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SZABMU ISLAMABAD

SZABMU Islamabad MDCAT 2026 Official Paper

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

🛡️ Official Admitting Board: Shaheed Zulfqar Ali Bhutto Medical University Islamabad 🎯 Archive Code: BEAMBE-FLP-SZABMU-2026

🕒 Duration: 210 Minutes (3h 30m)

180

TOTAL QUESTIONS

210m

OFFICIAL DURATION

+1 / 0.00

ZERO NEGATIVE MARKING

180

MAXIMUM MARKS

📄 EXAMINATION BLUEPRINT & SUBJECT WEIGHTAGE

Biology**81 MCQs**

45.0% weight

Chemistry**45 MCQs**

25.0% weight

Physics**36 MCQs**

20.0% weight

English**9 MCQs**

5.0% weight

Logical Reasoning**9 MCQs**

5.0% weight

BIO SECTION: BIOLOGY

Questions 1 to 81 (81 MCQs)

Q1. BIO

Constant region of a specific type of antibody is made up of _____ type of amino acids.

- (A) Same
- (B) Different
- (C) Variable
- (D) Hydrophobic

Q2. BIO

Primary immune response is characterized by:

- (A) Rapid antibody production
- (B) Slow and low antibody production
- (C) No antibody formation
- (D) Immediate and strong immunity

Q3. BIO

Breathing is also named as:

- (A) Internal respiration
- (B) Cellular respiration
- (C) Inspiration
- (D) Ventilation

Q4. BIO

Warming up of the air in the nasal cavity occurs with the help of blood capillaries, located _____:

- (A) Underneath mucous membrane
- (B) Surrounding the cilia
- (C) Surrounding cartilages
- (D) In the nasopharynx

Q5. BIO

Intercostal muscles are _____:

- (A) Skeletal muscles
- (B) Involuntary smooth muscles
- (C) Voluntary smooth muscles
- (D) Cardiac muscles

Q6. BIO

Expansion and contraction of the lungs is accomplished by:

- (A) Smooth muscles in bronchioles
- (B) Smooth muscles in alveoli
- (C) Intercostal muscles
- (D) Diaphragm and intercostal muscles

Q7. BIO

During gaseous exchange in human, how many times, cells membranes of different cells are crossed by oxygen molecule from alveolar air to reach in the RBC in alveolar capillaries?

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

Q8. BIO

The pepsin is converted into active form by the action of:

- (A) Trypsin
- (B) Chymotrypsin
- (C) Acidic medium
- (D) Alkaline medium

Q9. BIO

The back flush of acidic chyme from stomach to esophagus lead to burning sensation in the chest known as:

- (A) Pyrosis
- (B) Cirrhosis
- (C) Segmentation
- (D) Peristalsis

Q10. BIO

Which component of bile produced by liver may cause gall stones?

- (A) Iron
- (B) Bilirubin
- (C) Cholesterol
- (D) Lipase

Q11. BIO

Chymotrypsin present in pancreatic juice is responsible for:

- (A) Digestion of lipids to glycerol and fatty acids
- (B) Digestion of DNA and RNA into nucleotides
- (C) Digestion of proteins into smaller peptides
- (D) Digestion of polysaccharides into maltose or glucose

Q12. BIO

How does pancreatic amylase digests carbohydrates?

- (A) Digests polysaccharides into maltose
- (B) Digests polysaccharides into sucrose
- (C) Digests polysaccharides into lactose
- (D) Digests polysaccharides into galactose

Q13. BIO

Which of the following event would likely to produce hunger pangs in your stomach, when you are fasting:

- (A) Low sodium level in blood
- (B) Antiperistalsis of alimentary canal
- (C) Low blood glucose
- (D) Dehydration in body

Q14. BIO

Which process directly depends on hydrostatic pressure in the kidney functioning?

- (A) Pressure Filtration
- (B) Selective Reabsorption
- (C) Tubular Secretion
- (D) Osmoregulation

Q15. BIO

Hypercalcemia & Hypercalciuria are responsible for kidney stones and are due to condition:

- (A) Hypothyroidism
- (B) Hyperthyroidism
- (C) Hypoparathyroidism
- (D) Hyperparathyroidism

Q16. BIO

In situation of dehydration, human kidneys respond by:

- (A) Decreasing blood pressure
- (B) Decreasing ADH secretion
- (C) Increasing water reabsorption
- (D) Increasing urine output

Q17. BIO

Which of the following is not the function of kidney?

- (A) Ion regulation
- (B) Water regulation
- (C) Temperature regulation
- (D) Waste removal

Q18. BIO

An increased aldosterone secretion results in _____:

- (A) Loss of Na ions
- (B) Retention of Na ions
- (C) Increased glucose
- (D) Reduced urine

Q19. BIO

When monoclonal antibodies are combined with fluorescent labels, this technique is known as:

- (A) Fluorescence microscopy
- (B) Fluorescence crystallography
- (C) Fluorescence therapy
- (D) Fluorescence biography

Q20. BIO

The enzyme which joins two pieces of DNA is:

- (A) DNA Polymerase I
- (B) DNA Polymerase III
- (C) DNA Ligase
- (D) Restriction Endonuclease

Q21. BIO

DNA probes are best described as:

- (A) Enzymes that cut DNA
- (B) Short, single-stranded DNA sequences complementary to target DNA
- (C) Double-stranded RNA molecules
- (D) Antibodies that bind proteins

Q22. BIO

The shape of a bacteriophage is:

- (A) Spherical
- (B) Helical
- (C) Tadpole like
- (D) Comma like

Q23. BIO

In the host Helper-T lymphocytes, the viral RNA is converted into cDNA by _____:

- (A) Transcriptase
- (B) RNA polymerase
- (C) DNA polymerase
- (D) Reverse transcriptase

Q24. BIO

The virus is responsible for AIDS is classified as:

- (A) DNA virus
- (B) Retrovirus
- (C) Viroid
- (D) Bacteriophage

Q25. BIO

Which of the following best defines the removal of electrons from a substance by the addition of oxygen or removal of hydrogen?

- (A) Oxidation
- (B) Reduction
- (C) Phosphorylation
- (D) Dephosphorylation

Q26. BIO

Which of the following is a major benefit of anaerobic respiration during exercise in humans?

- (A) Glucose molecules are fully oxidized during anaerobic respiration.
- (B) Anaerobic respiration can supply ATP very rapidly for a short period of time.
- (C) It produces useful byproducts.
- (D) Anaerobic respiration can supply ATP indefinitely.

Q27. BIO

Oxidation, decarboxylation and addition of coenzyme-A to pyruvate results into the production of:

- (A) Acetyl Co-A
- (B) Phosphoenolpyruvate
- (C) Glucose 6-phosphate
- (D) Citrate

Q28. BIO

Water maintains the shape and structure of large biological molecules mainly through:

- (A) Covalent bonding
- (B) Hydrogen bonding and hydrophobic interactions
- (C) Ionic interactions
- (D) Disulfide bridges

Q29. BIO

The common feature(s) of prokaryotic and eukaryotic cells is/are:

- (A) Presence of plasma membrane only
- (B) Presence of ribosomes only
- (C) Presence of genetic material only
- (D) Presence of plasma membrane, ribosomes & genetic material

Q30. BIO

Which of the following is biopolymer?

- (A) Water
- (B) Phospholipids
- (C) Histone
- (D) Waxes

Q31. BIO

Information regarding living organism's body processes from construction of body structure to flow of information from nucleus are provided by:

- (A) Biogenic elements
- (B) Biological molecules
- (C) Inorganic molecules
- (D) Organic molecules

Q32. BIO

Peptide bond is formed between:

- (A) C-terminal and C-terminal
- (B) N-terminal and C-terminal
- (C) N-terminal and N-terminal
- (D) C-terminal and OH-terminal

Q33. BIO

In which of the following organelles, the process of Transcription takes place?

- (A) Ribosomes
- (B) Golgi complex
- (C) Lysosomes
- (D) Nucleus

Q34. BIO

The approximate diameter of chromatin at the level of supercoiling is:

- (A) 250nm
- (B) 300nm
- (C) 350nm
- (D) 400nm

Q35. BIO

Which of the following organelles predominantly produces Adenosine Triphosphate (ATP) in the cell?

- (A) Nucleus
- (B) Ribosome
- (C) Mitochondria
- (D) Endosome

Q36. BIO

In mitochondria, small knob like structures called F-1 particles are found in _____:

- (A) Outer membrane
- (B) Inner membrane
- (C) Outer component
- (D) Inner component

Q37. BIO

The disaccharide formed during digestion of starch is:

- (A) Sucrose
- (B) Cellobiose
- (C) Lactose
- (D) Maltose

Q38. BIO

Which of the following is correct about a nucleotide?

- (A) It may consist of one to five nitrogenous bases
- (B) It may consist of one or two pentose sugar units
- (C) It may consist of one to three phosphate groups
- (D) It may consist of a pentose or hexose sugar

Q39. BIO

Which of the two nucleotides have 2 ringed structures?

- (A) Adenine and Guanine
- (B) Cytosine and Thymine
- (C) Adenine and Thymine
- (D) Cytosine and Guanine

Q40. BIO

Which organelle is in abundance in secretory cells?

- (A) Mitochondria
- (B) Golgi complex
- (C) Nuclei
- (D) Nucleoli

Q41. BIO

Olfactory bulb is present in:

- (A) Nose
- (B) Nasal Cavity
- (C) Throat
- (D) Brain

Q42. BIO

The axon of motor neuron forms synapses with _____?

- (A) Axon of sensory neuron
- (B) Dendron of sensory neuron
- (C) Receptors
- (D) Muscle cells/effector

Q43. BIO

Which part of the brain stores human memory?

- (A) Cerebrum
- (B) Medulla oblongata
- (C) Hypothalamus
- (D) Corpus callosum

Q44. BIO

If there is an injury in the hypothalamus region of the brain, it is most likely to affect:

- (A) Coordination during locomotion
- (B) Short-term memory
- (C) Regulation of body temperature
- (D) Decision making

Q45. BIO

Which one of the following is involved in blinking of an eye?

- (A) Spinal reflex
- (B) Cranial reflex
- (C) Membrane reflex
- (D) Nuclear reflex

Q46. BIO

Brain stem include all of the following, Except:

- (A) Cerebrum
- (B) Pons
- (C) Midbrain
- (D) Medulla Oblongata

Q47. BIO

Which model best explains the specificity of enzymes for their substrate?

- (A) Induced fit model
- (B) Lock and Key model
- (C) Fluid mosaic model
- (D) Sliding filament model

Q48. BIO

Which of the following truly describe the Activation Energy of an Enzyme?

- (A) Total energy of the reaction system
- (B) Minimum energy required to start a chemical reaction
- (C) Energy lost during the chemical reaction
- (D) Energy difference between the chemical potential energy of the reactants and the products

Q49. BIO

How does an enzyme increase the rate of a reaction?

- (A) By bringing the reaction molecules into precise orientation
- (B) By increasing the rate of random collisions of molecules
- (C) By shifting the point of equilibrium of the reaction
- (D) By supplying the energy required to start the reaction

Q50. BIO

Naturally, enzymes increase reaction rate without:

- (A) Converting substrate into products
- (B) Being consumed in reaction
- (C) Lowering its activation energy
- (D) Forming enzyme-substrate complex

Q51. BIO

Darwin believed in perceived unity of life with _____ related through decent from _____:

- (A) all organisms: common ancestors
- (B) few organisms: different ancestors
- (C) few organisms: common ancestors
- (D) all organisms: different ancestors

Q52. BIO

In Darwin's theory of natural selection "struggle for existence" is:

- (A) Fight for territory
- (B) Competition for survival
- (C) Fight for evolution
- (D) To admit the rights of others

Q53. BIO

History of life is like a tree. This concept of Darwinism is called:

- (A) Natural selection
- (B) Descent with modification
- (C) Struggle for existence
- (D) Over production

Q54. BIO

A researcher claims that environment directly induces useful traits in organisms, that are inherited in next generations. This idea aligns with:

- (A) Lamarckism
- (B) Darwinism
- (C) Special creationism
- (D) Neo-Darwinism

Q55. BIO

The first menstrual flow is:

- (A) Menopause
- (B) Menstruation
- (C) Menarche
- (D) Ovulation

Q56. BIO

Which of the following is NOT a feature of cartilaginous joints?

- (A) Slight mobility
- (B) Absence of synovial fluid
- (C) Presence of cartilage
- (D) Presence of joint cavity

Q57. BIO

All enzymes are _____ proteins?

- (A) Globular & insoluble in water
- (B) Globular & soluble in water
- (C) Fibrous & insoluble in water
- (D) Fibrous & soluble in water

Q58. BIO

A marked increase in temperature reduces rate of the enzyme catalyzed reaction by _____:

- (A) Decreasing the kinetic energy of substrate
- (B) Changing the pH of reaction media
- (C) Destroying the tertiary structure of enzyme
- (D) Decreasing the activation energy

Q59. BIO

The cessation (end) of mensuration in female is called:

- (A) Menarche
- (B) Mensural cycle
- (C) Menopause
- (D) Maturation

Q60. BIO

A sudden rise in estrogen levels in females, may leads to which event?

- (A) Menstruation
- (B) LH surge
- (C) Implantation
- (D) Progesterone drop

Q61. BIO

Which hormone is involved in the menstrual cycle and its secretion is increased right after day 14 and starts decreasing again at the end of the cycle, and if fertilization takes place then its concentration is further increased by the placenta?

- (A) FSH
- (B) LH
- (C) Progesterone
- (D) Both LH and FSH

Q62. BIO

Nerve impulse carried directly to sarcoplasmic reticulum through?

- (A) Sarcolemma
- (B) Sarcoplasm
- (C) Nerve fibre
- (D) T-tubule

Q63. BIO

During muscle contraction, after calcium binds to troponin, the binding sites on which protein become exposed?

- (A) Actin
- (B) Myosin
- (C) Myoglobin
- (D) Tropomyosin

Q64. BIO

Osteoarthritis indicates inflammation in the joints of _____.

- (A) Toes
- (B) Neck
- (C) Knee
- (D) Wrist

Q65. BIO

Which of the following changes occur when skeletal muscles contract?

- (A) The A-bands shorten
- (B) The I-bands shorten
- (C) The Z-lines move further apart
- (D) The H-zone becomes more visible

Q66. BIO

When male parent (RR) has a cross with female parent (rr), then according to Law of segregation all F₁ offspring appears with a genotype:

- (A) RR
- (B) Rr
- (C) rr
- (D) Rrr

Q67. BIO

Which of the following genetic disorder cause bleeding disease?

- (A) Sickle cell anemia
- (B) Hemophilia
- (C) Thalassemia
- (D) Cystic fibrosis

Q68. BIO

Y-linked traits are always passed from father to the:

- (A) Sons only
- (B) Daughters only
- (C) 50% sons and 50% Daughters
- (D) 75% sons and 25% daughter

Q69. BIO

How many different genotypes are required for producing a pea plant with round and yellow seeds phenotype?

- (A) 1
- (B) 2
- (C) 4
- (D) 8

Q70. BIO

In which of the following phases of cell cycle, gene crossing over occurs?

- (A) Telophase
- (B) Prophase I
- (C) Metaphase I
- (D) Prophase II

Q71. BIO

Which of the following best describes the production of different combinations of alleles in daughter cells, as a result of the random alignment of bivalents on the equator of the spindle during metaphase I of meiosis?

- (A) Segregation
- (B) Sex Linkage
- (C) Crossing Over
- (D) Independent Assortment

Q72. BIO

A genetic disease is transferred from a phenotypically normal but carrier female to only some of male progeny. The disease is:

- (A) Autosomal dominant
- (B) Autosomal recessive
- (C) Sex-linked dominant
- (D) Sex-linked recessive

Q73. BIO

Which chamber of the heart pumps blood to the lungs?

- (A) Right Atrium
- (B) Right Ventricle
- (C) Left Atrium
- (D) Left Ventricle

Q74. BIO

Antigens bind with:

- (A) C-Region of antibody
- (B) V-Region of antigens
- (C) C-Region of antigens
- (D) V-Region of antibody

Q75. BIO

Which one of the following statements is correct for troponin?

- (A) It is an ATPase
- (B) It binds to actin only
- (C) It consists of three polypeptide chains.
- (D) It has greater affinity with Calcium ions than myosin

Q76. BIO

_____ are the bone dissolving cells.

- (A) Osteoclasts
- (B) Osteocytes
- (C) Osteoblasts
- (D) All of these are correct

Q77. BIO

Which one of the following statements is incorrect about circulatory system?

- (A) All arteries carry blood away from the heart.
- (B) All veins carry blood towards the heart.
- (C) All arteries carry oxygenated blood.
- (D) All veins carry blood at low pressure.

Q78. BIO

Which of the following valves control the entry of blood into the ventricles of a heart?

- (A) Atrioventricular valves
- (B) Semilunar valves
- (C) Pulmonary valves
- (D) Aortic valves

Q79. BIO

The valve of heart through which only oxygenated blood move is:

- (A) Tricuspid
- (B) Bicuspid
- (C) Pulmonary semilunar
- (D) Bicuspid and Tricuspid

Q80. BIO

Bicuspid valve guards the opening between _____ in a heart.

- Ⓐ Stomach and Intestine
 - Ⓑ Pulmonary Vein and Left Atrium
 - Ⓒ Right Atrium and Right Ventricle
 - Ⓓ Left Atrium and Left Ventricle
-

Q81. BIO

What are antigens, in the context of immune recognition?

- Ⓐ Hormones released during infection
 - Ⓑ Self-identifying lipids in plasma
 - Ⓒ Cell surface proteins and Oligosaccharides
 - Ⓓ Enzymes released by B-cells
-

CHEM SECTION: CHEMISTRY

Questions 82 to 126 (45 MCQs)

Q82. CHEM

Alkenes are less acidic than alkynes due to:

- (A) higher s character
- (B) lesser s character
- (C) stronger bonds
- (D) higher electronegativity

Q83. CHEM

1,3 Butadiene is more stable than 1-Butene, because it is a:

- (A) Conjugated Alkene
- (B) Cumulenes
- (C) Isolated diene
- (D) Separated dienes

Q84. CHEMName of $(C_2H_5)_4C$:

- (A) triethyl methane
- (B) tetramethyl methane
- (C) tetraethyl methane
- (D) trimethyl ethane

Q85. CHEM

Compared to benzene, nitration of toluene takes place at?

- (A) Same rate
- (B) Slow rate
- (C) Faster rate
- (D) Very slow rate

Q86. CHEM

During hydro halogenation of asymmetric alkenes which rule favors formation of secondary carbocation over primary carbocation?

- (A) Hydration rule.
- (B) Anti-Markovnikov's rule
- (C) Markovnikov's rule
- (D) Polymeros's rule

Q87. CHEM

Which reagent is used to distinguish 1-butyne and 2-butyne?

- (A) water in the presence of mercuric sulphate and sulfuric acid
- (B) ammoniacal silver nitrate
- (C) Acidified potassium manganate(VII)
- (D) aqueous bromine

Q88. CHEM

_____ can be added, to an alkyl halide to increase the no. of carbon atoms in the parent chain.

- (A) HCN in ethanol
- (B) KCN in ethanol
- (C) Iodoform
- (D) Amine.

Q89. CHEM

Which reagent gives white precipitates when added to phenol?

- (A) aq bromine
- (B) aq Na_2CO_3
- (C) aq NaOH
- (D) aq NaOH and benzoyl chloride

Q90. CHEM

Which of the following is more acidic?

- (A) Phenol
- (B) o-methyl phenol
- (C) o-nitro phenol
- (D) o-Aminophenol

Q91. CHEM

Which of these compounds reacts immediately with Lucas reagent and forms an oily layer by turning the solution turbid?

- (A) 2-butanol
- (B) 2-methyl-2-butanol
- (C) 1-propanol
- (D) 4-methylphenol (p-cresol)

Q92. CHEM

Which of the following gives positive silver mirror test:

- (A) CH_3CH_2OH
- (B) CH_3CHO
- (C) CH_3COOH
- (D) CH_3COCH_3

Q93. CHEM

Select the acid catalyzed addition reactions of carboxyl compounds from the following:

- (A) Addition of Grignard reagent
- (B) Addition of sodium bisulphite
- (C) Addition of alcohols
- (D) Addition of hydrogen cyanide

Q94. CHEM

When an aldehyde or ketone is reduced using LiAlH_4 , followed by hydrolysis, the resultant would be:

- (A) 1° alcohol from both aldehyde and ketone.
- (B) 1° alcohol from aldehyde and 2° alcohol from ketone.
- (C) 2° alcohol from both aldehyde and ketone.
- (D) 2° alcohol from aldehyde and 3° alcohol from ketone.

Q95. CHEM

Free radicals are produced by:

- (A) Homolytic cleavage
- (B) Heterolytic cleavage
- (C) Reducing agents
- (D) Oxidizing agents

Q96. CHEM

Acetic acid and ethanol reacts to produce:

- (A) aldehyde
- (B) ethyl acetate
- (C) nitrile
- (D) ketone

Q97. CHEM

Prosthetic groups are part of the following protein:

- (A) Derived
- (B) Conjugated
- (C) Simple
- (D) Non-derived

Q98. CHEM

Acrylate base polymers are:

- (A) Drying adhesives
- (B) Pressure sensitive adhesives
- (C) Contact adhesives
- (D) Hot adhesives

Q99. CHEM

What does the symbol (Δ) in a chemical equation represent?

- (A) Density
- (B) Direction
- (C) Heat
- (D) Pressure

Q100. CHEM

Calculate the number of molecules in 244g of benzoic acid? ($\text{C}_7\text{H}_6\text{O}_2$)

- (A) 12×10^{22}
- (B) 1.2×10^{24}
- (C) 0.12×10^{21}
- (D) 12×10^{24}

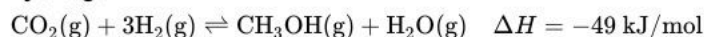
Q101. CHEM

The probability of spin of an electron is supposed to be:

- (A) 30% clockwise & 70% counterclockwise
- (B) 70% clockwise & 30% counterclockwise
- (C) 50% clockwise & 50% counterclockwise
- (D) 90% clockwise & 10% counterclockwise

Q102. CHEM

Methanol is manufactured by reacting carbon dioxide and hydrogen.



What would increase the equilibrium yield of methanol in this process?

- (A) Adding methanol
- (B) Adding an excess of steam.
- (C) Decreasing the pressure.
- (D) Decreasing the temperature.

Q103. CHEM

The order of reaction of an elementary reaction is:

- (A) equal to molecularity
- (B) depend on temperature
- (C) can't predicted
- (D) Depends on concentration

Q104. CHEM

The rate of reaction when concentration becomes unity is called:

- (A) Average rate
- (B) Instantaneous rate
- (C) Rate constant
- (D) Rate of reaction

Q105. CHEM

If enthalpy change of a reaction is negative, then by increasing temperature reaction will move in which direction?

- (A) Forward
- (B) Reverse
- (C) No change
- (D) First reverse then forward

Q106. CHEM

Which element will undergo oxidation preferably:

- (A) With low reduction potential
- (B) With high reduction potential
- (C) With low oxidation potential
- (D) Cannot be predicted

Q107. CHEM

In a redox reaction, the reducing agent is the species that:

- (A) Gains electrons
- (B) Loses electrons
- (C) Remains unchanged
- (D) Decrease in its oxidation state

Q108. CHEM

The surface of Triton, a moon of Neptune, contains condensed methane that flows rapidly. Which statement explains why condensed methane flow rapidly?

- (A) Condensed methane has a metallic structure
- (B) Methane molecules contain strong covalent bonds
- (C) The intermolecular forces between methane molecules are weak
- (D) Methane molecules have a tetrahedral shape

Q109. CHEM

Which of the following statement is true for water (temperature between 4°C to 0°C)?

- (A) The volume of water decreases on cooling
- (B) The density of water increases on cooling
- (C) The density of water decreases on cooling
- (D) The mass of decreases on cooling

Q110. CHEM

Number of sigma bond and pi bonds in acetylene are?

- (A) 3 & 1
- (B) 1 & 3
- (C) 5 & 2
- (D) 3 & 2

Q111. CHEM

Which compound will have a maximum dipole moment?

- (A) CH₄
- (B) CCl₄
- (C) CH₃Cl
- (D) C₂H₄

Q112. CHEM

An ion with a trinegative charge (-3) has valence shell electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6$. To which period and group of the periodic table does the given element belong?

- (A) Period III and Group IIIA
- (B) Period III and Group VA
- (C) Period V and Group IIIA
- (D) Period V and Group VA

Q113. CHEM

If the temperature of a gas is doubled at constant pressure, what will be its volume:

- (A) Halved
- (B) Doubled
- (C) Remains constant
- (D) Quadrupled

Q114. CHEM

Which pair of compounds form hydrogen bond?

- (A) Water and acetaldehyde
- (B) formic acid and acetic acid
- (C) Ethyl acetate and acetic acid
- (D) Acetone and water

Q115. CHEM

For an element "X", If the value of Principle quantum number (n) = 4, the largest value of magnetic quantum number "m" can be:

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

Q116. CHEM

A photon is moving with wave number $1.5 \times 10^{10} \text{ m}^{-1}$, its frequency is:

- (A) 4.5×10^{18}
- (B) 3.0×10^{18}
- (C) 4.5×10^{-18}
- (D) 3.0×10^{-18}

Q117. CHEM

Ideal gas equation for one mole of H₂ is:

- (A) $PV = nRT$
- (B) $P_1V_1/T_1 = P_2V_2/T_2$
- (C) $PV/RT = 1$
- (D) $P_1V_1 = P_2V_1T_2$

Q118. CHEM

Value of concentration for 1 mol of an ideal gas at STP will be:

- (A) 0.04
- (B) 0.40
- (C) 4.40
- (D) 4.00

Q119. CHEM

The ideal gas equation is a combination of laws:

- (A) Charles's, Boyle's
- (B) Charles's, Avogadro's
- (C) Boyle's, Avogadro's
- (D) Charles's, Boyle's, Avogadro's

Q120. CHEM

In body centered crystal system the central ion is attached with,

- (A) 1 unit cell
- (B) 4 unit cell
- (C) 6 unit cell
- (D) 10 unit cell

Q121. CHEM

For an endothermic reversible reaction, the yield will increase if:

- (A) Temperature increased
- (B) Temperature decreased
- (C) Catalyst added
- (D) Reactants removed

Q122. CHEM

Which of the following elements has the lowest electronegativity value?

