

**BEAMBEPREP**

PAKISTAN ENTRANCE EXAMINATION ENGINE

**SCAN TO SOLVE LIVE**Timer, instant scoring, and
percentile ranks on
beambeprep.com

UHS LAHORE

UHS Lahore MDCAT 2021 Official Paper

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

🛡️ Official Admitting Board: University of Health Sciences Lahore 🎯 Archive Code: BEAMBE-FLP-UHS-2021 ⌚ Duration: 200 Minutes (3h 20m)

200

TOTAL QUESTIONS

200m

OFFICIAL DURATION

+1 / 0.00

ZERO NEGATIVE MARKING

200

MAXIMUM MARKS

📄 EXAMINATION BLUEPRINT & SUBJECT WEIGHTAGE

Biology**68 MCQs**

34.0% weight

Chemistry**54 MCQs**

27.0% weight

Physics**54 MCQs**

27.0% weight

English**18 MCQs**

9.0% weight

Logical Reasoning**6 MCQs**

3.0% weight

BIO SECTION: BIOLOGY

Questions 1 to 68 (68 MCQs)

Q1. BIO

What does the term bacteriophage refer to?

- (A) A virus that infects bacteria
- (B) A bacterium that infects virus
- (C) A virus which behaves as bacteria
- (D) Combination of Bacterium & Virion

Q2. BIO

Which of the following viruses contains single-stranded DNA?

- (A) Adenovirus
- (B) Herpes virus
- (C) Parvovirus
- (D) Pox virus

Q3. BIO

How many tail fibrils are attached to the end plate of a bacteriophage?

- (A) 2
- (B) 4
- (C) 6
- (D) 8

Q4. BIO

The enzymes integrase, protease, and reverse transcriptase are found in which virus?

- (A) Hepatitis A virus
- (B) Herpes virus
- (C) Influenza virus
- (D) Human immunodeficiency virus

Q5. BIO

What is the end product of glucose by yeast in anaerobic respiration?

- (A) Ethanol and oxygen
- (B) Ethanol and water
- (C) Ethanol and CO₂
- (D) Lactic acid and CO₂

Q6. BIO

Each carrier in the electron transport chain is first _____ and then _____.

- (A) Broken-down, regenerated
- (B) Generated, broken-down
- (C) Oxidized, reduced
- (D) Reduced, oxidized

Q7. BIO

Electron transport chain explains:

- (A) Photophosphorylation
- (B) Z-Scheme
- (C) Photolysis
- (D) Mechanism of ATP synthesis

Q8. BIO

What is the color of the Chlorophyll-b molecule?

- (A) Bluish green
- (B) Yellowish green
- (C) Dark Green
- (D) Reddish green

Q9. BIO

Upon initial hydrolysis, starch yields:

- (A) Glucose
- (B) Maltose
- (C) Sucrose
- (D) Mannose

Q10. BIO

Human bone cells contain _____ % of water.

- (A) 20
- (B) 40
- (C) 85
- (D) 90

Q11. BIO

The unique three-dimensional shape of the fully folded polypeptide constitutes:

- (A) Primary structure of protein
- (B) Secondary structure of protein
- (C) Tertiary structure of protein
- (D) Quaternary structure of protein

Q12. BIO

Butyric acid is a _____ carbon fatty acid.

- (A) 6
- (B) 2
- (C) 4
- (D) 8

Q13. BIO

Which of the following is a conjugated molecule?

- (A) Protein
- (B) Lipid
- (C) Glycoproteins
- (D) Vitamins

Q14. BIO

The hydrolysis process is a reverse of the _____ process.

- (A) Photolysis
- (B) Condensation
- (C) Deduction
- (D) Convection

Q15. BIO

Proteins are the main _____ of the cell.

- (A) Physiological components
- (B) Functional components
- (C) Structural components
- (D) Biological components

Q16. BIO

A cell wall may be absent in which of the following?

- (A) Plant & Algae
- (B) Algae & Fungi
- (C) Fungi & Archaea
- (D) Bacteria & Archaea

Q17. BIO

_____ are the structures formed by invagination of the plasma membrane and have been associated with cell division and DNA replication in prokaryotic cells.

- (A) Lysosomes
- (B) Mesosomes
- (C) Golgi bodies
- (D) Phragmoplasts

Q18. BIO

Which of the following are single membranous organelles?

- (A) Mitochondria and ribosomes
- (B) Cytosol, mitochondria and ribosomes
- (C) Golgi bodies, Lysosome and ER
- (D) Golgi bodies, lysosome and mitochondria

Q19. BIO

Movement of molecules against the concentration gradient is:

- (A) Passive transport
- (B) Active transport
- (C) Facilitated diffusion
- (D) Filtration

Q20. BIO

The digestive vacuoles and autophagosomes are also known as:

- (A) Phagocytosis
- (B) Primary lysosome and autophagy
- (C) Secondary lysosome
- (D) Peroxisome

Q21. BIO

The cell wall of Bacteria is made up of:

- (A) Chitin
- (B) Murein
- (C) Cellulose
- (D) Hemicellulose

Q22. BIO

Which one is common in both prokaryotic and eukaryotic cells?

- (A) Cytoplasmic streaming movement
- (B) Ribosome
- (C) Binary fission
- (D) Nuclear envelope

Q23. BIO

There is no clear difference between dendrites and axons in sensory neurons, except:

- (A) Thickness
- (B) Length
- (C) Terminal portions
- (D) None of the above

Q24. BIO

The neurotransmitter active outside the CNS (Central Nervous System) is:

- (A) Acetylcholine
- (B) Dopamine
- (C) Glutamate
- (D) Serotonin

Q25. BIO

A hormone that plays a major role in social bonding, childbirth, milk ejection, and sexual reproduction is:

- (A) Estrogen
- (B) Oxytocin
- (C) Prolactin
- (D) Secretin

Q26. BIO

Hormone produced by placenta is:

- (A) Follicle-Stimulating Hormone (FSH)
- (B) Luteinizing Hormone (LH)
- (C) Progesterone
- (D) Testosterone

Q27. BIO

The middle layer of meninges is:

- (A) Arachnoid mater
- (B) Pia mater
- (C) Dura mater
- (D) Cranium

Q28. BIO

The part of the brain that guides smooth and accurate motions and maintains body position is:

- (A) Cerebrum
- (B) Cerebellum
- (C) Pons
- (D) Medulla

Q29. BIO

Water vascular system or ambulacral system is a unique and complex system specially present in?

- (A) Sponges
- (B) Arthropods
- (C) Echinoderms
- (D) Fishes

Q30. BIO

Round worms belong to which phylum?

- (A) Annelida
- (B) Coelenterata
- (C) Nematoda
- (D) Platyhelminthes

Q31. BIO

Silver fish is a/an?

- (A) Insect
- (B) Mollusc
- (C) Jawless fish
- (D) Cartilaginous fish

Q32. BIO

Tissue are not found in the following animal?

- (A) Flat worms
- (B) Sponges
- (C) Cnidarians
- (D) Round worms

Q33. BIO

Enzymes lower the activation energy by stabilizing the transition state of a metabolic reaction due to?

- (A) Changing conditions within the active site
- (B) Changing conditions within the protein framework
- (C) Rearranging the fatty acids in active site
- (D) Distorting the molecules in the allosteric site

Q34. BIO

Competitive inhibitors compete with?

- (A) Enzyme
- (B) Substrate
- (C) Product
- (D) Coenzyme

Q35. BIO

Non-competitive inhibitor molecules have:

- (A) similar structure to the normal substrate molecule
- (B) A quite different structure from the substrate molecule
- (C) A different conformation but fit into the active site
- (D) A similar conformation but does not fit into the active site

Q36. BIO

Zinc ion is attached at the active site of the enzyme carboxypeptidase. The zinc ion functions as:

- (A) coenzyme molecule
- (B) An activator
- (C) An inhibitor molecule
- (D) Controller of Allosteric site

Q37. BIO

What is the best physiological pH for optimum functioning for most of the cellular enzymes of human?

- (A) 2–3 pH
- (B) 3–5 pH
- (C) 6–8 pH
- (D) 8–10 pH

Q38. BIO

Adaptations that an organism acquires by its own actions during its life span without modifying its genome are:

- (A) Heritable
- (B) Non-heritable
- (C) Can be made heritable through so modification
- (D) Sometimes heritable and othertimes non-heritable

Q39. BIO

For evolutionary process to occur, which of the following is NOT a geographical barrier?

- (A) Ocean
- (B) River
- (C) Mountain
- (D) Atmosphere

Q40. BIO

According to the Biogenetic Law of Ernst Haeckel:

- (A) There is survival of the fittest
- (B) There is use and disuse of organs
- (C) Phylogeny recapitulates ontogeny
- (D) Ontogeny recapitulates phylogeny

Q41. BIO

The animal species on Galapagos resemble species living on the:

- (A) Northern Europe
- (B) Great Britain
- (C) North American mainland
- (D) South American mainland

Q42. BIO

Digested food from the intestine is carried to the liver by

- (A) Hepatic artery
- (B) Hepatic vein
- (C) Hepatic portal vein
- (D) Hepatic portal artery

Q43. BIO

_____ proteins are produced by WBC in response to _____ and provide immunity?

- (A) Antibiotics, antigen
- (B) Antibodies, RBC
- (C) Globulin, histamine
- (D) Antibodies, antigen

Q44. BIO

The lymphatic vessels of the body empty the lymph into blood stream at?

- (A) Abdominal vein
- (B) Jugular vein
- (C) Subclavian vein
- (D) Bile duct

Q45. BIO

Flow of blood in the capillaries is adjusted by?

- (A) Heart directly
- (B) Pre-capillary sphincters
- (C) Meta-arterioles
- (D) Valves

Q46. BIO

The pressure exerted by a solution separated by a semipermeable membrane from pure water is _____?

- (A) Osmotic Pressure
- (B) Soil potential
- (C) Solute potential
- (D) Solvent potential

Q47. BIO

Which of the following is NOT a consequence of anaerobic respiration in humans muscle cells?

- (A) Cramps
- (B) High consumption of energy
- (C) Pain
- (D) Tiredness

Q48. BIO

The respiratory surfaces exhibit the following characteristics:

- (A) It must be permeable
- (B) It must be thick for low diffusion
- (C) It should be non-vascularized
- (D) It should have low ventilation mechanism

Q49. BIO

Which of the following is a prokaryote?

- (A) Protista
- (B) *E. coli*
- (C) Amoeba
- (D) Fungi

Q50. BIO

Number of layers present in the Gram-negative bacterial cell wall:

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

Q51. BIO

The division of cocci in three planes forms Sarcina, which is a cube of _____ cocci.

- (A) 02
- (B) 04
- (C) 08
- (D) 16

Q52. BIO

Which of the following statements is correct regarding respiration at rest?

- (A) Inspiration is an active process
- (B) Expiration is an active process
- (C) Inspiration is a passive process
- (D) Both expiration and inspiration are passive processes

Q53. BIO

Nitrifying bacteria are an example of:

- (A) Heterotrophic bacteria
- (B) Chemosynthetic bacteria
- (C) Saprophytic bacteria
- (D) Parasitic bacteria

Q54. BIO

Each human testis is divided into:

- (A) 50–100 lobules
- (B) 150–200 lobules
- (C) 200–300 lobules
- (D) 250–300 lobules

Q55. BIO

Which cells in the human males are responsible for the release of testosterone?

- (A) Pituitary Gland
- (B) Hypothalamus
- (C) Sertoli cells
- (D) Leydig cells or interstitial cells

Q56. BIO

Fertilized ovum is implanted and undergoes further development in the:

- (A) Ovary
- (B) Uterus
- (C) Oviduct
- (D) Cervix

Q57. BIO

Level of luteinizing hormone (LH) is maximum in blood during which stage of menstrual cycle?

- (A) Menstrual stage
- (B) Proliferative stage
- (C) Ovulation stage
- (D) Secretory stage

Q58. BIO

Major source of transmission of syphilis is:

- (A) Blood transfusion
- (B) Insect bite
- (C) Contaminated water
- (D) Sexual contact

Q59. BIO

What is FALSE about cartilage?

- (A) There are many blood vessels in cartilage
- (B) It is a form of connective tissue
- (C) It covers ends of the bones at joints
- (D) It is much softer than bone

Q60. BIO

Which of the following is a muscle component that acts as a store for energy?

- (A) ATP
- (B) Creatine-PO₄
- (C) Myoglobin
- (D) Creatinine-PO₄

Q61. BIO

Which of the following is NOT found in skeletal muscle fibers in humans?

- (A) Multiple nuclei
- (B) Multiple mitochondria
- (C) Large amount of myoglobin
- (D) Large amount of hemoglobin

Q62. BIO

A hinge joint is present between which of the following bones?

- (A) Humerus and radio-ulna
- (B) Femur and pectoral girdle
- (C) Femur and acetabulum
- (D) Humerus and pectoral girdle

Q63. BIO

A test cross is made to check the genotype of a trait. Which of the following crosses is a test cross?

- (A) Unknown × At
- (B) Unknown × tt
- (C) Unknown × AB
- (D) Unknown × TT

Q64. BIO

What happens when an Rh⁻-negative woman, married to an Rh⁺-positive man, conceives a child who is Rh⁺-positive?

- (A) Maternal-foetal incompatibility
- (B) Paternal-foetal incompatibility
- (C) Cancer of the fetus
- (D) Death of mother

Q65. BIO

DNA stores biological information in discrete units termed as:

- Ⓐ Genes
- Ⓑ Phenotypes
- Ⓒ Karyotypes
- Ⓓ Cells

Q66. BIO

To study sex linkages in *Drosophila*, Morgan mated white-eyed males with wild-type red-eyed females. What will be the phenotype of the offspring?

- Ⓐ All red-eyed males and females
- Ⓑ Red-eyed females and white-eyed males
- Ⓒ White-eyed females and red-eyed males
- Ⓓ All white-eyed females and males

Q67. BIO

Which one of the following is an X-linked dominant disorder?

- Ⓐ Haemophilia
- Ⓑ Color blindness
- Ⓒ Hypophosphatemic rickets
- Ⓓ Becker muscular dystrophy

Q68. BIO

Mode of Inheritance in humans can be traced through:

- Ⓐ Experimental Mating
- Ⓑ Chi-Square Chart
- Ⓒ Pedigree analysis
- Ⓓ Probability analysis

CHEM SECTION: CHEMISTRY

Questions 69 to 122 (54 MCQs)

Q69. CHEM

One a.m.u. stands for:

- (A) An atom of C-12
- (B) $1/12$ th of a carbon-12 atom
- (C) $1/12$ th of H
- (D) 1 atom of all the elements

Q70. CHEM

A compound of sodium oxide has 74.2% of sodium and 25.8% of Oxygen. The empirical formula of the compound is?

- (A) NaO
- (B) NaO₂
- (C) Na₂O
- (D) Na₂O₂

Q71. CHEM

30 grams of 2-propanol were mixed with excess acidified $K_2Cr_2O_7$ and boiled under reflux for 20 minutes. The organic product was then collected by distillation. The yield of product was 75.0%. What is the mass of product produced?

- (A) 1.74 g
- (B) 21.75 g
- (C) 2.74 g
- (D) 29 g

Q72. CHEM

According to which scientist, the probability of finding an electron at a certain position is possible?

- (A) Bohr's
- (B) De-Broglie
- (C) Hund's
- (D) Schrodinger

Q73. CHEM

Which gas in the discharge tube produces lightest canal ray particles?

- (A) Ar
- (B) He
- (C) H₂
- (D) Ne

Q74. CHEM

Which element has the ground state electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6$?

- (A) Ar
- (B) Cl
- (C) Na
- (D) S

Q75. CHEM

What is the proton (atomic number) of an element that has four unpaired electrons in its ground state?

- (A) 6
- (B) 14
- (C) 22
- (D) 26

Q76. CHEM

A gaseous mixture contains 9.6% NH_3 , 22.6% N_2 and 67.8% H_2 gases. If the total pressure is 50 atm, then the partial pressure of H_2 is?

- (A) $67.8 \times 100 / 50$
- (B) $50 \times 100 / 100$
- (C) $67.8 \times 50 / 100$
- (D) $67.8 + 50 / 100$

Q77. CHEM

If we want to raise the temperature of one mole of an ideal gas by one kelvin we have to provide how much amount of energy?

- (A) 0.0821 joules
- (B) 8.314 dm³-atm
- (C) 0.0821 KJ
- (D) 0.0821 dm³-atm

Q78. CHEM

The process of heat flow between hotter and colder gases remains continued until all the molecules have equal:

- (A) Average translational kinetic energy
- (B) Average rotational kinetic energy
- (C) Average translational potential energy
- (D) Average vibrational kinetic energy

Q79. CHEM

In liquid, with the change in dipole-dipole forces, there is a change in some physical properties. select the property which is not affected by the strength of dipole-dipole forces?

- (A) Boiling point
- (B) Heat of vaporization
- (C) Heat of sublimation
- (D) Moles

Q80. CHEM

Which of the following factor does not affect the magnitude of vapor pressure?

- (A) Amount of liquid
- (B) Size of molecule
- (C) Temperature of liquid
- (D) Intermolecular forces

Q81. CHEM

A small building block which belongs to whole information about crystal structure is called?

- (A) Cell
- (B) Unit Cell
- (C) Crystal lattice
- (D) Crystal unit

Q82. CHEM

Which type of solid is called as atomic solid?

- (A) Covalent solids
- (B) Ionic solids
- (C) Metallic solids
- (D) Molecular solids

Q83. CHEM

The decrease in solubility of the salt in a solution that already contains an ion common to that salt is known as:

- (A) Le Chatelier's principle
- (B) Solubility Product
- (C) Common ion effect
- (D) K_{sp}

Q84. CHEM

The precipitation occurs if the ionic concentration is:

- (A) Less than K_{sp}
- (B) More than K_{sp}
- (C) Equal to K_{sp}
- (D) Present in any amount

Q85. CHEM

One can estimate the direction in which the equilibrium will shift with the help of:

- (A) Le Chatelier's principle
- (B) Law of mass action
- (C) Hess's law
- (D) Law of heat of formation

Q86. CHEM

What is the overall order of this rate equation? Rate = $k[H_2][NO_2]^2$

- (A) 1
- (B) 2
- (C) 3
- (D) 4

Q87. CHEM

The catalysis in which the catalyst and the reactants are in the same phase is known?

- (A) Heterogeneous catalyst
- (B) Homogeneous catalyst
- (C) Slow
- (D) Fast

Q88. CHEM

Born-Haber cycle is used to determine the Lattice energy of ionic compounds. It is the application of

- (A) Henry's law
- (B) Le - Chatelier's Principle
- (C) Hess's law
- (D) Common Ion effect

Q89. CHEM

Which of the following term is state function?

- (A) Freezing
- (B) Decomposition
- (C) Sublimation
- (D) Enthalpy

Q90. CHEM

An electrochemical cell is based upon which reaction?

- (A) Acid-base reaction
- (B) Redox reaction
- (C) Nuclear reaction
- (D) Neutralization reaction

Q91. CHEM

In which of the following, oxygen shows fractional oxidation number?

- (A) OF_2
- (B) Na_2O_2
- (C) KO_2
- (D) Cl_2O_7

Q92. CHEM

Which of the following element has smaller size?

- (A) Na
- (B) K
- (C) Rb
- (D) Li

Q93. CHEM

Among LiCl , BeCl_2 , NaCl , CsCl , the compounds with the greatest and the least ionic character respectively are:

- (A) LiCl and CsCl
- (B) NaCl and LiCl
- (C) CsCl and NaCl
- (D) CsCl and BeCl_2

Q94. CHEM

Which statement describes the conversion of magnesium atoms to magnesium ions for ionic bond formation with chlorine?

- (A) The change is reduction, because there has been a gain of electrons
- (B) The change is oxidation, because there has been a loss of electrons
- (C) The change is reduction, because there has been a loss of electrons
- (D) The change is oxidation, because there has been a gain of electrons

Q95. CHEM

AB_4 type with no lone pair; this geometry enables the formation of which shape of molecule?

- (A) Trigonal
- (B) Regular tetrahedron
- (C) Regular octahedron
- (D) Regular pyramidal

Q96. CHEM

Why dimer of Aluminum chloride is formed

- (A) Aluminum is electron rich
- (B) Aluminum is having lone pair of electron
- (C) Aluminum donates lone pair to form bridge
- (D) Aluminum forms coordinate bonds with chlorine to complete its octet

Q97. CHEM

Which group of the periodic table contain non-metals, metalloids and metals

- (A) IB
- (B) VIIA
- (C) IVA
- (D) VIA

Q98. CHEM

Which of the following sulfate compound is insoluble in water?

- (A) BeSO_4
- (B) BaSO_4
- (C) MgSO_4
- (D) CaSO_4

Q99. CHEM

Which of the following complex show a tetrahedral geometry?

- (A) $[\text{Fe}(\text{CO})_5]$
- (B) $[\text{Cu}(\text{CN})_4]^{2-}$
- (C) $[\text{Au}(\text{Cl})_4]^-$
- (D) $[\text{Pt}(\text{NH}_3)_4]^{2+}$

Q100. CHEM

In which pair one has all Unpaired d orbitals while other have all paired d orbitals?

- (A) Cu and Zn
- (B) Cr and Fe
- (C) Cr and Cu
- (D) Mn and Co

Q101. CHEM

In which of the following functional groups is the carbon atom sp^2 -hybridized?

- (A) $-\text{CHO}$
- (B) $-\text{COOH}$
- (C) $-\text{CN}$
- (D) $-\text{COOR}$

Q102. CHEM

The compounds containing the $\text{R}-\text{SH}$ functional group are known as:

- (A) Alcohols
- (B) Thio-alcohols
- (C) Thio-ether
- (D) Nitrile

Q103. CHEM

What is the number of isomers of a hydrocarbon having a molecular formula, C_4H_8 ?

- (A) 2
- (B) 3
- (C) 4
- (D) 5

Q104. CHEM

Alkylbenzene is formed when benzene is treated with an alkyl halide in the presence of anhydrous aluminum chloride. Identify the type of reaction:

- (A) Halogenation
- (B) Friedel-Crafts acylation reaction
- (C) Friedel-Crafts alkylation reaction
- (D) Sulphonation

Q105. CHEM

Three alternate single and double bonds in benzene are called?

- (A) Conjugate bonds
- (B) Coordinate covalent bonds
- (C) Fixed bonds
- (D) Ionic bonds

Q106. CHEM

Which of the following compound is more acidic?

- (A) Alkane
- (B) Alkene
- (C) Alkyne
- (D) Cycloalkane

Q107. CHEM

Consider the chlorination of methane, the attack of chlorine free radical on methane form methyl free radical occurs in?

- (A) Initiation step
- (B) Propagation step
- (C) Termination step
- (D) Last step

Q108. CHEM

The ratio of sigma to pi electrons in benzene is?

- (A) 1:3
- (B) 3:1
- (C) 4:1
- (D) 1:4

Q109. CHEM

When halogen is removed from an alkyl halide a carbocation is formed, identify the most reactive carbocation:

- (A) Primary carbocation
- (B) Secondary carbocation
- (C) Tertiary carbocation
- (D) Methyl carbocation

Q110. CHEM

Freon is commonly known as?

- (A) Refrigerant
- (B) A solvent
- (C) Insecticides
- (D) A fire extinguisher

Q111. CHEM

Neopentyl chloride belongs to which class of alkyl halides?

- (A) Primary alkyl halides
- (B) Secondary alkyl halides
- (C) Tertiary alkyl halides
- (D) Quaternary alkyl halides

Q112. CHEM

What is the common name of 1,2,3-propanetriol?

- (A) Butyl alcohol
- (B) Glycol
- (C) Glycerol
- (D) Propyl alcohol

Q113. CHEM

Benzene is formed when Na reacts with which of the following?

- (A) Alcohol
- (B) Butyl alcohol
- (C) Propanol
- (D) Phenol

Q114. CHEM

When Phenol reacts with formaldehyde, which of the following product is produced?

- (A) Adduct
- (B) Hydronium ion
- (C) Oxonium ion
- (D) Phenoxide ion

Q115. CHEM

Which of the following is the correct name of $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_2\text{CHO}$?

- (A) 3-oxo hexanal
- (B) 3-one hexanal
- (C) 2-oxo hexanol
- (D) 3-one hexanol

Q116. CHEM

Which of the most suitable reagent for the conversion of $\text{R-CH}_2\text{OH} \rightarrow \text{RCHO}$?

- (A) $\text{KMnO}_4/\text{NaOH}$
- (B) Pyridinium chlorochromate
- (C) CrO_3
- (D) $\text{Cr}_2\text{O}_4/\text{H}_2\text{SO}_4$ (Conc.)

Q117. CHEM

Which one of the following is also called the silver mirror test?

- (A) Fehling's solution test
- (B) Iodoform test
- (C) Tollen's reagent
- (D) Benedict's solution test

Q118. CHEM

Which among the following have least pH?

- (A) $\text{CH}_3\text{CH}_2\text{COOH}$
- (B) $\text{CH}_2\text{ClCH}_2\text{COOH}$
- (C) $\text{CH}_3\text{CCl}_2\text{COOH}$
- (D) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$

Q119. CHEM

If carboxylic acid and ketone groups $\text{C}=\text{O}$ are present in a chain, then final name will be given as:

- (A) oxo, oic acid
- (B) one, oic acid
- (C) Both 1 and 2
- (D) None of these

Q120. CHEM

When carboxylic acids and dicarboxylic acids have similar molecular weights, how do their melting points compare?

- (A) Carboxylic acids have greater melting points
- (B) Dicarboxylic acids have greater melting points
- (C) Both acids have similar melting points
- (D) No consistent trends exists

Q121. CHEM

When food reaches the stomach, the action of which of the following comes to an end due to acidic pH?

- (A) Lipases
- (B) Amylase
- (C) Maltase
- (D) Hydrolases

Q122. CHEM

_____ is a copper-containing protein found in blood plasma that binds and transports copper throughout the body.

- (A) Hemoglobin
- (B) Glycoproteins
- (C) Ceruloplasmin
- (D) Histones

PHY SECTION: PHYSICS

Questions 123 to 176 (54 MCQs)

Q123. PHY

What is the shape of velocity–time graph for constant acceleration?

- (A) Parabola line
- (B) Straight line
- (C) Incline curve
- (D) Decline curve

Q124. PHY

Which of the following is the correct definition of variable velocity?

- (A) Unequal distances are covered in equal intervals of time
- (B) Equal displacements are made in unequal intervals of time
- (C) Unequal displacements are made in equal intervals of time
- (D) Equal displacements are made in equal intervals of time

Q125. PHY

A stone thrown horizontally from the top of a tall building follows a path that is:

- (A) Circular
- (B) Made of two straight line segments
- (C) Hyperbolic
- (D) Parabolic

Q126. PHY

Which of the following is incorrect?

- (A) Reaction force on a body is always balanced by the action force
- (B) Reaction and action forces are always equal
- (C) Action and reaction forces never act on the same body
- (D) Newton's third law is always valid in all situations

Q127. PHY

A fireman wants to slide down a rope. The breaking load of the rope is $\frac{3}{4}$ of the weight of the man. With what acceleration should the fireman slide down?

(Acceleration due to gravity is 'g')

- (A) g
- (B) $g/4$
- (C) $3g/4$
- (D) 0

Q128. PHY

When a heavy coin falls a short distance towards the ground it does not reach terminal velocity. Why is this so?

- (A) The coin has not hit the ground
- (B) The weight of coin is equal to air resistance
- (C) The weight of coin increases as air resistance increases
- (D) The weight of coin is more than air resistance

Q129. PHY

The consumption of energy by a 60 W bulb in 2 s is:

- (A) 120 J
- (B) 60 J
- (C) 30 J
- (D) 0.02 J

Q130. PHY

A long spring, when stretched by a distance x, has potential energy V. On increasing the stretching to nx, the potential energy of the spring will be:

- (A) nV
- (B) V/n
- (C) $n^2 V$
- (D) V/n^2

Q131. PHY

Ignoring details associated with friction, extra forces exerted by arm and leg muscles, and other factors, we can consider a pole vault as the conversion of an athlete's running kinetic energy to gravitational potential energy. If an athlete is to lift his body 5m during a vault, what speed must he have when he plants his pole?

- (A) 5 m/s
- (B) 10 m/s
- (C) 15 m/s
- (D) 20 m/s

Q132. PHY

A particle of mass m at rest is acted upon by a force P for time t. Its kinetic energy is:

- (A) $(P^2 t^2)/m$
- (B) $(P^2 t^2)/2m$
- (C) $(P^2 t^2)/3m$
- (D) $(P^2 t^2)/4m$

Q133. PHY

The number of revolutions in 3π radians is:

- (A) $1/60$
- (B) $3/2$
- (C) 2
- (D) 6

Q134. PHY

If a flywheel is rotating at 3.0 rad/s, the time it takes to complete one revolution is:

- (A) 0.67 s
- (B) 10 s
- (C) 1.3 s
- (D) 2.1 s

Q135. PHY

A fighter plane is moving in a vertical circle of radius r . Its minimum velocity at the highest point of the circle will be?

