THE FINAL ADVANCED CEE PRACTICE EDITION

CEE MCQs

& SURE SHOTS

ADVANCED QUESTIONS & COMPLETE SOLUTIONS

BY KRISH RAUNIYAR

300 challenging CEE-style MCQs • Every question answered • Worked numericals • Scientific explanations • Exam traps

FOR MEDICAL ENTRANCE CANDIDATES

MBBS • BDS • BSc Nursing | MEC syllabus-aligned practice themes

Five subject sections • Original diagrams • Answer index • Source transparency

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HOW TO USE THIS HANDBOOK

- Solve each four-option question first. The answer is printed below its options, followed by a reasoned solution. Avoid reading the answer before attempting the problem.
- In Physics, Chemistry and MAT, follow each equation and check its units and assumptions. In Biology, identify the exact mechanism and why the distractors are tempting.
- Use the EXAM TRAP line to review recurring errors. Questions are grouped by subject, rather than arranged as a claim of one official 200-mark paper.

EDITORIAL INTEGRITY & SOURCE LABELS

PREVIOUS ADVANCED HANDBOOK 63 source-theme-adapted questions retained from the previous advanced 2026 volume. A past-year tag indicates an analogous memory-based theme, not a verbatim authenticated exam question.

USER-SUPPLIED ADVANCED MOCK 180 questions from the separately provided “180 Marks CEE Based QNS” practice PDF. They are advanced practice items and should not be presented as official PYQs.

NEW ORIGINAL EXPECTED PRACTICE 57 newly written questions (37 PCBZ + 20 MAT) designed around high-application CEE concepts. These are predictions/practice, not guaranteed upcoming questions.

MEC curriculum reference: “Syllabus for Bachelor Level Common Entrance Examination, 2020 (Revised 2026),” published 29 April 2026. Syllabus content and future examination notices should be checked directly with MEC.

Historical references: user-uploaded CEE MBBS 2021, 2022, 2023, 2024, 2025 memory-based PDFs; the supplied 2026 CEE model set; the supplied 180-question advanced mock. No official 2020 paper was established from these uploads.

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HIGH-YIELD FORMULA & CONCEPT SHEET

PHYSICS

- Equal kinetic energy: $p = \sqrt{(2mK)}$; equal momentum: $K = p^2/(2m)$.
- Projectile range: $R = u^2\sin 2\theta/g$; height: $H = u^2\sin^2\theta/(2g)$.
- Capacitors: series reciprocal sum; parallel direct sum. $U = Q^2/(2C) = \frac{1}{2}CV^2$.
- Young interference: $\beta = \lambda D/d$; photoelectric: $K_{max} = hf - \varphi$.
- Circuits: $V_{terminal} = E - Ir$; AC transformer $V_s/V_p = N_s/N_p$.

CHEMISTRY

- $pH = -\log[H^+]$; buffer: $pH = pK_a + \log([A^-]/[HA])$.
- Nernst at 25°C: $E = E° - (0.0591/n)\log Q$.
- $\Delta G = \Delta H - T\Delta S$ and $\Delta G° = -RT\ln K$.
- First-order kinetics: $t_{1/2} = 0.693/k$; Arrhenius slope $\ln k$ vs $1/T = -E_a/R$.
- Isoelectronic ions: radius decreases with increasing nuclear charge.

BOTANY

- DNA amount: G_1 usually 2C, post-S/G_2 4C; after meiosis I n,2C.
- Hardy-Weinberg: $p^2+2pq+q^2=1$; carriers=2pq.
- Genetic map: cM ≈ recombinant percentage for short intervals.
- Net productivity: NPP = GPP − autotrophic respiration.
- Water moves from higher (less negative) to lower water potential.

ZOOLOGY

- Oxygen unloading increases with CO_2, H^+ and temperature: right shift.
- Filtration fraction = GFR / renal plasma flow.
- ADH increases collecting-duct water permeability via aquaporin-2.
- Sodium-potassium pump: 3 Na^+ out / 2 K^+ in / one ATP.
- Secondary antibody responses rely on memory lymphocytes.

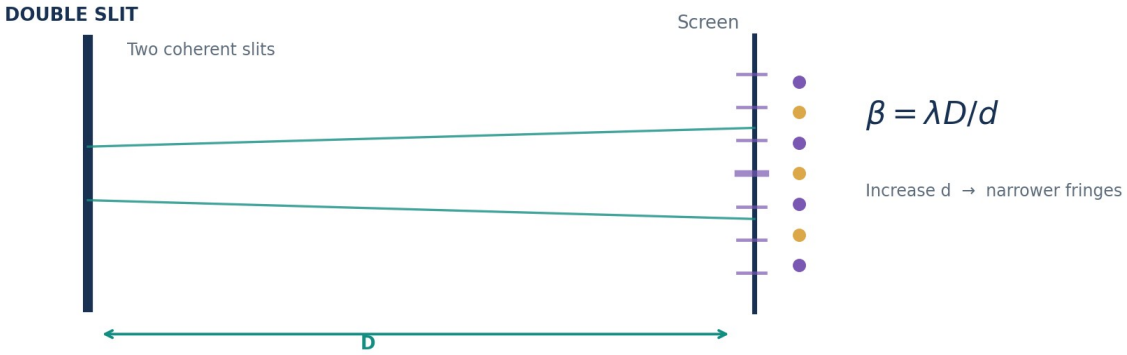
MAT

- Probability of A and B when independent = P(A)P(B).
- Union: $|A\cup B| = |A|+|B|-|A\cap B|$.
- Arrangements in circle (rotations identical): $(n-1)!$.
- Two trains overtaking in same direction: relative distance / relative speed.
- Weighted mean = total score / total number, not mean of subgroup means.

PART 1 / 76 EXAM-LEVEL QUESTIONS

PHYSICS

Conceptual mechanics, fields, optics, modern physics and multi-step calculations



Question range: Q001–Q076 • Practice level: concept-rich to application-heavy

Q001 NUMERICAL / APPLICATION

Two particles of masses 3m and 12m have equal kinetic energies. What is the ratio of their momentum magnitudes (lighter : heavier)?

A. 1 : 4
B. 1 : 2
C. 2 : 1
D. 4 : 1

CORRECT ANSWER B — 1 : 2

DETAILED SOLUTION

Use $K = p^2/(2m)$, hence $p = \sqrt{(2mK)}$. Since K is equal, $p \propto \sqrt{m}$. Therefore $\sqrt{(3m/12m)} = 1/2$.

EXAM TRAP Equal kinetic energy does not imply equal momentum.

SOURCE TYPE EQUAL KINETIC ENERGY — 2024 memory-based theme

Q002 CONCEPT / ANALYSIS

A projectile is fired with kinetic energy E at 60° to the vertical. Ignoring drag, what kinetic energy does it retain at its highest point?

A. E/4
B. E/2
C. 3E/4
D. E

CORRECT ANSWER C — 3E/4

DETAILED SOLUTION

The launch angle with the horizontal is 30°. At the top, $v_y = 0$ and $v_x = u \cos 30°$. $K_{top}/E = \cos^2 30° = 3/4$.

EXAM TRAP Always convert an angle specified from the vertical.

SOURCE TYPE PROJECTILE MOTION — 2024 memory-based theme

Q003 NUMERICAL / APPLICATION

A sphere floats across an oil–mercury interface with precisely half its volume in each liquid. Oil density = 0.8 g cm⁻³ and mercury density = 13.6 g cm⁻³. Find sphere density.

A. 6.4 g cm⁻³
B. 7.2 g cm⁻³
C. 13.6 g cm⁻³
D. 14.4 g cm⁻³

CORRECT ANSWER B — 7.2 g cm⁻³

DETAILED SOLUTION

At equilibrium, ρsVg = ρoil(V/2)g + ρHg(V/2)g; ρs = (0.8 + 13.6)/2 = 7.2 g cm⁻³. The upper and lower displaced volumes are both V/2. Balance total upward buoyancy from the two fluids against the sphere weight; gravity and total volume cancel.

EXAM TRAP Weight of displaced fluids, not mean depths, controls buoyancy.

SOURCE TYPE BUOYANCY — 2024 memory-based theme

Q004 CONCEPT / ANALYSIS

A car travels 90 km at 60 km h⁻¹ and returns along the same road at 40 km h⁻¹. Its average speed is:

A. 48 km h⁻¹
B. 50 km h⁻¹
C. 45 km h⁻¹
D. 0 km h⁻¹

CORRECT ANSWER A — 48 km h⁻¹

DETAILED SOLUTION

Total distance = 180 km. Total time = 90/60 + 90/40 = 1.5 + 2.25 = 3.75 h. Average speed = 180/3.75 = 48 km h⁻¹.

EXAM TRAP Average velocity is zero, but average speed is not.

SOURCE TYPE ROUND TRIP — 2024 memory-based theme

Q005 CONCEPT / ANALYSIS

A metal of work function 2.0 eV is illuminated with wavelength 400 nm. Using hc = 1240 eV nm, maximum photoelectron kinetic energy is:

A. 0.7 eV
B. 1.1 eV
C. 2.0 eV
D. 3.1 eV

CORRECT ANSWER B — 1.1 eV

DETAILED SOLUTION

Photon energy E = hc/λ = 1240/400 = 3.1 eV. Einstein equation: Kmax = E − φ = 3.1 − 2.0 = 1.1 eV.

EXAM TRAP Light intensity changes emission rate; frequency controls Kmax.

SOURCE TYPE PHOTOELECTRIC EFFECT — 2023–2024 recurring theme

Q006 NUMERICAL / APPLICATION

Five identical 10 μF capacitors are available. What is the smallest nonzero equivalent capacitance obtainable using all five?

A. 50 μF
B. 10 μF
C. 2 μF
D. 0.5 μF

CORRECT ANSWER C — 2 μF

DETAILED SOLUTION

Connect all five in series: 1/Ceq = 5/(10 μF), so Ceq = 10/5 = 2 μF. Any parallel connection would increase capacitance relative to an all-series chain.

EXAM TRAP All-series gives minimum capacitance.

SOURCE TYPE CAPACITOR COMBINATIONS — 2024 memory-based theme

Q007 CONCEPT / ANALYSIS

For a hydrogen atom, the wavelength of the n = 3 → 2 transition compared with n = 4 → 2 is:

A. Longer
B. Shorter
C. Equal
D. Cannot be compared

CORRECT ANSWER A — Longer

DETAILED SOLUTION

$\Delta E_{32} = 13.6(1/2^2 - 1/3^2) = 13.6 \times 5/36$ eV; $\Delta E_{42} = 13.6 \times 3/16$ eV. Because 5/36 < 3/16, the 3→2 photon has lower energy and longer wavelength (λ = hc/ΔE).

EXAM TRAP A larger energy gap produces shorter wavelength.

SOURCE TYPE HYDROGEN SPECTRUM — 2024 memory-based theme

Q008 CONCEPT / ANALYSIS

At a point sufficiently far from an ideal electric dipole, the potential on its axial line varies with distance r as:

A. 1/r
B. $1/r^2$
C. $1/r^3$
D. r^2

CORRECT ANSWER B — $1/r^2$

DETAILED SOLUTION

Dipole potential $V = (1/4\pi\varepsilon_0)(p\cos\theta/r^2)$. Along the axis, cosθ = ±1; therefore $V \propto r^{-2}$. The dipole electric field falls as r^{-3}, not the potential.

EXAM TRAP Field and potential have different distance laws.

SOURCE TYPE ELECTROSTATIC POTENTIAL — 2024 memory-based theme

Q009 NUMERICAL / APPLICATION

A car approaches a stationary wall with speed u and sounds a horn. The echo frequency heard by the driver is twice the emitted frequency. If sound speed is v, find u.

A. v/4
B. v/3
C. v/2
D. 2v/3

CORRECT ANSWER B — v/3

DETAILED SOLUTION

The wall first receives $f_1 = fv/(v-u)$; reflecting as a stationary source, the moving driver receives $f_2 = f_1(v+u)/v = f(v+u)/(v-u)$. Set $f_2=2f$: $v+u = 2v-2u$, so $3u=v$.

EXAM TRAP Reflection causes two Doppler stages.

SOURCE TYPE DOPPLER ECHO — 2024 memory-based theme

Q010 NUMERICAL / APPLICATION

An inductor of L = 0.40 H experiences a uniformly increasing current from 2 A to 7 A over 0.10 s. What is the induced emf magnitude?

