE CONCEPT & DERIVATION

Antonyms require identifying the precise conceptual opposite of a term's core semantic denotation.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- 'Hegemony' denotes leadership, political dominance, paramount authority, or supreme influence exerted by one group or nation over others.
- The direct polar opposite of authoritative dominance and supremacy is the absence or 'Lack of authority'.

Why other options are incorrect:

- Option A:** 'Lack of energy' defines lethargy or fatigue, not the absence of sociopolitical dominance.
- Option B:** 'Lack of precision' defines vagueness or inaccuracy.
- Option D:** 'Lack of confidence' defines insecurity or diffidence.

Question #16 **Key: (B)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

What is the opposite of CHAOTIC:

CORE CONCEPT & DERIVATION

Antonym determination involves isolating the lexical polar opposite of entropy, disarray, and disorder.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- 'Chaotic' describes a state of total confusion, lack of organization, and complete disorder.
- 'Orderly' describes a state characterized by neat, methodical arrangement, discipline, and systematic organization.
- Thus, 'Orderly' is the direct antonym of 'Chaotic'.

Why other options are incorrect:

- Option A:** 'Immersive' denotes deeply engaging or generating full absorption within an environment.
- Option C:** 'Hectic' is characterized by intense agitation, frantic pace, and confusion, acting as a near-synonym to chaotic.
- Option D:** 'Steady' denotes fixed, constant, or stable in motion, which is less precise than 'orderly' as an antonym to chaos.

Question #17 Key: (D)ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

Under ethical guidelines recently adopted by the National Institutes of Health, human genes are...

CORE CONCEPT & DERIVATION

Contextual sentence completion relies on identifying the modifier that accurately reflects medical policy and ethical stringency regarding experimental interventions.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Bioethical standards permit invasive or novel genetic manipulation only when other non-genetic or existing standard medical modalities ('alternative treatments') prove ineffective or unsatisfactory.
- 'Alternative' functions as the precise adjective indicating other available forms of therapeutic intervention.

Why other options are incorrect:

- **Option A:** 'Similar treatments' implies treatments identical to gene manipulation, which contradicts the rationale of gene therapy as a distinct modality.
- **Option B:** 'Most treatments' creates an imprecise and grammatically awkward construction in this restrictive context.
- **Option C:** 'Dangerous treatments' improperly limits the clause, as non-dangerous but ineffective treatments also justify novel interventions.

Question #18 Key: (A)ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

Identify the correct option for this sentence: If _____ the match, I will go to Lahore to meet...

CORE CONCEPT & DERIVATION

First conditional sentences dictate that the conditional 'if' clause must employ the simple present tense to represent a real future contingency.

Formula / Rule / Reaction:

If + Simple Present (Subject + base verb), Subject + will + base verb

Solution:

- The apodosis (main clause) features future certainty: 'I will go'.
- The protasis (conditional clause) requires a simple present verb structure.
- With the first-person singular subject 'I', the bare base form 'win' is syntactically correct: 'If I win'.

Why other options are incorrect:

- **Option B:** 'I will win' improperly inserts the modal auxiliary 'will' into an 'if' clause.
- **Option C:** 'I shall win' similarly violates conditional syntax by inserting modal futurity into the condition.
- **Option D:** 'I wins' commits a subject-verb agreement error, as the first-person pronoun 'I' never takes an inflected '-s' verb.

Question #19 Key: (B)BIOLOGY
01. Cell

The soluble shield of macromolecules that surrounds bacteria is called:

CORE CONCEPT & DERIVATION

Bacteria secrete extracellular polysaccharide or polypeptide matrices (glycocalyx). When this protective layer is loose, soluble, and easily washed off, it is termed a slime layer.

Formula / Rule / Reaction:

Glycocalyx = $\begin{cases} \text{Capsule} & (\text{dense, rigid, organized}) \\ \text{Slime layer} & (\text{diffuse, soluble, loosely bound}) \end{cases}$

Solution:

- The bacterial glycocalyx exists in two specialized formats: capsule and slime.
- A capsule is thick, organized, and tightly attached to the cell wall.
- In contrast, slime is a diffuse, loose, soluble shield of macromolecules that provides adherence and shields against desiccation.

Why other options are incorrect:

- **Option A:** Pili are hollow, non-helical filamentous protein appendages primarily involved in conjugation and attachment.
- **Option C:** Capsule consists of tightly organized, insoluble, dense material bonded firmly to the cell wall.
- **Option D:** Flagella are long, helical proteinaceous structures composed of flagellin that function exclusively as motility organelles.

Question #20 Key: (B)BIOLOGY
01. Cell

The following form of circular double-stranded, self-replicating DNA molecules present in many...

CORE CONCEPT & DERIVATION

Bacterial genomes possess an extrachromosomal hereditary element known as a plasmid, which replicates independently of chromosomal DNA.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Plasmids are small, circular, covalently closed, double-stranded DNA molecules found in bacterial cytoplasm.
- They possess autonomous origins of replication (replicons) and replicate independently of the primary chromosome.
- They are dispensable for basic cell growth and metabolism, but provide selective advantages such as antibiotic resistance (R-factors) and toxin production.

Why other options are incorrect:

- **Option A:** The nucleoid contains the primary, essential bacterial chromosome required for survival and baseline metabolism.
- **Option C:** Mesosomes are invaginations of the bacterial plasma membrane, not DNA molecules.
- **Option D:** The nuclear region is synonymous with the nucleoid, containing essential genomic DNA.

Question #21 Key: (B)BIOLOGY
04. Bioenergetics

Most fungi are:

CORE CONCEPT & DERIVATION

Members of the kingdom Fungi completely lack chlorophyll and chloroplasts; they are exclusively heterotrophic, obtaining carbon and energy by absorption.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Fungi lack photosynthetic pigments and cannot synthesize organic molecules from inorganic precursors.
- They are absorptive heterotrophs (osmoheterotrophs) that secrete exoenzymes into their surroundings to digest macromolecules and absorb the resulting soluble units.
- Consequently, all fungi are heterotrophs (saprotrophic, parasitic, or mutualistic).

Why other options are incorrect:

- Option A:** Fungi cannot fix carbon dioxide through chemosynthesis or photosynthesis; they are never autotrophs.
- Option C:** Fungi lack thylakoid membranes and chlorophyll, making photosynthesis impossible.
- Option D:** Since options A and C are false, this option is invalid.

Question #22 Key: (C)BIOLOGY
14. Reproduction

The life cycle during alternation of generation has the following feature:

CORE CONCEPT & DERIVATION

The plant life cycle exhibits sporic meiosis (diplohaplontic cycle), where a diploid sporophyte alternates with a haploid gametophyte.

Formula / Rule / Reaction:**Solution:**

- The diploid sporophyte generation contains specialized spore mother cells (sporocytes).
- These sporocytes undergo meiotic reduction division to generate haploid meiospores.
- The haploid spores subsequently germinate by mitosis to form the gametophyte generation.

Why other options are incorrect:

- Option A:** The diploid zygote undergoes mitosis (not meiosis) to develop into the multicellular diploid sporophyte.
- Option B:** The zygote develops into the diploid sporophyte, not the haploid gametophyte.
- Option D:** The haploid gametophyte produces haploid (not diploid) gametes via mitosis.

Question #23 Key: (B)BIOLOGY
10. Homeostasis

During high temperatures, plants usually remain cool by the loss of water from their bodies thr...

CORE CONCEPT & DERIVATION

Evaporation of water molecules from plant foliage absorbs substantial latent heat of vaporization, producing an evaporative cooling effect.

Formula / Rule / Reaction:

$$\Delta H_{\text{vap}} \approx 2.26 \times 10^6 \text{ J/kg} \quad (\text{at } 100^\circ\text{C})$$

Solution:

- Transpiration is the loss of water vapor from the aerial surfaces of plants, predominantly through stomatal pores.
- Because water possesses a high heat of vaporization, the phase transition from liquid water to water vapor absorbs thermal energy from the leaf tissue, lowering the plant's internal temperature.

Why other options are incorrect:

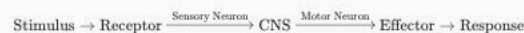
- Option A:** Guttation is the exudation of liquid water droplets via hydathodes caused by root pressure; it does not involve evaporative cooling.
- Option C:** Photosynthesis is a chemical synthesis process, not an evaporative cooling mechanism.
- Option D:** Osmosis is the passive diffusion of solvent across a semipermeable membrane down a water potential gradient, not a surface thermal regulation mechanism.

Question #24 Key: (D)BIOLOGY
12. Nervous Coordination

What is/are the element(s) of the nervous system that help in nervous coordination?

CORE CONCEPT & DERIVATION

Nervous coordination requires a functional arc comprising detection units, communication networks, and response organs.

Formula / Rule / Reaction:**Solution:**

- Receptors are specialized cells or sensory organs that detect internal or external environmental changes (stimuli).
- Neurons (sensory, associative, and motor) generate and transmit electrochemical nerve impulses.
- Effectors (muscles and glands) carry out physical movements or biochemical secretions to respond to the stimuli.
- All three components work together to achieve coordinated nervous control.

Why other options are incorrect:

- Option A:** Neurons represent only the transmission and processing network; coordination cannot proceed without detection and execution.
- Option B:** Receptors only gather sensory information and cannot transmit signals across the body alone.
- Option C:** Effectors simply execute instructions; they rely on receptors and neurons for incoming signals.

Question #25 Key: (C)BIOLOGY
08. Immunity

The _____ system aids in defending the human body against foreign invaders.

CORE CONCEPT & DERIVATION

The lymphatic system houses key elements of adaptive and innate immunity, including lymphocytes, lymphoid tissues, and filtration mechanisms that eliminate pathogens.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The lymphatic system consists of lymph fluid, lymphatic vessels, lymph nodes, the spleen, and the thymus.
- Lymph nodes contain macrophages and dendritic cells that filter out foreign pathogens, while providing sites where B and T lymphocytes encounter antigens.
- This system provides targeted immune defense against circulating foreign invaders.

Why other options are incorrect:

- **Option A:** The reproductive system is organized for gametogenesis, fertilization, and supporting embryonic development, not systemic immunity.
- **Option B:** The digestive system functions primarily in nutrient ingestion, mechanical breakdown, chemical digestion, and absorption.
- **Option D:** Since the reproductive system does not have systemic immune defense as its primary role, 'All of the given options' is incorrect.

Question #26 Key: (D)BIOLOGY
03. Enzymes

Which of the following is / are the characteristics of the enzymes?

CORE CONCEPT & DERIVATION

Enzymes are biological catalysts that increase reaction rates by lowering the activation energy barrier without being permanently consumed.

Formula / Rule / Reaction:

$$\text{Rate} \propto [\text{Substrate}] \quad (\text{at } [S] \ll K_m); \quad \Delta G_{\text{catalyzed}}^{\ddagger} < \Delta G_{\text{uncatalyzed}}^{\ddagger}$$

Solution:

- Protein enzymes adopt compact, water-soluble, three-dimensional globular conformations.
- They lower the activation energy ($\Delta G^{\ddagger}$) by stabilizing the transition state.
- Enzymatic reaction rates vary proportionally with substrate concentration at levels below saturation, making them sensitive to substrate fluctuations.
- Thus, all listed properties correctly describe enzymes.

Why other options are incorrect:

- **Option A:** While true in standard textbook definitions, selecting only A neglects the equally correct kinetic and energetic properties described in B and C.
- **Option B:** Lowering activation energy is accurate, but selecting it alone ignores options A and C.
- **Option C:** Substrate sensitivity is a recognized kinetic property, but it is not the only valid option listed.

Question #27 Key: (B)BIOLOGY
02. Biomolecules

The first step of the central dogma is the transfer of information from:

CORE CONCEPT & DERIVATION

The central dogma of molecular biology defines the directional flow of genetic information: DNA is transcribed into messenger RNA, which is then translated into a functional polypeptide.

Formula / Rule / Reaction:**Solution:**

- The initial step of genetic readout is transcription.
- During transcription, RNA polymerase utilizes the antisense strand of DNA as a template to synthesize complementary messenger RNA (mRNA).
- This step transfers genetic information directly from DNA to mRNA.

Why other options are incorrect:

- **Option A:** DNA to protein encompasses the entire pathway (transcription plus translation) rather than the first step alone.
- **Option C:** RNA to protein represents translation, which is the second step of the central dogma.
- **Option D:** Transfer of coding information to tRNA does not represent mRNA transcription, which directs protein synthesis.

Question #28 Key: (C)BIOLOGY
11. Support & Movement

_____ is a type of connective tissue.

CORE CONCEPT & DERIVATION

Connective tissues develop from embryonic mesenchyme and are characterized by cells suspended within an extracellular matrix containing collagen or elastic fibers.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- A ligament is a classic example of dense regular connective tissue, consisting of parallel bundles of collagen fibers that join bones together at joints.
- While bone is an osseous tissue, 'Jaw bone' represents an entire anatomical skeletal organ rather than a pure primary tissue classification.
- Therefore, 'Ligament' is the most accurate tissue-level answer.

Why other options are incorrect:

- **Option A:** Nails are epidermal appendages composed of dead, stratified squamous keratinized epithelial cells.
- **Option B:** Hair is formed from non-living, keratinized epithelial cells produced by epidermal follicles.
- **Option D:** The jaw bone is an organ consisting of bone tissue, marrow, nervous tissue, and blood vessels, rather than a primary tissue classification.

Question #29 Key: (C)BIOLOGY
03. Enzymes

The detachable _____ is called as an activator, if it is an inorganic ion.

CORE CONCEPT & DERIVATION

A non-protein chemical component required for an enzyme's biological activity is known as a cofactor. When an easily detachable cofactor is an inorganic ion, it is called an enzyme activator.

Formula / Rule / Reaction:

Holoenzyme = Apoenzyme (protein) + Cofactor (inorganic activator / organic coenzyme)

Solution:

- Enzyme cofactors can be divided into organic molecules (coenzymes or prosthetic groups) and inorganic ions.
- When an inorganic metal ion (such as Mg^{2+} , Fe^{2+} , or Zn^{2+}) reversibly binds to an apoenzyme to facilitate catalytic function, it is termed an activator.
- Thus, the detachable entity in this question is a cofactor.

Why other options are incorrect:

- Option A:** A substrate is the specific reactant molecule acted upon by an enzyme, not a catalytic helper factor.
- Option B:** A product is the molecular species formed at the conclusion of the enzymatic reaction.
- Option D:** Option C accurately describes the required term, making 'None of these' incorrect.

Question #30 Key: (B)BIOLOGY
01. Cell

Highly condensed proteins of chromatin are called:

CORE CONCEPT & DERIVATION

Nuclear chromatin is structurally organized into distinct domains: loosely coiled, transcriptionally active euchromatin, and densely packed, transcriptionally inactive heterochromatin.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Heterochromatin remains tightly compacted throughout the cell cycle, staining deeply with basic nuclear dyes during interphase.
- Because its nucleosomes are tightly packed, heterochromatin is largely inaccessible to RNA polymerases and remains transcriptionally silent.

Why other options are incorrect:

- Option A:** 'Homochromatin' is a non-standard term not recognized in cytogenetics.
- Option C:** 'Semi-heterochromatin' is a non-existent biological classification.
- Option D:** 'Semi-homochromatin' is an entirely fabricated term.

Question #31 Key: (D)BIOLOGY
02. Biomolecules

Hemoglobin has the following characteristics, except:

CORE CONCEPT & DERIVATION

Hemoglobin is an erythrocytic tetrameric metalloprotein. While its catabolic breakdown produces bile pigments, intact hemoglobin is not itself a component of bile.

Formula / Rule / Reaction:

Hemoglobin $\xrightarrow{\text{Macrophage clearance}}$ Globin + Iron + Biliverdin $\rightarrow$ Bilirubin (Bile pigment)

Solution:

- Hemoglobin contains four heme rings, each with a central Fe^{2+} ion, giving blood its characteristic red color and allowing reversible binding of O_2 .
- Bile pigments (bilirubin and biliverdin) are breakdown products of the protoporphyrin ring of heme, synthesized in the liver and reticuloendothelial system.
- Intact hemoglobin itself is not a constituent of normal bile pigment.

Why other options are incorrect:

- Option A:** Oxygenated and deoxygenated heme groups absorb light such that they give erythrocytes and blood their red color.
- Option B:** Each hemoglobin molecule binds up to four molecules of O_2 in a cooperative manner.
- Option C:** Hemoglobin contains four iron atoms in the ferrous (Fe^{2+}) oxidation state.

Question #32 Key: (A)BIOLOGY
16. Evolution

The hereditary material is:

CORE CONCEPT & DERIVATION

Experiments by Avery-MacLeod-McCarty (1944) and Hershey-Chase (1952) proved that deoxyribonucleic acid (DNA), not protein, is the universal vehicle for genetic inheritance in cellular organisms.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- DNA stores the nucleotide sequences that encode all heritable biological traits.
- Proteins provide structural and enzymatic support, but they do not function as the chemical vehicle of inheritance.
- Therefore, DNA alone is the hereditary material.

Why other options are incorrect:

- Option B:** Historical models proposed proteins as genetic carriers due to their amino acid diversity, but this hypothesis was disproven by the Hershey-Chase blender experiment.
- Option C:** While chromatin contains both DNA and histone proteins, the genetic information is carried exclusively by the DNA sequence.
- Option D:** DNA is the established hereditary material, making this statement incorrect.

Question #33 Key: (C)BIOLOGY
16. Evolution

In artificial selection, we develop desired characteristics in _____ offspring to create from ...

CORE CONCEPT & DERIVATION

Artificial selection involves selective breeding by humans over successive generations to fix desired morphological or physiological traits, giving rise to distinct agricultural and domestic varieties.

Formula / Rule / Reaction:

Wild Ancestral Stock + Selective Breeding $\xrightarrow{\text{Generations}}$ New Breeds / Cultivars

Solution:

- Artificial selection identifies specific variants within a population and selectively breeds them.
- Over generations, this process isolates desired phenotypic traits to generate distinct breeds of animals or cultivars/varieties of plants.
- Hence, the primary objective is producing 'New breeds'.

Why other options are incorrect:

- Option A:** Artificial selection works across both sexes, not for the sole purpose of producing males.
- Option B:** The process is not designed merely to produce individual females.
- Option D:** Artificial selection modifies existing phenotypes and genotypes; it does not construct novel anatomical organs.

Question #34 Key: (B)BIOLOGY
02. Biomolecules

There are types of reduction used for treating bone fractures.

CORE CONCEPT & DERIVATION

Orthopedic fracture reduction realigns displaced bone ends. Clinical standards identify three main approaches: closed reduction, open reduction, and traction reduction.

Formula / Rule / Reaction:

Fracture Reduction Methods = $\begin{cases} 1. \text{ Closed Reduction} \\ 2. \text{ Open Reduction} \\ 3. \text{ Traction} \end{cases}$

Solution:

- Closed reduction: Manual manipulation of bone fragments back into position without surgical incisions.
- Open reduction: Surgical realignment of fragments, often accompanied by internal fixation using pins, screws, or plates.
- Traction: Application of sustained pulling force along the limb's mechanical axis to gradually align fragments.
- This establishes three recognized clinical types of fracture reduction.

Why other options are incorrect:

- Option A:** Classifying only closed and open reduction overlooks traction as a recognized clinical reduction technique.
- Option C:** Four is not a standard primary classification for reduction in medical curricula.
- Option D:** Five exceeds the recognized main types of fracture reduction.

Question #35 Key: (C)BIOLOGY
05. Acellular Life

The conversion of lysogenic cycle to lytic cycle is called:

CORE CONCEPT & DERIVATION

Under physiological stress, a dormant prophage can excise itself from the bacterial host chromosome and switch to active viral replication and host lysis.

Formula / Rule / Reaction:

Prophage (Lysogeny) $\xrightarrow{\text{Induction (UV/Mitomycin C)}}$ Lytic Cycle (Synthesis, Assembly, Lysis)

Solution:

- In the lysogenic cycle, temperate phage DNA integrates into the host bacterial chromosome as a prophage.
- Exposure to environmental stressors (such as ultraviolet light or DNA-damaging agents) activates the host SOS response, cleaving the phage repressor protein.
- This causes the prophage to excise from the host genome and enter the lytic cycle, a process known as induction.

Why other options are incorrect:

- Option A:** Conduction refers to thermal or electrical transmission, not prophage excision.
- Option B:** Production is a generic term that does not describe the specific regulatory switch of a phage.
- Option D:** Induction is the correct biological term, making this option invalid.

Question #36 Key: (D)BIOLOGY
11. Support & Movement

Movement can be lost in the _____ due to Sciatica.

CORE CONCEPT & DERIVATION

The sciatic nerve is the largest peripheral nerve in the human body, arising from the lumbosacral plexus (L4–S3) to provide motor and sensory innervation to the lower extremity.

Formula / Rule / Reaction:

Sciatic Nerve $\rightarrow$ Tibial and Common Fibular Branches $\rightarrow$ Motor innervation to foot/ankle

Solution:

- Sciatica results from compression, herniation, or irritation of the nerve roots forming the sciatic nerve.
- Its motor branches innervate the hamstring muscles and, via the common fibular (peroneal) and tibial nerves, control the muscles of the lower leg, ankle, and foot.
- Severe sciatic neuropathy often causes foot drop, which is a loss of motor control over dorsiflexion and plantarflexion in the foot and ankle.

Why other options are incorrect:

- Option A:** The neck is innervated by the cervical plexus (C1–C4) and cranial nerves, which are completely independent of the sciatic nerve.
- Option B:** Hand toes is an anatomically invalid description; hand digits are innervated by median, ulnar, and radial nerves.
- Option C:** The hand and arm are innervated by the brachial plexus (C5–T1), with no connection to the sciatic nerve.

Question #37 **Key: (C)**BIOLOGY
01: Cell*Endomycorrhizae may enter the outer cells of the plant root and cause***CORE CONCEPT & DERIVATION**

Endomycorrhizal fungi penetrate the cortical cells of host roots, forming specialized intracellular structures (vesicles and arbuscules).

Formula / Rule / Reaction:

Endomycorrhizae → Cortical Penetration → { Arbuscules (minute tree-like branching)
Vesicles (swollen lipid storage structures)

Solution:

- Endomycorrhizae (arbuscular mycorrhizae) cross the root cell wall into the cortical space.
- They form arbuscules, which are finely branched structures used for nutrient exchange with the host plant.
- They also produce vesicles, which are swollen, oval structures used for nutrient and lipid storage.
- Therefore, endomycorrhizae induce both swelling and minute branching within root cortical cells.

Why other options are incorrect:

- **Option A:** Swelling describes vesicular development, but choosing only A omits the equally characteristic branching of arbuscules.
- **Option B:** Minute branching describes arbuscule formation, but choosing only B omits vesicle-associated swelling.
- **Option D:** Both structures occur in endomycorrhizae, making this option incorrect.

Question #38 **Key: (D)**BIOLOGY
02: Biomolecules*Water contributes _____% of total mammalian cell weight***CORE CONCEPT & DERIVATION**

Water serves as the primary biological solvent, making up roughly 70% of total protoplasmic mass in mammalian cells.

Formula / Rule / Reaction:

Mammalian Cell Composition (by mass) : Water ≈ 70%, Protein ≈ 15%, Lipids ≈ 2-3%

Solution:

- Water accounts for approximately 70% of total mammalian cell weight.
- This high water content provides the aqueous medium required for metabolic reactions, solute transport, and enzymatic conformations.

Why other options are incorrect:

- **Option A:** 40% represents a dehydrated physiological state; this is far below the baseline water content of mammalian cells.
- **Option B:** 50% underestimates intracellular water content and is more comparable to whole-body fat tissue hydration.
- **Option C:** 60% corresponds roughly to total body water as a percentage of total adult human body mass, but the cellular protoplasmic concentration specifically reaches 70%.

Question #39 **Key: (D)**BIOLOGY
14: Reproduction*Which of the following is not true regarding the phenomenon of aging?***CORE CONCEPT & DERIVATION**

Aging (senescence) is characterized by a gradual, progressive decline in physiological homeostasis, DNA repair efficiency, and immune responsiveness to environmental stressors.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- A hallmark of aging is the gradual loss of cellular repair mechanisms and immune function (immunosenescence).
- Consequently, an organism's resistance to environmental stress, pathogens, and physical trauma progressively declines with age.
- The claim that resistance 'remains the same throughout life' is scientifically incorrect, making it the correct answer to this 'not true' question.

Why other options are incorrect:

- **Option A:** Mitosis is indeed the cellular basis for organismal growth and tissue repair.
- **Option B:** Stem cell lineages proliferate and subsequently undergo terminal differentiation to establish specialized functional tissues.
- **Option C:** Following peak physiological performance, senescent cells accumulate damage and experience structural and functional deterioration.

Question #40 **Key: (D)**BIOLOGY
08: Immunity*Symptoms of Hepatitis are:***CORE CONCEPT & DERIVATION**

Hepatitis is defined as inflammation of the liver parenchyma, typically presenting with jaundice, fatigue, hepatomegaly, anorexia, and elevated transaminases.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Classic symptoms of acute and chronic hepatitis include jaundice (hyperbilirubinemia), dark urine, abdominal pain, nausea, and fever.
- Loss of adaptive immunity and depletion of CD4+ T helper cells are hallmark signs of HIV/AIDS, not hepatitis.
- Blood cancer refers to leukemias and lymphomas, which are distinct neoplastic disorders of hematopoietic origin.
- Because none of the listed choices describe the characteristic symptoms of hepatitis, 'None of the given options' is correct.

Why other options are incorrect:

- **Option A:** Severe loss of systemic adaptive immunity describes severe immunodeficiency syndromes, not uncomplicated viral hepatitis.
- **Option B:** Depletion of CD4+ T helper cells specifically characterizes the pathogenesis of Human Immunodeficiency Virus (HIV).
- **Option C:** Blood cancer (leukemia) is a hematologic malignancy, whereas chronic hepatitis predisposes primarily to hepatocellular carcinoma.