- (A) $\sqrt{3gr}$
- (B) $\sqrt{2gr}$
- (C) $\sqrt{gr}$
- (D) $\sqrt{(gr/2)}$

Q136. PHY

Which of the following increase by increasing amplitude?

- (A) Wavelength
- (B) Frequently
- (C) Zero
- (D) Loudness

Q137. PHY

An airplane travels at a speed of $0.5v$ where v is the speed of sound. The airplane approaches a stationary observer. The frequency of sound emitted by the aircraft is in 200Hz. Which frequency does the observer hear?

- (A) 400 HZ
- (B) 100 HZ
- (C) 120 HZ
- (D) 180 HZ

Q138. PHY

If the wavelength of light coming from a galaxy shifts towards the red end of space then galaxy is:

- (A) Approaching Earth
- (B) Receding the Earth
- (C) Stationary
- (D) Approaching Earth or is stationary

Q139. PHY

The shortest distance between any two points, in phase on a wave is called:

- (A) Displacement
- (B) Amplitude
- (C) Wavelength
- (D) Frequency

Q140. PHY

When will the oscillations stop in the absence of resistive forces?

- (A) Never
- (B) After 10 minutes
- (C) In 10 minutes
- (D) Immediately

Q141. PHY

The mechanical waves are not generated by:

- (A) Electric and magnetic fields
- (B) Coil of springs
- (C) Ropes
- (D) Water

Q142. PHY

Reducing mass M of a suspending body to one fourth will change the frequency of oscillation to:

- (A) One fourth
- (B) Double
- (C) Quadruple
- (D) Half

Q143. PHY

A distant star is receding from the Earth with a speed of 1.40×10^7 m/s. It emits light of frequency 4.57×10^{14} Hz. The speed of light is 3.0×10^8 m/s. The Doppler effect formula can be used with light waves. What will be the frequency of this light when detected on Earth?

- (A) 2.04×10^{13} Hz
- (B) 4.36×10^{14} Hz
- (C) 4.57×10^{14} Hz
- (D) 4.79×10^{14} Hz

Q144. PHY

Thermodynamics is that branch of Physics in which we study

- (A) relations between heat and mechanical
- (B) relations between heat and ionization energies
- (C) relations between chemical and mechanical energies
- (D) relations between kinetic and potential energies

Q145. PHY

When a gas is compressed isothermally, the product of its pressure and volume during the process is:

- (A) not constant
- (B) constant
- (C) zero
- (D) proportional

Q146. PHY

Temperature of given mass of a gas is changed from 150°C to 300°C during an isobaric process, volume of the gas will become:

- (A) Half
- (B) Double
- (C) Remain same
- (D) Less than double

Q147. PHY

A capacitor is charged with a battery and energy stored is u . After disconnecting battery another capacitor of same capacity is connected in parallel to the first capacitor. Then energy stored in each capacitor is

- (A) $U/2$
- (B) $U/4$
- (C) $4U$
- (D) $2U$

Q148. PHY

What is the potential difference between two point in an electric field if it takes 600J of energy to move a charge of $2C$ between two points?

- (A) 1200 J
- (B) 800 J
- (C) 300 J
- (D) 0J

Q149. PHY

Gauss law cannot be used to find which of the following quantity?

- (A) Electric field intensity
- (B) Electric flux density
- (C) Charge
- (D) permittivity

Q150. PHY

Which one of the following statements is true?

- (A) electrostatic force obeys inverse square law while gravitational force does not
- (B) Both gravitational force and electrostatic force are repulsive in nature
- (C) gravitational force is much weaker than electrostatic force.
- (D) Both electrostatic force and gravitational force don't obey inverse square law

Q151. PHY

The coulomb's constant k depends upon:

- (A) nature of medium
- (B) system of units
- (C) types of charge
- (D) nature of medium and system of units

Q152. PHY

A charged particle is moving in a uniform electric field. For the motion of the particle due to the field, which quantity has a constant non-zero value?

- (A) Acceleration
- (B) Displacement
- (C) Rate of change of acceleration
- (D) Velocity

Q153. PHY

A capacitor of capacitance C has charge Q and stored energy is W . If the charge is increase to $2Q$. The stored energy will be:

- (A) $W/4$
- (B) $W/2$
- (C) $2W$
- (D) $4W$

Q154. PHY

How much potential drop exist across closed switch?

- (A) 0 V
- (B) 1V
- (C) 2V
- (D) 3V

Q155. PHY

A 3 V battery is connected in series with ammeter and 2 ohm resistance after short circuiting. What will be the reading of ammeter?

- (A) 1 A
- (B) 1.5 A
- (C) 5 A
- (D) 6 A

Q156. PHY

The resistance of a conductor does not depend on which of the following?

- (A) area
- (B) resistivity
- (C) length
- (D) mass

Q157. PHY

Which of the following statement is NOT CORRECT about Kirchhoff's rule?

- (A) Kirchhoff's current rule based upon the law of conservation of charge
- (B) Wheatstone bridge is an application of Kirchhoff's rule
- (C) Kirchhoff's rules are more suitable in AC circuits
- (D) Kirchhoff's voltage rule based upon the law of conservation of energy

Q158. PHY

What do the substances whose resistance decreases with increase in temperature have?

- (A) high temperature coefficient
- (B) negative temperature coefficient
- (C) positive temperature coefficient
- (D) zero temperature coefficient

Q159. PHY

A low voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5 ohms is used to supply power to a heater of resistance 6.5 ohms in a fish tank. What is the power supplied to the water in the fish tank?

- (A) 41 W
- (B) 50 W
- (C) 53 W
- (D) 62 W

Q160. PHY

Electric forces change the magnitude and direction of velocity while magnetic forces change _____ of velocity.

- (A) Only Magnitude
- (B) Only direction
- (C) Magnitude and direction
- (D) Neither magnitude nor direction

Q161. PHY

Which surface has greater magnetic flux in same magnetic field, each has an area 1 m².

- (A) Circular
- (B) Rectangular
- (C) Square
- (D) Flux is independent of shape

Q162. PHY

The source of magnetic field is:

- (A) An isolated magnetic pole
- (B) Static electric charge
- (C) Nonmagnetic substance
- (D) Current loop

Q163. PHY

One meter long copper rod is moving with speed 20 m/sec in the magnetic field of strength 0.6 tesla. What is the value of induced emf?

- (A) 10 V
- (B) 12 V
- (C) 14 V
- (D) 16 V

Q164. PHY

The unit of $\Delta\Phi/\Delta t$ can be written as?

- (A) NmA-2s-1
- (B) NmAs-1
- (C) NmA-1s-1
- (D) NmA-2s1

Q165. PHY

Working principal of magnetic levitation train is according to?

- (A) Faraday law
- (B) Max planks law
- (C) Ohm law
- (D) Lenz law

Q166. PHY

A copper hoop is held in a vertical east-west plane in a uniform magnetic field whose field lines run along the north-south direction. The largest induced emf is produced when the hoop is.

- (A) Rotated about a north-south axis
- (B) Rotated about an east-west axis
- (C) Moved rapidly, without rotation toward the east
- (D) Moved rapidly, without rotation toward the south

Q167. PHY

In transformer, there is no _____ connection between the two coils but they are linked?

- (A) Magnetic, electrically
- (B) Electrical, magnetically
- (C) Magnetic, magnetically
- (D) Electrical, optically

Q168. PHY

When the temperature of semiconductor suddenly drops to zero kelvin, then a semiconductor acts as:

- (A) Conductor
- (B) Semi-conductor
- (C) Super conductor
- (D) Insulator

Q169. PHY

If electron, proton, neutron, and alpha particle have same velocity which of them have shortest wavelength?

- (A) Electron
- (B) Proton
- (C) Neutron
- (D) Alpha particle

Q170. PHY

The process of ejection of loosely bound electrons from a certain photo sensitive surface by absorption of photon is called:

- (A) Compton effect
- (B) Photoelectric effect
- (C) Pair production
- (D) Black body radiation

Q171. PHY

In a photoelectric effect experiment, the stopping potential is:

- (A) The kinetic energy of the most energetic electron ejected
- (B) The potential energy of the most energetic electron ejected
- (C) The photon energy
- (D) The electric potential that cause electron current to vanish

Q172. PHY

The line spectrum of hydrogen atom contains the spectral lines in the region of:

- (A) ultraviolet
- (B) infrared
- (C) visible
- (D) all of these

Q173. PHY

The speed of electron in the first Bohr orbit is:

- (A) $2.19 \times 10^6 \text{ ms}^{-1}$
- (B) $2.19 \times 10^{-6} \text{ ms}^{-1}$
- (C) $2.19 \times 10^4 \text{ ms}^{-1}$
- (D) $2.19 \times 10^{-4} \text{ ms}^{-1}$

Q174. PHY

A low energy neutron has RBE factor of 10. How much energy is absorbed by a man of mass 80 Kg if the value of equivalent dose is 400 rem?

- (A) 16 J
- (B) 32 J
- (C) 48 J
- (D) 64 J

Q175. PHY

It has been observed that Thorium ($_{90}^{234}\text{Th}$) is transformed into Protactinium ($_{91}^{234}\text{Pa}$) after the emission of particle:

- (A) Alpha
- (B) Beta
- (C) Gamma
- (D) Alpha, Beta, Gamma

Q176. PHY

The half-life of Strontium (Sr) is 8.70 hours. Its decay constant is:

- (A) 0.000022 s
- (B) 45000 /s
- (C) 0.000022 /s
- (D) 0.000032 /s

ENG SECTION: ENGLISH

Questions 177 to 194 (18 MCQs)

Q177. ENG

Synonym of the word "Capricious" is:

- (A) Fickle
- (B) Predictable
- (C) Uniform
- (D) Invariable

Q178. ENG

Which of the following words will fill in the blank most appropriately?

Diseases like diabetes are supposed to be taken seriously or they can be _____.

- (A) Cursing
- (B) Healthy
- (C) Fatal
- (D) Impersonating

Q179. ENG

Choose the most appropriate antonym for "abandonment":

- (A) Cessation
- (B) Stoppage
- (C) Halt
- (D) Extension

Q180. ENG

Fill in the blank with the correct word.

The shepherd ploughed this mountain with cattle the first time it _____ ever ploughed.

- (A) was
- (B) was been
- (C) had
- (D) had been

Q181. ENG

To give one some idea of rabies' horrors, one _____ only read such descriptions as the following: spasms, restlessness, shudders at the least breath of air, an ardent thirst, convulsive movements, and fits of furious rage.

- (A) Needs
- (B) Need
- (C) Needed
- (D) Has needed

Q182. ENG

By 2030, people _____ been reading the works of Charles Dickens for more than 190 years.

- (A) Had
- (B) Will
- (C) Have
- (D) Will have

Q183. ENG

Choose the most suitable or appropriate sentence out of the following:

- (A) Penny did not let me to get my book.
- (B) Penny was not leaving me to get my book.
- (C) Penny did not let me get my book.
- (D) Penny had not left me get my book.

Q184. ENG

Which one of the following is correct?

- (A) We visited, Istanbul, Turkey, and Kowloon, Hong Kong last summer.
- (B) We visited: Istanbul, Turkey, and Kowloon, Hong Kong last summer.
- (C) We visited Istanbul, Turkey, Kowloon, Hong Kong last summer.
- (D) We visited Istanbul, Turkey, and Kowloon, Hong Kong last summer.

Q185. ENG

Which of the following sentences is correct?

- (A) How could Sarah perswad her mum to stay out later?
- (B) How could Sarah persuade her mum to stay out later?
- (C) How could Sarah persuad her mum to stay out later?
- (D) How could Sarah parsuade her mum to stay out later?

Q186. ENG

Choose the sentence with the correct use of the article.

- (A) Natasha can play a piano and a violin.
- (B) Natasha can play the piano and the violin.
- (C) Natasha can play the piano and a violin.
- (D) Natasha can play piano and violin.

Q187. ENG

Choose the correct preposition.

Distribute the handouts _____ the candidates.

- (A) into
- (B) Among
- (C) In
- (D) On

Q188. ENG

Choose the correct sentence:

- (A) These scissors are very sharp.
- (B) This scissors is very sharp.
- (C) This scissor is very sharp.
- (D) These scissor are very sharp.

Q189. ENG

Identify the sentence, out of the following, that is error-free:

- (A) I do not enjoy being laughed at by other people.
- (B) I did not enjoy laughing by other people.
- (C) I am not enjoying laughing by other people.
- (D) I do not enjoying being laughed at other people.

Q190. ENG

Choose the sentence that is grammatically correct.

- (A) We agreed that the play was rather boring so we felt bored
- (B) We agreed that the play was rather bored so we felt boring
- (C) We agreed that the play was rather bore so we felt bores
- (D) We agreed that the play was rath bores so we felt bored

Q191. ENG

The most appropriate word to be filled in here is:

I decided to sell the piece of land when I was offered more _____ price.

- (A) True
- (B) Realistic
- (C) Exact
- (D) Perfect

Q192. ENG

"To cut off the head", this idiom means:

- (A) Defrock
- (B) Decapitate
- (C) Impaled
- (D) Urbanite

Q193. ENG

Wasim was so good at Mathematics that people considered him to be a _____. Fill in the blank with the correct response.

- (A) Prodigy
- (B) Prodgal
- (C) Primeval
- (D) Profligate

Q194. ENG

The newly elected president and CEO for the newly established branch of our company _____ arrived recently. Fill in the blank with the appropriate choice:

- (A) have
- (B) having
- (C) have been
- (D) has

LOGIC SECTION: LOGICAL REASONING

Questions 195 to 200 (6 MCQs)

Q195. LOGIC

Read the passage and the following statements below. Then choose the correct option, basing your answer only on the information provided.

Queen Elizabeth II's Platinum Jubilee, celebrating her 70 years on the British throne, was above all a tribute to one of history's great acts of constancy. Her reign spanned virtually the entire post-World War II era, making her a witness to cultural upheavals from the Beatles to Brexit.

STATEMENTS:

- I. There has been another queen of the British throne named Elizabeth before her.
- II. Brexit is a normal occurrence.
- III. Elizabeth was Queen of the British during World War II.

- (A) I, II and III; all are correct
- (B) Only III is correct
- (C) Only I is correct
- (D) Only I and III are correct

Q196. LOGIC

Observe the pattern and select the next term in the sequence:

CAB, FAE, IAH, _____

- (A) JHK
- (B) LAK
- (C) JGK
- (D) IGJ

Q197. LOGIC

Read the following and choose the correct answer:

Drake was wearing a blue shirt with black jeans and brown shoes. John was wearing a red shirt with black jeans and black shoes. Ahmad was wearing black jeans, a blue or red shirt, and shoes that were not black. Who copied drake?

- (A) Ahmad
- (B) John
- (C) Drake
- (D) Cannot elicit from given information

Q198. LOGIC

Some bags are pouches. All pouches are cases. No cases are purses. Which of the following conclusions are NECESSARILY TRUE?

CONCLUSIONS:

- I. Some pouches are purses.
- II. Some bags are cases.
- III. No bags are purses.

- (A) I and II
- (B) I and III
- (C) II
- (D) II and III

Q199. LOGIC

Read the following statement, assuming everything in it to be true. Then decide which of the given suggested courses of action logically follow and are worth pursuing.

Statement:

"Aalia wants to sleep but cannot due to regular noise in and around her house everyday."

Courses of Action:

- I. Insert good quality noise blockers into her ears.
- II. Take strong sleeping pills.

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

Q200. LOGIC

Given two statements:

- I. The literacy rate in the district has been increasing.
- II. The district administration has conducted extensive training program for the workers involved in the literacy drive.

Choose the correct relationship between the statements:

- (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 the statements I and II are independent causes
- (D) Both the statements I and II are effects of independent cause

OFFICIAL VERIFIED ANSWER KEY

UHS Lahore MDCAT 2021 Official Paper · Rapid Self-Grading Grid

[Online Portal >](#)

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

SUBJECT-WISE PERFORMANCE BREAKDOWN

SUBJECT	MAX	YOUR SCORE	ACCURACY
Biology	68		----- %
Chemistry	54		----- %
Physics	54		----- %
English	18		----- %
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)

BIOLOGY
05. Acellular Life

What does the term bacteriophage refer to?

CORE CONCEPT & DERIVATION

Bacteriophages are obligate intracellular viruses that specifically infect and replicate within bacterial hosts.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The term bacteriophage derives from 'bacteria' and the Greek 'phagein' (to devour).
- They inject their genetic material into bacterial cells, using the host metabolic machinery to assemble progeny virions.

Why other options are incorrect:

- **Option B:** Bacteria are cellular organisms and do not infect viruses.
- **Option C:** Bacteriophages do not display bacterial behavior; they are strictly acellular viruses.
- **Option D:** A bacteriophage is a distinct taxonomic viral entity, not a structural hybrid or physical fusion of a bacterium and a virion.

Question #2 Key: (C)

BIOLOGY
05. Acellular Life

Which of the following viruses contains single-stranded DNA?

CORE CONCEPT & DERIVATION

While the majority of DNA viruses contain double-stranded DNA genomes, parvoviruses are characterized by a single-stranded DNA genome.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Parvoviruses are small, non-enveloped icosahedral animal viruses possessing a linear single-stranded DNA (ssDNA) molecule.
- Adenoviruses, herpesviruses, and poxviruses all maintain double-stranded DNA (dsDNA) genomes.

Why other options are incorrect:

- **Option A:** Adenovirus contains a non-enveloped, linear double-stranded DNA genome.
- **Option B:** Herpesvirus contains an enveloped, linear double-stranded DNA genome.
- **Option D:** Poxvirus contains a complex, enveloped double-stranded DNA genome.

Question #3 Key: (C)BIOLOGY
05. Acellular Life*How many tail fibrils are attached to the end plate of a bacteriophage?***CORE CONCEPT & DERIVATION**

Complex T-even bacteriophages possess a hexagonal baseplate from which six tail fibers (fibrils) extend to facilitate host recognition.

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

- The baseplate of a T4 bacteriophage exhibits six-fold radial symmetry.
- Exactly six tail fibers emanate from the baseplate pins and bind to specific lipopolysaccharide or protein receptors on the bacterial outer membrane.

Why other options are incorrect:

- **Option A:** Two tail fibers do not conform to the hexameric symmetry of the T-even baseplate.
- **Option B:** Four tail fibers are characteristic of certain contractile systems, but not standard T-even phage morphology.
- **Option D:** Eight is incorrect because the structural baseplate consists of six peripheral anchor points.

Question #4 Key: (D)BIOLOGY
05. Acellular Life*The enzymes integrase, protease, and reverse transcriptase are found in which virus?***CORE CONCEPT & DERIVATION**

Human Immunodeficiency Virus (HIV) is a retrovirus that packages reverse transcriptase, integrase, and protease within its core capsid.

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

- Reverse transcriptase converts single-stranded viral RNA into double-stranded complementary DNA (cDNA).
- Integrase inserts the viral cDNA into the host cell chromosomal DNA to form a provirus.
- Protease cleaves large precursor polypeptides into structural proteins and mature enzymes during viral maturation.

Why other options are incorrect:

- **Option A:** Hepatitis A is a picornavirus (positive-sense single-stranded RNA) that does not undergo reverse transcription or integration.
- **Option B:** Herpes virus is a double-stranded DNA virus that relies on viral DNA polymerase rather than reverse transcriptase.
- **Option C:** Influenza is an orthomyxovirus (negative-sense RNA) that uses an RNA-dependent RNA polymerase complex without integrase.

Question #5 Key: (C)BIOLOGY
04. Bioenergetics*What is the end product of glucose by yeast in anaerobic respiration?***CORE CONCEPT & DERIVATION**

In the absence of oxygen, yeast cells undergo alcoholic fermentation, breaking down glucose into ethanol and carbon dioxide.

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

- Glycolysis converts one molecule of glucose into two molecules of pyruvate.
- Pyruvate decarboxylase converts pyruvate to acetaldehyde and CO_2 .
- Alcohol dehydrogenase subsequently reduces acetaldehyde to ethanol while regenerating NAD^+ .

Why other options are incorrect:

- **Option A:** Oxygen is consumed during aerobic respiration and is never an end product of anaerobic fermentation.
- **Option B:** Water is generated as a byproduct of terminal electron transport in aerobic respiration, not alcoholic fermentation.
- **Option D:** Lactic acid fermentation occurs in certain bacteria and vertebrate skeletal muscle without carbon dioxide release.

Question #6 Key: (D)BIOLOGY
04. Bioenergetics*Each carrier in the electron transport chain is first _____ and then _____.***CORE CONCEPT & DERIVATION**

The mitochondrial electron transport chain operates via coupled redox reactions where electron carriers accept electrons before transferring them downstream.

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

- Each carrier exists initially in an oxidized resting state.
- Upon receiving an electron from an upstream donor, the carrier is reduced.
- Upon passing that electron to the next carrier with higher electronegativity, it is oxidized back to its original state.

Why other options are incorrect:

- **Option A:** The protein complexes of the electron transport chain are stable catalysts that are not destroyed during electron transfer.
- **Option B:** Carriers are permanently embedded in the inner mitochondrial membrane, not continually created and degraded.
- **Option C:** A carrier in its resting oxidized state cannot lose an electron before it gains one.

Question #7 Key: (D)BIOLOGY
04. Bioenergetics*Electron transport chain explains:***CORE CONCEPT & DERIVATION**

The respiratory electron transport chain establishes a proton gradient across the inner mitochondrial membrane that powers ATP synthesis via chemiosmosis.

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

- Electrons donated by NADH and FADH₂ travel through transmembrane complexes I to IV.
- Pumping of protons into the intermembrane space creates a proton motive force.
- Proton return through the F₀F₁ ATP synthase drives phosphorylation of ADP to ATP (oxidative phosphorylation).

Why other options are incorrect:

- Option A:** Photophosphorylation specifically refers to light-driven ATP synthesis occurring in chloroplast thylakoids.
- Option B:** The Z-scheme is a graphical model of non-cyclic photosynthetic electron transport in plants.
- Option C:** Photolysis is the enzymatic splitting of water molecules powered by photons in photosystem II.

Question #8 Key: (B)BIOLOGY
04. Bioenergetics*What is the color of the Chlorophyll-b molecule?***CORE CONCEPT & DERIVATION**

Chlorophyll a and chlorophyll b have distinct molecular structures that result in different light absorption and reflection spectra.

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

- Chlorophyll a possesses a methyl group (–CH₃) at C-7 and reflects blue-green light.
- Chlorophyll b possesses a formyl carbonyl group (–CHO) at C-7, shifting its absorption profile and causing it to reflect yellow-green light.

Why other options are incorrect:

- Option A:** Blue-green is the characteristic reflected color of chlorophyll a.
- Option C:** Dark green represents the combined macroscopic appearance of leaf tissue containing multiple pigment classes.
- Option D:** Reddish green is an optical misnomer not corresponding to any photosynthetic pigment.

Question #9 Key: (B)BIOLOGY
02. Biomolecules*Upon initial hydrolysis, starch yields:***CORE CONCEPT & DERIVATION**

Initial enzymatic digestion of starch by alpha-amylase cleaves internal α -(1,4) glycosidic bonds to yield disaccharide subunits rather than monosaccharides.

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

- Amylase digests the polysaccharide starch primarily into the disaccharide maltose, along with maltotriose and dextrins.
- Terminal conversion of maltose into individual glucose units requires subsequent hydrolysis by maltase in the brush border.

Why other options are incorrect:

- **Option A:** Free glucose is the final product of complete digestion, not the immediate product of initial amylase cleavage.
- **Option C:** Sucrose is a disaccharide of glucose and fructose synthesized in plants, not a breakdown product of starch.
- **Option D:** Mannose is an epimer of glucose that does not form the polysaccharide chain of starch.

Question #10 Key: (A)BIOLOGY
02. Biomolecules*Human bone cells contain _____ % of water.***CORE CONCEPT & DERIVATION**

Water content varies across human tissues according to metabolic activity and extracellular matrix mineralization, with bone tissue exhibiting the lowest hydration level.

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

- According to the Punjab Textbook of Biology, human bone cells contain approximately 20% water due to heavy hydroxyapatite mineral deposition.
- Brain cells by comparison contain approximately 85% water.

Why other options are incorrect:

- **Option B:** 40% is significantly higher than the physiological hydration level of human bone cells.
- **Option C:** 85% is the water content of brain cells.
- **Option D:** 90% is found in fluid compartments such as blood plasma, not in dense skeletal matrix.

Question #11 Key: (C)BIOLOGY
02. Biomolecules

The unique three-dimensional shape of the fully folded polypeptide constitutes:

CORE CONCEPT & DERIVATION

The overall three-dimensional conformation of a single folded polypeptide chain defines its tertiary structure.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Tertiary structure forms through interactions among amino acid R-groups, including hydrophobic interactions, hydrogen bonds, ionic bonds, and disulfide bridges.
- This folding gives the single polypeptide chain its specific biological and catalytic properties.

Why other options are incorrect:

- **Option A:** Primary structure is the linear sequence of amino acids joined exclusively by covalent peptide bonds.
- **Option B:** Secondary structure consists of localized repetitive conformations (such as α -helices and β -pleated sheets) stabilized by peptide backbone hydrogen bonds.
- **Option D:** Quaternary structure requires the spatial association of two or more distinct polypeptide subunits.

Question #12 Key: (C)BIOLOGY
02. Biomolecules

Butyric acid is a _____ carbon fatty acid.

CORE CONCEPT & DERIVATION

Fatty acids are carboxylic acids with hydrocarbon chains of variable lengths; butyric acid is a short-chain saturated fatty acid with four carbons.

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

- Butyric acid (butanoic acid) contains a three-carbon hydrocarbon chain attached to a terminal carboxyl group, totaling 4 carbons.
- It is found naturally in dairy fats such as butter.

Why other options are incorrect:

- **Option A:** A 6-carbon saturated fatty acid is caproic acid (hexanoic acid).
- **Option B:** A 2-carbon carboxylic acid is acetic acid (ethanoic acid).
- **Option D:** An 8-carbon saturated fatty acid is caprylic acid (octanoic acid).

Question #13 Key: (C)BIOLOGY
02. Biomolecules*Which of the following is a conjugated molecule?***CORE CONCEPT & DERIVATION**

Conjugated molecules are formed when two structurally and chemically distinct classes of biomolecules combine covalently into a single functional unit.

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

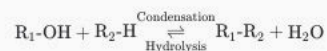
- Glycoproteins consist of carbohydrate oligosaccharide chains covalently linked to an amino acid polypeptide framework.
- They serve functional roles in cell surface recognition, receptor signaling, and membrane structure.

Why other options are incorrect:

- **Option A:** Pure proteins are polymers composed solely of amino acids.
- **Option B:** Lipids represent a single macromolecular class consisting of fatty acids and alcohol esters.
- **Option D:** Vitamins are organic micronutrients, not conjugated macromolecules.

Question #14 Key: (B)BIOLOGY
02. Biomolecules*The hydrolysis process is a reverse of the _____ process.***CORE CONCEPT & DERIVATION**

Condensation joins monomers with the elimination of water, whereas hydrolysis breaks covalent bonds within polymers through the addition of water.

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

- During condensation (dehydration synthesis), a hydroxyl group from one monomer and a hydrogen atom from another are removed to form a new bond and release H_2O .
- Hydrolysis adds H^+ and OH^- across the bond, cleaving the polymer back into separate monomers.

Why other options are incorrect:

- **Option A:** Photolysis is the chemical decomposition of molecules driven by radiant light energy.
- **Option C:** Deduction is a method of logical reasoning, not a chemical reaction.
- **Option D:** Convection is a physical mode of heat transfer in fluids.

Question #15 Key: (C)BIOLOGY
02. Biomolecules

Proteins are the main _____ of the cell.

CORE CONCEPT & DERIVATION

According to standard textbook biological classification, proteins form the primary structural architecture of cellular membranes, organelles, and the cytoskeleton.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Proteins provide physical form and framework to cells, constituting over 50% of the total cellular dry weight.
- Textbooks designate proteins primarily as the main structural components of living cells and tissues.

Why other options are incorrect:

- **Option A:** Physiological components is a non-standard descriptive phrase rather than a primary biological category.
- **Option B:** Functional components describes their catalytic roles, but textbook classification explicitly highlights their primary structural role.
- **Option D:** Biological components is an overly general category encompassing all classes of cellular organic molecules.

Question #17 Key: (B)BIOLOGY
01. Cell

_____ are the structures formed by invagination of the plasma membrane and have been associated with...

CORE CONCEPT & DERIVATION

Mesosomes are internal foldings of the bacterial plasma membrane that participate in chromosome segregation, DNA replication, and cross-wall synthesis.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Invaginations of the bacterial cytoplasmic membrane form vesicular, tubular, or lamellar structures known as mesosomes.
- They attach to the bacterial nucleoid, assisting in chromosome distribution into daughter cells during binary fission.