- (A) Fluorine
- (B) Iodine
- (C) Lithium
- (D) Cesium

Q123. CHEM

Sodium metal reacts with ice cold water to produce:

- (A) NaOH
- (B) Na_2O
- (C) Na_2O_2
- (D) NaCl

Q124. CHEM

Outer-Transition elements are also called;

- (A) s-block elements
- (B) p-block elements
- (C) d-block elements
- (D) f-block elements

Q125. CHEM

Those molecules which have a chiral center but not a mirror image of one another are called:

- (A) Epimers
- (B) Enantiomers
- (C) Diastereomers
- (D) Anomers

Q126. CHEM

Select the free radical involved in the initiation of halogenation of methane:

- (A) $\text{Cl}^\bullet$
- (B) $\text{CH}_3^\bullet$
- (C) CH_4
- (D) CH_3Cl

PHY SECTION: PHYSICS

Questions 127 to 162 (36 MCQs)

Q127. PHY1 mega ohm $\times$ 1 pico farad =

- (A) second
- (B) millisecond
- (C) microsecond
- (D) megasecond

Q128. PHY

If "F" is the force between two points charges submerged in a medium of dielectric constant "M", then on withdrawing the medium, the force between them becomes:

- (A) $F\sqrt{M}$
- (B) $F \cdot M$
- (C) F/M
- (D) M/F

Q129. PHY

Unit of resistivity i.e. specific resistance is:

- (A) $\Omega \cdot \text{m}$
- (B) Ω
- (C) $\Omega^{-1} \cdot \text{m}^{-1}$
- (D) $\Omega \cdot \text{m}^2$

Q130. PHY

If diameter of a wire is doubled, its resistivity will:

- (A) become half
- (B) decrease by four times
- (C) increases by four times
- (D) remain constant

Q131. PHY

Two particles with same charge and different masses enters perpendicularly in a uniform magnetic field with same speed, the lighter one will move in:

- (A) Straight path
- (B) Spiral path
- (C) Large circular path
- (D) Small circular path

Q132. PHY

Which quantity is a vector?

- (A) pressure
- (B) temperature
- (C) weight
- (D) work

Q133. PHY

During uniform circular motion, if "v" is tangential velocity, " ω " is angular velocity and "r" is radius. Then which of the following represents cross product correctly:

- (A) $\vec{\omega} = \vec{v} \times \vec{r}$
- (B) $\vec{r} = \vec{\omega} \times \vec{v}$
- (C) $\vec{v} = \vec{r} \times \vec{\omega}$
- (D) $\vec{v} = \vec{\omega} \times \vec{r}$

Q134. PHY

Cross product of two parallel vectors has a magnitude of:

- (A) A
- (B) $A \cos \theta$
- (C) zero
- (D) null vector

Q135. PHY

Projectile motion is best described as:

- (A) One-dimensional motion
- (B) Variable accelerated motion
- (C) Constant acceleration due to gravity
- (D) Velocity becomes zero at maximum height

Q136. PHY

A body of mass 5kg is moving with speed 10 m/s. A constant force acts on it for 5 seconds and brings it speed to 5 m/s. The magnitude of force is:

- (A) 3 N
- (B) 5 N
- (C) 15 N
- (D) 30 N

Q137. PHY

A passenger standing in a bus falls forward when the bus suddenly stops. This is due to:

- (A) Newton's first law
- (B) Newton's second law
- (C) Newton's third law
- (D) Law of gravitation

Q138. PHY

A stone is thrown horizontally with a velocity of 12 m/s from the top of a vertical cliff. How long stone takes to reach the ground 45 m below? Take $g = 10 \text{ m/s}^2$

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

Q139. PHY

If the force applied on an object and its velocity are in the same direction, the power delivered to the object is:

- (A) Zero
- (B) Positive
- (C) Negative
- (D) Infinite

Q140. PHY

If the velocity is doubled then the K.E of the body will be:

- (A) Double
- (B) Three times
- (C) Four times
- (D) Remains constant

Q141. PHY

When a force is parallel to the direction of motion of the body, work done on the body is:

- (A) Zero
- (B) minimum
- (C) maximum
- (D) Infinite

Q142. PHY

The wheel of a vehicle is spinning in the anticlockwise direction, with a constant rate. The direction of its angular velocity will be:

- (A) clockwise
- (B) anticlockwise
- (C) perpendicular to the plane of rotation
- (D) along the plane of rotation

Q143. PHY

A point P is on a disk rotating with constant angular velocity. If the distance from the center is tripled, what happens to the ratio of linear velocity and angular velocity (v/ω)?

- (A) It remains the same
- (B) It triples
- (C) It is reduced to one-third
- (D) It increases by factor 9

Q144. PHY

In deriving Bernoulli's equation, the quantity 'pressure $\times$ volume' represents:

- (A) density
- (B) kinetic energy
- (C) potential energy
- (D) work done

Q145. PHY

Drag force on a spherical object moving through a fluid depends on:

- (A) velocity of the object
- (B) viscosity of the medium
- (C) shape and size of the object
- (D) all of the above

Q146. PHY

Which of the following assumptions is INCORRECT about the fluid that follows equation of continuity?

- (A) It is a non-viscous fluid
- (B) It moves in a steady flow
- (C) It moves in a turbulent flow
- (D) It is an incompressible fluid

Q147. PHY

In a ripple tank 50 waves having wavelength 5cm pass through a certain point with a speed of 2m/s. The frequency of waves is:

- (A) 5 Hz
- (B) 10 Hz
- (C) 40 Hz
- (D) 50 Hz

Q148. PHY

In SHM the maximum displacement covered by the Particle from mean position is A. What is the total distance covered in one complete cycle?

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

Q149. PHY

Unlike electromagnetic waves, mechanical waves require:

- (A) source of energy
- (B) medium for propagation
- (C) source of disturbance
- (D) periodic motion

Q150. PHY

A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted until the sound from the tube is loudest. What is the nature of the sound wave in the tube?

- (A) Longitudinal and progressive
- (B) Longitudinal and stationary
- (C) Transverse and progressive
- (D) Transverse and stationary

Q151. PHY

An ideal gas is heated at constant volume. It absorbs 200 J of heat. The work done by the gas is:

- (A) 200 J
- (B) 0 J
- (C) -200 J
- (D) Varies with pressure

Q152. PHY

If "Q" heat and "W" is work done then " $W=Q$ " represents:

- (A) Isothermal process
- (B) Adiabatic process
- (C) Isochoric process
- (D) Isobaric process

Q153. PHY

Magnetic flux has unit but no direction because:

- (A) of scalar product
- (B) of cross product
- (C) of sum of two vectors
- (D) of product of two scalars

Q154. PHY

According to the Faraday's law of electromagnetic induction, the magnitude of induced emf depends upon:

- (A) magnetic flux
- (B) magnetic induction
- (C) change in magnetic flux
- (D) rate of change in magnetic flux

Q155. PHY

Lenz's law primarily refers to the direction of:

- (A) Voltage
- (B) Induced current
- (C) Power
- (D) Energy

Q156. PHY

When a capacitor is connected to an alternating power source:

- (A) the voltage leads the current by 90°
- (B) the voltage lags the current by 90°
- (C) the voltage leads the current by 180°
- (D) the voltage lags the current by 180°

Q157. PHY

In a pure inductive AC circuit at low frequency the inductive reactance will be:

- (A) remains same
- (B) increase
- (C) decrease
- (D) zero

Q158. PHY

Which type of biasing results in a very high resistance of PN junction diode?

- (A) Forward biasing
- (B) Reverse biasing
- (C) Unbiased
- (D) Doping

Q159. PHY

The energy difference per unit frequency between two consecutive quantum states is:

- (A) speed of light
- (B) Frequency
- (C) Planck's Constant
- (D) Mass

Q160. PHY

What is the primary reason for color line spectrum of hydrogen gas?

- (A) the heat energy inside gas
- (B) Transition of electrons from lower to higher energy levels in gas atoms
- (C) Transition of electrons from higher to lower energy levels in gas atoms
- (D) instability of gas atoms

Q161. PHY

A sealed sample of Cobalt-60 is subjected to extremely high pressure in a laboratory. Its decay rate will:

- (A) increase
- (B) decrease
- (C) remain unchanged
- (D) become infinite

Q162. PHY

Half-life of a radioactive element is 2 minutes. In how much time, one-eighth ($1/8$ th) of this sample will decay to its residual fraction?

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

ENG SECTION: ENGLISH

Questions 163 to 171 (9 MCQs)

Q163. ENG

Choose the option with correct spelling.

- (A) Nusance
- (B) Neusance
- (C) Nuisance
- (D) Nuissance

Q164. ENG

Choose the correctly structured sentence.

- (A) If he went on time, he will have caught the bus.
- (B) If he had gone on time, he would have caught the bus.
- (C) If he had gone on time, he would catch the bus.
- (D) If he has gone on time, he would have caught the bus.

Q165. ENG

"The students, along with their teacher, _____ leaving now." Choose the correct verb:

- (A) is
- (B) are
- (C) has
- (D) was

Q166. ENG

"Your reluctance to speak to the boss will create problems for you." What does "reluctance" mean in this context?

- (A) Confidence
- (B) Hesitation
- (C) Eagerness
- (D) Competence

Q167. ENG

"The silence tasted like stale bread left too long in the cupboard." Which literary technique is most evident here?

- (A) Metaphor
- (B) Personification
- (C) Simile
- (D) Alliteration

Q168. ENG

Choose the sentence with correct punctuation:

- (A) "It was a nice movie," said Kaleem.
- (B) "It was a nice, movie said Kaleem.
- (C) "It was a nice, movie;" said Kaleem.
- (D) "It was a nice movie, "said Kaleem".

Q169. ENG

"He walked _____ the park to reach school." Use correct preposition:

- (A) across
- (B) at
- (C) over
- (D) on

Q170. ENG

Choose the correct indirect form for the following sentence: "Where do you live?" he asked the old man.

- (A) He asked the old man where he has lived.
- (B) He asked the old man where do I live.
- (C) He asked the old man where he lived.
- (D) He asked the old man where did he live.

Q171. ENG

Complete the sentence with correct infinitive. He bade them _____ the house.

- (A) Forleaving
- (B) Leave
- (C) leaving
- (D) To leave

LOGIC SECTION: LOGICAL REASONING

Questions 172 to 180 (9 MCQs)

Q172. LOGIC

If 5 is subtracted from 30, what will be the square root of remaining?

- (A) 25
- (B) 30
- (C) 5
- (D) 10

Q173. LOGIC

Statement: A hospital staff shortage is causing long patient waiting times.

Course of Action:

I. Hire temporary staff and reschedule duties to manage the patient's workflow.

II. Close the hospital until full staffing is restored.

- (A) Only I follows
- (B) Only II follows
- (C) Both I and II follow
- (D) Neither follows

Q174. LOGIC

What makes a course of action realistic and executable?

- (A) Minimal risk
- (B) Attainable goals, detailed steps, and availability of appropriate resources
- (C) High expenses
- (D) Unclear execution plans

Q175. LOGIC

How does positive thinking influence social behavior?

- (A) It encourages social conflicts among the people.
- (B) It encourages mutual respect among the people.
- (C) It develops self-centeredness among the people.
- (D) It encourages isolation among the people.

Q176. LOGIC

In how many way(s), four persons A, B, C and D can stand in a line, if B must be at first and D is at third position?

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

Q177. LOGIC

Eman has 4 times as many books as Ayesha and 5 times as many as Khadijah. If Khadijah has more than 40 books, what is the least number of books that Eman could have?

- (A) 200
- (B) 205
- (C) 210
- (D) 220

Q178. LOGIC

Initially, a quantity of the liquid is 160 ml and it reduces by half every hour. How much liquid remains after two hours?

- (A) 20 ml
- (B) 40 ml
- (C) 60 ml
- (D) 80 ml

Q179. LOGIC

An item originally costs Rs. 2500. After a 10% price increase, what is the new price?

- (A) Rs. 2250
- (B) Rs. 2700
- (C) Rs. 2750
- (D) Rs. 2800

Q180. LOGIC

If you work hard, you will pass the exam.

Which of the following statements can be deduced from the above statement?

I: If you don't work hard, you will not pass the exam.

II: If you don't pass the exam, you have not worked hard.

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

OFFICIAL VERIFIED ANSWER KEY

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

SUBJECT-WISE PERFORMANCE BREAKDOWN

SUBJECT	MAX	YOUR SCORE	ACCURACY
Biology	81	_____	_____ %
Chemistry	45	_____	_____ %
Physics	36	_____	_____ %
English	9	_____	_____ %
Logical Reasoning	9	_____	_____ %
TOTAL	180	_____	_____ %

PMDC PROVINCIAL MERIT FORMULA

Official Weightage Law:

- MDCAT Component (50%): (Your Score / 180) × 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
Federal 2026

Constant region of a specific type of antibody is made up of _____ type of amino acids.

CORE CONCEPT & DERIVATION

The constant region (C region) of an immunoglobulin heavy or light chain possesses an identical amino acid sequence across all antibody molecules of a given class or isotype.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Antibodies consist of two identical light chains and two identical heavy chains, each subdivided into variable (V) and constant (C) domains.
- Within any specific antibody isotype (such as IgG, IgM, IgA), the amino acid sequence forming the constant region remains identical (the same) to preserve class-specific effector functions.

Why other options are incorrect:

- Option B:** Different sequences within a specific class would disrupt conserved Fc-mediated effector mechanisms such as complement activation.
- Option C:** Variable amino acid sequences are strictly restricted to the N-terminal antigen-binding hypervariable domains.
- Option D:** Constant regions contain both hydrophilic and hydrophobic residues to ensure water solubility in biological fluids and membrane anchorage where applicable.

Question #2 Key: (B)

BIOLOGY
Federal 2026

Primary immune response is characterized by:

CORE CONCEPT & DERIVATION

The primary immune response represents the initial adaptive response to an unfamiliar antigen, requiring time for naive lymphocyte activation, clonal selection, and plasma cell differentiation.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Upon primary antigen exposure, a latent or lag phase of several days precedes detectable serum antibody levels.
- Because clonal expansion starts from very few naive B cells, antibody synthesis is slow and attains a relatively low peak titer compared to secondary exposure.

Why other options are incorrect:

- Option A:** Rapid antibody synthesis is the defining feature of the secondary anamnestic response mediated by memory cells.
- Option C:** Functional antibodies (predominantly IgM followed by IgG) are synthesized during the primary response.
- Option D:** Immediate, robust protection requires pre-existing memory lymphocytes formed only after prior exposure.

Question #3 Key: (D)BIOLOGY
Federal 2026*Breathing is also named as:***CORE CONCEPT & DERIVATION**

Breathing, or pulmonary ventilation, is the rhythmic mechanical process of bulk airflow into and out of the lungs.

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

- Pulmonary ventilation consists of cyclic inspiration and expiration driven by thoracic pressure gradients.
- In human respiratory physiology, external ventilation is used synonymously with breathing.

Why other options are incorrect:

- **Option A:** Internal respiration refers to systemic gas exchange between capillary blood and metabolizing tissue cells.
- **Option B:** Cellular respiration is the catabolic biochemical oxidation of organic substrates to yield ATP inside cells.
- **Option C:** Inspiration is merely the active inhalation phase of breathing, not the entire cyclical process.

Question #5 Key: (A)BIOLOGY
Federal 2026*Intercostal muscles are _____:***CORE CONCEPT & DERIVATION**

Intercostal muscles attach to the ribs, are striated in histological organization, and are innervated by somatic spinal motor nerves.

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

- The internal and external intercostal muscles span the rib spaces and contract to alter the thoracic cage diameter during breathing.
- Because they attach to bone, contain multinucleated striated fibers, and receive somatic innervation, they are skeletal muscles.

Why other options are incorrect:

- **Option B:** Smooth muscle forms the walls of hollow visceral organs and blood vessels, not the intercostal wall.
- **Option C:** Smooth muscles are regulated involuntarily by the autonomic nervous system, making voluntary smooth muscle an invalid concept.
- **Option D:** Cardiac muscle tissue is restricted to the myocardium of the heart.

Question #4 Key: (A)BIOLOGY
Federal 2026*Warming up of the air in the nasal cavity occurs with the help of blood capillaries, located _____.***CORE CONCEPT & DERIVATION**

The respiratory mucosa of the nasal cavity possesses a rich superficial plexus of thin-walled capillary loops in the lamina propria directly below the epithelium to warm incoming air.

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

- Submucosal capillary beds lie immediately beneath the moist pseudostratified ciliated columnar epithelium of the nasal mucosa.
- Thermal conduction from maternal blood within these superficial vessels warms inspired air toward core body temperature before it reaches the lower respiratory tract.

Why other options are incorrect:

- **Option B:** Cilia are microscopic apical cellular projections; vascular capillary beds cannot reside around individual external ciliary shafts.
- **Option C:** Nasal cartilage plates are avascular structures that do not participate directly in heat exchange with airflow.
- **Option D:** While the nasopharynx also conducts air, the primary vascular warming and air conditioning occur within the nasal cavity itself.

Question #6 Key: (D)BIOLOGY
Federal 2026*Expansion and contraction of the lungs is accomplished by:***CORE CONCEPT & DERIVATION**

Because lungs possess no intrinsic skeletal muscle tissue, their passive ventilation relies on pressure changes generated by the combined action of the diaphragm and intercostal muscles.

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

- Contraction of the diaphragm increases the vertical dimension of the thoracic cavity.
- Contraction of the external intercostal muscles elevates the ribs to expand the transverse and anteroposterior thoracic dimensions.
- The resulting decrease in intrapleural pressure causes elastic lung expansion, followed by elastic recoil during relaxation.

Why other options are incorrect:

- **Option A:** Bronchiolar smooth muscle regulates airway resistance and caliber, not whole-lung volume changes.
- **Option B:** Alveolar walls contain elastic and collagen fibers, but completely lack smooth muscle layers.
- **Option C:** Intercostal muscles contribute, but omitting the primary muscle of respiration (the diaphragm) renders this choice incomplete.

Question #7 Key: (D)BIOLOGY
Federal 2026*During gaseous exchange in human, how many times, cells membranes of different cells are crossed...***CORE CONCEPT & DERIVATION**

Diffusion of oxygen from alveolar air into red blood cells requires traversing the lipid bilayer boundaries of the alveolar epithelium, capillary endothelium, and the erythrocyte.

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

- Membrane 1: Apical membrane of type I alveolar epithelial cell.
- Membrane 2: Basolateral membrane of type I alveolar epithelial cell.
- Membrane 3: Abluminal (outer) membrane of capillary endothelial cell.
- Membrane 4: Luminal (inner) membrane of capillary endothelial cell.
- Membrane 5: Plasma membrane of the red blood cell.
- Thus, an oxygen molecule crosses a total of 5 distinct cellular plasma membranes.

Why other options are incorrect:

- **Option A:** Two membranes would only account for crossing a single intervening cell.
- **Option B:** Three membranes omits either the complete endothelial barrier or the red blood cell envelope.
- **Option C:** Four membranes accounts for crossing both epithelial and endothelial cells, but omits entry into the red blood cell.

Question #8 Key: (C)BIOLOGY
Federal 2026

The pepsin is converted into active form by the action of:

CORE CONCEPT & DERIVATION

Pepsinogen is an inactive zymogen secreted by gastric chief cells that undergoes conformational unfolding and self-cleavage into active pepsin in an acidic environment created by hydrochloric acid.

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

- Gastric parietal cells secrete HCl, depressing the gastric luminal pH below 2.
- Low pH dissociates electrostatic interactions on pepsinogen, exposing its catalytic cleft and inducing removal of an inhibitory 44-amino-acid segment.

Why other options are incorrect:

- **Option A:** Trypsin activates pancreatic zymogens within the alkaline duodenum, not gastric pepsinogen.
- **Option B:** Chymotrypsin is a pancreatic endopeptidase that acts on chyme in the small intestine.
- **Option D:** Alkaline conditions denature and irreversibly inactivate pepsin.

Question #9 Key: (A)BIOLOGY
Federal 2026

The back flush of acidic chyme from stomach to esophagus lead to burning sensation in the chest...

CORE CONCEPT & DERIVATION

Gastroesophageal reflux of acidic gastric juice past an incompetent lower esophageal sphincter irritates esophageal sensory fibers, producing the substernal burning symptom termed pyrosis (heartburn).

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Retrograde flow of gastric acid, pepsin, and chyme directly exposes the stratified squamous epithelium of the esophagus to chemical irritation.
- This produces retrosternal discomfort medically defined as pyrosis.

Why other options are incorrect:

- **Option B:** Cirrhosis is advanced chronic hepatic fibrosis characterized by regenerative nodule formation.
- **Option C:** Segmentation is an alternating non-propulsive muscular contraction of the intestinal wall that promotes mixing.
- **Option D:** Peristalsis is the coordinated aboral wave of muscular contraction propelling luminal contents along the tract.

Question #10 Key: (C)BIOLOGY
Federal 2026*Which component of bile produced by liver may cause gall stones?***CORE CONCEPT & DERIVATION**

Biliary cholesterol supersaturation relative to bile salts and phospholipids leads to crystal precipitation and the formation of cholesterol gallstones (cholelithiasis).

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

- Cholesterol is insoluble in water and must be solubilized into mixed micelles by bile salts and lecithin.
- When the hepatic output of cholesterol exceeds micellar carrying capacity, insoluble monohydrate cholesterol crystals precipitate, forming the vast majority of gallstones.

Why other options are incorrect:

- Option A:** Iron is not a significant constituent of bile and does not generate biliary stones.
- Option B:** While unconjugated bilirubin can aggregate to form pigment stones, cholesterol constitutes the primary etiology recognized in the standard curriculum.
- Option D:** Lipase is an enzyme produced by the exocrine pancreas, not a biliary lipid produced by hepatocytes.

Question #11 Key: (C)BIOLOGY
Federal 2026*Chymotrypsin present in pancreatic juice is responsible for:***CORE CONCEPT & DERIVATION**

Chymotrypsin is a pancreatic serine endopeptidase that hydrolyzes internal peptide bonds adjacent to bulky aromatic amino acids, converting proteins into short peptides.

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

- Secreted as chymotrypsinogen and activated by trypsin in the duodenal lumen, chymotrypsin cleaves peptide linkages at carboxyl sites of phenylalanine, tyrosine, and tryptophan.
- This enzymatic hydrolysis breaks long protein chains down into smaller peptide fragments.

Why other options are incorrect:

- Option A:** Hydrolysis of triglycerides into glycerol and fatty acids is catalyzed by pancreatic lipase.
- Option B:** Cleavage of polynucleotide chains into nucleotides is executed by ribonuclease and deoxyribonuclease.
- Option D:** Breakdown of starch into maltose is carried out by pancreatic alpha-amylase.

Question #12 Key: (A)BIOLOGY
Federal 2026*How does pancreatic amylase digest carbohydrates?***CORE CONCEPT & DERIVATION**

Pancreatic alpha-amylase hydrolyzes internal α -(1,4)-glucosidic linkages of starch and glycogen to produce maltose, maltotriose, and limit dextrins.

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

- Starch consists of amylose and amylopectin polymers linked by α -(1,4) bonds.
- Pancreatic amylase cleaves these polysaccharides into disaccharide units called maltose, which are later hydrolyzed into free glucose by intestinal brush-border maltase.

Why other options are incorrect:

- Option B:** Sucrose is a plant disaccharide composed of glucose and fructose; it is not a degradation product of starch.
- Option C:** Lactose is a mammalian milk disaccharide composed of glucose and galactose.
- Option D:** Galactose is a monosaccharide obtained from the hydrolysis of lactose, not starch digestion.

Question #13 Key: (C)BIOLOGY
Federal 2026*Which of the following event would likely to produce hunger pangs in your stomach, when you are...***CORE CONCEPT & DERIVATION**

Hypoglycemia during prolonged fasting triggers the lateral hypothalamic hunger center, which initiates rhythmic vagal motor output that causes episodic gastric contractions termed hunger pangs.

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

- Depressed systemic glucose concentrations are detected by glucoreceptive neurons in the hypothalamus.
- This sensory activation sends parasympathetic signals through the vagus nerve to stimulate intense peristaltic contractions of the empty gastric muscularis.

Why other options are incorrect:

- Option A:** Hyponatremia alters plasma osmolarity and neuromuscular excitability, but does not specifically initiate hunger contractions.
- Option B:** Antiperistalsis moves contents retrogradely and is characteristic of the emetic (vomiting) reflex.
- Option D:** Dehydration activates hypothalamic osmoreceptors to trigger the sensation of thirst rather than hunger pangs.

Question #14 Key: (A)BIOLOGY
Federal 2026

Which process directly depends on hydrostatic pressure in the kidney functioning?

CORE CONCEPT & DERIVATION

Glomerular ultrafiltration is a passive process powered directly by glomerular capillary hydrostatic pressure, which drives fluid across the filtration barrier into Bowman's capsule.

Formula / Rule / Reaction:

$$\text{Net Filtration Pressure (NFP)} = P_{GC} - (P_{BS} + \pi_{GC})$$

Solution:

- Because the afferent arteriole has a wider diameter than the efferent arteriole, a high hydrostatic pressure (≈ 55 mmHg) is established within the glomerular capillaries.
- This hydrostatic force pushes water and dissolved micro-solutes across the fenestrated endothelium and basement membrane into the capsular space.