Question #41 Key: (A)BIOLOGY
16. Evolution

Hemichordata belongs to:

CORE CONCEPT & DERIVATION

Bilateral animals are divided into protostomes and deuterostomes based on embryonic development characteristics such as blastopore fate, cleavage patterns, and coelom origin.

Formula / Rule / Reaction:

$$\text{Deuterostomes} = \text{Phylum Echinodermata} + \text{Phylum Hemichordata} + \text{Phylum Chordata}$$
Solution:

- Hemichordates share key embryonic features with echinoderms and chordates: the blastopore develops into the anus, cleavage is radial and indeterminate, and the coelom forms via enterocoely.
- These embryological features place Hemichordata in the lineage Deuterostomia.

Why other options are incorrect:

- Option B:** Protostomes (e.g., Annelida, Arthropoda, Mollusca) undergo spiral, determinate cleavage, and the blastopore becomes the mouth.
- Option C:** An animal phylum follows either protostome or deuterostome embryonic development; it cannot belong to both simultaneously.
- Option D:** Hemichordata is a recognized deuterostome phylum, making this option incorrect.

Question #42 Key: (B)BIOLOGY
06. Digestion/Nutrition

Which one of the following is not an enzyme?

CORE CONCEPT & DERIVATION

Proteins perform distinct biological roles: enzymes serve as biochemical catalysts, whereas peptide hormones act as endocrine signaling molecules.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Insulin is a two-chain peptide hormone produced by the beta cells of pancreatic islets of Langerhans that regulates glucose homeostasis.
- Because it functions as an endocrine signaling ligand rather than an enzymatic catalyst, insulin is not an enzyme.

Why other options are incorrect:

- Option A:** Pepsin is an endopeptidase enzyme secreted by gastric chief cells to hydrolyze peptide bonds.
- Option C:** Sucrase is an enzyme of the intestinal brush border that hydrolyzes sucrose into glucose and fructose.
- Option D:** Catalase is an antioxidant enzyme found in peroxisomes that decomposes hydrogen peroxide into water and oxygen.

Question #43 Key: (B)BIOLOGY
15. Inheritance / Variation & Genetics

Which of the following is not true regarding the Dihybrid cross breeding as observed in experim...

CORE CONCEPT & DERIVATION

Mendel's Law of Independent Assortment establishes that unlinked allelic pairs segregate independently during gametogenesis, generating non-parental recombinant phenotypes.

Formula / Rule / Reaction:

$$F_2 \text{ Phenotypic Ratio} = 9 [\text{Both Dominant}] : 3 [\text{Dom/Rec}] : 3 [\text{Rec/Dom}] : 1 [\text{Both Recessive}]$$
Solution:

- In a dihybrid cross of seed shape and seed color (e.g., RrYy), alleles sort independently onto separate gametes.
- This produces recombinant gametic combinations (rY and Ry) alongside parental types (RY and ry).
- The claim that alleles for different traits 'always stay together' contradicts independent assortment, making it the incorrect statement.

Why other options are incorrect:

- Option A:** Recombination yields novel non-parental phenotypes (round green and wrinkled yellow), producing plants that differ from the parental phenotypes.
- Option C:** Classical dihybrid crosses involving genes on separate chromosomes demonstrate Mendel's Law of Independent Assortment.
- Option D:** In the F1 generation, heterozygous individuals (RrYy) express both dominant phenotypes (round yellow seeds).

Question #44 Key: (B)BIOLOGY
16. Evolution

In binomial nomenclature, the first name refers to the:

CORE CONCEPT & DERIVATION

The Linnaean system of binomial nomenclature identifies every biological organism using a two-part Latinized name.

Formula / Rule / Reaction:

$$\text{Scientific Name} = \text{Genus (Capitalized, Italicized)} + \text{species epithet (lowercase, Italicized)}$$
Solution:

- In binomial nomenclature (established by Carl Linnaeus), the first term designates the Genus to which the organism belongs.
- The second term specifies the species epithet within that genus.
- The genus name is always capitalized and italicized (e.g., *Homo sapiens*).

Why other options are incorrect:

- Option A:** The species designation is the second, uncapitalized component of the binomial name.
- Option C:** Family is a higher taxonomic rank that does not appear in a species' binomial name.
- Option D:** Order is an even broader taxonomic rank and is not part of the standard binomial designation.

Question #45 Key: (B)BIOLOGY
06. Digestion/Nutrition

The vital functions of the colon are the following:

CORE CONCEPT & DERIVATION

The large intestine (colon) receives unabsorbed chyme from the ileum, primarily absorbing remaining water and inorganic electrolytes to compact the waste into solid feces.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The primary physiological function of the human colon is the reabsorption of water, sodium, and other electrolytes from indigestible digestive residue.
- This fluid reclamation (up to 90% of entering fluid) prevents dehydration and converts liquid chyme into semisolid feces.

Why other options are incorrect:

- **Option A:** The rectum acts as the primary reservoir for storing feces prior to defecation, while the colon's main physiological task is reabsorption.
- **Option C:** Vitamin synthesis (such as vitamin K and biotin) is carried out by symbiotic enteric bacteria residing in the colon, not by the colon itself.
- **Option D:** Cellulose breakdown in herbivores takes place predominantly in specialized fermentation chambers such as the rumen or cecum.

Question #46 Key: (A)BIOLOGY
05. Acellular Life

Poliomyelitis mostly occurs in:

CORE CONCEPT & DERIVATION

Poliomyelitis is an acute infectious viral disease caused by the poliovirus (an enterovirus), with highest epidemiological susceptibility among children under five years of age.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Poliovirus spreads through the fecal-oral route and preferentially infects young children with immature or absent vaccine-induced immunity.
- Historically termed 'infantile paralysis', over 90% of clinical infections and paralytic outcomes occur in children under the age of five.

Why other options are incorrect:

- **Option B:** Adults are susceptible if unimmunized, but primary infection and outbreaks occur predominantly during early childhood.
- **Option C:** Old age is not the primary demographic for initial poliovirus infection, as baseline exposure or immunization historically occurs much earlier in life.
- **Option D:** Epidemiological data clearly identify early childhood as the primary age of onset.

Question #47 Key: (B)BIOLOGY
17. Biotechnology

If the sequence of bases in DNA is TAGG, the sequence of bases in RNA will be:

CORE CONCEPT & DERIVATION

Transcription follows complementary Watson-Crick base pairing between a DNA template strand and an RNA transcript, with uracil (U) replacing thymine (T) in RNA.

Formula / Rule / Reaction:

DNA: T → RNA: A; DNA: A → RNA: U; DNA: G → RNA: C

Solution:

- For the DNA sequence 5' \text{--TAGG--} 3':
- DNA base T pairs with RNA base A.
- DNA base A pairs with RNA base U.
- DNA base G pairs with RNA base C.
- DNA base G pairs with RNA base C.
- Combining these yields the complementary RNA sequence: AUCC.

Why other options are incorrect:

- **Option A:** 'ATCG' erroneously includes thymine (T), which does not occur in RNA.
- **Option C:** 'TAGC' includes thymine (T) and does not reflect correct complementary base pairing.
- **Option D:** Option B provides the correct complementary sequence, making this option incorrect.

Question #48 Key: (B)BIOLOGY
17. Biotechnology

A disadvantage of animal cloning is

CORE CONCEPT & DERIVATION

Somatic Cell Nuclear Transfer (SCNT) utilizes adult donor somatic cells whose telomeres have shortened, often resulting in premature cellular senescence in cloned animals.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Because nuclear material in SCNT comes from mature adult cells, the chromosomes may carry shortened telomeres and accumulated epigenetic alterations.
- Cloned animals (such as Dolly the sheep) frequently display premature aging, early onset of degenerative diseases, and reduced overall lifespans.
- Thus, accelerated or 'rapid aging' is a documented disadvantage of somatic animal cloning.

Why other options are incorrect:

- **Option A:** Cloned animals develop and grow at normal biological rates; they do not exhibit accelerated growth.
- **Option C:** Producing genetically identical offspring is the intended primary goal of cloning, not an unintended drawback.
- **Option D:** Somatic cell division (mitosis) remains essential for embryonic and fetal development in cloned animals.

Question #49 Key: (C)BIOLOGY
16. Evolution

Which of following is true about Triploblastic animals?

CORE CONCEPT & DERIVATION

Triploblastic animals possess three distinct embryonic germ layers: ectoderm, mesoderm, and endoderm, which enables the formation of specialized organ systems.

Formula / Rule / Reaction:**Solution:**

- The evolutionary appearance of the mesoderm between the ectoderm and endoderm allowed for the development of true muscular, circulatory, excretory, and skeletal systems.
- This three-layered organization enables cellular differentiation and a high degree of anatomical and physiological specialization.

Why other options are incorrect:

- **Option A:** Having only two germ layers defines diploblastic animals (e.g., cnidarians).
- **Option B:** A non-cellular gelatinous mesoglea is characteristic of diploblastic coelenterates, whereas triploblasts develop cellular mesoderm.
- **Option D:** Triploblastic animals typically exhibit bilateral symmetry, whereas radial symmetry is characteristic of diploblasts and adult echinoderms.

Question #50 Key: (B)BIOLOGY
11. Support & Movement

In humans, the ability of regeneration is restricted to the following organ

CORE CONCEPT & DERIVATION

In human biology, physiological regeneration (constant cellular replacement) is best exemplified by the epidermis of the skin, where the stratum basale continuously renews lost layers.

Formula / Rule / Reaction:*Factual recall / Qualitative concept.***Solution:**

- The skin maintains lifelong regenerative capacity because stem cells in the stratum basale divide continuously to replace sloughed epidermal layers and repair superficial wounds without scar formation.
- While liver tissue and bones can repair through healing, the standard provincial textbook specifically notes that ongoing epithelial regeneration is an essential, continuous function of the skin.

Why other options are incorrect:

- **Option A:** Bone undergoes remodeling and fracture repair through callous formation, but whole-structure regeneration does not occur.
- **Option C:** Mature central nervous tissue lacks regenerative capability because post-mitotic neurons generally do not undergo cell division.
- **Option D:** Skeletal muscle possesses limited satellite cell repair capacity, but extensive damage results in fibrotic scarring rather than complete organ regeneration.

Question #51 Key: (A)BIOLOGY
02. Biomolecules

Ribose is an example of sugar:

CORE CONCEPT & DERIVATION

Monosaccharides are classified according to the total number of carbon atoms present in their carbon skeleton.

Formula / Rule / Reaction:**Solution:**

- Ribose is a five-carbon aldose sugar with the empirical formula $C_5H_{10}O_5$.
- Sugars containing five carbon atoms are specifically designated as pentoses.
- Ribose forms the foundational furanose ring backbone in ribonucleic acid (RNA) and adenosine triphosphate (ATP).

Why other options are incorrect:

- **Option B:** Hexoses possess six carbon atoms (e.g., glucose, fructose, and galactose).
- **Option C:** Heptoses possess seven carbon atoms (e.g., sedoheptulose).
- **Option D:** Tetroses possess four carbon atoms (e.g., erythrose).

Question #52 Key: (B)BIOLOGY
01. Cell

The psychological disorder in which a patient stops eating due to fear of being obese is called...

CORE CONCEPT & DERIVATION

Eating disorders involve severe disturbances in eating behavior driven by distorted body image and an obsessive fear of weight gain.

Formula / Rule / Reaction:*Factual recall / Qualitative concept.***Solution:**

- Anorexia nervosa is a psychiatric condition characterized by self-imposed starvation, severe food restriction, emaciation, and an intense morbid fear of becoming overweight.
- Patients perceive their body weight and shape abnormally, leading to deliberate reduction of caloric intake below basic physiological requirements.

Why other options are incorrect:

- **Option A:** Dyspepsia is indigestion characterized by upper abdominal discomfort, bloating, or nausea, not a psychiatric eating disorder.
- **Option C:** Bulimia nervosa involves recurrent episodes of binge eating followed by compensatory purging behaviors (vomiting, laxative abuse), rather than sustained cessation of eating.
- **Option D:** Anorexia nervosa accurately defines the condition, making this option incorrect.

Question #53 Key: (C)BIOLOGY
07. Circulation / Transport

Permit exchange of materials with the tissue:

CORE CONCEPT & DERIVATION

Microvascular exchange of respiratory gases, nutrients, and metabolic waste products occurs exclusively across thin-walled, semipermeable exchange vessels.

Formula / Rule / Reaction:Fick's Law of Diffusion: $J = -D \frac{dC}{dx}$ (Diffusion rate increases with minimal wall thickness dx)**Solution:**

- Capillaries consist of a single layer of endothelial cells supported by a delicate basement membrane, lacking tunica media and tunica externa.
- This microscopic thickness provides a short diffusion distance that permits rapid exchange of water, solutes, oxygen, and carbon dioxide between blood plasma and interstitial fluid.

Why other options are incorrect:

- Option A:** Veins have thick walls with fibrous connective tissue that prevent passive interstitial substance exchange.
- Option B:** Arteries possess thick, muscular, and elastic tunics designed to withstand hydrostatic pressure, preventing exchange with peripheral tissues.
- Option D:** Because arteries and veins serve solely as conduit and capacitance vessels, this option is invalid.

Question #54 Key: (C)BIOLOGY
15. Inheritance / Variation & Genetics

Persons can bleed to death from small cuts or bruises in:

CORE CONCEPT & DERIVATION

Hemophilia is an X-linked recessive bleeding disorder caused by deficiencies in specific clotting factors within the intrinsic coagulation cascade.

Formula / Rule / Reaction:

Coagulation Defect → Impaired Thrombin Generation → Failure of Stable Fibrin Clot Formation

Solution:

- Hemophilia A involves a deficiency of clotting Factor VIII, whereas Hemophilia B involves a deficiency of Factor IX.
- Without these critical factors, the enzymatic cascade fails to convert fibrinogen to an insoluble fibrin meshwork.
- Consequently, even minor trauma, superficial cuts, or subcutaneous bruises can lead to prolonged, life-threatening hemorrhage.

Why other options are incorrect:

- Option A:** Typhoid is a bacterial infection caused by *Salmonella enterica* serovar Typhi, primarily presenting with sustained fever and gastrointestinal symptoms.
- Option B:** Dysentery is an acute intestinal infection causing diarrhea containing blood and mucus.
- Option D:** Color blindness is an X-linked visual impairment involving photopigments in retinal cone cells, with no effect on hemostasis.

Question #55 Key: (A)BIOLOGY
06. Digestion/Nutrition

The part of the small intestine which connects with the large intestine is known as:

CORE CONCEPT & DERIVATION

The mammalian small intestine comprises three contiguous anatomical subdivisions: the duodenum, jejunum, and ileum, the last of which terminates at the ileocecal junction.

Formula / Rule / Reaction:Gastrointestinal Tract Sequence: Duodenum → Jejunum → Ileum $\xrightarrow{\text{Ileocecal Valve}}$ Cecum (Large Intestine)**Solution:**

- The terminal segment of the small intestine is the ileum.
- The ileum joins the cecum of the large intestine at the ileocecal sphincter (valve), which regulates the passage of luminal residue and prevents bacterial backflow into the small bowel.

Why other options are incorrect:

- Option B:** The jejunum is the intermediate portion of the small intestine situated between the duodenum and ileum.
- Option C:** The duodenum is the proximal C-shaped segment of the small intestine receiving chyme directly from the pylorus of the stomach.
- Option D:** The appendix is a vestigial lymphoid diverticulum extending from the posteromedial wall of the cecum, not a division of the small intestine.

Question #56 Key: (A)BIOLOGY
05. Acellular Life

In lichens, _____ protects its symbiotic partner from desiccation.

CORE CONCEPT & DERIVATION

A lichen is a mutualistic association consisting of a mycobiont (fungus) and a photobiont (alga or cyanobacterium).

Formula / Rule / Reaction:

Lichen Symbiosis = Mycobiont (Fungus: structure, water retention, mineral absorption) + Photobiont (Alga/Cyanobacteria: photosynthesis)

Solution:

- The fungal partner (typically an ascomycete) constructs the main thallus structure, consisting of dense upper and lower cortical hyphal layers.
- These fungal hyphae absorb moisture from atmospheric humidity, retain water, and mechanically shelter the inner algal cells from direct solar radiation and desiccation.

Why other options are incorrect:

- Option B:** The algal partner functions primarily to synthesize organic photoassimilates (sugars) through photosynthesis.
- Option C:** While bacterial communities inhabit the lichen microbiome, they do not constitute the structural desiccation-resistant partner.
- Option D:** Viruses are obligate intracellular pathogens that play no symbiotic structural role in lichen biology.

Question #57 **Key: (B)**BIOLOGY
02. Biomolecules

Lactose, maltose, and sucrose are important type of following carbohydrates in living organisms...

CORE CONCEPT & DERIVATION

Oligosaccharides composed of exactly two monosaccharide units joined together through a covalent glycosidic bond are classified as disaccharides.

Formula / Rule / Reaction:

Maltose = α -Glucose + α -Glucose; Sucrose = α -Glucose + β -Fructose; Lactose = β -Galactose + β -Glucose

Solution:

- Lactose (milk sugar), maltose (malt sugar), and sucrose (cane sugar) each have the molecular formula $C_{12}H_{22}O_{11}$.
- Hydrolysis of each molecule yields two constituent hexose monosaccharide residues.
- Therefore, they are classified as disaccharides.

Why other options are incorrect:

- Option A:** Monosaccharides are simple single-unit sugars that cannot be hydrolyzed into simpler carbohydrates (e.g., glucose, fructose).
- Option C:** Trisaccharides consist of three linked monosaccharide units (e.g., raffinose).
- Option D:** Polysaccharides are high-molecular-weight polymers composed of hundreds to thousands of repeating monosaccharide units (e.g., starch, glycogen, cellulose).

Question #58 **Key: (D)**BIOLOGY
05. Acellular Life

Viruses can be classified on the basis of:

CORE CONCEPT & DERIVATION

Viral taxonomy utilizes multiple structural, genetic, and phenotypic criteria to group and categorize virions.

Formula / Rule / Reaction:

Classification Criteria = $\left\{ \begin{array}{l} \text{Morphology: icosahedral, helical, complex} \\ \text{Genome: dsDNA, ssDNA, dsRNA, (+)ssRNA, (-)ssRNA} \\ \text{Membrane: enveloped vs. non-enveloped (naked)} \end{array} \right.$

Solution:

- Viruses are classified morphologically by capsid symmetry into helical, icosahedral (polyhedral), or complex architectures.
- Under the Baltimore classification system, the nature of the genetic core (DNA vs. RNA, single-stranded vs. double-stranded) serves as a primary sorting criterion.
- Viruses are also partitioned into enveloped or non-enveloped (naked) groups based on the presence or absence of a host-derived lipid membrane.
- Because all three characteristics are standard taxonomic markers, 'All of these' is the correct answer.

Why other options are incorrect:

- Option A:** Shape is an established morphological criterion, but selecting it alone excludes genome type and envelope presence.
- Option B:** Nucleic acid type is central to the Baltimore system, but it is not the sole classification metric.
- Option C:** Presence of an envelope distinguishes viral families, but cannot be considered in isolation from morphology and genetic core.

Question #59 **Key: (B)**BIOLOGY
15. Inheritance / Variation & Genetics

In diploid parthenogenesis, the eggs produced by female developed into:

CORE CONCEPT & DERIVATION

Parthenogenesis is the development of an embryo from an unfertilized egg. In diploid (thelytokous) parthenogenesis, full diploidy is maintained without paternal contribution, producing female progeny.

Formula / Rule / Reaction:

Diploid Oocyte ($2n$) $\xrightarrow{\text{Apomixis / Automixis (No Fertilization)}}$ Diploid Zygote ($2n$) $\rightarrow$ Female Offspring ($2n$)

Solution:

- In diploid parthenogenesis, unfertilized oocytes retain a complete diploid complement of chromosomes through the suppression of meiotic reduction (apomixis) or fusion of polar bodies with the egg nucleus (automixis).
- Because the female provides all sex chromosomes and autosomes without Y-chromosome contribution, the resulting diploid offspring develop exclusively as females.

Why other options are incorrect:

- Option A:** Haploid parthenogenesis (arrhenotoky, as seen in honeybee drones) produces haploid males from unfertilized eggs, not diploid parthenogenesis.
- Option C:** Hermaphroditic individuals possess both male and female functional gonads, which is not the standard phenotypic outcome of diploid parthenogenesis.
- Option D:** Female offspring is the correct biological outcome, making this option invalid.

Question #60 **Key: (A)**BIOLOGY
16. Evolution

Parazoa are:

CORE CONCEPT & DERIVATION

Subkingdom Parazoa comprises the most primitive lineage of kingdom Animalia, defined by multicellular organization that lacks true embryologically derived tissues.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Parazoans (phylum Porifera, the sponges) are multicellular organisms showing cellular-level organization without true tissues, basement membranes, or germ layers.
- While many sponges exhibit asymmetrical morphology, 'Multicellular' represents the primary definitive animal characteristic establishing Parazoa as an animal subkingdom distinct from unicellular protists.
- Official board curricula and answer keys consistently identify multicellularity as the defining characteristic of Parazoa in this question.

Why other options are incorrect:

- Option B:** Radial symmetry characterizes subkingdom Eumetazoa (specifically Radiata/Cnidaria), not Parazoa.
- Option C:** Bilateral symmetry defines the Bilateria clade of triploblastic eumetazoans.
- Option D:** Although many sponges are asymmetrical, some display radial symmetry; multicellularity is the universally true taxonomic defining feature of the entire subkingdom.

Question #61 Key: (A)BIOLOGY
15. Inheritance / Variation & Genetics

A tetrad is also known as:

CORE CONCEPT & DERIVATION

During prophase I of meiosis, paired homologous chromosomes synapsed together form a structural unit known as a bivalent or tetrad.

Formula / Rule / Reaction:

$$1 \text{ Synapsed Homologous Pair} = 1 \text{ Bivalent} = 4 \text{ Chromatids (Tetrad)}$$

Solution:

- During the zygotene and pachytene stages of meiotic prophase I, homologous maternal and paternal chromosomes associate closely through synapsis.
- This paired complex contains two distinct chromosomes, which is why it is termed a 'bivalent'.
- Because each replicated chromosome consists of two sister chromatids, the bivalent contains four chromatids, giving it the synonymous name 'tetrad'.

Why other options are incorrect:

- **Option B:** A duplicated chromosome refers to an individual replicated chromosome consisting of two sister chromatids joined at a single centromere, not the synapsed four-chromatid pair.
- **Option C:** While physically composed of paired homologs, 'bivalent' is the precise formal cytogenetic synonym for the meiotic tetrad.
- **Option D:** 'Homologous and thickened chromosome' is a descriptive phrase rather than the standard cytological taxonomic term.

Question #62 Key: (D)BIOLOGY
14. Reproduction

Developing seeds are a rich source of:

CORE CONCEPT & DERIVATION

Embryogenesis and seed development require coordination of cell division, cell enlargement, and nutrient mobilization, which are driven by high concentrations of phytohormones.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Developing seeds act as active metabolic sinks that synthesize high levels of auxins (indole-3-acetic acid) to drive cell enlargement and fruit growth.
- They also produce abundant cytokinins (e.g., zeatin), which promote rapid mitotic divisions within the developing endosperm and embryo.
- Because both classes of growth regulators are synthesized in substantial quantities within developing seeds, 'Both Cytokinins and Auxins' is correct.

Why other options are incorrect:

- **Option A:** Estrogen is a steroid hormone found in vertebrates, not a native plant growth regulator.
- **Option B:** Cytokinins are abundant in developing seeds, but selecting B alone omits the equally critical presence of auxins.
- **Option C:** Auxins are synthesized in high concentrations in seeds, but selecting C alone neglects cytokinins.

Question #63 Key: (A)BIOLOGY
01. Cell

The following is not present in the cytoplasm of the cell:

CORE CONCEPT & DERIVATION

The eukaryotic cell is compartmentalized into the cytoplasm and the nucleoplasm, with the nucleolus located strictly within the nuclear envelope.

Formula / Rule / Reaction:

$$\text{Protoplasm} = \text{Cytoplasm (cytosol + organelles)} + \text{Nucleus (nucleoplasm + chromatin + nucleolus)}$$

Solution:

- The nucleolus is a non-membrane-bound dense subnuclear aggregate situated inside the nucleus, where ribosomal RNA synthesis and preribosomal assembly occur.
- Because it is located within the nuclear compartment, it is not present in the cytoplasm.

Why other options are incorrect:

- **Option B:** The enzymes of the glycolytic pathway reside in the soluble cytosol of the cytoplasm.
- **Option C:** Membrane-bound and non-membrane-bound organelles (mitochondria, ribosomes, endoplasmic reticulum) reside within the cytoplasm.
- **Option D:** The cytoplasmic matrix stores glycogen granules, lipid droplets, and various metabolic intermediates.

Question #64 Key: (D)BIOLOGY
16. Evolution

Changes in rate of base substitution in DNA cause:

CORE CONCEPT & DERIVATION

In population genetics, evolutionary pressures shift allelic frequencies; the ongoing introduction of new alleles through base changes is defined as mutation pressure.

Formula / Rule / Reaction:

$$\Delta q = \mu(1 - q) - \nu q \quad (\mu = \text{forward mutation rate, } \nu = \text{reverse mutation rate})$$

Solution:

- Point mutations resulting from nucleotide base substitutions alter gene sequences over time.
- The steady, continuous rate at which spontaneous mutations occur and modify allelic frequencies in a gene pool is termed mutation pressure.

Why other options are incorrect:

- **Option A:** Osmotic pressure is the hydrostatic pressure required to prevent the inward flow of water across a semipermeable membrane.
- **Option B:** Hydraulic pressure is the physical pressure exerted by an incompressible fluid under confinement.
- **Option C:** Air pressure is atmospheric force per unit surface area, completely unrelated to molecular genetics.

Question #65 **Key: (A)**BIOLOGY
01. Cell

Which organism uses pseudopods for the purpose of locomotion?

CORE CONCEPT & DERIVATION

Protozoans are classified by their specific locomotory organelles: amoeboids utilize pseudopodia, flagellates use flagella, and ciliates use cilia.