Why other options are incorrect:

- **Option A:** Lysosomes are single-membrane hydrolytic organelles found only in eukaryotes.
- **Option C:** Golgi bodies are eukaryotic endomembrane stacks responsible for protein post-translational modification.
- **Option D:** Phragmoplasts are plant-specific cytoskeletal complexes that guide cell plate formation during plant cytokinesis.

Question #16 Key: (D)BIOLOGY
01. Cell

A cell wall may be absent in which of the following?

CORE CONCEPT & DERIVATION

While most prokaryotes possess cell walls, specific lineages within both Bacteria and Archaea lack a rigid cell wall entirely.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Within Bacteria, the class Mollicutes (e.g., *Mycoplasma*) completely lacks peptidoglycan cell walls.
- Within Archaea, several genera (such as *Thermoplasma*) thrive without a rigid pseudomurein or S-layer cell wall.

Why other options are incorrect:

- **Option A:** Plants and algae consistently possess cellulose-based cell walls.
- **Option B:** Fungi universally produce cell walls composed of chitin and glucans.
- **Option C:** True fungi always possess a rigid cell wall; they are never naturally wall-less.

Question #18 Key: (C)BIOLOGY
01. Cell*Which of the following are single membranous organelles?***CORE CONCEPT & DERIVATION**

Eukaryotic organelles are classified by membrane boundaries into non-membranous, single-membrane, and double-membrane bound structures.

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

- The endoplasmic reticulum (ER), Golgi apparatus, and lysosomes are bound by a single phospholipid bilayer.
- They form a continuous and functionally coordinated endomembrane system within the cytoplasm.

Why other options are incorrect:

- **Option A:** Mitochondria possess a double membrane; ribosomes are non-membranous ribonucleoprotein complexes.
- **Option B:** Cytosol is an aqueous fluid medium, mitochondria are double-membraned, and ribosomes lack a membrane.
- **Option D:** Mitochondria contain two membranes (an outer membrane and a folded inner cristae membrane).

Question #19 Key: (B)BIOLOGY
01. Cell*Movement of molecules against the concentration gradient is:***CORE CONCEPT & DERIVATION**

Active transport is the carrier-mediated translocation of ions or molecules across a biological membrane against their concentration gradient, powered by cellular energy.

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

- Moving solutes from low concentration to high concentration opposes thermodynamic entropy.
- This requires work performed by transmembrane protein pumps coupled to ATP hydrolysis.

Why other options are incorrect:

- **Option A:** Passive transport moves solutes down their concentration gradient without metabolic energy expenditure.
- **Option C:** Facilitated diffusion uses channel or carrier proteins to speed up transport down the gradient without consuming ATP.
- **Option D:** Filtration is the bulk movement of fluid across a filter driven by hydrostatic pressure gradients.

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

The digestive vacuoles and autophagosomes are also known as:

CORE CONCEPT & DERIVATION

A secondary lysosome forms when a primary lysosome fuses with an endocytic vacuole (heterophagosome) or an autophagosome to initiate enzymatic digestion.

Formula / Rule / Reaction:

Primary Lysosome + Phagosome / Autophagosome → Secondary Lysosome

Solution:

- Primary lysosomes contain inactive acid hydrolases newly synthesized by the rough ER and packaged by the Golgi.
- Upon fusion with a vesicle carrying material for digestion, the resulting active structure is termed a secondary lysosome.

Why other options are incorrect:

- **Option A:** Phagocytosis is the cellular ingestion process itself, not an organellar structure.
- **Option B:** Primary lysosomes have not yet encountered substrate; autophagy is a catabolic cellular mechanism.
- **Option D:** Peroxisomes are oxidative organelles containing catalase and urate oxidase, distinct from the lysosomal lineage.

Question #21 Key: (B)BIOLOGY
01. Cell

The cell wall of Bacteria is made up of:

CORE CONCEPT & DERIVATION

The bacterial cell wall is a rigid sacculus composed of peptidoglycan, which is also referred to chemically as murein.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Murein consists of polysaccharide backbones of alternating *N*-acetylglucosamine (NAG) and *N*-acetylmuramic acid (NAM).
- These glycan strands are cross-linked by short oligopeptide chains to maintain osmotic stability.

Why other options are incorrect:

- **Option A:** Chitin is a homopolymer of *N*-acetylglucosamine found in fungal cell walls and arthropod exoskeletons.
- **Option C:** Cellulose is a polymer of β -D-glucose found in plant and algal cell walls.
- **Option D:** Hemicellulose is a branched structural polysaccharide found in plant cell walls.

Question #22 Key: (B)BIOLOGY
01. Cell

Which one is common in both prokaryotic and eukaryotic cells?

CORE CONCEPT & DERIVATION

Ribosomes are universally present in both prokaryotes and eukaryotes to perform translation of messenger RNA into polypeptides.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- All living cells require protein synthesis machinery.
- Prokaryotes contain 70S ribosomes, while eukaryotic cytoplasm contains 80S ribosomes.

Why other options are incorrect:

- **Option A:** Cytoplasmic streaming (cyclosis) relies on microfilament-myosin networks present only in eukaryotes.
- **Option C:** Binary fission is the characteristic mode of cell division in prokaryotes; eukaryotes divide by mitosis and cytokinesis.
- **Option D:** A nuclear envelope is a defining feature of eukaryotic cells and is absent in prokaryotes.

Question #23 Key: (C)BIOLOGY
12. Nervous Coordination

There is no clear difference between dendrites and axons in sensory neurons, except:

CORE CONCEPT & DERIVATION

In pseudounipolar sensory neurons, the peripheral fiber structurally resembles an axon throughout its length, differing primarily at its specialized terminal endings.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The peripheral process is myelinated and transmits action potentials toward the cell body, matching the histological profile of an axon.
- The distinct structural difference lies in its terminals: the peripheral end contains sensory receptor endings, while the central axon possesses synaptic terminals in the CNS.

Why other options are incorrect:

- **Option A:** Thickness is uniform along the length of both processes to support saltatory nerve conduction.
- **Option B:** Length varies depending on anatomical location and does not serve as a definitive histological criterion.
- **Option D:** Option C correctly identifies the structural distinction between the terminal arborizations.

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

The neurotransmitter active outside the CNS (Central Nervous System) is:

CORE CONCEPT & DERIVATION

Acetylcholine serves as the primary neurotransmitter of the peripheral nervous system, operating at the somatic neuromuscular junction and throughout the autonomic nervous system.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- In the peripheral nervous system, acetylcholine is released by all motor neurons at neuromuscular junctions to stimulate muscle contraction.
- It is also released by all preganglionic autonomic fibers and parasympathetic postganglionic fibers.

Why other options are incorrect:

- **Option B:** Dopamine operates primarily within central pathways (e.g., substantia nigra and ventral tegmental area).
- **Option C:** Glutamate is the principal fast excitatory neurotransmitter localized within the central nervous system.
- **Option D:** Serotonin acts predominantly within central neural circuits and localized enteric mucosal cells.

Question #25 Key: (B)BIOLOGY
13. Chemical Coordination

A hormone that plays a major role in social bonding, childbirth, milk ejection, and sexual repr...

CORE CONCEPT & DERIVATION

Oxytocin is a nonapeptide neurohormone synthesized in the hypothalamus and released by the posterior pituitary to regulate uterine contractions, milk let-down, and social attachment.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- During labor, oxytocin stimulates myometrial smooth muscle contraction via a positive feedback loop.
- During suckling, it stimulates contraction of mammary myoepithelial cells to cause milk ejection.
- In the brain, it modulates pair bonding, maternal behavior, and social recognition.

Why other options are incorrect:

- **Option A:** Estrogen stimulates uterine endometrial proliferation, but does not acutely trigger milk ejection or maternal social bonding.
- **Option C:** Prolactin stimulates milk synthesis in alveolar epithelial cells rather than acute milk ejection.
- **Option D:** Secretin is a gastrointestinal hormone that stimulates pancreatic bicarbonate secretion.

Question #26 Key: (C)BIOLOGY
13. Chemical Coordination

Hormone produced by placenta is:

CORE CONCEPT & DERIVATION

During pregnancy, the placenta takes over the endocrine role of the corpus luteum, synthesizing progesterone to maintain the gestational endometrium.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Trophoblastic cells of the placenta synthesize large quantities of progesterone from maternal cholesterol.
- Progesterone prevents menstruation, maintains the uterine decidua, and suppresses myometrial contractions during pregnancy.

Why other options are incorrect:

- **Option A:** FSH is synthesized and secreted by the anterior pituitary gland.
- **Option B:** LH is synthesized and secreted by gonadotropic cells of the anterior pituitary gland.
- **Option D:** Testosterone is produced predominantly by Leydig cells in the testes and to a lesser extent by the adrenal cortex.

Question #27 Key: (A)BIOLOGY
12. Nervous Coordination*The middle layer of meninges is:***CORE CONCEPT & DERIVATION**

The central nervous system is enveloped by three meningeal layers: the outer dura mater, middle arachnoid mater, and inner pia mater.

Formula / Rule / Reaction:

Dura mater (outer) → Arachnoid mater (middle) → Pia mater (inner)

Solution:

- The arachnoid mater is a web-like, avascular membrane positioned between the dura mater and pia mater.
- The subarachnoid space below it contains cerebrospinal fluid (CSF) that cushions the brain and spinal cord.

Why other options are incorrect:

- **Option B:** Pia mater is the delicate, highly vascular innermost layer adhering to the surface of the brain.
- **Option C:** Dura mater is the tough, fibrous outermost layer situated immediately beneath the skull.
- **Option D:** The cranium is the bony structure enclosing the brain, not a meningeal layer.

Question #28 Key: (B)BIOLOGY
12. Nervous Coordination*The part of the brain that guides smooth and accurate motions and maintains body position is:***CORE CONCEPT & DERIVATION**

The cerebellum integrates sensory inputs from the vestibular apparatus and proprioceptors to coordinate voluntary muscle movements and regulate balance.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The cerebellum compares intended movements planned by the motor cortex with actual body position.
- It continuously computes corrective signals to produce smooth, balanced, and precise voluntary motor execution.

Why other options are incorrect:

- **Option A:** The cerebrum initiates motor commands and processes sensory information, conscious thought, and memory.
- **Option C:** The pons serves as a bridge between brain regions and helps regulate respiratory rhythm.
- **Option D:** The medulla oblongata houses autonomic centers controlling heart rate, blood pressure, and breathing.

Question #29 Key: (C)BIOLOGY
10. Homeostasis

Water vascular system or ambulacral system is a unique and complex system specially present in?

CORE CONCEPT & DERIVATION

Echinoderms possess a coelomic water vascular system that uses hydraulic pressure to power tube feet for locomotion, feeding, and gas exchange.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Seawater enters the water vascular system through the porous madreporite plate.
- Water flows through stone, ring, and radial canals to extend and retract muscular tube feet via hydrostatic changes.

Why other options are incorrect:

- **Option A:** Sponges utilize a water canal system lined with choanocytes for filter feeding, not a water vascular system.
- **Option B:** Arthropods possess an open circulatory system with a hemocoel and chitinous exoskeleton.
- **Option D:** Fishes are vertebrates with a closed circulatory system and a bony or cartilaginous skeleton.

Question #30 Key: (C)BIOLOGY
16. Evolution

Round worms belong to which phylum?

CORE CONCEPT & DERIVATION

Roundworms are unsegmented, cylindrical pseudocoelomates classified under the phylum Nematoda.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Nematodes are characterized by a cylindrical body tapered at both ends, a tough protective cuticle, and a pseudocoelom.
- Examples include *Ascaris lumbricoides* and hookworms.

Why other options are incorrect:

- **Option A:** Annelida contains metamerically segmented coelomate worms, including earthworms and leeches.
- **Option B:** Coelenterata (Cnidaria) contains diploblastic organisms with radial symmetry, such as hydra and jellyfish.
- **Option D:** Platyhelminthes consists of dorsoventrally flattened, acoelomate flatworms like planaria and tapeworms.

Question #31 Key: (A)BIOLOGY
16. Evolution

Silver fish is a/an?

CORE CONCEPT & DERIVATION

Silverfish (*Lepisma saccharinum*) is a wingless, primitive terrestrial arthropod belonging to the class Insecta.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Silverfish possess three body divisions (head, thorax, abdomen), three pairs of jointed legs, and a chitinous exoskeleton.
- Despite its common name, it is a terrestrial hexapod insect rather than an aquatic vertebrate.

Why other options are incorrect:

- **Option B:** Molluscs are soft-bodied, unsegmented coelomates typically bearing a mantle, radula, and shell.
- **Option C:** Jawless fishes (Agnatha) are primitive aquatic vertebrates such as lampreys.
- **Option D:** Cartilaginous fishes (Chondrichthyes) are aquatic jawed vertebrates such as sharks and rays.

Question #32 Key: (B)BIOLOGY
10. Homeostasis

Tissue are not found in the following animal?

CORE CONCEPT & DERIVATION

Sponges (phylum Porifera, subkingdom Parazoa) exhibit a cellular level of organization without true tissues or germ layers.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Sponges are aggregations of specialized cells (pinacocytes, choanocytes, amoebocytes) embedded in a gelatinous mesohyl.
- These cells carry out independent functions without coordinated tissue sheets bound to basement membranes.

Why other options are incorrect:

- **Option A:** Flatworms possess triploblastic organ-system level organization.
- **Option C:** Cnidarians possess true tissue-level organization (epidermis and gastrodermis).
- **Option D:** Roundworms possess developed organ-system level organization with a pseudocoelomic cavity.

Question #33 Key: (A)BIOLOGY
03. Enzymes

Enzymes lower the activation energy by stabilizing the transition state of a metabolic reaction...

CORE CONCEPT & DERIVATION

Enzymes accelerate chemical reactions by optimizing the catalytic microenvironment inside the active site to stabilize the high-energy transition state.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The catalytic active site alters local conditions by orienting substrates, donating/accepting protons, and providing stabilizing charges.
- This reduces the free energy barrier needed to reach the transition state, lowering the overall activation energy.

Why other options are incorrect:

- **Option B:** The overall protein scaffold provides structural support, but catalysis occurs through specific conditions inside the active site.
- **Option C:** Active sites are lined by specific amino acid side chains, not fatty acids.
- **Option D:** Allosteric sites bind non-substrate regulatory effectors and do not participate in catalytic transition state stabilization.

Question #34 Key: (B)BIOLOGY
03. Enzymes

Competitive inhibitors compete with?

CORE CONCEPT & DERIVATION

A competitive inhibitor is a structural analog of the substrate that competes with it for reversible binding to the catalytic active site.

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

- Because both substrate and competitive inhibitor exhibit affinity for the same active site, they compete for site occupancy.
- Increasing substrate concentration overcomes this inhibition, restoring the maximum reaction velocity ($V_{\max}$).

Why other options are incorrect:

- **Option A:** The inhibitor binds to the enzyme rather than competing with it.
- **Option C:** Products are released at the end of catalysis and do not compete with the initial binding of inhibitors.
- **Option D:** Coenzymes bind to accessory prosthetic sites to assist catalysis rather than competing with active-site inhibitors.

Question #35 Key: (B)BIOLOGY
03. Enzymes*Non-competitive inhibitor molecules have:***CORE CONCEPT & DERIVATION**

Non-competitive inhibitors bind to a distinct allosteric site on the enzyme and bear no structural resemblance to the native substrate.

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

- Because non-competitive inhibitors bind outside the active site, they do not require structural similarity to the substrate.
- Binding to the allosteric site induces a conformational change in the enzyme, decreasing its turnover number without blocking substrate binding.

Why other options are incorrect:

- **Option A:** Structural similarity to the substrate is the defining property of competitive inhibitors.
- **Option C:** Non-competitive inhibitors do not bind within the active site.
- **Option D:** Non-competitive inhibitors possess distinct structures tailored to allosteric regulatory pockets.

Question #36 Key: (B)BIOLOGY
03. Enzymes*Zinc ion is attached at the active site of the enzyme carboxypeptidase. The zinc ion functions ...***CORE CONCEPT & DERIVATION**

Inorganic metal ions that bind to enzymes to enable or accelerate catalytic activity function as cofactors, often referred to as activators.

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

- In carboxypeptidase, a divalent zinc ion (Zn^{2+}) coordinates with the active site to polarize the substrate carbonyl bond.
- Because it is an inorganic metallic ion that enhances catalytic efficiency, it functions as an enzyme activator.

Why other options are incorrect:

- **Option A:** Coenzymes are non-protein organic carrier molecules, typically derived from vitamins.
- **Option C:** Zinc promotes catalysis rather than decreasing reaction velocity.
- **Option D:** The zinc ion coordinates directly within the catalytic active site, not at an allosteric site.

Question #37 Key: (C)BIOLOGY
03. Enzymes*What is the best physiological pH for optimum functioning for most of the cellular enzymes of h...***CORE CONCEPT & DERIVATION**

Most human cellular enzymes have evolved to function optimally near the neutral pH range of the intracellular cytosol and interstitial fluid (pH 6 to 8).

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

- Normal physiological pH within human body compartments is strictly buffered between 7.35 and 7.45.
- Consequently, the optimum pH for the vast majority of human metabolic enzymes falls within the range of 6.0 to 8.0.

Why other options are incorrect:

- **Option A:** A pH of 2 to 3 is strongly acidic, characteristic specifically of gastric enzymes like pepsin.
- **Option B:** A pH of 3 to 5 is found inside lysosomes for acid hydrolases, not in the general cytoplasm.
- **Option D:** A pH of 8 to 10 is excessively alkaline for most human cellular enzymes.

Question #38 Key: (B)BIOLOGY
16. Evolution*Adaptations that an organism acquires by its own actions during its life span without modifying...***CORE CONCEPT & DERIVATION**

Modifications acquired in somatic tissues during an organism's lifetime do not alter gametic DNA and cannot be transmitted to offspring.

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

- Only genetic variations present in germline cells (sperm or ova) are passed to subsequent generations.
- Phenotypic adaptations acquired through use, disuse, or environmental acclimation are strictly non-heritable.

Why other options are incorrect:

- **Option A:** Acquired somatic traits cannot be inherited without altering genomic nucleotide sequences.
- **Option C:** Somatic modifications cannot be retroactively incorporated into the germline code.
- **Option D:** Non-genetic adaptations are consistently non-heritable across all generations.

Question #39 Key: (D)BIOLOGY
16. Evolution

For evolutionary process to occur, which of the following is NOT a geographical barrier?

CORE CONCEPT & DERIVATION

Geographical barriers are physical topographical features on the earth's surface that isolate populations and prevent gene flow.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Geographical isolation requires physical barriers such as water bodies, mountain ranges, or deep canyons.
- The atmosphere is a continuous gas layer surrounding the entire planet and does not divide habitats into discrete physical barriers.

Why other options are incorrect:

- **Option A:** Oceans physically separate terrestrial populations, preventing migration and gene exchange.
- **Option B:** Large rivers act as barriers that isolate terrestrial organisms on opposite banks.
- **Option C:** Mountain ranges present geographic barriers that limit the dispersal of low-altitude organisms.

Question #40 Key: (D)BIOLOGY
16. Evolution

According to the Biogenetic Law of Ernst Haeckel:

CORE CONCEPT & DERIVATION

Ernst Haeckel's Biogenetic Law states that the embryonic development of an individual repeats the evolutionary history of its species.

Formula / Rule / Reaction:

Ontogeny Recapitulates Phylogeny

Solution:

- Ontogeny refers to the developmental history of an individual organism from zygote to adult.
- Phylogeny refers to the evolutionary history of a species or taxonomic group.
- Haeckel asserted that ontogeny recapitulates (repeats) phylogeny during embryonic stages.

Why other options are incorrect:

- **Option A:** Survival of the fittest was formulated by Herbert Spencer and incorporated into Darwinian natural selection.
- **Option B:** The principle of use and disuse of organs forms the foundation of Lamarck's evolutionary hypothesis.
- **Option C:** Inverting the phrase to 'phylogeny recapitulates ontogeny' is biologically incorrect, as evolutionary history does not repeat individual development.

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

The animal species on Galapagos resemble species living on the:

CORE CONCEPT & DERIVATION

Island biogeography demonstrates that oceanic island fauna most closely resemble species from the nearest continental mainland from which ancestors originally migrated.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The Galapagos Islands are located roughly 600 miles off the western coast of South America (Ecuador).
- Darwin observed that Galapagos finches, mockingbirds, and tortoises share strong taxonomic similarities with South American mainland species.

Why other options are incorrect:

- **Option A:** Northern Europe is geographically distant and contains unrelated Palearctic biomes.
- **Option B:** Great Britain is an Atlantic island system with unrelated cool-temperate wildlife.
- **Option C:** South America, rather than North America, was the direct ancestral source of Galapagos colonizers.

Question #42 Key: (C)BIOLOGY
07. Circulation / Transport

Digested food from the intestine is carried to the liver by

CORE CONCEPT & DERIVATION

The hepatic portal system transports deoxygenated, nutrient-rich blood from the intestinal capillary beds directly to the liver sinusoids.

Formula / Rule / Reaction:

Intestinal Capillaries → Hepatic Portal Vein → Liver Sinusoids

Solution:

- Nutrients absorbed through the intestinal villi enter the mesentery venous network.
- These veins converge into the hepatic portal vein, which carries absorbed amino acids and carbohydrates to the liver for metabolic processing.

Why other options are incorrect:

- **Option A:** The hepatic artery supplies oxygenated blood from the celiac trunk to the liver tissue.
- **Option B:** The hepatic vein drains processed venous blood from the liver into the inferior vena cava.
- **Option D:** Hepatic portal artery is an anatomical misnomer; the vessel entering the liver with portal blood is a vein.

Question #43 Key: (D)BIOLOGY
08. Immunity

_____ proteins are produced by WBC in response to _____ and provide immunity?

CORE CONCEPT & DERIVATION

In humoral adaptive immunity, B-lymphocyte derived plasma cells synthesize antibodies that bind stereospecifically to foreign antigens.

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

- White blood cells (plasma cells) produce specialized gamma-globulin proteins called antibodies.
- These are secreted in response to antigens to neutralize pathogens and provide long-term immunity.

Why other options are incorrect:

- **Option A:** Antibiotics are low-molecular-weight chemical compounds produced by microbes or synthesized chemically, not proteins made by human leukocytes.
- **Option B:** Antibodies are not generated against an individual's own normal red blood cells under healthy physiological conditions.
- **Option C:** Histamine is an inflammatory mediator released by mast cells, not a pathogen-associated antigen.

Question #44 Key: (C)BIOLOGY
07. Circulation / Transport

The lymphatic vessels of the body empty the lymph into blood stream at?

CORE CONCEPT & DERIVATION

The lymphatic drainage of the body converges into two main ducts that empty filtered lymph directly into the venous system at the subclavian veins.

Formula / Rule / Reaction:

Lymphatic System → Thoracic / Right Lymphatic Duct → Subclavian Veins

Solution:

- The thoracic duct drains lymph from the lower body and left upper quadrants into the left subclavian vein.
- The right lymphatic duct empties lymph from the right upper quadrant into the right subclavian vein.

Why other options are incorrect:

- **Option A:** Abdominal veins do not receive the terminal discharge of main lymphatic ducts.
- **Option B:** Although lymph vessels join near the junction with the internal jugular vein, standard anatomical reference identifies the subclavian vein as the main terminal site.
- **Option D:** The bile duct is a digestive conduit carrying bile into the duodenum.

Question #45 Key: (B)BIOLOGY
07. Circulation / Transport*Flow of blood in the capillaries is adjusted by?***CORE CONCEPT & DERIVATION**

Blood perfusion through capillary networks is controlled locally by precapillary sphincters located at the junction between meta-arterioles and true capillaries.

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

- Precapillary sphincters are muscular rings of smooth muscle that encircle the entrance to each true capillary.
- Contraction or relaxation of these sphincters regulates local blood flow in response to tissue metabolic needs.

Why other options are incorrect:

- **Option A:** The heart provides central cardiac output, but cannot selectively govern local perfusion in individual microvascular beds.
- **Option C:** Meta-arterioles provide bypass channels, but entry into actual capillaries is gated specifically by precapillary sphincters.
- **Option D:** Valves are structures found inside veins and lymphatics to prevent backflow, not in microvascular capillaries.

Question #46 Key: (A)BIOLOGY
10. Homeostasis*The pressure exerted by a solution separated by a semipermeable membrane from pure water is ____.***CORE CONCEPT & DERIVATION**

Osmotic pressure is the hydrostatic pressure required to prevent the net movement of pure water into a solution across an ideal semipermeable membrane.

Formula / Rule / Reaction:

$$\Pi = iCRT$$

Solution:

- When a solution is placed against pure water across a semipermeable barrier, water moves into the solution by osmosis.
- The mechanical pressure needed to stop this flow is defined as the osmotic pressure of that solution.

Why other options are incorrect:

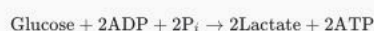
- **Option B:** Soil potential represents the energetic state of water bound within soil matrices.
- **Option C:** Solute potential (Ψ_s) is the thermodynamic component of water potential; it has a negative numerical value, whereas osmotic pressure is expressed as a positive pressure value.
- **Option D:** Solvent potential is a non-standard physical chemistry term.

Question #47 Key: (B)BIOLOGY
04. Bioenergetics

Which of the following is NOT a consequence of anaerobic respiration in humans muscles cells?

CORE CONCEPT & DERIVATION

Anaerobic glycolysis in human muscle generates only 2 ATP molecules per glucose molecule, resulting in a low yield of energy compared to aerobic pathways.

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

- Anaerobic glycolysis produces small amounts of energy per substrate molecule.
- Because it is an inefficient pathway yielding minimal ATP, 'high consumption of energy' (or high energy generation) is not a feature of this process.

Why other options are incorrect:

- **Option A:** Muscle cramps occur due to intracellular acidification and disruption of ionic gradients caused by lactic acid accumulation.
- **Option C:** Lactic acidosis stimulates local nociceptors, producing physical muscle pain.
- **Option D:** Rapid depletion of cellular glycogen and low ATP synthesis lead directly to muscular fatigue and tiredness.

Question #48 Key: (A)BIOLOGY
09. Respiration / Gaseous Exchange

The respiratory surfaces exhibit the following characteristics:

CORE CONCEPT & DERIVATION

Fick's law dictates that an effective respiratory surface must be highly permeable to respiratory gases, thin, moist, and well-vascularized.

Formula / Rule / Reaction:

$$\text{Rate of Diffusion} = \frac{D \cdot A \cdot \Delta P}{T}$$

Solution:

- Gases (O_2 and CO_2) must cross the membrane by simple diffusion.
- Therefore, high permeability to these gases is an essential requirement for any functional respiratory surface.

Why other options are incorrect:

- **Option B:** The respiratory surface must be extremely thin (small diffusion distance, T) to facilitate fast gas exchange.
- **Option C:** The surface must be richly vascularized to maintain steep partial pressure gradients across the membrane.
- **Option D:** High-capacity ventilation is required to continuously bring fresh environmental medium to the gas exchange surface.

Question #49 Key: (B)BIOLOGY
01. Cell

Which of the following is a prokaryote?

CORE CONCEPT & DERIVATION

Prokaryotes are single-celled organisms lacking a membrane-bound nucleus and membrane-enclosed organelles.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- ***Escherichia coli*** is a Gram-negative bacterium in the domain Bacteria.
- It contains a circular chromosome localized in a nucleoid without an enclosing nuclear membrane.

Why other options are incorrect:

- **Option A:** Protista is a kingdom composed of eukaryotic single-celled or colonial organisms.
- **Option C:** ***Amoeba*** is a unicellular eukaryotic organism with a defined nucleus and membrane-bound organelles.
- **Option D:** Fungi is a eukaryotic kingdom consisting of organisms with membrane-bound nuclei and chitinous cell walls.

Question #50 Key: (B)BIOLOGY
01. Cell*Number of layers present in the Gram-negative bacterial cell wall:***CORE CONCEPT & DERIVATION**

The Gram-negative bacterial cell wall is composed of two distinct structural layers: a thin inner peptidoglycan layer and an outer membrane.

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

- The inner layer consists of a thin sheet of peptidoglycan located within the periplasmic space.
- The outer layer is an asymmetrical lipid bilayer containing lipopolysaccharides (LPS) on its exterior surface.

Why other options are incorrect:

- **Option A:** A single thick layer of peptidoglycan is characteristic of Gram-positive bacterial cell walls.
- **Option C:** Three layers does not describe the structural division of the bacterial cell wall.
- **Option D:** Four layers is incorrect; the cell wall consists of two distinct layers exterior to the plasma membrane.

Question #51 Key: (C)BIOLOGY
11. Support & Movement*The division of cocci in three planes forms Sarcina, which is a cube of _____ cocci.***CORE CONCEPT & DERIVATION**

Cocci bacteria divide along specific geometric planes to yield distinctive cellular arrangements.

Formula / Rule / Reaction:

$$\text{Number of cells} = 2^n = 2^3 = 8 \quad (\text{where } n = 3 \text{ division planes})$$

Solution:

- Division in one plane forms diplococci or streptococci.
- Division in two perpendicular planes produces a tetrad of four cells.
- Regular division along three mutually perpendicular planes produces a cubical packet of eight cocci known as a sarcina.