A. 2 V
B. 10 V
C. 20 V
D. 28 V

CORRECT ANSWER C — 20 V

DETAILED SOLUTION

$|\varepsilon| = L|\Delta I/\Delta t| = 0.40 \times (7-2)/0.10 = 20$ V. The negative sign in Faraday's law specifies direction, not magnitude.

EXAM TRAP Use change in current, not final current.

SOURCE TYPE INDUCTORS — 2022–2024 recurring theme

Q011 CONCEPT / ANALYSIS

Germanium is doped with indium (Group 13). Which statement is most accurate?

A. n-type; electrons are majority carriers
B. p-type; holes are majority carriers
C. p-type; electrons are majority carriers
D. intrinsic; no majority carriers

CORRECT ANSWER B — p-type; holes are majority carriers

DETAILED SOLUTION

Group-13 indium has three valence electrons, one fewer than Ge. It introduces acceptor states, producing holes as majority charge carriers.

EXAM TRAP Donor = pentavalent; acceptor = trivalent.

SOURCE TYPE SEMICONDUCTORS — 2024 memory-based theme

Q012 CONCEPT / ANALYSIS

If a galaxy recedes at 1,540 km s^{-1} and H_0 = 70 km s^{-1} Mpc^{-1}, its Hubble-law distance is:

A. 11 Mpc
B. 22 Mpc
C. 70 Mpc
D. 110 Mpc

CORRECT ANSWER B — 22 Mpc

DETAILED SOLUTION

$v = H_0 d \Rightarrow d = v/H_0 = 1540/70 = 22$ Mpc. Distance follows the proportionality between recessional velocity and Hubble distance in the local Hubble approximation. Units cancel to leave megaparsecs, so the result is 22 Mpc.

EXAM TRAP The velocity and Hubble constant units must match.

SOURCE TYPE HUBBLE LAW — 2024 memory-based theme

Q013 NUMERICAL / APPLICATION

A cyclic engine absorbs 900 J and rejects 540 J per cycle. Find efficiency and net work.

A. 40%; 360 J
B. 60%; 360 J
C. 40%; 540 J
D. 25%; 225 J

CORRECT ANSWER A — 40%; 360 J

DETAILED SOLUTION

$W = Q_{hot} - Q_{cold} = 900 - 540 = 360$ J. $\eta = W/Q_{hot} = 360/900 = 0.40 = 40\%$. The cycle returns the working substance to its initial internal energy. Thus the net work equals input heat minus rejected heat, and efficiency is useful work divided by heat drawn from the hot reservoir.

EXAM TRAP Rejected heat is not equal to useful work.

SOURCE TYPE HEAT ENGINES — Advanced PYQ-pattern practice

Q014 NUMERICAL / APPLICATION

Young's slit separation doubles while wavelength and screen distance remain unchanged. The fringe width changes from β to:

A. 2β
B. β/2
C. β/4
D. β

CORRECT ANSWER B — β/2

DETAILED SOLUTION

$\beta = \lambda D/d$. Replacing d with 2d gives $\beta' = \lambda D/(2d) = \beta/2$. Screen separation D and wavelength λ are unchanged. Because the fringe width is inversely proportional to slit separation d, doubling d must halve the spacing between adjacent bright fringes.

EXAM TRAP Fringe width is inversely proportional to slit separation.

SOURCE TYPE INTERFERENCE — Advanced PYQ-pattern practice

Q015 CONCEPT / ANALYSIS

Two resistors of 6 Ω and 3 Ω are connected in parallel across a 12 V battery. The total power is:

A. 16 W
B. 24 W
C. 48 W
D. 72 W

CORRECT ANSWER D — 72 W

DETAILED SOLUTION

1/Req=1/6+1/3=1/2, so Req=2 Ω. Power P=V²/Req=144/2=72 W. Both parallel branches share the same 12 V, but equivalent resistance is less than the smallest branch resistance. Using total P = V²/Req avoids computing the two branch currents separately.

EXAM TRAP For parallel resistors, use equivalent resistance first.

SOURCE TYPE ELECTRIC CIRCUITS — Advanced PYQ-pattern practice

Q016 CONCEPT / ANALYSIS

A circular hole in a thin metal sheet has diameter 20 mm at temperature T. If the sheet is heated uniformly by 100 K and α = 1.2×10⁻⁵ K⁻¹, new hole diameter is approximately:

A. 19.976 mm
B. 20.000 mm
C. 20.024 mm
D. 20.240 mm

CORRECT ANSWER C — 20.024 mm

DETAILED SOLUTION

A hole expands as though it were made of the same metal: ΔD=αDΔT=1.2×10⁻⁵×20×100=0.024 mm. D′=20.024 mm.

EXAM TRAP Heating a sheet does not shrink its hole.

SOURCE TYPE THERMAL EXPANSION — Advanced PYQ-pattern practice

Q017 CONCEPT / ANALYSIS

[Numerical] A block slides from rest down a frictionless height h, crosses a rough horizontal patch of length L (coefficient μ), then rises frictionlessly. If μL<h, its greatest final height is:

A. h+μL
B. μh/L
C. h−μL
D. h(1−μ)

CORRECT ANSWER C — h−μL

DETAILED SOLUTION

Initial mechanical energy at height h is mgh. Friction over the horizontal patch does negative work W^f = −μmgL. The final rise converts remaining energy into mgH: mgH = mgh − μmgL, hence H = h − μL, provided μL < h.

EXAM TRAP Use energy loss μmgL rather than reducing height by μL/h.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q018 CONCEPT / ANALYSIS

Two projectiles are launched with equal speed at complementary angles. Ignoring air resistance, they have equal range. Which comparison is correct?

A. The larger-angle projectile has greater height and longer flight time
B. The smaller-angle projectile has greater height but shorter time
C. Their velocity vectors are identical at every instant
D. Equal maximum height and flight time

CORRECT ANSWER A — The larger-angle projectile has greater height and longer flight time

DETAILED SOLUTION

Projectile range $R = u^2\sin2\theta/g$ is unchanged when θ is replaced by $90°-\theta$. However, $H_{max} = u^2\sin^2\theta/(2g)$ and time $T = 2u\sin\theta/g$ both increase with launch angle. The steeper projectile therefore rises higher and remains in air longer.

EXAM TRAP Equal range does not mean equal peak height or flight time.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q019 NUMERICAL / APPLICATION

[Numerical] A 2 kg body moving at 6 m/s sticks to a 1 kg body at rest. The fraction of initial kinetic energy lost is:

A. 3/4
B. 1/2
C. 2/3
D. 1/3

CORRECT ANSWER D — 1/3

DETAILED SOLUTION

Momentum conservation gives common speed $v = (2\times6 + 1\times0)/(2+1) = 4$ m s^{-1}. Initial kinetic energy $= (1/2)(2)(6^2) = 36$ J; final $= (1/2)(3)(4^2) = 24$ J. Fraction lost $= (36-24)/36 = 1/3$.

EXAM TRAP Kinetic energy is not conserved in a perfectly inelastic collision.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q020 CONCEPT / ANALYSIS

A satellite in a circular orbit is moved instantaneously to a larger circular orbit. Compared with the original orbit, its speed and total mechanical energy respectively:

A. increase; become less negative
B. decrease; become more negative
C. decrease; become less negative
D. increase; become more negative

CORRECT ANSWER C — decrease; become less negative

DETAILED SOLUTION

For a circular orbit, $v = \sqrt{(GM/r)}$, so a larger radius means lower speed. The total mechanical energy is $E = -GMm/(2r)$; increasing r makes E less negative (numerically increases toward zero).

EXAM TRAP Lower orbital speed can accompany higher total mechanical energy.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q021 CONCEPT / ANALYSIS

[Numerical] A car travels half a distance at speed v and the other half at 2v. Its average speed is:

A. √2v
B. 4v/3
C. 3v/2
D. 5v/4

CORRECT ANSWER B — 4v/3

DETAILED SOLUTION

For equal distance halves d each, travel time = d/v + d/(2v) = 3d/(2v). Total distance = 2d, so mean speed = (2d)/(3d/2v) = 4v/3. The arithmetic mean 3v/2 is incorrect because times differ.

EXAM TRAP For equal distances use the harmonic mean of speeds.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q022 CONCEPT / ANALYSIS

A rigid body has zero net external force but a nonzero net external torque about its centre of mass. It can have:

A. zero angular acceleration necessarily
B. neither translation nor rotation
C. constant linear momentum and changing angular momentum
D. changing linear momentum and constant angular momentum

CORRECT ANSWER C — constant linear momentum and changing angular momentum

DETAILED SOLUTION

Net external force determines centre-of-mass acceleration through Fnet = MaCM. If force is zero, linear momentum stays constant. Nonzero external torque gives dL/dt = τ, so angular momentum changes and angular acceleration can occur.

EXAM TRAP Force governs translation; torque governs rotation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q023 CONCEPT / ANALYSIS

A ball is thrown vertically upward inside a lift accelerating upward. Relative to the lift, and ignoring air resistance, the ball has:

A. downward acceleration g+a
B. downward acceleration smaller than g
C. zero acceleration at the top
D. upward acceleration a

CORRECT ANSWER A — downward acceleration g+a

DETAILED SOLUTION

In the frame of a lift accelerating upward at a, a downward pseudo-acceleration a acts in addition to gravity g. Thus the ball's relative downward acceleration is g+a at every point of its flight, including the top.

EXAM TRAP Acceleration at the turning point is not zero.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q024 CONCEPT / ANALYSIS

[Numerical] A uniform rod of length 2 m pivots about one end. A 6 N force perpendicular to the rod at its centre balances a perpendicular force F at the far end. F equals:

A. 1.5 N
B. 12 N
C. 6 N
D. 3 N

CORRECT ANSWER D — 3 N

DETAILED SOLUTION

Torque = perpendicular force × distance from pivot. The 6 N force at the midpoint (1 m) supplies torque 6 N m. A force F at the far end (2 m) balances it when 2F = 6, hence F = 3 N.

EXAM TRAP Use the correct lever arm for each force.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q025 CONCEPT / ANALYSIS

For uniform circular motion, work done by the centripetal force over any interval is zero because the force is:

A. opposite to velocity
B. perpendicular to instantaneous displacement
C. constant in direction
D. zero

CORRECT ANSWER B — perpendicular to instantaneous displacement

DETAILED SOLUTION

The instantaneous centripetal force points toward the circle's centre while velocity and displacement are tangential. Hence dW = F·ds = 0 at every instant and the integrated work is zero, although the force continually redirects momentum.

EXAM TRAP A force can change direction of velocity without changing speed.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q026 CONCEPT / ANALYSIS

A spring is cut into two equal lengths. Each half, made of the same material and coil geometry, has spring constant approximately:

A. 4k
B. k/2
C. k
D. 2k

CORRECT ANSWER D — 2k

DETAILED SOLUTION

For a uniform helical spring with unchanged wire radius and coil diameter, spring constant is inversely proportional to active coil count and length. Halving the length halves coil count, giving khalf ≈ 2k.

EXAM TRAP Two half-springs in series restore the original k.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q027 CONCEPT / ANALYSIS

An ideal gas undergoes a complete cycle. Which quantity must be zero over the cycle?

A. Net work done
B. Net heat absorbed
C. Change in internal energy
D. Area enclosed on a P-V diagram

CORRECT ANSWER C — Change in internal energy

DETAILED SOLUTION

Internal energy is a thermodynamic state function, so completing a cycle returns the gas to its initial state and $\Delta U_{cycle} = 0$. The net heat and net work generally need not be zero; by the first law they are equal under the appropriate sign convention.

EXAM TRAP State-function change is zero over a closed cycle.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q028 CONCEPT / ANALYSIS

A metal ring is heated uniformly. Its central hole:

A. expands as if the missing material also expanded
B. remains unchanged
C. contracts because material expands inward
D. first closes and then opens

CORRECT ANSWER A — expands as if the missing material also expanded

DETAILED SOLUTION

Thermal expansion uniformly scales all lengths in the ring, including the boundary of the hole. The hole expands as though filled with the same material, rather than contracting because the solid moves inward.