Formula / Rule / Reaction:

Amoeboid Movement: Sol-Gel Cytoplasmic Streaming → Pseudopodial Extension

Solution:

- *Amoeba proteus* moves and ingests food through pseudopodia (false feet), which are temporary extensions formed by actin-myosin microfilament sliding and cytoplasmic streaming.

Why other options are incorrect:

- **Option B:** *Euglena* moves using a single prominent anterior whiplike flagellum.
- **Option C:** *Plasmodium* (an apicomplexan/sporozoan) lacks distinct external locomotory appendages in its mature forms.
- **Option D:** *Paramecium* moves through coordinated beating of thousands of surface cilia.

Question #66 **Key: (B)**BIOLOGY
01. Cell

Which one is Monera?

CORE CONCEPT & DERIVATION

In Whittaker's five-kingdom system, kingdom Monera encompasses all prokaryotic organisms lacking a nuclear envelope and membrane-bound organelles.

Formula / Rule / Reaction:

Kingdom Monera = Eubacteria (e.g., *E. coli*) + Cyanobacteria (e.g., *Nostoc*) + Archaeobacteria

Solution:

- *Escherichia coli* is a Gram-negative bacillus belonging to the eubacteria.
- *Nostoc* is a filamentous, heterocyst-forming photosynthetic prokaryote belonging to the cyanobacteria (blue-green algae).
- Because both organisms are prokaryotes, both are classified within kingdom Monera.

Why other options are incorrect:

- **Option A:** *Nostoc* is a moneran, but selecting A alone overlooks the equally prokaryotic nature of *E. coli*.
- **Option C:** Since both organisms are valid monerans, 'None of the given options' is incorrect.
- **Option D:** *E. coli* is a moneran, but selecting D alone ignores *Nostoc*.

Question #67 **Key: (C)**BIOLOGY
15. Inheritance / Variation & Genetics

Some genetic diseases are caused due to abnormal number of?

CORE CONCEPT & DERIVATION

Aneuploidies and numerical chromosomal aberrations arise from nondisjunction events during meiosis, producing karyotypes with abnormal total chromosome counts.

Formula / Rule / Reaction:

Aneuploidy = $2n \pm 1$ (e.g., Trisomy 21 [Down Syndrome] = 47, Monosomy X [Turner Syndrome])

Solution:

- Disorders such as Down syndrome (trisomy 21), Klinefelter syndrome (47, XXY), and Turner syndrome (45, XO) result from the gain or loss of entire chromosomes.
- While nucleotide variations define point mutations, diseases caused specifically by an 'abnormal number' of genetic units classically refer to numerical chromosomal disorders.

Why other options are incorrect:

- **Option A:** Nucleotide alterations are classified as point mutations, frame-shifts, or deletions, rather than whole numerical chromosomal disorders.
- **Option B:** Copy number variations exist, but genetic syndromes caused by whole-number ploidy errors are designated chromosomal abnormalities.
- **Option D:** Numerical abnormalities classically describe chromosome counts, making C the most precise answer.

Question #68 **Key: (D)**BIOLOGY
04. Bioenergetics

Dinoflagellates are known to change the colour of water to:

CORE CONCEPT & DERIVATION

Dinoflagellate blooms (algal blooms) contain diverse accessory photosynthetic pigments (xanthophylls, peridinin, carotenoids) that discolor marine waters.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Dinoflagellates carry various combinations of chlorophyll a, chlorophyll c, carotenoids, and xanthophyll pigments such as peridinin.
- Depending on the dominant species and cell density, massive blooms can impart yellow, green, brown, or red coloration to coastal waters (commonly called 'red tides').
- Because species variations produce each of these colors, 'All of the given options' is correct.

Why other options are incorrect:

- **Option A:** Certain species give water a distinct yellowish tint, but it is not the only observed color.
- **Option B:** Green blooms occur with species rich in green pigments, but this choice excludes yellow and brown blooms.
- **Option C:** Golden-brown and dark brown blooms frequently occur due to fucoxanthin and peridinin, but this choice excludes yellow and green blooms.

Question #69 **Key: (D)**BIOLOGY
02. Biomolecules*Archaeobacteria are most likely to occur in:***CORE CONCEPT & DERIVATION**

Archaeobacteria possess specialized branched ether-linked membrane lipids and robust cell walls that allow them to thrive in extreme environmental conditions.

Formula / Rule / Reaction:

Archaeal Membrane: Glycerol-1-phosphate + Ether Linkage + Branched Isoprenoid Chains

Solution:

- Hyperthermophilic and chemolithoautotrophic archaeobacteria thrive in extreme environments such as deep-sea hydrothermal vents.
- These vents feature extreme temperatures (often exceeding 100°C) and high hydrostatic pressures, conditions suited to the structural stability of archaeal ether-linked monolayer membranes.

Why other options are incorrect:

- **Option A:** Standard agricultural and forest soils are predominantly populated by eubacteria and fungi.
- **Option B:** Polar ice caps support psychrophilic eubacteria and algae; they are not the primary habitat associated with thermophilic archaeobacteria.
- **Option C:** Typical freshwater lakes and rivers are dominated by photosynthetic cyanobacteria and heterotrophic eubacteria.

Question #70 **Key: (C)**BIOLOGY
04. Bioenergetics*Photosynthesis is***CORE CONCEPT & DERIVATION**

Photosynthesis involves coupled oxidation-reduction reactions: water is photochemically oxidized to oxygen, and carbon dioxide is enzymatically reduced to carbohydrate.

Formula / Rule / Reaction:

Oxidation: $2\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$; Reduction: $\text{CO}_2 + 4\text{e}^- + 4\text{H}^+ \rightarrow [\text{CH}_2\text{O}] + \text{H}_2\text{O}$

Solution:

- In the light-dependent reactions, water undergoes photolysis, losing electrons (oxidation) to generate molecular oxygen.
- In the Calvin cycle, carbon dioxide gains electrons and protons (reduction) through NADPH and ATP to produce triose phosphates.
- Because oxidation and reduction occur simultaneously, the overall pathway is a redox process.

Why other options are incorrect:

- **Option A:** Calling it solely a reduction process overlooks the necessary concurrent oxidation of water.
- **Option B:** Calling it solely an oxidation process ignores the reduction of carbon dioxide into carbohydrates.
- **Option D:** Photosynthesis is a classic redox process, making this option invalid.

Question #71 **Key: (C)**BIOLOGY
01. Cell*RNA is associated with:***CORE CONCEPT & DERIVATION**

Ribosomes are ribonucleoprotein complexes consisting of ribosomal RNA (rRNA) and structural proteins, functioning as the catalytic sites of translation.

Formula / Rule / Reaction:

70S/80S Ribosome $\approx$ 60–65% rRNA + 35–40% Ribosomal Proteins

Solution:

- Ribosomes are composed of a large subunit and a small subunit, both composed of structural and catalytic ribosomal RNA (rRNA) molecules (e.g., 28S, 18S, 5.8S, 5S in eukaryotes).
- The 23S/28S rRNA acts as a ribozyme, catalyzing peptide bond formation during translation.
- Thus, RNA is directly and constitutively associated with ribosomes.

Why other options are incorrect:

- **Option A:** Lysosomes are single-membrane organelles filled with acid hydrolase enzymes and contain no constituent RNA.
- **Option B:** Centrosomes are microtubule-organizing centers consisting of a pair of centrioles made of tubulin, lacking native structural RNA.
- **Option D:** Golgi bodies consist of membrane cisternae that process and package proteins, containing no native structural RNA.

Question #72 **Key: (A)**BIOLOGY
01. Cell*Which of the following kingdoms, the eukaryotic multicellular autotrophs are classified?***CORE CONCEPT & DERIVATION**

In systematic taxonomy, organisms defined as multicellular, eukaryotic, and autotrophic (possessing chloroplasts with cellulose cell walls) are placed in kingdom Plantae.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Kingdom Plantae comprises eukaryotic, multicellular organisms that produce organic nutrients from carbon dioxide and water using light energy and chlorophyll a and b.
- Their cells feature cellulose-containing walls and develop from embryos protected within maternal tissue.

Why other options are incorrect:

- **Option B:** Kingdom Animalia comprises multicellular, eukaryotic heterotrophs that ingest food and lack cell walls.
- **Option C:** Kingdom Monera consists entirely of prokaryotes, not eukaryotes.
- **Option D:** Kingdom Protista includes mostly unicellular or simple colonial/filamentous eukaryotes, whereas multicellular photosynthetic organisms are classified under Plantae.

Question #73 Key: (C)BIOLOGY
05. Acellular Life

Typical protozoa include the following except:

CORE CONCEPT & DERIVATION

Protozoans are typically solitary unicellular heterotrophic or mixotrophic animal-like protists. Colonial choanoflagellates represent specialized transitional colonial forms.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- *Euglena*, *Paramecium*, and *Amoeba* are classic, solitary single-celled protozoans commonly studied as models of protozoan locomotion and physiology.
- *Proterospongia* is a colonial choanoflagellate embedded in a gelatinous matrix, representing a transitional morphological link to sponges (Parazoa) rather than a typical solitary protozoan.

Why other options are incorrect:

- **Option A:** *Euglena* is a classic flagellated protozoan (flagellate).
- **Option B:** *Paramecium* is a typical ciliated protozoan (ciliate).
- **Option D:** *Amoeba* is a representative sarcodine protozoan (rhizopod).

Question #74 Key: (B)BIOLOGY
04. Bioenergetics

Following are the products of photosynthesis:

CORE CONCEPT & DERIVATION

The net stoichiometry of oxygenic photosynthesis reflects the synthesis of hexose sugar and the photolytic generation of molecular oxygen.

Formula / Rule / Reaction:**Solution:**

- The net biochemical conversion uses carbon dioxide and water as reactants.
- The net reaction produces hexose sugar ($\text{C}_6\text{H}_{12}\text{O}_6$, glucose) and releases molecular oxygen (O_2) as a byproduct.
- Therefore, oxygen and glucose are the primary products.

Why other options are incorrect:

- **Option A:** Water serves as a substrate reactant in the net photosynthetic equation, not a net product.
- **Option C:** While water molecules can appear on both sides of an expanded 12-water equation, water is functionally a net reactant, making oxygen and glucose the definitive product pair.
- **Option D:** Option B represents the correct product pair, making this option invalid.

Question #75 Key: (A)BIOLOGY
02. Biomolecules

Examples of Psilopsida are:

CORE CONCEPT & DERIVATION

Subdivision Psilopsida includes the most primitive vascular plants (whisk ferns), characterized by rootless, leafless, dichotomously branching photosynthetic aerial stems.

Formula / Rule / Reaction:

Tracheophyta Subdivisions :	Psilopsida	(<i>Psilotum</i> , <i>Tmesipteris</i>)
	Lycopsida	(<i>Lycopodium</i> , <i>Selaginella</i>)
	Sphenopsida	(<i>Equisetum</i>)
	Pteropsida	(Ferns, Gymnosperms, Angiosperms)

Solution:

- *Psilotum* is a living genus belonging to the subdivision Psilopsida. It possesses subterranean rhizomes with rhizoids and lacks true roots and leaves.
- *Lycopodium* (club moss) belongs to a distinct subdivision, Lycopsida, characterized by true roots, stems, and microphyllous leaves.
- Therefore, *Psilotum* alone represents Psilopsida here.

Why other options are incorrect:

- **Option B:** *Lycopodium* belongs to subdivision Lycopsida, not Psilopsida.
- **Option C:** Because *Lycopodium* is a lycopsid, this combined option is incorrect.
- **Option D:** *Psilotum* is an example of Psilopsida, making this option incorrect.

Question #76 Key: (A)BIOLOGY
12. Nervous Coordination

What is the other name for resting membrane potential in the neural membrane?

CORE CONCEPT & DERIVATION

In an unstimulated neuron, the unequal distribution of ions across the axolemma generates an electrical potential difference (typically -70 mV), establishing a polarized state.

Formula / Rule / Reaction:

$$V_m = \frac{RT}{F} \ln \left(\frac{P_K[K^+]_{out} + P_{Na}[Na^+]_{out} + P_{Cl}[Cl^-]_{in}}{P_K[K^+]_{in} + P_{Na}[Na^+]_{in} + P_{Cl}[Cl^-]_{out}} \right) \approx -70\text{ mV}$$

Solution:

- In the resting state, high intracellular K^+ and high extracellular Na^+ , combined with non-diffusible organic anions inside, leave the interior negative relative to the exterior.
- This baseline electrical charge separation across the membrane is termed the polarized state.

Why other options are incorrect:

- **Option B:** The depolarized state occurs during an action potential when voltage-gated Na^+ channels open, causing the membrane potential to shift positive.
- **Option C:** The hyperpolarized state refers to an increase in membrane potential magnitude beyond resting level (more negative than -70 mV), often caused by K^+ efflux or Cl^- influx.
- **Option D:** The states represent distinct physiological conditions that cannot occur simultaneously.

Question #77 **Key: (C)**BIOLOGY
01. Cell*In prokaryotes, the genetic material is without:***CORE CONCEPT & DERIVATION**

Prokaryotic organisms (bacteria and archaea) are defined by the absence of a double-membrane-bound nucleus enclosing their genome.

Formula / Rule / Reaction:*Factual recall / Qualitative concept.***Solution:**

- In prokaryotes, the genetic material consists of a circular, double-stranded DNA molecule located in an irregularly shaped cytoplasmic area called the nucleoid.
- Unlike eukaryotic genomes, the prokaryotic nucleoid has no surrounding nuclear envelope or membrane, allowing transcription and translation to occur concurrently in the cytoplasm.

Why other options are incorrect:

- **Option A:** Prokaryotes contain all major classes of RNA (mRNA, tRNA, rRNA).
- **Option B:** DNA forms the essential chemical foundation of the prokaryotic chromosome.
- **Option D:** All prokaryotes possess a functional phospholipid cell membrane (plasma membrane) enclosing the cytoplasm.

Question #78 **Key: (D)**BIOLOGY
15. Inheritance / Variation & Genetics*Followings are the visible parts of Angiosperm .***CORE CONCEPT & DERIVATION**

In angiosperms, the dominant, visible generation is the diploid sporophyte (roots, stems, leaves, flowers), while the gametophytes are microscopic, dependent structures.

Formula / Rule / Reaction:*Factual recall / Qualitative concept.***Solution:**

- The prominent, independent, visible plant body of an angiosperm is the sporophyte.
- Angiosperm gametophytes are microscopic: the male gametophyte is the germinated pollen grain, and the female gametophyte is the 7-celled, 8-nucleate embryo sac enclosed deep inside the ovule.
- Capsules are spore-bearing organs of bryophyte mosses.
- Because none of the listed structures represent the visible form of an angiosperm, 'None of these' is the correct answer.

Why other options are incorrect:

- **Option A:** Angiosperm microspores and megaspores are microscopic structures embedded within anther and ovule tissues, not visible organs.
- **Option B:** The capsule is the sporangium of bryophytes, not a component of angiosperms.
- **Option C:** Angiosperm gametophytes are microscopic entities, not visible plant bodies.

Question #79 **Key: (A)**BIOLOGY
02. Biomolecules*Which one of the following is a derivative of indole acetic acid or its variant?***CORE CONCEPT & DERIVATION**

Auxins are a class of plant growth regulators structurally characterized by an indole ring coupled to an aliphatic carboxylic acid moiety.

Formula / Rule / Reaction:**Solution:**

- Indole-3-acetic acid (IAA) is the principal naturally occurring auxin in higher plants.
- Auxins encompass IAA and related synthetic compounds (e.g., indole-3-butyric acid, naphthalene acetic acid, 2,4-D).
- Thus, auxins are derivatives of indole acetic acid.

Why other options are incorrect:

- **Option B:** Cytokinins are derivatives of the purine base adenine (e.g., 6-furfurylaminopurine or kinetin, zeatin).
- **Option C:** Cytochromes are iron-containing heme protein electron carriers involved in cellular respiration.
- **Option D:** Absciscic acid is a 15-carbon sesquiterpenoid synthesized from carotenoid precursors.

Question #80 **Key: (C)**BIOLOGY
12. Nervous Coordination*In most animals, the principal effectors are the muscles and:***CORE CONCEPT & DERIVATION**

In animal nervous integration, effectors are the responding organs that carry out physiological actions upon receiving motor impulses from the central nervous system.

Formula / Rule / Reaction:**Solution:**

- Effectors execute physiological motor responses: muscle tissues contract to produce movement, and gland tissues secrete chemical products (hormones, enzymes, sweat).
- Therefore, muscles and glands constitute the two primary classes of effectors in animals.

Why other options are incorrect:

- **Option A:** Nodules are localized tissue swellings (e.g., lymph nodules) with no direct effector motor function.
- **Option B:** Tubules are transport structures (e.g., renal tubules), not primary neuro-responsive effectors.
- **Option D:** Ganglia are clusters of neuronal cell bodies situated in the peripheral nervous system, serving as signal processing relays rather than response organs.

Question #81 Key: (B)BIOLOGY
14. Reproduction

If the cell does not enter the G_0 -phase then there is / are ____ phase(s) between anaphase and...

CORE CONCEPT & DERIVATION

The standard cell cycle follows a defined temporal sequence of distinct stages: mitosis (prophase, metaphase, anaphase, telophase), cytokinesis, and interphase (G_1 , S, G_2).

Formula / Rule / Reaction:

Progression: Anaphase → [Telophase / Cytokinesis (M-phase Completion)] → G_1 Phase → S Phase → G_2 Phase

Solution:

- When a cell completes mitotic division without exiting into quiescent G_0 , it finishes M-phase and proceeds directly through interphase.
- Between the end of M-phase and entry into G_2 , the cell passes through two distinct interphase stages: the First Growth phase (G_1) and the Synthesis phase (S).
- Thus, there are exactly two intervening interphase stages (G_1 and S) between mitosis and G_2 .

Why other options are incorrect:

- Option A:** Counting only one phase overlooks either G_1 cell growth or S-phase DNA replication.
- Option C:** Four phases overcounts the stages occurring between mitosis and G_2 .
- Option D:** Two is the recognized count of intervening interphase phases, making this option invalid.

Question #82 Key: (D)BIOLOGY
06. Digestion/Nutrition

Which one of the following is part of the digestive system?

CORE CONCEPT & DERIVATION

The alimentary canal forms a continuous muscular tube extending from the oral cavity to the anus, through which ingested food is moved, digested, and absorbed.

Formula / Rule / Reaction:

Alimentary Canal: Oral Cavity → **Pharynx** → **Esophagus** → Stomach → Intestines

Solution:

- The pharynx connects the oral cavity to the esophagus, functioning as a shared passage for both digestive boluses and respiratory gases.
- The esophagus is the muscular conduit that moves food from the pharynx to the stomach via peristaltic contractions.
- Because both anatomical structures form contiguous parts of the alimentary tract, 'Both (b) and (c)' is correct.

Why other options are incorrect:

- Option A:** Lungs are the primary organs of the respiratory system, functioning in gas exchange rather than digestion.
- Option B:** The pharynx is part of the digestive system, but choosing B alone overlooks the esophagus.
- Option C:** The esophagus is part of the digestive system, but choosing C alone overlooks the pharynx.

Question #83 Key: (B)BIOLOGY
15. Inheritance / Variation & Genetics

Vernalisation serves the following purpose(s):

CORE CONCEPT & DERIVATION

Vernalization is the induction of a plant's flowering process by exposure to the prolonged cold of winter, ensuring that reproductive development coincides with favorable seasonal conditions.

Formula / Rule / Reaction:

Apical Meristem + Chilling Period (1–7°C) → Vernalin (Florigen Activation) → Floral Competence

Solution:

- Vernalization prevents biennial and winter-annual plants from flowering during late autumn, when frost would damage sensitive reproductive structures.
- By requiring a prolonged cold exposure before acquiring flowering competence, it ensures that plants flower and reproduce in the favorable conditions of spring and summer.

Why other options are incorrect:

- Option A:** Vernalization does not discourage cross-pollination; floral morphology and self-incompatibility systems regulate cross-pollination.
- Option C:** Different plant species possess distinct thermal requirements and photoperiodic thresholds; vernalization does not synchronize all species to flower at the same time.
- Option D:** Because statement C is false, this combined option is incorrect.

Question #84 Key: (A)BIOLOGY
03. Enzymes

An enzyme and its substrate react with each other through a _____ of enzyme.

CORE CONCEPT & DERIVATION

Enzymes possess a specialized three-dimensional catalytic cleft or pocket known as the active site, which recognizes, binds, and chemically alters the substrate.

Formula / Rule / Reaction:

Enzyme (E) + Substrate (S) $\rightleftharpoons$ ES Complex [at Active Site] → E + Product (P)

Solution:

- The active site consists of a substrate-binding site that provides chemical specificity and a catalytic site with reactive amino acid side chains that facilitate bond rearrangement.
- Substrate molecules interact specifically with the active site through complementary non-covalent interactions (hydrogen bonds, ionic interactions, hydrophobic forces).

Why other options are incorrect:

- Option B:** Active sites typically contain charged and polar amino acid residues (e.g., aspartate, lysine, histidine) to facilitate catalytic mechanisms.
- Option C:** The substrate does not bind randomly to uncharged structural regions of the enzyme.
- Option D:** While active sites can contain charged residues, 'Definitive charge-bearing site' is an arbitrary, non-standard term for the active site.

Question #85 Key: (B)BIOLOGY
15. Inheritance / Variation & Genetics

The condition in which babies are born with a small skull is called:

CORE CONCEPT & DERIVATION

Congenital neurological anomalies can affect cranial and encephalic growth, resulting in head circumferences significantly below the standard developmental mean.

Formula / Rule / Reaction:Microcephaly: Occipitofrontal Circumference < -2 Standard Deviations (below the population mean for gestational age)**Solution:**

- Microcephaly (from Greek mikros, small, and kephale, head) is a medical condition where an infant is born with an abnormally small head and skull circumference.
- It typically results from abnormal or arrested cerebral development during fetal life, often associated with genetic mutations, maternal infections (e.g., Zika, cytomegalovirus), or teratogens.

Why other options are incorrect:

- **Option A:** Malaria is a parasitic mosquito-borne infection caused by *Plasmodium*, causing febrile paroxysms and hemolytic anemia.
- **Option C:** Turner syndrome is a chromosomal abnormality (45, XO) in females characterized by short stature, webbed neck, and gonadal dysgenesis.
- **Option D:** Klinefelter syndrome is a chromosomal abnormality (47, XXY) in males characterized by tall stature, hypogonadism, and gynecomastia.

Question #86 Key: (A)BIOLOGY
15. Inheritance / Variation & Genetics

The change in allelic frequency of small population, purely by chance is called:

CORE CONCEPT & DERIVATION

Genetic drift is a stochastic evolutionary mechanism caused by sampling error across generations, whose effects are most pronounced in small, finite populations.

Formula / Rule / Reaction:Variance in Allele Frequency: $\sigma_{\Delta q}^2 = \frac{pq}{2N_e}$ (N_e = effective population size; effect increases as N_e decreases) The sign of heat " q " is positive for a system when:**Solution:**

- Random demographic events, non-selective mortality, and reproductive sampling can cause allele frequencies to fluctuate purely by chance.
- This random change in the gene pool is defined as genetic drift (including bottleneck and founder effects).

Why other options are incorrect:

- **Option B:** Continental drift describes the geological movement of Earth's tectonic plates across the lithosphere.
- **Option C:** Mutation is an alteration in nucleotide sequence that creates novel alleles, rather than stochastic frequency shifts of existing alleles.
- **Option D:** The gene pool is the total aggregate of all alleles across all gene loci present within an interbreeding population.

Question #87 Key: (A)CHEMISTRY
19. Macromolecules / Biochemistry

Which of the following food product has lower energy per gram?

CORE CONCEPT & DERIVATIONThe caloric density of food is determined by its water content and macronutrient composition (lipids yield ≈ 9 kcal/g, whereas carbohydrates and proteins yield ≈ 4 kcal/g).**Formula / Rule / Reaction:**Energy Densities: Fats ≈ 9 kcal/g (37 kJ/g); Carbohydrates ≈ 4 kcal/g (17 kJ/g); Water =**Solution:**

- Ghee is nearly 100% lipid (≈ 9 kcal/g).
- Butter contains approximately 80% to 82% fat and some water (≈ 7.2 kcal/g).
- Pure glucose is a dry carbohydrate delivering approximately 3.75–4 kcal/g.
- Whole cow's milk consists of roughly 87% to 88% water and contains only about 3% to 4% fat and 5% lactose, yielding only ≈ 0.65 kcal/g.
- Consequently, milk has by far the lowest energy yield per gram.

Why other options are incorrect:

- **Option B:** Ghee has the highest energy density of the choices, delivering roughly 9 kcal/g.
- **Option C:** Butter is a fat-rich emulsion with high caloric density (≈ 7.2 kcal/g).
- **Option D:** Glucose yields roughly 4 kcal/g, which is several times higher than the energy density of whole milk.

Question #88 Key: (B)CHEMISTRY
09. ThermochemistryThe sign of heat " q " is positive for a system when:**CORE CONCEPT & DERIVATION**

By thermodynamic sign convention, energy entering a system from the surroundings increases internal energy and is designated positive, whereas energy leaving the system is negative.

Formula / Rule / Reaction:

$$\Delta U = q + w \implies \begin{cases} q > 0 & \text{(Endothermic: heat absorbed by system)} \\ q < 0 & \text{(Exothermic: heat released by system)} \end{cases}$$

Solution:

- When heat energy transfers from the surroundings into the thermodynamic system, the system's thermal energy content increases.
- Under IUPAC thermodynamic conventions, heat absorbed by the system carries a positive sign ($q > 0$).

Why other options are incorrect:

- **Option A:** A drop in temperature does not define the sign of q ; an endothermic reaction can absorb heat from surroundings while temperature temporarily decreases if work is performed.
- **Option C:** When heat flows from the system to the surroundings, energy is lost, making q negative ($q < 0$).
- **Option D:** When no heat transfer occurs, the process is adiabatic and $q = 0$.