Why other options are incorrect:

- **Option A:** A pair of two cocci resulting from a single division plane is a diplococcus.
- **Option B:** A square cluster of four cocci resulting from two division planes is a tetrad.
- **Option D:** Packets of 16 or more irregular cells form staphylococcal clusters rather than the standard sarcina packet.

Question #52 Key: (A)BIOLOGY
09. Respiration / Gaseous Exchange*Which of the following statements is correct regarding respiration at rest?***CORE CONCEPT & DERIVATION**

During quiet breathing at rest, inhalation requires active muscular contraction, whereas exhalation relies on passive elastic recoil.

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

- Resting inspiration requires somatic motor stimulation causing contraction of the diaphragm and external intercostal muscles.
- Because metabolic ATP is consumed to drive this muscular contraction, quiet inspiration is an active process.
- Resting expiration occurs passively as thoracic tissues and lungs recoil to their resting volumes without muscle contraction.

Why other options are incorrect:

- **Option B:** Resting expiration is passive; active muscular contraction occurs only during forced expiration.
- **Option C:** Inspiration cannot proceed passively because atmospheric air must be drawn in by actively expanding the thoracic cavity.
- **Option D:** Inspiration requires continuous active energy input, so both processes cannot be passive.

Question #53 Key: (B)BIOLOGY
04. Bioenergetics*Nitrifying bacteria are an example of:***CORE CONCEPT & DERIVATION**

Chemosynthetic autotrophs derive biochemical energy by oxidizing reduced inorganic nitrogen compounds to fix carbon dioxide into carbohydrates.

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

- *Nitrosomonas* oxidizes ammonia to nitrite, and *Nitrobacter* oxidizes nitrite to nitrate.
- The energy liberated from these inorganic chemical oxidations is trapped as ATP to fix carbon, classifying them as chemosynthetic autotrophs.

Why other options are incorrect:

- **Option A:** Heterotrophic bacteria require preformed organic carbon sources for nutrition.
- **Option C:** Saprophytic bacteria obtain nutrients by secreting enzymes to decompose non-living organic matter.
- **Option D:** Parasitic bacteria inhabit living host tissues to obtain nutrients, often producing pathology.

Question #54 Key: (D)BIOLOGY
14. Reproduction*Each human testis is divided into:***CORE CONCEPT & DERIVATION**

The dense fibrous tunica albuginea sends internal septa into the testicular parenchyma, dividing each testis into distinct lobules containing seminiferous tubules.

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

- According to human reproductive anatomy in the Punjab Textbook of Biology, each testis is subdivided by connective tissue septa into 250 to 300 conical lobules.
- Each individual lobule contains one to four highly convoluted seminiferous tubules where spermatogenesis occurs.

Why other options are incorrect:

- **Option A:** 50 to 100 lobules significantly undercounts the lobular compartments of the testis.
- **Option B:** 150 to 200 lobules is below the established anatomical range.
- **Option C:** 200 to 300 is an imprecise bracket, whereas 250 to 300 matches the standard textbook anatomical value.

Question #55 Key: (D)BIOLOGY
14. Reproduction*Which cells in the human males are responsible for the release of testosterone?***CORE CONCEPT & DERIVATION**

In the male testes, luteinizing hormone (LH/ICSH) stimulates the interstitial endocrine cells to synthesize and secrete androgenic steroids.

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

- Leydig cells reside in the interstitial connective tissue spaces between adjacent seminiferous tubules.
- Upon stimulation by pituitary LH, Leydig cells convert cholesterol into testosterone.

Why other options are incorrect:

- **Option A:** The anterior pituitary gland secretes gonadotropins (LH and FSH), not steroid androgens.
- **Option B:** The hypothalamus secretes gonadotropin-releasing hormone (GnRH).
- **Option C:** Sertoli cells provide mechanical and nutritional support to developing germ cells and secrete inhibin, not testosterone.

Question #56 Key: (B)BIOLOGY
14. Reproduction

Fertilized ovum is implanted and undergoes further development in the:

CORE CONCEPT & DERIVATION

Following fertilization in the fallopian tube, the developing blastocyst migrates into the uterine cavity where it implants into the glandular endometrium.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Fertilization occurs within the ampulla of the oviduct (fallopian tube).
- The resulting zygote undergoes cleavage while traveling to the uterus, where it implants into the endometrium approximately six to seven days post-fertilization for subsequent gestation.

Why other options are incorrect:

- **Option A:** The ovary produces secondary oocytes and secretes female sex steroids; implantation here constitutes an ovarian ectopic pregnancy.
- **Option C:** The oviduct is the normal site of fertilization; implantation within the tube is an abnormal tubal ectopic pregnancy.
- **Option D:** The cervix forms the inferior neck and outlet of the uterus, not the site of gestational implantation.

Question #57 Key: (C)BIOLOGY
14. Reproduction

Level of luteinizing hormone (LH) is maximum in blood during which stage of menstrual cycle?

CORE CONCEPT & DERIVATION

A positive feedback surge of estradiol from the mature Graafian follicle triggers an acute surge of luteinizing hormone that induces follicular rupture and ovulation.

Formula / Rule / Reaction:

High Estrogen $\xrightarrow{\text{Positive Feedback}}$ LH Surge $\rightarrow$ Ovulation

Solution:

- Mid-cycle estrogen levels exceed a critical threshold, stimulating the pituitary to release a surge of LH.
- Peak circulating concentrations of LH occur roughly 12 to 24 hours prior to follicle rupture during the ovulation phase (day 14 of a 28-day cycle).

Why other options are incorrect:

- **Option A:** During the menstrual phase (days 1 to 5), LH and progesterone concentrations are at baseline.
- **Option B:** In the early proliferative (follicular) stage, LH levels are low and rise only at the conclusion of the phase.
- **Option D:** In the secretory (luteal) phase, high progesterone exerts negative feedback, suppressing LH release.

Question #58 Key: (D)BIOLOGY
14. Reproduction*Major source of transmission of syphilis is:***CORE CONCEPT & DERIVATION**

Syphilis is a sexually transmitted infection caused by the spirochete bacterium *Treponema pallidum**, transmitted predominantly via direct contact with infectious lesions.

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

- *Treponema pallidum** is extremely sensitive to drying and environmental exposure, requiring direct intimate contact for transmission.
- Direct sexual contact with infectious cutaneous or mucosal lesions (such as chancres) accounts for the vast majority of clinical transmissions.

Why other options are incorrect:

- **Option A:** Blood transfusion transmission is rare due to standard donor serological screening and cold storage fragility of spirochetes.
- **Option B:** *Treponema pallidum** has no known insect vector and is not transmitted by arthropod bites.
- **Option C:** Syphilis cannot be contracted via contaminated water or food because the organism quickly lyses outside a mammalian host.

Question #59 Key: (A)BIOLOGY
11. Support & Movement*What is FALSE about cartilage?***CORE CONCEPT & DERIVATION**

Cartilage is an avascular specialized connective tissue; chondrocytes receive nutrients and oxygen exclusively by diffusion through the extracellular matrix.

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

- Healthy mature cartilage contains no internal blood vessels, lymphatics, or nerve fibers.
- Its avascular nature causes cartilage to heal slowly following mechanical trauma.
- Therefore, the statement claiming cartilage contains many blood vessels is false.

Why other options are incorrect:

- **Option B:** Cartilage is a recognized form of skeletal supporting connective tissue.
- **Option C:** Articular cartilage covers articulating bone ends at synovial joints to reduce friction.
- **Option D:** Cartilage matrix lacks heavy hydroxyapatite calcification, making it more flexible and softer than bone.

Question #60 Key: (B)BIOLOGY
11. Support & Movement*Which of the following is a muscle component that acts as a store for energy?***CORE CONCEPT & DERIVATION**

Phosphocreatine (creatine phosphate) acts as a high-energy phosphate reservoir in skeletal muscle to rapidly regenerate ATP during immediate contractile demands.

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

- Resting skeletal muscle stores roughly five times more creatine phosphate than free ATP.
- During the onset of intense exercise, creatine kinase transfers a phosphate group from creatine-PO₄ to ADP, sustaining ATP levels during the first 10 to 15 seconds of exertion.

Why other options are incorrect:

- **Option A:** Free ATP is the immediate energy currency for myosin ATPase, but cellular pools are depleted within seconds and are not stored in bulk.
- **Option C:** Myoglobin is an iron-containing hemoprotein that stores molecular oxygen, not high-energy chemical bonds.
- **Option D:** Creatinine is an end-stage metabolic waste product excreted by the kidneys, not an energy storage molecule.

Question #61 Key: (D)BIOLOGY
11. Support & Movement*Which of the following is NOT found in skeletal muscle fibers in humans?***CORE CONCEPT & DERIVATION**

Skeletal muscle fibers synthesize myoglobin to store oxygen internally, whereas hemoglobin is restricted to erythrocytes circulating in the blood vascular space.

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

- Hemoglobin is localized within red blood cells inside capillaries, delivering oxygen to muscle tissue without entering the sarcoplasm.
- Within the muscle fiber itself, oxygen is bound and stored by the monomeric hemoprotein myoglobin.

Why other options are incorrect:

- **Option A:** Skeletal muscle fibers form from the syncytial fusion of embryonic myoblasts, leaving each mature fiber multinucleated.
- **Option B:** Skeletal muscle possesses abundant mitochondria located between myofibrils to supply ATP for contraction.
- **Option C:** Sarcoplasm contains high concentrations of myoglobin to facilitate intramuscular oxygen diffusion.

Question #62 Key: (A)BIOLOGY
11. Support & Movement

A hinge joint is present between which of the following bones?

CORE CONCEPT & DERIVATION

A hinge joint is a uniaxial synovial joint that allows motion along a single plane, specifically flexion and extension.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The elbow joint, formed by the articulation of the trochlea of the humerus with the trochlear notch of the ulna (and head of the radius), is a classic hinge joint.
- It restricts movement to angular changes in one plane.

Why other options are incorrect:

- **Option B:** The femur belongs to the lower extremity and does not articulate with the shoulder pectoral girdle.
- **Option C:** The head of the femur articulates with the acetabulum of the pelvis to form a multi-axial ball-and-socket hip joint.
- **Option D:** The humerus articulates with the glenoid fossa of the pectoral girdle to form the multi-axial ball-and-socket shoulder joint.

Question #63 Key: (B)BIOLOGY
15. Inheritance / Variation & Genetics

A test cross is made to check the genotype of a trait. Which of the following crosses is a test...

CORE CONCEPT & DERIVATION

A test cross involves breeding an individual displaying a dominant phenotype with an individual that is homozygous recessive for that trait to determine the unknown genotype.

Formula / Rule / Reaction:

Test Cross = Individual (dominant phenotype) × Homozygous Recessive (tt)

Solution:

- If the unknown dominant organism is homozygous dominant (TT), 100% of the progeny display the dominant phenotype.
- If the unknown organism is heterozygous (Tt), a 1:1 phenotypic ratio of dominant to recessive offspring results.
- Therefore, the tester parent must always be homozygous recessive (tt).

Why other options are incorrect:

- **Option A:** At does not represent a homozygous recessive genotype for a single Mendelian locus.
- **Option C:** AB represents non-allelic markers or codominant alleles, not a homozygous recessive tester.
- **Option D:** Crossing with a homozygous dominant parent (TT) masks recessive alleles, producing dominant phenotypes regardless of the unknown genotype.

Question #64 Key: (A)BIOLOGY
15. Inheritance / Variation & Genetics

What happens when an [Formula] -negative woman, married to an [Formula] -positive man, conceive...

CORE CONCEPT & DERIVATION

Transplacental passage of fetal Rh^+ red cells into an Rh^- mother stimulates maternal anti-Rh antibody production, creating maternal-fetal immune incompatibility (erythroblastosis fetalis).

Formula / Rule / Reaction:

Rh^+ Fetal RBCs $\rightarrow$ Maternal Isoimmunization $\rightarrow$ Anti-D IgG Antibodies Cross Placenta

Solution:

- The mother lacks the Rh (D) antigen on her erythrocytes.
- Exposure to fetal Rh^+ antigens during gestation or delivery induces maternal synthesis of anti-Rh IgG antibodies.
- In subsequent Rh^+ pregnancies, these IgG antibodies cross the placenta and hemolyze fetal erythrocytes, a condition known as maternal-fetal incompatibility.

Why other options are incorrect:

- **Option B:** Paternal-fetal incompatibility is an incorrect immunological designation; the immune response is mounted by maternal antibodies against fetal antigens.
- **Option C:** Rh alloimmunization causes immune-mediated hemolytic anemia, not malignant fetal neoplasms.
- **Option D:** The maternal immune response targets fetal erythrocytes and does not cause maternal mortality.

Question #65 Key: (A)BIOLOGY
15. Inheritance / Variation & Genetics

DNA stores biological information in discrete units termed as:

CORE CONCEPT & DERIVATION

A gene is a discrete segment of a DNA molecule that contains the nucleotide sequence encoding a functional RNA or polypeptide product.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The genetic information in a chromosome is organized into distinct loci called genes.
- Each gene serves as the physical and functional unit of heredity, directing the transcription of specific mRNA transcripts.

Why other options are incorrect:

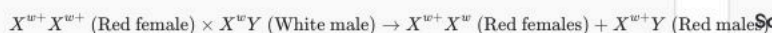
- **Option B:** A phenotype is the observable physical, biochemical, or physiological manifestation of an organism's genotype.
- **Option C:** A karyotype is the complete photographic profile of the metaphase chromosomes of an individual.
- **Option D:** A cell is the basic structural and functional living unit of an organism, not a chemical storage unit of DNA.

Question #66 Key: (A)BIOLOGY
15. Inheritance / Variation & Genetics

To study sex linkages in *Drosophila*, Morgan mated white-eyed males with wild-type red-eyed females...

CORE CONCEPT & DERIVATION

Eye color in *Drosophila melanogaster* is an X-linked trait where the wild-type red eye allele (X^{w+}) is dominant over the mutant white eye allele (X^w).

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

- The homozygous red-eyed mother passes an X^{w+} chromosome to all male and female offspring.
- The daughters receive X^{w+} from the mother and X^w from the father, yielding heterozygous red-eyed females ($X^{w+}X^w$).
- The sons receive X^{w+} from the mother and the Y chromosome from the father, yielding hemizygous red-eyed males ($X^{w+}Y$).
- Thus, 100% of the F_1 progeny possess red eyes.

Why other options are incorrect:

- Option B:** White-eyed males appear in the F_1 generation only when the parental cross is reversed (white-eyed female $\times$ red-eyed male).
- Option C:** White-eyed females require two recessive alleles (X^wX^w), which cannot form when the maternal parent contributes X^{w+} .
- Option D:** Recessive white eyes are masked by the dominant X^{w+} allele passed from the homozygous red-eyed mother.

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

Which one of the following is an X-linked dominant disorder?

CORE CONCEPT & DERIVATION

Hypophosphatemic rickets (vitamin D-resistant rickets) is inherited as an X-linked dominant trait caused by mutations in the PHEX gene.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- In X-linked dominant conditions, a single mutant allele on the X chromosome is sufficient to cause the phenotypic disorder in both males and females.
- Affected fathers transmit the trait to all of their daughters, but none of their sons.
- Hypophosphatemic rickets displays this characteristic inheritance pattern.

Why other options are incorrect:

- Option A:** Hemophilia (A and B) is inherited as an X-linked recessive disorder.
- Option B:** Red-green color blindness is an X-linked recessive trait.
- Option D:** Becker muscular dystrophy is an X-linked recessive dystrophinopathy.

Question #68 Key: (C)BIOLOGY
15. Inheritance / Variation & Genetics*Mode of inheritance in humans can be traced through:***CORE CONCEPT & DERIVATION**

Because controlled experimental breeding is unethical and impractical in humans, human genetic inheritance patterns are investigated retrospectively via pedigree analysis.

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

- Pedigree analysis plots familial relationships and phenotypic distribution over several generations using standardized genealogical symbols.
- Analyzing the transmission history allows geneticists to deduce whether a trait is autosomal dominant, autosomal recessive, X-linked, or mitochondrial.

Why other options are incorrect:

- **Option A:** Controlled experimental breeding cannot be conducted in humans due to ethical prohibitions and long generation times.
- **Option B:** Chi-square analysis is a statistical test for goodness of fit, not an observational method for tracking human inheritance.
- **Option D:** Probability calculations assist in predicting outcome frequencies, but cannot substitute for mapping phenotypic family lineages.

Question #69 Key: (B)CHEMISTRY
01. Stoichiometry*One a.m.u. stands for:***CORE CONCEPT & DERIVATION**

The atomic mass unit (a.m.u. or dalton) is defined relative to the mass of an unbound carbon-12 nuclide in its ground electronic state.

Formula / Rule / Reaction:

$$1 \text{ a.m.u.} = \frac{1}{12} \times m(^{12}\text{C}) \approx 1.66054 \times 10^{-24} \text{ g} = 1.66054 \times 10^{-27} \text{ kg}$$

Solution:

- By international IUPAC agreement, exactly one atomic mass unit equals one-twelfth of the mass of a single neutral carbon-12 atom.
- This serves as the standard reference scale for assigning relative atomic and molecular masses.

Why other options are incorrect:

- **Option A:** The entire mass of a carbon-12 atom equals exactly 12 a.m.u., not 1 a.m.u.
- **Option C:** Hydrogen was an older reference standard; the current carbon-12 scale is not based on $\frac{1}{12}$ of hydrogen.
- **Option D:** Atoms of different elements possess distinct atomic masses depending on nucleon counts.

Question #70 Key: (C)CHEMISTRY
01. Stoichiometry

A compound of sodium oxide has 74.2% of sodium and 25.8% of Oxygen. The empirical formula of th...

CORE CONCEPT & DERIVATION

The empirical formula reflects the simplest whole-number molar ratio of elements present in a chemical compound.

Formula / Rule / Reaction:

$$\text{Moles of element} = \frac{\text{Mass in 100 g}}{\text{Molar mass}}$$

Solution:

- In a 100 g sample:
Moles of Na = $\frac{74.2 \text{ g}}{23.0 \text{ g/mol}} = 3.226 \text{ mol}$.
- Moles of O = $\frac{25.8 \text{ g}}{16.0 \text{ g/mol}} = 1.6125 \text{ mol}$.
- Dividing both values by the smallest mole value (1.6125):
Ratio for Na = $\frac{3.226}{1.6125} = 2.00$, Ratio for O = $\frac{1.6125}{1.6125} = 1.00$
- The simplest integer ratio is 2 : 1, yielding the empirical formula Na_2O .

Why other options are incorrect:

- Option A:** NaO corresponds to a 1:1 molar ratio, representing roughly 59% Na and 41% O.
- Option B:** NaO_2 (sodium superoxide) corresponds to a 1:2 molar ratio.
- Option D:** Na_2O_2 is the molecular formula of sodium peroxide, but its empirical formula reduces to NaO.

Question #71 Key: (B)CHEMISTRY
01. Stoichiometry

30 grams of 2-propanol were mixed with excess acidified [Formula] and boiled under reflux for 2...

CORE CONCEPT & DERIVATION

Acidified potassium dichromate oxidizes the secondary alcohol 2-propanol quantitatively to propanone (acetone).

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

- Molar mass of 2-propanol ($\text{C}_3\text{H}_8\text{O}$) = $3(12) + 8(1) + 16 = 60 \text{ g/mol}$.
- Moles of 2-propanol reacted = $\frac{30 \text{ g}}{60 \text{ g/mol}} = 0.50 \text{ mol}$.
- Molar mass of propanone ($\text{C}_3\text{H}_6\text{O}$) = $3(12) + 6(1) + 16 = 58 \text{ g/mol}$.
- Theoretical mass of propanone = $0.50 \text{ mol} \times 58 \text{ g/mol} = 29.0 \text{ g}$.
- Actual yield at 75.0% = $29.0 \text{ g} \times 0.75 = 21.75 \text{ g}$.

Why other options are incorrect:

- Option A:** 1.74 g is a calculation error arising from an incorrect decimal place.
- Option C:** 2.74 g is an erroneous arithmetic distractor.
- Option D:** 29 g represents the theoretical yield at 100% conversion, ignoring the 75.0% experimental efficiency.

Question #72 Key: (D)CHEMISTRY
02. Atomic Structure

According to which scientist, the probability of finding an electron at a certain position is ψ^2 ...

CORE CONCEPT & DERIVATION

The wave mechanical model of the atom replaces fixed classical orbits with statistical wave functions, where the square of the wave function (ψ^2) represents electron probability density.

Formula / Rule / Reaction:

$$\hat{H}\psi = E\psi \quad \text{where } |\psi|^2 dV = \text{Probability of finding electron}$$

Solution:

- Erwin Schrödinger formulated wave mechanics, describing electrons as three-dimensional stationary matter waves.
- Solving Schrödinger's wave equation produces orbitals, defined as regions in space where the probability of finding an electron is maximal (around 90 to 95%).

Why other options are incorrect:

- **Option A:** Niels Bohr proposed fixed circular orbits with deterministic electron position and radius.
- **Option B:** Louis de Broglie hypothesized the dual wave-particle nature of matter ($\lambda = h/p$), but did not develop the probability orbital equation.
- **Option C:** Hund formulated the rule of maximum multiplicity regarding electron spin in degenerate subshells.

Question #73 Key: (C)CHEMISTRY
02. Atomic Structure

Which gas in the discharge tube produces lightest canal ray particles?

CORE CONCEPT & DERIVATION

Canal rays (positive rays) consist of positive ions formed when high-energy electrons ionize residual gas molecules inside the discharge tube.

Formula / Rule / Reaction:

$$\frac{e}{m} = \frac{q}{M} \quad (\text{Lowest mass } M \rightarrow \text{Lightest particle})$$

Solution:

- Unlike cathode rays (electrons) which are identical for all gases, the nature and mass of canal ray particles depend entirely on the gas introduced.
- Hydrogen gas (H_2) produces bare protons (H^+), which have a mass of approximately 1 a.m.u.
- Because hydrogen has the lowest atomic weight among all elements, it yields the lightest positive canal ray particles.

Why other options are incorrect:

- **Option A:** Argon produces positive ions with an atomic mass of roughly 40 a.m.u., far heavier than protons.
- **Option B:** Helium produces alpha particles or helium ions with a mass of roughly 4 a.m.u.
- **Option D:** Neon produces canal ray ions with an atomic mass of roughly 20 a.m.u.

Question #74 Key: (A)CHEMISTRY
11. S & P Block Elements*Which element has the ground state electronic configuration of [Formula]?***CORE CONCEPT & DERIVATION**

The electronic configuration of a neutral ground-state atom reflects the distribution of its atomic number (Z) of electrons among available orbitals.

Formula / Rule / Reaction:

$$\text{Total electrons} = 2 + 2 + 6 + 2 + 6 = 18$$

Solution:

- Summing the superscripts gives 18 total electrons.
- In an uncharged neutral atom, the number of electrons equals the atomic number: $Z = 18$.
- Element 18 is the noble gas Argon (Ar).

Why other options are incorrect:

- Option B:** Chlorine has $Z = 17$, terminating with $3s^2 3p^5$.
- Option C:** Sodium has $Z = 11$, terminating with $3s^1$.
- Option D:** Sulfur has $Z = 16$, terminating with $3s^2 3p^4$.

Question #75 Key: (D)CHEMISTRY
12. Transition Elements*What is the proton (atomic number) of an element that has four unpaired electrons in its ground...***CORE CONCEPT & DERIVATION**

According to Hund's rule, electrons occupy degenerate orbitals singly with parallel spins before pairing occurs.

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

- For $Z = 26$ (Iron):
The five degenerate $3d$ orbitals receive 6 electrons.
- One orbital receives an electron pair (2 electrons), while the remaining four orbitals contain one unpaired electron each.
- This yields four unpaired electrons in the ground state.

Why other options are incorrect:

- Option A:** Carbon ($Z = 6$) has the configuration $1s^2 2s^2 2p^2$, possessing only two unpaired electrons in the $2p$ subshell.
- Option B:** Silicon ($Z = 14$) has the configuration $[\text{Ne}] 3s^2 3p^2$, containing two unpaired electrons.
- Option C:** Titanium ($Z = 22$) has the configuration $[\text{Ar}] 3d^2 4s^2$, containing two unpaired electrons.

Question #76 Key: (C)

CHEMISTRY
04. Gases

A gaseous mixture contains 9.6% [Formula], 22.6% [Formula] and 67.8% [Formula] gases. If the t...

CORE CONCEPT & DERIVATION

Dalton's law of partial pressures states that the partial pressure of an individual gas in an ideal mixture equals its mole fraction (or percentage volume) multiplied by the total pressure.

Formula / Rule / Reaction:

$$P_i = X_i \times P_{\text{total}} = \left(\frac{\% \text{ of gas } i}{100} \right) \times P_{\text{total}}$$

Solution:

- The percentage of H_2 is 67.8%.

- Mole fraction of $\text{H}_2 = \frac{67.8}{100}$.

- Therefore, the partial pressure of H_2 is:

$$P_{\text{H}_2} = \frac{67.8 \times 50}{100} \text{ atm} = 33.9 \text{ atm}$$

Why other options are incorrect:

- Option A:** Inverts total pressure and percentage, yielding an unphysical pressure value.
- Option B:** Omits the hydrogen fraction entirely.
- Option D:** Adds percentage to pressure rather than calculating a proportional product.

Question #77 Key: (D)

CHEMISTRY
04. Gases

If we want to raise the temperature of one mole of an ideal gas by one kelvin we have to provid...

CORE CONCEPT & DERIVATION

From the ideal gas law, the expansion work performed per mole per kelvin corresponds numerically to the universal gas constant R expressed in pressure-volume units.

Formula / Rule / Reaction:

$$W = P\Delta V = R\Delta T = 0.0821 \text{ dm}^3 \cdot \text{atm} \cdot \text{K}^{-1} \cdot \text{mol}^{-1} \times 1 \text{ K} = 0.0821 \text{ dm}^3 \cdot \text{atm}$$

Solution:

- The universal gas constant R represents work or energy per mole per kelvin.
- When P is in atmospheres and V is in dm^3 , $R = 0.0821 \text{ dm}^3 \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$.
- Hence, raising the temperature of one mole of an ideal gas by 1 K requires $0.0821 \text{ dm}^3 \cdot \text{atm}$ of mechanical expansion energy.

Why other options are incorrect:

- Option A:** In SI energy units of joules, $R = 8.314 \text{ J}$, not 0.0821 J .
- Option B:** 8.314 has units of $\text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$, not $\text{dm}^3 \cdot \text{atm}$.
- Option C:** 0.0821 kJ corresponds to 82.1 J , which does not match any standard constant.

Question #78 Key: (A)CHEMISTRY
04. Gases

The process of heat flow between hotter and colder gases remains continued until all the molecu...

CORE CONCEPT & DERIVATION

According to kinetic molecular theory, macroscopic thermodynamic temperature is directly proportional to the average translational kinetic energy of gas molecules.

Formula / Rule / Reaction:

$$\overline{KE}_{\text{trans}} = \frac{3}{2}k_B T$$

Solution:

- Spontaneous net heat transfer proceeds between two bodies until thermal equilibrium is established.
- At thermal equilibrium, both systems achieve identical temperatures.
- Because temperature is defined by average translational kinetic energy, net energy exchange ceases when the mean translational kinetic energy becomes equal.

Why other options are incorrect:

- **Option B:** Monoatomic gases lack rotational degrees of freedom, yet reach thermal equilibrium normally.
- **Option C:** Ideal gas particles exert no intermolecular attractive forces, meaning translational potential energy is zero.
- **Option D:** Vibrational modes are inactive at standard temperatures for simple noble and diatomic gases.

Question #79 Key: (D)CHEMISTRY
05. Liquids

In liquid, with the change in dipole-dipole forces, there is a change in some physical propert...

CORE CONCEPT & DERIVATION

Intermolecular forces determine bulk physical transitions and phase properties, but have no effect on the chemical quantity of matter (number of moles).

Formula / Rule / Reaction:

$$\text{Moles } (n) = \frac{\text{Mass } (m)}{\text{Molar mass } (M)}$$

Solution:

- Boiling point, heat of vaporization, and heat of sublimation depend directly on the energy required to overcome attractive intermolecular dipole-dipole interactions.
- The number of moles is an extensive chemical property defined strictly by particle count and sample mass, completely independent of intermolecular attraction.

Why other options are incorrect:

- **Option A:** Stronger dipole-dipole forces increase boiling point by requiring higher thermal kinetic energy for vaporization.
- **Option B:** Heat of vaporization increases directly with intermolecular dipole attractive strength.
- **Option C:** Heat of sublimation depends on cohesive lattice forces holding molecules together in the condensed phase.

Question #80 Key: (A)

CHEMISTRY
05. Liquids

Which of the following factor does not affect the magnitude of vapor pressure?

CORE CONCEPT & DERIVATION

Vapor pressure is an intensive property of a liquid that depends on temperature and intermolecular attraction, but is independent of sample quantity or surface area.