EXAM TRAP Holes in heated plates expand with the plate.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q029 NUMERICAL / APPLICATION

[Numerical] Equal heat is supplied to 100 g water and 100 g copper. Taking $c_{water}=4200$ and $c_{copper}=400$ J kg^{-1} K^{-1}, the ratio $\Delta T_{copper}/\Delta T_{water}$ is:

A. 1
B. 0.095
C. 42
D. 10.5

CORRECT ANSWER D — 10.5

DETAILED SOLUTION

For heat $Q = mc\Delta T$, $\Delta T = Q/(mc)$. Equal Q and mass yield $\Delta T_{copper}/\Delta T_{water} = c_{water}/c_{copper} = 4200/400 = 10.5$. Copper warms much more because its specific heat is much lower.

EXAM TRAP Temperature rise is inversely proportional to specific heat for equal Q,m.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q030 CONCEPT / ANALYSIS

During isothermal expansion of an ideal gas, its internal energy remains constant because internal energy depends only on:

A. temperature
B. pressure
C. volume
D. work

CORRECT ANSWER A — temperature

DETAILED SOLUTION

An ideal gas has $U = nC_vT$ (for fixed composition), so internal energy depends only on absolute temperature. Isothermal expansion keeps T constant, hence $\Delta U = 0$; the heat absorbed equals work done by the gas using the conventional work-by-system sign.

EXAM TRAP Isothermal does not mean zero heat or zero work.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q031 CONCEPT / ANALYSIS

A refrigerator cannot transfer heat from cold to hot without external work because that would violate the:

A. conservation of charge
B. second law of thermodynamics
C. law of gravitation
D. zeroth law only

CORRECT ANSWER B — second law of thermodynamics

DETAILED SOLUTION

The Clausius statement of the second law forbids a cyclic device whose sole result is heat flow from colder to hotter without external work. A refrigerator uses work input to pump heat against the natural temperature direction.

EXAM TRAP Refrigerators need work; they do not violate energy conservation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q032 CONCEPT / ANALYSIS

[Numerical] An engine absorbs 600 J and rejects 360 J per cycle. Its efficiency is:

A. 1.67
B. 0.60
C. 0.24
D. 0.40

CORRECT ANSWER D — 0.40

DETAILED SOLUTION

The engine's useful work per cycle is $W = Q_{in} - Q_{out} = 600 - 360 = 240$ J. Thermal efficiency $\eta = W/Q_{in} = 240/600 = 0.40 = 40\%$.

EXAM TRAP Efficiency is useful work divided by heat supplied.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q033 CONCEPT / ANALYSIS

At the same temperature, molecules of H_2 and O_2 have equal average translational kinetic energy, but H_2 has:

A. zero momentum always
B. higher rms speed
C. the same rms speed
D. lower rms speed

CORRECT ANSWER B — higher rms speed

DETAILED SOLUTION

Average translational energy per molecule is (3/2)kBT, independent of molecular mass. At the same T, $v_{rms} = \sqrt{(3RT/M)}$, so lower-molar-mass H_2 molecules move faster than O_2 molecules.

EXAM TRAP Equal average energy does not imply equal molecular speed.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q034 CONCEPT / ANALYSIS

A wave travels from a light string into a heavier string under equal tension. At the boundary its frequency:

A. decreases
B. becomes zero
C. remains fixed by the source
D. increases

CORRECT ANSWER C — remains fixed by the source

DETAILED SOLUTION

Frequency is fixed by the vibrating source and must be continuous across a stationary boundary. Wave speed $v = \sqrt{(T/\mu)}$ decreases in the heavier string because linear density μ rises; wavelength $\lambda = v/f$ decreases accordingly.

EXAM TRAP At an interface, frequency stays fixed; speed and wavelength may change.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q035 CONCEPT / ANALYSIS

[Numerical] A pipe closed at one end has fundamental frequency v/4L. If its length doubles with v unchanged, the new fundamental is:

A. v/16L
B. v/2L
C. v/8L
D. v/4L

CORRECT ANSWER C — v/8L

DETAILED SOLUTION

The fundamental of a closed-open pipe is f = v/(4L). Replacing L by 2L gives f' = v/[4(2L)] = v/(8L), exactly half the original frequency.

EXAM TRAP Closed pipes have fundamental wavelength 4L.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q036 CONCEPT / ANALYSIS

Two coherent equal-amplitude waves arrive π radians out of phase. Their resultant intensity ideally is:

A. four times one wave
B. zero
C. equal to one wave
D. twice one wave

CORRECT ANSWER B — zero

DETAILED SOLUTION

For equal coherent amplitudes A, a phase difference π means displacement amplitudes sum to A−A = 0. Since intensity is proportional to the square of the resultant amplitude, I = 0 at ideal destructive interference.

EXAM TRAP Intensities do not simply add when waves are coherent.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q037 CONCEPT / ANALYSIS

[Numerical] A convex lens forms a real image twice the object size. If focal length is 10 cm, the object distance is:

A. 5 cm
B. 30 cm
C. 15 cm
D. 10 cm

CORRECT ANSWER C — 15 cm

DETAILED SOLUTION

A real image twice the object height has magnification m = −2 = v/u (Cartesian signs), giving v = −2u. Lens formula 1/f = 1/v − 1/u yields object distance magnitude 3f/2 = 15 cm for f = 10 cm.

EXAM TRAP Use signed magnification before applying the lens equation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q038 CONCEPT / ANALYSIS

When light passes from air to glass, which pair remains unchanged?

A. Frequency and phase velocity
B. Speed and wavelength
C. Wavelength and speed
D. Frequency and color as set by frequency

CORRECT ANSWER D — Frequency and color as set by frequency

DETAILED SOLUTION

At a stationary optical interface, the frequency of light remains fixed by its source. Its perceived color is characterized by this frequency, while speed becomes c/n and wavelength changes proportionally to speed.

EXAM TRAP Refraction changes speed and wavelength, not frequency.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q039 CONCEPT / ANALYSIS

A myopic eye is corrected with a concave lens because the lens:

A. increases focal power of the eye
B. converges rays more strongly
C. diverges incoming rays so the eye focuses them on retina
D. moves retina forward

CORRECT ANSWER C — diverges incoming rays so the eye focuses them on retina

DETAILED SOLUTION

A myopic eye focuses distant parallel rays in front of the retina. A concave diverging lens reduces their convergence before entering the eye, moving the final image plane backward onto the retina.

EXAM TRAP Myopia needs a negative-power (diverging) corrective lens.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q040 NUMERICAL / APPLICATION

In Young double-slit interference, increasing slit separation while other quantities remain fixed causes fringe width to:

A. decrease
B. become wavelength independent
C. remain constant
D. increase

CORRECT ANSWER A — decrease

DETAILED SOLUTION

In Young's double-slit setup, fringe spacing $\beta = \lambda D/d$, where d is the slit separation. Increasing d while keeping wavelength and screen distance fixed decreases β. This follows from the inverse proportionality.

EXAM TRAP Larger slit separation gives narrower fringes.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q041 CONCEPT / ANALYSIS

Total internal reflection occurs only when light travels:

A. from vacuum to glass normally
B. from denser to rarer with incidence above critical angle
C. through a thin lens
D. from rarer to denser at any angle

CORRECT ANSWER B — from denser to rarer with incidence above critical angle

DETAILED SOLUTION

Total internal reflection requires light incident from optically denser medium (higher n) to rarer medium (lower n) and incidence angle greater than $\theta c = \sin^{-1}(n_2/n_1)$. Otherwise a transmitted ray is present.

EXAM TRAP Both medium order and angle condition are necessary.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q042 NUMERICAL / APPLICATION

Two resistors R and 2R are in parallel across a battery. The ratio of powers PR:P2R is:

A. 1:2
B. 1:4
C. 4:1
D. 2:1

CORRECT ANSWER D — 2:1

DETAILED SOLUTION

The parallel resistors have the same voltage V. Power is $P = V^2/R$, giving $PR = V^2/R$ and $P2R = V^2/(2R)$. Therefore PR:P2R = 2:1; the smaller resistance dissipates more at fixed voltage.

EXAM TRAP In parallel compare powers via V^2/R; in series via I^2R.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q043 CONCEPT / ANALYSIS

[Numerical] A cell of emf 12 V and internal resistance 1 Ω supplies 5 Ω. The terminal voltage is:

A. 14 V
B. 10 V
C. 12 V
D. 2 V

CORRECT ANSWER B — 10 V

DETAILED SOLUTION

Current from the cell is $I = E/(R+r) = 12/(5+1) = 2$ A. Terminal voltage across the load is $V = IR = 2\times5 = 10$ V, equivalently $E-Ir = 12-2 = 10$ V.

EXAM TRAP Internal resistance causes terminal voltage to fall under load.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q044 CONCEPT / ANALYSIS

[Numerical] A wire is stretched to twice its length without volume change. If resistivity is unchanged, its resistance becomes:

A. 4R
B. R
C. R/2
D. 2R

CORRECT ANSWER A — 4R

DETAILED SOLUTION

Assuming constant volume, doubling length L while keeping material volume AL fixed reduces area to A/2. Resistance $R' = \rho(2L)/(A/2) = 4\rho L/A = 4R$, if resistivity does not change.

EXAM TRAP Both length increase and area decrease contribute.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q045 CONCEPT / ANALYSIS

Kirchhoff junction rule follows directly from conservation of:

A. energy
B. magnetic flux
C. charge
D. momentum

CORRECT ANSWER C — charge

DETAILED SOLUTION

At a junction, charge cannot accumulate indefinitely in a steady circuit. Therefore total current entering equals total current leaving: ΣIin = ΣIout. This is Kirchhoff's current law, a statement of electric-charge conservation.

EXAM TRAP Loop rule uses energy conservation; junction rule uses charge.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q046 CONCEPT / ANALYSIS

A charged particle moves parallel to a uniform magnetic field. Its magnetic force is:

A. qvB
B. zero
C. qvB/2
D. dependent only on mass

CORRECT ANSWER B — zero

DETAILED SOLUTION

Magnetic Lorentz force magnitude is F = abs(q) vB sinθ. If velocity is parallel or antiparallel to B, θ = 0° or 180° and sinθ = 0, so no magnetic deflection occurs.

EXAM TRAP A charged particle may move in B without magnetic force.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q047 CONCEPT / ANALYSIS

Two long parallel wires carry currents in the same direction. They:

A. exert no force
B. alternate attraction and repulsion
C. repel
D. attract

CORRECT ANSWER D — attract

DETAILED SOLUTION

The magnetic field from each long straight wire acts on current in the other. For parallel currents in the same direction, the forces are attractive; for opposite currents, repulsive. The magnitude per length is $\mu_0 I_1 I_2/(2\pi d)$.

EXAM TRAP Parallel currents: same attracts, opposite repels.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q048 CONCEPT / ANALYSIS

[Numerical] A 2 Ω and 4 Ω resistor are in series across 12 V. Power in the 4 Ω resistor is:

A. 8 W
B. 16 W
C. 4 W
D. 24 W

CORRECT ANSWER B — 16 W

DETAILED SOLUTION

Total series resistance = 2 + 4 = 6 Ω. Circuit current I = V/R = 12/6 = 2 A. Power in the 4 Ω resistor is $P = I^2R = (2^2)(4) = 16$ W.

EXAM TRAP In series, current is the same through every resistor.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q049 CONCEPT / ANALYSIS

Lenz law states that induced current opposes:

A. the magnetic field itself in every case
B. electric current in the source always
C. the change in magnetic flux producing it
D. motion regardless of flux change

CORRECT ANSWER C — the change in magnetic flux producing it

DETAILED SOLUTION

Lenz's law states that the induced current creates a magnetic effect opposing the change in magnetic flux that caused it. It need not oppose the original field itself: if flux decreases, the induced field tends to support the original direction.

EXAM TRAP Opposition is to flux change, not necessarily to flux.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q050 CONCEPT / ANALYSIS

A transformer cannot operate with steady DC because steady DC produces:

A. a changing flux of constant rate
B. no continuously changing magnetic flux
C. infinite secondary voltage
D. zero primary current

CORRECT ANSWER B — no continuously changing magnetic flux

DETAILED SOLUTION

Transformer voltage obeys $\varepsilon s = -Ns(d\Phi/dt)$. Steady DC after the switching transient gives constant flux in the core, so $d\Phi/dt = 0$ and no sustained secondary emf is produced. AC maintains varying flux.