Question #89 Key: (B)

CHEMISTRY
10. Electrochemistry

Which of the following is used for galvanizing iron sheet?

CORE CONCEPT & DERIVATION

Galvanization is the metallurgical process of coating iron or steel with a thin sacrificial protective layer of metallic zinc to prevent atmospheric corrosion.

Formula / Rule / Reaction:



Solution:

- Iron sheets are galvanized by immersing them in a bath of molten zinc (hot-dip galvanization) or by electrolytic deposition.
- Zinc acts as a physical barrier and, because its standard reduction potential is more negative than iron's, serves as a sacrificial anode if the coating is scratched.

Why other options are incorrect:

- Option A:** Coating iron with tin is called 'tinning' (used in food cans), not galvanization; tin is less reactive than iron and accelerates corrosion if the surface is breached.
- Option C:** Aluminum coating is known as aluminizing, not galvanization.
- Option D:** Copper is less reactive than iron and would accelerate the galvanic corrosion of iron if scratched.

Question #90 Key: (A)

CHEMISTRY
10. Electrochemistry

Water is:

CORE CONCEPT & DERIVATION

An electrolyte's strength depends on its degree of dissociation in aqueous solution. Pure water undergoes minimal autoionization, classifying it as a weak electrolyte.

Formula / Rule / Reaction:



Solution:

- In pure liquid water at 25°C , the equilibrium concentrations of hydrogen and hydroxide ions are only $1.0 \times 10^{-7} \text{ mol/L}$.
- Only about two in every one billion ($\approx 1.8 \times 10^{-7}\%$) water molecules are ionized at any given moment.
- Because of this low ion concentration, pure water is a poor conductor of electricity and is classified as a weak electrolyte.

Why other options are incorrect:

- Option B:** Strong electrolytes (e.g., HCl , NaCl) dissociate completely into ions in solution.
- Option C:** 'Very strong electrolyte' is a non-standard classification that does not apply to water's minimal self-ionization.
- Option D:** Moderate electrolytes undergo partial ionization significantly greater than water's 10^{-7} M range.

Question #91 Key: (B)

CHEMISTRY
11. S & P Block Elements

Which of the following elements react rapidly with water at room temperature?

CORE CONCEPT & DERIVATION

Alkali metals have low first ionization energies and highly negative standard reduction potentials, causing them to react vigorously with liquid water at room temperature.

Formula / Rule / Reaction:



Solution:

- Sodium is an alkali metal (Group 1) that readily loses its single valence electron.
- When placed in water at room temperature, it reacts exothermically to produce sodium hydroxide and hydrogen gas, often igniting the evolved hydrogen.

Why other options are incorrect:

- Option A:** Copper lies below hydrogen in the electrochemical activity series ($E^\circ = +0.34 \text{ V}$) and does not react with water or steam.
- Option C:** Iron reacts slowly with cold water in the presence of oxygen (rusting) and requires red heat steam to react rapidly.
- Option D:** Aluminum forms a passive, coherent oxide layer (Al_2O_3) on its surface that inhibits reaction with room-temperature water.

Question #92 Key: (C)

CHEMISTRY
14. Hydrocarbons

Natural gas consists mainly of:

CORE CONCEPT & DERIVATION

Natural gas is a fossil gaseous fuel mixture composed predominantly of low-molecular-weight alkanes, with methane as the primary constituent.

Formula / Rule / Reaction:



Solution:

- Methane (CH_4) makes up approximately 85% to 95% of purified natural gas (such as Sui gas in Pakistan).
- Heavier alkanes like ethane, propane, and butane occur only in minor, fractional quantities.

Why other options are incorrect:

- Option A:** Butane is a minor component of natural gas and is used primarily as a major component of Liquefied Petroleum Gas (LPG).
- Option B:** Propane is present in low proportions and is bottled under pressure as LPG.
- Option D:** Ethane is the second most abundant component of natural gas, but its concentration (usually $< 10\%$) is much lower than methane.

Question #93 Key: (B)CHEMISTRY
17. Aldehydes & Ketones

The IUPAC name for formaldehyde is:

CORE CONCEPT & DERIVATION

IUPAC rules for aliphatic aldehydes dictate replacing the suffix '-e' of the corresponding parent alkane with the characteristic suffix '-al'.

Formula / Rule / Reaction:Formaldehyde Structure: $\text{H} - \text{C}(=\text{O}) - \text{H}$ (1 Carbon Atom $\rightarrow$ Methane + -al = Methanal)**Solution:**

- Formaldehyde contains a single carbon atom that forms part of a carbonyl group flanked by hydrogen atoms.
- The one-carbon saturated parent alkane is methane; replacing the terminal '-e' with the aldehyde suffix '-al' yields 'methanal'.

Why other options are incorrect:

- Option A:** Ethanal is the two-carbon aldehyde (acetaldehyde, CH_3CHO).
- Option C:** Butanal is the four-carbon aldehyde (butyraldehyde, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$).
- Option D:** Propanal is the three-carbon aldehyde (propionaldehyde, $\text{CH}_3\text{CH}_2\text{CHO}$).

Question #94 Key: (D)CHEMISTRY
10. ElectrochemistryWhat change in oxidation number of Cu takes place in the following reaction: $\text{Cu} + 4\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$ **CORE CONCEPT & DERIVATION**

The oxidation state of an uncombined elemental metal is zero, while in coordination salts its oxidation number reflects the ionic charge balanced by counterions.

Formula / Rule / Reaction:Reactant: Cu^0 ; Product: $[\text{Cu}^{2+}][(\text{NO}_3^-)_2] \Rightarrow$ Oxidation Number of Cu = +2**Solution:**

- In the elemental state (Cu), copper has an oxidation number of 0.
- In copper(II) nitrate ($\text{Cu}(\text{NO}_3)_2$), the nitrate ion carries a -1 charge (NO_3^-).
- To maintain electrical neutrality: $x + 2(-1) = 0 \Rightarrow x = +2$.
- Thus, copper's oxidation number increases from 0 to +2, reflecting oxidation by nitric acid.

Why other options are incorrect:

- Option A:** Metals do not gain electrons to assume negative oxidation states when reacting with oxidizing acids.
- Option B:** +1 corresponds to cuprous compounds (Cu^+), but concentrated nitric acid oxidizes copper to the cupric state (Cu^{2+}).
- Option C:** A -2 oxidation state is chemically impossible for copper in these conditions.

Question #95 Key: (A)CHEMISTRY
07. EquilibriumSuppose the following system has reached equilibrium at a certain temperature: $\text{N}_2 + 2\text{O}_2 \rightleftharpoons \text{N}_2\text{O}_4$ **CORE CONCEPT & DERIVATION**

Le Chatelier's principle states that if a dynamic equilibrium is perturbed by changing reactant or product concentration, the position of equilibrium shifts to counteract the perturbation.

Formula / Rule / Reaction:

$$Q_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} \quad (\text{Adding } \text{N}_2\text{O}_4 \Rightarrow Q_c < K_c \Rightarrow \text{Net Forward Shift})$$

Solution:

- Adding reactant N_2O_4 raises its concentration above the equilibrium value, causing the reaction quotient Q_c to drop below the equilibrium constant K_c .
- To restore equilibrium, the system consumes the added N_2O_4 by driving the forward reaction, producing more NO_2 .
- Therefore, adding N_2O_4 promotes the forward reaction.

Why other options are incorrect:

- Option B:** The reverse reaction would be favored if NO_2 were added, not if N_2O_4 is added.
- Option C:** Altering reactant concentration changes the chemical potential and directly shifts the equilibrium position.
- Option D:** While the forward dissociation is endothermic, adding a chemical reactant at constant temperature does not intrinsically heat the system.

Question #96 Key: (C)CHEMISTRY
04. Gases

5 calories are equivalent to _____ Joule.

CORE CONCEPT & DERIVATION

The thermochemical calorie is defined as exactly 4.184 Joules, establishing the standard conversion between these two thermal energy units.

Formula / Rule / Reaction:

$$1 \text{ cal} = 4.184 \text{ J} \Rightarrow E (\text{J}) = n (\text{cal}) \times 4.184 \text{ J/cal}$$

Solution:

- Using the standard conversion factor for 5 calories:
- $E = 5 \times 4.184 \text{ J} = 20.92 \text{ J}$
- Thus, 5 calories equals 20.92 Joules.

Why other options are incorrect:

- Option A:** 4.184 Joules represents the energy of exactly 1 calorie, not 5 calories.
- Option B:** 10.26 Joules is an arbitrary value resulting from an incorrect conversion factor.
- Option D:** 25.65 Joules overestimates the value, corresponding to roughly 6.13 calories.

Question #97 Key: (B)

CHEMISTRY
17. Aldehydes & Ketones

Which one of the following statements is NOT correct?

CORE CONCEPT & DERIVATION

Formaldehyde (methanal, HCHO) has a low molecular weight and weak intermolecular dipole-dipole attractions, giving it a boiling point of -19°C .

Formula / Rule / Reaction:

Physical State at 25°C : Boiling point of HCHO = $-19.5^{\circ}\text{C} \Rightarrow$ Gas

Solution:

- Because its boiling point is well below room temperature (-19.5°C vs. $20-25^{\circ}\text{C}$), formaldehyde exists as a colorless, pungent gas at standard ambient conditions.
- The common liquid product sold commercially (formalin) is an aqueous solution containing roughly 37% dissolved formaldehyde, not pure liquid formaldehyde.
- Therefore, the statement claiming formaldehyde is a liquid at room temperature is incorrect, making B the correct choice for this question.

Why other options are incorrect:

- Option A:** Formaldehyde is indeed a gas at room temperature.
- Option C:** Controlled catalytic dehydrogenation or oxidation of methanol over silver or copper catalysts produces formaldehyde: $\text{CH}_3\text{OH} + [\text{O}] \rightarrow \text{HCHO} + \text{H}_2\text{O}$.
- Option D:** Pyrolysis (dry distillation) of calcium formate yields formaldehyde: $(\text{HCOO})_2\text{Ca} \xrightarrow{\Delta} \text{HCHO} + \text{CaCO}_3$.

Question #98 Key: (A)

CHEMISTRY
02. Atomic Structure

Select the correct one:

CORE CONCEPT & DERIVATION

Chemical reactions involve breaking and forming chemical bonds through the sharing, gain, or loss of outer valence electrons, while the atomic nuclei remain completely unchanged.

Formula / Rule / Reaction:

Chemical Phenomenon $\equiv \Delta[\text{Electronic Cloud / Valence Orbitals}]$; Nucleus (Protons + Neutrons) = Constant

Solution:

- Ordinary chemical reactions involve changes in the electronic structure of atoms (specifically valence electrons in chemical bonds).
- The atomic nucleus, containing protons and neutrons, remains stable and intact throughout chemical transformations.
- Processes involving changes to nuclear composition are nuclear reactions, not chemical reactions.

Why other options are incorrect:

- Option B:** Protons and neutrons are bound tightly within the nucleus by the strong nuclear force and do not participate in ordinary chemical reactions.
- Option C:** Protons determine atomic identity and remain sequestered inside the nucleus; they do not engage in chemical bond rearrangements.
- Option D:** Neutrons are uncharged nuclear particles that play no role in chemical bonding or reactivity.

Question #99 Key: (A)

CHEMISTRY
07. Equilibrium

Le Chatelier's principle does NOT give information about the effect of the following on the equ...

CORE CONCEPT & DERIVATION

Le Chatelier's principle predicts the thermodynamic direction of equilibrium shifts in response to external perturbations, but provides no information regarding chemical reaction rates or time scales.

Formula / Rule / Reaction:

Thermodynamics (Equilibrium Position) $\neq$ Chemical Kinetics (Rate, Time to Equilibrium)

Solution:

- Le Chatelier's principle is a thermodynamic principle that predicts how changes in concentration, total pressure, or temperature shift an equilibrium position.
- It does not address chemical kinetics, activation energy, or the rate of reaction, and therefore provides no information about the time required to establish or re-establish equilibrium.

Why other options are incorrect:

- Option B:** Le Chatelier's principle directly predicts that increasing pressure shifts gas-phase equilibria toward the side with fewer moles of gas.
- Option C:** It directly predicts that increasing temperature shifts equilibria in the endothermic direction.
- Option D:** It directly predicts that adding or removing reactants or products shifts equilibria to offset the concentration change.

Question #100 Key: (C)

CHEMISTRY
04. Gases

Conversion of Fahrenheit to Celsius scale by:

CORE CONCEPT & DERIVATION

The Celsius and Fahrenheit scales are linked by a linear thermometric conversion based on the freezing and boiling points of pure water at standard atmospheric pressure.

Formula / Rule / Reaction:

$$\frac{^{\circ}\text{C} - 0}{100 - 0} = \frac{^{\circ}\text{F} - 32}{212 - 32} \Rightarrow \frac{^{\circ}\text{C}}{100} = \frac{^{\circ}\text{F} - 32}{180}$$

Solution:

- Simplifying the ratio of fundamental intervals:

$$\frac{^{\circ}\text{C}}{5} = \frac{^{\circ}\text{F} - 32}{9}$$

- Solving explicitly for temperature in degrees Celsius:

$$^{\circ}\text{C} = \frac{5}{9}(^{\circ}\text{F} - 32)$$

- Thus, option C provides the correct algebraic relationship.

Why other options are incorrect:

- Option A:** Adding 32 instead of subtracting it reverses the zero-point offset of the Fahrenheit scale.
- Option B:** The factor $\frac{9}{5}$ inverts the slope ratio, which would apply when solving for Fahrenheit ($^{\circ}\text{F} = \frac{9}{5}^{\circ}\text{C} + 32$).
- Option D:** Inverting the ratio and adding 32 produces an incorrect relationship on both counts.

Question #101 Key: (A)

CHEMISTRY
15. Alkyl Halides

Having knowledge of the bond energies of alkyl halides; the most reactive one is the

CORE CONCEPT & DERIVATION

The chemical reactivity of alkyl halides in nucleophilic substitution and elimination reactions is governed primarily by carbon-halogen bond length and bond dissociation energy.

Formula / Rule / Reaction:

Bond Energy: C – F (467 kJ/mol) > C – Cl (346 kJ/mol) > C – Br (290 kJ/mol) > C – I (228 kJ/mol)

Solution:

- Because iodine has the largest atomic radius among the halogens, the C – I bond is the longest and has the lowest bond dissociation energy.
- The weak C – I bond cleaves readily, making iodide (I^-) an excellent leaving group.
- Consequently, alkyl iodides exhibit the highest chemical reactivity among alkyl halides.

Why other options are incorrect:

- **Option B:** The C – Br bond has a higher bond dissociation energy (290 kJ/mol) than the C – I bond, making bromo-compounds less reactive than iodo-compounds.
- **Option C:** The C – Cl bond is strong (346 kJ/mol), resulting in lower reactivity toward substitution.
- **Option D:** The C – F bond is exceptionally strong (467 kJ/mol), rendering alkyl fluorides largely unreactive under standard conditions.

Question #102 Key: (B)

CHEMISTRY
19. Macromolecules / Biochemistry

Amino acids, which are not synthesized by the human body are:

CORE CONCEPT & DERIVATION

Amino acids are nutritionally categorized based on the human body's metabolic capability to biosynthesize their carbon skeletons de novo.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Humans can synthesize approximately 10 of the 20 standard proteinogenic amino acids through transamination pathways.
- The remaining amino acids (such as leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, and histidine) cannot be synthesized endogenously.
- Because they must be acquired through dietary sources, they are designated as essential amino acids.

Why other options are incorrect:

- **Option A:** Non-essential amino acids can be synthesized endogenously from metabolic intermediates.
- **Option C:** 'Dietary amino acids' is an informal description rather than the formal biochemical taxonomic classification.
- **Option D:** Synthetic amino acids are non-natural peptides produced chemically in vitro.

Question #103 Key: (B)

CHEMISTRY
12. Transition Elements

Transition metal compounds containing unpaired electrons are:

CORE CONCEPT & DERIVATION

Chemical species with unpaired electronic spins possess permanent net magnetic dipole moments, causing them to be drawn into externally applied magnetic fields.

Formula / Rule / Reaction:

$$\mu_{\text{eff}} = \sqrt{n(n+2)} \mu_B \quad (n = \text{number of unpaired electrons, } \mu_B = \text{Bohr magnetons})$$

Solution:

- In transition metal complexes with partially filled d -subshells, unpaired electrons generate permanent magnetic dipoles due to spin and orbital angular momentum.
- When placed in an external magnetic field, these magnetic dipoles align parallel to the field lines.
- This alignment results in a net attractive force pulling the substance into the magnetic field, a property termed paramagnetism.

Why other options are incorrect:

- **Option A:** Diamagnetism occurs only when all electrons are paired, resulting in zero net magnetic spin moment.
- **Option C:** Paramagnetic substances experience a measurable attractive force toward magnetic poles.
- **Option D:** Substances that are weakly repelled by magnetic fields are diamagnetic, not paramagnetic.

Question #104 Key: (D)

CHEMISTRY
04. Gases

Which of the following is NOT the state of matter:

CORE CONCEPT & DERIVATION

States of matter represent distinct macroscopic physical forms assumed by chemical substances depending on temperature and pressure.

Formula / Rule / Reaction:

Fundamental States of Matter = Solid, Liquid, Gas, Plasma, Bose-Einstein Condensate

Solution:

- Solids, liquids, gases, and ionized plasma represent universal physical states of matter.
- Ether refers to a specific class of organic chemical compounds containing an oxygen atom bonded to two alkyl or aryl groups (R-O-R').
- Therefore, ether is a chemical class, not a state of matter.

Why other options are incorrect:

- **Option A:** Plasma is a recognized state of matter consisting of a gas-like mixture of free electrons and positive ions.
- **Option B:** Liquid is one of the three classical fundamental states of matter.
- **Option C:** Gas is a recognized fundamental state of matter characterized by widely spaced particles.

Question #105 Key: (B)

CHEMISTRY
15. Alkyl Halides

In organic chemistry, a nucleus liking agent, rich in electrons, is defined as:

CORE CONCEPT & DERIVATION

Chemical reagents are classified as nucleophiles or electrophiles based on their electronic density and Lewis acid-base behavior.

Formula / Rule / Reaction:



Solution:

- A nucleophile (meaning 'nucleus lover') is an electron-rich chemical species possessing an unshared lone pair of electrons or a pi-bond.
- It acts as a Lewis base by donating an electron pair to an electron-deficient, positively polarized atomic center.
- Thus, an electron-rich, nucleus-seeking species is defined as a nucleophile.

Why other options are incorrect:

- Option A:** A nucleotide is a biochemical monomer comprising a nitrogenous base, a pentose sugar, and a phosphate group.
- Option C:** An electrophile is an electron-deficient species (Lewis acid) that accepts an electron pair.
- Option D:** 'Electron affluent' is an informal descriptive phrase rather than a recognized IUPAC chemical term.

Question #106 Key: (A)

CHEMISTRY
06. Solids

The term 'Transition Temperature' is used for the temperature:

CORE CONCEPT & DERIVATION

The transition temperature of an allotropic or polymorphic solid is the temperature at which two distinct crystalline forms coexist in thermodynamic equilibrium.

Formula / Rule / Reaction:



$\text{\text{Example: } } \alpha \text{ (Rhombic Sulfur)} \rightleftharpoons \beta \text{ (Monoclinic Sulfur)}$

Solution:

- Polymorphic elements and compounds can adopt different crystal lattice structures depending on temperature.
- The transition temperature is the precise point at which one crystalline phase reversibly transforms into another, with both structures sharing identical free energy at that point.

Why other options are incorrect:

- Option B:** The temperature at which a crystalline solid transforms into a turbid liquid-crystal state is termed the melting point of the liquid crystal, while clearance to an isotropic liquid occurs at the clearing point.
- Option C:** Crystal habit relates to external geometric growth conditions rather than polymorphic phase transition equilibrium.
- Option D:** Anisotropic properties change continuously or discontinuously across various phase boundaries, but the formal definition refers to polymorphic crystal transformation.

Question #107 Key: (B)

CHEMISTRY
19. Macromolecules / Biochemistry

The non-protein part of an enzyme is called:

CORE CONCEPT & DERIVATION

Conjugated enzymes (holoenzymes) consist of a catalytic protein portion (apoenzyme) joined to a non-protein cofactor or coenzyme.

Formula / Rule / Reaction:



Solution:

- When an enzyme requires a non-protein component to achieve catalytic activity, the protein portion alone is designated the apoenzyme.
- The non-protein organic cofactor that assists catalytic transfer is termed a coenzyme (e.g., NAD⁺, FAD, Coenzyme A).
- Among the given options, co-enzyme represents the non-protein component of the enzyme system.

Why other options are incorrect:

- Option A:** Activator refers specifically to an inorganic metal ion cofactor (e.g., Mg²⁺, Zn²⁺), not the broader non-protein group.
- Option C:** The substrate is the external reactant molecule that binds the enzyme, not a component of the enzyme itself.
- Option D:** The apoenzyme is specifically the protein portion of the enzyme, excluding the non-protein group.

Question #108 Key: (C)

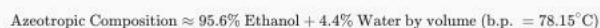
CHEMISTRY
16. Alcohols & Phenols

The concentration of rectified spirit is:

CORE CONCEPT & DERIVATION

Fractional distillation of aqueous ethanol mixtures forms an azeotrope that prevents simple distillation beyond a constant boiling point composition.

Formula / Rule / Reaction:



Solution:

- Rectified spirit is the concentrated ethanol distillate obtained from the industrial fermentation of molasses or starch.
- Because ethanol and water form a minimum-boiling azeotropic mixture at approximately 95.6% ethanol by volume, straightforward fractional distillation cannot exceed this threshold.
- Textbook conventions round this concentration to 95% ethanol.

Why other options are incorrect:

- Option A:** 85% represents an intermediate distillate before final rectification column enrichment.
- Option B:** 90% is below the stable azeotropic limit achieved by standard industrial rectification columns.
- Option D:** 100% represents absolute alcohol, which cannot be achieved by simple distillation and requires azeotropic distillation with benzene or dehydration over calcium oxide.

Question #109 Key: (A)

CHEMISTRY
15. Alkyl Halides

Alkyl halides can yield ethers when heated in the presence of the metallic compound:

CORE CONCEPT & DERIVATION

Alkyl halides react with dry silver oxide upon heating to form symmetrical ethers via nucleophilic displacement of halide ions by the bridging oxide.

Formula / Rule / Reaction:



Solution:

- Heating an alkyl halide with dry silver oxide precipitates silver halide and produces a symmetrical ether.
- Although silver oxide is stoichiometric Ag_2O , older board examinations and curricula write silver oxide as 'AgO'.
- Thus, option A represents the intended reagent for this ether synthesis reaction.

Why other options are incorrect:

- **Option B:** Copper(II) oxide (CuO) is an oxidizing agent that does not convert alkyl halides to ethers under these conditions.
- **Option C:** ' Cu_2O_2 ' is a non-standard chemical formula.
- **Option D:** Iron(II) oxide (FeO) does not displace alkyl halides to yield ethers.

Question #110 Key: (D)

CHEMISTRY
19. Macromolecules / Biochemistry

The lipids which have a tetracyclic compound are called Steroids. The tetracyclic compound is:

CORE CONCEPT & DERIVATION

Steroids are non-saponifiable lipids characterized by a shared carbon framework of four fused rings: three six-membered rings and one five-membered ring.

Formula / Rule / Reaction:

Steroid Core: Cyclopentanoperhydrophenanthrene = Perhydrophenanthrene (Rings A, B, C) + Cyclopentane (Ring D)

Solution:

- The steroid carbon skeleton consists of a 17-carbon fused ring system: cyclopentanoperhydrophenanthrene.
- The three six-membered rings (A, B, and C) adopt the fused arrangement of the aromatic hydrocarbon phenanthrene (in fully saturated, perhydrogenated form).
- Hence, the primary parent polycyclic hydrocarbon referenced in standard curricula is phenanthrene.

Why other options are incorrect:

- **Option A:** Benzene is a single, isolated six-membered aromatic ring (C_6H_6), not a polycyclic system.
- **Option B:** 'Tetracyclic' is a general descriptor for four-ring compounds, not the chemical name of the parent hydrocarbon system.
- **Option C:** Cyclopentane forms only the single five-membered terminal ring (Ring D), rather than the larger parent polycyclic framework.

Question #111 Key: (C)

CHEMISTRY
07. Equilibrium

The equilibrium constant has no units if the number of moles of products is:

CORE CONCEPT & DERIVATION

The dimensional units of the concentration equilibrium constant K_c depend directly on the change in stoichiometric coefficients across the reaction.

Formula / Rule / Reaction:

$$\text{Units of } K_c = (\text{mol} \cdot \text{dm}^{-3})^{\Delta n}, \quad \text{where } \Delta n = \sum n_{\text{products}} - \sum n_{\text{reactants}}$$

Solution:

- When the sum of moles of gaseous or dissolved products equals the sum of moles of reactants, $\Delta n = 0$.
- Substituting this into the dimensional formula gives:
- Units of $K_c = (\text{mol} \cdot \text{dm}^{-3})^0 = 1$ (dimensionless)
- Therefore, K_c has no units when the number of moles of products equals the number of moles of reactants.

Why other options are incorrect:

- **Option A:** When products are fewer than reactants, $\Delta n < 0$, giving K_c inverse concentration units (e.g., $\text{dm}^3 \cdot \text{mol}^{-1}$).
- **Option B:** When products exceed reactants, $\Delta n > 0$, giving K_c positive concentration units (e.g., $\text{mol} \cdot \text{dm}^{-3}$).
- **Option D:** When products are half of reactants, Δn is negative, which also leaves K_c with dimensional units.

Question #112 Key: (D)

CHEMISTRY
02. Atomic Structure

Which statement is NOT correct for cathode rays?

CORE CONCEPT & DERIVATION

Cathode rays are streams of fast-moving electrons produced in gas discharge tubes, possessing finite rest mass, electrical charge, and variable subluminal velocity.