Formula / Rule / Reaction:

$$\ln(P) = -\frac{\Delta H_{\text{vap}}}{RT} + C \quad (\text{Clausius-Clapeyron equation})$$

Solution:

- Dynamic equilibrium between evaporation and condensation depends on molecular kinetic energy and escape velocity.
- Changing the volume or mass of the liquid changes the rates of evaporation and condensation equally without shifting the equilibrium vapor pressure.

Why other options are incorrect:

- **Option B:** Larger molecular size increases polarizability and dispersion forces, lowering vapor pressure.
- **Option C:** Vapor pressure increases exponentially with increasing temperature.
- **Option D:** Stronger intermolecular forces (e.g., hydrogen bonding) decrease vapor pressure by hindering molecular escape into the vapor phase.

Question #81 Key: (B)

CHEMISTRY
06. Solids

A small building block which belongs to whole information about crystal structure is called?

CORE CONCEPT & DERIVATION

A unit cell is the smallest repeating geometric unit of a crystalline solid that possesses the full structural symmetry and composition of the macroscopic crystal.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- When repeated in three-dimensional space by translational vectors, the unit cell generates the entire crystal lattice.
- It is defined by six lattice parameters: three edge lengths (a, b, c) and three axial angles (α, β, γ).

Why other options are incorrect:

- **Option A:** Cell is a general biological or electrochemical term lacking crystallographic definition.
- **Option C:** A crystal lattice is the extended, infinite three-dimensional array of points representing the entire crystal structure.
- **Option D:** Crystal unit is a non-standard colloquial phrase rather than an accepted crystallographic term.

Question #82 Key: (A)CHEMISTRY
06. Solids*Which type of solid is called as atomic solid?***CORE CONCEPT & DERIVATION**

Covalent network solids consist of individual neutral atoms bonded continuously throughout a crystal lattice by directional covalent bonds, classifying them as atomic or network solids.

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

- In solids such as diamond, graphite, and silicon carbide, discrete atoms occupy the lattice positions and are connected by strong covalent bonds.
- Because individual neutral atoms form the structural basis of the entire extended giant lattice, covalent solids are termed atomic or covalent network solids.

Why other options are incorrect:

- **Option B:** Ionic solids consist of alternating positive cations and negative anions held by electrostatic attraction.
- **Option C:** Metallic solids consist of metal kernels bathed in a delocalized sea of valence electrons.
- **Option D:** Molecular solids consist of discrete covalent molecules held by weak intermolecular forces.

Question #83 Key: (C)CHEMISTRY
07. Equilibrium*The decrease in solubility of the salt in a solution that already contains an ion common to tha...***CORE CONCEPT & DERIVATION**

The common ion effect describes the suppression of the ionization or solubility of a weak electrolyte or sparingly soluble salt when a soluble strong electrolyte containing a common ion is added.

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

- Introducing a common ion increases that ion's concentration in solution.
- In accordance with Le Chatelier's principle, the dissolution equilibrium shifts in reverse toward the undissolved solid, reducing solubility.

Why other options are incorrect:

- **Option A:** Le Chatelier's principle is the broad thermodynamic rule governing all systems at equilibrium; the common ion effect is its specific application to ionic equilibria.
- **Option B:** Solubility product (K_{sp}) is the equilibrium constant governing salt dissolution at a given temperature.
- **Option D:** K_{sp} is the constant numerical value and remains unchanged upon the addition of a common ion.

Question #84 Key: (B)CHEMISTRY
07. Equilibrium*The precipitation occurs if the ionic concentration is:***CORE CONCEPT & DERIVATION**

Precipitation of an ionic compound occurs whenever the ionic product of its constituent ions in solution exceeds its solubility product constant (K_{sp}).

Formula / Rule / Reaction:

$$Q_{sp} > K_{sp} \implies \text{Precipitation occurs (Supersaturated)}$$

Solution:

- If $Q_{sp} < K_{sp}$, the solution is unsaturated and no precipitate forms.
- If $Q_{sp} = K_{sp}$, the solution is saturated and in dynamic equilibrium.
- When the product of the ionic concentrations exceeds K_{sp} , the solution becomes supersaturated and excess solute precipitates until $Q_{sp} = K_{sp}$.

Why other options are incorrect:

- **Option A:** When the ionic product is less than K_{sp} , the solution remains unsaturated and can dissolve additional salt.
- **Option C:** When equal to K_{sp} , dynamic equilibrium exists without spontaneous precipitation.
- **Option D:** Precipitation requires the concentration threshold to exceed K_{sp} ; it does not occur at arbitrary concentrations.

Question #85 Key: (A)CHEMISTRY
07. Equilibrium*One can estimate the direction in which the equilibrium will shift with the help of:***CORE CONCEPT & DERIVATION**

Le Chatelier's principle predicts how a chemical system at equilibrium responds when disturbed by changes in concentration, temperature, or pressure.

Formula / Rule / Reaction:

Perturbation Applied $\rightarrow$ Equilibrium shifts to oppose and partially cancel the change.

Solution:

- If stress (e.g., adding reactant, removing product, altering pressure or temperature) is applied to a reaction at equilibrium, the position of equilibrium shifts in the direction that counteracts the disturbance.
- This qualitative assessment is formalized through Le Chatelier's principle.

Why other options are incorrect:

- **Option B:** The law of mass action states that the rate of a reaction is proportional to the active masses of the reacting substances, defining equilibrium expressions.
- **Option C:** Hess's law states that overall enthalpy change is independent of the reaction pathway.
- **Option D:** The law of heat of formation is a thermochemical principle dealing with standard enthalpy changes of substance synthesis.

Question #86 Key: (C)CHEMISTRY
08. Reaction KineticsWhat is the overall order of this rate equation? $\text{Rate} = k[\text{H}_2][\text{NO}_2]^2$ **CORE CONCEPT & DERIVATION**

The overall order of a chemical reaction is the sum of the partial orders (exponents) of all reactant concentration terms appearing in the experimental rate law.

Formula / Rule / Reaction:

$$\text{Rate} = k[\text{H}_2]^m[\text{NO}_2]^n \implies \text{Overall Order} = m + n$$

Solution:

- From the given rate equation: $\text{Rate} = k[\text{H}_2]^1[\text{NO}_2]^2$.
- Partial order with respect to $[\text{H}_2]$ is $m = 1$.
- Partial order with respect to $[\text{NO}_2]$ is $n = 2$.
- Overall reaction order $= 1 + 2 = 3$ (third-order reaction).

Why other options are incorrect:

- Option A:** 1 represents only the partial order with respect to hydrogen.
- Option B:** 2 represents only the partial order with respect to nitrogen dioxide.
- Option D:** 4 incorrectly inflates the sum of the exponents.

Question #87 Key: (B)CHEMISTRY
08. Reaction Kinetics

The catalysis in which the catalyst and the reactants are in the same phase is known?

CORE CONCEPT & DERIVATION

Catalytic reactions are classified by phase distribution into homogeneous catalysis (same phase) and heterogeneous catalysis (different phases).

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- When reactants, products, and catalyst exist uniformly within a single phase (such as all liquids or all gases), the process is termed homogeneous catalysis.
- An example is the acid-catalyzed esterification of carboxylic acids and alcohols in liquid solution.

Why other options are incorrect:

- Option A:** In heterogeneous catalysis, the catalyst exists in a different physical phase than the reactants (e.g., solid platinum catalyst in gaseous Haber process).
- Option C:** Slow describes reaction kinetics rather than phase classification.
- Option D:** Fast is a qualitative kinetic descriptor, not a phase classification term.

Question #88 Key: (C)CHEMISTRY
09. Thermochemistry

Born-Haber cycle is used to determine the Lattice energy of Ionic compounds. It is the applicat...

CORE CONCEPT & DERIVATION

The Born-Haber cycle calculates crystal lattice energy by applying Hess's law of constant heat summation across a closed thermodynamic cycle.

Formula / Rule / Reaction:

$$\Delta H_f^\circ = \Delta H_{\text{sub}} + \frac{1}{2}\Delta H_{\text{diss}} + \text{IE} + \text{EA} + U_{\text{lattice}}$$

Solution:

- Because lattice energy cannot be measured directly by experiment, it is determined indirectly.
- The Born-Haber cycle sums the standard enthalpy of formation, sublimation, dissociation, ionization energy, and electron affinity, applying Hess's law.

Why other options are incorrect:

- Option A:** Henry's law relates gas solubility in a liquid to the partial pressure of that gas.
- Option B:** Le Chatelier's principle governs shifts in chemical equilibria, not enthalpy summation.
- Option D:** The common ion effect describes equilibrium shifts in sparingly soluble salts.

Question #89 Key: (D)CHEMISTRY
09. Thermochemistry

Which of the following term is state function?

CORE CONCEPT & DERIVATION

A state function is a macroscopic property whose value depends solely on the current equilibrium state of a system, independent of the path taken.

Formula / Rule / Reaction:

$$\Delta H = H_{\text{final}} - H_{\text{initial}}$$

Solution:

- Enthalpy (H), internal energy (E), entropy (S), pressure (P), volume (V), and temperature (T) are classic state functions.
- Their net changes (ΔH) depend only on initial and final states, not on intermediate mechanistic steps.

Why other options are incorrect:

- Option A:** Freezing is a physical phase transition process rather than a thermodynamic state variable.
- Option B:** Decomposition describes a chemical reaction process, not a thermodynamic state function.
- Option C:** Sublimation is a phase change process from solid to gas.

Question #90 Key: (B)CHEMISTRY
10. Electrochemistry*An electrochemical cell is based upon which reaction?***CORE CONCEPT & DERIVATION**

Electrochemical cells convert chemical energy into electrical energy (galvanic cells) or vice versa (electrolytic cells) via coupled oxidation-reduction (redox) reactions.

Formula / Rule / Reaction:

Anode (Oxidation): $M \rightarrow M^{n+} + ne^-$ | Cathode (Reduction): $X^{n+} + ne^- \rightarrow X$

Solution:

- Oxidation occurs at the anode with the release of electrons.
- These electrons flow through an external circuit to the cathode, where reduction consumes them.
- Hence, an electrochemical cell relies fundamentally on electron transfer in a redox process.

Why other options are incorrect:

- **Option A:** Acid-base reactions involve proton (H^+) transfers without changing oxidation states or driving electrical current.
- **Option C:** Nuclear reactions involve changes in nuclear composition, which do not operate conventional electrochemical cells.
- **Option D:** Neutralization reactions produce water and salts from acids and bases without net redox electron transfer.

Question #91 Key: (C)CHEMISTRY
10. Electrochemistry*In which of the following, oxygen shows fractional oxidation number?***CORE CONCEPT & DERIVATION**

In superoxide compounds of alkali metals, the superoxide ion exists as the diatomic anion O_2^- , giving each oxygen atom a formal fractional oxidation state of $-\frac{1}{2}$.

Formula / Rule / Reaction:

$$\text{In } KO_2 : (+1) + 2(x) = 0 \Rightarrow 2x = -1 \Rightarrow x = -\frac{1}{2}$$

Solution:

- Potassium is an alkali metal with a fixed oxidation number of +1.
- Setting the neutral formula sum equal to zero gives $2x = -1$, so oxygen has an oxidation number of $-\frac{1}{2}$.

Why other options are incorrect:

- **Option A:** In OF_2 , fluorine is more electronegative than oxygen (−1), giving oxygen an integer oxidation state of +2.
- **Option B:** In Na_2O_2 (peroxide), the peroxide ion is O_2^{2-} , giving oxygen an integer oxidation state of −1.
- **Option D:** In Cl_2O_7 , oxygen exhibits its standard integer oxidation state of −2.

Question #92 Key: (D)CHEMISTRY
03. Chemical Bonding*Which of the following element has smaller size?***CORE CONCEPT & DERIVATION**

Atomic radius increases down a group in the periodic table due to the addition of successive principal electronic shells.

Formula / Rule / Reaction:

Atomic Radius Order (Group 1): $\text{Li} < \text{Na} < \text{K} < \text{Rb} < \text{Cs}$

Solution:

- Lithium ($Z = 3$) possesses only two electron shells ($n = 1, 2$).
- Sodium has three shells, potassium has four shells, and rubidium has five shells.
- Because lithium has the fewest shells and minimal electronic shielding, its valence electrons experience strong nuclear attraction, making it the smallest atom in Group 1.

Why other options are incorrect:

- Option A:** Sodium possesses three shells, so its atomic radius is larger than lithium.
- Option B:** Potassium possesses four electronic shells, making it larger than sodium and lithium.
- Option C:** Rubidium possesses five electronic shells, giving it the largest atomic radius among the options.

Question #93 Key: (D)CHEMISTRY
03. Chemical Bonding*Among LiCl , BeCl_2 , NaCl , CsCl , the compounds with the greatest and the least ionic character re...***CORE CONCEPT & DERIVATION**

According to Fajan's rules and electronegativity differences, ionic character increases with increasing cation size and lower cation charge, and decreases with high charge density.

Formula / Rule / Reaction:

$$\% \text{ Ionic Character} \propto \Delta \text{Electronegativity} \propto \frac{1}{\text{Charge Density of Cation}}$$

Solution:

- Cesium (Cs) has the lowest electronegativity (0.79) and largest cation size among alkali metals, giving CsCl the greatest electronegativity difference and greatest ionic character.
- Beryllium (Be^{2+}) has a high charge-to-size ratio and strongly polarizes chloride electron clouds, making BeCl_2 largely covalent (least ionic).

Why other options are incorrect:

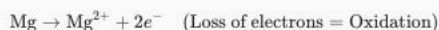
- Option A:** LiCl does not possess the greatest ionic character because lithium has a higher polarizing power than cesium.
- Option B:** NaCl has less ionic character than CsCl , and LiCl is not the least ionic compound listed.
- Option C:** NaCl is an ionic salt with substantial ionic character, whereas BeCl_2 exhibits the lowest ionic character.

Question #94 Key: (B)CHEMISTRY
11. S & P Block Elements

Which statement describes the conversion of magnesium atoms to magnesium ions for ionic bond fo...

CORE CONCEPT & DERIVATION

Oxidation is defined as the loss of electrons resulting in an increase in oxidation state, whereas reduction is the gain of electrons.

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

- A neutral magnesium atom has an electron configuration of $[\text{Ne}] 3s^2$.
- To achieve a stable octet, it loses two valence electrons to form an Mg^{2+} cation.
- The loss of electrons represents oxidation.

Why other options are incorrect:

- **Option A:** Magnesium loses electrons rather than gaining them, which cannot be termed reduction.
- **Option C:** A loss of electrons is defined as oxidation, not reduction.
- **Option D:** Oxidation corresponds to a loss of electrons, not a gain of electrons.

Question #95 Key: (B)CHEMISTRY
03. Chemical Bonding

AB_4 type with no lone pair; this geometry enables the formation of which shape of molecule?

CORE CONCEPT & DERIVATION

According to VSEPR theory, a central atom surrounded by four bonding electron pairs and zero lone pairs directs its bond pairs toward the vertices of a regular tetrahedron.

Formula / Rule / Reaction:

$$\text{Steric Number} = 4 \text{ bond pairs} + 0 \text{ lone pairs} = 4 \Rightarrow sp^3 \text{ hybridization} \quad (109.5^\circ)$$

Solution:

- Four equivalent electron domains experience minimum mutual electrostatic repulsion when oriented symmetrically in three dimensions.
- This spatial distribution creates bond angles of 109.5° , producing a regular tetrahedral molecular geometry (e.g., CH_4 , CCl_4).

Why other options are incorrect:

- **Option A:** Trigonal planar geometry forms from AB_3 systems possessing three bonding electron pairs and zero lone pairs.
- **Option C:** Regular octahedral geometry forms from AB_6 systems with six bonding electron domains.
- **Option D:** Trigonal pyramidal geometry forms from AB_3E systems containing three bonding pairs and one lone pair (e.g., NH_3).

Question #96 Key: (D)CHEMISTRY
03. Chemical Bonding*Why dimer of Aluminum chloride is formed***CORE CONCEPT & DERIVATION**

Monomeric AlCl_3 is electron-deficient with only six valence electrons around the aluminum atom, driving dimer formation to complete an octet.

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

- In monomeric AlCl_3 , aluminum shares three pairs of electrons, leaving an incomplete octet.
- Two AlCl_3 units dimerize as a chlorine atom from each monomer donates a non-bonding lone pair into the vacant $3p$ orbital of the opposing aluminum atom.
- This forms two coordinate covalent bridging bonds, allowing both aluminum centers to complete stable octets.

Why other options are incorrect:

- **Option A:** Aluminum is electron-deficient with an incomplete octet, not electron-rich.
- **Option B:** Aluminum has no remaining lone pairs; all three valence electrons are engaged in sigma bonding.
- **Option C:** Bridging lone pairs are donated by chlorine atoms, not by aluminum.

Question #97 Key: (C)CHEMISTRY
11. S & P Block Elements*Which group of the periodic table contain non-metals, metalloids and metals***CORE CONCEPT & DERIVATION**

Group IV-A (Group 14) exhibits a transition in properties down the group, containing non-metals, metalloids, and true metals.

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

- Carbon (C) is a non-metal.
- Silicon (Si) and Germanium (Ge) are metalloids (semimetals).
- Tin (Sn) and Lead (Pb) are true post-transition metals.
- Thus, Group IV-A contains all three element classifications.

Why other options are incorrect:

- **Option A:** Group I-B (Coinage metals: Cu, Ag, Au) consists exclusively of transition metals.
- **Option B:** Group VII-A (Halogens) consists of non-metals (F, Cl, Br, I) and the radioactive metalloid/halogen astatine, lacking true metals.
- **Option D:** Group VI-A contains non-metals (O, S, Se) and metalloids (Te, Po), but lacks true post-transition base metals like tin and lead.

Question #98 Key: (B)CHEMISTRY
11. S & P Block Elements*Which of the following sulfate compound is insoluble in water?***CORE CONCEPT & DERIVATION**

The aqueous solubility of Group II-A (alkaline earth metal) sulfates decreases down the group as lattice energy becomes more dominant than hydration enthalpy.

Formula / Rule / Reaction:

Solubility Order: $\text{BeSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4 > \text{BaSO}_4 \downarrow$

Solution:

- As cation radius increases from Be^{2+} to Ba^{2+} , hydration enthalpy decreases more rapidly than lattice enthalpy.
- For BaSO_4 , the enthalpy of solution is highly endothermic, rendering it virtually insoluble in water ($K_{sp} \approx 1.1 \times 10^{-10}$).

Why other options are incorrect:

- Option A:** BeSO_4 is soluble in water due to the high hydration energy of the small Be^{2+} cation.
- Option C:** MgSO_4 is readily soluble in water (commonly used as Epsom salt).
- Option D:** CaSO_4 is slightly (sparingly) soluble, whereas BaSO_4 is practically insoluble.

Question #99 Key: (B)CHEMISTRY
12. Transition Elements*Which of the following complex show a tetrahedral geometry?***CORE CONCEPT & DERIVATION**

The geometry of a coordination complex depends on coordination number, d-electron configuration, and the crystal field strength of the ligands.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- $[\text{Cu}(\text{CN})_4]^{2-}$ involves copper(II) with a coordination number of 4. In accordance with standard textbook classification, it adopts a tetrahedral geometry.
- $[\text{Fe}(\text{CO})_5]$ has coordination number 5 and adopts a trigonal bipyramidal geometry.
- $[\text{AuCl}_4]^-$ and $[\text{Pt}(\text{NH}_3)_4]^{2+}$ are d^8 complexes of 5d transition metals and adopt square planar geometries.

Why other options are incorrect:

- Option A:** $[\text{Fe}(\text{CO})_5]$ is a five-coordinate pentacarbonyl complex with a trigonal bipyramidal structure.
- Option C:** Gold(III) in $[\text{AuCl}_4]^-$ is a $5d^8$ ion that forms square planar complexes.
- Option D:** Platinum(II) in $[\text{Pt}(\text{NH}_3)_4]^{2+}$ is a $5d^8$ ion that forms square planar complexes.

Question #100 Key: (C)

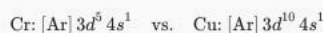
CHEMISTRY
12. Transition Elements

In which pair one has all Unpaired d orbitals while other have all paired d orbitals?

CORE CONCEPT & DERIVATION

Ground-state electronic configurations of $3d$ transition metals are governed by exchange energy stabilization of half-filled and fully filled subshells.

Formula / Rule / Reaction:



Solution:

- Chromium ($Z = 24$) has a $3d^5 4s^1$ configuration; all five of its $3d$ orbitals are singly occupied (all unpaired d -orbitals).
- Copper ($Z = 29$) has a $3d^{10} 4s^1$ configuration; all five of its $3d$ orbitals are doubly occupied (all paired d -orbitals).
- Therefore, the pair Cr and Cu fulfills both conditions.

Why other options are incorrect:

- Option A:** Cu has all paired d -orbitals ($3d^{10}$) and Zn also has all paired d -orbitals ($3d^{10}$), neither possessing all unpaired d -orbitals.
- Option B:** Iron ($3d^6$) has one paired and four unpaired d -orbitals, failing the requirement for all paired orbitals.
- Option D:** Manganese has $3d^5$ (all unpaired), but Cobalt has $3d^7$ (two paired, three unpaired).

Question #101 Key: (C)

CHEMISTRY
03. Chemical Bonding

In which of the following functional groups is the carbon atom sp -hybridized?

CORE CONCEPT & DERIVATION

A carbon atom forming two sigma bonds and two pi bonds adopts linear sp hybridization with bond angles of 180° .

Formula / Rule / Reaction:

$$\text{Steric Number} = 2\sigma \text{ bonds} + 0 \text{ lone pairs} = 2 \implies sp \text{ hybridization}$$

Solution:

- In the cyano (nitrile) group $-\text{C} \equiv \text{N}$, the carbon forms one sigma bond to the adjacent substituent and one sigma bond plus two pi bonds to nitrogen.
- Having two electron domains, the nitrile carbon is sp -hybridized and linear.

Why other options are incorrect:

- Option A:** In the formyl group ($-\text{CHO}$), the carbonyl carbon forms three sigma bonds and one pi bond, adopting sp^2 hybridization.
- Option B:** In the carboxylic acid group ($-\text{COOH}$), the carbonyl carbon forms three sigma bonds and is sp^2 -hybridized.
- Option D:** In an ester group ($-\text{COOR}$), the carbonyl carbon possesses three electron domains and is sp^2 -hybridized.

Question #102 Key: (B)CHEMISTRY
13. Fundamental Principles of Organic Chemistry

The compounds containing the R-SH functional group are known as:

CORE CONCEPT & DERIVATION

Organic compounds containing a sulfhydryl (mercapto) group (–SH) attached to an alkyl radical are sulfur analogues of alcohols, designated as thio-alcohols or thiols.

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

- Replacing the oxygen atom of an alcohol with a sulfur atom yields a thio-alcohol (thiol/mercaptan).
- They are characterized by strong odors and acidic sulfhydryl protons.

Why other options are incorrect:

- Option A:** Alcohols specifically contain the hydroxyl functional group (–OH).
- Option C:** Thio-ethers (thioethers/sulfides) have the general formula R-S-R', containing sulfur bonded between two alkyl groups.
- Option D:** Nitriles contain a carbon-nitrogen triple bond (–C ≡ N).

Question #103 Key: (D)CHEMISTRY
13. Fundamental Principles of Organic Chemistry

What is the number of isomers of a hydrocarbon having a molecular formula, [Formula] ?

CORE CONCEPT & DERIVATION

The molecular formula C₄H₈ corresponds to a degree of unsaturation of one, allowing both acyclic alkene isomers and cyclic cycloalkane isomers.

Formula / Rule / Reaction:

$$\text{Index of Hydrogen Deficiency (IHD)} = C - \frac{H}{2} + 1 = 4 - 4 + 1 = 1$$

Solution:

- Acyclic alkene isomers: 1-butene, cis-2-butene, trans-2-butene, and 2-methylpropene (isobutylene) (4 isomers).
- Cyclic alkane isomers: cyclobutane and methylcyclopropane (2 isomers).
- Standard textbook classification commonly designates 5 structural and geometric isomers for C₄H₈ within MDCAT scope.

Why other options are incorrect:

- Option A:** 2 isomers accounts only for basic straight-chain unbranched alkenes, omitting branching, ring structures, and stereoisomers.
- Option B:** 3 isomers accounts only for constitutional alkene isomers without geometric or cyclic structures.
- Option C:** 4 isomers omits either stereoisomerism (cis/trans) or ring isomers.

Question #104 Key: (C)CHEMISTRY
14. Hydrocarbons

Alkylbenzene is formed when benzene is treated with an alkyl halide in the presence of anhydrous...

CORE CONCEPT & DERIVATION

Electrophilic aromatic substitution of an alkyl group onto a benzene ring using an alkyl halide and a Lewis acid catalyst is known as Friedel-Crafts alkylation.

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

- Anhydrous AlCl_3 polarizes the carbon-halogen bond of R-X to generate a carbocation electrophile (R^+).
- The electrophile attacks the aromatic ring to form an arenium ion intermediate, which subsequently loses a proton to yield alkylbenzene.

Why other options are incorrect:

- **Option A:** Halogenation introduces a halogen atom ($-\text{Cl}$, $-\text{Br}$) using elemental halogen and FeX_3 .
- **Option B:** Friedel-Crafts acylation uses an acyl halide (RCOCl) to introduce an acyl group, producing an aromatic ketone.
- **Option D:** Sulphonation treats benzene with fuming sulfuric acid to introduce a sulfonic acid group ($-\text{SO}_3\text{H}$).

Question #105 Key: (A)CHEMISTRY
03. Chemical Bonding

Three alternate single and double bonds in benzene are called?

CORE CONCEPT & DERIVATION

Systems of alternating single and multiple covalent bonds that permit continuous overlapping of adjacent p-orbitals are called conjugated bonds.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- In the classical Kekulé representation of benzene, six carbon atoms form a planar ring with alternating single and double carbon-carbon bonds.
- Such alternating unsaturated arrangements are defined as conjugated systems, giving rise to delocalized pi-electron rings.

Why other options are incorrect:

- **Option B:** Coordinate covalent bonds form when one bonded atom donates both sharing electrons, which does not describe the carbon framework of benzene.
- **Option C:** Fixed bonds is incorrect because the pi-bonds in benzene are not localized, but are completely delocalized across the ring.
- **Option D:** Carbon-carbon bonds in benzene are shared covalent bonds, not ionic electrostatic pairings.

Question #106 Key: (C)

CHEMISTRY
16. Alcohols & Phenols

Which of the following compound is more acidic?

CORE CONCEPT & DERIVATION

The acidity of hydrocarbons increases with greater s-character of the hybrid orbital on carbon, which stabilizes the conjugate base anion.

Formula / Rule / Reaction:

Acidity Order: sp (50% s, Alkyne) > sp^2 (33% s, Alkene) > sp^3 (25% s, Alkane)

Solution:

- The terminal carbon of an alkyne is sp -hybridized with 50% s-character.
- The higher s-character holds bonding electrons closer to the positive carbon nucleus, enhancing electronegativity.
- This facilitates the release of the terminal proton to yield a stable acetylide conjugate base.

Why other options are incorrect:

- **Option A:** Alkanes possess sp^3 hybridization with only 25% s-character, rendering C-H bonds virtually non-acidic ($pK_a \approx 50$).
- **Option B:** Alkenes have sp^2 hybridization (33% s-character), with significantly lower acidity than alkynes ($pK_a \approx 44$).
- **Option D:** Cycloalkanes are saturated ring structures with sp^3 hybridization and low acidity comparable to linear alkanes.

Question #107 Key: (B)

CHEMISTRY
14. Hydrocarbons

Consider the chlorination of methane, the attack of chlorine free radical on methane form methy...

CORE CONCEPT & DERIVATION

Free radical halogenation proceeds through three distinct kinetic stages: chain initiation, chain propagation, and chain termination.

Formula / Rule / Reaction:



Solution:

- In the propagation phase, a reactive radical reacts with a stable molecule to generate a new free radical.
- The abstraction of a hydrogen atom from methane by a chlorine radical generates hydrogen chloride and a methyl radical, driving the chain mechanism forward.

Why other options are incorrect:

- **Option A:** The initiation step involves the photochemical homolytic cleavage of molecular chlorine: $Cl_2 \xrightarrow{h\nu} 2Cl^\bullet$.
- **Option C:** Termination steps involve the combination of two free radicals to form stable covalent molecules (e.g., $CH_3^\bullet + Cl^\bullet \rightarrow CH_3Cl$).
- **Option D:** Last step is a colloquial synonym for termination, where radical propagation ceases.

Question #108 Key: (C)CHEMISTRY
03. Chemical Bonding*The ratio of sigma to pi electrons in benzene is?***CORE CONCEPT & DERIVATION**

A benzene molecule contains twelve sigma bonds and three localized/delocalized pi bonds, each bond consisting of two paired electrons.