EXAM TRAP Transformer action requires time-varying magnetic flux.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q051 CONCEPT / ANALYSIS

Inside a conductor in electrostatic equilibrium, the electric field is zero because free charges:

A. cease to exist
B. become neutrons
C. are all at the centre
D. redistribute until their field cancels the internal applied field

CORRECT ANSWER D — redistribute until their field cancels the internal applied field

DETAILED SOLUTION

If an electric field existed in the bulk of a conductor at electrostatic equilibrium, free charges would continue moving. They redistribute on the conductor surface until the induced field cancels the internal applied field, making E = 0 inside the material.

EXAM TRAP Zero interior E is an equilibrium result, not absence of charge.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q052 NUMERICAL / APPLICATION

[Numerical] Two identical capacitors C are first connected in parallel and then in series. The ratio Ceq(parallel):Ceq(series) is:

A. 1:4
B. 4:1
C. 2:1
D. 1:1

CORRECT ANSWER B — 4:1

DETAILED SOLUTION

Two equal capacitors in parallel give Cp = C+C = 2C. In series, 1/Cs = 1/C+1/C, so Cs = C/2. Therefore Cp:Cs = 2C:(C/2) = 4:1.

EXAM TRAP Parallel increases capacitance; series decreases it.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q053 CONCEPT / ANALYSIS

A dielectric is inserted into an isolated charged capacitor. Which pair decreases?

A. Capacitance and charge
B. Charge and capacitance
C. Capacitance and electric permittivity
D. Potential difference and stored energy

CORRECT ANSWER D — Potential difference and stored energy

DETAILED SOLUTION

An isolated capacitor retains the same free charge Q when a dielectric is inserted. Capacitance increases to κC, so voltage V = Q/C decreases and energy U = $Q^2/(2C)$ also decreases. The lost electrostatic energy is linked to mechanical work during insertion.

EXAM TRAP Isolated: Q fixed; battery-connected: V fixed.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q054 CONCEPT / ANALYSIS

Electric potential can be nonzero where electric field is zero, as illustrated by:

A. a point on an electric field line
B. every point near a single charge
C. the surface of an uncharged conductor only
D. the centre of a uniformly charged spherical shell

CORRECT ANSWER D — the centre of a uniformly charged spherical shell

DETAILED SOLUTION

A uniformly charged spherical shell creates zero electric field everywhere inside, but its potential is constant and equal to kQ/R relative to infinity. Since $E = -\nabla V$, zero electric field means zero potential gradient, not necessarily zero potential.

EXAM TRAP Potential can be constant and nonzero.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q055 CONCEPT / ANALYSIS

Light of frequency below the threshold strikes a metal with arbitrarily high intensity. Photoelectrons are absent because:

A. total energy is always zero
B. intensity lowers work function to infinity
C. electrons require momentum but photons have none
D. each photon lacks sufficient energy

CORRECT ANSWER D — each photon lacks sufficient energy

DETAILED SOLUTION

Each photoelectron is liberated by absorbing a photon of energy hf. If f is below threshold $f_0 = \varphi/h$, individual photons cannot overcome work function φ, no matter how many photons arrive per second; increasing intensity cannot compensate for insufficient photon energy.

EXAM TRAP Intensity affects count of photons; frequency affects photon energy.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q056 NUMERICAL / APPLICATION

[Numerical] For a radioactive sample with half-life 6 h, the fraction remaining after 18 h is:

A. 1/6
B. 1/18
C. 1/8
D. 1/3

CORRECT ANSWER C — 1/8

DETAILED SOLUTION

Elapsed time 18 h represents n = 18/6 = 3 half-lives. The surviving fraction is $(1/2)^n = (1/2)^3 = 1/8$, or 12.5% of the initial number.

EXAM TRAP Convert time into number of half-lives first.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q057 CONCEPT / ANALYSIS

In Bohr model, an electron moving from n=3 to n=2 emits a photon whose energy equals:

- **A.** E3+E2
- **B.** E3−E2 in magnitude
- **C.** E2−E3 with negative photon energy
- **D.** the ionization energy from n=1

CORRECT ANSWER B — E3−E2 in magnitude

DETAILED SOLUTION

Hydrogen energy levels are negative: $E_n = -13.6/n^2$ eV. During $n = 3 \to 2$, energy released is $E3-E2 > 0$ numerically because the electron moves to a more negative level. Photon energy is the magnitude of $E3-E2 = 13.6(1/4-1/9)$ eV.

EXAM TRAP Emission photon energy is a positive level difference.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q058 CONCEPT / ANALYSIS

An electron and a proton have equal de Broglie wavelength. They must have equal:

- **A.** speed
- **B.** mass
- **C.** momentum magnitude
- **D.** kinetic energy

CORRECT ANSWER C — momentum magnitude

DETAILED SOLUTION

De Broglie wavelength is $\lambda = h/p$, where p is momentum magnitude. Equal λ therefore implies equal p, regardless of differing masses. Speeds are not equal because $v = p/m$ in the nonrelativistic limit.

EXAM TRAP Matter-wave wavelength directly tests momentum, not speed.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q059 CONCEPT / ANALYSIS

A p-n junction under forward bias has reduced barrier potential, so its current:

- **A.** decreases below reverse saturation current
- **B.** remains exactly zero
- **C.** flows without charge carriers
- **D.** increases strongly after threshold

CORRECT ANSWER D — increases strongly after threshold

DETAILED SOLUTION

Forward bias reduces the junction's built-in potential barrier and permits strong diffusion of majority carriers. Once the applied bias approaches the characteristic turn-on region, current rises sharply according to the diode I−V relation.

EXAM TRAP Forward bias reduces barrier; reverse bias widens it.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q060 CONCEPT / ANALYSIS

An intrinsic semiconductor is warmed. Its conductivity generally:

A. decreases because all electrons stop
B. increases because more electron-hole pairs are generated
C. remains exactly constant
D. becomes superconducting

CORRECT ANSWER B — increases because more electron-hole pairs are generated

DETAILED SOLUTION

Heating an intrinsic semiconductor thermally excites more electrons into its conduction band, creating equal numbers of electrons and holes. The large increase in intrinsic carrier density generally outweighs mobility reduction, so conductivity rises.

EXAM TRAP Semiconductors generally have negative temperature coefficient of resistance.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q061 CONCEPT / ANALYSIS

A NAND gate output is 0 only when inputs are:

A. 1,0
B. 0,0
C. 1,1
D. 0,1

CORRECT ANSWER C — 1,1

DETAILED SOLUTION

NAND output is the negation of AND: $Y = \neg(A \cdot B)$. It equals 0 only when both inputs are 1; for 00, 01 or 10 the AND is 0 and NAND is 1.

EXAM TRAP NAND is a universal gate; 11 is its sole zero-output input.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q062 CONCEPT / ANALYSIS

[Numerical] A nucleus has mass defect 0.20 u. Using 1 u≈931 MeV/c², its binding energy is approximately:

A. 46.6 MeV
B. 931 MeV
C. 93.1 MeV
D. 186 MeV

CORRECT ANSWER D — 186 MeV

DETAILED SOLUTION

Binding energy is Δmc^2. With $\Delta m = 0.20$ u and 1 u $c^2 \approx 931$ MeV, $E_b \approx 0.20 \times 931 = 186.2$ MeV, nearest 186 MeV. Binding energy per nucleon requires dividing by mass number, which is not requested.

EXAM TRAP Use u×931 MeV for a nucleus's total mass defect.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q063 CONCEPT / ANALYSIS

In β− decay, conservation laws require emission of an electron and:

A. a neutrino with zero role
B. a proton only
C. an antineutrino
D. an alpha particle

CORRECT ANSWER C — an antineutrino

DETAILED SOLUTION

In β^- decay, a neutron converts into a proton, electron and electron antineutrino: $n \rightarrow p + e^- + \bar{\nu}e$. The antineutrino permits conservation of lepton number, energy, momentum and angular momentum across the decay.

EXAM TRAP Beta-minus emission includes an electron antineutrino.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q064 CONCEPT / ANALYSIS

[Numerical] A galaxy recedes at 1400 km/s. If H0=70 km s−1 Mpc−1, its estimated distance is:

A. 10 Mpc
B. 98 Mpc
C. 70 Mpc
D. 20 Mpc

CORRECT ANSWER D — 20 Mpc

DETAILED SOLUTION

Hubble's empirical relation is $v = H_0 d$ for relatively nearby cosmological objects where the approximation applies. Thus $d = v/H_0 = (1400 \text{ km s}^{-1})/(70 \text{ km s}^{-1} \text{ Mpc}^{-1}) = 20$ Mpc; km/s units cancel.

EXAM TRAP Hubble distance uses recessional speed divided by H_0.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q065 CONCEPT / ANALYSIS

Gamma rays differ from alpha particles because gamma rays:

A. are stopped more easily by paper than alpha rays
B. are electrons from nucleus
C. are neutral electromagnetic radiation with high penetration
D. carry charge +2e and mass 4 u

CORRECT ANSWER C — are neutral electromagnetic radiation with high penetration

DETAILED SOLUTION

Gamma radiation is electromagnetic photons emitted during nuclear de-excitation. It carries no electric charge and has high penetrating power compared with alpha particles, which are helium nuclei with +2e charge and about 4 u mass.

EXAM TRAP Gamma changes nuclear energy state but not proton/neutron count.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q066 CONCEPT / ANALYSIS

In the photoelectric effect, raising light frequency above threshold at fixed intensity primarily increases:

A. maximum kinetic energy of emitted electrons
B. number of photons necessarily without limit
C. work function of metal
D. threshold frequency

CORRECT ANSWER A — maximum kinetic energy of emitted electrons

DETAILED SOLUTION

Einstein's photoelectric equation is $K_{max} = hf - \varphi$ for $f \geq f_0$. At a fixed work function, increasing f raises the energy of each emitted electron and therefore Kmax. The threshold frequency is a property of the emitting surface, not the incoming intensity.

EXAM TRAP Frequency controls Kmax; intensity usually controls emission rate.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q067 NUMERICAL / APPLICATION

An isolated capacitor originally stores energy U. A dielectric of relative permittivity κ = 4 is fully inserted without changing plate separation. Its new stored energy is:

A. 4U
B. 2U
C. U/2
D. U/4

CORRECT ANSWER D — U/4

DETAILED SOLUTION

The capacitor is isolated, so its free charge Q is fixed. Insertion increases capacitance from C to 4C. Energy at constant charge is $U = Q^2/(2C)$, giving $U_{new} = Q^2/(2\times4C) = U/4$. The result differs for a battery-connected capacitor.

EXAM TRAP For isolated capacitors charge is fixed; for connected ones voltage is fixed.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q068 CONCEPT / ANALYSIS

Two thin lenses of focal lengths +20 cm and −30 cm are in contact. Their combined focal length is:

A. +12 cm
B. +60 cm
C. −60 cm
D. −12 cm

CORRECT ANSWER B — +60 cm

DETAILED SOLUTION

Powers add for thin lenses in contact: $1/F = 1/f_1 + 1/f_2 = 1/20 - 1/30 = (3-2)/60 = 1/60\ cm^{-1}$. Therefore F = +60 cm, a weak converging combination.

EXAM TRAP The diverging lens has negative focal length.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q069 NUMERICAL / APPLICATION

In a double-slit experiment the light wavelength is halved and slit separation is doubled. The new fringe width is:

A. β/4
B. β/2
C. 2β
D. 4β

CORRECT ANSWER A — β/4

DETAILED SOLUTION

Fringe width $\beta = \lambda D/d$. Replacing λ by $\lambda/2$ and d by 2d gives $\beta_{new} = (\lambda/2)D/(2d) = \lambda D/(4d) = \beta/4$. Screen distance D is unchanged.

EXAM TRAP Apply both changes, not only one.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q070 NUMERICAL / APPLICATION

A nonrelativistic electron is accelerated from rest through potential difference V. If the potential becomes 4V, its de Broglie wavelength becomes:

A. 4λ
B. 2λ
C. λ/2
D. λ/4

CORRECT ANSWER C — λ/2

DETAILED SOLUTION

Accelerating energy eV becomes kinetic energy $p^2/(2m)$. Thus $p = \sqrt{(2meV)}$, and $\lambda = h/p \propto V^{-1/2}$. Increasing potential by a factor four doubles momentum and halves wavelength.

EXAM TRAP Momentum scales with the square root of accelerating voltage.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q071 CONCEPT / ANALYSIS

A singly charged particle enters a uniform magnetic field perpendicular to it. If its kinetic energy doubles while B stays fixed, circular orbit radius changes by factor:

A. 2
B. √2
C. 1/√2
D. 4

CORRECT ANSWER B — √2

DETAILED SOLUTION

Magnetic force provides centripetal force: $qvB = mv^2/r$, so $r = mv/(qB) = \sqrt{(2mK)}/(qB)$. With mass, charge and B fixed, $r \propto \sqrt{K}$. Doubling K increases radius by √2.