Formula / Rule / Reaction:

$$v = \sqrt{\frac{2eV}{m_e}} < c \quad (c = 3.0 \times 10^8 \text{ m/s})$$

Solution:

- Because electrons have non-zero rest mass ($m_e = 9.11 \times 10^{-31} \text{ kg}$), special relativity dictates that they cannot reach the speed of light in vacuum (c).
- The velocity of cathode-ray electrons depends on the applied potential difference V and typically ranges from $0.05c$ to $0.2c$.
- Therefore, stating that cathode rays travel at the speed of light is incorrect, making D the correct choice.

Why other options are incorrect:

- **Option A:** J.J. Thomson and William Crookes showed that cathode rays rotate small paddle wheels, proving they consist of material particles carrying mechanical momentum.
- **Option B:** Electrons have a measurable rest mass of $9.109 \times 10^{-31} \text{ kg}$.
- **Option C:** For a fixed accelerating voltage across the tube, the electrons have a defined kinetic velocity.

Question #113 Key: (B)

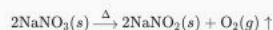
CHEMISTRY
11. S & P Block Elements

Sodium nitrate ([Formula]), on heating, decomposes forming:

CORE CONCEPT & DERIVATION

Thermal stability of Group 1 metal nitrates depends on cationic charge density; alkali metal nitrates (except lithium) decompose upon gentle heating into nitrites and oxygen.

Formula / Rule / Reaction:



Solution:

- Because Na^+ has a relatively large ionic radius and low polarizability compared to Li^+ , it does not heavily polarize the nitrate ion.
- Consequently, thermal decomposition of sodium nitrate produces pale-yellow sodium nitrite (NaNO_2) and evolves oxygen gas (O_2).
- It does not decompose to sodium oxide and nitrogen dioxide under standard heating.

Why other options are incorrect:

- Option A:** Lithium nitrate decomposes to form Li_2O , NO_2 , and O_2 due to lithium's high charge density, but sodium nitrate decomposes to the nitrite instead.
- Option C:** Thermal decomposition of nitrates does not yield free elemental sodium metal.
- Option D:** ' O_1 ' is chemically unviable; oxygen gas is released as diatomic O_2 .

Question #114 Key: (D)

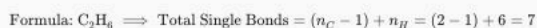
CHEMISTRY
03. Chemical Bonding

A molecule of ethane has _____ bonds.

CORE CONCEPT & DERIVATION

The total number of covalent bonds in an alkane molecule is determined by summing its carbon-carbon and carbon-hydrogen single sigma bonds.

Formula / Rule / Reaction:



Solution:

- Ethane ($\text{CH}_3 - \text{CH}_3$) contains two carbon atoms and six hydrogen atoms.
- There is 1 carbon-carbon single bond ($\text{C} - \text{C}$).
- There are 6 carbon-hydrogen single bonds ($\text{C} - \text{H}$).
- Summing these yields $1 + 6 = 7$ total covalent bonds.

Why other options are incorrect:

- Option A:** Four bonds describes methane (CH_4), which has only four $\text{C} - \text{H}$ bonds.
- Option B:** Five bonds accounts for only a portion of the covalent bonds in ethane.
- Option C:** Six counts only the $\text{C} - \text{H}$ bonds, omitting the central $\text{C} - \text{C}$ bond.

Question #115 Key: (C)

CHEMISTRY
02. Atomic Structure

The only group of lines occurring in the visible region of the hydrogen spectrum is labeled as ...

CORE CONCEPT & DERIVATION

Electronic de-excitation in atomic hydrogen produces spectral series whose transition energies correspond to specific regions of the electromagnetic spectrum.

Formula / Rule / Reaction:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right) \quad (n_2 = 3, 4, 5, \dots; \text{ Balmer Series: } \lambda \approx 400\text{--}700 \text{ nm})$$

Solution:

- When an electron in an excited hydrogen atom falls to the $n_1 = 2$ energy level from higher levels ($n_2 \geq 3$), the emitted photons have wavelengths between 364 nm and 656 nm.
- This wavelength range corresponds to the visible spectrum, comprising the four classical spectral lines: H_α (red), H_β (cyan), H_γ (blue), and H_δ (violet).
- This series is designated the Balmer series.

Why other options are incorrect:

- Option A:** The Paschen series (transitions to $n_1 = 3$) lies in the near-infrared region.
- Option B:** The Pfund series (transitions to $n_1 = 5$) lies in the far-infrared region.
- Option D:** The Lyman series (transitions to $n_1 = 1$) produces high-energy emissions in the ultraviolet region.

Question #116 Key: (A)

CHEMISTRY
10. Electrochemistry

Electric current in solutions is carried by:

CORE CONCEPT & DERIVATION

Electrical conduction in electrolytic solutions occurs via the directional migration of solvated ions toward oppositely charged electrodes under an electric field.

Formula / Rule / Reaction:

$$\text{Total Current: } I = I_{\text{cations}} + I_{\text{anions}} = AF \sum |z_i| u_i c_i E$$

Solution:

- In aqueous solutions of electrolytes, solute molecules dissociate into positively charged cations and negatively charged anions.
- When an external electric potential is applied, cations migrate toward the cathode, while anions migrate toward the anode.
- This collective movement of ions constitutes the electric current in solution.

Why other options are incorrect:

- Option B:** Canal rays are beams of positive gaseous ions produced in low-pressure discharge tubes, not carriers in liquid solutions.
- Option C:** Free protons do not exist independently in solution; they associate with water molecules to form hydronium ions (H_3O^+).
- Option D:** Free electrons conduct current in solid metallic conductors and graphite, but cannot move freely through aqueous electrolytic solutions.

Question #117 Key: (A)

CHEMISTRY
14. Hydrocarbons

In alkane series, all the linkages between carbon atoms is / are _____ bond(s).

CORE CONCEPT & DERIVATION

Alkanes are saturated acyclic hydrocarbons containing only sp^3 -hybridized carbon atoms linked entirely by single sigma bonds.

Formula / Rule / Reaction:

Alkanes: $C_nH_{2n+2} \Rightarrow$ Every C – C bond is a single σ -bond formed by sp^3 - sp^3 orbital overlap

Solution:

- By IUPAC definition, alkanes are saturated hydrocarbons containing the maximum possible number of bonded hydrogen atoms per carbon.
- They contain no pi-bonds; every carbon-carbon linkage is a single sigma bond.

Why other options are incorrect:

- Option B:** Double bonds characterize unsaturated hydrocarbons belonging to the alkene series (C_nH_{2n}).
- Option C:** Triple bonds characterize unsaturated hydrocarbons belonging to the alkyne series (C_nH_{2n-2}).
- Option D:** Quadruple covalent bonds between carbon atoms do not occur in stable organic molecules.

Question #118 Key: (B)

CHEMISTRY
01. Stoichiometry

In a chemical reaction, a limiting reactant is that:

CORE CONCEPT & DERIVATION

The limiting reactant is the reagent that is consumed first in a chemical reaction, thereby limiting the theoretical yield of products formed.

Formula / Rule / Reaction:

$$\text{Limiting Reactant} \Rightarrow \min \left(\frac{n_{\text{available}}}{\text{stoichiometric coefficient}} \right)$$

Solution:

- In a non-stoichiometric mixture of reactants, one reagent will be present in a smaller stoichiometric amount than required to consume all other reactants.
- This reactant is fully consumed first, leaving other reagents in excess and halting further product formation.
- Because it is completely consumed, it is the reactant that is not in excess.

Why other options are incorrect:

- Option A:** The reactant present in excess remains unreacted after the limiting reagent is completely consumed.
- Option C:** A catalyst increases the reaction rate without being consumed and does not determine theoretical product yield.
- Option D:** This describes an inert solvent, promoter, or catalyst rather than a chemical reactant.

Question #119 Key: (C)

CHEMISTRY
09. Thermochemistry

Units of change in enthalpy of a system are

CORE CONCEPT & DERIVATION

Enthalpy is an extensive state function defined as $H = U + PV$, with units corresponding to energy.

Formula / Rule / Reaction:

$$\Delta H = q_p \quad (\text{SI Unit: Joule [J] or Kilojoule [kJ]})$$

$$\text{Base Units: } 1 \text{ J} = 1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{m}^2 \cdot \text{s}^{-2}$$

Solution:

- Enthalpy change (ΔH) represents the heat absorbed or evolved by a system at constant pressure.
- Because it quantifies energy, its standard International System of Units (SI) unit is the Joule (J).

Why other options are incorrect:

- Option A:** Cubic centimeters ("cc") is a volumetric unit, not an energy unit.
- Option B:** Degrees Celsius ("°C") is a unit of temperature, not energy.
- Option D:** Pascal ("Pa") is the SI unit of pressure (N/m^2).

Question #120 Key: (B)

CHEMISTRY
06. Solids

Electrically diamond is a:

CORE CONCEPT & DERIVATION

Electrical conduction in solids requires mobile delocalized electrons or ions; diamond's rigid covalent network locks all valence electrons into localized sigma bonds.

Formula / Rule / Reaction:

Diamond: sp^3 -hybridized carbons $\rightarrow$ 4 covalent σ -bonds per carbon $\Rightarrow$ Band Gap (E_g) $\approx$ 5.5 eV

Solution:

- In diamond, each carbon atom is tetrahedrally bonded to four neighboring carbon atoms via localized sp^3 sigma bonds.
- All four valence electrons of every carbon atom are firmly engaged in covalent bonding, leaving no free or delocalized electrons.
- Its wide band gap ($\approx$ 5.5 eV) prevents thermal promotion of electrons to the conduction band at ordinary temperatures, making diamond an electrical non-conductor (insulator).

Why other options are incorrect:

- Option A:** Good conductors (such as metals or graphite) contain mobile, delocalized electrons that move under an electric field.
- Option C:** Semiconductors possess narrow band gaps ($\approx$ 1 eV), whereas diamond's large band gap makes it an insulator.
- Option D:** Diamond is a non-conductor, making this option invalid.

Question #121 Key: (A)CHEMISTRY
19. Macromolecules / Biochemistry

Which of the following food product has lower energy per gram?

CORE CONCEPT & DERIVATION

The caloric density of food is determined by its water content and macronutrient composition (lipids yield ≈ 9 kcal/g, whereas carbohydrates and proteins yield ≈ 4 kcal/g).

Formula / Rule / Reaction:

Caloric Values: Lipids ≈ 9 kcal/g; Carbohydrates ≈ 4 kcal/g; Water = 0 kcal/g

Solution:

- Ghee is concentrated butterfat delivering approximately 9 kcal/g.
- Butter contains roughly 80% fat, yielding around 7.2 kcal/g.
- Glucose is a solid carbohydrate yielding approximately 4 kcal/g.
- Whole liquid milk consists of approximately 87% water, yielding only 0.65 kcal/g.
- Thus, milk has the lowest energy content per gram.

Why other options are incorrect:

- Option B:** Ghee has the highest energy density of the choices, providing roughly 9 kcal/g.
- Option C:** Butter delivers high energy density due to its 80% lipid content.
- Option D:** Glucose provides roughly 4 kcal/g, six times the caloric density of liquid milk.

Question #122 Key: (B)CHEMISTRY
10. Electrochemistry

Which of the following is used for galvanizing iron sheet?

CORE CONCEPT & DERIVATION

Galvanization is the application of a sacrificial protective zinc coating to iron or steel components to prevent rusting.

Formula / Rule / Reaction:

Anodic Oxidation: $\text{Zn}(s) \rightarrow \text{Zn}^{2+}(aq) + 2e^-$ ($E^\circ = -0.76$ V vs. $E^\circ_{\text{Fe}} = -0.44$ V)

Solution:

- Galvanizing involves applying a layer of metallic zinc to iron or steel surfaces.
- Zinc protects iron both as a physical barrier and, because it has a more negative reduction potential than iron, as a sacrificial anode if the coating is damaged.

Why other options are incorrect:

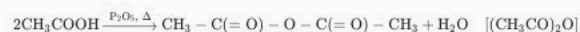
- Option A:** Applying a tin coating to iron is called tinning, not galvanizing.
- Option C:** Coating with aluminum is known as aluminizing.
- Option D:** Copper is less active than iron; a damaged copper coating accelerates the electrochemical corrosion of underlying iron.

Question #123 Key: (D)CHEMISTRY
18. Carboxylic Acids

On heating acetic acid in the presence of [Formula], dehydration occurs with the formation of

CORE CONCEPT & DERIVATION

Phosphorus pentoxide (P_2O_5 or P_2O_3) is a potent chemical dehydrating agent that removes water intermolecularly from carboxylic acids to form acid anhydrides.

Formula / Rule / Reaction:**Solution:**

- Heating two molecules of acetic acid (ethanoic acid) with P_2O_5 removes one molecule of water between their carboxyl groups.
- This condensation reaction links the two acyl groups through an oxygen bridge, forming acetic anhydride (ethanoic anhydride).

Why other options are incorrect:

- Option A:** Acetamide (CH_3CONH_2) forms by heating ammonium acetate, which requires a nitrogen source.
- Option B:** Octyl acetate is an ester synthesized by reacting acetic acid with octanol, not by self-dehydration.
- Option C:** Methyl acetate is an ester synthesized by esterifying acetic acid with methanol.

Question #124 Key: (D)CHEMISTRY
02. Atomic Structure

One picometer (pm) = ?

CORE CONCEPT & DERIVATION

The International System of Units (SI) assigns standardized decimal prefixes to designate submultiples of length.

Formula / Rule / Reaction:

SI Prefixes: Micro (μ) = 10^{-6} ; Nano (n) = 10^{-9} ; Pico (p) = 10^{-12} ; Femto (f) = 10^{-15}

Solution:

- By international metrological definition, the prefix 'pico-' denotes a factor of 10^{-12} .
- Therefore, one picometer (1 pm) equals exactly 10^{-12} meters.

Why other options are incorrect:

- Option A:** 10^{-6} m defines one micrometer (1 μm).
- Option B:** 10^{-8} m is ten nanometers (10 nm), not a standard single-prefix unit.
- Option C:** 10^{-10} m defines one angstrom (1 Å or 100 pm).

Question #125 Key: (B)

CHEMISTRY
01. Stoichiometry*Isotopes differ from each other on the basis of:***CORE CONCEPT & DERIVATION**

Isotopes are nuclides of the same chemical element that contain identical numbers of protons (same atomic number Z) but different numbers of neutrons (different mass number A).

Formula / Rule / Reaction:

$$\text{Mass Number } (A) = Z \text{ (protons)} + N \text{ (neutrons)} \Rightarrow \text{Different } N \Rightarrow \text{Different } A$$

Solution:

- Isotopes share the same atomic number Z and therefore possess identical electron counts and electronic configurations in their neutral states.
- They differ in the number of neutrons N contained within their nuclei.
- Because $A = Z + N$, varying neutron counts give isotopes distinct mass numbers A .

Why other options are incorrect:

- Option A:** Neutral isotopes of the same element have the same number of electrons (equal to Z).
- Option C:** Because they have the same number of electrons, isotopes share identical ground-state electronic configurations.
- Option D:** Crystal lattice describes bulk solid-state packing geometry rather than the nuclear definition of isotopes.

Question #126 Key: (C)

CHEMISTRY
01. Stoichiometry*Carbon atom is used to measure relative:***CORE CONCEPT & DERIVATION**

The modern atomic weight scale is based on the carbon-12 (^{12}C) nuclide, which serves as the international reference standard for relative atomic mass.

Formula / Rule / Reaction:

$$1 \text{ atomic mass unit (amu or u)} = \frac{1}{12} \times \text{mass of one } ^{12}\text{C atom} \approx 1.66054 \times 10^{-27} \text{ kg}$$

Solution:

- By international agreement (IUPAC, 1961), the isotope carbon-12 was defined as having an atomic mass of exactly 12 unified atomic mass units.
- The atomic masses of all other elements are determined relative to one-twelfth the mass of a single carbon-12 atom.
- Therefore, the carbon atom serves as the universal standard for relative atomic mass.

Why other options are incorrect:

- Option A:** Atomic size is determined experimentally using X-ray diffraction and spectroscopy, not relative to a carbon standard.
- Option B:** Atomic number is the absolute count of nuclear protons, determined by Moseley's law and X-ray emission characteristics.
- Option D:** Atomic volume is calculated from molar mass and density rather than measured against a carbon-12 standard.

Question #127 Key: (C)

CHEMISTRY
14. Hydrocarbons*_____ is regarded as the simplest and the parent member of aromatic class of compounds.***CORE CONCEPT & DERIVATION**

Aromatic hydrocarbons (arenes) are cyclic, planar, conjugated compounds obeying Hückel's rule ($4n + 2 \pi$ electrons), with benzene serving as the parent structure.

Formula / Rule / Reaction:

$$\text{Benzene: } \text{C}_6\text{H}_6 \quad (n = 1 \Rightarrow 4(1) + 2 = 6 \pi \text{ electrons, fully delocalized})$$

Solution:

- Benzene (C_6H_6) is a planar hexagonal ring of six sp^2 -hybridized carbon atoms with a continuous ring of six delocalized π -electrons.
- It is the simplest stable aromatic hydrocarbon and serves as the structural parent from which all benzenoid aromatic derivatives are derived.

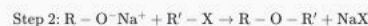
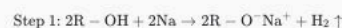
Why other options are incorrect:

- Option A:** Methanol (CH_3OH) is a simple aliphatic alcohol.
- Option B:** Acetylene (C_2H_2) is a linear aliphatic alkyne containing a carbon-carbon triple bond.
- Option D:** Acetic acid (CH_3COOH) is an aliphatic carboxylic acid.

Question #128 Key: (C)

CHEMISTRY
15. Alkyl Halides*The procedure for the preparation of ethers in which an alcohol is first allowed to react with ...***CORE CONCEPT & DERIVATION**

The Williamson ether synthesis prepares symmetrical and unsymmetrical ethers via an $\text{S}_{\text{N}}2$ displacement of a halide from an alkyl halide by an alkoxide ion.

Formula / Rule / Reaction:**Solution:**

- An alcohol first reacts with metallic sodium to form a reactive sodium alkoxide ($\text{R} - \text{O}^- \text{Na}^+$) with the evolution of hydrogen gas.
- The alkoxide ion then acts as a nucleophile, attacking an alkyl halide in an $\text{S}_{\text{N}}2$ displacement to form an ether.
- This two-step procedure is the Williamson ether synthesis.

Why other options are incorrect:

- Option A:** Tollens' reagent (ammoniacal silver nitrate) is an analytical test used to oxidize aldehydes, producing a silver mirror.
- Option B:** Fehling's solution is an analytical test used to detect reducing sugars and aliphatic aldehydes.
- Option D:** Grignard synthesis involves organomagnesium halides used to construct carbon-carbon bonds, forming alcohols or carboxylic acids.

Question #129 Key: (B)

CHEMISTRY
04. Gases

Inter molecular repulsive forces in gases are due to

CORE CONCEPT & DERIVATION

Intermolecular interactions described by the Lennard-Jones potential encompass both long-range attractions and short-range repulsions, grouped under Van der Waals phenomena.

Formula / Rule / Reaction:

$$V(r) = 4\epsilon \left[\left(\frac{\sigma}{r} \right)^{12} - \left(\frac{\sigma}{r} \right)^6 \right] \quad (r^{-12} = \text{short-range Pauli electron repulsion})$$

Solution:

- Real gas molecules exhibit attractive forces at intermediate distances and strong repulsive forces when their electron clouds overlap at very short distances (Pauli repulsion).
- The Van der Waals equation of state accounts for these intermolecular forces and molecular volume via parameters a and b .
- In standard curriculum terminology, these non-bonding intermolecular interactions in gases are grouped under Van der Waals forces.

Why other options are incorrect:

- Option A:** Ionic bonding involves strong electrostatic forces between oppositely charged ions in crystal lattices, not neutral gas molecules.
- Option C:** Permanent dipoles produce electrostatic attractions and repulsions, but do not describe the universal repulsive interactions in non-polar gases.
- Option D:** Covalent bonding involves intramolecular orbital sharing within molecules, not intermolecular gas repulsions.

Question #130 Key: (C)

CHEMISTRY
20. Industrial Chemistry

The polymer formed from a single type of monomer is called:

CORE CONCEPT & DERIVATION

Synthetic and natural polymers are classified by monomer diversity into homopolymers (one monomer species) and copolymers (multiple monomer species).

Formula / Rule / Reaction:



Solution:

- A homopolymer is constructed entirely from repeated additions or condensations of a single chemical monomer species.
- Examples include polyethylene (from ethylene), polyvinyl chloride (from vinyl chloride), and polypropylene (from propylene).

Why other options are incorrect:

- Option A:** A terpolymer is synthesized by polymerizing three distinct monomer species (e.g., ABS resin).
- Option B:** A copolymer is synthesized from two or more distinct monomer species (e.g., nylon-6,6 or SBR rubber).
- Option D:** A thermosetting polymer is defined by its irreversible cross-linking upon heating, regardless of monomer count.

Question #131 Key: (B)

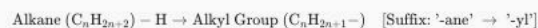
CHEMISTRY
14. Hydrocarbons

When a hydrogen atom of an alkane is removed, the resulting group is called:

CORE CONCEPT & DERIVATION

Removing a terminal hydrogen atom from an aliphatic alkane produces a monovalent hydrocarbon radical or substituent designated as an alkyl group.

Formula / Rule / Reaction:



Solution:

- Removing one hydrogen atom from an alkane leaves a monovalent radical with the general formula $C_nH_{2n+1}-$.
- This substituent is named by replacing the alkane suffix '-ane' with '-yl' (e.g., methane $\rightarrow$ methyl, ethane $\rightarrow$ ethyl).
- These groups are collectively termed alkyl groups.

Why other options are incorrect:

- Option A:** An aryl group ($Ar-$) is formed by removing a hydrogen atom from an aromatic ring.
- Option C:** An alkenyl group is formed by removing a hydrogen atom from an alkene (e.g., ethenyl or vinyl).
- Option D:** A phenyl group (C_6H_5-) is a specific aryl group formed by removing a hydrogen atom from benzene.

Question #132 Key: (D)

CHEMISTRY
13. Fundamental Principles of Organic Chemistry

The IUPAC name of the following compound is: $\text{CH}_3-\text{CH}_2-\text{CH}(\text{Cl})-\text{CH}_2-\text{CH}_3$

CORE CONCEPT & DERIVATION

IUPAC rules for branched haloalkanes require identifying the longest continuous carbon chain and numbering it from the end that gives substituents the lowest possible locants.

Formula / Rule / Reaction:



Solution:

- The longest continuous carbon chain contains five carbon atoms, identifying the parent alkane as pentane.
- Numbering from either end locates the branching tertiary carbon symmetrically at position 3.
- Carbon-3 bears two substituents: a chloro group ($-\text{Cl}$) and a methyl group ($-\text{CH}_3$).
- Listing substituents alphabetically yields: '3-chloro-3-methylpentane'.

Why other options are incorrect:

- Option A:** Hexylchloride denotes 1-chlorohexane, a linear six-carbon primary alkyl halide.
- Option B:** '3-chloromethylhexane' misidentifies the longest carbon chain length and treats the main chain incorrectly.
- Option C:** '3-chloro-3-ethylbutane' chooses a shorter four-carbon chain (butane) instead of the continuous five-carbon chain (pentane).

Question #133 Key: (B)

CHEMISTRY
13. Fundamental Principles of Organic Chemistry

The early chemists never succeeded in synthesizing organic compounds, and their failure led the...

CORE CONCEPT & DERIVATION

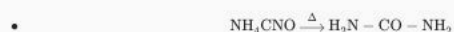
The Vital Force Theory (proposed by Jöns Jacob Berzelius) held that organic compounds could not be synthesized in vitro from inorganic matter and required a 'vital force' found only in living organisms.

Formula / Rule / Reaction:



Solution:

- Early chemists were unable to synthesize organic substances directly from elemental or mineral precursors in the laboratory.
- This experimental limitation led to the hypothesis that organic compounds could be produced only by and within living organisms through an inherent 'vital force'.
- This theory was disproved in 1828 when Friedrich Wöhler synthesized organic urea from inorganic ammonium cyanate:



Why other options are incorrect:

- **Option A:** The failure to synthesize organic compounds using pure reagents led chemists to assume a vital force was required, rather than assuming pure reagents were the missing factor.
- **Option C:** Early chemists had access to organic solvents (such as alcohol and ether) but still could not synthesize organic molecules from minerals.
- **Option D:** High-temperature/pressure industrial techniques were developed much later in the 19th and 20th centuries.

Question #134 Key: (C)

CHEMISTRY
10. Electrochemistry

Oxidation number of Mn in [Formula] is:

CORE CONCEPT & DERIVATION

The oxidation number of a central transition metal in a neutral salt is calculated by balancing the assigned oxidation states of the surrounding ions to maintain electrical neutrality.

Formula / Rule / Reaction:

$$\sum \text{Oxidation Numbers} = 0 \implies 2(\text{O.N. of K}) + (\text{O.N. of Mn}) + 4(\text{O.N. of O}) = 0$$

Solution:

- Potassium is an alkali metal with an oxidation state of +1.
- Oxygen in oxoanions has an oxidation state of -2.
- Setting up the algebraic equation for neutral K_2MnO_4 :

$$2(+1) + x + 4(-2) = 0$$

$$+2 + x - 8 = 0 \implies x - 6 = 0 \implies x = +6$$

- Thus, the oxidation state of manganese in potassium manganate is +6.

Why other options are incorrect:

- **Option A:** +4 is the oxidation state of manganese in manganese dioxide (MnO_2).
- **Option B:** +5 corresponds to the hypomanganate ion (MnO_4^{3-}), not the manganate salt.
- **Option D:** +7 is the oxidation state of manganese in potassium permanganate (KMnO_4).

Question #135 Key: (D)

CHEMISTRY
16. Alcohols & Phenols

Which of the following compound is not an alcohol:

CORE CONCEPT & DERIVATION

Aliphatic alcohols are organic compounds conforming to the general formula $\text{C}_n\text{H}_{2n+1}\text{OH}$ (or $\text{R}-\text{OH}$), where a hydroxyl group is bonded to an sp^3 -hybridized carbon.