Why other options are incorrect:

- **Option B:** Selective reabsorption is governed by secondary active transport, carrier-mediated facilitated diffusion, and concentration gradients across tubular epithelial cells.
- **Option C:** Tubular secretion relies on active membrane transport pumps (such as primary ATPases and antiporters).
- **Option D:** Osmoregulation is a broad neuroendocrine homeostatic mechanism mediated by hormones like ADH and aldosterone.

Question #15 Key: (D)BIOLOGY
Federal 2026

Hypercalcemia & Hypercalciuria are responsible for kidney stones and are due to condition:

CORE CONCEPT & DERIVATION

Primary hyperparathyroidism causes excessive parathyroid hormone (PTH) secretion, which stimulates bone resorption and elevates blood calcium, leading to hypercalcemia, spillover hypercalciuria, and calcium renal calculi.

Formula / Rule / Reaction:

$$\uparrow \text{PTH} \rightarrow \uparrow \text{Bone Resorption} + \uparrow \text{Renal Filtered Load of Ca}^{2+} \rightarrow \text{Nephrolithiasis}$$

Solution:

- Excess PTH stimulates osteoclasts to dissolve hydroxyapatite matrix, discharging calcium into the vascular compartment.
- The filtered load of calcium exceeds the maximal reabsorptive capacity of the renal tubules, precipitating calcium phosphate or calcium oxalate stones within the renal collecting system.

Why other options are incorrect:

- **Option A:** Hypothyroidism lowers basal metabolic rate and does not lead to hypercalcemia or calcium stones.
- **Option B:** While severe thyrotoxicosis can mildly increase bone turnover, classic nephrolithiasis with hypercalcemia is driven by hyperparathyroidism.
- **Option C:** Hypoparathyroidism causes hypocalcemia, often manifested as neuromuscular tetany.

Question #16 Key: (C)BIOLOGY
Federal 2026*In situation of dehydration, human kidneys respond by:***CORE CONCEPT & DERIVATION**

Dehydration elevates plasma osmolarity, stimulating hypothalamic osmoreceptors to release antidiuretic hormone (ADH), which increases water permeability in renal collecting ducts to maximize water conservation.

Formula / Rule / Reaction:

$\uparrow$ Plasma Osmolarity $\rightarrow \uparrow$ ADH $\rightarrow \uparrow$ Aquaporin-2 Channels $\rightarrow \uparrow$ Water Reabsorption

Solution:

- Circulating ADH binds to basolateral V2 receptors on principal cells in the collecting ducts.
- Intracellular signaling triggers the exocytic insertion of aquaporin-2 water channels into the apical membrane, facilitating osmotic water reabsorption into the hypertonic medullary interstitium.

Why other options are incorrect:

- **Option A:** The kidneys respond to conserve fluid and activate RAAS to maintain or raise blood pressure, not decrease it.
- **Option B:** ADH secretion increases during dehydration, rather than decreases.
- **Option D:** High water reabsorption concentrates the tubular fluid, reducing urine output (oliguria).

Question #17 Key: (C)BIOLOGY
Federal 2026*Which of the following is not the function of kidney?***CORE CONCEPT & DERIVATION**

The kidneys are the principal organs for fluid, electrolyte, and acid-base homeostasis and nitrogenous waste excretion, whereas thermoregulation is managed by the skin, somatic muscles, and the hypothalamus.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Kidneys maintain electrolyte levels, regulate systemic extracellular water volume, and excrete urea, creatinine, and uric acid.
- Thermoregulation relies on cutaneous vasodilation or vasoconstriction, sweat gland secretion, and shivering thermogenesis, which are not direct renal functions.

Why other options are incorrect:

- **Option A:** Kidneys regulate plasma concentrations of Na^+ , K^+ , Ca^{2+} , and HCO_3^- .
- **Option B:** Kidneys control total body water volume via the countercurrent multiplier mechanism and ADH-mediated reabsorption.
- **Option D:** Kidneys filter and eliminate metabolic wastes and foreign xenobiotics.

Question #18 Key: (B)BIOLOGY
Federal 2026

An increased aldosterone secretion results in _____:

CORE CONCEPT & DERIVATION

Aldosterone is a mineralocorticoid secreted by the adrenal cortex that upregulates apical epithelial sodium channels (ENaC) and basolateral Na^+/K^+ -ATPase pumps in the collecting ducts, driving sodium retention.

Formula / Rule / Reaction:

$\uparrow \text{Aldosterone} \rightarrow \uparrow \text{ENaC} + \uparrow (\text{Na}^+/\text{K}^+ \text{-ATPase}) \rightarrow \uparrow \text{Na}^+ \text{ Reabsorption (Retention)}$

Solution:

- Aldosterone diffuses into principal cells of the distal nephron, binding to mineralocorticoid receptors.
- The receptor-hormone complex stimulates transcription of Na^+/K^+ -ATPase pumps and ENaC channels, returning filtered sodium back to the blood.

Why other options are incorrect:

- **Option A:** Aldosterone prevents sodium excretion; sodium loss (natriuresis) occurs when aldosterone is deficient or blocked.
- **Option C:** Glucose homeostasis is controlled by insulin, glucagon, and glucocorticoids (cortisol), not aldosterone.
- **Option D:** While water passively follows reabsorbed sodium, the direct molecular action of aldosterone is the retention of sodium ions.

Question #19 Key: (A)BIOLOGY
Federal 2026

When monoclonal antibodies are combined with fluorescent labels, this technique is known as:

CORE CONCEPT & DERIVATION

Immunofluorescence microscopy utilizes monoclonal antibodies conjugated to fluorescent dyes (fluorophores) to identify and visualize specific target cellular antigens under a fluorescence microscope.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Specific fluorophores (such as fluorescein isothiocyanate) are coupled to the Fc or Fab regions of monoclonal antibodies.
- When the antibody binds to its corresponding antigen, exposure to short-wavelength light excites the label, which emits visible light captured by fluorescence microscopy.

Why other options are incorrect:

- **Option B:** X-ray crystallography determines 3D atomic structures using diffracted X-rays, not fluorescence labels.
- **Option C:** Fluorescent antibody labeling is an analytical detection technique rather than a therapeutic method.
- **Option D:** Fluorescence biography is an invalid biological term.

Question #20 Key: (C)BIOLOGY
Federal 2026

The enzyme which joins two pieces of DNA is:

CORE CONCEPT & DERIVATION

DNA ligase is the molecular enzyme that covalently seals nicks in the phosphodiester backbone by joining a 3'-hydroxyl group to a 5'-phosphate group.

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

- During recombinant DNA technology and Okazaki fragment maturation, discontinuous DNA fragments must be covalently joined.
- DNA ligase catalyzes phosphodiester bond formation between adjacent nucleotides, linking recombinant fragments together.

Why other options are incorrect:

- **Option A:** DNA Polymerase I removes RNA primers and fills the gaps with complementary deoxyribonucleotides.
- **Option B:** DNA Polymerase III is the primary replication enzyme responsible for leading and lagging strand elongation.
- **Option D:** Restriction endonucleases cleave phosphodiester bonds at specific palindromic recognition sequences.

Question #21 Key: (B)BIOLOGY
Federal 2026

DNA probes are best described as:

CORE CONCEPT & DERIVATION

A DNA probe is a defined, labeled single-stranded oligonucleotide sequence designed to hybridize specifically with its complementary sequence within a target DNA sample.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Probes are engineered with a specific nucleotide sequence tagged with a fluorophore or radioactive isotope (such as ^{32}P).
- Upon denaturation of the target DNA, the single-stranded probe anneals to its exact complementary partner, enabling visual detection.

Why other options are incorrect:

- **Option A:** Enzymes that cleave phosphodiester bonds within DNA are endonucleases, not probes.
- **Option C:** Probes are single-stranded nucleic acids, usually made of DNA rather than double-stranded RNA.
- **Option D:** Antibodies that bind specific protein antigens are used in assays like Western blotting and ELISA.

Question #22 Key: (C)BIOLOGY
Federal 2026

The shape of a bacteriophage is:

CORE CONCEPT & DERIVATION

Complex bacteriophages (such as the T-even coliphages) exhibit binal symmetry with an icosahedral head and a cylindrical tail assembly, producing a tadpole-like morphology.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The phage virion comprises a polyhedral protein head housing double-stranded DNA attached to a rod-shaped contractile tail tube with tail fibers.
- This morphology resembles a microscopic tadpole in standard biology textbooks.

Why other options are incorrect:

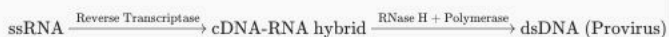
- **Option A:** Spherical morphology is seen in enveloped viruses such as influenza or unenveloped capsids like poliovirus.
- **Option B:** Helical morphology is characteristic of filamentous viruses such as tobacco mosaic virus (TMV).
- **Option D:** Comma-like morphology describes bacterial shapes such as *Vibrio cholerae*.

Question #23 Key: (D)BIOLOGY
Federal 2026

In the host Helper-T lymphocytes, the viral RNA is converted into cDNA by _____.

CORE CONCEPT & DERIVATION

Retroviruses like HIV encode reverse transcriptase (an RNA-dependent DNA polymerase) to synthesize a complementary DNA (cDNA) strand using the viral positive-sense RNA genome as a template.

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

- Following HIV entry into the CD4⁺ T-helper lymphocyte, the viral core unpacks its single-stranded RNA and reverse transcriptase.
- Reverse transcriptase synthesizes a complementary DNA strand, degrades the RNA strand, and synthesizes a second DNA strand to complete double-stranded proviral cDNA.

Why other options are incorrect:

- **Option A:** Standard transcriptase synthesizes RNA from a DNA template.
- **Option B:** Host RNA polymerase transcribes genes from DNA templates into RNA molecules.
- **Option C:** Conventional host DNA polymerase replicates DNA from an existing DNA template during S phase.

Question #24 Key: (B)BIOLOGY
Federal 2026

The virus is responsible for AIDS is classified as:

CORE CONCEPT & DERIVATION

Human Immunodeficiency Virus (HIV) belongs to the family *Retroviridae* and genus *Lentivirus*, defined by an enveloped ssRNA genome replicated through a DNA intermediate via reverse transcription.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Retroviruses carry RNA as their genetic material along with reverse transcriptase.
- Because HIV produces a proviral DNA intermediate that integrates into host chromosomal DNA, it is classified as a retrovirus.

Why other options are incorrect:

- **Option A:** DNA viruses (such as herpesviruses and adenoviruses) contain DNA genomes without requiring reverse transcription.
- **Option C:** Viroids are infectious naked single-stranded circular RNA molecules that lack capsids and infect plants.
- **Option D:** Bacteriophages infect bacterial cells, not human lymphocytes.

Question #25 Key: (A)BIOLOGY
Federal 2026

Which of the following best defines the removal of electrons from a substance by the addition of...

CORE CONCEPT & DERIVATION

Oxidation is the chemical or biochemical loss of electrons from an atom or molecule, which manifests in biological systems as the addition of oxygen or the loss of hydrogen (dehydrogenation).

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

- Oxidation involves an increase in oxidation state driven by electron removal.
- In living cells, oxidation reactions frequently transfer electrons accompanied by protons (hydrogen atoms) to coenzymes such as NAD^+ and FAD.

Why other options are incorrect:

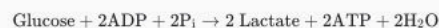
- **Option B:** Reduction is the gain of electrons, gain of hydrogen atoms, or loss of oxygen.
- **Option C:** Phosphorylation is the addition of a phosphate group to an organic compound.
- **Option D:** Dephosphorylation is the hydrolytic cleavage of a phosphate group from a molecule.

Question #26 Key: (B)BIOLOGY
Federal 2026

Which of the following is a major benefit of anaerobic respiration during exercise in humans?

CORE CONCEPT & DERIVATION

Anaerobic glycolysis supplies ATP through rapid substrate-level phosphorylation, producing energy much faster than aerobic oxidative phosphorylation when oxygen delivery is temporarily limited.

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

- During high-intensity muscular exertion, the cardiovascular system cannot supply oxygen fast enough to meet mitochondrial demand.
- Anaerobic glycolysis produces ATP up to 100 times faster than aerobic pathways, sustaining short, intense contractions.

Why other options are incorrect:

- **Option A:** Glucose is only partially cleaved into lactate, leaving most of its chemical energy trapped in carbon bonds.
- **Option C:** Lactic acid accumulation lowers intracellular pH, contributing to muscle fatigue rather than serving as an advantageous byproduct.
- **Option D:** Glycogen depletion and proton accumulation limit anaerobic glycolysis to brief bursts, preventing indefinite ATP production.

Question #27 Key: (A)BIOLOGY
Federal 2026

Oxidation, decarboxylation and addition of coenzyme-A to pyruvate results into the production o...

CORE CONCEPT & DERIVATION

The mitochondrial pyruvate dehydrogenase multienzyme complex catalyzes the oxidative decarboxylation of pyruvate, generating acetyl-CoA, CO₂, and NADH.

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

- Decarboxylation releases the carboxyl group of 3-carbon pyruvate as CO₂.
- The remaining 2-carbon hydroxyethyl group is oxidized to an acetyl unit while transferring electrons to NAD⁺.
- The acetyl group is transferred to coenzyme A via a high-energy thioester bond, forming acetyl-CoA.

Why other options are incorrect:

- **Option B:** Phosphoenolpyruvate is a high-energy glycolytic precursor converted to pyruvate by pyruvate kinase.
- **Option C:** Glucose-6-phosphate is formed during the initial step of glycolysis by hexokinase.
- **Option D:** Citrate is formed in the subsequent Krebs cycle step via condensation of acetyl-CoA with oxaloacetate.

Question #28 Key: (B)BIOLOGY
Federal 2026

Water maintains the shape and structure of large biological molecules mainly through:

CORE CONCEPT & DERIVATION

The aqueous cellular environment stabilizes macromolecular 3D conformations by forming surface hydrogen bonds with hydrophilic groups while driving nonpolar side chains into shielded hydrophobic cores.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Water molecules form stabilizing hydrogen bonds with polar amino acid residues and nucleic acid bases exposed on molecular surfaces.
- The hydrophobic effect clusters nonpolar residues inward to minimize ordered clathrate-like water cages, maximizing entropy and establishing stable protein and nucleic acid conformations.

Why other options are incorrect:

- **Option A:** Covalent bonds link monomers along the polymer backbone, but water does not form covalent linkages to maintain folded conformation.
- **Option C:** Due to its high dielectric constant, water generally weakens electrostatic ionic interactions between charged groups.
- **Option D:** Disulfide bridges are covalent linkages formed between cysteine thiols, independent of direct water-molecule bonding.

Question #29 Key: (D)BIOLOGY
Federal 2026

The common feature(s) of prokaryotic and eukaryotic cells is/are:

CORE CONCEPT & DERIVATION

All cellular organisms on Earth share foundational cellular components: a bounding phospholipid plasma membrane, ribosomes for translation, and double-stranded DNA as the hereditary genetic material.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Prokaryotes and eukaryotes are enveloped by a selective phospholipid bilayer plasma membrane.
- Both contain ribosomes to translate mRNA transcripts into proteins (70S in prokaryotes and 80S in eukaryotic cytosol).
- Both store hereditary blueprints within double-stranded DNA polymers.

Why other options are incorrect:

- **Option A:** Selecting only the plasma membrane omits shared ribosomes and genetic material.
- **Option B:** Selecting only ribosomes omits the plasma membrane and DNA.
- **Option C:** Selecting only genetic material omits the essential boundaries and translational machinery.

Question #30 Key: (C)BIOLOGY
Federal 2026

Which of the following is biopolymer?

CORE CONCEPT & DERIVATION

A biopolymer is a biological macromolecule assembled from repeating monomeric units joined by covalent bonds; proteins are biopolymers composed of amino acid chains.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Histones are basic nuclear proteins that package DNA into structural nucleosomes.
- Because histones are polypeptides synthesized by polymerizing amino acid monomers via covalent peptide bonds, they are biopolymers.

Why other options are incorrect:

- **Option A:** Water is a simple inorganic triatomic molecule (H_2O).
- **Option B:** Phospholipids are lipids formed by the esterification of glycerol with two fatty acids and a phosphate group, not repeating monomer chains.
- **Option D:** Waxes are esters of long-chain fatty acids with long-chain fatty alcohols, rather than polymeric chains.

Question #31 Key: (B)BIOLOGY
Federal 2026

Information regarding living organism's body processes from construction of body structure to f...

CORE CONCEPT & DERIVATION

Biological molecules (biomolecules), including nucleic acids and proteins, store and transmit the genetic and biochemical instructions that direct structural organization and physiological processes.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Biological molecules provide the structural framework and chemical instructions that govern life from the gene level to the whole organism.
- DNA and RNA encode and transmit information from the nucleus to the cytoplasm, directing protein assembly and metabolic processes.

Why other options are incorrect:

- **Option A:** Biogenic elements are the constituent atoms (C, H, O, N, P, S), but complex biological information resides in macromolecular biomolecules.
- **Option C:** Inorganic molecules (such as mineral salts and water) do not encode genetic or developmental programs.
- **Option D:** Organic molecules encompass synthetic, non-biological chemicals, making biological molecules the precise curriculum term.

Question #32 Key: (B)BIOLOGY
Federal 2026

Peptide bond is formed between:

CORE CONCEPT & DERIVATION

A peptide bond is a covalent amide linkage formed by a condensation (dehydration) reaction between the α -carboxyl group of one amino acid and the α -amino group of another amino acid.

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

- The carboxyl terminus (C-terminal) of the growing peptide chain reacts with the amino terminus (N-terminal) of an incoming amino acid.
- Elimination of a water molecule produces a planar -CO-NH- peptide bond.

Why other options are incorrect:

- **Option A:** Two carboxyl groups cannot condense to form an amide peptide linkage.
- **Option C:** Two amino groups cannot react together to yield a peptide bond.
- **Option D:** The OH group belongs to the carboxyl terminus; this formulation omits the required amino terminal partner.

Question #33 Key: (D)BIOLOGY
Federal 2026*In which of the following organelles, the process of Transcription takes place?***CORE CONCEPT & DERIVATION**

In eukaryotic cells, genomic DNA is housed in the nucleus, where RNA polymerase enzymes transcribe genes into complementary RNA molecules.

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

- Chromatin and the enzymatic transcription machinery reside within the nuclear nucleoplasm.
- RNA polymerases bind to promoter sequences on the nuclear DNA template to synthesize mRNA, tRNA, and rRNA.

Why other options are incorrect:

- **Option A:** Ribosomes are ribonucleoprotein complexes responsible for mRNA translation into protein.
- **Option B:** The Golgi complex modifies, sorts, and packages glycoproteins and lipids.
- **Option C:** Lysosomes contain acid hydrolases that degrade macromolecules and damaged organelles.

Question #34 Key: (B)BIOLOGY
Federal 2026*The approximate diameter of chromatin at the level of supercoiling is:***CORE CONCEPT & DERIVATION**

Eukaryotic DNA packaging progresses from the 10 nm nucleosomal fiber to the 30 nm solenoid, which supercoils into looped domains attached to a protein scaffold, forming a 300 nm fiber.

Formula / Rule / Reaction:

DNA (2 nm) → Nucleosome (10 nm) → Solenoid (30 nm) → Supercoiled loops (300 nm)

Solution:

- The basic 11 nm bead-on-a-string nucleosomal array compacts into a 30 nm chromatin fiber.
- During interphase and chromosome condensation, this 30 nm fiber forms radial loops anchored to a non-histone chromosomal scaffold, yielding a supercoiled diameter of approximately 300 nm.

Why other options are incorrect:

- **Option A:** 250 nm does not correspond to an established level in the standard hierarchical chromatin packaging model.
- **Option C:** 350 nm is not a recognized diameter for chromatin looped domains.
- **Option D:** 400 nm does not match the standardized dimensions described in the biology curriculum.

Question #35 Key: (C)BIOLOGY
Federal 2026

Which of the following organelles predominantly produces Adenosine Triphosphate (ATP) in the ce...

CORE CONCEPT & DERIVATION

Mitochondria generate the majority of cellular ATP via the Krebs cycle and oxidative phosphorylation across the inner mitochondrial membrane.

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

- The inner mitochondrial membrane houses the electron transport chain complexes (I through IV).
- The resulting proton gradient powers the F_0-F_1 ATP synthase to synthesize high volumes of ATP, earning the mitochondrion the title of the powerhouse of the cell.

Why other options are incorrect:

- Option A:** The nucleus contains genetic material and consumes ATP during replication and transcription.
- Option B:** Ribosomes translate mRNA into polypeptides, consuming energy in the form of ATP and GTP.
- Option D:** Endosomes sort endocytosed macromolecules and do not synthesize ATP.

Question #36 Key: (B)BIOLOGY
Federal 2026

In mitochondria, small knob like structures called F_1 particles are found in -----:

CORE CONCEPT & DERIVATION

The inner mitochondrial membrane is invaginated into cristae and contains F_0-F_1 ATP synthase complexes whose knob-like F_1 heads protrude directly into the matrix.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The inner mitochondrial membrane contains the catalytic complexes of the respiratory chain and ATP synthase.
- The F_1 headpiece (the catalytic subunit that synthesizes ATP) is anchored via the hydrophobic F_0 base embedded directly within the inner membrane.

Why other options are incorrect:

- Option A:** The outer mitochondrial membrane is permeable to small solutes via porin channels and lacks ATP-synthesizing F_1 particles.
- Option C:** The intermembrane space (outer compartment) contains accumulated protons, not structural F_1 knobs.
- Option D:** While the F_1 head projects toward the inner matrix space, the complex is an integral structural constituent of the inner membrane.

Question #37 Key: (D)BIOLOGY
Federal 2026

The disaccharide formed during digestion of starch is:

CORE CONCEPT & DERIVATION

Alpha-amylase hydrolyzes internal α -(1,4)-glycosidic linkages of starch to produce the disaccharide maltose.

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

- Salivary and pancreatic amylases break down dietary starch (amylose and amylopectin) into two-glucose units.
- These two α -D-glucose units joined by an α -(1,4)-glycosidic bond constitute the disaccharide maltose.

Why other options are incorrect:

- Option A:** Sucrose is table sugar composed of glucose and fructose; it is synthesized by plants, not formed by starch breakdown.
- Option B:** Cellobiose is composed of two glucose units joined by a β -(1,4) bond, derived from cellulose degradation.
- Option C:** Lactose is a milk disaccharide composed of galactose and glucose.

Question #38 Key: (C)BIOLOGY
Federal 2026

Which of the following is correct about a nucleotide?

CORE CONCEPT & DERIVATION

A nucleotide monomer consists of one nitrogenous base, one five-carbon pentose sugar, and one to three phosphate groups attached to the 5' carbon.

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

- Nucleotides can exist as nucleoside monophosphates (such as AMP), nucleoside diphosphates (such as ADP), or nucleoside triphosphates (such as ATP).
- Every nucleotide contains strictly one base and one pentose sugar.

Why other options are incorrect:

- Option A:** Each nucleotide contains exactly one nitrogenous base, never multiple bases.
- Option B:** Each nucleotide contains only a single pentose sugar molecule.
- Option D:** The sugar component in nucleic acid nucleotides is always a 5-carbon pentose (ribose or deoxyribose), never a 6-carbon hexose.

Question #39 Key: (A)BIOLOGY
Federal 2026

Which of the two nucleotides have 2 ringed structures?

CORE CONCEPT & DERIVATION

Purine nitrogenous bases possess a double-ring (two-ringed) bicyclic structure composed of a fused pyrimidine and imidazole ring; purines include adenine and guanine.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Adenine (A) and guanine (G) are purines and consist of a six-membered ring fused to a five-membered ring.
- Cytosine (C), thymine (T), and uracil (U) are pyrimidines, which contain only a single six-membered heterocyclic ring.

Why other options are incorrect:

- Option B:** Cytosine and thymine are single-ringed pyrimidine bases.
- Option C:** Thymine contains a single pyrimidine ring, although adenine is a double-ringed purine.
- Option D:** Cytosine contains a single ring, although guanine is a double-ringed purine.

Question #40 Key: (B)BIOLOGY
Federal 2026

Which organelle is in abundance in secretory cells?

CORE CONCEPT & DERIVATION

The Golgi apparatus modifies, sorts, and packages newly synthesized proteins from the rough endoplasmic reticulum into secretory granules for exocytosis.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Cells specialized for secretion (such as pancreatic acinar cells, plasma cells, and goblet cells) have extensive secretory pathways.
- The Golgi complex is developed and abundant in these cells to condense secretory proteins and bud off transport vesicles.

Why other options are incorrect:

- **Option A:** Abundant mitochondria characterize cells with high mechanical or transport energy expenditure, such as skeletal muscle or renal proximal tubular cells.
- **Option C:** Normal secretory cells possess a single nucleus; nuclear multiplicity is not a marker of secretory activity.
- **Option D:** Prominent nucleoli indicate active ribosome assembly, but the organelle that processes and packages secretions is the Golgi complex.

Question #41 Key: (D)BIOLOGY
Federal 2026

Olfactory bulb is present in:

CORE CONCEPT & DERIVATION

The olfactory bulb is a neural structure of the vertebrate forebrain (telencephalon) that receives olfactory sensory axons through the cribriform plate.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Primary bipolar sensory neurons reside in the nasal epithelium, but their axons project through the cribriform plate of the ethmoid bone into the cranial cavity.
- These axons synapse in the olfactory bulb, which is an anatomical component of the brain located on the inferior aspect of the frontal lobe.

Why other options are incorrect:

- **Option A:** The external nose contains cartilaginous structures and skin, not the olfactory bulb.
- **Option B:** The nasal cavity houses the sensory olfactory mucosa, but the bulb itself resides intracranially within the skull.
- **Option C:** The throat (pharynx) serves respiratory and digestive transit and does not contain olfactory neural centers.

Question #42 Key: (D)BIOLOGY
Federal 2026

The axon of motor neuron forms synapses with _____?

CORE CONCEPT & DERIVATION

Motor (efferent) neurons conduct action potentials away from the central nervous system to innervate peripheral effector organs, forming neuromuscular junctions with muscle fibers or neuroglandular junctions with glands.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Somatic motor neurons originate in the ventral horn of the spinal cord or brainstem.
- Their terminal axon arborizations form specialized chemical synapses (neuromuscular junctions) on skeletal muscle fibers to stimulate contraction.