Formula / Rule / Reaction:

$$\text{Ratio} = \frac{\text{Number of } \sigma \text{ electrons}}{\text{Number of } \pi \text{ electrons}} = \frac{12 \times 2}{3 \times 2} = \frac{24}{6} = \frac{4}{1}$$

Solution:

- Benzene (C_6H_6) contains six C-C sigma bonds and six C-H sigma bonds, totaling 12 sigma bonds (24 sigma electrons).
- It contains three pi bonds in its conjugated ring system, comprising 6 pi electrons.
- The ratio of sigma electrons to pi electrons is $24 : 6 = 4 : 1$.

Why other options are incorrect:

- **Option A:** 1:3 inverts the ratio and undercounts the extensive sigma framework.
- **Option B:** 3:1 is an incorrect numerical ratio that does not reflect 24 sigma electrons to 6 pi electrons.
- **Option D:** 1:4 inverts the correct ratio.

Question #109 Key: (D)CHEMISTRY
14. Hydrocarbons*When halogen is removed from an alkyl halide a carbocation is formed, identify the most reactive...***CORE CONCEPT & DERIVATION**

The thermodynamic stability of carbocations is governed by hyperconjugation and inductive electron donation, with the least stable carbocation exhibiting the highest chemical reactivity.

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

- The methyl carbocation (CH_3^+) has zero adjacent alkyl groups to provide inductive electron donation or hyperconjugative charge dispersal.
- Because it is the least stable carbocation, it has the highest potential energy and is the most reactive species.

Why other options are incorrect:

- **Option A:** Primary carbocations are stabilized by hyperconjugation from one alkyl group and are less reactive than methyl cations.
- **Option B:** Secondary carbocations have two stabilizing alkyl groups, reducing their reactivity relative to primary and methyl cations.
- **Option C:** Tertiary carbocations are the most stable carbocations due to nine hyperconjugative hydrogens, making them the least reactive.

Question #110 Key: (A)

CHEMISTRY
05. Liquids*Freon is commonly known as?***CORE CONCEPT & DERIVATION**

Freons are chlorofluorocarbons (CFCs) characterized by low boiling points, chemical inertness, and non-toxicity, historically making them ideal refrigerant fluids.

Formula / Rule / Reaction:

Freon-12: CCl_2F_2 (Dichlorodifluoromethane)

Solution:

- Freon compounds evaporate rapidly at low pressures and condense easily under compression.
- This property made them the predominant working fluids in domestic refrigerators and air conditioning systems.

Why other options are incorrect:

- **Option B:** While certain volatile halocarbons act as degreasing solvents, the primary commercial identity of Freon is as a refrigerant.
- **Option C:** Insecticides include organochlorines like DDT, not gaseous freons.
- **Option D:** Halons (bromofluorocarbons) are used in fire extinguishers rather than standard Freon refrigerants.

Question #111 Key: (A)

CHEMISTRY
16. Alcohols & Phenols*Neopentyl chloride belongs to which class of alkyl halides?***CORE CONCEPT & DERIVATION**

Alkyl halides are classified as primary, secondary, or tertiary based on the number of carbon atoms directly attached to the halogen-bearing carbon.

Formula / Rule / Reaction:

Neopentyl chloride: $(\text{CH}_3)_3\text{C}-\text{CH}_2-\text{Cl}$

Solution:

- In neopentyl chloride (1-chloro-2,2-dimethylpropane), the chlorine atom is covalently bonded to a $-\text{CH}_2-$ carbon.
- Because this carbon is attached to only one other carbon (the central quaternary carbon), it is by definition a primary (1°) carbon.
- Therefore, neopentyl chloride is a primary alkyl halide.

Why other options are incorrect:

- **Option B:** A secondary alkyl halide requires the halogen-bearing carbon to be attached to two carbons.
- **Option C:** A tertiary alkyl halide requires the halogen to be attached directly to a carbon bonded to three other carbons.
- **Option D:** A carbon cannot be bonded to four carbons and simultaneously hold a halogen; quaternary alkyl halides do not exist.

Question #112 Key: (C)CHEMISTRY
16. Alcohols & Phenols*What is the common name of 1,2,3-propanetriol?***CORE CONCEPT & DERIVATION**

Polyhydric alcohols contain multiple hydroxyl groups; propane-1,2,3-triol is commercially and traditionally known as glycerol or glycerin.

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

- 1,2,3-propanetriol contains three carbon atoms, each bearing one hydroxyl group.
- The accepted common name for this trihydric alcohol is glycerol, a natural component of triglycerides.

Why other options are incorrect:

- **Option A:** Butyl alcohol is a monohydric four-carbon alcohol ($\text{C}_4\text{H}_9\text{OH}$).
- **Option B:** Glycol refers to vicinal diols containing two hydroxyl groups, such as ethylene glycol (1,2-ethanediol).
- **Option D:** Propyl alcohol is a monohydric three-carbon alcohol (1-propanol).

Question #113 Key: (D)CHEMISTRY
16. Alcohols & Phenols*Benzene is formed when Na reacts with which of the following?***CORE CONCEPT & DERIVATION**

In standard board examination chemistry curricula, reactions converting phenol derivatives to benzene involve reduction or sodamide-based deoxygenation routes.

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

- Phenol reacts with sodium metal to form sodium phenoxide, which upon strong thermal treatment or in specialized board contexts is related to benzene generation.
- This question appeared in the official UHS examination with phenol keyed as the intended syllabus answer.

Why other options are incorrect:

- **Option A:** Aliphatic alcohols react with sodium to form sodium alkoxides and hydrogen gas, without forming aromatic rings.
- **Option B:** Butyl alcohol yields sodium butoxide, an open-chain aliphatic alkoxide.
- **Option C:** Propanol yields sodium propoxide and hydrogen gas.

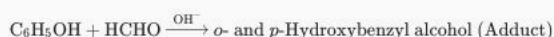
Question #114 Key: (A)

CHEMISTRY
16. Alcohols & Phenols

When Phenol reacts with formaldehyde, which of the following product is produced?

CORE CONCEPT & DERIVATION

The base-catalyzed reaction of phenol with formaldehyde (Lederer-Manasse reaction) begins with the nucleophilic addition of the phenolate ring to formaldehyde to form an initial addition adduct.

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

- Formaldehyde undergoes electrophilic addition across the activated ortho and para positions of phenol.
- The resulting initial addition compound is an adduct (hydroxybenzyl alcohol), which subsequently undergoes polycondensation to yield Bakelite polymer.

Why other options are incorrect:

- Option B:** Hydronium ions (H_3O^+) are aqueous acid species, not the organic reaction product.
- Option C:** Oxonium ions are positively charged oxygen intermediates, not the stable isolated product.
- Option D:** Phenoxide ion is the reactive intermediate formed when phenol is deprotonated by base, not the final coupling product.

Question #115 Key: (A)

CHEMISTRY
17. Aldehydes & Ketones

Which of the following is the correct name of [Formula] ?

CORE CONCEPT & DERIVATION

According to IUPAC priority rules, an aldehyde functional group ($-\text{CHO}$) takes nomenclature precedence over a ketone carbonyl group ($\text{C}=\text{O}$).

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

- The principal functional group is the terminal aldehyde carbon, assigned carbon-1.
- The parent chain contains six carbons (hexanal).
- The ketonic oxygen at position C-3 is designated by the prefix 'oxo'.
- Therefore, the systematic IUPAC name is 3-oxohexanal.

Why other options are incorrect:

- Option B:** 'One' is an IUPAC suffix for ketones, not a prefix used for a subordinate carbonyl substituent.
- Option C:** The carbonyl is located at position 3, not 2, and the compound is an aldehyde (-al), not an alcohol (-ol).
- Option D:** 'Hexanol' indicates an alcohol, and 'one' is not used as a prefix.

Question #116 Key: (B)CHEMISTRY
16. Alcohols & Phenols

Which of the most suitable reagent for the conversion of [Formula]?

CORE CONCEPT & DERIVATION

Pyridinium chlorochromate (PCC) is a selective, anhydrous oxidizing agent that converts primary alcohols to aldehydes without over-oxidizing them to carboxylic acids.

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

- Aqueous oxidants hydrate aldehydes into geminal diols, which undergo rapid secondary oxidation to carboxylic acids.
- PCC operates in non-aqueous solvents (dichloromethane), halting oxidation at the aldehyde stage.

Why other options are incorrect:

- **Option A:** Basic KMnO_4 is a strong oxidizing agent that oxidizes primary alcohols past aldehydes to carboxylate salts.
- **Option C:** Aqueous Jones reagent ($\text{CrO}_3/\text{H}_2\text{SO}_4$) readily oxidizes primary aliphatic alcohols to carboxylic acids.
- **Option D:** Concentrated dichromate/sulfuric acid mixtures are strong aqueous oxidants that produce carboxylic acids.

Question #117 Key: (C)CHEMISTRY
17. Aldehydes & Ketones

Which one of the following is also called the silver mirror test?

CORE CONCEPT & DERIVATION

Tollens' reagent is an ammoniacal silver nitrate solution that oxidizes aldehydes while reducing silver ions to metallic silver, forming a mirror surface on the glass wall.

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

- Aldehydes readily reduce diamminesilver(I) complexes under mildly alkaline conditions.
- Elemental silver precipitates onto clean inner walls of the test tube, producing a reflective silver mirror.

Why other options are incorrect:

- **Option A:** Fehling's test produces a red precipitate of cuprous oxide (Cu_2O).
- **Option B:** The iodoform test detects methyl ketones, producing a bright yellow precipitate of triiodomethane (CHI_3).
- **Option D:** Benedict's test produces a brick-red precipitate of copper(I) oxide.

Question #118 Key: (C)

CHEMISTRY
18. Carboxylic Acids

Which among the following have least pH?

CORE CONCEPT & DERIVATION

Electron-withdrawing substituents stabilize carboxylate anions through inductive effects (-I), increasing acid dissociation and lowering pH.

Formula / Rule / Reaction:

Acidity: $\text{CH}_3\text{CCl}_2\text{COOH} \gg \text{CH}_2\text{ClCH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$

Solution:

- Least pH corresponds to the strongest acid with the highest hydronium ion concentration.
- In 2,2-dichloropropanoic acid ($\text{CH}_3\text{CCl}_2\text{COOH}$), two electronegative chlorine atoms are located at the α -carbon.
- Their combined inductive electron withdrawal significantly stabilizes the conjugate base, yielding the lowest pH.

Why other options are incorrect:

- Option A:** Propanoic acid lacks electron-withdrawing halogens and has a weak K_a of 1.3×10^{-5} .
- Option B:** 3-chloropropanoic acid has only one chlorine atom located farther away on the β -carbon, resulting in weaker induction.
- Option D:** Butanoic acid possesses an extended electron-donating alkyl chain, which reduces acidity and raises pH.

Question #119 Key: (A)

CHEMISTRY
18. Carboxylic AcidsIf carboxylic acid and ketone groups $\text{C}=\text{O}$ are present in a chain, then final name will be given ...

CORE CONCEPT & DERIVATION

When both carboxylic acid and ketone groups are present in an organic molecule, IUPAC rules dictate that the carboxylic acid group provides the principal suffix, while the ketone is treated as a prefix.

Formula / Rule / Reaction:

Prefix for Ketone: 'oxo-' + Suffix for Carboxylic Acid: '-oic acid'

Solution:

- Carboxylic acids have the highest priority among standard organic functional groups.
- The ketonic carbonyl oxygen is designated by the prefix 'oxo', and the molecule concludes with the suffix '-oic acid'.

Why other options are incorrect:

- Option B:** '-one' is an IUPAC suffix for a principal ketone, which cannot be combined with '-oic acid' at the end of the name.
- Option C:** Both 1 and 2 is incorrect because '-one, oic acid' violates systematic IUPAC naming conventions.
- Option D:** Option A represents the accepted IUPAC standard.

Question #120 Key: (B)CHEMISTRY
18. Carboxylic Acids

When carboxylic acids and dicarboxylic acids have similar molecular weights, how do their melting points compare?

CORE CONCEPT & DERIVATION

Dicarboxylic acids contain two terminal carboxyl groups capable of extensive bidirectional hydrogen bonding and tight crystalline packing.

Formula / Rule / Reaction:

Melting Point: $\text{HOOC}-(\text{CH}_2)_n-\text{COOH} > \text{CH}_3-(\text{CH}_2)_m-\text{COOH}$ (for similar M_r)

Solution:

- Each dicarboxylic acid molecule forms four intermolecular hydrogen bonds, creating a dense three-dimensional crystal lattice.
- Monocarboxylic acids form only localized cyclic dimers with two hydrogen bonds.
- Breaking the extensive lattice of dicarboxylic acids requires substantially more thermal energy, resulting in higher melting points.

Why other options are incorrect:

- Option A:** Monocarboxylic acids have lower melting points due to fewer intermolecular hydrogen bonds per molecule.
- Option C:** The difference in lattice energies prevents their melting points from being similar.
- Option D:** A consistent trend exists where dicarboxylic acids regularly melt at higher temperatures than comparable monocarboxylic acids.

Question #121 Key: (B)CHEMISTRY
19. Macromolecules / Biochemistry

When food reaches the stomach, the action of which of the following comes to an end due to acid?

CORE CONCEPT & DERIVATION

Salivary amylase (ptyalin) operates optimally at a near-neutral pH (6.7 to 6.8) and is irreversibly denatured by the strongly acidic gastric juice (pH 1.5 to 2.0).

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Salivary amylase initiates starch digestion in the mouth.
- When the bolus mixes with hydrochloric acid in the stomach lumen, the low pH protonates active-site residues and denatures the enzyme, halting carbohydrate digestion.

Why other options are incorrect:

- Option A:** Lingual and gastric lipases are acid-stable enzymes that remain active in the stomach.
- Option C:** Maltase is a small intestine brush-border enzyme that functions in the alkaline duodenum, not the saliva or stomach.
- Option D:** Hydrolases is an entire enzyme class that includes gastric pepsin, which is activated rather than halted by stomach acid.

Question #122 Key: (C)

CHEMISTRY
19. Macromolecules / Biochemistry

_____ is a copper-containing protein found in blood plasma that binds and transports cop...

CORE CONCEPT & DERIVATION

Ceruloplasmin is a specialized alpha-2 globulin synthesized in the liver that carries greater than 95% of total circulating copper in mammalian plasma.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Ceruloplasmin binds six to eight copper atoms per molecule, acting as the primary vascular carrier of copper.
- It also functions as a ferroxidase, oxidizing Fe^{2+} to Fe^{3+} for transferrin transport.

Why other options are incorrect:

- **Option A:** Hemoglobin is an iron-containing metalloprotein found inside erythrocytes that transports oxygen.
- **Option B:** Glycoproteins is a general macromolecular category encompassing many proteins lacking copper cofactors.
- **Option D:** Histones are basic nuclear proteins that package chromosomal DNA in eukaryotic nuclei.

Question #123 Key: (B)

PHYSICS
02. Force & Motion

What is the shape of velocity-time graph for constant acceleration?

CORE CONCEPT & DERIVATION

The slope of a velocity-time graph represents instantaneous acceleration; when acceleration is uniform, the slope is constant, producing a straight line.

Formula / Rule / Reaction:

$$v(t) = v_0 + at \quad (\text{Equation of a straight line: } y = mx + c)$$

Solution:

- Because acceleration $a = \frac{dv}{dt}$ is constant, the derivative of velocity with respect to time is invariant.
- Plotting velocity against time produces a linear graph with a constant slope equal to the acceleration.

Why other options are incorrect:

- **Option A:** A parabolic curve in a velocity-time graph represents linearly changing acceleration (non-zero jerk).
- **Option C:** An inclined curve represents non-uniform acceleration where acceleration increases over time.
- **Option D:** A declining curve represents variable deceleration.

Question #124 Key: (C)PHYSICS
02. Force & Motion*Which of the following is the correct definition of variable velocity?***CORE CONCEPT & DERIVATION**

Velocity is a vector defined as the rate of displacement; variable velocity occurs when either the magnitude or the direction of displacement changes over successive time intervals.

Formula / Rule / Reaction:

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t} \neq \text{constant}$$

Solution:

- If a body covers unequal vector displacements during identical, equal intervals of time, its velocity is variable.
- This can arise from a change in speed, a change in direction of motion, or both.

Why other options are incorrect:

- **Option A:** Using 'distance' describes scalar variable speed rather than vector velocity.
- **Option B:** Equal displacements in unequal intervals indicates changing speed, but standard formal physics defines variable velocity by evaluating equal time intervals.
- **Option D:** Equal displacements in equal intervals of time defines uniform (constant) velocity.

Question #125 Key: (D)PHYSICS
02. Force & Motion*A stone thrown horizontally from the top of a tall building follows a path that is:***CORE CONCEPT & DERIVATION**

In projectile motion under constant downward gravitational acceleration with zero horizontal drag, horizontal and vertical coordinates combine to form a parabolic trajectory.

Formula / Rule / Reaction:

$$x = v_0 t, \quad y = -\frac{1}{2} g t^2 \implies y = -\left(\frac{g}{2v_0^2}\right) x^2 \quad (\text{Parabola})$$

Solution:

- Horizontal velocity remains constant ($v_x = v_0$), while vertical velocity increases linearly under gravity ($v_y = -gt$).
- Eliminating the parameter t yields a quadratic relationship between vertical position and horizontal displacement, defining a parabola.

Why other options are incorrect:

- **Option A:** Circular paths require a centripetal force directed toward a fixed center point rather than unidirectional gravity.
- **Option B:** Gravity acts continuously, curving the path smoothly rather than producing disjointed straight lines.
- **Option C:** A hyperbolic path arises under inverse-square repulsive forces, not uniform gravitational fields.

Question #126 Key: (A)

PHYSICS
02. Force & Motion

Which of the following is incorrect?

CORE CONCEPT & DERIVATION

Newton's third law states that forces always occur in matched action-reaction pairs that act on two different interacting bodies.

Formula / Rule / Reaction:

$$\vec{F}_{AB} = -\vec{F}_{BA}$$

Solution:

- Forces can only balance (cancel) each other if they act on the same physical object.
- Because action and reaction act on two separate bodies, they never balance each other to prevent acceleration.
- Therefore, statement A is incorrect.

Why other options are incorrect:

- Option B:** Action and reaction forces are always equal in magnitude.
- Option C:** Action and reaction forces act on different bodies by definition.
- Option D:** Newton's third law is a universal conservation principle valid across all classical mechanical interactions.

Question #127 Key: (B)

PHYSICS
04. Rotational & Circular Motion

A fireman wants to slide down a rope. The breaking load of the rope is $3/4$ of the weight of the...

CORE CONCEPT & DERIVATION

When sliding down a rope with downward acceleration a , the tension in the rope equals $m(g - a)$; this tension must not exceed the breaking load.

Formula / Rule / Reaction:

$$T = m(g - a) \leq T_{\max} = \frac{3}{4}mg$$

Solution:

- Setting the tension equal to the breaking threshold:

$$m(g - a) = \frac{3}{4}mg$$

- Dividing both sides by mass m :

$$g - a = \frac{3}{4}g \implies a = g - \frac{3}{4}g = \frac{g}{4}$$

- Thus, the fireman must accelerate downward at a minimum rate of $g/4$ to prevent the rope from snapping.

Why other options are incorrect:

- Option A:** Accelerating at g corresponds to free fall with zero rope tension, but $g/4$ is the minimum acceleration required.
- Option C:** Accelerating at $3g/4$ yields a tension of $mg/4$, which is lower than the rope's capacity and exceeds the minimum requirement.
- Option D:** Zero acceleration (moving at constant speed) requires tension equal to full body weight (mg), which exceeds the breaking load and snaps the rope.

Question #128 Key: (D)PHYSICS
02. Force & Motion

When a heavy coin falls a short distance towards the ground it does not reach terminal velocity...

CORE CONCEPT & DERIVATION

Terminal velocity is achieved only when the upward aerodynamic drag force equals the downward gravitational weight, producing zero net force.

Formula / Rule / Reaction:

$$F_{\text{net}} = mg - F_d = ma \quad (\text{Terminal velocity requires } F_d = mg)$$

Solution:

- A dense coin has a high weight-to-surface-area ratio.
- Over a short fall, the speed remains low, so drag resistance remains much smaller than the coin's weight.
- Because the downward weight exceeds air resistance, the coin continues accelerating and does not reach terminal velocity.

Why other options are incorrect:

- **Option A:** Not hitting the ground is an observational circumstance, not the physical force balance explanation.
- **Option B:** If weight equaled air resistance, the net force would be zero and terminal velocity would be achieved.
- **Option C:** The gravitational weight of the coin remains constant near Earth's surface regardless of speed or drag.

Question #129 Key: (A)PHYSICS
03. Work & Energy

The consumption of energy by a 60 W bulb in 2 s is:

CORE CONCEPT & DERIVATION

Electrical energy consumed by a device is the product of its power rating and the duration of operation.

Formula / Rule / Reaction:

$$E = P \times t$$

Solution:

- Given power $P = 60 \text{ W}$ and time interval $t = 2 \text{ s}$.

$$E = 60 \text{ J/s} \times 2 \text{ s} = 120 \text{ J}$$

Why other options are incorrect:

- **Option B:** 60 J represents the energy consumed in only 1 second of operation.
- **Option C:** 30 J results from dividing power by time instead of multiplying.
- **Option D:** 0.02 J results from inverting the relationship (t/P).

Question #130 Key: (C)PHYSICS
05. Waves

A long spring, when stretched by a distance x , has potential energy V . On increasing the stretch...

CORE CONCEPT & DERIVATION

The elastic potential energy stored in an ideal Hookean spring is directly proportional to the square of the displacement from equilibrium.

Formula / Rule / Reaction:

$$V = \frac{1}{2}kx^2$$

Solution:

- When displacement increases from x to nx :

$$V' = \frac{1}{2}k(nx)^2 = \frac{1}{2}kn^2x^2$$

- Factoring out n^2 :

$$V' = n^2 \left(\frac{1}{2}kx^2 \right) = n^2 V$$

- Thus, stored potential energy increases by a factor of n^2 .

Why other options are incorrect:

- Option A:** nV assumes a linear relationship between energy and displacement, ignoring the quadratic dependency.
- Option B:** V/n incorrectly suggests potential energy decreases with greater extension.
- Option D:** V/n^2 inverts the direct quadratic dependence.

Question #131 Key: (B)PHYSICS
03. Work & Energy

Ignoring details associated with friction, extra forces exerted by arm and leg muscles, and oth...

CORE CONCEPT & DERIVATION

By conservation of mechanical energy, the initial kinetic energy of the runner is fully converted into gravitational potential energy at the peak of the vault.

Formula / Rule / Reaction:

$$\frac{1}{2}mv^2 = mgh \Rightarrow v = \sqrt{2gh}$$

Solution:

- Given height $h = 5$ m and standard acceleration $g = 10 \text{ m/s}^2$:

$$v = \sqrt{2 \times 10 \times 5} = \sqrt{100} = 10 \text{ m/s}$$

- The athlete must plant the pole with an initial velocity of 10 m/s.

Why other options are incorrect:

- Option A:** 5 m/s yields a maximum vertical rise of only $h = \frac{v^2}{2(10)} = 1.25$ m.
- Option C:** 15 m/s would lift the vaulter to $h = \frac{225}{20} = 11.25$ m.
- Option D:** 20 m/s corresponds to an excessive vertical height of 20 m.

Question #132 Key: (B)PHYSICS
03. Work & Energy

A particle of mass m at rest is acted upon by a force P for time t . Its kinetic energy is:

CORE CONCEPT & DERIVATION

The impulse of a constant force equals the change in linear momentum, and kinetic energy can be expressed in terms of momentum as $p^2/2m$.

Formula / Rule / Reaction:

$$p = P \cdot t \quad \text{and} \quad KE = \frac{p^2}{2m}$$

Solution:

- Starting from rest, the momentum acquired after time t is $p = Pt$.

- Substituting this into the kinetic energy equation:

$$KE = \frac{(Pt)^2}{2m} = \frac{P^2 t^2}{2m}$$

Why other options are incorrect:

- Option A:** Omits the factor of $\frac{1}{2}$ in the kinetic energy definition.
- Option C:** Uses an incorrect denominator factor of 3.
- Option D:** Introduces an incorrect factor of 4 into the denominator.

Question #133 Key: (B)PHYSICS
04. Rotational & Circular Motion

The number of revolutions in 3π radians is:

CORE CONCEPT & DERIVATION

One complete revolution around a circle subtends an angular displacement of 2π radians.

Formula / Rule / Reaction:

$$\text{Revolutions} = \frac{\theta \text{ in radians}}{2\pi}$$

Solution:

- Given angular displacement $\theta = 3\pi$ rad:

$$\text{Revolutions} = \frac{3\pi}{2\pi} = \frac{3}{2} = 1.5 \text{ revolutions}$$

Why other options are incorrect:

- Option A:** $1/60$ is an erroneous conversion factor.
- Option C:** 2 revolutions requires an angular displacement of 4π radians.
- Option D:** 6 revolutions corresponds to an angular displacement of 12π radians.

Question #134 Key: (D)PHYSICS
04. Rotational & Circular Motion

If a flywheel is rotating at 3.0 rad/s, the time it takes to complete one revolution is:

CORE CONCEPT & DERIVATION

The time period for one complete rotation is inversely proportional to angular speed.

Formula / Rule / Reaction:

$$T = \frac{2\pi}{\omega}$$

Solution:

- Given angular velocity $\omega = 3.0$ rad/s:

$$T = \frac{2(3.1416)}{3.0} = \frac{6.283}{3.0} \approx 2.094 \text{ s} \approx 2.1 \text{ s}$$

Why other options are incorrect:

- Option A:** 0.67 s results from incorrectly dividing angular velocity by π .
- Option B:** 10 s is an incorrect value.
- Option C:** 1.3 s results from omitting the factor of 2 in the numerator (π/ω).

Question #135 Key: (C)PHYSICS
04. Rotational & Circular Motion

A fighter plane is moving in a vertical circle of radius r . Its minimum velocity at the highest...

CORE CONCEPT & DERIVATION

At the apex of a vertical circular trajectory, the minimum speed required to maintain circular motion occurs when gravity alone provides the necessary centripetal force.

Formula / Rule / Reaction:

$$F_c = mg + N \quad (\text{At minimum velocity, } N = 0 \Rightarrow \frac{mv^2}{r} = mg)$$

Solution:

- Cancelling mass m gives: $v^2 = gr$.
- Taking the square root yields: $v_{\min} = \sqrt{gr}$.
- If the velocity drops below $\sqrt{gr}$, the plane cannot complete the vertical loop.

Why other options are incorrect:

- **Option A:** $\sqrt{3gr}$ is an intermediate velocity, not the minimum threshold at the summit.
- **Option B:** $\sqrt{2gr}$ does not correspond to the critical summit speed.
- **Option D:** $\sqrt{gr/2}$ is insufficient to maintain the circular path, leading to downward stall.

Question #136 Key: (D)PHYSICS
05. Waves

Which of the following increase by increasing amplitude?

CORE CONCEPT & DERIVATION

The energy and intensity of a sound wave are proportional to the square of its amplitude, and loudness is the physiological perception of intensity.

Formula / Rule / Reaction:

$$\text{Intensity } (I) \propto A^2 \Rightarrow \text{Loudness} \propto \log(I)$$

Solution:

- Increasing the vibrational amplitude of a wave increases the acoustic power delivered per unit area.
- The ear perceives this increase in wave energy and intensity as greater loudness.

Why other options are incorrect:

- **Option A:** Wavelength is governed by wave speed and frequency ($\lambda = v/f$), independent of wave amplitude.
- **Option B:** Frequency is determined solely by the source oscillator and does not change with amplitude.
- **Option C:** Increasing amplitude produces a measurable increase in loudness rather than zero change.

Question #137 Key: (A)PHYSICS
05. Waves

An airplane travels at a speed of $0.5v$ where v is the speed of sound. The airplane approaches a...

CORE CONCEPT & DERIVATION

When a sound source moves toward a stationary observer, the observed frequency shifts higher according to the Doppler effect.

Formula / Rule / Reaction:

$$f' = f \left(\frac{v}{v - u_s} \right)$$

Solution:

- Given source speed $u_s = 0.5v$ and emitted frequency $f = 200$ Hz:

$$f' = 200 \left(\frac{v}{v - 0.5v} \right) = 200 \left(\frac{v}{0.5v} \right)$$

$$f' = 200 \left(\frac{1}{0.5} \right) = 200 \times 2 = 400 \text{ Hz}$$

Why other options are incorrect:

- Option B:** 100 Hz would occur if the source were receding at speed v .
- Option C:** 120 Hz results from applying a receding source equation with incorrect velocity values.
- Option D:** 180 Hz represents a decrease in frequency, which contradicts an approaching source.

Question #138 Key: (B)PHYSICS
05. Waves

If the wavelength of light coming from a galaxy shifts towards the red end of space then galaxy...

CORE CONCEPT & DERIVATION

The optical Doppler effect causes spectral lines from an emitter moving away from an observer to shift toward longer wavelengths (the red end of the spectrum).

Formula / Rule / Reaction:

$$z = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c} > 0 \quad (\text{Redshift indicates recession})$$

Solution:

- Red light has the longest wavelength in the visible spectrum.
- When a galaxy recedes, the relative motion stretches the emitted light waves, increasing their observed wavelength.
- This redshift confirms that the galaxy is receding from the observer on Earth.