Formula / Rule / Reaction:

$$\text{General Formula: } \text{C}_n\text{H}_{2n+1}\text{OH} \quad (n = 3, 4, 5)$$

Solution:

- $\text{C}_3\text{H}_7\text{OH}$ represents propanol (propyl alcohol, $n = 3$).
- $\text{C}_4\text{H}_9\text{OH}$ represents butanol (butyl alcohol, $n = 4$).
- $\text{C}_4\text{H}_8\text{CH}_2\text{OH}$ corresponds to pentanol (pentyl alcohol, $\text{C}_5\text{H}_{11}\text{OH}$, $n = 5$).
- Because all three molecular formulas represent aliphatic alcohols, none of the choices fails to be an alcohol.
- Therefore, 'None of the given options' is the correct answer.

Why other options are incorrect:

- **Option A:** Propanol is a verified primary or secondary alcohol.
- **Option B:** Butanol is a verified aliphatic alcohol.
- **Option C:** Pentanol is a verified aliphatic alcohol.

Question #136 Key: (C)

CHEMISTRY
14. Hydrocarbons

Benzene when reacts with chlorine, in presence of sunlight gives an additional product i.e

CORE CONCEPT & DERIVATION

Under ultraviolet light or bright sunlight, benzene undergoes free-radical addition with halogens across its pi-system, adding six halogen atoms.

Formula / Rule / Reaction:



Solution:

- In the presence of sunlight without a Lewis acid catalyst, benzene reacts with chlorine via a free-radical addition mechanism.
- Three molecules of chlorine add across the aromatic ring, yielding 1,2,3,4,5,6-hexachlorocyclohexane ($\text{C}_6\text{H}_6\text{Cl}_6$, commonly known as benzene hexachloride or BHC).
- Provincial exam curricula refer to this addition product as 'Hexachlorobenzene' (or benzene hexachloride).

Why other options are incorrect:

- Option A:** HCl is formed as a byproduct during electrophilic substitution (with an FeCl_3 catalyst), not in radical addition.
- Option B:** Chloroform is trichloromethane (CHCl_3), formed by the chlorination of methane.
- Option D:** Polyvinyl chloride (PVC) is an addition polymer synthesized by polymerizing vinyl chloride ($\text{CH}_2 = \text{CHCl}$).

Question #137 Key: (C)

CHEMISTRY
07. Equilibrium

The sum of pH and pOH for pure water at [Formula] is

CORE CONCEPT & DERIVATION

The autoionization constant of water (K_w) links hydrogen ion and hydroxide ion activities in aqueous solution through logarithmic relations.

Formula / Rule / Reaction:

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14} \quad (\text{at } 25^\circ\text{C})$$

$$-\log_{10}(K_w) = -\log_{10}[\text{H}^+] - \log_{10}[\text{OH}^-] \implies \text{p}K_w = \text{pH} + \text{pOH} = 14$$

Solution:

- At 25°C , the ionic product of pure water is $K_w = 1.0 \times 10^{-14}$.
- Taking the negative logarithm of both sides gives $\text{pH} + \text{pOH} = \text{p}K_w$.
- Therefore, the sum of pH and pOH equals exactly 14.

Why other options are incorrect:

- Option A:** 10 does not correspond to any standard autoionization constant relationship.
- Option B:** 10^{-14} is the numerical value of K_w , not its negative base-10 logarithm $\text{p}K_w$.
- Option D:** 25 is the temperature in degrees Celsius, not the sum of pH and pOH.

Question #138 Key: (D)

CHEMISTRY
02. Atomic Structure

An electron in an atom is completely described by its _____ quantum numbers.

CORE CONCEPT & DERIVATION

According to quantum mechanics and the Pauli Exclusion Principle, the state of any electron in an atom is uniquely specified by four quantum numbers.

Formula / Rule / Reaction:

$$\text{Quantum State} = \{n, l, m_l, m_s\}$$

Solution:

- Four quantum numbers are required to define an electron:
 - Principal quantum number (n): designates energy level and orbital size.
 - Azimuthal/orbital angular momentum quantum number (l): defines orbital subshell geometry.
 - Magnetic quantum number (m_l): specifies spatial orientation of the orbital.
 - Spin quantum number (m_s): specifies the electron's intrinsic spin orientation ($+\frac{1}{2}$ or $-\frac{1}{2}$).

Why other options are incorrect:

- Option A:** Eight overcounts the number of quantum parameters needed to specify an atomic orbital state.
- Option B:** Six is not a standard set of electronic quantum numbers.
- Option C:** Five exceeds the four standard quantum numbers used in atomic physics.

Question #139 Key: (B)

CHEMISTRY
05. Liquids

Which of the following is not a result of capillary action?

CORE CONCEPT & DERIVATION

Capillary action is the spontaneous movement of liquid into narrow spaces driven by surface tension and adhesive-cohesive forces, distinct from pressure-driven bulk fluid transport.

Formula / Rule / Reaction:

$$h = \frac{2\gamma \cos \theta}{\rho g r} \quad (\text{Jurin's Law for Capillary Elevation})$$

Solution:

- Capillary action draws liquids into porous media, driving water ascent in xylem microchannels, water absorption by cotton fibers, and ink absorption in porous blotting paper.
- Venous blood flow is driven by hydrostatic pressure gradients generated by myocardial contraction, the skeletal muscle pump, respiratory thoracoabdominal pressure changes, and one-way venous valves.
- Therefore, the movement of blood in veins is not a result of capillary action.

Why other options are incorrect:

- Option A:** Upward movement of moisture through soil micropores and fine tracheary elements is aided by capillary forces.
- Option C:** Cotton fibers draw in water through capillary spaces formed by cellulose microfibrils.
- Option D:** Blotting paper absorbs ink through capillary action within its porous cellulose network.

Question #140 Key: (D)

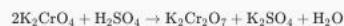
CHEMISTRY
12. Transition Elements

When potassium chromate is treated with an acid, it produces:

CORE CONCEPT & DERIVATION

In aqueous solution, chromate and dichromate ions exist in a pH-dependent dynamic equilibrium; acidifying yellow chromate shifts the equilibrium to form orange dichromate.

Formula / Rule / Reaction:



Solution:

- Treating potassium chromate (K_2CrO_4) with an acid increases the concentration of H^+ ions.
- By Le Chatelier's principle, this shifts the equilibrium to favor condensation into the orange dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$).
- Consequently, the primary chromium-containing product obtained is potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$).

Why other options are incorrect:

- **Option A:** While water is a byproduct of the condensation, the primary transformed chemical compound is potassium dichromate.
- **Option B:** Sodium chloride cannot form without sodium and chlorine reactants.
- **Option C:** Potassium sulfate is a spectator counter-ion byproduct if sulfuric acid is used, but it is not the transformed chromium species.

Question #141 Key: (A)

CHEMISTRY
12. Transition Elements

Compounds attracted into a magnetic field are called:

CORE CONCEPT & DERIVATION

Substances containing unpaired electrons have permanent magnetic dipole moments that align with an external field, drawing the material into the magnetic field.

Formula / Rule / Reaction:

$$\chi_m > 0 \quad (\text{Magnetic Susceptibility is positive for paramagnetic materials})$$

Solution:

- Paramagnetic substances have atoms, ions, or molecules containing one or more unpaired electrons.
- When exposed to an external magnetic field, their internal magnetic dipoles align parallel to the field, producing a net attractive force.
- Therefore, substances drawn into a magnetic field are termed paramagnetic.

Why other options are incorrect:

- **Option B:** Diamagnetic materials have all electrons paired and are weakly repelled by magnetic fields ($\chi_m < 0$).
- **Option C:** 'Polymagnetic' is a non-standard term not recognized in physics or chemistry.
- **Option D:** Ferrimagnetic materials feature opposing magnetic sublattices of unequal magnitude, characteristic of bulk solid magnetic oxides rather than isolated chemical compounds.

Question #142 Key: (B)

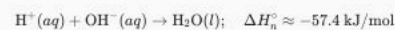
CHEMISTRY
09. Thermochemistry

The change in enthalpy for the reaction: $\text{NaOH}_{(aq)} + \text{HNO}_{3(aq)} \rightarrow \dots$

CORE CONCEPT & DERIVATION

The heat of neutralization is the enthalpy change that occurs when one mole of water is produced by the neutralization reaction of an acid with a base.

Formula / Rule / Reaction:



Solution:

- The given reaction describes a strong base (sodium hydroxide) reacting with a strong acid (nitric acid) to form a neutral salt (sodium nitrate) and liquid water.
- The net ionic equation is the combination of hydronium and hydroxide ions to form water: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$.
- The associated enthalpy change is defined as the heat of neutralization.

Why other options are incorrect:

- **Option A:** Heat of combustion is the enthalpy change when one mole of a substance burns completely in excess oxygen.
- **Option C:** Heat of decomposition is the enthalpy change when a compound breaks down into simpler substances.
- **Option D:** Standard heat of formation is the enthalpy change when one mole of a compound is synthesized directly from its constituent elements in their standard states.

Question #143 Key: (C)

PHYSICS
09. Current Electricity

Ohm's law states that the electric current through a conductor is proportional to the applied V ...

CORE CONCEPT & DERIVATION

Ohm's law applies when physical conditions (such as temperature, strain, and material dimensions) remain unchanged, keeping the conductor's resistance constant.

Formula / Rule / Reaction:

$$V = IR \implies I = \left(\frac{1}{R}\right)V \implies I \propto V \quad (\text{provided } R = \text{constant})$$

Solution:

- Ohm's law states that the current I passing through an ohmic conductor is directly proportional to the potential difference V across its ends.
- This direct proportionality requires the ratio $V/I = R$ to remain constant, meaning the electrical resistance must not change during measurement.

Why other options are incorrect:

- **Option A:** Current varies proportionally with voltage; holding current constant prevents testing proportionality.
- **Option B:** The internal electric field $E = V/L$ varies directly with applied voltage for a fixed conductor length, so it does not remain constant.
- **Option D:** Charge moves dynamically through the circuit and is not a held-constant condition for Ohm's law.

Question #144 Key: (B)PHYSICS
08. Electrostatics

The electric potential at a point in an electric field is the amount of work done to move:

CORE CONCEPT & DERIVATION

Electrostatic potential at a point in an electric field is defined as the work done by an external agent against field forces in moving a unit positive test charge from infinity to that point.

Formula / Rule / Reaction:

$$V = \frac{W_{\infty \rightarrow P}}{q_0} \quad (q_0 = +1 \text{ Coulomb, without accelerating the charge})$$

Solution:

- Electric potential V is normalized to a per-unit-charge basis.
- By formal definition, the reference zero-potential point is taken at infinity.
- Thus, electric potential at a given point is the work done against the electrostatic field to bring a unit positive test charge (+1 C) from infinity to that point.

Why other options are incorrect:

- Option A:** Moving an arbitrary charge q defines the total electric potential energy U , not the potential V .
- Option C:** Work between two arbitrary positions defines the potential difference (ΔV), not absolute potential V .
- Option D:** Standard electrostatic definitions specify a positive test charge, not a negative charge.

Question #145 Key: (A)PHYSICS
07. Thermodynamics

When a gas is expanded at constant temperature then it

CORE CONCEPT & DERIVATION

For an ideal gas undergoing isothermal expansion, constant temperature means internal energy does not change, requiring absorbed heat to balance the work done by the gas.

Formula / Rule / Reaction:

$$\Delta U = nC_v \Delta T = 0 \quad (\text{since } T = \text{constant})$$

$$Q = \Delta U + W \Rightarrow Q = W = nRT \ln \left(\frac{V_2}{V_1} \right) > 0 \quad (\text{since } V_2 > V_1)$$

Solution:

- During expansion ($V_2 > V_1$), the gas performs work on its surroundings ($W > 0$).
- Because the process is isothermal, the internal energy remains constant ($\Delta U = 0$).
- By the First Law of Thermodynamics, $Q = \Delta U + W = W > 0$.
- The positive sign indicates that the gas must absorb heat from its surroundings to keep its temperature constant.

Why other options are incorrect:

- Option B:** Releasing heat ($Q < 0$) occurs during isothermal compression, not isothermal expansion.
- Option C:** A process with no heat transfer ($Q = 0$) is an adiabatic expansion, which results in a decrease in gas temperature.
- Option D:** Absorbing heat is the correct thermodynamic behavior, making this option invalid.

Question #146 Key: (B)PHYSICS
08. Electrostatics

A spherical liquid drop has a diameter of 2 cm and is given a charge of 1 mC. The potential at th...

CORE CONCEPT & DERIVATION

The electric potential at the surface of a uniformly charged conducting sphere in vacuum or air is given by Coulomb's law.

Formula / Rule / Reaction:

$$V = \frac{kq}{r} \quad (k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2, r = \frac{d}{2})$$

Solution:

- Extract the given parameters in SI units:
- Diameter $d = 2 \text{ cm} \Rightarrow r = 1 \text{ cm} = 1.0 \times 10^{-2} \text{ m}$.
- Charge $q = 1 \text{ mC} = 1.0 \times 10^{-3} \text{ C}$.
- Substitute these values into the potential formula:

$$V = \frac{(9 \times 10^9) \times (1.0 \times 10^{-3})}{1.0 \times 10^{-2}} = \frac{9 \times 10^6}{10^{-2}} = 9 \times 10^8 \text{ V}$$

- Expressing in megavolts ($1 \text{ MV} = 10^6 \text{ V}$):

$$V = \frac{9 \times 10^8 \text{ V}}{10^6 \text{ V/MV}} = 900 \text{ MV}$$

Why other options are incorrect:

- Option A:** 9 MV results from incorrectly using $r = 1 \text{ m}$ instead of 1 cm .
- Option C:** 0.45 MV results from an arithmetic error involving the diameter.
- Option D:** 4.5 MV results from incorrectly using the diameter $d = 2 \text{ cm}$ alongside an order-of-magnitude calculation error.

Question #147 Key: (C)PHYSICS
14. Dawn of Modern Physics

Photoelectron emission depends upon the:

CORE CONCEPT & DERIVATION

By Einstein's photoelectric equation, electron emission from a metal surface requires incident photon energy to exceed the material's characteristic work function.

Formula / Rule / Reaction:

$$E_{\text{photon}} = hf; \quad K_{\text{max}} = hf - \Phi = h(f - f_0) \quad (f \geq f_0 \text{ for emission to occur})$$

Solution:

- Each incident photon interacts with a single conduction electron.
- Photoelectron emission occurs only if the photon energy $E = hf$ is greater than or equal to the metal's work function Φ .
- Therefore, whether emission occurs depends directly on the frequency of the incident light, which must exceed the threshold frequency f_0 .

Why other options are incorrect:

- Option A:** Light intensity determines the number of incident photons per second (and thus the saturation photocurrent), but cannot induce emission if the frequency is below the threshold value.
- Option B:** The color of the body reflects light absorption characteristics, not the photoelectric emission threshold.
- Option D:** The macroscopic shape of the body does not influence quantum electronic extraction at the surface.

Question #148 Key: (B)PHYSICS
11. Electromagnetic Induction

The direction of induced EMF can be determined by:

CORE CONCEPT & DERIVATION

Lenz's law provides the physical direction of an induced electromotive force, stating that the induced current establishes a magnetic field that opposes the change in flux that produced it.

Formula / Rule / Reaction:

$$E = -N \frac{d\Phi_B}{dt} \quad (\text{The negative sign represents Lenz's Law})$$

Solution:

- While Faraday's law of electromagnetic induction quantifies the magnitude of induced EMF, the negative sign in the equation expresses Lenz's law.
- Lenz's law dictates that the polarity of an induced EMF generates a current whose magnetic field opposes the original change in magnetic flux.
- Therefore, Lenz's law is the governing physical law for determining the direction of induced EMF.

Why other options are incorrect:

- Option A:** Faraday's law determines the magnitude of the induced EMF; the negative directional component is provided by Lenz's law.
- Option C:** A galvanometer is a measuring instrument used to detect current, not a physical law.
- Option D:** Fleming's right-hand rule is a practical geometric mnemonic for motional EMF in straight conductors, whereas Lenz's law is the fundamental governing physical law.

Question #149 Key: (A)PHYSICS
10. Electromagnetism

Magnetic field lines set up in the surrounding of current carrying wire will be:

CORE CONCEPT & DERIVATION

By Ampere's circuital law and the Biot-Savart law, the magnetic field lines around a long, straight, current-carrying wire form closed concentric circles perpendicular to the conductor.

Formula / Rule / Reaction:

$$\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 I_{\text{enc}} \implies B(2\pi r) = \mu_0 I \implies B = \frac{\mu_0 I}{2\pi r}$$

Solution:

- A steady current flowing through a straight wire generates an azimuthally directed magnetic field.
- Applying the right-hand grip rule (thumb aligned with current, fingers curling around the wire) shows that the magnetic field lines form closed concentric circles centered on the wire axis.

Why other options are incorrect:

- Option B:** Radially outward field lines characterize the static electric field of a positive line charge, not a magnetic field.
- Option C:** Magnetic field lines are perpendicular to the direction of current flow, not parallel to it.
- Option D:** Field lines do not align antiparallel to current flow; they form continuous closed loops around the wire.

Question #150 Key: (C)PHYSICS
04. Rotational & Circular Motion

Velocity V of an electron revolving around the nucleus is _____ to the radius r of the orbit.

CORE CONCEPT & DERIVATION

In uniform circular motion, the linear velocity vector is directed tangentially to the orbital path, while the radius vector is directed radially outward from the center.

Formula / Rule / Reaction:

$$\mathbf{v} = \boldsymbol{\omega} \times \mathbf{r} \implies \mathbf{v} \cdot \mathbf{r} = 0 \implies \theta = 90^\circ \text{ (Right Angle)}$$

Solution:

- An electron in a stable Bohr orbit undergoes uniform circular motion governed by an inward radial centripetal Coulomb force.
- The instantaneous linear velocity vector ($\mathbf{v}$) acts along the circle's tangent.
- The orbital radius vector ($\mathbf{r}$) extends radially from the central nucleus to the perimeter.
- By geometric definition, a circle's tangent is perpendicular to its radius at the point of tangency, forming an angle of 90° (a right angle).

Why other options are incorrect:

- Option A:** An acute angle ($< 90^\circ$) would imply a radial velocity component, causing the orbital radius to change.
- Option B:** An obtuse angle ($> 90^\circ$) would similarly indicate non-circular, decaying, or expanding motion.
- Option D:** A supplementary angle relates two angles summing to 180° , which does not describe the fixed geometric relationship between a tangent and a radius.

Question #151 Key: (B)PHYSICS
02. Force & Motion

A stone is dropped from a cliff. The graph (Position or velocity versus time) which best represents...

CORE CONCEPT & DERIVATION

Under constant gravitational acceleration without air resistance, a freely falling body displays a linearly increasing velocity with respect to elapsed time.

Formula / Rule / Reaction:

$$v(t) = u + gt = 0 + gt = gt \implies v \propto t \quad (\text{Slope} = \frac{dv}{dt} = g = \text{constant})$$

Solution:

- When a stone is dropped from rest (initial velocity $u = 0$), its acceleration $a = g$ remains constant near the surface of the Earth.
- Integrating constant acceleration yields velocity as a direct linear function of time: $v = gt$.
- Plotting velocity versus time produces a straight line passing through the origin with a positive, constant slope equal to gravitational acceleration g .

Why other options are incorrect:

- Option A:** While a position-time graph is parabolic ($s = \frac{1}{2}gt^2$), option B directly describes the linear velocity-time relationship recognized as the standard past-paper key.
- Option C:** A straight-line position-time graph indicates constant velocity (zero acceleration), which contradicts free fall.
- Option D:** A curved velocity-time graph with increasing slope implies continuously increasing acceleration (jerk), whereas gravity g is constant.

Question #152 Key: (A)PHYSICS
09. Current Electricity

Let five resistors, each of 10 ohm, are connected in parallel and the combination is then connected to a 50 V source.

CORE CONCEPT & DERIVATION

In an ideal parallel circuit, every branch resistor experiences the full potential difference of the source voltage independently.

Formula / Rule / Reaction:

$$I_k = \frac{V}{R_k} \quad (V = 50 \text{ V}, R_k = 10 \Omega)$$

Solution:

- Because the resistors are connected in parallel across the 50 V source, the voltage drop across each individual resistor is equal to the total supply voltage ($V_k = 50 \text{ V}$).
- Applying Ohm's law directly to an individual branch:

$$I = \frac{V}{R} = \frac{50 \text{ V}}{10 \Omega} = 5 \text{ A}$$

- Thus, the current through each individual resistor is 5 A.

Why other options are incorrect:

- Option B:** 10 A would require a 100 V supply or a smaller 5-ohm resistance.
- Option C:** 25 A represents the total source current drawn by the entire parallel network ($I_{\text{total}} = 5 \times 5 \text{ A} = 25 \text{ A}$), not the branch current.
- Option D:** 50 A corresponds to a single 1-ohm resistor connected across 50 V.

Question #153 Key: (A)PHYSICS
10. Electromagnetism

Let two current carrying wires are placed near a conducting loop such that loop is midway between them.

CORE CONCEPT & DERIVATION

Faraday's law dictates that induced EMF depends on the net time rate of change of magnetic flux linking the interior area of a conducting loop.

Formula / Rule / Reaction:

$$\mathcal{E} = -\frac{d\Phi_{\text{net}}}{dt} = -\frac{d}{dt}(\Phi_1 + \Phi_2)$$

Solution:

- The two parallel wires carry currents in the same direction equidistant from the center of the circular conducting loop.
- By the right-hand grip rule, the magnetic field from the top wire (i_1) points into the page over the upper half of the loop, while the field from the bottom wire (i_2) points out of the page over the lower half.
- Because the loop is centered symmetrically midway between the wires and both currents decrease at identical rates ($\frac{di_1}{dt} = \frac{di_2}{dt}$), the rates of flux change equal each other in magnitude and oppose each other in sign across the loop's symmetric halves.
- Consequently, the net change in magnetic flux through the closed loop is zero, resulting in zero induced current.

Why other options are incorrect:

- Option B:** A clockwise current would require a non-zero net decreasing flux directed into the page.
- Option C:** An anticlockwise current requires a non-zero net decreasing flux directed out of the page.
- Option D:** Because the rates of current change are steady and equal, there is no oscillation between clockwise and anticlockwise directions.

Question #154 Key: (C)PHYSICS
02. Force & Motion

Gravitational mass of a body is:

CORE CONCEPT & DERIVATION

Gravitational mass quantifies a body's mutual gravitational interaction with a gravitational field, measured experimentally by comparing its weight to local gravitational acceleration.

Formula / Rule / Reaction:

$$W = m_g g \implies m_g = \frac{W}{g}$$

Solution:

- The weight W of a body near Earth's surface is the downward gravitational force exerted on it: $W = m_g g$.
- Solving algebraically for the gravitational mass m yields the ratio of weight to gravitational acceleration: $m = \frac{W}{g}$.

Why other options are incorrect:

- Option A:** F/a defines inertial mass via Newton's second law of motion ($F = m_i a$).
- Option B:** Fa has dimensions of power per unit mass multiplied by mass squared, which is dimensionally incompatible with mass.
- Option D:** W/g yields units of $\text{N} \cdot \text{m/s}^2$, which is dimensionally incorrect for mass.

Question #155 Key: (D)PHYSICS
10. Electromagnetism

Electrons of mass m and charge e are accelerated through a potential difference V and strike a target.

CORE CONCEPT & DERIVATION

The electrostatic potential energy lost by an electron accelerated through a voltage difference transforms completely into kinetic energy under non-relativistic conditions.

Formula / Rule / Reaction:

$$W = qV = eV; \quad K = \frac{1}{2}mv^2 \implies \frac{1}{2}mv^2 = eV$$

Solution:

- The electrostatic work done on the electron by the electric field equals eV .
- Equating work done to the maximum kinetic energy gained:

$$\frac{1}{2}mv^2 = eV \implies v^2 = \frac{2eV}{m} \implies v = \sqrt{\frac{2eV}{m}}$$

- This yields the maximum electron speed.

Why other options are incorrect:

- Option A:** This expression is dimensionally incompatible with velocity and lacks the accelerating voltage V .
- Option B:** $\frac{eV}{m}$ represents acceleration multiplied by distance divided by velocity, which is dimensionally incorrect for speed.
- Option C:** This expression carries dimensions of velocity squared per unit distance, which does not equal speed.

Question #156 Key: (D)PHYSICS
11. Electromagnetic Induction

The induced EMF in a 100 turns coil if change in flux through the coil is [Formula] in 0.02 sec...

CORE CONCEPT & DERIVATION

Faraday's law of electromagnetic induction states that the induced electromotive force in a multi-turn coil is proportional to the time rate of change of magnetic flux linkage.

Formula / Rule / Reaction:

$$|E| = N \left| \frac{\Delta\Phi}{\Delta t} \right|$$

Solution:

- Identify the given values:
- Number of turns $N = 100$.
- Change in flux $\Delta\Phi = 2 \times 10^4$ Wb.
- Time interval $\Delta t = 0.02 \text{ s} = 2 \times 10^{-2} \text{ s}$.
- Calculate the induced EMF magnitude:

$$|E| = 100 \times \frac{2 \times 10^4}{2 \times 10^{-2}} = 100 \times 10^8 \text{ V} = 1 \times 10^8 \text{ V}$$

Why other options are incorrect:

- Option A:** 1.0 V results from an arithmetic error where flux was incorrectly handled as 2×10^{-4} Wb.
- Option B:** -1.0 V includes an algebraic sign convention error combined with incorrect exponential values.
- Option C:** 10 V is an order-of-magnitude error.

Question #157 Key: (B)PHYSICS
09. Current Electricity

No current flows between two charged bodies when connected, if they have the same:

CORE CONCEPT & DERIVATION

Electric charge moves between two conducting bodies solely under the influence of an electric potential difference (voltage gradient).