Why other options are incorrect:

- **Option A:** Motor axons transmit signals outward to targets; they do not form synapses on afferent sensory axons.
- **Option B:** Sensory dendrons carry impulses inward from receptors toward the sensory cell body.
- **Option C:** Receptors transduce environmental stimuli into electrical signals for sensory neurons, rather than receiving motor output.

Question #44 Key: (C)BIOLOGY
Federal 2026

If there is an injury in the hypothalamus region of the brain, it is most likely to affect:

CORE CONCEPT & DERIVATION

The hypothalamus houses the body's primary thermoregulatory center (preoptic area), integrating temperature signals to control sweating, shivering, and vasomotor tone.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The anterior hypothalamus initiates heat-loss mechanisms, while the posterior hypothalamus triggers heat conservation and heat generation.
- Structural injury to the hypothalamus impairs these homeostatic feedback loops, compromising core temperature regulation.

Why other options are incorrect:

- **Option A:** Coordination of voluntary movements and locomotion is controlled by the cerebellum.
- **Option B:** Short-term memory consolidation is mediated primarily by the hippocampus and temporal lobes.
- **Option D:** High-order decision making and executive planning are functions of the prefrontal cerebral cortex.

Question #43 Key: (A)BIOLOGY
Federal 2026

Which part of the brain stores human memory?

CORE CONCEPT & DERIVATION

Higher cognitive faculties, including memory acquisition, consolidation, and long-term storage, are localized within the cerebrum, particularly the cerebral cortex and hippocampus.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The cerebrum is the site of intellectual and mnemonic functions.
- Memories are consolidated by the hippocampus and stored across distributed neural circuits in the neocortex of the cerebrum.

Why other options are incorrect:

- **Option B:** The medulla oblongata coordinates autonomic vital reflexes, such as respiratory rhythm, vasodilation, and cardiac rate.
- **Option C:** The hypothalamus regulates endocrine release, autonomic balance, water balance, and body temperature.
- **Option D:** The corpus callosum is a commissural tract of myelinated axons facilitating communication between the two cerebral hemispheres.

Question #45 Key: (B)BIOLOGY
Federal 2026*Which one of the following is involved in blinking of an eye?***CORE CONCEPT & DERIVATION**

The blink (corneal) reflex is an involuntary protective cranial reflex integrated within the brainstem, mediated by cranial nerves V and VII.

Formula / Rule / Reaction:

Corneal contact → CN V (Afferent) → Pons → CN VII (Efferent) → Blink

Solution:

- Sensory innervation of the cornea is conveyed via the ophthalmic branch of the trigeminal nerve (cranial nerve V).
- Central interneurons in the brainstem activate motor neurons of the facial nerve (cranial nerve VII), causing contraction of the orbicularis oculi muscle.
- Because its pathways pass entirely through cranial nerves and the brainstem, it is classified as a cranial reflex.

Why other options are incorrect:

- **Option A:** Spinal reflexes (such as the knee-jerk or withdrawal reflex) are integrated within the spinal cord.
- **Option C:** Membrane reflex is not a recognized physiological category of somatic motor reflexes.
- **Option D:** Nuclear reflex is an invalid anatomical classification for somatic protective reflexes.

Question #46 Key: (A)BIOLOGY
Federal 2026*Brain stem include all of the following, Except:***CORE CONCEPT & DERIVATION**

The anatomical brainstem consists of three continuous structures: the midbrain, pons, and medulla oblongata, which connect the higher forebrain centers to the spinal cord.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The brainstem is composed of the midbrain (mesencephalon), pons (part of metencephalon), and medulla oblongata (myelencephalon).
- The cerebrum is the major portion of the forebrain (telencephalon) that sits superior to the brainstem rather than forming part of it.

Why other options are incorrect:

- **Option B:** The pons is an integral brainstem structure located between the midbrain and the medulla.
- **Option C:** The midbrain forms the most rostral division of the brainstem.
- **Option D:** The medulla oblongata is the caudal division of the brainstem continuous with the spinal cord.

Question #47 Key: (B)BIOLOGY
Federal 2026*Which model best explains the specificity of enzymes for their substrate?***CORE CONCEPT & DERIVATION**

Emil Fischer's Lock and Key model illustrates strict stereospecificity, where an enzyme active site possesses a predetermined, rigid conformation complementary to a specific substrate.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Emil Fischer proposed the lock-and-key hypothesis in 1894 to explain why an enzyme acts on only one specific substrate stereoisomer.
- The active site acts as a rigid lock into which only a specific substrate key fits, providing a clear explanation of enzyme specificity.

Why other options are incorrect:

- **Option A:** The induced fit model explains dynamic conformational flexibility and transition state stabilization during catalysis rather than rigid lock-and-key specificity.
- **Option C:** The fluid mosaic model describes the dynamic phospholipid bilayer and protein arrangement of biological membranes.
- **Option D:** The sliding filament model describes sarcomere shortening during muscular contraction.

Question #48 Key: (B)BIOLOGY
Federal 2026*Which of the following truly describe the Activation Energy of an Enzyme?***CORE CONCEPT & DERIVATION**

Activation energy (E_a) is the minimum kinetic energy that colliding reactant molecules must possess to overcome thermodynamic electrostatic repulsion and form the transition state.

Formula / Rule / Reaction:

$$E_a = E_{\text{transition state}} - E_{\text{reactants}}$$

Solution:

- Chemical reactions require an initial input of energy to distort chemical bonds into a reactive transition state configuration.
- This threshold energy requirement is defined as the activation energy.

Why other options are incorrect:

- **Option A:** Total energy comprises internal thermal, vibrational, and chemical bond energy, far exceeding the activation requirement.
- **Option C:** Energy released or lost represents the enthalpy change (ΔH) of an exothermic process.
- **Option D:** The difference in chemical potential energy between reactants and products is the net Gibbs free energy change (ΔG).

Question #49 Key: (A)BIOLOGY
Federal 2026*How does an enzyme increase the rate of a reaction?***CORE CONCEPT & DERIVATION**

Enzymes accelerate biochemical reactions by binding substrates within catalytic clefts, aligning reactive groups in precise spatial orientations that reduce entropy and lower the activation energy barrier.

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

- Enzyme active sites position functional groups of substrates into precise steric proximity, facilitating productive bond-forming collisions.
- This stabilization of the transition state reduces the free energy of activation without changing the overall equilibrium.

Why other options are incorrect:

- **Option B:** Raising the temperature increases random collisions; enzymes constrain collisions into non-random stereospecific interactions.
- **Option C:** Enzymes do not alter the chemical equilibrium position or equilibrium constant (K_{eq}).
- **Option D:** Enzymes do not supply external thermal or chemical energy; they lower the barrier height.

Question #50 Key: (B)BIOLOGY
Federal 2026

Naturally, enzymes increase reaction rate without:

CORE CONCEPT & DERIVATION

A catalyst accelerates the rate of a chemical transformation without undergoing permanent chemical change or being consumed in the overall reaction balance.

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

- Enzymes interact transiently with substrates to form enzyme-substrate (ES) complexes.
- Upon releasing the completed products, the enzyme returns to its original native conformation, ready to catalyze another cycle without net consumption.

Why other options are incorrect:

- Option A:** The fundamental role of an enzyme is the catalytic conversion of substrate molecules into products.
- Option C:** Enzymes increase reaction rate by lowering the activation energy barrier.
- Option D:** Formation of an enzyme-substrate complex is an obligatory intermediate phase of all enzymatic catalysis.

Question #51 Key: (A)BIOLOGY
Federal 2026

Darwin believed in perceived unity of life with _____ related through descent from _____:

CORE CONCEPT & DERIVATION

Charles Darwin's evolutionary framework postulated universal common descent, asserting that all living species share a historical continuum of ancestry originating from common ancestors.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Darwin attributed the perceived unity of life to the descent of all organisms from common ancestors.
- Over deep time, adaptive divergence through natural selection produced the diversity of modern life from shared ancestral lineages.

Why other options are incorrect:

- Option B:** Darwin rejected polyphyletic models proposing multiple unrelated ancestral stems for a few isolated organisms.
- Option C:** Darwin's concept was universal, applying to all living organisms rather than merely a select few.
- Option D:** Separate independent ancestors for all organisms reflects static creationism, the direct opposite of Darwinian evolution.

Question #52 Key: (B)BIOLOGY
Federal 2026

In Darwin's theory of natural selection "struggle for existence" is:

CORE CONCEPT & DERIVATION

The struggle for existence represents the biological competition among organisms for limited environmental resources, such as food, water, light, and shelter, necessary to survive and reproduce.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Because species produce more offspring than the environment can sustain (superfecundity), populations face ecological resource limitations.
- This produces intraspecific and interspecific competition for survival, where organisms possessing favorable adaptations are selected.

Why other options are incorrect:

- **Option A:** Territorial combat is one localized behavioral manifestation, but Darwin's concept broadly encompasses overall survival competition.
- **Option C:** Organisms do not struggle consciously to evolve; evolution is a population-level consequence of differential survival.
- **Option D:** Admitting rights is a human ethical and legal concept irrelevant to evolutionary natural selection.

Question #53 Key: (B)BIOLOGY
Federal 2026

History of life is like a tree. This concept of Darwinism is called:

CORE CONCEPT & DERIVATION

Darwin depicted macroevolution as a branching phylogenetic tree where the common trunk represents ancestral organisms and branching limbs represent lineages that undergo descent with modification.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The tree-of-life metaphor encapsulates descent with modification.
- As ancestral lineages diversify over generations, descendants accumulate structural and physiological modifications suited to their ecological niches.

Why other options are incorrect:

- **Option A:** Natural selection is the differential survival and reproductive mechanism driving adaptive change, not the tree metaphor itself.
- **Option C:** The struggle for existence refers to environmental competition among individuals.
- **Option D:** Overproduction refers to geometric reproductive capacity exceeding carrying capacity.

Question #54 Key: (A)BIOLOGY
Federal 2026

A researcher claims that environment directly induces useful traits in organisms, that are inherited...

CORE CONCEPT & DERIVATION

Jean-Baptiste Lamarck's theory of evolution proposed that environmental needs induce somatic modifications through use and disuse, which are directly transmitted to subsequent generations.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Lamarckism asserts that phenotypic changes acquired during an individual organism's lifetime in response to the environment are inherited by its progeny.
- This hypothesis of the inheritance of acquired characteristics directly matches the researcher's claim.

Why other options are incorrect:

- Option B:** Darwinism relies on preexisting, random variations selected by differential environmental reproductive success.
- Option C:** Special creationism maintains that species are immutable and created independently by supernatural intervention.
- Option D:** Neo-Darwinism synthesizes Mendelian genetics with natural selection, proving that somatic modifications do not alter germline DNA sequences.

Question #55 Key: (C)BIOLOGY
Federal 2026

The first menstrual flow is:

CORE CONCEPT & DERIVATION

Menarche is the developmental occurrence of the first menstrual bleed during female puberty, marking the onset of cyclic ovarian activity.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- During female adolescence, rising pulsatile secretion of GnRH stimulates pituitary gonadotropins, initiating follicle growth and estrogen release.
- The initial sloughing of the built-up endometrium marks the first menstrual bleed, medically designated as menarche.

Why other options are incorrect:

- Option A:** Menopause is the permanent cessation of menstrual cycles resulting from ovarian follicular depletion in late adulthood.
- Option B:** Menstruation is the general recurring physiological term for the regular cyclic shedding of endometrial tissue.
- Option D:** Ovulation is the mid-cycle release of a secondary oocyte from the Graafian follicle.

Question #56 Key: (D)BIOLOGY
Federal 2026

Which of the following is NOT a feature of cartilaginous joints?

CORE CONCEPT & DERIVATION

Cartilaginous joints unite adjacent bones via hyaline cartilage or fibrocartilage, lacking an internal fluid-filled synovial joint cavity.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Cartilaginous joints (synchondroses and symphyses, such as the pubic symphysis and intervertebral discs) feature cartilage tissue directly continuous between articulating bones.
- A distinct joint cavity containing synovial fluid is an anatomical hallmark restricted to synovial (diarthrodial) joints.

Why other options are incorrect:

- Option A:** Cartilaginous joints typically allow slight movement (amphiarthroses).
- Option B:** The absence of synovial fluid is a true characteristic of cartilaginous joints.
- Option C:** The presence of intervening cartilage (hyaline or fibrocartilage) defines these joints.

Question #57 Key: (B)BIOLOGY
Federal 2026

All enzymes are _____ proteins?

CORE CONCEPT & DERIVATION

Enzymes are globular proteins with spherical tertiary conformations that position polar amino acid side chains on the exterior, rendering them soluble in aqueous cellular fluids.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- All biological enzymes are globular proteins folded into precise 3D configurations containing catalytic active sites.
- Hydrophilic residues oriented toward the external surface allow them to form colloidal solutions and dissolve in water.

Why other options are incorrect:

- **Option A:** Insoluble globular proteins would precipitate out of solution, losing metabolic utility.
- **Option C:** Fibrous proteins (such as collagen and keratin) provide structural scaffolding and are insoluble, lacking catalytic active sites.
- **Option D:** Fibrous proteins are insoluble and structural, not catalytic.

Question #59 Key: (C)BIOLOGY
Federal 2026

The cessation (end) of mensuration in female is called:

CORE CONCEPT & DERIVATION

Menopause is the physiological end of menstrual cycles in human females, resulting from the exhaustion of responsive ovarian follicles and the cessation of ovarian estrogen production.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- With aging (typically between 45 and 55 years), the ovaries become unresponsive to gonadotropins due to follicular depletion.
- This causes the permanent cessation of menstruation, designated as menopause.

Why other options are incorrect:

- **Option A:** Menarche marks the onset of the first menstrual flow during puberty.
- **Option B:** The menstrual cycle is the ongoing monthly reproductive rhythm.
- **Option D:** Maturation refers to general biological development rather than the termination of reproductive cycles.

Question #58 Key: (C)BIOLOGY
Federal 2026

A marked increase in temperature reduces rate of the enzyme catalyzed reaction by _____:

CORE CONCEPT & DERIVATION

Excessive thermal kinetic energy disrupts weak non-covalent interactions (hydrogen bonds, ionic linkages, and van der Waals interactions) that maintain the native tertiary architecture of the enzyme.

Formula / Rule / Reaction:

Native Enzyme (Folded Active Site) $\xrightarrow{\Delta T > T_{opt}}$ Denatured Enzyme (Inactivated)

Solution:

- Above the optimum temperature, internal atomic vibrations overcome stabilizing secondary and tertiary bonds.
- This thermal denaturation uncoils the polypeptide chain and disrupts the geometry of the active site, inactivating catalysis.

Why other options are incorrect:

- **Option A:** Increasing temperature raises rather than decreases the kinetic energy of substrate molecules.
- **Option B:** Heating does not directly alter buffer pH to cause thermal enzyme inactivation.
- **Option D:** Thermal denaturation halts catalytic efficiency; it does not lower activation energy.

Question #60 Key: (B)BIOLOGY
Federal 2026

A sudden rise in estrogen levels in females, may leads to which event?

CORE CONCEPT & DERIVATION

In the late follicular phase, high circulating estradiol concentrations switch from negative to positive feedback on the pituitary, triggering a large surge of luteinizing hormone (LH).

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

- As the dominant Graafian follicle matures, it secretes elevated levels of estrogen.
- Once plasma estrogen crosses a critical threshold, it stimulates the anterior pituitary to rapidly release LH, producing the mid-cycle LH surge that triggers ovulation.

Why other options are incorrect:

- **Option A:** Menstruation occurs when progesterone and estrogen levels sharply drop following corpus luteum regression.
- **Option C:** Implantation occurs days after fertilization in the luteal phase, requiring high progesterone.
- **Option D:** Progesterone levels rise after the LH surge as the corpus luteum forms.

Question #61 Key: (C)BIOLOGY
Federal 2026

Which hormone is involved in the menstrual cycle and its secretion is increased right after day...

CORE CONCEPT & DERIVATION

Progesterone is secreted by the corpus luteum during the post-ovulatory luteal phase (days 15 to 28) and by the syncytiotrophoblast of the placenta to maintain gestation if pregnancy occurs.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Following ovulation on day 14, the collapsed follicle reorganizes into the corpus luteum, which secretes abundant progesterone.
- If pregnancy does not occur, the corpus luteum degenerates and progesterone drops; if fertilization occurs, the placenta takes over production, raising progesterone levels further to maintain the endometrium.

Why other options are incorrect:

- **Option A:** Follicle-stimulating hormone (FSH) peaks during the early follicular phase and mid-cycle, not during the post-ovulatory luteal phase.
- **Option B:** Luteinizing hormone (LH) peaks sharply on day 14 and falls precipitously immediately thereafter.
- **Option D:** Both gonadotropins drop to low baseline levels during the luteal phase due to steroid negative feedback.

Question #62 Key: (D)BIOLOGY
Federal 2026*Nerve impulse carried directly to sarcoplasmic reticulum through?***CORE CONCEPT & DERIVATION**

Transverse tubules (T-tubules) are deep tubular invaginations of the sarcolemma that conduct electrical action potentials into the fiber interior to depolarize the terminal cisternae of the sarcoplasmic reticulum.

Formula / Rule / Reaction:

Action Potential $\rightarrow$ T-tubule $\xrightarrow{\text{DHPR/RyR}}$ Ca^{2+} release from Sarcoplasmic Reticulum

Solution:

- When an action potential propagates across the muscle cell surface, it travels into the fiber via transverse tubules (T-tubules).
- Voltage-sensitive dihydropyridine receptors on the T-tubules activate ryanodine receptor channels on the abutting sarcoplasmic reticulum, releasing calcium into the sarcoplasm.

Why other options are incorrect:

- **Option A:** The sarcolemma lines the surface of the fiber; internal transmission requires T-tubule conduits.
- **Option B:** Sarcoplasm is the intracellular fluid of the muscle fiber, not a membrane propagation pathway.
- **Option C:** Nerve fibers terminate at the motor end plate outside the muscle fiber membrane.

Question #63 Key: (A)BIOLOGY
Federal 2026*During muscle contraction, after calcium binds to troponin, the binding sites on which protein ...***CORE CONCEPT & DERIVATION**

Calcium binding to the troponin C subunit induces a conformational shift that rolls tropomyosin out of the groove, uncovering the myosin-binding sites on the actin filament.

Formula / Rule / Reaction:

$\text{Ca}^{2+} + \text{Troponin C} \rightarrow \text{Conformational Shift} \rightarrow \text{Tropomyosin Rolls Away} \rightarrow \text{Actin S}$

Solution:

- In resting muscle, filamentous tropomyosin physically blocks the active sites on actin.
- Upon excitation, Ca^{2+} binds troponin, which pulls tropomyosin aside to expose the binding sites on actin, allowing myosin heads to attach and form cross-bridges.

Why other options are incorrect:

- **Option B:** The myosin heads harbor the actin-binding domains and ATPase sites, but their binding sites on actin are the ones being unmasked.
- **Option C:** Myoglobin is an intracellular oxygen storage hemoprotein that does not participate in cross-bridge formation.
- **Option D:** Tropomyosin is shifted away from the sites, but it is actin that bears the actual myosin-binding sites.

Question #64 Key: (C)BIOLOGY
Federal 2026

Osteoarthritis indicates inflammation in the joints of _____.

CORE CONCEPT & DERIVATION

Osteoarthritis is a degenerative joint disease characterized by progressive breakdown of articular cartilage and secondary subchondral inflammation, most frequently affecting major weight-bearing joints like the knee.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The knee joint endures sustained mechanical stress and bearing loads, making it the most common and clinically significant site of osteoarthritis.
- Friction and cartilage degradation in the knee lead to pain, joint stiffness, and osteophyte formation.

Why other options are incorrect:

- **Option A:** Involvement of the first metatarsophalangeal toe joint is classical for gout rather than typical primary osteoarthritis.
- **Option B:** Cervical spine arthritis is termed cervical spondylosis.
- **Option D:** Symmetric inflammation of the wrist joints is characteristic of rheumatoid arthritis.

Question #65 Key: (B)BIOLOGY
Federal 2026

Which of the following changes occur when skeletal muscles contract?

CORE CONCEPT & DERIVATION

According to the sliding filament model, during sarcomere contraction thin actin filaments slide past thick myosin filaments toward the M-line, shortening the I-bands and H-zone while the length of the A-band remains unchanged.

Formula / Rule / Reaction:

Contraction :↓ Sarcomere Length, ↓ I-band, ↓ H-zone, A-band constant

Solution:

- As cross-bridges pull the thin filaments inward, the distance between adjacent thick filaments (the I-band) narrows.
- Consequently, the I-bands shorten as the Z-discs move closer together.

Why other options are incorrect:

- **Option A:** The A-band corresponds to the full length of the thick myosin filaments and remains constant during contraction.
- **Option C:** The Z-lines move closer together during contraction rather than moving further apart.
- **Option D:** The H-zone narrows and can disappear entirely during maximal contraction.

Question #66 Key: (B)BIOLOGY
Federal 2026

When male parent (RR) has a cross with female parent (rr), then according to Law of segregation...

CORE CONCEPT & DERIVATION

Mendel's Law of Segregation states that parental allele pairs separate during meiosis such that each gamete carries only one allele, producing uniform heterozygous progeny in an $RR \times rr$ cross.

Formula / Rule / Reaction:

$$P_1 : RR \times rr \rightarrow \text{Gametes: } R, r \rightarrow F_1 : Rr \text{ (100\%)}$$

Solution:

- The homozygous dominant male parent produces gametes that all carry the R allele.
- The homozygous recessive female parent produces gametes that all carry the r allele.
- Fertilization unites these gametes to yield 100 percent heterozygous Rr genotypes in the F_1 generation.

Why other options are incorrect:

- **Option A:** Homozygous dominant offspring require both parents to provide an R allele.
- **Option C:** Homozygous recessive offspring require both parents to provide an r allele.
- **Option D:** Triploid genotype Rrr cannot occur from normal diploid gamete fusion.

Question #67 Key: (B)BIOLOGY
Federal 2026

Which of the following genetic disorder cause bleeding disease?

CORE CONCEPT & DERIVATION

Hemophilia is an X-linked recessive genetic coagulopathy caused by a deficiency in coagulation factor VIII (Hemophilia A) or factor IX (Hemophilia B), resulting in impaired hemostasis and prolonged bleeding episodes.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Mutations on the X chromosome cause deficiencies in essential intrinsic clotting factors.
- Failure of the secondary coagulation cascade leads to persistent spontaneous or traumatic hemorrhage into joints (hemarthrosis) and deep tissues.

Why other options are incorrect:

- **Option A:** Sickle cell anemia is a hemoglobinopathy caused by a point mutation in the β -globin gene, causing vaso-occlusive crises and hemolytic anemia.
- **Option C:** Thalassemia is a quantitative hemoglobin synthesis defect leading to microcytic hypochromic anemia.
- **Option D:** Cystic fibrosis is an autosomal recessive disorder of the CFTR chloride channel causing viscous mucus accumulation in lungs and pancreas.

Question #68 Key: (A)BIOLOGY
Federal 2026*Y-linked traits are always passed from father to the:***CORE CONCEPT & DERIVATION**

Y-linked (holandric) genes reside exclusively on the non-homologous portion of the Y chromosome, which is transmitted solely from father to son.

Formula / Rule / Reaction:

Father (XY) → Y chromosome passed exclusively to male progeny (XY)

Solution:

- Human males possess one X and one Y chromosome, while females possess two X chromosomes.
- A father contributes his Y chromosome to all sons and his X chromosome to all daughters, meaning Y-linked traits are passed exclusively to sons.

Why other options are incorrect:

- Option B:** Daughters inherit the paternal X chromosome, never the paternal Y chromosome.
- Option C:** Transmission is 100 percent to sons and zero percent to daughters, not equally divided.
- Option D:** Fractional gender distribution contradicts the chromosomal basis of sex determination.

Question #69 Key: (C)BIOLOGY
Federal 2026*How many different genotypes are required for producing a pea plant with round and yellow seeds...***CORE CONCEPT & DERIVATION**

In Mendelian dihybrid inheritance, the dominant round seed shape (R) and dominant yellow seed color (Y) phenotype corresponds to four distinct genotypic combinations.

Formula / Rule / Reaction:

Phenotype [R_Y_] = {RRYY, RRYy, RrYY, RrYy} ⇒ Total = 4

Solution:

- The round trait can be produced by RR or Rr (2 possibilities).
- The yellow trait can be produced by YY or Yy (2 possibilities).
- Multiplying the independent genotypic possibilities yields $2 \times 2 = 4$ distinct genotypes.

Why other options are incorrect:

- Option A:** One genotype accounts only for the homozygous dominant form (RRYY).
- Option B:** Two genotypes omits the heterozygous combinations across both gene pairs.
- Option D:** Eight genotypes exceeds the total number of genotypic variants capable of displaying this dual dominant phenotype.

Question #70 Key: (B)BIOLOGY
Federal 2026*In which of the following phases of cell cycle, gene crossing over occurs?***CORE CONCEPT & DERIVATION**

Crossing over (homologous genetic recombination) occurs during the pachytene sub-stage of Prophase I in meiosis, where non-sister chromatids exchange reciprocal genetic segments.

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

- During Prophase I of meiosis, homologous chromosomes pair up closely during synapsis to form bivalents (tetrads).
- Chiasmata form between non-sister chromatids, mediating the physical exchange of maternal and paternal DNA during pachytene.

Why other options are incorrect:

- **Option A:** Telophase involves nuclear envelope reassembly and chromosomal decondensation.
- **Option C:** Metaphase I involves alignment of bivalents along the equatorial plate.
- **Option D:** Prophase II occurs in haploid cells without homologous pairing or crossing over.

Question #71 Key: (D)BIOLOGY
Federal 2026*Which of the following best describes the production of different combinations of alleles in da...***CORE CONCEPT & DERIVATION**

Mendel's Law of Independent Assortment is mechanistically driven by the random orientation and alignment of paternal and maternal bivalents along the metaphase I plate.