EXAM TRAP Radius is proportional to momentum, not directly to kinetic energy.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q072 CONCEPT / ANALYSIS

An ideal monatomic gas (γ = 5/3) expands reversibly and adiabatically to eight times its original volume. Final absolute temperature is:

A. $T_1/8$
B. $T_1/2$
C. $T_1/4$
D. $4T_1$

CORRECT ANSWER C — $T_1/4$

DETAILED SOLUTION

For a reversible adiabatic ideal-gas process, $TV^{(\gamma-1)} = \text{constant}$. Here $\gamma-1 = 2/3$ and $V_2/V_1 = 8$. Therefore $T_2/T_1 = (1/8)^{(2/3)} = 1/4$.

EXAM TRAP Do not use PV = constant for an adiabatic change.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q073 CONCEPT / ANALYSIS

A capacitor in an RC charging circuit reaches half its final charge at what time, measured from switching on?

A. RC/2
B. RC ln2
C. RC
D. 2RC

CORRECT ANSWER B — RC ln2

DETAILED SOLUTION

Charging law: $Q(t) = CV[1-e^{(-t/RC)}]$. At half charge, $1/2 = 1-e^{(-t/RC)}$, hence $e^{(-t/RC)} = 1/2$ and $t = RC \ln 2$. This is about 0.693 times the time constant.

EXAM TRAP One time constant gives about 63%, not 50%, of final charge.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q074 NUMERICAL / APPLICATION

Two bodies of masses m and 4m possess the same momentum magnitude. Their kinetic-energy ratio Km:K4m is:

A. 1:4
B. 1:2
C. 2:1
D. 4:1

CORRECT ANSWER D — 4:1

DETAILED SOLUTION

At fixed momentum, $K = p^2/(2m)$, so kinetic energy varies inversely with mass. $K(m)/K(4m) = [p^2/(2m)]/[p^2/(8m)] = 4$.

EXAM TRAP Equal momentum favors greater kinetic energy for the lighter object.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q075 CONCEPT / ANALYSIS

An ideal transformer has 500 primary and 100 secondary turns. If the input voltage is 240 V, the output voltage is:

- **A.** 48 V
- **B.** 120 V
- **C.** 240 V
- **D.** 1200 V

CORRECT ANSWER A — 48 V

DETAILED SOLUTION

For an ideal transformer, Vs/Vp = Ns/Np = 100/500 = 1/5. Therefore Vs = 240/5 = 48 V. The device steps down voltage while increasing available current inversely for negligible losses.

EXAM TRAP Turns ratio relates voltages in the same orientation.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q076 CONCEPT / ANALYSIS

A uniform wire has resistance R. It is cut into three equal pieces and all three pieces are connected in parallel. Equivalent resistance is:

- **A.** R/3
- **B.** R/6
- **C.** R/9
- **D.** 3R

CORRECT ANSWER C — R/9

DETAILED SOLUTION

Each one-third length has resistance R/3, assuming unchanged material and cross-section. Three equal resistors R/3 in parallel give Req = (R/3)/3 = R/9. The two operations (cut, then parallel) both reduce the resistance.

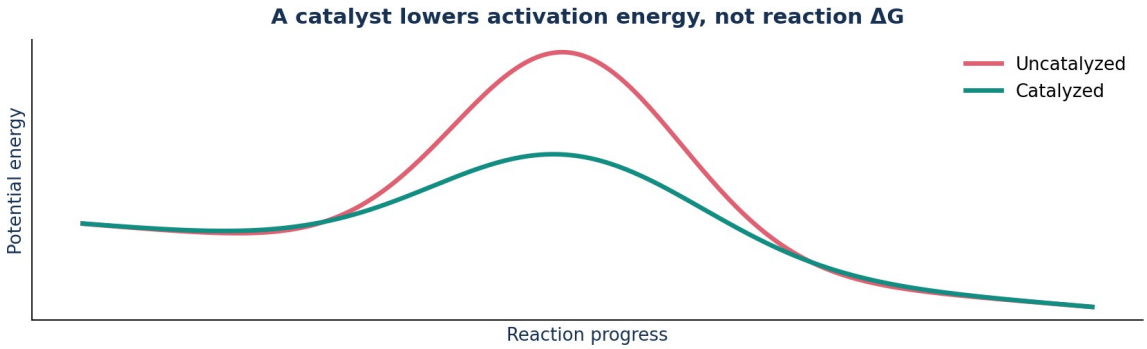
EXAM TRAP Do not treat the pieces as three original R resistors.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

PART 2 / 75 EXAM-LEVEL QUESTIONS

CHEMISTRY

Equilibria, reaction pathways, electrochemistry, periodicity and analytical decisions



Question range: Q077–Q151 • Practice level: concept-rich to application-heavy

Q077 CONCEPT / ANALYSIS

Arrange O^{2-}, F^{-}, Na^{+} and Mg^{2+} in descending ionic radius.

A. $Mg^{2+} > Na^{+} > F^{-} > O^{2-}$
B. $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$
C. $F^{-} > O^{2-} > Mg^{2+} > Na^{+}$
D. $Na^{+} > Mg^{2+} > O^{2-} > F^{-}$

CORRECT ANSWER B — $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$

DETAILED SOLUTION

All have 10 electrons. Greater nuclear charge attracts the same electron cloud more strongly. Z values are O 8, F 9, Na 11, Mg 12, giving $O^{2-} > F^{-} > Na^{+} > Mg^{2+}$.

EXAM TRAP Compare nuclear charge only after confirming equal electrons.

SOURCE TYPE IONIZATION / ISOELECTRONIC SERIES — 2021–2025 recurring theme

Q078 NUMERICAL / APPLICATION

In acidic medium, one mole of MnO_4^{-} oxidizes how many moles of Fe^{2+} to Fe^{3+}?

A. 1
B. 3
C. 5
D. 8

CORRECT ANSWER C — 5

DETAILED SOLUTION

Reduction: $MnO_4^{-} + 8H^{+} + 5e^{-} \rightarrow Mn^{2+} + 4H_2O$. Oxidation: $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$. Five Fe^{2+} ions provide the five electrons required.

EXAM TRAP Permanganate takes 5 electrons in acid, 3 in neutral/basic reduction to MnO_2.

SOURCE TYPE OXIDATION–REDUCTION — 2025 memory-based theme

Q079 CONCEPT / ANALYSIS

For 2A + B → products, doubling [A] quadruples the rate while doubling [B] leaves it unchanged. The empirical rate law is:

- **A.** k[A][B]
- **B.** k[A]²
- **C.** k[A]²[B]
- **D.** k[B]²

CORRECT ANSWER B — k[A]²

DETAILED SOLUTION

If rate ∝ $[A]^m$, then $4 = 2^m \Rightarrow m = 2$. Since B has no effect, n = 0. Rate = $k[A]^2[B]^0 = k[A]^2$.

EXAM TRAP Reaction stoichiometry does not determine experimental rate order.

SOURCE TYPE CHEMICAL KINETICS — 2023 memory-based theme

Q080 NUMERICAL / APPLICATION

At fixed temperature, the initial concentration of reactants is doubled in an equilibrium mixture. What happens to equilibrium constant K?

- **A.** Doubles
- **B.** Halves
- **C.** Remains constant
- **D.** Becomes zero

CORRECT ANSWER C — Remains constant

DETAILED SOLUTION

K depends on temperature, not the starting concentrations. Changing concentrations shifts the equilibrium position until the same K is re-established.

EXAM TRAP Concentration affects Q and direction, not K at fixed T.

SOURCE TYPE CHEMICAL EQUILIBRIUM — 2025 memory-based theme

Q081 CONCEPT / ANALYSIS

Which halogen has the most exothermic first electron-gain enthalpy (largest electron affinity magnitude in conventional comparison)?

- **A.** F
- **B.** Cl
- **C.** Br
- **D.** I

CORRECT ANSWER B — Cl

DETAILED SOLUTION

Cl generally releases more energy upon electron addition than F. Fluorine's very compact 2p orbital increases electron–electron repulsion of the incoming electron.

EXAM TRAP Highest electronegativity is F; greatest first electron affinity magnitude is Cl.

SOURCE TYPE ELECTRONEGATIVITY VS ELECTRON AFFINITY — 2025 memory-based theme

Q082 CONCEPT / ANALYSIS

At the same molality, which ideal solution produces the largest freezing-point depression?

A. Glucose
B. Urea
C. NaCl (fully dissociated)
D. $CaCl_2$ (fully dissociated)

CORRECT ANSWER D — $CaCl_2$ (fully dissociated)

DETAILED SOLUTION

$\Delta T_f = iK_fm$. At equal m, the van't Hoff factors are i≈1 for glucose/urea, 2 for NaCl, and 3 for $CaCl_2$. Therefore $CaCl_2$ gives the greatest effect.

EXAM TRAP Count dissolved particles, not chemical formula units.

SOURCE TYPE COLLIGATIVE PROPERTIES — Advanced PYQ-pattern practice

Q083 CONCEPT / ANALYSIS

Which species has a bond order of 2.5 by the standard molecular orbital diagram?

A. N_2
B. O_2
C. NO
D. F_2

CORRECT ANSWER C — NO

DETAILED SOLUTION

NO has 15 total electrons and an effective bond order $(N_b - N_a)/2 = 2.5$. N_2 is 3, O_2 is 2, and F_2 is 1.

EXAM TRAP Odd-electron diatomics can have fractional bond order.

SOURCE TYPE CHEMICAL BONDING — 2023–2025 recurring theme

Q084 CONCEPT / ANALYSIS

50.0 mL of 0.10 M HCl is mixed with 30.0 mL of 0.10 M NaOH. Assuming volumes are additive, pH is approximately:

A. 1.60
B. 2.00
C. 7.00
D. 12.40

CORRECT ANSWER A — 1.60

DETAILED SOLUTION

$n(H^+)=0.0050$ mol; $n(OH^-)=0.0030$ mol; excess $H^+=0.0020$ mol. Total volume=0.080 L; $[H^+]=0.025$ M; $pH=-\log(0.025)=1.60$.

EXAM TRAP Subtract moles before calculating concentration.

SOURCE TYPE PH AFTER MIXING — Advanced PYQ-pattern practice

Q085 CONCEPT / ANALYSIS

Which compound most readily undergoes Cannizzaro reaction with concentrated alkali?

- **A.** CH_3CHO
- **B.** C_6H_5CHO
- **C.** CH_3COCH_3
- **D.** CH_3CH_2CHO

CORRECT ANSWER B — C_6H_5CHO

DETAILED SOLUTION

Cannizzaro disproportionation requires an aldehyde without α-hydrogen. Benzaldehyde C_6H_5CHO lacks an α-H, while ethanal and propanal have α-H and favor aldol-type chemistry.

EXAM TRAP The key is absence of α-hydrogen, not mere presence of CHO.

SOURCE TYPE CANNIZZARO REACTION — 2023–2025 recurring theme

Q086 CONCEPT / ANALYSIS

Which electrophilic substitution product predominates when nitrobenzene is nitrated further?

- **A.** o-dinitrobenzene
- **B.** m-dinitrobenzene
- **C.** p-dinitrobenzene
- **D.** 1,2,4-trinitrobenzene directly

CORRECT ANSWER B — m-dinitrobenzene

DETAILED SOLUTION

NO_2 is strongly deactivating and meta-directing by −I and −M effects. Ortho/para σ-complexes are especially destabilized, so further nitration gives predominantly meta substitution.

EXAM TRAP Electron-withdrawing NO_2 directs meta.

SOURCE TYPE AROMATIC SUBSTITUTION — 2025 memory-based theme

Q087 CONCEPT / ANALYSIS

Given $E°(Cu^{2+}/Cu)=+0.34$ V and $E°(Zn^{2+}/Zn)=-0.76$ V, standard EMF of Daniell cell is:

- **A.** −1.10 V
- **B.** −0.42 V
- **C.** +0.42 V
- **D.** +1.10 V

CORRECT ANSWER D — +1.10 V

DETAILED SOLUTION

$E°cell = E°cathode - E°anode = 0.34 - (-0.76) = +1.10$ V. Cu^{2+} is reduced and Zn is oxidized.