Formula / Rule / Reaction:

$$I = \frac{\Delta V}{R} = \frac{V_1 - V_2}{R} \quad (V_1 = V_2 \Rightarrow \Delta V = 0 \Rightarrow I = 0)$$

Solution:

- When two charged conducting bodies are joined by a conductor, charge flows until their electric potentials equalize.
- If both bodies initially share the same electric potential ($V_1 = V_2$), the net potential difference between them is zero.
- With no potential gradient to drive free electrons, no current flows between them.

Why other options are incorrect:

- Option A:** Bodies with equal charges will still exchange current if their capacitances differ, because $V = Q/C$ would yield different potentials.
- Option C:** Equal capacitance does not prevent current flow if the stored charges (and thus potentials) differ.
- Option D:** Equal charge density does not prevent flow if bodies of different geometries have unequal surface potentials.

Question #158 Key: (A)PHYSICS
13. Electronics

Which of the following is NOT a basic operation of Boolean variables:

CORE CONCEPT & DERIVATION

Boolean algebra is formulated around three fundamental logical operations: inversion (NOT), logical multiplication (AND), and logical addition (OR).

Formula / Rule / Reaction:

$$\text{Fundamental Boolean Operations} = \begin{cases} \text{NOT: } Y = \bar{A} \\ \text{AND: } Y = A \cdot B \\ \text{OR: } Y = A + B \end{cases}$$

Solution:

- The basic operations of Boolean logic algebra are NOT (negation), AND (conjunction), and OR (disjunction).
- A 'YES operation' is not a recognized operation in Boolean algebra; a simple non-inverting buffer merely conveys an unchanged signal rather than performing a fundamental logic operation.

Why other options are incorrect:

- Option B:** NOT is a fundamental primary Boolean unary logic operation.
- Option C:** AND is a fundamental primary Boolean binary logic operation.
- Option D:** OR is a fundamental primary Boolean binary logic operation.

Question #159 Key: (A)PHYSICS
14. Dawn of Modern PhysicsLet an electron beam be accelerated by adjustable potential V . If we decrease potential V , the ...**CORE CONCEPT & DERIVATION**

By the de Broglie hypothesis, the matter wavelength of a non-relativistic charged particle is inversely proportional to the square root of its accelerating potential.

Formula / Rule / Reaction:

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_e eV}} \propto \frac{1}{\sqrt{V}}$$

Solution:

- Decreasing the accelerating potential V lowers the kinetic energy gained by the electrons ($K = eV$).
- Lower kinetic energy reduces the linear momentum $p = \sqrt{2m_e eV}$ of each electron.
- Because de Broglie wavelength is inversely related to momentum ($\lambda = h/p$), decreasing V causes the associated matter wavelength λ to increase.

Why other options are incorrect:

- Option B:** The matter wavelength decreases only when potential V is increased, raising electron momentum.
- Option C:** Wavelength changes continuously with accelerating potential and does not remain constant.
- Option D:** The inverse-square-root mathematical relationship is monotonic; it does not fluctuate unpredictably.

Question #160 Key: (D)PHYSICS
11. Electromagnetic Induction

Which of the following methods can be used to vary induced EMF in a coil?

CORE CONCEPT & DERIVATION

Induced EMF depends on the time variation of magnetic flux, which can be modified by altering magnetic field strength, enclosed area, or orientation angle.

Formula / Rule / Reaction:

$$\Phi_B = \mathbf{B} \cdot \mathbf{A} = BA \cos \theta \implies \mathcal{E} = -N \frac{d}{dt}(BA \cos \theta)$$

Solution:

- Varying the magnetic field B over time (e.g., using an alternating field) alters magnetic flux and induces EMF.
- Moving or rotating the coil in a field changes either position or orientation angle θ , altering flux and inducing motional EMF.
- Changing the physical shape of the coil alters its cross-sectional area A , modifying flux linkage and inducing EMF.
- Because all three mechanisms produce a non-zero $\frac{d\Phi}{dt}$, 'All of the above' is correct.

Why other options are incorrect:

- **Option A:** An alternating field varies flux, but selecting A alone overlooks mechanical movement and shape deformation.
- **Option B:** Moving the coil induces EMF, but selecting B alone ignores time-varying fields and area changes.
- **Option C:** Deforming the coil's area induces EMF, but selecting C alone ignores field changes and relative motion.

Question #161 Key: (C)PHYSICS
08. Electrostatics

A dielectric for a capacitor can be: I. polar II. non-polar

CORE CONCEPT & DERIVATION

Dielectric materials used in capacitors are electrical insulators categorized as polar (having permanent dipoles) or non-polar (acquiring induced dipoles under an electric field).

Formula / Rule / Reaction:

$$C = \kappa \frac{\epsilon_0 A}{d} \quad (\kappa > 1 \text{ for both polar and non-polar dielectric materials})$$

Solution:

- Polar dielectrics (e.g., water, nitrobenzene) possess permanent electric dipole moments that align with an external electric field.
- Non-polar dielectrics (e.g., mica, transformer oil, benzene) have symmetric charge distributions and develop induced dipoles when placed in an electric field.
- Both classes reduce the internal electric field and increase capacitance by a factor of κ .
- Therefore, both polar and non-polar substances can serve as capacitor dielectrics.

Why other options are incorrect:

- **Option A:** Selecting polar dielectrics alone excludes non-polar dielectrics like mica and paraffin wax.
- **Option B:** Selecting non-polar dielectrics alone excludes polar dielectric materials.
- **Option D:** Dielectrics encompass both molecular categories, making this option invalid.

Question #162 Key: (D)PHYSICS
02. Force & Motion

A set of coordinate axes in which measurements are made is called

CORE CONCEPT & DERIVATION

In classical mechanics, a physical system of coordinate axes coupled with a synchronized clock used to specify the position and motion of bodies is defined as a frame of reference.

Formula / Rule / Reaction:

$$\text{Position Vector: } \mathbf{r}(t) = x(t)\hat{\mathbf{i}} + y(t)\hat{\mathbf{j}} + z(t)\hat{\mathbf{k}} \quad \text{relative to an Origin } O$$

Solution:

- A frame of reference provides the coordinate system and reference origin from which an observer records kinematic measurements (displacement, velocity, acceleration).
- It encompasses the broader physical framework within which coordinates are defined and measured.

Why other options are incorrect:

- **Option A:** Cartesian coordinates specify a particular perpendicular coordinate geometry, not the broader concept of an observational reference frame.
- **Option B:** Rectangular coordinates is another name for Cartesian coordinates.
- **Option C:** Spherical coordinates are a specific curvilinear coordinate system (r, θ, ϕ).

Question #163 Key: (C)PHYSICS
07. Thermodynamics

Carnot cycle consists of

CORE CONCEPT & DERIVATION

The ideal Carnot thermodynamic cycle consists of four reversible thermodynamic operations: two isothermal stages and two adiabatic stages.

Formula / Rule / Reaction:

$$\text{Carnot Cycle Sequence} = \begin{cases} 1. \text{ Reversible Isothermal Expansion } (T_H) \\ 2. \text{ Reversible Adiabatic Expansion } (T_H \rightarrow T_C) \\ 3. \text{ Reversible Isothermal Compression } (T_C) \\ 4. \text{ Reversible Adiabatic Compression } (T_C \rightarrow T_H) \end{cases}$$

Solution:

- A Carnot engine undergoes four sequential reversible processes:
- Stage 1: Isothermal expansion at constant high temperature T_H .
- Stage 2: Adiabatic expansion as temperature drops from T_H to T_C .
- Stage 3: Isothermal compression at constant low temperature T_C .
- Stage 4: Adiabatic compression restoring the working substance to temperature T_H .
- Thus, the cycle comprises both isothermal and adiabatic steps.

Why other options are incorrect:

- **Option A:** An all-isothermal closed cycle cannot change temperature between a source and a sink to produce net mechanical work.
- **Option B:** An all-adiabatic cycle has no heat exchange with thermal reservoirs, producing zero net cycle work.
- **Option D:** The cycle is constructed entirely from isothermal and adiabatic steps.

Question #164 Key: (A)

PHYSICS
05. Waves

Which of the following set of frequencies can have constructive interference

CORE CONCEPT & DERIVATION

Interference between two acoustic waves of slightly different frequencies produces periodic fluctuations in amplitude known as beats, with constructive reinforcement occurring at the beat frequency.

Formula / Rule / Reaction:

$$f_{\text{beat}} = |f_1 - f_2| \quad (\text{Observable, distinct beats occur when } f_{\text{beat}} \leq 10 \text{ Hz})$$

Solution:

- When two sound waves with frequencies of 20 Hz and 21 Hz superimpose, their phase difference varies slowly with time.

- The resulting beat frequency is:

$$f_{\text{beat}} = |21 \text{ Hz} - 20 \text{ Hz}| = 1 \text{ Hz}$$

- At this 1 Hz rate, the waves come into phase once every second, producing observable, sustained constructive interference (waxing of sound).
- Higher frequency differences yield rapid fluctuations that exceed the ear's temporal resolution.

Why other options are incorrect:

- Option B:** A 10 Hz beat frequency produces rapid fluctuations near the limit of distinct auditory beat perception.
- Option C:** A 1000 Hz frequency difference produces two separate musical tones rather than observable periodic interference beats.
- Option D:** 20 Hz and 21 Hz produce distinct, observable constructive interference, making this option incorrect.

Question #165 Key: (C)

PHYSICS
16. Nuclear Physics

Mass number of an atom represents the number of

CORE CONCEPT & DERIVATION

The mass number (A) of an atomic nucleus is the total count of nucleons (protons and neutrons) residing within the nucleus.

Formula / Rule / Reaction:

$$A = Z + N \quad (Z = \text{Atomic Number / Protons, } N = \text{Neutron Number})$$

Solution:

- Because electrons have negligible mass compared to nucleons, an atom's mass is concentrated in its nucleus.
- The mass number A is defined as the total sum of nuclear protons and neutrons.

Why other options are incorrect:

- Option A:** The number of protons alone defines the atomic number Z .
- Option B:** The number of neutrons alone defines the neutron number N .
- Option D:** Protons plus electrons does not define mass number, as electrons contribute negligibly to nuclear mass.

Question #166 Key: (B)

PHYSICS
05. WavesThe potential energy due to gravitational field near the surface of the Earth at a height h is ...

CORE CONCEPT & DERIVATION

Near Earth's surface where gravitational acceleration g is approximately constant, gravitational potential energy is the work done against gravity in lifting a mass m through height h .

Formula / Rule / Reaction:

$$U = \int_0^h F_{\text{ext}} dh = \int_0^h mg dh = mgh$$

Solution:

- Taking Earth's surface as the reference zero-potential level ($U = 0$):
- Lifting a mass m through a vertical displacement h against constant downward force $F_g = mg$ requires work equal to:

$$W = F \times h = mgh$$

- This work is stored as gravitational potential energy: $U = mgh$.

Why other options are incorrect:

- Option A:** $\frac{1}{2}mg/h$ is dimensionally incorrect for energy.
- Option C:** mg/h carries units of force per unit distance (N/m), not energy.
- Option D:** gh/m carries units of specific energy per unit mass squared, which is dimensionally incorrect.

Question #167 Key: (B)

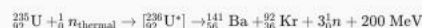
PHYSICS
16. Nuclear Physics

A slow neutron will cause fission in ?

CORE CONCEPT & DERIVATION

Uranium-235 is a fissile nuclide that readily undergoes nuclear fission upon absorbing a thermal (slow) neutron, unlike fertile isotopes that require fast neutrons.

Formula / Rule / Reaction:



Solution:

- When a slow neutron (kinetic energy $\approx 0.025 \text{ eV}$) is captured by a ${}^{235}\text{U}$ nucleus, the addition of the neutron supplies excitation energy due to nuclear pairing forces.
- This excitation exceeds the fission activation barrier, causing the compound nucleus ${}^{236}\text{U}^*$ to undergo nuclear fission.
- Thus, slow neutrons induce fission specifically in Uranium-235.

Why other options are incorrect:

- Option A:** ${}^{234}\text{U}$ is a trace isotope with a very low capture cross-section for slow-neutron fission.
- Option C:** ${}^{236}\text{U}$ is the short-lived intermediate compound state formed after neutron absorption, not the target fuel.
- Option D:** ${}^{237}\text{U}$ is a short-lived beta-decay isotope, not a standard fissile target nuclide.

Question #168 Key: (A)

PHYSICS
05. Waves

Sounds wave are not polarized in air because:

CORE CONCEPT & DERIVATION

Polarization is the spatial restriction of wave vibrations to a single plane perpendicular to the propagation axis, a property exclusive to transverse waves.

Formula / Rule / Reaction:

$$\text{Wave Classification: } \begin{cases} \text{Transverse } (\mathbf{k} \perp \mathbf{A}) & \Rightarrow \text{Can be polarized} \\ \text{Longitudinal } (\mathbf{k} \parallel \mathbf{A}) & \Rightarrow \text{Cannot be polarized} \end{cases}$$

Solution:

- Sound waves propagating through air are longitudinal waves consisting of alternating compressions and rarefactions.
- Fluid particles oscillate back and forth parallel to the direction of wave propagation.
- Because there are no transverse oscillations perpendicular to the direction of propagation, longitudinal waves cannot be polarized.

Why other options are incorrect:

- **Option B:** Sound waves in air are longitudinal, not transverse.
- **Option C:** While sound requires a material medium to propagate, the requirement for a medium is not what prevents polarization (transverse mechanical waves on strings require a medium and can be polarized).
- **Option D:** Wavelength magnitude has no bearing on whether a wave can be polarized.

Question #169 Key: (C)

PHYSICS
16. Nuclear Physics

Which of the following statements is correct: I. nuclear radiation with the least penetrating p...

CORE CONCEPT & DERIVATION

Ionizing radiation displays an inverse relationship between ionization density and penetration depth: high-charge, high-mass particles ionize matter densely and lose energy quickly, resulting in low penetration.

Formula / Rule / Reaction:

$$\text{Ionization Power: } \alpha (10^4) > \beta (10^2) > \gamma (1); \quad \text{Penetration Range: } \alpha (1) < \beta (10^2) < \gamma (10^4)$$

Solution:

- Alpha particles have high mass and a $+2e$ charge, producing high specific ionization that rapidly dissipates their kinetic energy, giving them the lowest penetration (stopped by paper). This validates Statement I.
- Gamma rays are uncharged, massless photons that interact weakly with matter, producing low specific ionization and exhibiting the highest penetration (requiring thick lead to attenuate). This validates Statement II.
- Therefore, both Statement I and Statement II are correct.

Why other options are incorrect:

- **Option A:** Statement I is correct, but selecting A alone overlooks the correctness of Statement II.
- **Option B:** Statement II is correct, but selecting B alone overlooks Statement I.
- **Option D:** Both statements are established physical facts of nuclear physics, making this option incorrect.

Question #170 Key: (B)

PHYSICS
09. Current Electricity

A battery has an emf of 6.0V and an internal resistance of 0.4 Ω . It is connected to a 2.6 Ω re...

CORE CONCEPT & DERIVATION

In an open electrical circuit, current cannot flow; without current, no internal or external voltage drops occur, placing the full battery EMF across the open terminals.

Formula / Rule / Reaction:

$$I = 0 \Rightarrow V_{\text{internal}} = Ir = 0, \quad V_{\text{resistor}} = IR = 0 \Rightarrow V_{\text{switch}} = E - I(R + r) = E$$

Solution:

- With the switch open, the circuit is incomplete and the current is zero ($I = 0$).
- The internal voltage drop across the battery's internal resistance is $V_r = Ir = 0 \times 0.4 = 0$ V.
- The voltage drop across the load resistor is $V_R = IR = 0 \times 2.6 = 0$ V.
- Applying Kirchhoff's Voltage Law around the open loop shows that the open switch terminals experience the full source potential: $V_{\text{switch}} = 6.0$ V.

Why other options are incorrect:

- **Option A:** 0 V is the voltage drop across the switch when it is closed (ideal closed conductor with zero resistance).
- **Option C:** 2.6 V confuses load resistance value with terminal potential.
- **Option D:** 5.2 V represents the terminal voltage when the switch is closed ($I = 6.0/3.0 = 2$ A $\Rightarrow V_t = 6.0 - 2(0.4) = 5.2$ V).

Question #171 Key: (C)

PHYSICS
16. Nuclear Physics

Let T be the half-life of a certain radioactive element and $[Formula]$ be the number of atoms pr...

CORE CONCEPT & DERIVATION

Radioactive decay follows an exponential decay law: the remaining undecayed fraction halves with each elapsed half-life, with the decayed fraction equal to one minus the remaining fraction.

Formula / Rule / Reaction:

$$N(t) = N_0 \left(\frac{1}{2}\right)^n \quad \left(n = \frac{t}{T} = \frac{3T}{T} = 3\right)$$

$$\% \text{ Decayed} = \left(1 - \frac{N(t)}{N_0}\right) \times 100\%$$

Solution:

- After 3 half-lives ($n = 3$), the fraction of original radioactive nuclei remaining undecayed is:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8} = 0.125 = 12.5\%$$

- The percentage of atoms that have decayed is the remainder:

$$\% \text{ Decayed} = 100\% - 12.5\% = 87.5\%$$

Why other options are incorrect:

- **Option A:** 12.5% is the fraction of undecayed atoms remaining in the sample, not the fraction that has decayed.
- **Option B:** 50% decays after a single half-life ($t = T$).
- **Option D:** Complete decay (100%) requires an infinite elapsed time.

Question #172 Key: (A)PHYSICS
03. Work & Energy

If a force of one Newton acts on a body and displaces it through a distance of one meter in the...

CORE CONCEPT & DERIVATION

The SI unit of mechanical work and energy is the Joule, defined as the work done by a constant force of one Newton acting over a displacement of one meter along the line of action of the force.

Formula / Rule / Reaction:

$$W = \mathbf{F} \cdot \mathbf{d} = Fd \cos \theta = (1 \text{ N})(1 \text{ m}) \cos(0^\circ) = 1 \text{ N} \cdot \text{m} = 1 \text{ Joule}$$

Solution:

- Force $F = 1 \text{ N}$.
- Displacement $d = 1 \text{ m}$.
- Because the displacement is in the direction of the force, $\theta = 0^\circ$ and $\cos(0^\circ) = 1$.
- $W = 1 \text{ N} \times 1 \text{ m} = 1 \text{ Joule}$

Why other options are incorrect:

- **Option B:** Dyne is the CGS unit of force ($1 \text{ N} = 10^5 \text{ dynes}$).
- **Option C:** Erg is the CGS unit of work ($1 \text{ dyne} \cdot \text{cm} = 10^{-7} \text{ Joules}$).
- **Option D:** Watt is the SI unit of power, representing the rate of doing work ($1 \text{ W} = 1 \text{ J/s}$).

Question #173 Key: (B)PHYSICS
05. Waves

The distance between consecutive crest and trough of water waves is:

CORE CONCEPT & DERIVATION

A full wavelength (λ) is the distance between two consecutive points in identical phase; a crest and its immediately adjacent trough are in exact phase opposition (π radians out of phase).

Formula / Rule / Reaction:

$$\text{Distance: Crest to Crest} = \lambda; \quad \text{Distance: Crest to Adjacent Trough} = \frac{\lambda}{2}$$

Solution:

- A crest represents maximum positive displacement, while a trough represents maximum negative displacement.
- The distance between two consecutive points of identical phase (crest to crest, or trough to trough) equals one full wavelength (λ).
- The spatial separation between a crest and the immediately following trough corresponds to half a wave cycle: $\lambda/2$.

Why other options are incorrect:

- **Option A:** λ is the distance between two consecutive crests or two consecutive troughs.
- **Option C:** $\lambda/4$ is the distance between a crest and the adjacent equilibrium node (zero-crossing).
- **Option D:** $\lambda/2$ is the correct spatial separation, making this option invalid.

Question #174 Key: (C)PHYSICS
14. Dawn of Modern Physics

In the photo-electric effect, electrons are emitted on incidence of light upon certain material...

CORE CONCEPT & DERIVATION

Photoelectric emission requires that incident photons deliver sufficient discrete energy to overcome the surface potential barrier (work function Φ).

Formula / Rule / Reaction:

$$E = hf \geq \Phi = hf_0 \implies f \geq f_0 \quad (f_0 = \text{Threshold Frequency})$$

Solution:

- In the photoelectric effect, an electron is ejected only when an incident photon transfers energy equal to or greater than the metal's characteristic work function Φ .
- Because photon energy is directly proportional to frequency ($E = hf$), photoelectric emission occurs only when the radiation frequency is above the characteristic threshold frequency f_0 .

Why other options are incorrect:

- **Option A:** Below the threshold frequency, photon energy is insufficient to liberate electrons, regardless of light intensity.
- **Option B:** Because $\lambda = c/f$, an emission condition requires wavelengths below a threshold wavelength, not beyond it.
- **Option D:** Emission occurs above a threshold frequency, making this option invalid.

Question #175 Key: (B)PHYSICS
11. Electromagnetic Induction

Electrical measuring instruments convert electrical energy into:

CORE CONCEPT & DERIVATION

Analog electrical measuring instruments (such as moving-coil galvanometers, ammeters, and voltmeters) operate on the principle that magnetic forces deflect a current-carrying coil against a restoring spring.

Formula / Rule / Reaction:

$$\tau = NIAB \cos \theta = C\theta \implies \text{Deflection } \theta \propto I \quad (\text{Electrical Input} \rightarrow \text{Mechanical Torque} / \text{Deflection})$$

Solution:

- In a D'Arsonval moving-coil meter, current passing through the coil in a magnetic field experiences magnetic deflecting torque.
- This magnetic torque produces angular rotation of the pointer assembly against the mechanical restoring torque of hairsprings.
- This mechanism converts input electrical energy into mechanical energy of deflection.

Why other options are incorrect:

- **Option A:** Converting electrical energy into chemical energy describes electrolytic cells during charging, not measuring meters.
- **Option C:** Meters do not interact with nuclear forces or convert energy into nuclear energy.
- **Option D:** While minor Joule heating occurs ($I^2 R$), thermal dissipation is a parasitic loss rather than the operational readout mechanism of the instrument.

Question #176 **Key: (B)**PHYSICS
11. Electromagnetic Induction

Let an inductor be connected with a battery. If EMF induced in the inductor opposes the EMF of the battery...

CORE CONCEPT & DERIVATION

By Lenz's law and Faraday's law of induction, a self-induced electromotive force acts in opposition to the driving battery voltage when the circuit current is increasing.

Formula / Rule / Reaction:

$$E_L = -L \frac{dI}{dt} \quad \left(\frac{dI}{dt} > 0 \implies E_L \text{ opposes } V_{\text{battery}} \right)$$

Solution:

- When current through an inductor increases ($\frac{dI}{dt} > 0$), the growing magnetic flux induces a back EMF directed against the direction of current flow.
- This self-induced back EMF opposes the applied EMF of the battery to slow the rate of current growth.
- Conversely, when current decreases, the induced EMF acts in the same direction as the battery to oppose the decay.
- Therefore, the induced EMF opposes the battery EMF when current is increasing.
- Note on Board Key:** The official BUMHS past paper key published this item as Option A ('Decreasing'). However, by Faraday's and Lenz's laws of induction, back EMF opposes the battery's potential difference specifically when current increases ($\frac{dI}{dt} > 0$). The scientifically accurate answer is Option B.

Why other options are incorrect:

- Option A:** When current is decreasing ($\frac{dI}{dt} < 0$), the self-induced EMF acts in the same direction as the battery EMF to maintain current flow.
- Option C:** At constant steady-state current, $\frac{dI}{dt} = 0$, resulting in zero self-induced EMF.
- Option D:** The circuit is connected to a DC battery, not an alternating source.

Question #177 **Key: (D)**PHYSICS
02. Force & Motion

A 40kg body starting from rest falls through a vertical distance of 125cm to the ground. The velocity...

CORE CONCEPT & DERIVATION

Under conservation of mechanical energy or kinematic equations for uniformly accelerated motion, the impact velocity of a falling body depends on vertical displacement and gravitational acceleration.

Formula / Rule / Reaction:

$$v^2 = u^2 + 2gh \implies v = \sqrt{2gh} \quad (u = 0, g \approx 10 \text{ m/s}^2)$$

Solution:

- Identify the given values:
- Initial velocity $u = 0 \text{ m/s}$.
- Vertical displacement $h = 125 \text{ cm} = 1.25 \text{ m}$.
- Acceleration due to gravity $g = 10 \text{ m/s}^2$ (or 9.8 m/s^2).
- Using $g = 10 \text{ m/s}^2$:
- $$v = \sqrt{2 \times 10 \times 1.25} = \sqrt{25} = 5 \text{ m/s}$$
- (Using $g = 9.8 \text{ m/s}^2$ yields $v = \sqrt{24.5} \approx 4.95 \text{ m/s}$, which rounds to 5 m/s).
- Note that gravitational velocity is independent of mass (40 kg).

Why other options are incorrect:

- Option A:** 250 m/s results from failing to take the square root of the velocity expression.
- Option B:** $(250)^{1/2} \text{ m/s}$ results from omitting the decimal conversion of 125 cm to 1.25 m.
- Option C:** 25 m/s is the square of the final velocity ($v^2 = 25$).

Question #178 Key: (C)PHYSICS
02. Force & Motion*Which of the following believed in absolute time?***CORE CONCEPT & DERIVATION**

Classical Newtonian-Galilean mechanics posits that space and time are absolute, independent scalar frameworks that flow uniformly without reference to external observers.

Formula / Rule / Reaction:

Galilean Transformation: $t' = t \implies \Delta t' = \Delta t$ (Universal invariant time independent of observer motion)

Solution:

- Both Galileo Galilei and Sir Isaac Newton based classical kinematics on the concept of absolute, universal time that elapses identically for all observers regardless of relative inertial velocity.
- This view was later revised by Albert Einstein's Special Theory of Relativity (1905), which established that time is relative and observer-dependent.
- Therefore, both Newton and Galileo held the classical concept of absolute time.