Formula / Rule / Reaction:

$$\text{Total Gametic Combinations} = 2^n \quad (n = \text{haploid chromosome number})$$

Solution:

- During metaphase I, each pair of homologous chromosomes aligns independently of all other pairs relative to the spindle poles.
- This random positioning yields novel mixtures of maternal and paternal alleles in daughter cells, defining independent assortment.

Why other options are incorrect:

- **Option A:** Segregation refers to the separation of two alleles of a single locus during anaphase.
- **Option B:** Sex linkage refers to genes physically located on the sex chromosomes (X or Y).
- **Option C:** Crossing over is physical non-sister chromatid exchange during Prophase I, not the alignment of bivalents.

Question #72 Key: (D)BIOLOGY
Federal 2026

A genetic disease is transferred from a phenotypically normal but carrier female to only some o...

CORE CONCEPT & DERIVATION

X-linked recessive disorders are transmitted by carrier females ($X^A X^a$) to 50 percent of their sons, who express the phenotype because they are hemizygous ($X^a Y$).

Formula / Rule / Reaction:

$$X^A X^a \times X^A Y \rightarrow \text{Male Offspring: } \frac{1}{2} X^A Y \text{ (Normal)}, \frac{1}{2} X^a Y \text{ (Affected)}$$

Solution:

- Females with one mutant allele remain asymptomatic carriers due to compensation by the normal dominant X allele.
- Sons inherit either the normal or mutant maternal X chromosome with equal probability, resulting in roughly half of the male progeny exhibiting the disorder.

Why other options are incorrect:

- Option A:** Autosomal dominant traits cannot have asymptomatic carriers; any individual possessing the allele exhibits the disease.
- Option B:** Autosomal recessive transmission requires carrier status in both parents, affecting sons and daughters with equal probability.
- Option C:** Sex-linked dominant disorders manifest in heterozygous females, precluding asymptomatic carrier mothers.

Question #73 Key: (B)BIOLOGY
Federal 2026

Which chamber of the heart pumps blood to the lungs?

CORE CONCEPT & DERIVATION

The right ventricle ejects deoxygenated systemic venous blood through the pulmonary semilunar valve into the pulmonary trunk, supplying the pulmonary circulation.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Deoxygenated blood passes from the right atrium through the tricuspid valve into the right ventricle.
- During ventricular systole, the right ventricle contracts, driving blood through the pulmonary arteries to the capillary beds of the lungs for oxygenation.

Why other options are incorrect:

- Option A:** The right atrium receives systemic venous blood from the venae cavae and transfers it into the right ventricle.
- Option C:** The left atrium receives oxygenated blood returning from the lungs via pulmonary veins.
- Option D:** The left ventricle pumps oxygenated blood into the aorta to supply the systemic circulation.

Question #74 Key: (D)BIOLOGY
Federal 2026

Antigens bind with:

CORE CONCEPT & DERIVATION

The antigen-binding fragment (Fab) of an antibody consists of hypervariable (V) domains from both heavy and light chains that form the specific antigen-binding paratope.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The N-terminal domains of immunoglobulin polypeptide chains feature variable amino acid sequences that match target epitopes.
- These variable (V) regions form the paratope cleft that physically binds the antigen.

Why other options are incorrect:

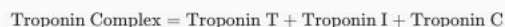
- Option A:** The constant (C) region of the antibody mediates secondary effector functions, such as complement fixation and macrophage Fc-receptor binding.
- Option B:** Antigens possess epitopes rather than standardized V-regions.
- Option C:** Antigens do not possess constant (C) structural regions like immunoglobulins.

Question #75 Key: (C)BIOLOGY
Federal 2026

Which one of the following statements is correct for troponin?

CORE CONCEPT & DERIVATION

Troponin is a heterotrimeric protein complex bound to tropomyosin on the thin filament, composed of three distinct polypeptide subunits: TnT, TnI, and TnC.

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

- Troponin T attaches the complex to tropomyosin.
- Troponin I inhibits actin-myosin interaction in resting muscle.
- Troponin C provides high-affinity binding sites for activating calcium ions.

Why other options are incorrect:

- **Option A:** ATPase activity is an intrinsic enzymatic property of the myosin globular head, not troponin.
- **Option B:** Troponin binds simultaneously to tropomyosin, actin, and calcium ions.
- **Option D:** Myosin does not bind regulatory calcium ions directly to activate contraction; comparisons of calcium affinity are structurally irrelevant.

Question #76 Key: (A)BIOLOGY
Federal 2026

_____ are the bone dissolving cells.

CORE CONCEPT & DERIVATION

Osteoclasts are specialized multinucleated giant cells derived from the monocyte-macrophage lineage that reabsorb and dissolve mineralized bone matrix during remodeling.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Osteoclasts adhere to bone surfaces, forming sealed resorption lacunae (Howship's lacunae).
- They secrete hydrochloric acid to dissolve calcium hydroxyapatite and cathepsin K to degrade collagen, breaking down bone tissue.

Why other options are incorrect:

- **Option B:** Osteocytes are mature bone cells entombed within lacunae that monitor mechanical strain and maintain matrix homeostasis.
- **Option C:** Osteoblasts are bone-forming cells that synthesize osteoid matrix and promote mineralization.
- **Option D:** Only osteoclasts dissolve and resorb bone matrix.

Question #77 Key: (C)BIOLOGY
Federal 2026

Which one of the following statements is incorrect about circulatory system?

CORE CONCEPT & DERIVATION

Vessels are classified directionally relative to the heart: arteries carry blood away from the heart, while veins carry blood toward it, regardless of blood oxygen saturation.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The pulmonary arteries carry deoxygenated blood away from the right ventricle into the lungs.
- Therefore, the assertion that all arteries carry oxygenated blood is physiologically incorrect.

Why other options are incorrect:

- **Option A:** This statement is correct; by anatomical definition, all arteries carry blood away from cardiac ventricles.
- **Option B:** This statement is correct; by anatomical definition, all veins transport blood toward cardiac atria.
- **Option D:** This statement is correct; the venous system is a low-pressure capacitance circuit.

Question #78 Key: (A)BIOLOGY
Federal 2026

Which of the following valves control the entry of blood into the ventricles of a heart?

CORE CONCEPT & DERIVATION

Atrioventricular (AV) valves guard the orifices between the atria and the ventricles, opening during diastole to permit ventricular filling.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The tricuspid valve regulates inflow into the right ventricle, while the bicuspid (mitral) valve regulates inflow into the left ventricle.
- Collectively, these are termed atrioventricular valves.

Why other options are incorrect:

- **Option B:** Semilunar valves control the exit of blood from the ventricles into the arterial outflow tracts.
- **Option C:** The pulmonary semilunar valve guards the outflow from the right ventricle into the pulmonary artery.
- **Option D:** The aortic semilunar valve guards the outflow from the left ventricle into the systemic aorta.

Question #80 Key: (D)BIOLOGY
Federal 2026

Bicuspid valve guards the opening between _____ in a heart.

CORE CONCEPT & DERIVATION

The bicuspid (mitral) valve is the left atrioventricular valve, anatomically situated between the left atrium and left ventricle.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The bicuspid valve consists of two fibrous cusps attached via chordae tendineae to papillary muscles in the left ventricle.
- It prevents retrograde backflow of blood into the left atrium during left ventricular systole.

Why other options are incorrect:

- **Option A:** The pyloric sphincter guards the opening between the stomach and duodenum.
- **Option B:** Pulmonary veins enter the left atrium without true mechanical cuspid valves.
- **Option C:** The tricuspid valve guards the opening between the right atrium and right ventricle.

Question #79 Key: (B)BIOLOGY
Federal 2026

The valve of heart through which only oxygenated blood move is:

CORE CONCEPT & DERIVATION

The left side of the human heart handles fully oxygenated blood returned from the pulmonary circulation, meaning valves on the left side transmit strictly oxygenated blood.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- The bicuspid (mitral) valve is positioned between the left atrium and left ventricle.
- Because the pulmonary veins deliver oxygenated blood to the left atrium, only oxygenated blood flows across the bicuspid valve.

Why other options are incorrect:

- **Option A:** The tricuspid valve handles deoxygenated blood returning from the systemic venae cavae on the right side of the heart.
- **Option C:** The pulmonary semilunar valve handles deoxygenated blood exiting the right ventricle.
- **Option D:** The tricuspid valve transmits deoxygenated blood, making this combined option incorrect.

Question #81 Key: (C)BIOLOGY
Federal 2026

What are antigens, in the context of immune recognition?

CORE CONCEPT & DERIVATION

Antigens are molecular markers (most often foreign proteins, glycoproteins, or cell-surface oligosaccharides) that can be recognized by antibody paratopes or T-cell receptors.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Macromolecular foreign structures, including viral capsid proteins, bacterial wall glycoproteins, and surface oligosaccharides, display antigenic determinants (epitopes).
- These surface macromolecules trigger specific recognition by B-cell and T-cell receptors.

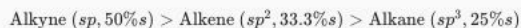
Why other options are incorrect:

- **Option A:** Soluble signaling messengers released during infection are inflammatory cytokines and chemokines, not antigens.
- **Option B:** Circulating plasma lipids are transport molecules (such as lipoproteins), not the foreign antigens that induce adaptive immunity.
- **Option D:** B-cells differentiate into plasma cells that secrete immunoglobulins (antibodies), not antigen molecules.

Question #82 Key: (B)

CHEMISTRY
Federal 2026*Alkenes are less acidic than alkynes due to:***CORE CONCEPT & DERIVATION**

The acidity of a hydrocarbon C-H bond correlates directly with the percentage of *s*-character in the hybridized carbon orbital; higher *s*-character draws electron density closer to the carbon nucleus, stabilizing the resulting carbanion conjugate base.

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

- In alkynes, the terminal carbon is *sp*-hybridized (50% *s*-character).
- In alkenes, the carbon is *sp*²-hybridized (33.3% *s*-character).
- Because alkenes have lesser *s*-character, the carbon is less electronegative, holding conjugate electron pairs less tightly and exhibiting lower acidity.

Why other options are incorrect:

- **Option A:** Alkenes have lower, not higher, *s*-character compared to alkynes.
- **Option C:** Bond strength relates to bond dissociation energy, but acidity is determined by the thermodynamic stability of the conjugate base.
- **Option D:** Carbon in an alkene is less electronegative than the *sp* carbon of an alkyne.

Question #83 Key: (A)

CHEMISTRY
Federal 2026*1,3 Butadiene is more stable than 1-Butene, because it is a:***CORE CONCEPT & DERIVATION**

Conjugated dienes feature alternating single and double carbon-carbon bonds, permitting continuous overlap of unhybridized *p*-orbitals and thermodynamic resonance stabilization.

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

- 1,3-Butadiene possesses two conjugated π -bonds separated by a single σ -bond.
- Delocalization of the four π -electrons across all four carbon centers lowers the electronic energy of the molecule, giving 1,3-butadiene extra stability compared to unconjugated alkenes like 1-butene.

Why other options are incorrect:

- **Option B:** Cumulenes feature adjacent cumulative double bonds (such as allene, C = C = C) and have higher strain.
- **Option C:** Isolated dienes contain two or more single bonds separating the double bonds, preventing stabilizing orbital overlap.
- **Option D:** Separated diene is an informal synonym for an isolated diene.

Question #84 Key: (C)

CHEMISTRY
Federal 2026

Name of [Formula]:

CORE CONCEPT & DERIVATION

In common hydrocarbon nomenclature, a central carbon atom fully substituted by four identical alkyl groups is named by prefixing the alkyl radical name to the parent root 'methane'.

Formula / Rule / Reaction:



Solution:

- The formula depicts a quaternary carbon bonded to four ethyl groups ($-\text{C}_2\text{H}_5$).
- By classical naming, four ethyl groups attached to a single methane carbon form tetraethyl methane.

Why other options are incorrect:

- Option A:** Triethyl methane possesses only three ethyl groups and one hydrogen atom on the central carbon: $\text{CH}(\text{C}_2\text{H}_5)_3$.
- Option B:** Tetramethyl methane describes neopentane, $\text{C}(\text{CH}_3)_4$.
- Option D:** Trimethyl ethane is 2-methylpropane, $\text{CH}(\text{CH}_3)_3$.

Question #85 Key: (C)

CHEMISTRY
Federal 2026

Compared to benzene, nitration of toluene takes place at?

CORE CONCEPT & DERIVATION

The methyl substituent ($-\text{CH}_3$) on toluene is an electron-donating group via hyperconjugation and inductive effect ($+I$), which activates the aromatic ring toward electrophilic aromatic substitution.

Formula / Rule / Reaction:



Solution:

- Nitration requires electrophilic attack by the nitronium ion (NO_2^+) on the π -system.
- Because the methyl group enriches electron density within the aromatic ring and stabilizes the carbocation intermediate, toluene undergoes nitration approximately 25 times faster than benzene.

Why other options are incorrect:

- Option A:** The ring-activating substituent accelerates the reaction rate relative to benzene.
- Option B:** Slower nitration rates are characteristic of rings bearing electron-withdrawing deactivating groups like nitro or halogen substituents.
- Option D:** Very slow rates occur in strongly deactivated rings such as nitrobenzene.

Question #86 Key: (C)

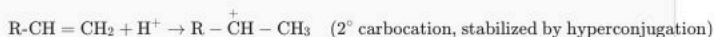
CHEMISTRY
Federal 2026

During hydro halogenation of asymmetric alkenes which rule favors formation of secondary carbocation...

CORE CONCEPT & DERIVATION

Markovnikov's rule dictates that in electrophilic additions to unsymmetrical alkenes, the electrophile (H^+) adds to the carbon with more hydrogen atoms to yield the more stable secondary carbocation intermediate.

Formula / Rule / Reaction:



Solution:

- Proton addition can generate either a primary or a secondary carbocation.
- Because secondary carbocations are more stable than primary ones due to alkyl hyperconjugation and inductive stabilization, reaction pathway proceeds via the secondary cation as formulated by Markovnikov's rule.

Why other options are incorrect:

- Option A:** Hydration rule is not an established chemical reaction law governing regiochemistry.
- Option B:** Anti-Markovnikov addition occurs via free radical mechanisms in the presence of peroxides and proceeds through a primary halide addition pathway.
- Option D:** Polymeros's rule is an invalid scientific distractor.

Question #87 Key: (B)

CHEMISTRY
Federal 2026

Which reagent is used to distinguish 1-butyne and 2-butyne?

CORE CONCEPT & DERIVATION

Terminal alkynes possess an acidic sp -hybridized $C-H$ bond that reacts with ammoniacal silver nitrate (Tollens' reagent) to precipitate silver acetylide, whereas internal alkynes lack an acetylenic hydrogen and do not react.

Formula / Rule / Reaction:



Solution:

- 1-Butyne is a terminal alkyne ($CH_3CH_2C \equiv CH$) and forms an insoluble white precipitate with ammoniacal silver nitrate solution.
- 2-Butyne is an internal alkyne ($CH_3C \equiv CCH_3$) lacking an acidic terminal proton, yielding no precipitate under identical conditions.

Why other options are incorrect:

- Option A:** Hydration using $HgSO_4/H_2SO_4$ converts both alkynes into carbonyl compounds (ketones), which cannot easily distinguish them by visual inspection.
- Option C:** Acidified $KMnO_4$ cleaves both alkynes oxidatively, discharging the purple color in both cases.
- Option D:** Aqueous bromine decolorizes readily with both terminal and internal alkynes via electrophilic addition.

Question #88 Key: (B)

CHEMISTRY
Federal 2026

_____ can be added, to an alkyl halide to increase the no. of carbon atoms in the parent cha...

CORE CONCEPT & DERIVATION

Nucleophilic substitution of an alkyl halide with alcoholic potassium cyanide (KCN) substitutes the halogen with a nitrile ($-C \equiv N$) group, lengthening the carbon chain by one carbon atom.

Formula / Rule / Reaction:



Solution:

- Cyanide ion ($C \equiv N^-$) acts as a strong ambident nucleophile, displacing the halide leaving group.
- This nucleophilic substitution introduces an additional carbon into the organic molecule, which can then be hydrolyzed to a carboxylic acid or reduced to an amine.

Why other options are incorrect:

- **Option A:** Hydrogen cyanide (HCN) is a weak acid and a poor source of free nucleophilic cyanide ions compared to ionic KCN.
- **Option C:** The iodoform test detects methyl ketones and secondary methyl alcohols rather than lengthening alkyl chains.
- **Option D:** Reaction with an amine forms alkylamines without increasing the carbon chain length of the original alkyl group.

Question #89 Key: (A)

CHEMISTRY
Federal 2026

Which reagent gives white precipitates when added to phenol?

CORE CONCEPT & DERIVATION

The hydroxyl group strongly activates the aromatic ring of phenol toward electrophilic aromatic substitution, causing rapid tribromination with bromine water to form a white precipitate of 2,4,6-tribromophenol.

Formula / Rule / Reaction:



Solution:

- Aqueous bromine water donates bromonium electrophiles that substitute at all ortho and para positions of phenol.
- The resulting 2,4,6-tribromophenol is insoluble in water and precipitates out as a distinct white crystalline solid.

Why other options are incorrect:

- **Option B:** Phenol is too weak an acid to react with sodium carbonate; it produces no reaction or precipitate.
- **Option C:** Aqueous NaOH deprotonates phenol to form clear, water-soluble sodium phenoxide.
- **Option D:** Benzoylation under Schotten-Baumann conditions produces phenyl benzoate, not the classic qualitative white precipitate test of bromine water.

Question #90 Key: (C)

CHEMISTRY
Federal 2026

Which of the following is more acidic?

CORE CONCEPT & DERIVATION

Electron-withdrawing substituents stabilize the negative charge on the phenoxide conjugate base through resonance and inductive effects, markedly increasing phenolic acidity.

Formula / Rule / Reaction:

pK_a values: o-Nitrophenol (7.2) < o-Aminophenol (9.7) < Phenol (10.0) < o-Methylphenol (10.3)

Solution:

- The nitro group ($-\text{NO}_2$) is strongly electron-withdrawing through both inductive ($-I$) and resonance ($-M$) effects.
- In ortho-nitrophenol, the phenoxide negative charge is delocalized onto the electronegative oxygens of the nitro group, giving it the lowest pK_a and greatest acidity among the choices.
- Note on board errata: The official board key recorded Option D (*o*-aminophenol). Because the amino group donates electron density via resonance ($+M$) to decrease acidity, *o*-nitrophenol (Option C) is the scientifically correct answer.

Why other options are incorrect:

- Option A:** Unsubstituted phenol lacks stabilizing electron-withdrawing groups and has a higher pK_a (≈ 10.0).
- Option B:** The methyl group donates electron density via inductive and hyperconjugative effects, destabilizing the phenoxide ion and reducing acidity.
- Option D:** The amino group is a strong resonance electron-donating group ($+M$) that destabilizes the conjugate phenoxide base, making it less acidic than ortho-nitrophenol.

Question #91 Key: (B)

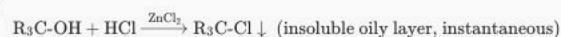
CHEMISTRY
Federal 2026

Which of these compounds reacts immediately with Lucas reagent and forms an oily layer by turni...

CORE CONCEPT & DERIVATION

Lucas reagent (equimolar concentrated HCl and anhydrous ZnCl_2) tests for alcohol classification based on the rate of formation of an insoluble alkyl chloride layer via an $\text{S}_{\text{N}}1$ carbocation pathway.

Formula / Rule / Reaction:



Solution:

- 2-Methyl-2-butanol is a tertiary (3°) alcohol.
- Tertiary alcohols form highly stable tertiary carbocations rapidly, producing an immediate cloudiness and oily phase separation within seconds.

Why other options are incorrect:

- Option A:** 2-Butanol is a secondary (2°) alcohol and requires 5 to 10 minutes to turn turbid.
- Option C:** 1-Propanol is a primary (1°) alcohol that does not react at room temperature, requiring heat.
- Option D:** 4-Methylphenol is an aromatic phenol and does not undergo aliphatic nucleophilic substitution with Lucas reagent.

Question #92 Key: (B)CHEMISTRY
Federal 2026

Which of the following gives positive silver mirror test:

CORE CONCEPT & DERIVATION

Tollens' reagent (ammoniacal silver nitrate) is a mild oxidizing agent that readily oxidizes aldehydes to carboxylate anions while reducing silver ions to metallic silver, depositing a reflective silver mirror on the glass wall.

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

- Acetaldehyde (CH_3CHO) contains an easily oxidizable carbonyl hydrogen atom.
- Reaction with Tollens' reagent precipitates elemental silver as a diagnostic silver mirror.

Why other options are incorrect:

- **Option A:** Ethanol is a primary alcohol that is resistant to mild oxidation by Tollens' reagent.
- **Option C:** Acetic acid is already fully oxidized at its carbonyl center and cannot be further oxidized by Tollens' reagent.
- **Option D:** Acetone is a ketone lacking a carbonyl hydrogen atom, yielding a negative Tollens' test.

Question #93 Key: (C)CHEMISTRY
Federal 2026

Select the acid catalyzed addition reactions of carboxyl compounds from the following:

CORE CONCEPT & DERIVATION

The nucleophilic addition of weak nucleophiles like alcohols to carbonyl groups requires an acid catalyst to protonate the carbonyl oxygen, making the carbonyl carbon electrophilic enough for attack.

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

- Alcohols are neutral, relatively weak nucleophiles that react sluggishly with unactivated carbonyl groups.
- Protonation of the carbonyl oxygen by dry HCl enhances the electrophilicity of the carbonyl carbon, driving the formation of hemiacetals and acetals.

Why other options are incorrect:

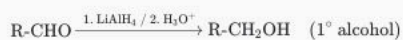
- **Option A:** Grignard reagents are powerful organometallic nucleophiles that undergo direct base-free addition; acid destroys them instantly.
- **Option B:** Addition of sodium bisulphite occurs via direct nucleophilic attack of bisulphite ion without an acid catalyst.
- **Option D:** Addition of hydrogen cyanide is base-catalyzed to generate free cyanide ion (^-CN).

Question #94 Key: (B)CHEMISTRY
Federal 2026

When an aldehyde or ketone is reduced using [Formula], followed by hydrolysis, the resultant w...

CORE CONCEPT & DERIVATION

Lithium aluminum hydride (LiAlH_4) delivers nucleophilic hydride ions (H^-) to the carbonyl carbon, converting aldehydes into primary alcohols and ketones into secondary alcohols.

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

- Hydride attack on an aldehyde yields an alkoxide attached to one alkyl group and two hydrogen atoms, giving a primary (1°) alcohol.
- Hydride attack on a ketone yields an alkoxide attached to two alkyl groups and one hydrogen atom, giving a secondary (2°) alcohol.

Why other options are incorrect:

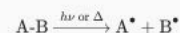
- Option A:** Ketones cannot form primary alcohols because they already possess two alkyl substituents on the carbonyl carbon.
- Option C:** Aldehydes yield primary alcohols upon reduction, never secondary alcohols.
- Option D:** Tertiary alcohols are synthesized from ketones using Grignard reagents, not by hydride reduction.

Question #95 Key: (A)CHEMISTRY
Federal 2026

Free radicals are produced by:

CORE CONCEPT & DERIVATION

Homolytic bond cleavage (homolysis) occurs when a covalent bond breaks symmetrically such that each departing atom retains one of the two shared bonding electrons, generating neutral free radicals.

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

- Under ultraviolet light or high temperature, nonpolar covalent bonds (such as Cl-Cl or peroxides) undergo symmetrical homolytic fission.
- This produces chemical species with unpaired valence electrons, known as free radicals.

Why other options are incorrect:

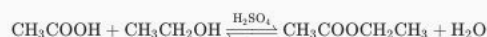
- Option B:** Heterolytic cleavage involves asymmetrical bond breakage where one fragment takes both bonding electrons, forming an anion and a cation.
- Option C:** Reducing agents donate electrons in redox reactions, not directly causing symmetrical homolysis.
- Option D:** Oxidizing agents accept electrons rather than cleaving nonpolar bonds homolytically.

Question #96 Key: (B)CHEMISTRY
Federal 2026

Acetic acid and ethanol reacts to produce:

CORE CONCEPT & DERIVATION

Fischer esterification involves the acid-catalyzed condensation of a carboxylic acid with an alcohol to yield an ester and water.

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

- Acetic acid (ethanoic acid) combines with ethanol in the presence of concentrated sulfuric acid as a dehydrating catalyst.
- The resulting sweet-smelling ester product is ethyl acetate (ethyl ethanoate).

Why other options are incorrect:

- Option A:** Aldehydes are obtained by controlled oxidation of primary alcohols.
- Option C:** Nitriles contain a cyano ($-\text{C} \equiv \text{N}$) group, absent in this oxygen-based esterification.
- Option D:** Ketones are produced by oxidation of secondary alcohols.

Question #97 Key: (B)CHEMISTRY
Federal 2026

Prosthetic groups are part of the following protein:

CORE CONCEPT & DERIVATION

Conjugated (complex) proteins are composed of a simple protein framework covalently or tightly bound to a non-protein component termed a prosthetic group.

Formula / Rule / Reaction:

Conjugated Protein = Apoprotein (polypeptide) + Prosthetic Group (non-protein)

Solution:

- Proteins like hemoglobin contain a polypeptide globin moiety united with a non-protein iron-porphyrin prosthetic group (heme).
- This structure classifies them as conjugated proteins.

Why other options are incorrect:

- Option A:** Derived proteins are denaturation or hydrolysis fragments formed from native proteins (such as peptones or proteoses).
- Option C:** Simple proteins yield exclusively amino acids upon complete hydrolysis (such as albumin and globulin).
- Option D:** Non-derived is not a recognized biochemical category of protein classification.