EXAM TRAP Use reduction potentials consistently; do not reverse signs twice.

SOURCE TYPE CHEMICAL REDOX POTENTIALS — Advanced PYQ-pattern practice

Q088 CONCEPT / ANALYSIS

A 5.0 g sample of $CaCO_3$ is fully decomposed. What mass of CO_2 is released? Use $M(CaCO_3)=100$ and $M(CO_2)=44$ g mol^{-1}.

A. 1.10 g
B. 2.20 g
C. 4.40 g
D. 5.00 g

CORRECT ANSWER B — 2.20 g

DETAILED SOLUTION

$CaCO_3 \rightarrow CaO + CO_2$. Moles $CaCO_3 = 5/100 = 0.050$ mol; CO_2 produced $= 0.050$ mol; mass $= 0.050 \times 44 = 2.20$ g.

EXAM TRAP Stoichiometric mole ratio is 1:1.

SOURCE TYPE STOICHIOMETRY — Advanced PYQ-pattern practice

Q089 CONCEPT / ANALYSIS

For a reaction, $\Delta H = -40$ kJ mol^{-1} and $\Delta S = -100$ J mol^{-1} K^{-1}. Above approximately what temperature does it become nonspontaneous?

A. 100 K
B. 250 K
C. 400 K
D. 800 K

CORRECT ANSWER C — 400 K

DETAILED SOLUTION

Convert $\Delta S = -0.100$ kJ mol^{-1} K^{-1}. $\Delta G = \Delta H - T\Delta S = -40 + 0.100T$. At $\Delta G = 0$, $T = 400$ K. For $T > 400$ K, ΔG positive.

EXAM TRAP Use consistent kJ units for both H and S.

SOURCE TYPE THERMOCHEMISTRY — Advanced PYQ-pattern practice

Q090 CONCEPT / ANALYSIS

The conjugate base of HPO_4^{2-} is:

A. $H_2PO_4^-$
B. PO_4^{3-}
C. H_3PO_4
D. HPO_4^-

CORRECT ANSWER B — PO_4^{3-}

DETAILED SOLUTION

A conjugate base is formed by loss of one proton: $HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$. Charge becomes one unit more negative.

EXAM TRAP Conjugate-base formation always removes H^+.

SOURCE TYPE CONJUGATE ACID-BASE — 2024 memory-based theme

Q091 CONCEPT / ANALYSIS

Which substrate gives fastest SN1 solvolysis in water under otherwise comparable conditions?

- **A.** CH_3Cl
- **B.** CH_3CH_2Cl
- **C.** $(CH_3)_2CHCl$
- **D.** $(CH_3)_3CCl$

CORRECT ANSWER D — $(CH_3)_3CCl$

DETAILED SOLUTION

SN1 rate depends on formation of a carbocation. Tertiary tert-butyl chloride forms the most stabilized carbocation via inductive/hyperconjugative stabilization.

EXAM TRAP SN1 favors stable carbocations; SN2 favors minimal hindrance.

SOURCE TYPE ORGANIC MECHANISM — Advanced PYQ-pattern practice

Q092 CONCEPT / ANALYSIS

For $N_2(g)+3H2(g)\rightleftharpoons 2NH3(g)$, an inert gas is added at constant volume. At unchanged temperature, which statement is correct?

- **A.** Kp increases
- **B.** Equilibrium shifts right because total pressure rises
- **C.** Equilibrium shifts left because mole fraction falls
- **D.** Equilibrium composition is unchanged because reacting partial pressures are unchanged

CORRECT ANSWER D — Equilibrium composition is unchanged because reacting partial pressures are unchanged

DETAILED SOLUTION

For ideal gases, partial pressure $p_i = n_iRT/V$. Adding an inert gas at fixed V and T does not change n_i of any reacting gas, so its partial pressure and reaction quotient Q remain unchanged. The equilibrium position therefore does not shift, though total pressure rises.

EXAM TRAP At constant pressure the outcome can differ because volume changes.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q093 CONCEPT / ANALYSIS

A spontaneous process has $\Delta H>0$. Which condition must make spontaneity possible?

- **A.** Entropy of surroundings alone must rise while universe entropy falls
- **B.** $\Delta S<0$ at all temperatures
- **C.** $T\Delta S>\Delta H$ with $\Delta S>0$
- **D.** $\Delta G>0$

CORRECT ANSWER C — $T\Delta S>\Delta H$ with $\Delta S>0$

DETAILED SOLUTION

Gibbs free energy is $\Delta G = \Delta H - T\Delta S$. With ΔH positive, spontaneous change ($\Delta G < 0$) requires a positive entropy change large enough that $T\Delta S > \Delta H$. Such endothermic processes may become spontaneous at sufficiently high temperature.

EXAM TRAP Spontaneity is controlled by ΔG, not ΔH alone.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q094 NUMERICAL / APPLICATION

Equal masses of two ideal gases at the same temperature have rms speeds in ratio 2:1. Their molar masses are in ratio:

A. 2:1
B. 1:2
C. 1:4
D. 4:1

CORRECT ANSWER C — 1:4

DETAILED SOLUTION

At a fixed temperature, $v_{rms} = \sqrt{(3RT/M)}$, so speed is inversely proportional to $\sqrt{M}$. Given $v_1/v_2 = 2$, squaring gives $M_2/M_1 = 4$, hence $M_1:M_2 = 1:4$. The equal-mass stipulation is irrelevant to the molecular rms speeds.

EXAM TRAP Remember to square the speed ratio when comparing molar masses.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q095 CONCEPT / ANALYSIS

A weak acid HA is half-neutralized by strong base. Neglecting activity effects, which relation holds?

A. pH=pKa because [HA]=[A−]
B. Ka=0
C. pH=7 always
D. $[H^+]$=initial acid concentration

CORRECT ANSWER A — pH=pKa because [HA]=[A−]

DETAILED SOLUTION

At half-neutralization of HA by a strong base, half the original weak acid remains and half has become A^-. Henderson-Hasselbalch gives $pH = pK_a + \log([A^-]/[HA])$; the ratio is 1, so $\log 1 = 0$ and $pH = pK_a$.

EXAM TRAP This exact shortcut applies at the half-equivalence point.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q096 NUMERICAL / APPLICATION

For a first-order reaction, doubling initial concentration while keeping temperature constant changes the half-life to:

A. four times
B. unchanged
C. twice
D. half

CORRECT ANSWER B — unchanged

DETAILED SOLUTION

For a first-order reaction, $[A] = [A]_0 e^{-kt}$ and $t_{1/2} = \ln 2/k$. Since k at fixed temperature does not depend on the initial concentration, doubling $[A]_0$ does not affect half-life. It does change the initial rate.

EXAM TRAP Do not transfer zero-order half-life rules to first order.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q097 CONCEPT / ANALYSIS

A catalyst speeds both forward and reverse reactions because it:

A. lowers activation barriers for both directions
B. makes an endothermic reaction exothermic
C. changes ΔG°
D. increases equilibrium constant

CORRECT ANSWER A — lowers activation barriers for both directions

DETAILED SOLUTION

A catalyst provides a lower-activation-energy pathway. That increases both forward and reverse reaction rates without changing ΔG°, the equilibrium constant or the position of equilibrium at the same temperature.

EXAM TRAP A catalyst hastens equilibrium; it does not shift it.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q098 CONCEPT / ANALYSIS

A gas expands freely into vacuum in an insulated vessel. For an ideal gas, which set is correct?

A. $q=0, w<0, \Delta T>0$
B. $q>0, w<0, \Delta U=0$
C. $q=0, w=0, \Delta U=0$
D. $q<0, w=0, \Delta U<0$

CORRECT ANSWER C — $q=0, w=0, \Delta U=0$

DETAILED SOLUTION

In free expansion against vacuum, the external pressure is zero so work $w = 0$. For an insulated system $q = 0$; thus $\Delta U = q + w = 0$. An ideal gas has U depending only on T, hence its temperature remains unchanged.

EXAM TRAP Free expansion is not a reversible adiabatic expansion.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q099 NUMERICAL / APPLICATION

In a galvanic cell, increasing the concentration of oxidized species in the reduction half-cell generally:

A. lowers its reduction potential by Nernst equation
B. reverses electron flow in every case
C. leaves potential necessarily zero
D. raises its reduction potential

CORRECT ANSWER D — raises its reduction potential

DETAILED SOLUTION

For a reduction $Ox + ne^- \rightarrow Red$, the Nernst relation is $E = E^\circ - (RT/nF)\ln([Red]/[Ox])$ under the usual activities approximation. Increasing [Ox] lowers Q and raises the reduction potential, other conditions constant.

EXAM TRAP Identify which species appears in the denominator of Q.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q100 CONCEPT / ANALYSIS

Two solutions have pH 3 and pH 5. The first has, ideally:

A. 100 times the $[H^+]$
B. 2 times the $[H^+]$
C. the same $[H^+]$
D. 1/100 the $[H^+]$

CORRECT ANSWER A — 100 times the $[H^+]$

DETAILED SOLUTION

$pH = -\log_{10}[H^+]$. A solution at pH 3 has 10^{-3} M H^+, whereas pH 5 has 10^{-5} M. The ratio is $10^{-3}/10^{-5} = 10^2 = 100$.

EXAM TRAP Every pH unit corresponds to a tenfold change in H^+ activity.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q101 CONCEPT / ANALYSIS

At equilibrium, ΔG for the reaction as written is zero, while ΔG° may be nonzero because:

A. all concentrations equal unity
B. forward and reverse activation energies vanish
C. Q has adjusted so $\Delta G° + RT \ln Q = 0$
D. standard free energy never relates to K

CORRECT ANSWER C — Q has adjusted so $\Delta G° + RT \ln Q = 0$

DETAILED SOLUTION

The actual free-energy change is $\Delta G = \Delta G° + RT \ln Q$. At equilibrium, $Q = K$ and $\Delta G = 0$, so $\Delta G° = -RT \ln K$. $\Delta G°$ need not be zero unless $K = 1$.

EXAM TRAP At equilibrium the actual ΔG is zero, not necessarily ΔG°.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q102 CONCEPT / ANALYSIS

A saturated solution of a sparingly soluble salt receives a common ion. Precipitation occurs when:

A. ionic product exceeds Ksp
B. ionic product falls below Ksp
C. temperature alone is unchanged
D. Ksp becomes zero

CORRECT ANSWER A — ionic product exceeds Ksp

DETAILED SOLUTION

For a salt, dissolution equilibrium requires the ionic activity product $Q_{sp} = K_{sp}$. Adding a common ion may raise Q_{sp} above K_{sp}, making the solution supersaturated; precipitation reduces dissolved ion concentrations until equilibrium returns.

EXAM TRAP K_{sp} does not become zero when a common ion is added.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q103 CONCEPT / ANALYSIS

Real gases approach ideal behavior most closely at:

A. critical point only
B. high pressure and low temperature
C. low volume with strong attraction
D. low pressure and high temperature

CORRECT ANSWER D — low pressure and high temperature

DETAILED SOLUTION

At low pressure, intermolecular separations are large and molecular interactions matter less. At high temperature, attraction has less relative influence on molecular motion. These conditions favor ideal-gas behaviour; high pressure or near-condensation conditions increase deviations.

EXAM TRAP Ideal approximation is best far from condensation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q104 CONCEPT / ANALYSIS

For an exothermic equilibrium, raising temperature causes:

A. activation energy to become negative
B. K to decrease as equilibrium favors reactants
C. K to increase because collisions increase
D. K to remain constant at all temperatures

CORRECT ANSWER B — K to decrease as equilibrium favors reactants

DETAILED SOLUTION

For an exothermic forward reaction, heat behaves as a product in a qualitative Le Chatelier argument. Raising temperature favors the reverse endothermic direction, reducing K for the forward reaction. Reaction speed and equilibrium yield are separate questions.

EXAM TRAP Equilibrium constant changes only with temperature, not catalyst.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q105 CONCEPT / ANALYSIS

A solution freezes below the pure solvent. For equal molalities, the greatest ideal depression is produced by:

A. urea
B. glucose
C. ethanol
D. NaCl (complete dissociation)

CORRECT ANSWER D — NaCl (complete dissociation)

DETAILED SOLUTION

Freezing-point depression ideally follows $\Delta T^f = iK^f m$, where i is the number of solute particles produced per formula unit. Complete NaCl dissociation gives $i \approx 2$, larger than $i \approx 1$ for glucose, urea or ethanol at the same molality.