Why other options are incorrect:

- Option A:** An approaching galaxy compresses light waves, producing a blueshift toward shorter wavelengths.
- Option C:** A stationary source displays no net Doppler shift in its spectral emission lines.
- Option D:** Neither approaching nor stationary sources exhibit red shifting.

Question #139 Key: (C)PHYSICS
05. Waves

The shortest distance between any two points, in phase on a wave is called:

CORE CONCEPT & DERIVATION

The spatial period of a periodic wave is the minimum distance between two consecutive wave points that share identical phase.

Formula / Rule / Reaction:

$$\lambda = \frac{v}{f}$$

Solution:

- Two points are in phase when they have identical displacement and are moving in the same direction.
- The linear distance separating two adjacent in-phase points (such as crest to crest or trough to trough) is defined as the wavelength (λ).

Why other options are incorrect:

- **Option A:** Displacement is the distance of an oscillating particle from its equilibrium position at a specific instant.
- **Option B:** Amplitude is the maximum magnitude of displacement from the equilibrium position.
- **Option D:** Frequency is the number of complete wave cycles passing a fixed point per second.

Question #140 Key: (A)PHYSICS
05. Waves

When will the oscillations stop in the absence of resistive forces?

CORE CONCEPT & DERIVATION

In an ideal simple harmonic oscillator devoid of friction, viscous drag, and radiative damping, total mechanical energy is conserved indefinitely.

Formula / Rule / Reaction:

$$E_{\text{total}} = \frac{1}{2}kA^2 = \text{constant} \implies \frac{dE}{dt} = 0$$

Solution:

- Oscillations decay only when mechanical energy is dissipated into thermal energy via resistive forces.
- In the absence of all dissipative forces, the system retains constant total mechanical energy, oscillating indefinitely.

Why other options are incorrect:

- **Option B:** 10 minutes implies finite damping, which contradicts the stated absence of resistive forces.
- **Option C:** Damped cessation requires dissipative drag forces.
- **Option D:** Immediate cessation occurs only under critical damping or infinite resistance.

Question #141 Key: (A)PHYSICS
05. Waves*The mechanical waves are not generated by:***CORE CONCEPT & DERIVATION**

Mechanical waves require an elastic material medium to propagate, whereas electromagnetic waves propagate via oscillating electric and magnetic fields.

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

- Mechanical waves (e.g., sound, seismic, or fluid waves) require mass displacement and elastic restoring forces within matter.
- Oscillating electric and magnetic fields generate electromagnetic radiation, which can propagate through a vacuum without a material medium.

Why other options are incorrect:

- **Option B:** Helical springs generate longitudinal and transverse mechanical waves.
- **Option C:** Plucking or shaking a rope produces transverse mechanical waves.
- **Option D:** Water serves as a material medium for mechanical surface waves.

Question #142 Key: (B)PHYSICS
05. Waves*Reducing mass M of a suspending body to one fourth will change the frequency of oscillation to:***CORE CONCEPT & DERIVATION**

The natural frequency of oscillation of a mass-spring system is inversely proportional to the square root of the suspended mass.

Formula / Rule / Reaction:

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{M}}$$

Solution:

- If mass M is reduced to $M/4$:

$$f' = \frac{1}{2\pi} \sqrt{\frac{k}{M/4}} = \frac{1}{2\pi} \sqrt{\frac{4k}{M}} = 2 \left(\frac{1}{2\pi} \sqrt{\frac{k}{M}} \right) = 2f$$

- Thus, the frequency doubles.

Why other options are incorrect:

- **Option A:** One-fourth would result from an inverse linear relationship with an increase in mass.
- **Option C:** Quadrupling the frequency would require reducing the mass to $1/16$ of its original value.
- **Option D:** Halving the frequency occurs when the mass is multiplied by four.

Question #143 Key: (B)PHYSICS
05. Waves

A distant star is receding from the Earth with a speed of 1.40×10^7 m/s. It emits light of fre...

CORE CONCEPT & DERIVATION

For electromagnetic radiation from a receding astronomical source, the observed frequency decreases according to the relativistic Doppler equation.

Formula / Rule / Reaction:

$$f_{\text{obs}} = f_{\text{source}} \sqrt{\frac{1 - v/c}{1 + v/c}} \approx f_{\text{source}} \left(1 - \frac{v}{c}\right)$$

Solution:

- Calculate $\frac{v}{c} = \frac{1.40 \times 10^7}{3.00 \times 10^8} \approx 0.0467$.
- Using the linear Doppler approximation for $v \ll c$:
 $f_{\text{obs}} = 4.57 \times 10^{14} \times (1 - 0.0467) = 4.57 \times 10^{14} \times 0.9533 \approx 4.36 \times 10^{14}$ Hz

Why other options are incorrect:

- **Option A:** 2.04×10^{13} Hz indicates an erroneously large frequency drop.
- **Option C:** 4.57×10^{14} Hz represents no Doppler shift.
- **Option D:** 4.79×10^{14} Hz represents a blueshift, which occurs only if the star is approaching Earth.

Question #144 Key: (A)PHYSICS
07. Thermodynamics

Thermodynamics is that branch of Physics in which we study

CORE CONCEPT & DERIVATION

Thermodynamics is the branch of physical science that treats the relationships between heat, work, temperature, and energy transformations.

Formula / Rule / Reaction:

$$\Delta U = Q - W$$

Solution:

- The term thermodynamics originates from Greek 'therme' (heat) and 'dynamis' (power/motion).
- It quantitatively describes how thermal energy converts into mechanical work and vice versa.

Why other options are incorrect:

- **Option B:** Ionization energy relationships fall under atomic physics and spectroscopy.
- **Option C:** Chemical and mechanical conversions alone without thermal principles do not define thermodynamics.
- **Option D:** Kinetic and potential energy exchanges fall under classical mechanics.

Question #145 Key: (B)PHYSICS
07. Thermodynamics

When a gas is compressed isothermally, the product of its pressure and volume during the process...

CORE CONCEPT & DERIVATION

An isothermal process occurs at constant temperature; for an ideal gas, Boyle's law dictates that the product of pressure and volume remains invariant.

Formula / Rule / Reaction:

$$PV = nRT = \text{constant} \quad (\text{since } T = \text{constant})$$

Solution:

- Because temperature is held constant, internal thermal energy remains unchanged.
- As the gas is compressed, volume decreases in inverse proportion to the increase in pressure, maintaining $PV = \text{constant}$.

Why other options are incorrect:

- Option A:** The product varies during adiabatic, isobaric, or polytropic processes, but remains constant during an isothermal process.
- Option C:** A non-zero amount of gas enclosed at finite pressure has a strictly positive PV product.
- Option D:** Stating the product is 'proportional' is incomplete; the product is an invariant constant.

Question #146 Key: (D)PHYSICS
07. Thermodynamics

Temperature of given mass of a gas is changed from 150°C to 300°C during an isobaric process, v...

CORE CONCEPT & DERIVATION

According to Charles's law, the volume of a fixed mass of gas at constant pressure is directly proportional to its absolute thermodynamic temperature in kelvins.

Formula / Rule / Reaction:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \implies V_2 = V_1 \left(\frac{T_2}{T_1} \right)$$

Solution:

- Convert Celsius temperatures to thermodynamic kelvin temperatures:

$$T_1 = 150 + 273 = 423 \text{ K}, \quad T_2 = 300 + 273 = 573 \text{ K}$$

- Calculate the volume ratio:

$$\frac{V_2}{V_1} = \frac{573}{423} \approx 1.35$$

- Because 1.35 is less than 2, the volume increases, but becomes less than double.

Why other options are incorrect:

- Option A:** The gas expands upon heating; its volume cannot halve.
- Option B:** Doubling would occur if absolute temperature doubled (e.g., from 300 K to 600 K); doubling the Celsius value does not double the kelvin value.
- Option C:** Thermal expansion causes volume to change when temperature increases at constant pressure.

Question #147 Key: (B)PHYSICS
08. Electrostatics

A capacitor is charged with a battery and energy stored is u . After disconnecting battery another...

CORE CONCEPT & DERIVATION

When a charged capacitor is connected in parallel to an uncharged capacitor of equal capacitance, the initial charge divides equally, altering the stored electrostatic energy.

Formula / Rule / Reaction:

$$U = \frac{Q^2}{2C}, \quad U' = \frac{q^2}{2C}$$

Solution:

- The initial capacitor stores charge Q with energy $U = \frac{Q^2}{2C}$.
- Upon connecting an identical uncharged capacitor in parallel, the total charge Q distributes equally: $q = Q/2$ on each capacitor.
- The energy in each capacitor becomes:

$$U' = \frac{(Q/2)^2}{2C} = \frac{Q^2}{4(2C)} = \frac{U}{4}$$

Why other options are incorrect:

- Option A:** $U/2$ represents the total energy remaining in both capacitors combined, not the energy stored in each individual capacitor.
- Option C:** Stored energy decreases due to dissipative Joule heating during charge redistribution; it cannot quadruple.
- Option D:** Passive redistribution without a power supply cannot increase stored energy.

Question #148 Key: (C)PHYSICS
08. Electrostatics

What is the potential difference between two points in an electric field if it takes 600 J of energy...

CORE CONCEPT & DERIVATION

Electric potential difference is defined as the work required per unit positive charge to move a charge between two points in an electrostatic field.

Formula / Rule / Reaction:

$$\Delta V = \frac{W}{q}$$

Solution:

- Given work $W = 600$ J and charge $q = 2$ C:
- $$\Delta V = \frac{600 \text{ J}}{2 \text{ C}} = 300 \text{ J/C} = 300 \text{ V}$$

Why other options are incorrect:

- Option A:** 1200 J results from multiplying work by charge rather than dividing.
- Option B:** 800 J is an incorrect arithmetic distractor.
- Option D:** 0 J would indicate that the two points reside on the same equipotential surface.

Question #149 Key: (D)PHYSICS
08. Electrostatics*Gauss law cannot be used to find which of the following quantity?***CORE CONCEPT & DERIVATION**

Gauss's law calculates enclosed charge, electric flux, or electric field intensity around symmetric charge distributions, but treats permittivity as an intrinsic constant.

Formula / Rule / Reaction:

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enclosed}}}{\epsilon_0}$$

Solution:

- Gauss's law relates field flux to enclosed charge.
- Permittivity (ϵ) is a constitutive property of the medium that must be known beforehand and cannot be determined through Gauss's law.

Why other options are incorrect:

- **Option A:** Electric field intensity is calculated using Gauss's law for symmetric configurations (spheres, cylinders, planes).
- **Option B:** Electric flux density ($D = \epsilon E$) is determined directly from the enclosed charge distribution.
- **Option C:** Enclosed charge is determined by evaluating total electric flux across a closed Gaussian surface.

Question #150 Key: (C)PHYSICS
08. Electrostatics*Which one of the following statements is true?***CORE CONCEPT & DERIVATION**

Both electrostatic and gravitational forces are fundamental central forces obeying inverse square laws, but electrostatic forces are substantially stronger at the subatomic scale.

Formula / Rule / Reaction:

$$\frac{F_e}{F_g} = \frac{ke^2}{Gm_p m_e} \approx 10^{39}$$

Solution:

- Comparing the electrostatic attraction to the gravitational attraction between an electron and proton reveals that electrostatic force is approximately 10^{39} times stronger.
- Thus, gravitational force is much weaker than electrostatic force.

Why other options are incorrect:

- **Option A:** Both forces strictly obey the inverse-square law ($F \propto 1/r^2$).
- **Option B:** Gravitational force is always attractive, whereas electrostatic force can be attractive or repulsive.
- **Option D:** Both forces obey inverse-square distance relationships.

Question #151 Key: (D)

PHYSICS
08. ElectrostaticsThe coulomb's constant k depends upon:

CORE CONCEPT & DERIVATION

Coulomb's electrostatic proportionality constant k is governed by both the electrical permittivity of the intervening medium and the selected system of physical units.

Formula / Rule / Reaction:

$$k = \frac{1}{4\pi\epsilon} = \frac{1}{4\pi\epsilon_0\epsilon_r}$$

Solution:

- In SI units in a vacuum, $k = \frac{1}{4\pi\epsilon_0} \approx 8.99 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$.
- In Gaussian CGS units, k is set by definition to 1.
- When an insulating dielectric material with relative permittivity ϵ_r is introduced, the value of k decreases by a factor of ϵ_r .
- Therefore, k depends on both the system of units and the nature of the medium.

Why other options are incorrect:

- **Option A:** The medium dictates permittivity, but the numerical magnitude also changes with the measurement unit system.
- **Option B:** Changing units alters the constant, but placing a dielectric in the medium also changes its value.
- **Option C:** The constant k is independent of whether the interacting charges are positive or negative.

Question #152 Key: (A)

PHYSICS
08. Electrostatics

A charged particle is moving in a uniform electric field. For the motion of the particle due to...

CORE CONCEPT & DERIVATION

A uniform electric field exerts an invariant electrostatic force on a charged particle, producing uniform, constant acceleration in accordance with Newton's second law.

Formula / Rule / Reaction:

$$\vec{F} = q\vec{E} = m\vec{a} \implies \vec{a} = \frac{q\vec{E}}{m} = \text{constant}$$

Solution:

- Because the electric field $\vec{E}$ is uniform, both its magnitude and direction are spatially invariant.
- The resulting electrostatic force $q\vec{E}$ is constant in time and space.
- Consequently, the acceleration $\vec{a} = q\vec{E}/m$ remains constant and non-zero.

Why other options are incorrect:

- **Option B:** Displacement changes quadratically with time under constant acceleration ($d = v_0t + \frac{1}{2}at^2$).
- **Option C:** Because acceleration is constant, its time derivative (the jerk) is identically zero.
- **Option D:** Velocity varies continuously with time ($\vec{v} = \vec{v}_0 + \vec{a}t$).

Question #153 Key: (D)PHYSICS
08. Electrostatics

A capacitor of capacitance C has charge Q and stored energy is W . If the charge is increase to ...

CORE CONCEPT & DERIVATION

The electrostatic potential energy stored within a capacitor of fixed capacitance is directly proportional to the square of its accumulated charge.

Formula / Rule / Reaction:

$$W = \frac{Q^2}{2C}$$

Solution:

- When charge increases from Q to $2Q$:

$$W' = \frac{(2Q)^2}{2C} = \frac{4Q^2}{2C} = 4\left(\frac{Q^2}{2C}\right) = 4W$$

- Thus, doubling the stored charge quadruples the total stored energy.

Why other options are incorrect:

- Option A:** $W/4$ would result if the charge were halved rather than doubled.
- Option B:** $W/2$ incorrectly assumes that energy is inversely related to charge.
- Option C:** $2W$ assumes a linear relationship, neglecting the quadratic dependence on charge.

Question #154 Key: (A)PHYSICS
09. Current Electricity

How much potential drop exist across closed switch?

CORE CONCEPT & DERIVATION

An ideal closed switch functions as a zero-resistance electrical short circuit across which no potential difference can develop.

Formula / Rule / Reaction:

$$V = I \times R \quad (\text{where } R_{\text{switch}} = 0 \implies V = 0 \text{ V})$$

Solution:

- When a switch is closed, it connects two points with a path of zero electrical resistance.
- By Ohm's law, the voltage drop across any zero-resistance conductor is zero regardless of current flow.

Why other options are incorrect:

- Option B:** A 1 V potential drop requires a non-zero internal contact resistance.
- Option C:** A 2 V potential drop across a closed switch indicates an anomalous high-resistance fault.
- Option D:** An ideal closed switch does not drop circuit voltage.

Question #155 Key: (B)PHYSICS
09. Current Electricity

A 3 V battery is connected in series with ammeter and 2 ohm resistance after short circuiting. ...

CORE CONCEPT & DERIVATION

In a simple direct-current series circuit, the current measured by an ideal ammeter is determined directly by Ohm's law.

Formula / Rule / Reaction:

$$I = \frac{V}{R}$$

Solution:

- Given supply voltage $V = 3 \text{ V}$ and circuit resistance $R = 2 \Omega$:

$$I = \frac{3 \text{ V}}{2 \Omega} = 1.5 \text{ A}$$

- The ammeter registers a current of 1.5 A.

Why other options are incorrect:

- Option A:** 1 A corresponds to an effective circuit resistance of 3 ohms.
- Option C:** 5 A is an incorrect numerical value.
- Option D:** 6 A results from multiplying voltage by resistance instead of dividing.

Question #156 Key: (D)PHYSICS
09. Current Electricity

The resistance of a conductor does not depend on which of the following?

CORE CONCEPT & DERIVATION

The electrical resistance of a uniform conductor is determined by its geometry (length and cross-sectional area) and the intrinsic resistivity of its material.

Formula / Rule / Reaction:

$$R = \rho \frac{L}{A}$$

Solution:

- Resistance is directly proportional to length L and resistivity ρ , and inversely proportional to cross-sectional area A .
- Total mass does not directly enter the fundamental constitutive resistance equation.

Why other options are incorrect:

- Option A:** Resistance depends inversely on the cross-sectional area A .
- Option B:** Resistance depends directly on material resistivity ρ .
- Option C:** Resistance depends directly on the length L of the conductor.

Question #157 Key: (C)PHYSICS
09. Current Electricity

Which of the following statement is NOT CORRECT about Kirchhoff's rule?

CORE CONCEPT & DERIVATION

Kirchhoff's laws are steady-state circuit laws formulated for direct-current (DC) networks and lumped parameter systems, rather than high-frequency AC circuits.

Formula / Rule / Reaction:

$$\sum I = 0 \quad (\text{KCL}), \quad \sum V = 0 \quad (\text{KVL})$$

Solution:

- Kirchhoff's current law represents conservation of electric charge, and Kirchhoff's voltage law represents conservation of energy.
- These rules are most directly applied to DC circuits; at high AC frequencies, time-varying magnetic flux and radiation effects require Maxwell's field equations.
- Therefore, stating that Kirchhoff's rules are 'more suitable in AC circuits' is incorrect.

Why other options are incorrect:

- **Option A:** Kirchhoff's junction rule is a direct statement of conservation of electric charge.
- **Option B:** The Wheatstone bridge balance condition is derived using Kirchhoff's rules.
- **Option D:** Kirchhoff's loop rule is an application of conservation of energy around a closed path.

Question #158 Key: (B)PHYSICS
09. Current Electricity

What do the substances whose resistance decreases with increase in temperature have?

CORE CONCEPT & DERIVATION

Materials in which thermal excitation releases additional charge carriers to lower bulk resistance possess a negative temperature coefficient of resistance.

Formula / Rule / Reaction:

$$\alpha = \frac{R_T - R_0}{R_0 \Delta T} < 0$$

Solution:

- In semiconductors and electrolytes, higher temperature provides thermal energy that breaks covalent bonds, freeing electrons and holes.
- This increase in charge carrier density outweighs lattice scattering, decreasing resistance and yielding a negative temperature coefficient (NTC).

Why other options are incorrect:

- **Option A:** A high temperature coefficient could be positive or negative; the algebraic sign is the critical property.
- **Option C:** A positive temperature coefficient indicates that resistance increases as temperature increases, as seen in typical metals.
- **Option D:** A zero temperature coefficient indicates that resistance remains invariant with changing temperature.

Question #159 Key: (A)PHYSICS
09. Current Electricity

A low voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5 ohms is used to s...

CORE CONCEPT & DERIVATION

The electrical power delivered to an external load resistor by a real voltage source depends on the loop current established through both the load and internal resistance.

Formula / Rule / Reaction:

$$I = \frac{E}{R + r}, \quad P_{\text{load}} = I^2 R$$

Solution:

- Total series resistance in the circuit:

$$R_{\text{total}} = R + r = 6.5 \, \Omega + 1.5 \, \Omega = 8.0 \, \Omega$$

- Circuit current:

$$I = \frac{20 \, \text{V}}{8.0 \, \Omega} = 2.5 \, \text{A}$$

- Power dissipated in the heater load (supplied to the water):

$$P = I^2 R = (2.5 \, \text{A})^2 \times 6.5 \, \Omega = 6.25 \times 6.5 = 40.625 \, \text{W} \approx 41 \, \text{W}$$

Why other options are incorrect:

- **Option B:** 50 W is the total power generated by the source ($E \times I = 20 \times 2.5$), not the power delivered to the water.
- **Option C:** 53 W results from neglecting internal resistance and calculating V^2/R_{heater} .
- **Option D:** 62 W is an incorrect arithmetic distractor.

Question #160 Key: (B)PHYSICS
10. Electromagnetism

Electric forces change the magnitude and direction of velocity while magnetic forces change _____

CORE CONCEPT & DERIVATION

The magnetic Lorentz force acts perpendicular to the instantaneous velocity of a charged particle, doing zero work and altering only the direction of motion.

Formula / Rule / Reaction:

$$\vec{F}_B = q(\vec{v} \times \vec{B}) \implies \vec{F}_B \cdot \vec{v} = 0 \implies P = \frac{dK}{dt} = 0$$

Solution:

- Because the magnetic force vector is perpendicular to the velocity vector at all times, it does no work on the particle.
- With zero work done, the particle's kinetic energy and speed (magnitude of velocity) remain constant.
- The force serves exclusively as a centripetal force, changing only the direction of the velocity vector.

Why other options are incorrect:

- **Option A:** The magnetic force cannot alter the magnitude of velocity because it performs zero work.
- **Option C:** Only electric fields can change both magnitude and direction; magnetic fields alter direction only.
- **Option D:** The magnetic force accelerates the particle centripetally, deflecting its direction of motion.

Question #161 Key: (D)PHYSICS
10. Electromagnetism

Which surface has greater magnetic flux in same magnetic field, each has an area 1 m^2 .

CORE CONCEPT & DERIVATION

Magnetic flux across a planar surface is defined as the surface integral of the normal magnetic field component over total area, independent of the perimeter geometry.

Formula / Rule / Reaction:

$$\Phi_B = \vec{B} \cdot \vec{A} = BA \cos \theta$$

Solution:

- Magnetic flux depends only on magnetic field strength B , surface area A , and orientation angle θ .
- Given equal area (1 m^2) and identical magnetic field conditions, the shape of the perimeter (circle, square, or rectangle) does not affect the total flux.

Why other options are incorrect:

- **Option A:** A circular geometry maximizes area for a fixed perimeter, but for a given constant area, it carries the same flux as any other shape.
- **Option B:** A rectangular shape of 1 m^2 area intercepts the same total magnetic flux.
- **Option C:** A square surface with equal area intercepts the identical flux.

Question #162 Key: (D)PHYSICS
11. Electromagnetic Induction

The source of magnetic field is:

CORE CONCEPT & DERIVATION

Magnetic fields are generated by moving electric charges, electric currents, or current-carrying conductor loops as described by Ampère's law and the Biot-Savart law.

Formula / Rule / Reaction:

$$\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{\text{enclosed}}$$

Solution:

- Moving electric charges constitute an electric current.
- A closed loop of current produces a magnetic dipole field matching that of a magnetic doublet, acting as a source of magnetism.

Why other options are incorrect:

- **Option A:** Isolated magnetic monopoles do not exist in nature; Gauss's law for magnetism states that $\nabla \cdot \vec{B} = 0$.
- **Option B:** Stationary electric charges produce only electrostatic fields, not magnetic fields.
- **Option C:** Non-magnetic substances lack aligned atomic magnetic moments and do not generate magnetic fields.

Question #163 Key: (B)PHYSICS
11. Electromagnetic Induction

One meter long copper rod is moving with speed 20 m/sec in the magnetic field of strength 0.6 T...

CORE CONCEPT & DERIVATION

Motional electromotive force induced across a straight conductor moving perpendicular to a uniform magnetic field is the product of field strength, velocity, and length.

Formula / Rule / Reaction:

$$E = vBL \sin \theta \quad (\text{where } \theta = 90^\circ)$$

Solution:

- Given velocity $v = 20$ m/s, magnetic field $B = 0.6$ T, and length $L = 1$ m:

$$E = 20 \times 0.6 \times 1 = 12 \text{ V}$$

Why other options are incorrect:

- Option A:** 10 V results from an arithmetic error in multiplying field and velocity.
- Option C:** 14 V does not match the product of the given parameters.
- Option D:** 16 V is an incorrect value.

Question #164 Key: (C)PHYSICS
11. Electromagnetic Induction

The unit of $\Delta\Phi/\Delta t$ can be written as?

CORE CONCEPT & DERIVATION

By Faraday's law of induction, the time rate of change of magnetic flux equals induced electromotive force in volts, which can be decomposed into base SI units.

Formula / Rule / Reaction:

$$\frac{\Delta\Phi}{\Delta t} = \text{Volt} = \frac{\text{Joule}}{\text{Coulomb}} = \frac{\text{N} \cdot \text{m}}{\text{A} \cdot \text{s}} = \text{N} \cdot \text{m} \cdot \text{A}^{-1} \cdot \text{s}^{-1}$$

Solution:

- Magnetic flux Φ has units of webers (Wb), where $1 \text{ Wb} = 1 \text{ V} \cdot \text{s} = 1 \text{ J/A} = 1 \text{ N} \cdot \text{m/A}$.

- Dividing flux by time in seconds gives:

$$\frac{\text{N} \cdot \text{m/A}}{\text{s}} = \text{N} \cdot \text{m} \cdot \text{A}^{-1} \cdot \text{s}^{-1}$$

Why other options are incorrect:

- Option A:** Contains an incorrect exponent of -2 on amperes.
- Option B:** Shows amperes in the numerator instead of the denominator.
- Option D:** Has an incorrect positive exponent on seconds.

Question #165 Key: (D)PHYSICS
11. Electromagnetic Induction*Working principal of magnetic levitation train is according to?***CORE CONCEPT & DERIVATION**

Electrodynamic suspension (EDS) in maglev trains uses eddy currents induced in guideway tracks that produce repulsive opposing magnetic fields in accordance with Lenz's law.

Formula / Rule / Reaction:

$$E = -\frac{d\Phi_B}{dt} \quad (\text{Lenz's law: opposition to motion/change})$$

Solution:

- Superconducting magnets on the moving train induce eddy currents in guideway conductors.
- By Lenz's law, these induced currents generate opposing magnetic poles that repel the train's magnets, creating stable levitation.

Why other options are incorrect:

- **Option A:** Faraday's law defines the magnitude of induced emf, but Lenz's law specifies the opposing polarity responsible for repulsive levitation.
- **Option B:** Planck's law governs quantum black-body radiation ($E = h\nu$).
- **Option C:** Ohm's law relates current, voltage, and resistance in dissipative conductors.

Question #166 Key: (B)PHYSICS
11. Electromagnetic Induction*A copper hoop is held in a vertical east-west plane in a uniform magnetic field whose field line...***CORE CONCEPT & DERIVATION**

Electromagnetic induction requires a time-varying magnetic flux across the loop area; rotating about an axis perpendicular to the field lines maximizes the rate of change of flux.

Formula / Rule / Reaction:

$$\Phi(t) = BA \cos(\omega t) \implies E(t) = -\frac{d\Phi}{dt} = BA\omega \sin(\omega t)$$

Solution:

- The magnetic field runs along the north-south axis, perpendicular to the east-west plane of the hoop, producing maximum initial flux.
- Rotating the hoop about its east-west axis changes the angle between the normal vector and field lines at maximum rate, generating the largest induced emf.

Why other options are incorrect:

- **Option A:** Rotating about a north-south axis keeps the area normal perpendicular to the field, causing zero net flux variation.
- **Option C:** Translating the hoop without rotation through a uniform magnetic field does not change intercepted flux, producing zero net emf.
- **Option D:** Linear translation without reorientation in a uniform field induces no net circulatory emf.

Question #167 Key: (B)PHYSICS
11. Electromagnetic Induction

In transformer, there is no _____ connection between the two coils but they are linked?

CORE CONCEPT & DERIVATION

A conventional transformer provides galvanic electrical isolation between primary and secondary windings, transferring power exclusively via mutual magnetic flux linkage.

Formula / Rule / Reaction:

$$E_s = -M \frac{dI_p}{dt}$$

Solution:

- The primary and secondary coils are wound on a common high-permeability ferromagnetic core without direct physical contact.
- Alternating current in the primary coil generates an alternating magnetic flux in the core, inducing voltage across the secondary coil through mutual magnetic induction.

Why other options are incorrect:

- **Option A:** Inverts the relationship; transformers possess strong magnetic coupling with zero direct electrical contact.
- **Option C:** Primary and secondary windings are linked magnetically, but lack direct conductive contact.
- **Option D:** Transformers utilize magnetic induction rather than optical signal couplers.

Question #168 Key: (D)PHYSICS
13. Electronics

When the temperature of semiconductor suddenly drops to zero kelvin, then a semiconductor acts a...

CORE CONCEPT & DERIVATION

At absolute zero, intrinsic semiconductors lack the thermal energy needed to promote valence electrons across the forbidden bandgap into the conduction band.