Question #98 Key: (B)CHEMISTRY
Federal 2026

Acrylate base polymers are:

CORE CONCEPT & DERIVATION

Polyacrylate polymers form viscoelastic materials that adhere firmly to surfaces under light, momentary mechanical pressure without requiring solvent evaporation or heat activation, functioning as pressure-sensitive adhesives (PSAs).

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Acrylic ester polymers (polyacrylates) maintain low glass transition temperatures and high tackiness.
- This enables them to wet and bond to substrates upon light application of pressure, forming the chemical foundation of pressure-sensitive adhesive tapes and labels.

Why other options are incorrect:

- Option A:** Drying adhesives set through the evaporation of solvent or water (such as white PVA glue).
- Option C:** Contact adhesives are polychloroprene (neoprene) rubber formulations applied to both mating surfaces.
- Option D:** Hot adhesives (hot-melt) are solid thermoplastics (like ethylene-vinyl acetate) applied in molten form.

Question #99 Key: (C)CHEMISTRY
Federal 2026What does the symbol (Δ) in a chemical equation represent?**CORE CONCEPT & DERIVATION**In standard chemical reaction notation, the Greek capital letter delta (Δ) positioned above or below the reaction arrow indicates the application of heat to drive the reaction.**Formula / Rule / Reaction:****Solution:**

- A delta symbol written over a reaction arrow signifies thermal activation or heating of the reaction mixture.

Why other options are incorrect:

- Option A:** Density is represented by the lower case Greek letter rho (ρ) or d .
- Option B:** Reaction direction is indicated by horizontal arrows ($\rightarrow$ or $\rightleftharpoons$).
- Option D:** Pressure conditions are specified using the letter P or designated numerical values in atmospheres (atm).

Question #100 Key: (B)

CHEMISTRY
Federal 2026

Calculate the number of molecules in 244g of benzoic acid? ([Formula])

CORE CONCEPT & DERIVATION

The number of molecules in a given sample mass is calculated by multiplying the number of moles by Avogadro's number ($N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$).

Formula / Rule / Reaction:

$$n = \frac{m}{M}, \quad N = n \times N_A$$

Solution:

- Molar mass of benzoic acid ($\text{C}_7\text{H}_6\text{O}_2$):
 $M = (7 \times 12) + (6 \times 1) + (2 \times 16) = 84 + 6 + 32 = 122 \text{ g/mol}$.
- Number of moles in 244 g:
 $n = \frac{244 \text{ g}}{122 \text{ g/mol}} = 2.0 \text{ mol}$.
- Number of molecules:
 $N = 2.0 \times 6.022 \times 10^{23} = 1.204 \times 10^{24} \approx 1.2 \times 10^{24} \text{ molecules}$.

Why other options are incorrect:

- **Option A:** $12 \times 10^{22} = 1.2 \times 10^{23}$, an error by an order of magnitude.
- **Option C:** 0.12×10^{21} contains an incorrect exponent.
- **Option D:** $12 \times 10^{24} = 1.2 \times 10^{25}$, which overstates the molecular count by a factor of 10.

Question #102 Key: (D)

CHEMISTRY
Federal 2026

Methanol is manufactured by reacting carbon dioxide and hydrogen.
 $\text{CO}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{l}) + \text{H}_2\text{O}(\text{l})$

CORE CONCEPT & DERIVATION

According to Le Chatelier's principle, lowering the temperature of an exothermic reaction ($\Delta H < 0$) shifts the equilibrium toward the forward, heat-releasing direction, increasing product yield.

Formula / Rule / Reaction:

$$\Delta H = -49 \text{ kJ/mol} \implies \text{Exothermic: Heat is a product}$$

Solution:

- Because the synthesis of methanol releases heat, removing heat by cooling the system shifts the equilibrium toward the products.
- Therefore, decreasing the temperature increases the equilibrium yield of methanol.

Why other options are incorrect:

- **Option A:** Adding methanol introduces product, shifting equilibrium backward toward reactants.
- **Option B:** Adding steam ($\text{H}_2\text{O}(\text{g})$) introduces product, driving the equilibrium in reverse.
- **Option C:** The forward reaction decreases gas moles (from 4 moles of reactants to 2 moles of products); decreasing pressure shifts equilibrium toward the side with more gas moles (reverse).

Question #101 Key: (C)

CHEMISTRY
Federal 2026

The probability of spin of an electron is supposed to be:

CORE CONCEPT & DERIVATION

In the absence of an external magnetic field, the two degenerate spin quantum states of an electron ($m_s = +1/2$ and $m_s = -1/2$) are equiprobable.

Formula / Rule / Reaction:

$$P(m_s = +1/2) = P(m_s = -1/2) = 0.50 \quad (50\%)$$

Solution:

- An electron exhibits an intrinsic spin angular momentum with two possible orientations: spin-up (clockwise) and spin-down (counterclockwise).
- Because both spin projections possess identical energy in field-free space, the probability of an electron having either spin state is exactly 50 percent.

Why other options are incorrect:

- **Options A, B, and D:** Unequal probabilities violate quantum mechanical time-reversal symmetry and spatial isotropy in an unmagnetized state.

Question #103 Key: (A)

CHEMISTRY
Federal 2026*The order of reaction of an elementary reaction is:***CORE CONCEPT & DERIVATION**

An elementary reaction occurs in a single mechanistic step through a single transition state; therefore, its reaction order with respect to each reactant equals its stoichiometric coefficient, making the overall order equal to its molecularity.

Formula / Rule / Reaction:

For elementary step: $aA + bB \rightarrow \text{Products} \implies \text{Rate} = k[A]^a[B]^b \implies \text{Order} = a + b = \text{Molecularity}$

Solution:

- Molecularity is the number of reactant particles colliding simultaneously in an elementary step.
- Because no intermediate stages exist, the kinetic order matches the molecularity directly.

Why other options are incorrect:

- **Option B:** Temperature affects the rate constant (k) via the Arrhenius equation, but does not alter the stoichiometric reaction order.
- **Option C:** While complex multi-step reactions require empirical determination, an elementary reaction's order can be deduced directly from its balanced molecular equation.
- **Option D:** Reaction order is an inherent power dependency independent of reactant concentration levels.

Question #104 Key: (C)

CHEMISTRY
Federal 2026*The rate of reaction when concentration becomes unity is called:***CORE CONCEPT & DERIVATION**

The specific rate constant (k) is numerically equal to the rate of a chemical reaction when the molar concentrations of all reactants are set to unity (1 mol/dm^3).

Formula / Rule / Reaction:

$$\text{Rate} = k[A]^x[B]^y \implies \text{When } [A] = [B] = 1.0 \text{ M, Rate} = k$$

Solution:

- Setting all concentration terms to unity reduces the rate law expression to the proportionality constant k .
- Hence, the rate constant is also called the specific reaction rate.

Why other options are incorrect:

- **Option A:** Average rate is the finite concentration change divided by elapsed time interval ($\Delta c / \Delta t$).
- **Option B:** Instantaneous rate is the derivative rate at a specific point in time (dc/dt).
- **Option D:** Rate of reaction varies continuously as concentrations change, rather than representing the normalized proportionality constant.

Question #105 Key: (B)

CHEMISTRY
Federal 2026

If enthalpy change of a reaction is negative, then by increasing temperature reaction will move...

CORE CONCEPT & DERIVATION

In an exothermic reaction ($\Delta H < 0$), thermal energy acts as a product; increasing the temperature shifts the equilibrium in the endothermic reverse direction to absorb added heat.

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

- According to Le Chatelier's principle, a system at equilibrium responds to stress by opposing the disturbance.
- Supplying heat to an exothermic system favors the backward reaction that consumes heat, causing the net reaction to move in the reverse direction.

Why other options are incorrect:

- **Option A:** The forward reaction is favored by heating in an endothermic reaction ($\Delta H > 0$), not an exothermic one.
- **Option C:** Temperature variation alters the equilibrium constant (K) and shifts equilibrium composition.
- **Option D:** The directional shift is continuous and uniform, not biphasic.

Question #106 Key: (A)

CHEMISTRY
Federal 2026

Which element will undergo oxidation preferably:

CORE CONCEPT & DERIVATION

Standard reduction potential (E°) measures the tendency of a species to gain electrons; a lower (more negative) reduction potential corresponds to a higher oxidation potential, indicating a greater tendency to lose electrons and undergo oxidation.

Formula / Rule / Reaction:

$$E^\circ_{\text{oxidation}} = -E^\circ_{\text{reduction}}$$

Solution:

- Elements positioned at the top of the electrochemical activity series (such as alkali metals) exhibit strongly negative standard reduction potentials.
- Having a low reduction potential means they possess high oxidation potential, losing electrons and undergoing oxidation preferably.

Why other options are incorrect:

- **Option B:** High reduction potentials indicate a strong propensity to undergo reduction (such as fluorine, +2.87 V).
- **Option C:** A low oxidation potential indicates resistance to oxidation.
- **Option D:** Standard reduction potential values reliably predict redox direction.

Question #107 Key: (B)

CHEMISTRY
Federal 2026

In a redox reaction, the reducing agent is the species that:

CORE CONCEPT & DERIVATION

A reducing agent reduces another chemical species by donating electrons; in doing so, the reducing agent loses electrons and undergoes oxidation.

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

- By supplying electrons to the substance being reduced, the reducing agent loses electrons.
- This loss of electrons corresponds to an increase in its oxidation number.

Why other options are incorrect:

- **Option A:** The species that gains electrons is the oxidizing agent, which is reduced.
- **Option C:** Spectator ions remain unchanged; the reducing agent participates in electron transfer.
- **Option D:** A decrease in oxidation state reflects reduction, which occurs in the oxidizing agent.

Question #108 Key: (C)

CHEMISTRY
Federal 2026

The surface of Triton, a moon of Neptune, contains condensed methane that flows rapidly. Which ...

CORE CONCEPT & DERIVATION

Fluid viscosity and resistance to flow are governed by the strength of intermolecular attractions; non-polar molecules held solely by weak London dispersion forces slide past one another easily, resulting in low viscosity and rapid flow.

Formula / Rule / Reaction:

$$\text{Viscosity } (\eta) \propto \text{Strength of Intermolecular Forces}$$

Solution:

- Methane (CH_4) is a nonpolar symmetrical molecule lacking permanent dipoles or hydrogen bonding.
- Methane molecules in liquid form are held only by weak, temporary induced dipole (London dispersion) forces, resulting in low shear resistance and rapid flow.

Why other options are incorrect:

- **Option A:** Methane is a molecular covalent substance, not a metallic lattice.
- **Option B:** Strong intramolecular C-H covalent bonds hold atoms together within the molecule, but flow depends on intermolecular forces between distinct molecules.
- **Option D:** Tetrahedral geometry accounts for non-polarity, but the direct physical cause of rapid fluid flow is weak intermolecular attraction.

Question #109 Key: (C)

CHEMISTRY
Federal 2026

Which of the following statement is true for water (temperature between [Formula] to [Formula]) ...

CORE CONCEPT & DERIVATION

Water displays anomalous expansion between 4°C and 0°C; upon cooling across this range, hydrogen bonding organizes into an open cage-like hexagonal lattice, increasing volume and decreasing density.

Formula / Rule / Reaction:

$$\text{From } 4^{\circ}\text{C} \rightarrow 0^{\circ}\text{C}: \uparrow V \Rightarrow \downarrow \rho \quad \left(\rho = \frac{m}{V}\right)$$

Solution:

- Water attains its maximum density at 4°C (1.000 g/cm³).
- Cooling below 4°C causes water molecules to expand into open hydrogen-bonded clusters, lowering its density until ice forms at 0°C (0.917 g/cm³).

Why other options are incorrect:

- **Option A:** The volume of water expands (increases) on cooling between 4°C and 0°C.
- **Option B:** Density decreases rather than increases upon cooling across this interval.
- **Option D:** Mass is conserved during temperature changes in a closed system.

Question #110 Key: (D)

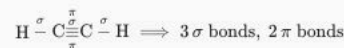
CHEMISTRY
Federal 2026

Number of sigma bond and pi bonds in acetylene are?

CORE CONCEPT & DERIVATION

Acetylene (ethyne, C₂H₂) contains a carbon-carbon triple bond and two carbon-hydrogen single bonds, with the triple bond composed of one σ bond and two perpendicular π bonds.

Formula / Rule / Reaction:



Solution:

- Two C-H single bonds are σ bonds (2).
- The C $\equiv$ C triple bond consists of one $sp-sp$ σ bond and two mutually perpendicular unhybridized $p-p$ π bonds.
- Summing these yields a total of 3 σ bonds and 2 π bonds.

Why other options are incorrect:

- **Option A:** Omits one of the two π bonds in the triple bond.
- **Option B:** Inverts the counts for σ and π bonds.
- **Option C:** 5 σ bonds would correspond to a saturated hydrocarbon such as ethane.

Question #111 Key: (C)

CHEMISTRY
Federal 2026

Which compound will have a maximum dipole moment?

CORE CONCEPT & DERIVATION

Molecular dipole moment is the vector sum of individual bond dipoles; highly symmetrical molecules have opposing bond dipoles that cancel to zero, whereas asymmetric polar molecules retain a substantial net dipole moment.

Formula / Rule / Reaction:

$$\vec{\mu}_{\text{net}} = \sum \vec{\mu}_{\text{bond}}$$

Solution:

- Methane (CH₄) and carbon tetrachloride (CCl₄) are regular tetrahedral molecules where bond dipole vectors cancel, resulting in $\mu = 0$ D.
- Ethene (C₂H₄) is planar and centrosymmetric, yielding $\mu = 0$ D.
- Chloromethane (CH₃Cl) possesses an electronegative chlorine substituent that breaks tetrahedral symmetry, generating a strong net dipole moment ($\mu \approx 1.87$ D).

Why other options are incorrect:

- **Options A, B, and D:** All have net dipole moments of zero due to spatial symmetry.

Question #112 Key: (B)

CHEMISTRY
Federal 2026

An ion with a trinegative charge (-3) has valence shell electronic configuration of [Formula]

CORE CONCEPT & DERIVATION

The group and period of an element are determined by the electronic configuration of its neutral ground state, where the highest principal quantum number (n) indicates the period and the valence electron count determines the group.

Formula / Rule / Reaction:

$$\text{Total electrons in } X^{3-} = 2 + 2 + 6 + 2 + 6 = 18 \implies Z = 18 - 3 = 15$$

Solution:

- The neutral atom has atomic number $Z = 15$, which is Phosphorus (P).
- Its ground state configuration is $1s^2 2s^2 2p^6 3s^2 3p^3$.
- The highest principal quantum number is $n = 3$ (Period III).
- The number of valence electrons is $2 + 3 = 5$, placing it in Group VA (Group 15).

Why other options are incorrect:

- Option A:** Group IIIA elements possess 3 valence electrons ($s^2 p^1$), such as Aluminum.
- Option C:** Period V corresponds to valence electrons filling the $n = 5$ shell.
- Option D:** Period V corresponds to elements such as Antimony (Sb), not $n = 3$.

Question #113 Key: (B)

CHEMISTRY
Federal 2026

If the temperature of a gas is doubled at constant pressure, what will be its volume:

CORE CONCEPT & DERIVATION

Charles's law states that at constant pressure, the volume of a fixed mass of an ideal gas is directly proportional to its absolute thermodynamic temperature.

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:

- Given that temperature is doubled, $T_2 = 2T_1$.
- Substituting into Charles's law yields:

$$V_2 = V_1 \left(\frac{2T_1}{T_1} \right) = 2V_1$$
- Thus, the volume of the gas is doubled.

Why other options are incorrect:

- Option A:** Volume is halved when pressure is doubled at constant temperature (Boyle's law).
- Option C:** Volume cannot remain constant unless the container is rigid (isochoric process).
- Option D:** Volume quadrupling would require a fourfold increase in absolute temperature.

Question #114 Key: (B)

CHEMISTRY
Federal 2026

Which pair of compounds form hydrogen bond?

CORE CONCEPT & DERIVATION

Carboxylic acids possess both strongly polarized hydrogen bond donor hydroxyl groups (—O—H) and hydrogen bond acceptor carbonyl groups (C=O), enabling them to form stable intermolecular cyclic hydrogen-bonded networks.

Formula / Rule / Reaction:



Solution:

- Both formic acid (HCOOH) and acetic acid (CH_3COOH) contain highly electronegative oxygen atoms bound to acidic hydrogen atoms.
- When mixed, they form strong intermolecular hydrogen bonds with each other, producing stable dimeric complexes.

Why other options are incorrect:

- Option A:** Acetaldehyde lacks an O—H bond, so it can only accept hydrogen bonds, not form reciprocal networks as effectively as carboxylic acid pairs.
- Option C:** Ethyl acetate is an ester and lacks a hydrogen bond donor —O—H proton.
- Option D:** Although acetone accepts hydrogen bonds from water, carboxylic acid pairs form reciprocal dual hydrogen-bonded dimers emphasized in organic chemistry curricula.

Question #115 Key: (C)

CHEMISTRY
Federal 2026For an element "X", if the value of Principle quantum number [Formula], the largest value of m_l ...

CORE CONCEPT & DERIVATION

For a principal quantum number n , the azimuthal quantum number l ranges from 0 to $n - 1$, and the magnetic quantum number m_l takes integral values ranging from $-l$ to $+l$.

Formula / Rule / Reaction:

$$l_{\max} = n - 1, \quad m_{l,\max} = +l_{\max}$$

Solution:

- For $n = 4$, the possible values of l are 0, 1, 2, 3.
- The maximum value of l is $l = 3$ (corresponding to the f -subshell).
- For $l = 3$, m_l spans from $-3, -2, -1, 0, +1, +2, +3$.
- Hence, the largest value of the magnetic quantum number is $+3$.

Why other options are incorrect:

- Options A and B:** Submaximum values corresponding to p ($l = 1$) and d ($l = 2$) subshells.
- Option D:** A value of $+4$ would require $l = 4$, which is not permitted for the $n = 4$ shell.

Question #116 Key: (A)

CHEMISTRY
Federal 2026

A photon is moving with wave number [Formula], its frequency is:

CORE CONCEPT & DERIVATION

Wavenumber ($\bar{\nu}$) is the reciprocal of wavelength ($1/\lambda$); frequency (ν) is related to wavenumber by the speed of light (c).

Formula / Rule / Reaction:

$$\nu = c \times \bar{\nu}$$

Solution:

- Given wavenumber $\bar{\nu} = 1.5 \times 10^{10} \text{ m}^{-1}$ and $c = 3.0 \times 10^8 \text{ m/s}$.
- Calculate frequency:

$$\nu = (3.0 \times 10^8 \text{ m/s}) \times (1.5 \times 10^{10} \text{ m}^{-1}) = 4.5 \times 10^{18} \text{ s}^{-1} (\text{Hz})$$

Why other options are incorrect:

- Option B:** Represents an arithmetic error omitting the factor of 1.5.
- Option C:** Possesses an inverted negative exponent.
- Option D:** Erroneous magnitude and negative sign in the exponent.

Question #117 Key: (C)

CHEMISTRY
Federal 2026

Ideal gas equation for one mole of [Formula] is:

CORE CONCEPT & DERIVATION

The general ideal gas law is $PV = nRT$; when specified for one mole of gas ($n = 1$), rearranging the expression gives $PV/RT = 1$.

Formula / Rule / Reaction:

$$PV = nRT \xrightarrow{n=1} PV = RT \Rightarrow \frac{PV}{RT} = 1$$

Solution:

- For exactly 1 mole of any ideal gas (including H_2), substituting $n = 1$ yields $PV = RT$.
- Dividing both sides by RT yields the normalized molar compressibility expression $PV/RT = 1$.

Why other options are incorrect:

- Option A:** Contains the variable n , representing the generalized equation for n moles rather than evaluated for 1 mole.
- Option B:** The combined gas law comparing two states of a gas.
- Option D:** An algebraically invalid expression with mismatched subscripts.

Question #118 Key: (A)

CHEMISTRY
Federal 2026

Value of concentration for 1 mol of an ideal gas at STP will be:

CORE CONCEPT & DERIVATION

Molar concentration (molarity) is the ratio of moles to volume in liters; at standard temperature and pressure (STP), 1 mole of an ideal gas occupies a molar volume of 22.414 dm^3 .

Formula / Rule / Reaction:

$$C = \frac{n}{V_m} = \frac{1 \text{ mol}}{22.414 \text{ dm}^3}$$

Solution:

- Dividing 1 mole by standard molar volume:

$$C = \frac{1}{22.414} \approx 0.0446 \text{ mol/dm}^3 \approx 0.04 \text{ mol/L}$$
- Rounding to two decimal places yields 0.04.

Why other options are incorrect:

- Option B:** 0.40 is larger by an order of magnitude.
- Option C:** 4.40 represents an error in decimal point placement.
- Option D:** 4.00 is 100 times larger than the correct molar concentration.

Question #119 Key: (D)

CHEMISTRY
Federal 2026

The ideal gas equation is a combination of laws:

CORE CONCEPT & DERIVATION

The ideal gas equation ($PV = nRT$) is derived by combining Boyle's law, Charles's law, and Avogadro's law into a unified relationship.

Formula / Rule / Reaction:

$$V \propto \frac{1}{P} \text{ (Boyle)}, \quad V \propto T \text{ (Charles)}, \quad V \propto n \text{ (Avogadro)} \Rightarrow V \propto \frac{nT}{P} \Rightarrow PV = nRT$$

Solution:

- Boyle's law contributes the inverse pressure dependence.
- Charles's law contributes direct temperature dependence.
- Avogadro's law contributes direct dependence on amount of substance.
- Synthesizing all three produces the universal ideal gas law.

Why other options are incorrect:

- Options A, B, and C:** Each omits one of the three foundational gas laws.

Question #120 Key: (A)

CHEMISTRY
Federal 2026

In body centered crystal system the central ion is attach with,

CORE CONCEPT & DERIVATION

In a body-centered cubic (BCC) lattice, the atom or ion positioned at the exact geometrical center of the cube lies entirely within that individual unit cell and is not shared with any neighboring unit cell.

Formula / Rule / Reaction:

$$\text{Contribution of center particle} = 1 \times 1 = 1$$

Solution:

- Corner particles of a cubic cell are shared among 8 adjacent unit cells (contribution $1/8$).
- Face-centered particles are shared between 2 unit cells (contribution $1/2$).
- The body-centered particle resides entirely within the interior, belonging strictly to that 1 unit cell.

Why other options are incorrect:

- **Option B:** Edge particles are shared among 4 unit cells.
- **Option C:** Central particles are not shared across 6 cells; octahedral coordination refers to neighboring ions, not unit cell sharing.
- **Option D:** 10 unit cells is geometrically impossible for cubic crystallographic sharing.

Question #121 Key: (A)

CHEMISTRY
Federal 2026

For an endothermic reversible reaction, the yield will increase if:

CORE CONCEPT & DERIVATION

In an endothermic equilibrium reaction ($\Delta H > 0$), heat is absorbed as a reactant; increasing the temperature shifts the equilibrium forward, raising product yield.

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

- According to Le Chatelier's principle, adding heat favors the endothermic forward reaction to consume the added thermal energy.
- This forward shift raises the equilibrium constant (K) and increases product yield.

Why other options are incorrect:

- **Option B:** Lowering temperature shifts an endothermic reaction in reverse, lowering product yield.
- **Option C:** Catalysts accelerate forward and reverse rates equally without changing equilibrium yield.
- **Option D:** Removing reactants shifts the equilibrium backward, decreasing product yield.

Question #122 Key: (D)

CHEMISTRY
Federal 2026

Which of the following elements has the lowest electronegativity value?

CORE CONCEPT & DERIVATION

Electronegativity decreases down a group due to increased shielding and atomic radius, and increases across a period; alkali metals at the bottom of Group 1 exhibit the lowest electronegativities.

Formula / Rule / Reaction:

Pauling Electronegativities: Cs (0.79) < Li (1.0) < I (2.5) < F (4.0)

Solution:

- Cesium (Cs) is located at the bottom left of the representative periodic table.
- Its large atomic radius and heavy core shielding make it hold valence electrons very weakly, giving it an electronegativity of approximately 0.79, the lowest among the options.

Why other options are incorrect:

- **Option A:** Fluorine has the highest electronegativity on the periodic table (4.0).
- **Option B:** Iodine is a halogen with a relatively high electronegativity of 2.5.
- **Option C:** Lithium is a Group 1 element with an electronegativity of 1.0, higher than cesium.

Question #123 Key: (A)

CHEMISTRY
Federal 2026

Sodium metal reacts with ice cold water to produce:

CORE CONCEPT & DERIVATION

Alkali metals react vigorously and exothermically with liquid water, even at freezing temperatures, displacing hydrogen to yield an aqueous metal hydroxide and hydrogen gas.

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

- Sodium readily loses its single valence electron to reduce water protons into hydrogen gas.
- The residual solution becomes strongly alkaline due to the formation of sodium hydroxide (NaOH).

Why other options are incorrect:

- **Option B:** Sodium monoxide (Na_2O) is formed by heating sodium with limited oxygen, not by reaction with liquid water.
- **Option C:** Sodium peroxide (Na_2O_2) is formed by burning sodium in excess air or oxygen.
- **Option D:** Sodium chloride requires a chlorine source, which is absent in pure water.

Question #124 Key: (C)

CHEMISTRY
Federal 2026

Outer-Transition elements are also called;

CORE CONCEPT & DERIVATION

The transition elements of the periodic table are divided into d-block outer-transition elements (filling $(n-1)d$ subshells) and f-block inner-transition elements (filling $(n-2)f$ subshells).

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Elements in Groups 3 through 12 where the incoming electron enters the penultimate d -subshell are called transition elements or outer-transition elements.
- Lanthanides and actinides in the f -block are termed inner-transition elements.

Why other options are incorrect:

- **Option A:** The s -block contains alkali and alkaline earth metals (representative elements).
- **Option B:** The p -block contains representative non-metals, metalloids, and post-transition metals.
- **Option D:** The f -block elements are classified specifically as inner-transition elements.