EXAM TRAP Colligative effects count particles, not chemical names.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q106 CONCEPT / ANALYSIS

In electrolysis of aqueous $CuSO_4$ using inert electrodes, Cu deposits preferentially at the cathode because:

- **A.** the cathode oxidizes Cu^{2+}
- **B.** copper atoms are negatively charged
- **C.** sulfate is reduced first
- **D.** Cu^{2+} reduction is favored over water reduction under the stated conditions

CORRECT ANSWER D — Cu^{2+} reduction is favored over water reduction under the stated conditions

DETAILED SOLUTION

At the cathode reduction occurs. $Cu^{2+} + 2e^- \rightarrow Cu(s)$ is typically favoured over water reduction in aqueous $CuSO_4$ under appropriate concentrations and inert-electrode conditions, producing a copper deposit. Oxidation instead takes place at the anode.

EXAM TRAP Cathode always reduces, even in an electrolytic cell.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q107 CONCEPT / ANALYSIS

The slope of ln k versus 1/T is negative. Its magnitude is proportional to:

- **A.** collision frequency independent of temperature
- **B.** activation energy
- **C.** equilibrium concentration
- **D.** reaction enthalpy only

CORRECT ANSWER B — activation energy

DETAILED SOLUTION

The Arrhenius law $k = A\, e^{-E_a/RT}$ gives $\ln k = \ln A - E_a/(RT)$. In a plot of ln k against 1/T, the slope is $-E_a/R$; multiplying its magnitude by R gives the activation energy.

EXAM TRAP Use temperature in kelvin and the logarithm base specified.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q108 CONCEPT / ANALYSIS

When equal volumes of 0.10 M strong monoprotic acid and 0.10 M strong monobasic base are mixed at 25°C, the final pH is near 7 because:

- **A.** H^+ and OH− react stoichiometrically to water
- **B.** both remain at 0.05 M
- **C.** the acid becomes weak
- **D.** pH values are averaged arithmetically

CORRECT ANSWER A — H^+ and OH− react stoichiometrically to water

DETAILED SOLUTION

Strong monoprotic acid and strong monobasic base of equal concentration and equal volume supply equal moles H^+ and OH^-. Neutralization consumes both to form water; the spectator salts do not appreciably hydrolyse in the idealized case, so pH ≈ 7 at 25 °C.

EXAM TRAP Never average the two pH readings arithmetically.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q109 CONCEPT / ANALYSIS

The first ionization energy of oxygen is lower than nitrogen despite greater nuclear charge mainly because oxygen has:

- **A.** paired-electron repulsion in a 2p orbital
- **B.** a larger principal shell
- **C.** no shielding
- **D.** a filled 2p subshell

CORRECT ANSWER A — paired-electron repulsion in a 2p orbital

DETAILED SOLUTION

Nitrogen has the particularly stable half-filled $2p^3$ configuration. Oxygen is $2p^4$, so one 2p orbital holds paired electrons whose mutual repulsion facilitates electron removal. This produces the O < N first-ionization-energy exception.

EXAM TRAP Trends have exceptions from orbital occupancy and pairing.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q110 CONCEPT / ANALYSIS

Across a period, oxide character generally changes from basic to acidic because:

- **A.** metallic character decreases and electronegativity increases
- **B.** atomic size always increases
- **C.** all oxides become ionic
- **D.** oxidation states become zero

CORRECT ANSWER A — metallic character decreases and electronegativity increases

DETAILED SOLUTION

Moving left to right across a period, effective nuclear charge rises and metallic electropositive character generally falls. Oxides accordingly change from predominantly ionic/basic toward covalent/acidic, with some amphoteric intermediates.

EXAM TRAP The trend is general; identify amphoteric intermediate oxides.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q111 CONCEPT / ANALYSIS

$AlCl_3$ behaves as a Lewis acid because aluminium:

- **A.** can accept an electron pair into an incomplete valence shell
- **B.** releases H^+ from every solvent
- **C.** donates a lone pair
- **D.** has a filled octet in the monomer

CORRECT ANSWER A — can accept an electron pair into an incomplete valence shell

DETAILED SOLUTION

A Lewis acid accepts an electron pair. Monomeric $AlCl_3$ has electron-deficient aluminium (six electrons around Al in a simple bonding description) and can accept donation from a Lewis base; proton release is not required.

EXAM TRAP Lewis acidity concerns electron-pair acceptance.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q112 CONCEPT / ANALYSIS

NH_3 has a higher boiling point than PH3 chiefly because NH_3 molecules exhibit:

A. stronger hydrogen bonding
B. ionic bonding
C. greater molar mass
D. metallic bonding

CORRECT ANSWER A — stronger hydrogen bonding

DETAILED SOLUTION

NH_3 possesses N−H bonds and a nitrogen lone pair, allowing significant intermolecular hydrogen bonding. PH_3 has much weaker analogous attractions, so NH_3 boils at a higher temperature despite its lower molar mass.

EXAM TRAP Intermolecular forces can outweigh molar-mass trends.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q113 CONCEPT / ANALYSIS

Chlorine disproportionates in cold dilute alkali. This means chlorine is:

A. only reduced
B. neither oxidized nor reduced
C. only oxidized
D. simultaneously oxidized and reduced

CORRECT ANSWER D — simultaneously oxidized and reduced

DETAILED SOLUTION

Cold dilute alkali converts chlorine to chloride and hypochlorite: $Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O$. Chlorine starts at oxidation number 0 and becomes −1 and +1, meaning reduction and oxidation occur simultaneously.

EXAM TRAP Disproportionation needs the same element to gain and lose electrons.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q114 CONCEPT / ANALYSIS

Transition metals commonly show variable oxidation states because:

A. their nuclei change charge in reactions
B. they lack d electrons entirely
C. their ns and (n−1)d energies are comparable
D. all their compounds are covalent

CORRECT ANSWER C — their ns and (n−1)d energies are comparable

DETAILED SOLUTION

In transition metals, ns and (n−1)d electron energies can be similar, so different numbers can participate in bonding or be removed. This helps account for variable oxidation states, particularly in the first-row transition series.

EXAM TRAP Do not confuse variable valency with isotopic variation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q115 CONCEPT / ANALYSIS

Aqueous Cu^{2+} is colored whereas Zn^{2+} is usually colorless because Cu^{2+} has:

- **A.** a completely filled d subshell like Zn^{2+}
- **B.** no d electrons
- **C.** partially filled d orbitals permitting d-level transitions
- **D.** only s-s transitions in visible light

CORRECT ANSWER C — partially filled d orbitals permitting d-level transitions

DETAILED SOLUTION

A Cu^{2+} ion is $3d^9$ and can undergo d−d transitions between crystal-field-split states that absorb visible light. Zn^{2+} is $3d^{10}$, with a filled d subshell and generally no analogous d−d transition, so its simple aqueous ions are colorless.

EXAM TRAP Partly filled d orbitals often permit characteristic colors.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q116 CONCEPT / ANALYSIS

Amphoteric Al_2O_3 reacts with both acid and strong base. The best interpretation is that it can:

- **A.** act solely as neutral oxide
- **B.** only release oxygen gas
- **C.** change aluminium atomic number
- **D.** behave as basic oxide toward acid and acidic oxide toward base

CORRECT ANSWER D — behave as basic oxide toward acid and acidic oxide toward base

DETAILED SOLUTION

Amphoteric oxides react with both acids and strong bases. Al_2O_3 neutralizes acids to produce aluminium salts and can dissolve in alkali forming aluminate species; its acid-base response depends on the reactant.

EXAM TRAP Amphoteric does not mean merely neutral.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q117 CONCEPT / ANALYSIS

Among halide ions, reducing power in aqueous solution generally increases down the group because:

- **A.** ionic radius decreases
- **B.** larger ions lose electrons more readily despite hydration effects
- **C.** all bond energies increase uniformly
- **D.** electron affinity becomes infinitely large

CORRECT ANSWER B — larger ions lose electrons more readily despite hydration effects

DETAILED SOLUTION

Halide reducing power usually increases down Group 17 because the larger iodide ion gives up an electron more readily than fluoride under standard aqueous conditions. The typical reducing-strength order is $I^- > Br^- > Cl^- > F^-$.

EXAM TRAP This is the order for halide ions as reductants, not halogens as oxidants.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q118 CONCEPT / ANALYSIS

Temporary hardness is removed by boiling because bicarbonates decompose to:

- **A.** metal atoms
- **B.** insoluble carbonates with CO_2 and water
- **C.** nitrates
- **D.** soluble chlorides

CORRECT ANSWER B — insoluble carbonates with CO_2 and water

DETAILED SOLUTION

Temporary hardness arises mainly from Ca^{2+}/Mg^{2+} bicarbonates. Heating decomposes bicarbonate equilibria, allowing precipitation of $CaCO_3$ and related Mg-containing solids; dissolved ions are removed and hardness decreases.

EXAM TRAP Permanent hardness from chlorides/sulfates is not removed by boiling alone.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q119 CONCEPT / ANALYSIS

2-methylpropene reacts with HBr without peroxide. The major product follows Markovnikov addition because:

- **A.** the double bond remains unchanged
- **B.** the more stable tertiary carbocation pathway is favored
- **C.** Br+ attacks the less substituted carbon first
- **D.** a primary radical is mandatory

CORRECT ANSWER B — the more stable tertiary carbocation pathway is favored

DETAILED SOLUTION

HBr adds to 2-methylpropene via protonation of its double bond. Formation of the more stable tertiary carbocation is favored, then bromide attack gives 2-bromo-2-methylpropane. Anti-Markovnikov radical addition is associated with peroxide conditions.

EXAM TRAP Identify the favored carbocation before assigning product.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q120 CONCEPT / ANALYSIS

Which reagent sequence most directly converts a primary alcohol to a carboxylic acid without changing carbon number?

- **A.** Hydrogenation over Ni
- **B.** Mild dehydration only
- **C.** Aqueous base only
- **D.** Strong oxidation under reflux

CORRECT ANSWER D — Strong oxidation under reflux

DETAILED SOLUTION

A primary alcohol must be oxidized sufficiently strongly to pass through the aldehyde and reach the carboxylic acid, for example using acidified dichromate under reflux or strong suitable permanganate conditions. Oxidative conditions should preserve the carbon skeleton.

EXAM TRAP Distillation may stop at aldehyde; reflux favors further oxidation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q121 CONCEPT / ANALYSIS

Phenol is more acidic than cyclohexanol chiefly because:

A. phenol has no O-H bond
B. cyclohexanol is aromatic
C. phenoxide concentrates charge on carbon only
D. phenoxide ion is resonance stabilized

CORRECT ANSWER D — phenoxide ion is resonance stabilized

DETAILED SOLUTION

Phenol forms phenoxide on deprotonation, and the negative charge can delocalize into the aromatic π system. Cyclohexanol forms a localized alkoxide without comparable resonance stabilization, making phenol appreciably more acidic.

EXAM TRAP Compare stability of conjugate bases, not bond polarity alone.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q122 CONCEPT / ANALYSIS

An aldehyde and a ketone have the same molecular formula. Tollens reagent distinguishes them because aldehydes:

A. cannot contain carbonyl groups
B. undergo only reduction
C. are always aromatic
D. are more readily oxidized under mild conditions

CORRECT ANSWER D — are more readily oxidized under mild conditions

DETAILED SOLUTION

Tollens reagent, $[Ag(NH_3)_2]^+$ in alkaline solution, oxidizes ordinary aldehydes to carboxylate while reducing Ag^+ to metallic silver. Ketones generally resist this mild oxidation; both contain C=O, so carbonyl presence is not diagnostic.

EXAM TRAP A positive Tollens test points to an oxidizable aldehyde under standard conditions.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q123 CONCEPT / ANALYSIS

Hydrolysis of an ester in alkali is effectively driven forward because the carboxylic acid product:

A. becomes an alkane
B. immediately reforms ester quantitatively
C. produces no alcohol
D. forms a resonance-stabilized carboxylate salt

CORRECT ANSWER D — forms a resonance-stabilized carboxylate salt

DETAILED SOLUTION

Base hydrolysis initially yields an alcohol and carboxylic acid equivalent. In alkali, the carboxylic acid is promptly deprotonated to a resonance-stabilized carboxylate, removing a reactant for reverse esterification and driving saponification forward.