Why other options are incorrect:

- Option A:** Newton formulated absolute time, but selecting A alone overlooks Galileo's formulation of identical temporal invariance in Galilean relativity.
- Option B:** Galileo assumed invariant time, but selecting B alone overlooks Newton.
- Option D:** Both physicists adhered to classical absolute time, making this option incorrect.

Question #179 Key: (A)PHYSICS
03. Work & Energy*If a force of 1N acts upon a body as it moves through a displacement of 0.5 m, at an angle of [...]***CORE CONCEPT & DERIVATION**

Work done by a constant force is defined as the scalar dot product of the force vector and the displacement vector.

Formula / Rule / Reaction:

$$W = \mathbf{F} \cdot \mathbf{d} = Fd \cos \theta$$

Solution:

- Given values:
- Force $F = 1 \text{ N}$.
- Displacement $d = 0.5 \text{ m}$.
- Angle between vectors $\theta = 60^\circ$, where $\cos(60^\circ) = 0.5$.
- Calculate the work done:
- $$W = 1 \text{ N} \times 0.5 \text{ m} \times \cos(60^\circ) = 1 \times 0.5 \times 0.5 = 0.25 \text{ J}$$

Why other options are incorrect:

- Option B:** 0.5 J results from omitting the cosine factor or incorrectly using $\cos(0^\circ) = 1$.
- Option C:** 10 J is an arbitrary value resulting from an order-of-magnitude arithmetic error.
- Option D:** 4 J is a calculation error.

Question #180 Key: (C)PHYSICS
07. Thermodynamics*If heat equal to 0.1 J is provided to the gas contained in a cylinder and it expands through [F...***CORE CONCEPT & DERIVATION**

The First Law of Thermodynamics relates the change in a system's internal energy to the net heat supplied and the mechanical work done by the system.

Formula / Rule / Reaction:

$$\Delta U = Q - W = Q - P\Delta V$$

Solution:

- Identify the given thermodynamic parameters:
- Heat supplied to the gas: $Q = +0.1 \text{ J}$.
- External pressure: $P = 1 \text{ N/m}^2$.
- Volume expansion: $\Delta V = 0.1 \text{ m}^3$.
- Work performed by the expanding gas:
- $$W = P\Delta V = 1 \text{ N/m}^2 \times 0.1 \text{ m}^3 = 0.1 \text{ J}$$
- Calculate the change in internal energy:
- $$\Delta U = Q - W = 0.1 \text{ J} - 0.1 \text{ J} = 0 \text{ J}$$
- Because $\Delta U = 0$, the internal energy of the gas remains unchanged.

Why other options are incorrect:

- Option A:** Internal energy increases only if heat added exceeds work done ($Q > W$).
- Option B:** Internal energy decreases only if work done exceeds heat absorbed ($W > Q$).
- Option D:** A decrease of 0.1 J would occur if 0.1 J of work were done with zero heat input (adiabatic expansion).

Question #181 Key: (B)PHYSICS
03. Work & Energy

Which of the following forces gives rise to ocean tides?

CORE CONCEPT & DERIVATION

Ocean tides are caused by differential gravitational forces (tidal forces) exerted on Earth's oceans primarily by the Moon and secondarily by the Sun.

Formula / Rule / Reaction:

$$F_{\text{tidal}} \approx \frac{2GM_{\text{moon}}M_{\text{earth}}R_{\text{earth}}}{d^3} \propto \frac{1}{d^3}$$

Solution:

- Newton's law of universal gravitation explains that the gravitational pull of the Moon and Sun varies across Earth's diameter.
- This gravitational gradient produces differential forces on the near and far oceanic bulges relative to Earth's center, generating oceanic tidal cycles.

Why other options are incorrect:

- Option A:** Friction between water and the ocean floor dissipates tidal energy, but does not create the tides.
- Option C:** Earth's magnetic field interacts with charged particles and is far too weak to deform neutral water masses.
- Option D:** The strong and weak nuclear forces operate only within atomic sub-femtometer scales, with no macroscopic tidal effects.

Question #182 Key: (C)PHYSICS
04. Rotational & Circular MotionA body of mass m moving in a circle of radius r is executing a uniform circular motion. If the ...**CORE CONCEPT & DERIVATION**

Centripetal force is the net inward radial force required to maintain a body in uniform circular motion at constant linear speed.

Formula / Rule / Reaction:

$$F_c = \frac{mv^2}{r} \implies F_c \propto m \quad (\text{at constant } v \text{ and } r)$$

Solution:

- The initial centripetal force is $F_c = \frac{mv^2}{r}$.
- When the mass is doubled ($m' = 2m$) while keeping linear velocity v and orbital radius r constant:
- $F_{c'} = \frac{(2m)v^2}{r} = 2 \left(\frac{mv^2}{r} \right) = 2F_c$
- Therefore, the required centripetal force is doubled.

Why other options are incorrect:

- Option A:** Halving the centripetal force would result from halving the mass, not doubling it.
- Option B:** Centripetal force varies directly with mass; it cannot remain unchanged when mass changes at constant speed and radius.
- Option D:** Doubling is the exact mathematical outcome, making this option invalid.

Question #183 Key: (C)PHYSICS
02. Force & Motion

A person's life was saved in a car accident due to airbags system. During that car accident, ai...

CORE CONCEPT & DERIVATION

The impulse-momentum theorem states that stopping a moving body requires a fixed change in linear momentum, meaning average impact force is inversely proportional to collision duration.

Formula / Rule / Reaction:

$$J = \Delta p = F_{\text{avg}} \Delta t \implies F_{\text{avg}} = \frac{\Delta p}{\Delta t}$$

Solution:

- Bringing an occupant's head to rest requires dissipating its full momentum ($\Delta p = \text{constant}$).
- Deploying an airbag increases the deceleration distance and time of impact (Δt) compared to a rapid impact with a rigid windshield.
- Because collision duration Δt is extended, the average impact force F_{avg} exerted on the head is substantially reduced.
- Thus, the airbag protects life by applying a much smaller force over a longer duration of time.

Why other options are incorrect:

- Option A:** Airbags reduce impact force, rather than increasing it.
- Option B:** High force over a short time describes collision with a rigid windshield, which causes severe injury.
- Option D:** Reducing force while also reducing collision time would require reducing the initial momentum, which is fixed before the crash.

Question #184 Key: (A)PHYSICS
13. Electronics

The circuit required for change of AC voltage to DC voltage is called:

CORE CONCEPT & DERIVATION

Rectification is the electronic process of converting bidirectional alternating current (AC) into unidirectional direct current (DC) using semiconductor diodes.

Formula / Rule / Reaction:

$$\text{AC Input } (V_m \sin \omega t) \xrightarrow{\text{Rectifier Circuit (Half-wave / Full-wave Bridge)}} \text{Pulsating DC Output}$$

Solution:

- Diodes conduct current primarily in the forward-biased direction while blocking current in reverse bias.
- Arranging diodes into half-wave or full-wave bridge circuits converts alternating voltage waveforms into unidirectional DC voltage.
- This circuit is termed a rectifier.

Why other options are incorrect:

- Option B:** An amplifier increases the amplitude or power of an input AC or DC electrical signal without changing its waveform from AC to DC.
- Option C:** A detector (demodulator) extracts baseband information from an RF carrier wave in radio communications.
- Option D:** An emitter is one of the three doped regions of a bipolar junction transistor (BJT) that injects charge carriers into the base.

Question #185 Key: (C)PHYSICS
14. Dawn of Modern Physics

When placed in light which of the following can generate an output voltage across its electrode...

CORE CONCEPT & DERIVATION

The photovoltaic effect converts absorbed photon energy into electrical potential across an unbiased semiconductor p-n junction through electron-hole pair separation.

Formula / Rule / Reaction:**Solution:**

- A photodiode (or solar cell) contains a p-n junction with an optical window.
- When incident light delivers photon energy greater than the band gap ($h\nu \geq E_g$), electron-hole pairs are generated within the depletion region.
- The junction's built-in electric field separates these carriers, sweeping electrons into the n-region and holes into the p-region, generating an open-circuit output voltage across the terminals.

Why other options are incorrect:

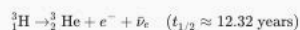
- **Option A:** Standard silicon diodes are encased in opaque packaging and do not function as light-to-voltage transducers.
- **Option B:** A light-emitting diode (LED) converts forward-bias electrical current into emitted light, operating as an emitter rather than a primary voltage generator.
- **Option D:** Only the photodiode operates specifically to convert incident light into an electrical voltage.

Question #186 Key: (C)PHYSICS
16. Nuclear Physics

Which of the following isotope of hydrogen is unstable?

CORE CONCEPT & DERIVATION

Hydrogen isotopes vary in nuclear stability based on neutron-to-proton ratio, with tritium possessing an unstable nucleus that undergoes radioactive beta decay.

Formula / Rule / Reaction:**Solution:**

- Protium (${}^1_1\text{H}$) contains 1 proton and 0 neutrons, and is stable.
- Deuterium (${}^2_1\text{H}$ or D) contains 1 proton and 1 neutron, and is also stable.
- Tritium (${}^3_1\text{H}$ or T) contains 1 proton and 2 neutrons, giving an unstable neutron-to-proton ratio.
- Tritium decays via low-energy beta-minus emission into helium-3 with a half-life of roughly 12.3 years.

Why other options are incorrect:

- **Option A:** Protium is a non-radioactive, stable isotope that makes up over 99.98% of natural hydrogen.
- **Option B:** Deuterium is a non-radioactive, stable isotope of hydrogen.
- **Option D:** Because protium and deuterium are stable, 'All of these' is incorrect.

Question #187 Key: (D)PHYSICS
10. Electromagnetism

A current-carrying conductor of length 'L' and current 'I' is lying at an angle of 90 degrees t...

CORE CONCEPT & DERIVATION

The magnetic Lorentz force on a straight current-carrying wire in a uniform magnetic field depends on the vector cross product of current displacement and magnetic field.

Formula / Rule / Reaction:

$$\mathbf{F} = I(\mathbf{L} \times \mathbf{B}) \implies F = ILB \sin \theta$$

Solution:

- Initially, the conductor lies perpendicular to the field ($\theta_1 = 90^\circ$), with magnetic force $F_1 = ILB \sin(90^\circ) = ILB$.
- Rotating the wire by 90° aligns it parallel (or antiparallel) to the magnetic field vector, so the angle becomes $\theta_2 = 0^\circ$ or 180° .

- Because $\sin(0^\circ) = 0$ and $\sin(180^\circ) = 0$:

$$F_2 = ILB \sin(0^\circ) = \left(\frac{2}{3}IL\right) LB(0) = 0$$

- Therefore, the net magnetic force becomes zero regardless of the current magnitude.

Why other options are incorrect:

- **Option A:** 2/3 times would occur if the conductor's orientation remained perpendicular ($\theta = 90^\circ$) while current dropped to $\frac{2}{3}I$.
- **Option B:** 1/3 times is a calculation error.
- **Option C:** 4/3 times incorrectly implies an increase in magnetic force.

Question #188 Key: (C)PHYSICS
02. Force & Motion

Which of the following statements is absolutely correct: I. Forces can stop or make objects mov...

CORE CONCEPT & DERIVATION

By Newton's first and second laws of motion, a net force acting on a body accelerates it, changing its speed, its direction of motion, or both.

Formula / Rule / Reaction:

$$\Sigma \mathbf{F} = m\mathbf{a} = m \frac{d\mathbf{v}}{dt} \quad (\mathbf{v} = v\hat{\mathbf{u}} \implies \text{Force changes magnitude } v \text{ or direction } \hat{\mathbf{u}})$$

Solution:

- Applying a force with or against the direction of motion changes the body's speed, accelerating or decelerating it to rest. This validates Statement I.
- Applying a force with a component perpendicular to motion (such as a centripetal force) changes the velocity vector's direction without necessarily altering speed. This validates Statement II.
- Therefore, both Statement I and Statement II are correct.

Why other options are incorrect:

- **Option A:** Statement I is correct, but selecting A alone overlooks Statement II.
- **Option B:** Statement II is correct, but selecting B alone overlooks Statement I.
- **Option D:** Both statements are direct consequences of Newtonian mechanics, making this option invalid.

Question #189 Key: (A)

PHYSICS
05. Waves

Compression is that portion of the longitudinal wave where pressure is:

CORE CONCEPT & DERIVATION

In longitudinal elastic waves, compressions are regions where oscillating medium particles are displaced toward one another, producing localized increases in density and pressure.

Formula / Rule / Reaction:

$$\Delta P = -B \frac{\partial s}{\partial x} \quad (\text{In compressions, particle convergence produces } \Delta P > 0)$$

Solution:

- Longitudinal waves propagate via alternating compressions and rarefactions.
- In compressions, the displacement gradient causes medium particles to crowd together, maximizing particle density and raising local pressure above ambient equilibrium pressure.
- Rarefactions are the complementary regions where particle density and pressure drop below ambient equilibrium.
- Thus, compressions are characterized by high pressure.

Why other options are incorrect:

- Option B:** Low pressure characterizes rarefactions.
- Option C:** Zero gauge pressure corresponds to the undisturbed equilibrium state of the medium.
- Option D:** Pressure cannot be simultaneously high, low, and zero in the same region of a wave.

Question #190 Key: (D)

PHYSICS
11. Electromagnetic Induction

If the rate of change of current [Formula] in the primary coil is increased by one half then em...

CORE CONCEPT & DERIVATION

Mutual induction dictates that the electromotive force induced across a secondary coil is directly proportional to the time rate of change of current in the primary coil.

Formula / Rule / Reaction:

$$E_s = M \left(\frac{dI_p}{dt} \right) \implies E_s \propto \frac{dI_p}{dt}$$

Solution:

- Let the initial rate of change of current be $R = \frac{dI}{dt}$, giving an initial secondary EMF of $E_1 = MR$.
- Increasing this rate 'by one half' means adding $\frac{1}{2}R$ to the initial value:
- $R' = R + \frac{1}{2}R = \frac{3}{2}R$
- The new induced EMF is:
- $\mathcal{E}_2 = MR' = M \left(\frac{3}{2}R \right) = \frac{3}{2} \mathcal{E}_1$
- Therefore, the induced EMF becomes $3/2$ times its initial value.

Why other options are incorrect:

- Option A:** Half would occur if the rate were reduced to 50% of its initial value.
- Option B:** Double would occur if the rate were increased by 100% (doubled).
- Option C:** $2/3$ times represents the inverse ratio, which would apply if the rate had decreased.

Question #191 Key: (D)

PHYSICS
02. Force & Motion

Which of the following is a vector quantity?

CORE CONCEPT & DERIVATION

Physical quantities possessing both magnitude and spatial direction that transform according to vector addition laws are classified as vectors, whereas quantities defined solely by magnitude are scalars.

Formula / Rule / Reaction:

$$\Phi_E = \iint \mathbf{E} \cdot d\mathbf{A} \text{ (Scalar); } W = \int \mathbf{F} \cdot d\mathbf{r} \text{ (Scalar); } U = qV \text{ (Scalar)}$$

Solution:

- Electric flux (Φ_E) is defined as the surface integral of the scalar dot product between electric field and area vectors, yielding a scalar quantity.
- Work done (W) is the scalar dot product of force and displacement vectors, representing energy (a scalar).
- Electric potential energy (U) is a scalar quantity quantifying stored energy.
- Because all three listed quantities are scalars, 'None of the given options' is correct.

Why other options are incorrect:

- Option A:** Electric flux is a scalar resulting from a vector dot product.
- Option B:** Work is a scalar energy quantity.
- Option C:** Potential energy is a scalar quantity.

Question #192 Key: (C)

PHYSICS
07. Thermodynamics

Which of the following condition must be true for transfer of energy from an object at temperature...

CORE CONCEPT & DERIVATION

By the Second Law of Thermodynamics (Clausius statement), thermal energy transfers spontaneously from a body at higher temperature to one at lower temperature.

Formula / Rule / Reaction:

$$\dot{Q}_{1 \rightarrow 2} = kA \left(\frac{T_1 - T_2}{L} \right) > 0 \iff T_1 > T_2$$

Solution:

- Heat is thermal energy in transit driven by a temperature gradient.
- Spontaneous net heat transfer from body 1 to body 2 requires body 1 to be at a higher temperature than body 2.
- Therefore, the condition $T_1 > T_2$ must hold.

Why other options are incorrect:

- Option A:** When $T_1 = T_2$, the bodies are in thermal equilibrium and net heat transfer is zero.
- Option B:** When $T_1 < T_2$, spontaneous heat transfer proceeds in the reverse direction (from body 2 to body 1).
- Option D:** $T_1 > T_2$ is the correct thermodynamic condition, making this option invalid.

Question #193 Key: (D)PHYSICS
09. Current Electricity

Resistance is the measure of:

CORE CONCEPT & DERIVATION

Electrical resistance is the property of a conductor that quantifies its opposition to the flow of electric charge, caused by collisions between conduction electrons and lattice ions.

Formula / Rule / Reaction:

$$R = \frac{\rho L}{A} = \frac{V}{I}$$

Solution:

- As conduction electrons drift through a conductor under an applied electric field, they collide with oscillating lattice ions and impurities.
- These collisions impede the free motion of charges, dissipating electrical energy as heat.
- Resistance is the quantitative measure of this opposition to the motion of charges.

Why other options are incorrect:

- Option A:** Current is the time rate of flow of electric charge ($I = dq/dt$), not the opposition to it.
- Option B:** Voltage is the electrical potential difference or work done per unit charge ($V = W/q$).
- Option C:** Motion of charges constitutes electrical current, which resistance opposes.

Question #194 Key: (D)PHYSICS
04. Rotational & Circular Motion

A particle is executing uniform circular motion in a circle of radius 100 mm. If its speed is 1...

CORE CONCEPT & DERIVATION

In circular kinematics, tangential linear speed is related to angular velocity by the radius of the circular path.

Formula / Rule / Reaction:

$$v = r\omega \implies \omega = \frac{v}{r}$$

Solution:

- Convert all quantities into consistent units:
- Radius: $r = 100 \text{ mm} = 10 \text{ cm} = 0.1 \text{ m}$.
- Linear speed: $v = 10 \text{ cm/s} = 0.1 \text{ m/s}$.
- Calculate the angular velocity:
- $$\omega = \frac{v}{r} = \frac{0.1 \text{ m/s}}{0.1 \text{ m}} = 1 \text{ rad/s}$$
- Because the correct value of 1 rad/s is not listed among options A (10 rad/s), B (0.1 rad/s), or C (10 rev/s), the answer is 'None of the given options'.

Why other options are incorrect:

- Option A:** 10 rad/s results from mistakenly dividing 10 cm/s by 1 mm rather than 100 mm.
- Option B:** 0.1 rad/s results from an erroneous decimal shift.
- Option C:** 10 revolutions/s corresponds to $20\pi \text{ rad/s} \approx 62.8 \text{ rad/s}$, which is incorrect.

Question #195 Key: (C)LOGICAL REASONING
03. Courses of Action & Decision-Making

Statement: The vegetable traders feel that the prices of onion will again go up. Courses of Act...

CORE CONCEPT & DERIVATION

In administrative decision-making, a course of action is valid if it represents a feasible, direct, and constructive measure that mitigates the stated problem without generating disproportionate secondary complications.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Course I proposes establishing a buffer stock by purchasing and storing onions in advance, which is a standard administrative mechanism used to stabilize market supply and suppress price spikes.
- Course II proposes opening fair-price shops during shortages, which directly protects consumer purchasing power from speculative hoarding.
- Both proposals are practical, complementary administrative interventions that address the anticipated price rise.
- Therefore, both courses of action follow logically.

Why other options are incorrect:

- Option A:** Action I is appropriate, but selecting A alone overlooks the equally valid intervention outlined in Action II.
- Option B:** Action II is appropriate, but selecting B alone neglects the preventative buffer-stock strategy in Action I.
- Option D:** Because both courses of action are standard economic stabilization practices, this option is invalid.

Question #196 Key: (A)LOGICAL REASONING
14. Direction, Distance & Spatial/Visual Patterns

Five cities P, Q, R, S and T are connected by different modes of transport as follows: P and Q ...

CORE CONCEPT & DERIVATION

Network pathfinding requires identifying an uninterrupted path between source and destination vertices where all connecting edges share the same transport mode.

Formula / Rule / Reaction:Target Route: $Q \rightarrow \dots \rightarrow R$ (Mode = Constant throughout)**Solution:**

- Analyze available transport edges:
- Edges from Q: $\{(Q, P): [\text{Boat, Rail}], (Q, T): [\text{Air}]\}$.
- Test Boat: Q connects to P by Boat. From P, there is an edge to R only by Boat. The sequence $Q \xrightarrow{\text{Boat}} P \xrightarrow{\text{Boat}} R$ completes the journey entirely by Boat.
- Test Rail: Q connects to P by Rail, but P connects to R only by Boat (requiring a mode change). Q connects to T by Air, not Rail.
- Test Air: Q connects to T by Air, but T connects to R by Rail and Bus (no air connection to R).
- Test Bus: There are no bus routes departing from Q.
- Thus, Boat is the only mode that connects Q to R without a transfer between modes.

Why other options are incorrect:

- Option B:** Rail routes from Q terminate at P without a connecting rail route from P to R.
- Option C:** There are no bus connections leaving city Q.
- Option D:** Air travel from Q terminates at T, which has no onward air connection to R.

Question #197 Key: (B)LOGICAL REASONING
13. Blood Relations & Kinship

Statement 1: A is the brother of B. Statement 2: B is the daughter of C. Based on these statements...

CORE CONCEPT & DERIVATION

Family lineage deductions evaluate gender, filial links, and fraternal relationships across generational steps.

Formula / Rule / Reaction: $A \text{ (male)} \leftrightarrow B \text{ (female, sibling)}; C \rightarrow B \Rightarrow C \rightarrow A \Rightarrow A \text{ is the son of } C$ **Solution:**

- Statement 1 establishes that A is the brother of B (A is male, and A and B are siblings sharing the same parents).
- Statement 2 establishes that B is the daughter of C (C is the parent of B).
- Because A and B are siblings, C must also be the parent of A.
- Since A is male, A is the son of C.

Why other options are incorrect:

- Option A:** A is the brother of B, not the brother of C.
- Option C:** C is the parent of A, meaning A cannot be the father of C.
- Option D:** A is male ('brother'), so A cannot be a daughter.

Question #198 Key: (B)LOGICAL REASONING
12. Linear Ranking, Ordering & Inequalities

If the first two statements are true, the third statement is: I. Maria runs faster than Amna. I...

CORE CONCEPT & DERIVATIONTransitivity in strict ordering relations dictates that if $X > Y$ and $Y > Z$, then $X > Z$, precluding the inverse inequality.**Formula / Rule / Reaction:**Premise I: $M > A$; Premise II: $L > M \Rightarrow L > M > A \Rightarrow L > A$ **Solution:**

- Statement I establishes: $\text{Speed}(\text{Maria}) > \text{Speed}(\text{Amna})$.
- Statement II establishes: $\text{Speed}(\text{Laiba}) > \text{Speed}(\text{Maria})$.
- By the transitive property of inequalities: $\text{Speed}(\text{Laiba}) > \text{Speed}(\text{Maria}) > \text{Speed}(\text{Amna})$, which proves that Laiba runs faster than Amna.
- Statement III asserts that Amna runs faster than Laiba ($\text{Speed}(\text{Amna}) > \text{Speed}(\text{Laiba})$).
- This assertion directly contradicts the established ordering, making Statement III False.

Why other options are incorrect:

- Option A:** The assertion directly contradicts the established inequality chain, so it cannot be True.
- Option C:** The relative ordering is completely specified by premises I and II, leaving no ambiguity or uncertainty.
- Option D:** The statement is definitively False, making this option invalid.

Question #199 Key: (B)LOGICAL REASONING
02. Cause and Effect Analysis

Statements: I. The university authority has instructed all the colleges under its jurisdiction ...

CORE CONCEPT & DERIVATION

Cause-and-effect reasoning identifies the temporal and logical sequence where an initial triggering event or grievance (cause) motivates an administrative policy response (effect).

Formula / Rule / Reaction:Teacher Grievance (Statement II: Cause) $\rightarrow$ Official Campus Ban (Statement I: Effect)**Solution:**

- Statement II describes college teachers submitting a formal joint petition complaining about classroom disturbances caused by mobile phone rings.
- Statement I describes the governing university administration issuing a formal ban on mobile phones inside college premises.
- The joint complaint and petition provided the direct rationale that prompted the university authority to enact the campus-wide ban.
- Therefore, Statement II is the cause and Statement I is its effect.

Why other options are incorrect:

- Option A:** Reversing the relationship implies that the university ban prompted teachers to petition against ringtone disruptions, which reverses logical cause and effect.
- Option C:** The statements are linked by a direct grievance-to-policy relationship, rather than existing as isolated causes.
- Option D:** The actions form a direct cause-and-effect sequence, rather than being independent effects of separate causes.

Question #200 **Key: (D)**LOGICAL REASONING
02. Cause and Effect Analysis

Statements: I. Kenya has surpassed the value of tea exports this year due to an increase in dem...

CORE CONCEPT & DERIVATION

Events in distinct economic sectors (international tea exports versus domestic coffee retail) that are driven by separate commercial factors are classified as effects of independent causes.

Formula / Rule / Reaction:

{ Global Tea Demand Factors → Kenya Tea Export Growth (Effect I)
Domestic Consumer Preferences → Local Coffee Demand Growth (Effect II)

Solution:

- Statement I reports an increase in the value of Kenyan tea exports, driven by foreign demand for quality tea in international markets.
- Statement II reports increased domestic consumption and demand for coffee in the local market over the preceding two years.
- These two market shifts involve different agricultural commodities operating in distinct market environments (foreign export vs. domestic retail) without direct causal links between them.
- Therefore, both statements represent effects of independent causes.

Why other options are incorrect:

- **Option A:** Higher foreign tea export values do not cause local domestic consumers to purchase more coffee.
- **Option B:** Higher domestic retail coffee demand does not drive international foreign consumer demand for Kenyan tea.
- **Option C:** Both statements report observed outcomes (effects) rather than primary causal mechanisms.