Question #125 Key: (C)

CHEMISTRY
Federal 2026

Those molecules which have chiral center but not mirror image of one another is called:

CORE CONCEPT & DERIVATION

Diastereomers are stereoisomers that possess two or more chiral centers and are not mirror images of each other, displaying different physical and chemical properties.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Enantiomers are stereoisomers that are non-superimposable mirror images.
- Stereoisomers with chiral centers that are non-superimposable and not mirror images are defined as diastereomers.

Why other options are incorrect:

- **Option A:** Epimers are a specific subset of diastereomers that differ at only one of several stereocenters.
- **Option B:** Enantiomers are stereoisomers that are nonsuperimposable mirror images of each other.
- **Option D:** Anomers are cyclic carbohydrate stereoisomers differing only at the hemiacetal or hemiketal anomeric carbon.

Question #126 Key: (A)

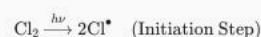
CHEMISTRY
Federal 2026

Select free radical involved in initiation of halogenation of methane:

CORE CONCEPT & DERIVATION

The photochemical free radical halogenation of methane begins with an initiation step where ultraviolet light homolytically cleaves the chlorine-chlorine bond into chlorine free radicals.

Formula / Rule / Reaction:



Solution:

- The Cl-Cl single bond has a lower bond dissociation energy (242 kJ/mol) than the C-H bond of methane (413 kJ/mol).
- Absorption of light triggers homolytic cleavage to generate the initial chlorine radical ($\text{Cl}^\bullet$), which initiates the chain reaction.

Why other options are incorrect:

- **Option B:** The methyl radical ($\text{CH}_3^\bullet$) is formed in the subsequent propagation step: $\text{CH}_4 + \text{Cl}^\bullet \rightarrow \text{CH}_3^\bullet + \text{HCl}$.
- **Option C:** Methane is a stable intact reactant molecule, not a radical.
- **Option D:** Chloromethane is a completed neutral product formed during propagation or termination.

Question #127 Key: (C)

PHYSICS
Federal 2026

[Formula]

CORE CONCEPT & DERIVATION

The product of resistance (R) and capacitance (C) yields the capacitive time constant (τ), which has the physical dimension of time (seconds).

Formula / Rule / Reaction:

$$\tau = R \times C \Rightarrow (\Omega) \times (\text{F}) = \text{seconds}$$

Solution:

- Substitute the metric prefix multipliers:
 $R = 1 \text{ M}\Omega = 10^6 \Omega$
 $C = 1 \text{ pF} = 10^{-12} \text{ F}$
- Multiply the values:
 $\tau = (10^6 \Omega) \times (10^{-12} \text{ F}) = 10^{-6} \text{ seconds} = 1 \mu\text{s} \text{ (microsecond)}$

Why other options are incorrect:

- **Option A:** 1 second corresponds to 10^0 s .
- **Option B:** A millisecond corresponds to 10^{-3} s .
- **Option D:** A megasecond corresponds to 10^6 s .

Question #128 Key: (B)PHYSICS
Federal 2026

If "F" is the force between two points charges submerged in a medium of dielectric constant "M"...

CORE CONCEPT & DERIVATION

The electrostatic force between two charges is inversely proportional to the dielectric constant (relative permittivity) of the medium; removing the dielectric increases the force to its vacuum value.

Formula / Rule / Reaction:

$$F_{\text{med}} = \frac{F_{\text{vac}}}{M} \implies F_{\text{vac}} = F_{\text{med}} \cdot M$$

Solution:

- In the medium with dielectric constant M , the measured force is $F = \frac{F_{\text{vac}}}{M}$.
- When the medium is removed and replaced by a vacuum (or air), the electrostatic shielding is eliminated, and the force becomes $F_{\text{vac}} = F \cdot M$.

Why other options are incorrect:

- **Option A:** Square root relationships apply to wave propagation velocities, not electrostatic Coulomb attenuation.
- **Option C:** Dividing by M represents the force when inserting a medium into a vacuum, not when removing it.
- **Option D:** Inverts the dimensions of force.

Question #129 Key: (A)PHYSICS
Federal 2026

Unit of resistivity i.e. specific resistance is:

CORE CONCEPT & DERIVATION

Resistivity (ρ) is the intrinsic electrical resistance of a conductor per unit cross-sectional area per unit length, expressed in ohm-meters ($\Omega \cdot \text{m}$).

Formula / Rule / Reaction:

$$R = \rho \frac{L}{A} \implies \rho = \frac{R \cdot A}{L}$$

Solution:

- Substitute the SI units for resistance, area, and length:

$$[\rho] = \frac{\Omega \cdot \text{m}^2}{\text{m}} = \Omega \cdot \text{m}$$

Why other options are incorrect:

- **Option B:** The ohm (Ω) is the unit of electrical resistance (R).
- **Option C:** $\Omega^{-1} \cdot \text{m}^{-1}$ (or $\text{S} \cdot \text{m}^{-1}$) is the unit of electrical conductivity (σ).
- **Option D:** Omits the division by unit length.

Question #130 Key: (D)PHYSICS
Federal 2026

If diameter of a wire is doubled, its resistivity will:

CORE CONCEPT & DERIVATION

Resistivity is an intensive material property that depends exclusively on the electronic structure and temperature of the conductor, remaining independent of specimen geometry such as diameter or length.

Formula / Rule / Reaction:

$$\rho = \text{constant at constant temperature}$$

Solution:

- While changing the diameter alters the macroscopic resistance ($R \propto 1/d^2$), the specific resistivity (ρ) of the material is unchanged.
- Hence, doubling the diameter leaves the resistivity constant.

Why other options are incorrect:

- **Options A, B, and C:** These describe changes in total resistance (R), confusing it with intrinsic resistivity (ρ).

Question #131 Key: (D)PHYSICS
Federal 2026

Two particles with same charge and different masses enters perpendicularly in a uniform magnetic field...

CORE CONCEPT & DERIVATION

A charged particle entering perpendicularly into a uniform magnetic field experiences a centripetal Lorentz force, producing a circular orbit whose radius is directly proportional to its mass.

Formula / Rule / Reaction:

$$F_B = qvB = \frac{mv^2}{r} \implies r = \frac{mv}{qB}$$

Solution:

- Because both particles enter with identical charge (q), identical velocity (v), and into the same magnetic field (B), the radius of curvature depends directly on mass:
 $r \propto m$
- The lighter particle has a smaller mass, so it traverses an orbit with a smaller radius, moving in a small circular path.

Why other options are incorrect:

- **Option A:** Particles move in a straight path only if uncharged or moving parallel to the magnetic field vectors.
- **Option B:** A helical/spiral path occurs when velocity has a component parallel to the field lines ($0^\circ < \theta < 90^\circ$).
- **Option C:** A larger circular path is traversed by the heavier particle.

Question #132 Key: (C)

PHYSICS
Federal 2026

Which quantity is a vector?

CORE CONCEPT & DERIVATION

A vector quantity possesses both magnitude and direction; weight is the downward gravitational force acting on mass, making it a true vector.

Formula / Rule / Reaction:

$$\vec{W} = m\vec{g}$$

Solution:

- Weight represents the gravitational force vector directed toward the center of the Earth.
- Because it has both magnitude and a defined direction in space, weight is a vector quantity.

Why other options are incorrect:

- **Option A:** Pressure is defined as compressive normal force per unit area and acts isotropically in fluids, making it a scalar.
- **Option B:** Temperature is a scalar measuring mean molecular kinetic energy.
- **Option D:** Work is the scalar dot product of force and displacement vectors ($W = \vec{F} \cdot \vec{d}$).

Question #133 Key: (D)

PHYSICS
Federal 2026

During uniform circular motion, if "v" is tangential velocity, "[Formula]" is angular velocity...

CORE CONCEPT & DERIVATION

In rotational vector kinematics, linear tangential velocity ($\vec{v}$) is defined as the vector cross product of angular velocity ($\vec{\omega}$) and the position radius vector ($\vec{r}$).

Formula / Rule / Reaction:

$$\vec{v} = \vec{\omega} \times \vec{r}$$

Solution:

- By the right-hand rule, curling fingers from the axial angular velocity vector $\vec{\omega}$ toward the outward position vector $\vec{r}$ gives a thumb pointing along the tangent vector $\vec{v}$.
- Because the cross product is anticommutative ($\vec{A} \times \vec{B} = -\vec{B} \times \vec{A}$), the order $\vec{\omega} \times \vec{r}$ must be preserved.

Why other options are incorrect:

- **Option A:** Inverts the cross product, which would make dimensions inconsistent.
- **Option B:** Incorrect algebraic cross product relationship.
- **Option C:** Reversing the vector cross order gives $-\vec{v}$, pointing in the opposite direction.

Question #134 Key: (C)PHYSICS
Federal 2026

Cross product of two parallel vectors has a magnitude of:

CORE CONCEPT & DERIVATION

The magnitude of the vector cross product of two vectors is given by $|\vec{A} \times \vec{B}| = AB \sin \theta$; for parallel vectors, the angle between them is 0° , yielding a magnitude of zero.

Formula / Rule / Reaction:

$$|\vec{A} \times \vec{B}| = AB \sin(0^\circ) = AB(0) = 0$$

Solution:

- Parallel vectors point along the same line ($\theta = 0^\circ$).
- Since $\sin(0^\circ) = 0$, the cross product vector is the null vector, whose magnitude is the scalar number zero.

Why other options are incorrect:

- **Option A:** Non-zero magnitude A occurs only in specific non-parallel configurations.
- **Option B:** The cosine function belongs to the scalar dot product ($\vec{A} \cdot \vec{B} = AB \cos \theta$).
- **Option D:** The question asks specifically for the magnitude; magnitude is a scalar (zero), whereas a null vector is a vector quantity.

Question #135 Key: (C)PHYSICS
Federal 2026

Projectile motion is best described as:

CORE CONCEPT & DERIVATION

Projectile motion is two-dimensional motion in a vertical plane under a constant downward gravitational acceleration (g), neglecting air resistance.

Formula / Rule / Reaction:

$$\vec{a} = -g\hat{j} = \text{constant}$$

Solution:

- A projectile travels with uniform horizontal velocity (zero horizontal acceleration) and experiences constant downward vertical acceleration due to gravity ($a_y = -9.8 \text{ m/s}^2$).
- Hence, the total motion proceeds under constant acceleration due to gravity.

Why other options are incorrect:

- **Option A:** Projectile motion occurs simultaneously along horizontal and vertical axes, making it two-dimensional motion.
- **Option B:** Near the Earth's surface, gravitational acceleration is constant, not variable.
- **Option D:** At maximum height, only the vertical velocity component (v_y) is zero; the horizontal velocity component (v_x) remains non-zero.

Question #136 Key: (B)PHYSICS
Federal 2026

A body of mass 5 kg is moving with speed 10 m/s . A constant force acts on it for 5 seconds and b...

CORE CONCEPT & DERIVATION

According to Newton's second law of motion, the magnitude of a net constant force acting on a body equals the product of its mass and acceleration.

Formula / Rule / Reaction:

$$a = \frac{v_f - v_i}{t}, \quad F = m|a|$$

Solution:

- Calculate acceleration:

$$a = \frac{5 \text{ m/s} - 10 \text{ m/s}}{5 \text{ s}} = \frac{-5}{5} = -1 \text{ m/s}^2$$

- Calculate force magnitude:

$$F = (5 \text{ kg}) \times |-1 \text{ m/s}^2| = 5 \text{ N}$$

Why other options are incorrect:

- **Option A:** 3 N would correspond to a velocity decrease of only 3 m/s over 5 seconds.
- **Option C:** 15 N corresponds to three times the required retarding acceleration.
- **Option D:** 30 N represents an arithmetic error multiplying momentum by elapsed time.

Question #137 Key: (A)

PHYSICS
Federal 2026

A passenger standing in a bus falls forward when the bus suddenly stops. This is due to:

CORE CONCEPT & DERIVATION

Newton's first law of motion (law of inertia) dictates that an object in motion continues in uniform motion in a straight line unless acted upon by an external net force.

Formula / Rule / Reaction:

$$\sum \vec{F} = 0 \implies \vec{v} = \text{constant}$$

Solution:

- When the bus decelerates abruptly, friction applies a stopping force to the passenger's feet in contact with the floor.
- Because no horizontal force acts directly on the passenger's upper torso, inertia causes the upper body to persist forward at its original velocity.

Why other options are incorrect:

- **Option B:** Newton's second law quantifies acceleration resulting from a net unbalanced force ($\vec{F} = m\vec{a}$).
- **Option C:** Newton's third law governs equal and opposite contact force pairs between two interacting bodies.
- **Option D:** Newton's law of gravitation describes mutual mass attraction, not horizontal forward lurching.

Question #138 Key: (B)

PHYSICS
Federal 2026

A stone is thrown horizontally with a velocity of 12 m/s from the top of a vertical cliff. How ...

CORE CONCEPT & DERIVATION

In projectile motion, horizontal and vertical motions are completely independent; the time of flight depends exclusively on the vertical height and vertical gravitational acceleration.

Formula / Rule / Reaction:

$$h = v_{iy}t + \frac{1}{2}gt^2 \xrightarrow{v_{iy}=0} h = \frac{1}{2}gt^2 \implies t = \sqrt{\frac{2h}{g}}$$

Solution:

- Initial vertical velocity $v_{iy} = 0$ m/s.
- Substitute height and gravity:

$$45 = \frac{1}{2}(10)t^2 = 5t^2 \implies t^2 = \frac{45}{5} = 9 \implies t = 3 \text{ s}$$

Why other options are incorrect:

- **Option A:** In 2 seconds, the stone falls only $h = \frac{1}{2}(10)(2^2) = 20$ m.
- **Option C:** In 4 seconds, the stone falls $h = \frac{1}{2}(10)(4^2) = 80$ m.
- **Option D:** In 5 seconds, the stone falls 125 m.

Question #139 Key: (B)

PHYSICS
Federal 2026

If the force applied on an object and its velocity are in the same direction, the power deliver...

CORE CONCEPT & DERIVATION

Instantaneous mechanical power delivered by a force is the scalar dot product of the force vector and the velocity vector.

Formula / Rule / Reaction:

$$P = \vec{F} \cdot \vec{v} = Fv \cos \theta$$

Solution:

- When force and velocity point in the same direction, the angle between them is $\theta = 0^\circ$.
- Because $\cos(0^\circ) = +1$, power evaluates to $P = Fv > 0$, delivering positive power that increases kinetic energy.

Why other options are incorrect:

- **Option A:** Power is zero only when force and velocity are perpendicular ($\theta = 90^\circ$) or when force or velocity is zero.
- **Option C:** Power is negative when force opposes velocity ($\theta = 180^\circ$), as in kinetic friction.
- **Option D:** Finite forces and velocities yield finite real values, never infinite power.

Question #140 Key: (C)PHYSICS
Federal 2026

If the velocity is doubled then the K.E of the body will be:

CORE CONCEPT & DERIVATION

Kinetic energy varies directly with the square of the velocity of the body.

Formula / Rule / Reaction:

$$K = \frac{1}{2}mv^2 \implies K \propto v^2$$

Solution:

- Let the new velocity be $v' = 2v$.

- Calculate new kinetic energy:

$$K' = \frac{1}{2}m(2v)^2 = 4\left(\frac{1}{2}mv^2\right) = 4K$$

- Therefore, doubling velocity increases kinetic energy fourfold.

Why other options are incorrect:

- Option A:** Linear doubling describes momentum ($p = mv$), not kinetic energy.
- Option B:** Three times is an incorrect multiplier.
- Option D:** Kinetic energy cannot remain constant when speed increases.

Question #141 Key: (C)PHYSICS
Federal 2026

When a force is parallel to the direction of motion of the body, work done on the body is:

CORE CONCEPT & DERIVATION

Work done by a constant force is defined as $W = Fd \cos \theta$; the cosine function reaches its maximal value of +1 when the force vector is aligned parallel to displacement.

Formula / Rule / Reaction:

$$W = Fd \cos(0^\circ) = Fd \quad (\text{Maximum work})$$

Solution:

- Parallel alignment means the angle between force and displacement is $\theta = 0^\circ$.
- Because $\cos(0^\circ) = 1$, the entire magnitude of force contributes to displacement without angular loss, maximizing work done.

Why other options are incorrect:

- Option A:** Work done is zero when force is perpendicular to displacement ($\theta = 90^\circ$).
- Option B:** Minimum work (most negative) occurs when force is anti-parallel ($\theta = 180^\circ$, $W = -Fd$).
- Option D:** Work performed by finite forces across finite distances is finite.

Question #142 Key: (C)PHYSICS
Federal 2026

The wheel of a vehicle is spinning in the anticlockwise direction, with a constant rate. The di...

CORE CONCEPT & DERIVATION

Angular velocity is an axial vector whose direction is defined by the right-hand grip rule, pointing along the axis of rotation perpendicular to the plane of motion.

Formula / Rule / Reaction:

$$\vec{\omega} = \frac{d\vec{\theta}}{dt} \quad (\text{Direction normal to rotation plane})$$

Solution:

- Curl the fingers of the right hand in the direction of anticlockwise rotation.
- The extended right thumb points outwardly along the central rotational axis, perpendicular to the circular plane of rotation.

Why other options are incorrect:

- **Options A and B:** Clockwise and anticlockwise describe circular rotational sense within the plane, whereas vector direction is an axial ray.
- **Option D:** In-plane vectors represent linear tangential velocities or centripetal accelerations, not the axial angular velocity vector.

Question #143 Key: (B)PHYSICS
Federal 2026

A point P is on a disk rotating with constant angular velocity. If the distance from the center...

CORE CONCEPT & DERIVATION

The tangential linear velocity (v) of a point on a rotating rigid body is related to angular velocity (ω) by $v = r\omega$, meaning the ratio v/ω is identically equal to the radial distance r .

Formula / Rule / Reaction:

$$v = r\omega \implies \frac{v}{\omega} = r$$

Solution:

- The ratio v/ω evaluates directly to the radial distance from the center of rotation: $\frac{v}{\omega} = r$.
- If the distance r is tripled ($r' = 3r$), the ratio $v'/\omega = r' = 3r$ also triples.

Why other options are incorrect:

- **Option A:** The ratio depends directly on radial position and cannot remain unchanged.
- **Option C:** One-third corresponds to tripling angular velocity at fixed linear speed, not tripling radius.
- **Option D:** Quadratic scaling (factor of 9) applies to centripetal acceleration ($a_c = r\omega^2$), not the ratio v/ω .

Question #144 Key: (D)PHYSICS
Federal 2026

In deriving Bernoulli's equation, the quantity 'pressure [Formula] volume' represents:

CORE CONCEPT & DERIVATION

The product of pressure and volume ($P\Delta V$) represents flow work (pressure energy), which is the mechanical work performed by pressure forces to move fluid elements across a boundary.

Formula / Rule / Reaction:

$$W = F \cdot d = (P \cdot A) \cdot d = P(A \cdot d) = P \cdot V \implies [\text{N/m}^2] \times [\text{m}^3] = \text{N} \cdot \text{m} = \text{Joules}$$

Solution:

- In fluid dynamics, external pressure acting across cross-sectional area A exerts force $F = PA$.
- Displacing this area through length Δx performs work $\Delta W = PA\Delta x = P\Delta V$.
- Thus, pressure multiplied by volume represents mechanical work done.

Why other options are incorrect:

- **Option A:** Density is mass per unit volume (kg/m^3).
- **Option B:** Kinetic energy of fluid is expressed as $\frac{1}{2}mv^2$ (or $\frac{1}{2}\rho v^2$ per unit volume).
- **Option C:** Potential energy is expressed as mgh (or ρgh per unit volume).

Question #145 Key: (D)

PHYSICS
Federal 2026

Drag force on a spherical object moving through a fluid depends on:

CORE CONCEPT & DERIVATION

According to Stokes' Law, the retarding viscous drag force acting on a sphere moving through a fluid depends directly on fluid viscosity, object radius (size), geometry (shape), and relative velocity.

Formula / Rule / Reaction:

$$F_d = 6\pi\eta r v$$

Solution:

- Viscous drag force varies directly with fluid viscosity (η).
- It depends on the radius (r) and spherical geometry of the object.
- It scales directly with the terminal or instantaneous relative velocity (v).
- Because all three factors determine drag force, all of the above is correct.

Why other options are incorrect:

- **Options A, B, and C:** Each identifies a valid parameter, but selecting any single factor in isolation provides an incomplete description.

Question #146 Key: (C)

PHYSICS
Federal 2026

Which of the following assumptions is **INCORRECT** about the fluid that follows equation of contin...

CORE CONCEPT & DERIVATION

The classical equation of continuity for ideal fluid flow assumes an incompressible, non-viscous fluid moving in steady, laminar, streamline (non-turbulent) motion.

Formula / Rule / Reaction:

$$A_1 v_1 = A_2 v_2 = \text{constant} \quad (\text{Valid for streamline, non-turbulent flow})$$

Solution:

- Ideal fluids must maintain laminar, steady streamlines where velocity at every point remains constant over time.
- Turbulent flow generates chaotic eddies and vortices that dissipate mechanical energy and violate the steady-state assumption of the continuity equation.

Why other options are incorrect:

- **Option A:** Zero viscosity is a standard assumption of ideal fluid flow.
- **Option B:** Steady (streamline) flow is an essential prerequisite for continuity.
- **Option D:** Incompressibility (constant density ρ) is required for the volumetric form $A_1 v_1 = A_2 v_2$.

Question #147 Key: (C)

PHYSICS
Federal 2026

In a ripple tank 50 waves having wavelength 5cm pass through a certain point with a speed of 2m...

CORE CONCEPT & DERIVATION

The fundamental wave equation relates wave speed (v), frequency (f), and wavelength (λ) through $v = f\lambda$.

Formula / Rule / Reaction:

$$f = \frac{v}{\lambda}$$

Solution:

- Convert wavelength to SI units:
 $\lambda = 5 \text{ cm} = 0.05 \text{ m}$
- Calculate wave frequency:
 $f = \frac{2 \text{ m/s}}{0.05 \text{ m}} = 40 \text{ Hz}$

Why other options are incorrect:

- **Option A:** 5 Hz results from incorrectly dividing speed by numerical wavelength in centimeters without unit conversion.
- **Option B:** 10 Hz represents an arithmetic miscalculation.
- **Option D:** 50 Hz confuses the number of passing waves with the calculated frequency in hertz.

Question #148 Key: (B)PHYSICS
Federal 2026

In SHM the maximum displacement covered by the Particle from mean position is A . What is the to...

CORE CONCEPT & DERIVATION

In simple harmonic motion (SHM), one complete oscillation cycle consists of motion from the mean position to one extreme, through the mean to the opposite extreme, and back to the mean position.

Formula / Rule / Reaction:

$$\text{Total Distance per cycle} = A + A + A + A = 4A$$

Solution:

- From mean position to right extreme: distance = A .
- From right extreme back to mean position: distance = A .
- From mean position to left extreme: distance = A .
- From left extreme back to mean position: distance = A .
- Summing the four quarter-cycle displacements gives a total distance of $4A$.

Why other options are incorrect:

- **Option A:** $2A$ is the distance traversed in one half-cycle.
- **Option C:** $6A$ corresponds to 1.5 complete oscillations.
- **Option D:** $8A$ corresponds to two full cycles.

Question #149 Key: (B)PHYSICS
Federal 2026

Unlike electromagnetic waves, mechanical waves require:

CORE CONCEPT & DERIVATION

Mechanical waves propagate via elastic collisions and inertial coupling between particles, requiring a material medium; electromagnetic waves consist of self-sustaining oscillating fields that propagate through a vacuum.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Mechanical waves (such as sound, seismic, and water waves) cannot travel through empty space because they require atomic particles to transmit mechanical vibrations.
- Hence, an elastic physical medium is an absolute requirement for mechanical waves.

Why other options are incorrect:

- **Option A:** Both mechanical and electromagnetic waves require an initial energy source.
- **Option C:** Both types of waves originate from an initial disturbance or oscillating charge.
- **Option D:** Both types of continuous waves can be generated by periodic motion.

Question #150 **Key: (B)**PHYSICS
Federal 2026

A sound wave is set up in a long tube, closed at one end. The length of the tube is adjusted un...

CORE CONCEPT & DERIVATION

Sound waves in air are longitudinal waves; resonance inside a closed tube occurs when incident and reflected waves interfere to produce standing (stationary) longitudinal waves with fixed nodes and antinodes.

Formula / Rule / Reaction:

$$\text{Resonance condition : } L = (2n - 1) \frac{\lambda}{4} \quad (\text{Standing/Stationary Wave})$$

Solution:

- Sound waves propagate through air by longitudinal compressions and rarefactions.
- Acoustic resonance (loudest sound) occurs when incident waves interfere with reflected waves from the closed end, establishing a longitudinal standing (stationary) wave.

Why other options are incorrect:

- **Option A:** Progressive waves continuously transport net acoustic energy along the tube without forming stationary resonant patterns.
- **Option C:** Sound in fluids cannot propagate as transverse waves because fluids lack shear elasticity.
- **Option D:** Sound waves in air are longitudinal, not transverse.

Question #151 **Key: (B)**PHYSICS
Federal 2026

An ideal gas is heated at constant volume. It absorbs 200 J of heat. The work done by the gas i...

CORE CONCEPT & DERIVATION

In an isochoric (constant volume) process, the change in volume is zero ($\Delta V = 0$), meaning no boundary work is performed by or on the gas.

Formula / Rule / Reaction:

$$W = P\Delta V \xrightarrow{\Delta V=0} W = 0 \text{ J}$$

Solution:

- Because the container volume is rigid and fixed, $\Delta V = 0$.
- Work done is identically zero ($W = 0 \text{ J}$), and all absorbed heat ($Q = 200 \text{ J}$) goes toward increasing the internal energy of the gas ($\Delta U = Q = 200 \text{ J}$).

Why other options are incorrect:

- **Option A:** 200 J of work would occur in an isothermal expansion where all absorbed heat converts into work.
- **Option C:** Negative work indicates external compression, which cannot occur at fixed volume.
- **Option D:** Pressure rises during isochoric heating, but work remains strictly zero because boundaries do not move.