Formula / Rule / Reaction:

$$n_i \propto T^{3/2} \exp\left(-\frac{E_g}{2k_B T}\right) \xrightarrow{T \rightarrow 0 \text{ K}} n_i = 0$$

Solution:

- Electrical conduction requires mobile charge carriers in the conduction band.
- At 0 K, all electrons remain in the valence band, leaving the conduction band empty and turning the semiconductor into an ideal insulator.

Why other options are incorrect:

- **Option A:** Conduction requires mobile charge carriers, which are absent at 0 K.
- **Option B:** Semiconduction requires finite conductivity, which drops to zero at absolute zero.
- **Option C:** Superconductivity is a specific quantum phenomenon observed in certain materials, not a property of zero-kelvin semiconductors.

Question #169 Key: (D)PHYSICS
14. Dawn of Modern Physics

If electron, proton, neutron, and alpha particle have same velocity which of them have shortest...

CORE CONCEPT & DERIVATION

The de Broglie matter wavelength is inversely proportional to momentum; at constant velocity, wavelength is inversely proportional to particle mass.

Formula / Rule / Reaction:

$$\lambda = \frac{h}{p} = \frac{h}{mv} \implies \lambda \propto \frac{1}{m} \quad (\text{for constant } v)$$

Solution:

- The masses of the particles compare as follows:

$$m_e \ll m_p \approx m_n \ll m_\alpha \approx 4m_p$$

- Because the alpha particle has the greatest mass, it possesses the largest momentum at equal velocity.
- Consequently, it exhibits the shortest de Broglie wavelength.

Why other options are incorrect:

- Option A:** The electron has the smallest mass, resulting in the longest de Broglie wavelength.
- Option B:** Protons have roughly one-fourth the mass of an alpha particle, giving them a longer wavelength.
- Option C:** Neutrons are comparable in mass to protons, with longer wavelengths than alpha particles.

Question #170 Key: (B)PHYSICS
14. Dawn of Modern Physics

The process of ejection of loosely bound electrons from a certain photo sensitive surface by ab...

CORE CONCEPT & DERIVATION

The emission of electrons from a material when irradiated with electromagnetic radiation of frequency above a characteristic threshold is known as the photoelectric effect.

Formula / Rule / Reaction:

$$h\nu = \Phi + K_{\max} = h\nu_0 + \frac{1}{2}mv_{\max}^2$$

Solution:

- An incident photon transfers its entire quantum of energy to an electron within the photosensitive material.
- If this energy exceeds the surface work function (Φ), the electron is liberated as a photoelectron.

Why other options are incorrect:

- Option A:** The Compton effect involves the inelastic scattering of high-energy X-ray or gamma photons by loosely bound electrons, producing a shifted scattered photon.
- Option C:** Pair production is the creation of an electron-positron pair from a high-energy photon near an atomic nucleus.
- Option D:** Black body radiation is thermal electromagnetic radiation emitted by an idealized non-reflecting absorber in thermodynamic equilibrium.

Question #171 Key: (D)PHYSICS
14. Dawn of Modern Physics*In a photoelectric effect experiment, the stopping potential is:***CORE CONCEPT & DERIVATION**

The stopping potential is the negative retarding electric potential applied between collector and emitter electrodes that completely halts the photocurrent.

Formula / Rule / Reaction:

$$eV_0 = K_{\max}$$

Solution:

- As the collector electrode is made negative relative to the emitter, emitted photoelectrons are repelled.
- At the stopping potential V_0 , even the fastest photoelectrons with maximum kinetic energy are turned back.
- At this potential, the measured photocurrent drops to zero.

Why other options are incorrect:

- **Option A:** Stopping potential is an electric potential (measured in volts), not kinetic energy (measured in joules or eV).
- **Option B:** Stopping potential is an applied retarding voltage rather than the potential energy of an electron.
- **Option C:** Photon energy ($h\nu$) is larger than eV_0 by the material's work function (Φ).

Question #172 Key: (D)PHYSICS
15. Atomic Spectra*The line spectrum of hydrogen atom contains the spectral lines in the region of:***CORE CONCEPT & DERIVATION**

The emission spectrum of atomic hydrogen consists of discrete spectral series spanning the ultraviolet, visible, and infrared regions.

Formula / Rule / Reaction:

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

Solution:

- Lyman series ($n_1 = 1$) transitions fall in the ultraviolet region.
- Balmer series ($n_1 = 2$) transitions fall in the visible and near-UV spectrum.
- Paschen ($n_1 = 3$), Brackett ($n_1 = 4$), and Pfund ($n_1 = 5$) series fall in the infrared spectrum.
- Thus, hydrogen spectral lines appear across all three electromagnetic regions.

Why other options are incorrect:

- **Option A:** Ultraviolet includes only the Lyman series, omitting the Balmer and Paschen series.
- **Option B:** Infrared includes only higher series, omitting the visible and UV transitions.
- **Option C:** Visible includes only the Balmer series.

Question #173 Key: (A)

PHYSICS
15. Atomic Spectra

The speed of electron in the first Bohr orbit is:

CORE CONCEPT & DERIVATION

In Bohr's atomic model, orbital speed in the principal quantum orbit n is determined by quantization of angular momentum combined with electrostatic centripetal equilibrium.

Formula / Rule / Reaction:

$$v_n = \frac{e^2}{2\epsilon_0 n h} = \frac{c}{137n}$$

Solution:

- In the ground state ($n = 1$):

$$v_1 = \frac{3.00 \times 10^8 \text{ m/s}}{137} \approx 2.19 \times 10^6 \text{ m/s}$$

- Thus, the orbital speed of the electron in the first Bohr orbit is approximately $2.19 \times 10^6 \text{ m/s}$.

Why other options are incorrect:

- Option B:** $2.19 \times 10^{-6} \text{ m/s}$ introduces an unphysical negative exponent.
- Option C:** $2.19 \times 10^4 \text{ m/s}$ is roughly two orders of magnitude too slow.
- Option D:** $2.19 \times 10^{-4} \text{ m/s}$ is an incorrect value.

Question #174 Key: (B)

PHYSICS
16. Nuclear Physics

A low energy neutron has RBE factor of 10. How much energy is absorbed by a man of mass 80 Kg i...

CORE CONCEPT & DERIVATION

Equivalent radiation dose is the product of absorbed physical dose and the relative biological effectiveness (RBE) factor, with 1 rem equivalent to 0.01 J/kg.

Formula / Rule / Reaction:

$$\text{Absorbed Dose } (D) = \frac{\text{Equivalent Dose } (D_e)}{\text{RBE}}, \quad E_{\text{absorbed}} = D \times m$$

Solution:

- Calculate absorbed dose in rad/rem units:

$$D = \frac{400 \text{ rem}}{10} = 40 \text{ rad}$$

- Convert to SI absorbed dose (1 rad = 0.01 Gy = 0.01 J/kg):

$$D = 40 \times 0.01 \text{ J/kg} = 0.40 \text{ J/kg}$$

- Total absorbed energy across an 80 kg body:

$$E = 0.40 \text{ J/kg} \times 80 \text{ kg} = 32 \text{ J}$$

Why other options are incorrect:

- Option A:** 16 J results from using an incorrect mass of 40 kg.
- Option C:** 48 J is an erroneous arithmetic distractor.
- Option D:** 64 J doubles the absorbed physical energy.

Question #175 Key: (B)PHYSICS
16. Nuclear Physics

It has been observed that Thorium (${}_{90}^{234}\text{Th}$) is transformed into Protactinium (${}_{91}^{234}\text{Pa}$) after ...

CORE CONCEPT & DERIVATION

Beta-minus decay involves the conversion of a nuclear neutron into a proton, emitting an electron (beta particle) and an antineutrino.

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

- The mass number A remains unchanged at 234.
- The atomic number Z increases by 1 (from 90 to 91).
- This nuclear signature corresponds uniquely to beta-minus (β^-) emission.

Why other options are incorrect:

- **Option A:** Alpha decay decreases atomic number by 2 and mass number by 4.
- **Option C:** Gamma emission is isomeric de-excitation with no change in atomic or mass number.
- **Option D:** Simultaneous emission of all three particles does not produce this single-step transformation.

Question #176 Key: (C)PHYSICS
16. Nuclear Physics

The half-life of Strontium (Sr) is 8.70 hours. Its decay constant is:

CORE CONCEPT & DERIVATION

The radioactive decay constant λ is inversely proportional to half-life, calculated via the natural logarithm of 2.

Formula / Rule / Reaction:

$$\lambda = \frac{\ln(2)}{T_{1/2}} = \frac{0.693}{T_{1/2}}$$

Solution:

- Convert half-life from hours into seconds:
 $T_{1/2} = 8.70 \text{ h} \times 3600 \text{ s/h} = 31320 \text{ s}$
- Calculate the decay constant:
 $\lambda = \frac{0.693}{31320 \text{ s}} \approx 2.21 \times 10^{-5} \text{ s}^{-1} = 0.000022 \text{ s}^{-1}$

Why other options are incorrect:

- **Option A:** Carries units of seconds (s) instead of reciprocal seconds (s^{-1}).
- **Option B:** Inverts the formula, calculating reciprocal decay rate.
- **Option D:** 0.000032 is an incorrect numerical calculation.

Question #177 Key: (A)ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

Synonym of the word "Capricious" is:

CORE CONCEPT & DERIVATION

'Capricious' describes sudden, unaccountable changes of mood or behavior; its primary synonym is 'fickle'.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- 'Capricious' indicates inconstancy, erratic impulsiveness, or unpredictable behavior.
- 'Fickle' shares this meaning, describing shifting allegiances or changing loyalties.

Why other options are incorrect:

- **Option B:** 'Predictable' means expected or consistent, serving as an antonym.
- **Option C:** 'Uniform' means regular and unchanging, opposing capricious.
- **Option D:** 'Invariable' means constant and immutable, acting as an antonym.

Question #178 **Key: (C)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

Which of the following words will fill in the blank most appropriately? Diseases like diabetes ...

CORE CONCEPT & DERIVATION

Contextual vocabulary requires selecting an adjective that accurately characterizes the life-threatening consequences of unmanaged medical pathology.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The sentence emphasizes the necessity of managing diabetes to avoid life-threatening outcomes.
- 'Fatal' means capable of causing death, which logically completes the conditional warning.

Why other options are incorrect:

- **Option A:** 'Cursing' is semantically inappropriate for describing physiological disease progression.
- **Option B:** 'Healthy' contradicts the medical warning expressed in the sentence.
- **Option D:** 'Impersonating' means assuming another identity, which is nonsensical in this medical context.

Question #180 **Key: (A)**ENGLISH
05. Active-Passive Voice, Reported Speech & Syntax

Fill in the blank with the correct word. The shepherd ploughed this mountain with cattle the fi...

CORE CONCEPT & DERIVATION

In standard literary past narratives describing historical events, simple past passive ('was ploughed') is used.

Formula / Rule / Reaction:

Subject + was/were + Past Participle (Simple Past Passive)

Solution:

- The action occurred as a completed historical event in the past.
- The construction requires the passive voice: 'the first time it was ever ploughed'.

Why other options are incorrect:

- **Option B:** 'Was been' is an ungrammatical verb combination.
- **Option C:** 'Had' lacks the auxiliary passive participle 'been' required for a passive construction.
- **Option D:** 'Had been' is unnecessary here because the narrative establishes simple historical past rather than past anteriority.

Question #179 **Key: (D)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

Choose the most appropriate antonym for "abandonment":

CORE CONCEPT & DERIVATION

'Abandonment' refers to withdrawing support, stopping, or deserting an action, whereas 'extension' involves prolonging or continuing it.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- 'Abandonment' means terminating or relinquishing an undertaking.
- 'Extension' means continuing, lengthening, or sustaining an undertaking, providing a direct contextual antonym.

Why other options are incorrect:

- **Option A:** 'Cessation' means ending or terminating, acting as a synonym for abandonment.
- **Option B:** 'Stoppage' means halting, aligning in meaning with abandonment.
- **Option C:** 'Halt' denotes an interruption or termination, synonymous with stopping.

Question #181 **Key: (B)**ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

To give one some idea of rabies' horrors, one _____ only read such descriptions as the follo...

CORE CONCEPT & DERIVATION

When used as a semi-modal auxiliary verb followed by a bare infinitive without 'to', 'need' takes an invariable base form without third-person '-s'.

Formula / Rule / Reaction:

Subject + need + only + Bare Infinitive

Solution:

- In the formal quasi-modal construction 'one need only read', 'need' functions as an auxiliary verb.
- It does not take the third-person singular suffix '-s' and is followed directly by the bare infinitive 'read'.

Why other options are incorrect:

- **Option A:** 'Needs' is the full lexical verb form, which would require a full infinitive with 'to' ('needs only to read').
- **Option C:** 'Needed' introduces an unnecessary past tense into a present expository statement.
- **Option D:** 'Has needed' is a present perfect form that does not fit this semi-modal idiom.

Question #182 **Key: (D)**ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

By 2030, people _____ been reading the works of Charles Dickens for more than 190 years.

CORE CONCEPT & DERIVATION

An action that began in the past and continues up to a specified future reference point ('By 2030') requires the future perfect continuous tense.

Formula / Rule / Reaction:

By [Future Time] + Subject + will have been + Verb-ing

Solution:

- The temporal marker 'By 2030' establishes a future milestone.
- Coupled with the duration 'for more than 190 years', the future perfect continuous tense 'will have been reading' is required.

Why other options are incorrect:

- **Option A:** 'Had' indicates past perfect, which contradicts the future reference point 'By 2030'.
- **Option B:** 'Will been' is ungrammatical without the auxiliary 'have'.
- **Option C:** 'Have' indicates present perfect, which cannot be governed by the future prepositional phrase 'By 2030'.

Question #183 **Key: (C)**ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals

Choose the most suitable or appropriate sentence out of the following:

CORE CONCEPT & DERIVATION

The causative verb 'let' is followed by a direct object and a bare infinitive without 'to'.

Formula / Rule / Reaction:

Subject + let + Object + Bare Infinitive (without 'to')

Solution:

- Causative 'let' requires the bare infinitive 'get', making 'Penny did not let me get my book' grammatically correct.

Why other options are incorrect:

- **Option A:** Using the full infinitive 'to get' violates the bare infinitive rule for causative 'let'.
- **Option B:** 'Leaving me to get' distorts the intended meaning of permission or prevention.
- **Option D:** 'Left me get' combines the verb 'leave' with a bare infinitive, which is ungrammatical.

Question #184 Key: (D)

06. Punctuation, Capitalization & Reading Comprehension

ENGLISH

Which one of the following is correct?

CORE CONCEPT & DERIVATION

Geographical names comprising a city and country/territory require a comma between the city and territory, while direct objects must not be separated from verbs by rogue punctuation.

Formula / Rule / Reaction:

Subject + Verb + [City, Country] + and + [City, Country]

Solution:

- A comma correctly separates the city 'Istanbul' from its country 'Turkey', and 'Kowloon' from its region 'Hong Kong'.
- The coordinate conjunction 'and' joins the two destination phrases without unnecessary commas or colons interrupting the verb 'visited'.

Why other options are incorrect:

- **Option A:** Erroneously places a comma immediately after the transitive verb 'visited'.
- **Option B:** Uses an incorrect colon between the transitive verb 'visited' and its direct object.
- **Option C:** Omits the coordinating conjunction 'and' between the two paired geographical destinations.

Question #185 Key: (B)

05. Active-Passive Voice, Reported Speech & Syntax

ENGLISH

Which of the following sentences is correct?

CORE CONCEPT & DERIVATION

Standard English orthography requires the correct spelling of the verb 'persuade'.

Formula / Rule / Reaction:

Correct Orthography: P - E - R - S - U - A - D - E

Solution:

- The verb meaning to induce someone to do something through reasoning or argument is spelled 'persuade'.
- Sentence B contains this spelling and correct question punctuation.

Why other options are incorrect:

- **Option A:** 'Perswad' is an incorrect phonetic spelling.
- **Option C:** 'Persuad' omits the terminal silent 'e'.
- **Option D:** 'Parsuade' incorrectly uses 'a' in the first syllable.

Question #186 Key: (B)

03. Parts of Speech, Prepositions & Modifiers

ENGLISH

Choose the sentence with the correct use of the article.

CORE CONCEPT & DERIVATION

In standard English grammar, the definite article 'the' is used before names of musical instruments when referring to the skill or ability to play them.

Formula / Rule / Reaction:

play + the + [Musical Instrument]

Solution:

- When discussing musical performance ability, the definite article 'the' precedes each instrument.
- Therefore, 'play the piano and the violin' is grammatically correct.

Why other options are incorrect:

- **Option A:** Using indefinite articles ('a piano') refers to physical objects rather than the musical skill.
- **Option C:** Uses mismatched articles ('the piano' and 'a violin'), violating parallel structure.
- **Option D:** Omitting articles entirely is informal and non-standard in traditional British English grammar.

Question #187 Key: (B)

03. Parts of Speech, Prepositions & Modifiers

ENGLISH

Choose the correct preposition. Distribute the handouts _____ the candidates.

CORE CONCEPT & DERIVATION

The preposition 'among' is used when distributing or dividing items within a collective group of three or more individuals.

Formula / Rule / Reaction:

Distribute + [Items] + among + [Plural Group ≥ 3]

Solution:

- Because 'the candidates' represents an unspecified group of three or more people, 'among' is the appropriate preposition.

Why other options are incorrect:

- **Option A:** 'Into' indicates movement to an interior space, which is semantically incorrect here.
- **Option C:** 'In' indicates location within boundaries rather than distribution to multiple recipients.
- **Option D:** 'On' denotes surface placement and does not express distribution.

Question #188 Key: (A)ENGLISH
06. Punctuation, Capitalization & Reading Comprehension

Choose the correct sentence:

CORE CONCEPT & DERIVATION

Pluralia tantum nouns (such as 'scissors') exist only in plural form and require plural demonstrative adjectives and plural verbs.

Formula / Rule / Reaction:

Plural Demonstrative ('These') + Plural Noun ('scissors') + Plural Verb ('are')

Solution:

- 'Scissors' is an inherently plural noun referring to a tool with two blades.
- It requires the plural demonstrative 'These' and the plural verb 'are'.

Why other options are incorrect:

- Option B:** Combines a singular demonstrative ('This') and singular verb ('is') with a plural noun.
- Option C:** 'Scissor' in the singular is non-standard English for the cutting tool.
- Option D:** 'Scissor' lacks the required plural ending '-s'.

Question #189 Key: (A)ENGLISH
05. Active-Passive Voice, Reported Speech & Syntax

Identify the sentence, out of the following, that is error-free:

CORE CONCEPT & DERIVATION

The verb 'enjoy' takes a gerund complement; when the subject is the recipient of the action, the passive gerund 'being + past participle' with its dependent preposition 'at' is required.

Formula / Rule / Reaction:

Subject + enjoy + being + Past Participle + at + by + Agent

Solution:

- The speaker is the target of other people's ridicule, requiring the passive gerund 'being laughed at'.
- Sentence A correctly includes the required preposition 'at' and the passive auxiliary 'being'.

Why other options are incorrect:

- Option B:** 'Laughing by other people' distorts the meaning and uses incorrect active phrasing.
- Option C:** Active 'laughing' fails to express that the speaker is the object of the laughter.
- Option D:** 'Do not enjoying' incorrectly pairs an auxiliary with a present participle, and omits the preposition 'by'.

Question #190 Key: (A)ENGLISH
05. Active-Passive Voice, Reported Speech & Syntax

Choose the sentence that is grammatically correct.

CORE CONCEPT & DERIVATION

Participle adjectives ending in '-ing' describe the entity that causes an effect, while adjectives ending in '-ed' describe the person experiencing the feeling.

Formula / Rule / Reaction:

Thing causing boredom = boring, Person feeling boredom = bored

Solution:

- The play causes the feeling, so it is 'boring'.
- The spectators experience the feeling, so they are 'bored'.

Why other options are incorrect:

- Option B:** Inverts the participles, implying the play experienced boredom while the people caused it.
- Option C:** Uses the bare noun/verb 'bore' and the plural noun 'bores' instead of adjectives.
- Option D:** Contains typographical corruptions ('rath bores') and ungrammatical phrasing.

Question #191 Key: (B)ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling

The most appropriate word to be filled in here is: I decided to sell the piece of land when I w...

CORE CONCEPT & DERIVATION

In financial transactions, 'realistic' is the standard adjective describing a practical price that reflects fair market value.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- A 'realistic price' describes an offer that is fair, practical, and aligned with market conditions.
- It appropriately completes the comparative construction 'more realistic price'.

Why other options are incorrect:

- Option A:** 'True' is rarely used in standard English to describe financial offers in comparative constructions.
- Option C:** 'Exact' refers to mathematical precision rather than fair commercial value.
- Option D:** 'Perfect' is an absolute adjective that does not take the comparative modifier 'more'.

Question #192 **Key: (B)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling*"To cut off the head", this idiom means:***CORE CONCEPT & DERIVATION**

The precise English verb meaning to cut off or sever the head of a person or animal is 'decapitate'.

Formula / Rule / Reaction:

Latin: de-(off/from) + caput(head) → Decapitate

Solution:

- 'Decapitate' means to execute or kill by beheading (cutting off the head).

Why other options are incorrect:

- **Option A:** 'Defrock' means to deprive a priest of ecclesiastical status.
- **Option C:** 'Impaled' means pierced through with a sharp wooden or metal stake.
- **Option D:** 'Urbanite' refers to a person who lives in a city or town.

Question #193 **Key: (A)**ENGLISH
01. Vocabulary, Synonyms, Antonyms & Spelling*Wasim was so good at Mathematics that people considered him to be a _____. Fill in the blank ...***CORE CONCEPT & DERIVATION**

A person, especially a child, endowed with exceptional talent or precocious intelligence in a specific field is defined as a 'prodigy'.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The context describes exceptional mathematical talent.
- A 'prodigy' is an individual who demonstrates early, innate expertise in a domain like mathematics or music.

Why other options are incorrect:

- **Option B:** 'Prodigal' means wasteful or recklessly extravagant.
- **Option C:** 'Primeval' means belonging to the earliest ages of the world; ancient or prehistoric.
- **Option D:** 'Profligate' means recklessly extravagant or wasteful in resource use.

Question #194 **Key: (D)**ENGLISH
04. Subject-Verb Agreement, Tenses & Conditionals*The newly elected president and CEO for the newly established branch of our company _____ar...***CORE CONCEPT & DERIVATION**

When two singular titles joined by 'and' are preceded by a single definite article ('The'), they refer to one person holding both roles, requiring a singular verb.

Formula / Rule / Reaction:

The + [Noun₁] + and + [Noun₂] ⇒ Single Person (Singular Verb)

Solution:

- The presence of a single article 'The' preceding 'newly elected president and CEO' indicates that both titles belong to one person.
- Because the subject is singular, the singular auxiliary verb 'has' is required.

Why other options are incorrect:

- **Option A:** 'Have' is a plural auxiliary verb, which would apply only if two separate people were specified ('The president and the CEO').
- **Option B:** 'Having' is a non-finite participle that cannot serve as the finite predicate verb.
- **Option C:** 'Have been' is plural and passive, which is grammatically incorrect for an active arrival.

Question #195 Key: (C)LOGICAL REASONING
04. Argument Evaluation & Ethics

Read the passage and the following statements below. Then choose the correct option, basing you...

CORE CONCEPT & DERIVATION

In formal reading comprehension and deductive logic, inferences must be supported strictly and exclusively by explicit passage statements.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The regnal title 'Queen Elizabeth II' establishes by direct Roman numeral designation that a prior Queen Elizabeth I preceded her, making Statement I correct.
- The text identifies Brexit as a 'cultural upheaval', which contradicts the claim in Statement II that it is a 'normal occurrence'.
- The passage explicitly states her reign spanned the 'post-World War II era', which directly refutes Statement III that she reigned during World War II.
- Therefore, only Statement I is logically supported.

Why other options are incorrect:

- **Option A:** Statements II and III are directly contradicted by the text.
- **Option B:** Statement III contradicts the stated 'post-World War II' timeline of her reign.
- **Option D:** Statement III is incorrect, making this combination invalid.

Question #196 Key: (B)LOGICAL REASONING
08. Letter Series & Coding-Decoding

Observe the pattern and select the next term in the sequence: CAB, FAE, IAH, -----

CORE CONCEPT & DERIVATION

Alphabetical letter series follow modular arithmetic progressions based on the numeric positions of letters in the English alphabet.

Formula / Rule / Reaction:

Position: $(n + 3, 'A', m + 3)$

Solution:

- First letter: $C(3) \xrightarrow{+3} F(6) \xrightarrow{+3} I(9) \xrightarrow{+3} L(12)$.
- Middle letter: Invariant 'A' across all terms.
- Third letter: $B(2) \xrightarrow{+3} E(5) \xrightarrow{+3} H(8) \xrightarrow{+3} K(11)$.
- Combining these letters yields LAK.

Why other options are incorrect:

- **Option A:** JHK fails the +3 step on the first letter and omits the invariant middle letter 'A'.
- **Option C:** JGK uses an incorrect first and second letter progression.
- **Option D:** IGJ fails both letter intervals and the fixed center pattern.

Question #197 Key: (A)LOGICAL REASONING
12. Linear Ranking, Ordering & Inequalities

Read the following and choose the correct answer: Drake was wearing a blue shirt with black jeans...

CORE CONCEPT & DERIVATION

Logical deduction through set intersection eliminates incompatible candidates to isolate the matching element.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Drake's attire: Blue shirt, black jeans, brown shoes.
- John's attire: Red shirt, black jeans, black shoes.
- Ahmad's attire: Black jeans, a blue or red shirt, and non-black shoes.
- Because Ahmad wore non-black shoes, he did not wear John's shoes; his attire matches Drake's ensemble, identifying Ahmad as the person who copied Drake.

Why other options are incorrect:

- **Option B:** John wore black shoes and a red shirt, differing from Drake in two items.
- **Option C:** Drake is the person being copied, not the one doing the copying.
- **Option D:** The constraints provided in the premises are sufficient to deduce Ahmad.

Question #198 Key: (C)LOGICAL REASONING
05. Categorical Syllogisms & Overlapping Sets

Some bags are pouches. All pouches are cases. No cases are purses. Which of the following concl...

CORE CONCEPT & DERIVATION

In categorical syllogisms, a conclusion is necessarily true only if it is valid in every Venn diagram satisfying all premises.

Formula / Rule / Reaction:

$$\text{Bags} \cap \text{Pouches} \neq \emptyset, \quad \text{Pouches} \subseteq \text{Cases}, \quad \text{Cases} \cap \text{Purses} = \emptyset$$

Solution:

- Conclusion I: Because all pouches are inside cases and no cases overlap with purses, no pouches can be purses. Thus, I is false.
- Conclusion II: Because some bags are pouches and all pouches are inside cases, those bags that are pouches are necessarily cases. Thus, II is necessarily true.
- Conclusion III: The premise states that cases and purses cannot overlap, but bags that are not pouches may or may not overlap with purses. Thus, III is not necessarily true in all models.
- Therefore, only conclusion II is necessarily true.

Why other options are incorrect:

- **Option A:** Conclusion I is definitively false based on the premise disjoint relation.
- **Option B:** Conclusion I is false, and III is not necessarily true.
- **Option D:** Conclusion III can be violated in models where the non-pouch portion of bags overlaps with purses.

Question #199 Key: (A)LOGICAL REASONING
03. Courses of Action & Decision-Making

Read the following statement, assuming everything in it to be true. Then decide which of the gi...

CORE CONCEPT & DERIVATION

In logical problem evaluation, an appropriate course of action must address the root cause safely and proportionately without introducing severe secondary risks.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Action I directly addresses the cause (auditory noise) using a non-invasive, safe physical barrier (noise blockers), making it a sound course of action.
- Action II recommends strong pharmaceutical sedatives for an environmental problem, which poses health risks and dependency issues without solving the noise.
- Therefore, only Course of Action I logically follows.

Why other options are incorrect:

- **Option B:** Taking strong sedatives for ambient environmental noise is an excessive, disproportionate response.
- **Option C:** Course II is medically imprudent, invalidating the combination.
- **Option D:** Course I provides a safe, direct remedy, so 'Neither' is incorrect.

Question #200 Key: (B)LOGICAL REASONING
02. Cause and Effect Analysis

Given two statements: I. The literacy rate in the district has been increasing. II. The district...

CORE CONCEPT & DERIVATION

In cause-and-effect reasoning, an administrative intervention or program represents the cause, while the resulting measurable improvement represents the effect.

Formula / Rule / Reaction:

Action / Intervention (Statement II) → Outcome / Improvement (Statement I)

Solution:

- Statement II describes an educational intervention: training workers dedicated to the literacy drive.
- Statement I documents the direct measurable outcome: a rising literacy rate in the district.
- Thus, Statement II is the cause and Statement I is its logical effect.

Why other options are incorrect:

- **Option A:** A rising literacy rate does not cause the administration to initiate a training program; rather, the program produces the literacy gains.
- **Option C:** The statements share a clear functional link, so they are not independent causes.
- **Option D:** Statement II is an active causative measure rather than an effect of an external factor.