Question #152 Key: (A)PHYSICS
Federal 2026

If "Q" heat and "W" is work done then " $W=Q$ " represents:

CORE CONCEPT & DERIVATION

In an ideal gas isothermal process, temperature remains constant ($\Delta T = 0$), meaning the internal energy change is zero ($\Delta U = 0$); by the first law of thermodynamics, heat added equals work done.

Formula / Rule / Reaction:

$$Q = \Delta U + W \xrightarrow{\Delta U=0} Q = W$$

Solution:

- For an ideal gas, internal energy depends solely on temperature: $U = \frac{f}{2}nRT$.
- During an isothermal expansion, $T = \text{constant} \implies \Delta U = 0$.
- Substituting $\Delta U = 0$ into the First Law yields $W = Q$.

Why other options are incorrect:

- **Option B:** In an adiabatic process, no heat enters or leaves the system ($Q = 0$), giving $W = -\Delta U$.
- **Option C:** In an isochoric process, work done is zero ($W = 0$), giving $Q = \Delta U$.
- **Option D:** In an isobaric process, heat divides between internal energy and work ($Q = \Delta U + P\Delta V$).

Question #153 Key: (A)PHYSICS
Federal 2026

Magnetic flux has unit but no direction because:

CORE CONCEPT & DERIVATION

Magnetic flux (Φ_B) is defined mathematically as the scalar dot product of the magnetic field vector ($\vec{B}$) and the area vector ($\vec{A}$), resulting in a scalar quantity.

Formula / Rule / Reaction:

$$\Phi_B = \vec{B} \cdot \vec{A} = BA \cos \theta$$

Solution:

- The scalar product (dot product) of two vectors yields a pure scalar magnitude with algebraic sign, without spatial directional components.
- Hence, magnetic flux carries physical units (weber or $T \cdot m^2$) but lacks directional vector components.

Why other options are incorrect:

- **Option B:** A cross product yields an axial vector perpendicular to both input vectors.
- **Option C:** The sum of two vectors is a vector with magnitude and direction.
- **Option D:** Both magnetic field and area are vector quantities, not scalars.

Question #154 Key: (D)PHYSICS
Federal 2026

According to the Faraday's law of electromagnetic induction, the magnitude of induced emf depen...

CORE CONCEPT & DERIVATION

Faraday's law states that the induced electromotive force (E) in a closed circuit is directly proportional to the time rate of change of magnetic flux through that circuit.

Formula / Rule / Reaction:

$$E = -N \frac{d\Phi_B}{dt}$$

Solution:

- A steady, static magnetic flux (even of large magnitude) generates zero induced emf.
- Induced emf is produced only when flux varies over time, scaling directly with the time derivative (rate of change) of magnetic flux.

Why other options are incorrect:

- **Option A:** Static magnetic flux does not induce an emf.
- **Option B:** Magnetic induction (B) is magnetic field strength; constant B produces no induced potential.
- **Option C:** Net change alone is insufficient; the time duration matters, as rate determines voltage magnitude.

Question #155 Key: (B)PHYSICS
Federal 2026

Lenz's law primarily refers to the direction of:

CORE CONCEPT & DERIVATION

Lenz's law states that the polarity of induced emf and the direction of the resulting induced current generate a magnetic field that opposes the change in magnetic flux producing it.

Formula / Rule / Reaction:

$$E = - \frac{\Delta \Phi}{\Delta t} \quad (\text{Negative sign embodies Lenz's law})$$

Solution:

- Lenz's law provides the physical rule for determining the circulation direction of induced current in a conducting loop.
- The induced magnetic field acts to oppose the original flux variation, ensuring conservation of energy.

Why other options are incorrect:

- **Option A:** While it dictates induced emf polarity, Lenz's law is primarily defined through the directional circulation of induced current.
- **Option C:** Power is a scalar rate of energy transfer, lacking directional vector properties.
- **Option D:** Energy is a scalar quantity; while Lenz's law is a consequence of energy conservation, it specifically dictates the direction of induced current.

Question #156 Key: (B)PHYSICS
Federal 2026

When a capacitor is connected to an alternating power source:

CORE CONCEPT & DERIVATION

In a purely capacitive AC circuit, electric current must flow onto capacitor plates before potential difference develops, causing the current to lead the voltage by 90° (voltage lags current by 90°).

Formula / Rule / Reaction:

$$i(t) = C \frac{dv}{dt} \implies I = I_0 \sin(\omega t), \quad V = V_0 \sin\left(\omega t - \frac{\pi}{2}\right)$$

Solution:

- Capacitor charging requires charge accumulation before a counter-voltage appears across the dielectric.
- Hence, the sinusoidal voltage wave reaches its peak one-quarter of a cycle (90° or $\pi/2$ radians) after current peaks, meaning voltage lags current by 90° .

Why other options are incorrect:

- **Option A:** Voltage leads current by 90° in a purely inductive AC circuit.
- **Options C and D:** A 180° phase shift occurs in inverted amplifier stages, not in basic reactive passive components.

Question #157 Key: (C)PHYSICS
Federal 2026

In a pure inductive AC circuit at low frequency the inductive reactance will be:

CORE CONCEPT & DERIVATION

Inductive reactance (X_L) is the opposition an inductor offers to alternating current, and it is directly proportional to the frequency of the applied AC supply.

Formula / Rule / Reaction:

$$X_L = 2\pi fL \Rightarrow X_L \propto f$$

Solution:

- At lower frequencies (f), the rate of change of current (di/dt) slows down.
- Consequently, the opposing self-induced back emf decreases, causing the inductive reactance (X_L) to decrease.

Why other options are incorrect:

- **Option A:** Reactance depends dynamically on frequency, remaining constant only if frequency is fixed.
- **Option B:** Inductive reactance increases at higher frequencies, not lower frequencies.
- **Option D:** Inductive reactance becomes zero only in pure direct current ($f = 0$ Hz).

Question #158 Key: (B)PHYSICS
Federal 2026

Which type of biasing results in a very high resistance of PN junction diode?

CORE CONCEPT & DERIVATION

Reverse biasing widens the space-charge depletion region and elevates the internal barrier potential, offering very high electrical resistance to majority carrier flow.

Formula / Rule / Reaction:

Reverse Bias : V_{applied} reinforces $V_{\text{barrier}} \rightarrow \uparrow$ Depletion Width $\rightarrow R_{\text{reverse}} \approx 10^6 \Omega$

Solution:

- Connecting the p-type region to the negative terminal and the n-type region to the positive terminal pulls majority carriers away from the junction.
- This widens the insulating depletion region, increasing diode resistance to megaohm levels.

Why other options are incorrect:

- **Option A:** Forward biasing narrows the depletion layer and reduces diode resistance to a few ohms.
- **Option C:** An unbiased junction maintains intermediate equilibrium resistance without external voltage reinforcement.
- **Option D:** Doping is the process of introducing impurity atoms to decrease base semiconductor resistance.

Question #159 Key: (C)PHYSICS
Federal 2026

The energy difference per unit frequency between two consecutive quantum states is:

CORE CONCEPT & DERIVATION

According to Planck's quantum hypothesis and the Bohr frequency condition, the energy difference between two quantum states is directly proportional to radiation frequency, with Planck's constant serving as the proportionality constant.

Formula / Rule / Reaction:

$$\Delta E = h\nu \implies \frac{\Delta E}{\nu} = h$$

Solution:

- Energy difference divided by transition frequency yields:

$$\frac{\Delta E}{\nu} = h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

- This fundamental physical constant is Planck's constant.

Why other options are incorrect:

- Option A:** The speed of light (c) relates wavelength to frequency ($c = \nu\lambda$).
- Option B:** Frequency is the denominator term itself, not the resulting ratio.
- Option D:** Mass possesses units of kilograms, which do not match the units of action ($\text{J} \cdot \text{s}$).

Question #160 Key: (C)PHYSICS
Federal 2026

What is the primary reason for color line spectrum of hydrogen gas?

CORE CONCEPT & DERIVATION

The atomic emission line spectrum is produced when excited electrons transition from discrete higher energy levels down to lower energy levels, emitting photons of quantized wavelengths corresponding to discrete spectral colors.

Formula / Rule / Reaction:

$$\Delta E = E_2 - E_1 = \frac{hc}{\lambda}$$

Solution:

- Electrons in excited hydrogen atoms drop from outer discrete orbitals to lower principal quantum shells (such as the Balmer series transitions to $n = 2$).
- Each downward drop emits a photon with discrete energy and visible wavelength, producing sharp, colored emission spectral lines.

Why other options are incorrect:

- Option A:** Bulk thermal kinetic energy produces continuous blackbody radiation, not sharp quantum lines.
- Option B:** Transitions from lower to higher energy levels absorb photons, creating dark absorption lines.
- Option D:** Ground-state hydrogen atoms are thermodynamically stable.

Question #161 Key: (C)PHYSICS
Federal 2026

A sealed sample of Cobalt-60 is subjected to extremely high pressure in a laboratory. Its decay...

CORE CONCEPT & DERIVATION

Radioactive decay is a spontaneous nuclear phenomenon governed by fundamental nuclear forces, operating entirely independently of external environmental factors like pressure, temperature, or chemical bonding.

Formula / Rule / Reaction:

$$\lambda = \frac{\ln 2}{T_{1/2}} = \text{constant}$$

Solution:

- The atomic nucleus is shielded by electron shells and bound by strong nuclear forces exceeding external laboratory pressures by many orders of magnitude.
- Consequently, macroscopic physical stressors like high pressure have no effect on decay probability or half-life, meaning the decay rate remains unchanged.

Why other options are incorrect:

- Options A, B, and D:** These violate the principle of nuclear decay invariance with respect to thermodynamic pressure and temperature.

Question #162 Key: (C)PHYSICS
Federal 2026

Half-life of a radioactive element is 2 minutes. In how much time, one-eighth (1/8th) of this s...

CORE CONCEPT & DERIVATION

The fraction of radioactive nuclei remaining after n consecutive half-lives is given by $N(t)/N_0 = (1/2)^n$.

Formula / Rule / Reaction:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n, \quad t = n \times T_{1/2}$$

Solution:

- Set the remaining fraction to one-eighth:

$$\frac{N}{N_0} = \frac{1}{8} = \left(\frac{1}{2}\right)^3 \Rightarrow n = 3 \text{ half-lives}$$

- Multiply number of half-lives by the half-life duration:

$$t = 3 \times 2 \text{ minutes} = 6 \text{ minutes}$$

- Note on phrasing: In provincial examinations, questions asking when 1/8th of a sample remains use this half-life progression to designate three elapsed periods.

Why other options are incorrect:

- Option A:** In 2 minutes (1 half-life), one-half (1/2) remains.
- Option B:** In 4 minutes (2 half-lives), one-fourth (1/4) remains.
- Option D:** In 8 minutes (4 half-lives), one-sixteenth (1/16) remains.

Question #163 Key: (C)ENGLISH
Federal 2026

Choose the option with correct spelling.

CORE CONCEPT & DERIVATION

Standard English orthography requires the spelling 'nuisance' for the noun meaning a person, thing, or circumstance causing annoyance.

Formula / Rule / Reaction:

Root: Anglo-Norman / Old French *nuire* → N-U-I-S-A-N-C-E

Solution:

- The correct alphabetical sequence is n-u-i-s-a-n-c-e.

Why other options are incorrect:

- Options A, B, and D:** These contain erroneous vowel clusters and consonant duplications.

Question #164 Key: (B)ENGLISH
Federal 2026

Choose the correctly structured sentence.

CORE CONCEPT & DERIVATION

Third conditional sentences express past counterfactual hypothetical situations and require a past perfect subordinate clause paired with a perfect conditional main clause.

Formula / Rule / Reaction:

If + Subject + had + V₃ ... , Subject + would have + V₃

Solution:

- Subordinate clause: 'If he had gone on time' (past perfect).
- Main clause: 'he would have caught the bus' (would have + past participle).
- This structure adheres to the grammatical requirements of the third conditional.

Why other options are incorrect:

- Option A:** Mismatches simple past ('went') with future perfect ('will have caught').
- Option C:** Combines past perfect with simple conditional ('would catch') in a mixed conditional without present temporal anchoring.
- Option D:** Combines present perfect ('has gone') with past counterfactual ('would have caught').

Question #165 Key: (B)ENGLISH
Federal 2026

"The students, along with their teacher, _____ leaving now." Choose the correct verb:

CORE CONCEPT & DERIVATION

Subject-verb agreement requires the verb to agree in number with the grammatical subject of the sentence, ignoring intervening parenthetical phrases introduced by 'along with'.

Formula / Rule / Reaction:

Plural Subject [The students] + [along with ...] $\Rightarrow$ Plural Verb [are]

Solution:

- The true grammatical subject is the plural noun 'The students'.
- The prepositional modifier 'along with their teacher' is quasi-parenthetical and does not alter subject number.
- The temporal adverb 'now' requires the present tense, making the plural auxiliary 'are' the correct choice.

Why other options are incorrect:

- **Option A:** 'is' is a singular verb that fails to agree with plural 'students'.
- **Option C:** 'has' is singular and requires a past participle ('left') rather than a present participle ('leaving').
- **Option D:** 'was' is singular and denotes past tense, conflicting with 'now'.

Question #166 Key: (B)ENGLISH
Federal 2026

"Your reluctance to speak to the boss will create problems for you." What does "reluctance" mean...

CORE CONCEPT & DERIVATION

Contextual vocabulary definition requires identifying the precise synonym of a word as used in an evaluative statement.

Formula / Rule / Reaction:

Reluctance $\equiv$ Unwillingness, hesitation, or disinclination

Solution:

- The noun 'reluctance' denotes unwillingness or hesitation to take action.
- In the sentence, hesitation to approach the employer directly conveys this meaning.

Why other options are incorrect:

- **Option A:** Confidence denotes self-assurance, which is antonymous to hesitation.
- **Option C:** Eagerness denotes keen readiness or enthusiasm, the direct opposite of reluctance.
- **Option D:** Competence refers to skill or ability rather than emotional hesitation.

Question #167 Key: (C)ENGLISH
Federal 2026

"The silence tasted like stale bread left too long in the cupboard." Which literary technique i...

CORE CONCEPT & DERIVATION

A simile is a figure of speech that directly compares two distinct things using connecting words such as 'like' or 'as'.

Formula / Rule / Reaction:

Simile = Explicit figurative comparison utilizing 'like' or 'as'

Solution:

- The sentence explicitly compares the sensory perception of silence to stale bread using the comparative preposition 'like'.
- This explicit comparative marker defines the literary technique as a simile.

Why other options are incorrect:

- **Option A:** A metaphor asserts an implicit equation between two things without using 'like' or 'as'.
- **Option B:** Personification attributes human emotions, intent, or speech to non-human entities.
- **Option D:** Alliteration involves the repetition of initial consonant sounds in neighboring words.

Question #168 Key: (A)ENGLISH
Federal 2026

Choose the sentence with correct punctuation:

CORE CONCEPT & DERIVATION

In standard direct quotation punctuation, direct speech is enclosed in quotation marks, and a separating comma must be placed inside the closing quotation mark preceding the attribution tag.

Formula / Rule / Reaction:

"[Quoted text]," [dialogue attribution].

Solution:

- The spoken clause is completely enclosed: "It was a nice movie," with the comma set inside the quotation mark.
- The reporting attribution follows with appropriate spacing and ends with a terminal period: 'said Kaleem.'

Why other options are incorrect:

- **Option B:** Inserts an erroneous comma between adjective and noun ('nice, movie') and omits the closing quotation mark.
- **Option C:** Erroneously introduces an internal comma and an incorrect semicolon.
- **Option D:** Leaves a space before the closing quotation mark and adds an erroneous trailing quotation mark after the proper noun.

Question #169 Key: (A)ENGLISH
Federal 2026

"He walked _____ the park to reach school." Use correct preposition:

CORE CONCEPT & DERIVATION

The preposition 'across' denotes movement from one side of an enclosed, bounded two-dimensional area to the opposite side.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- A park is an expansive bounded area.
- Traversing through it from boundary to boundary to reach a destination on the other side is expressed by 'walked across'.

Why other options are incorrect:

- **Option B:** 'at' designates static point localization rather than dynamic transit.
- **Option C:** 'over' indicates traversing above a raised obstacle (such as a bridge or wall).
- **Option D:** 'on' refers to supporting surfaces rather than transit through an area.

Question #170 **Key: (C)**ENGLISH
Federal 2026

Choose the correct indirect form for the following sentence: "Where do you live?" he asked the ...

CORE CONCEPT & DERIVATION

In converting a direct wh-question into indirect speech, interrogative auxiliary verbs are eliminated, the word order becomes affirmative (subject preceding verb), and the verb backshifts into the past tense.

Formula / Rule / Reaction:

Direct: "Where do you live?" → Indirect: where + subject + past tense verb

Solution:

- The reporting verb 'asked' establishes past tense narrative framing.
- The second-person pronoun 'you' shifts to third-person 'he' referring to 'the old man'.
- Present simple 'live' backshifts to past simple 'lived' without the auxiliary 'do' or 'did', yielding: 'He asked the old man where he lived.'

Why other options are incorrect:

- **Option A:** Incorrectly backshifts to present perfect ('has lived').
- **Option B:** Retains direct interrogative auxiliary 'do' and incorrect first-person pronoun 'I'.
- **Option D:** Retains interrogative inversion with 'did', which is ungrammatical in reported noun clauses.

Question #171 **Key: (B)**ENGLISH
Federal 2026

Complete the sentence with correct infinitive. He bade them _____ the house.

CORE CONCEPT & DERIVATION

The verb 'bid' (past tense 'bade') belongs to a specific class of causative and perception verbs that require an objective complement formed with a bare infinitive (an infinitive without 'to').

Formula / Rule / Reaction:

Subject + bade + Object + Bare Infinitive (Base Verb)

Solution:

- Verbs like bid, let, make, hear, and see govern the bare infinitive in active voice constructions.
- Consequently, 'He bade them leave the house' is the grammatically correct form.

Why other options are incorrect:

- **Option A:** 'Forleaving' is a non-standard compound.
- **Option C:** 'leaving' is a present participle rather than a bare infinitive.
- **Option D:** 'To leave' is a full infinitive; 'bid' does not take a full infinitive with 'to' in active voice.

Question #172 **Key: (C)**LOGICAL REASONING
Federal 2026

If 5 is subtracted from 30, what will be the square root of remaining?

CORE CONCEPT & DERIVATION

Perform direct sequential arithmetic subtraction followed by evaluation of the principal square root.

Formula / Rule / Reaction:

$$\text{Result} = \sqrt{30 - 5}$$

Solution:

- Subtract 5 from 30:
 $30 - 5 = 25$
- Evaluate the square root of the remainder:
 $\sqrt{25} = 5$

Why other options are incorrect:

- **Option A:** 25 is the difference before taking the square root.
- **Option B:** 30 is the original minuend.
- **Option D:** 10 is an arbitrary value not matching the principal root.

Question #173 Key: (A)LOGICAL REASONING
Federal 2026

Statement: A hospital staff shortage is causing long patient waiting times.
Course of Action: I...

CORE CONCEPT & DERIVATION

In logical evaluation of courses of action, a valid measure must be feasible, proportionate, and directly address the problem without creating worse secondary crises.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Course I addresses the immediate issue by increasing staffing flexibility through temporary personnel and optimized shift scheduling, making it a realistic remedy.
- Course II is extreme, disproportionate, and endangers public health by depriving the community of essential medical care.
- Therefore, only Course I logically follows.

Why other options are incorrect:

- **Options B and C:** Incorporate Course II, which is unviable and counterproductive.
- **Option D:** Dismisses Course I, which is a practical administrative solution.

Question #175 Key: (B)LOGICAL REASONING
Federal 2026

How does positive thinking influence social behavior?

CORE CONCEPT & DERIVATION

Constructive psychological orientation promotes prosocial behaviors, including empathy, collaborative communication, and mutual interpersonal respect.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Positive behavioral attitudes reduce interpersonal friction and encourage constructive communication.
- This builds mutual respect and cooperation within social communities.

Why other options are incorrect:

- **Option A:** Social conflict arises from hostility and cognitive biases, which positive thinking helps mitigate.
- **Option C:** Self-centeredness reflects egocentrism rather than prosocial attitudes.
- **Option D:** Social isolation is a consequence of maladaptive or depressive states, not positive thinking.

Question #174 Key: (B)LOGICAL REASONING
Federal 2026

What makes a course of action realistic and executable?

CORE CONCEPT & DERIVATION

In decision analysis, an operational plan is defined as executable and realistic when its goals are attainable, supported by clear procedural steps, and matched to available physical and human resources.

Formula / Rule / Reaction:

Factual recall / Qualitative concept.

Solution:

- Execution requires practical targets, structured procedures, and sufficient operational capacity.
- Hence, clear steps, attainable goals, and appropriate resources define an executable plan.

Why other options are incorrect:

- **Option A:** Real-world plans often handle inherent risks, meaning minimal risk alone does not guarantee executability.
- **Option C:** High expenses hinder rather than ensure practical execution.
- **Option D:** Ambiguous execution plans cause failure in practical implementation.

Question #176 Key: (B)LOGICAL REASONING
Federal 2026

In how many way(s), four persons A, B, C and D can stand in a line, if B must be at first and D...

CORE CONCEPT & DERIVATION

When specific positions in a permutation are fixed, the total number of arrangements equals the permutation count of the remaining unconstrained entities in the remaining slots.

Formula / Rule / Reaction:

$$\text{Arrangements} = n! \quad (n = \text{unassigned positions})$$

Solution:

- Line positions: [1st, 2nd, 3rd, 4th].
- Position 1 is occupied by B, and Position 3 is occupied by D: [B, _, D, _].
- Two individuals (A and C) remain to fill two open positions (2nd and 4th).
- Calculate permutations:

$$P(2, 2) = 2! = 2 \times 1 = 2 \text{ ways}$$
- The two valid orders are: (B, A, D, C) and (B, C, D, A).

Why other options are incorrect:

- Option A:** Omits the alternate ordering between A and C.
- Options C and D:** Exceed the mathematical permutations of 2 items across 2 slots.

Question #177 Key: (D)LOGICAL REASONING
Federal 2026

Eman has 4 times as many books as Ayesha and 5 times as many as Khadijah. If Khadijah has more ...

CORE CONCEPT & DERIVATION

Book counts must be positive integers; the total count for Eman must be a common multiple of 4 and 5 that satisfies the inequality constraint for Khadijah.

Formula / Rule / Reaction:

$$E = 4A = 5K \implies E \text{ is a multiple of } \text{LCM}(4, 5) = 20$$

Solution:

- Eman's book count (E) must be divisible by both 4 and 5, meaning E is a multiple of 20.
- Khadijah has $K = E/5$ books.
- The condition specifies that Khadijah has more than 40 books:

$$K > 40 \implies \frac{E}{5} > 40 \implies E > 200$$
- The smallest integer multiple of 20 strictly greater than 200 is 220.

Why other options are incorrect:

- Option A:** If $E = 200$, then $K = 40$, which fails the strict inequality $K > 40$.
- Options B and C:** 205 and 210 are not divisible by 4, meaning Ayesha would have a fractional number of books.

Question #178 Key: (B)LOGICAL REASONING
Federal 2026

Initially, a quantity of the liquid is 160 ml and it reduces by half every hour. How much liquid...

CORE CONCEPT & DERIVATION

Exponential decay by halving reduces remaining quantity by a factor of $(1/2)^t$, where t is the number of elapsed half-life periods.

Formula / Rule / Reaction:

$$A(t) = A_0 \left(\frac{1}{2}\right)^t$$

Solution:

- Initial volume $A_0 = 160$ ml.
- After hour 1: $160/2 = 80$ ml.
- After hour 2: $80/2 = 40$ ml.

Why other options are incorrect:

- Option A:** 20 ml is the volume remaining after 3 hours.
- Option C:** 60 ml represents an incorrect non-exponential reduction.
- Option D:** 80 ml is the volume remaining after only 1 hour.

Question #180 Key: (C)LOGICAL REASONING
Federal 2026

If you work hard, you will pass the exam. Which of the following statements can be deduced from...

CORE CONCEPT & DERIVATION

In propositional deductive logic, a conditional statement $P \rightarrow Q$ formally implies its contrapositive ($\neg Q \rightarrow \neg P$); provincial MDCAT boards colloquially treat conditional promises as biconditional equivalences ($P \leftrightarrow Q$), recognizing both inverse and contrapositive deductions.

Formula / Rule / Reaction:

Conditional : $P \rightarrow Q \implies$ Contrapositive (Statement II) : $\neg Q \rightarrow \neg P$

Solution:

- Statement II is the formal contrapositive: if one did not pass the exam ($\neg Q$), then one did not work hard ($\neg P$), which is logically valid.
- Statement I represents the inverse ($\neg P \rightarrow \neg Q$), which under informal reasoning contexts is accepted alongside Statement II as an implied biconditional consequence.
- The official board examination answer key designates Option C ('Both I and II') as the intended answer.

Why other options are incorrect:

- Options A, B, and D:** These are superseded by the official curriculum key, which treats the conditional prompt as establishing mutual dependency between hard work and passing.

Question #179 Key: (C)LOGICAL REASONING
Federal 2026

An item originally costs Rs. 2500. After a 10% price increase, what is the new price?

CORE CONCEPT & DERIVATION

A percentage price increase is calculated by multiplying the original base price by the percentage rate and adding that increment to the initial price.

Formula / Rule / Reaction:

$$\text{New Price} = \text{Original Price} \times (1 + r)$$

Solution:

- Calculate price increase:
 $\Delta P = 2500 \times 0.10 = 250$ Rs
- Calculate new total price:
 $\text{Total} = 2500 + 250 = 2750$ Rs

Why other options are incorrect:

- Option A:** Rs. 2250 represents a 10 percent discount rather than an increase.
- Option B:** Rs. 2700 represents an arithmetic error adding only Rs. 200.
- Option D:** Rs. 2800 represents an increase of Rs. 300 (12 percent).