EXAM TRAP Acidic ester hydrolysis is reversible; basic saponification is strongly driven.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q124 CONCEPT / ANALYSIS

Benzene undergoes substitution rather than ordinary addition mainly because addition would:

- **A.** retain all six π electrons unchanged
- **B.** make every carbon sp hybridized
- **C.** destroy aromatic stabilization
- **D.** increase resonance

CORRECT ANSWER C — destroy aromatic stabilization

DETAILED SOLUTION

Benzene benefits from aromatic cyclic electron delocalization. Ordinary electrophilic addition would disrupt that stabilization, whereas electrophilic aromatic substitution restores aromaticity after loss of a proton. This explains its characteristic substitution chemistry.

EXAM TRAP Do not treat benzene like an ordinary isolated alkene.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q125 CONCEPT / ANALYSIS

Which pair represents functional isomers?

- **A.** Ethane and ethene
- **B.** Ethanol and dimethyl ether
- **C.** Propan-1-ol and propan-2-ol
- **D.** cis- and trans-but-2-ene

CORRECT ANSWER B — Ethanol and dimethyl ether

DETAILED SOLUTION

Ethanol (CH_3CH_2OH) and dimethyl ether (CH_3OCH_3) both have molecular formula C_2H_6O but different functional groups. Propan-1-ol and propan-2-ol are position isomers, and cis/trans-but-2-ene are stereoisomers.

EXAM TRAP Functional isomers share formula but differ in functional group.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q126 CONCEPT / ANALYSIS

A compound rotates plane-polarized light only when the sample contains:

- **A.** a net excess of one enantiomer
- **B.** equal enantiomers
- **C.** only constitutional isomers
- **D.** a carbonyl group necessarily

CORRECT ANSWER A — a net excess of one enantiomer

DETAILED SOLUTION

Equal enantiomers rotate plane-polarized light equally in opposite directions, giving zero net rotation in a racemic mixture. Net optical rotation generally requires enantiomeric excess in an appropriate optically active sample.

EXAM TRAP A molecule may be chiral while the bulk racemate is optically inactive.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q127 CONCEPT / ANALYSIS

During SN1 substitution of a tertiary halide, rate depends mainly on:

A. both nucleophile and halide equally in one step
B. product concentration
C. halide concentration alone in the rate-determining ionization
D. nucleophile concentration only

CORRECT ANSWER C — halide concentration alone in the rate-determining ionization

DETAILED SOLUTION

In a typical SN1 reaction, the slow step is unimolecular ionization of the substrate to a carbocation. Thus rate = k[substrate] for the rate-determining stage; the nucleophile attacks in a later faster step.

EXAM TRAP SN1 rate is first order in substrate, unlike typical SN2.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q128 CONCEPT / ANALYSIS

A primary alkyl halide with a strong nucleophile favors SN2 because:

A. steric crowding accelerates attack
B. backside attack can occur with low steric hindrance
C. a primary carbocation is highly stable
D. reaction proceeds through two carbocations

CORRECT ANSWER B — backside attack can occur with low steric hindrance

DETAILED SOLUTION

SN2 is a concerted backside displacement; steric crowding around the reacting carbon hampers nucleophilic attack. Primary alkyl halides with good leaving groups therefore commonly favor SN2 with strong nucleophiles, provided solvent conditions are appropriate.

EXAM TRAP Low hindrance favors SN2; tertiary centres rarely undergo simple SN2.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q129 NUMERICAL / APPLICATION

Dehydration of butan-2-ol can yield more than one alkene. The major product is generally the:

A. more substituted, more stable alkene
B. alcohol with more water
C. product formed by carbon-chain cleavage only
D. least substituted alkane

CORRECT ANSWER A — more substituted, more stable alkene

DETAILED SOLUTION

Elimination of water from butan-2-ol can form but-1-ene or but-2-ene. The more substituted but-2-ene is generally favored by Zaitsev's rule; the trans isomer is commonly more stable than cis.

EXAM TRAP Major alkene is often the more substituted, not the terminal one.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q130 CONCEPT / ANALYSIS

Ethanal reacts with HCN to give a cyanohydrin. The carbonyl carbon is attacked because it is:

A. strongly nucleophilic
B. electron deficient due to C=O polarization
C. negatively charged in the reactant
D. aromatic

CORRECT ANSWER B — electron deficient due to C=O polarization

DETAILED SOLUTION

The C=O bond is polarized toward oxygen, leaving the carbonyl carbon partially positive. Cyanide attacks this electrophilic carbon, forming a tetrahedral alkoxide that is protonated to the cyanohydrin.

EXAM TRAP Carbonyl addition begins with nucleophile attack at carbon, not oxygen.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q131 CONCEPT / ANALYSIS

Aniline is less basic than ethylamine because the nitrogen lone pair in aniline is:

A. held by hydrogen only
B. converted into a σ bond with oxygen
C. delocalized into the benzene ring
D. absent

CORRECT ANSWER C — delocalized into the benzene ring

DETAILED SOLUTION

The nitrogen lone pair of aniline overlaps with the benzene π system and becomes resonance-delocalized, decreasing its availability to bind H^+. In ethylamine the lone pair is more localized and the alkyl group exerts an electron-donating inductive effect.

EXAM TRAP Resonance lowers aniline basicity relative to aliphatic amines.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q132 CONCEPT / ANALYSIS

A peptide bond forms through condensation between:

A. amino and carboxyl groups with loss of water
B. two phosphate groups
C. an aldehyde and alkane only
D. two hydrocarbon groups with gain of oxygen

CORRECT ANSWER A — amino and carboxyl groups with loss of water

DETAILED SOLUTION

A peptide linkage (−CO−NH−) forms when the carboxyl group of one amino acid condenses with the amino group of another, releasing H_2O. The resulting amide bond links residues in a polypeptide chain.

EXAM TRAP Peptide bonds join amino-acid residues via amide linkage.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q133 CONCEPT / ANALYSIS

Glucose gives a positive reducing-sugar test despite being predominantly cyclic because:

A. it contains a ketone only and never opens
B. the test hydrolyses it to methane
C. all alcohols reduce Cu^{2+} identically
D. its ring can equilibrate with an open-chain aldehyde form

CORRECT ANSWER D — its ring can equilibrate with an open-chain aldehyde form

DETAILED SOLUTION

Even though glucose is predominantly cyclic in water, its hemiacetal ring can open to a small equilibrium concentration of open-chain aldehyde. This form reduces Tollens or Benedict reagents; reaction consumption draws more molecules into the open-chain form.

EXAM TRAP A cyclic sugar can be reducing if its anomeric carbon is available.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q134 CONCEPT / ANALYSIS

Addition polymerization of ethene changes each monomer primarily by:

A. eliminating CO_2 from every unit
B. opening the π bond to form new σ bonds in a chain
C. retaining isolated C=C bonds in each repeat unit
D. forming peptide bonds

CORRECT ANSWER B — opening the π bond to form new σ bonds in a chain

DETAILED SOLUTION

In chain addition polymerization of ethene, the carbon-carbon π bond is consumed while new C−C σ bonds link monomers into $-(CH_2-CH_2)_n-$. No small molecule is eliminated, distinguishing this from condensation polymerization.

EXAM TRAP Addition polymers generally retain all monomer atoms in repeat units.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q135 CONCEPT / ANALYSIS

A compound C_3H_6O is oxidized by Tollens reagent and reduced to a primary alcohol. It is most consistent with:

A. propanoic acid
B. propan-2-ol
C. propanone
D. propanal

CORRECT ANSWER D — propanal

DETAILED SOLUTION

The formula C_3H_6O permits propanal or propanone. Tollens-positive behaviour and reduction to a primary alcohol indicate an aldehyde: propanal → propan-1-ol. Propanone instead reduces to secondary propan-2-ol.

EXAM TRAP Reduction product distinguishes aldehyde from ketone.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q136 CONCEPT / ANALYSIS

Soap cleans oily dirt poorly in hard water chiefly because Ca^{2+} and Mg^{2+}:

A. increase soap solubility indefinitely
B. oxidize water into oxygen
C. form insoluble salts with fatty-acid anions
D. convert oil to glucose

CORRECT ANSWER C — form insoluble salts with fatty-acid anions

DETAILED SOLUTION

Soap anions react with Ca^{2+} or Mg^{2+} to form insoluble calcium or magnesium carboxylates ('scum'). This consumes surfactant, reduces lather and decreases cleaning efficiency in hard water.

EXAM TRAP Hard water forms precipitates with soaps, not all detergents.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q137 CONCEPT / ANALYSIS

Ozone depletion by chlorofluorocarbons is catalytic because a chlorine radical:

A. adds ozone to make more ozone
B. acts only as greenhouse gas without reaction
C. is regenerated while converting ozone to oxygen
D. is permanently consumed in the first step

CORRECT ANSWER C — is regenerated while converting ozone to oxygen

DETAILED SOLUTION

UV light can release chlorine radicals from CFC-derived compounds. A chlorine radical reacts with O_3 and is regenerated after intermediate steps, permitting one radical to destroy many ozone molecules. This regeneration makes the process catalytic.

EXAM TRAP Catalytic radicals are reused rather than consumed in a single step.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q138 CONCEPT / ANALYSIS

In Haber manufacture, high pressure favors ammonia yield, but moderate temperature is used as a compromise between:

A. atomic number and isotope abundance
B. electrode mass and charge
C. pH and solubility only
D. equilibrium yield and reaction rate

CORRECT ANSWER D — equilibrium yield and reaction rate

DETAILED SOLUTION

Ammonia synthesis is exothermic and converts four gas moles to two; high pressure favors NH_3 thermodynamically. Lower temperature favors equilibrium yield but slows kinetics, so industry uses a moderate high temperature and catalyst for reasonable reaction rate.

EXAM TRAP Distinguish equilibrium yield from production rate.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q139 NUMERICAL / APPLICATION

In acid-base titration, an indicator should be chosen so its transition range lies:

A. within the steep pH change near equivalence
B. outside every attainable pH
C. exactly at pH 7 for all titrations
D. at the initial pH only

CORRECT ANSWER A — within the steep pH change near equivalence

DETAILED SOLUTION

An acid-base indicator changes color over a finite pH interval. Choose one whose transition interval falls within the steep pH change near the equivalence point, minimizing endpoint error. The correct indicator depends on acid and base strengths.

EXAM TRAP Indicator endpoint should be close to stoichiometric equivalence.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q140 CONCEPT / ANALYSIS

Repeated measurements are tightly clustered but far from the accepted value. They are:

A. neither measurable nor reproducible
B. both accurate and precise
C. precise but inaccurate
D. accurate but imprecise

CORRECT ANSWER C — precise but inaccurate

DETAILED SOLUTION

Precision describes reproducibility of repeated measurements; accuracy describes closeness to the accepted or true value. A tight cluster displaced from the true value has low random spread but systematic bias, so it is precise yet inaccurate.

EXAM TRAP Systematic error can produce precise but inaccurate results.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q141 CONCEPT / ANALYSIS

A precipitate is washed before gravimetric weighing mainly to:

A. add indicator color
B. remove soluble adhering impurities without dissolving appreciable precipitate
C. increase its unknown composition
D. convert it completely to filtrate

CORRECT ANSWER B — remove soluble adhering impurities without dissolving appreciable precipitate

DETAILED SOLUTION

In gravimetric analysis, soluble mother liquor and other ions may adhere to a freshly precipitated solid. Careful washing removes those impurities before drying and weighing while a suitable wash liquid avoids dissolving significant precipitate.

EXAM TRAP Wash enough to remove soluble contaminants without losing analyte.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q142 CONCEPT / ANALYSIS

100 mL of 0.10 M HCl is mixed with 100 mL of 0.05 M NaOH at 25°C. Ignoring volume contraction, the pH is approximately:

A. 1.60
B. 2.00
C. 7.00
D. 12.40

CORRECT ANSWER A — 1.60

DETAILED SOLUTION

Moles of H^+ = 0.100 L×0.10 = 0.010 mol; moles OH^- = 0.100 L×0.05 = 0.005 mol. Excess H^+ = 0.005 mol in 0.200 L, so $[H^+]$ = 0.025 M. pH = $-\log(0.025) \approx 1.60$.

EXAM TRAP Find excess moles before calculating concentration and pH.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q143 CONCEPT / ANALYSIS

For $Zn(s)+Cu^{2+}(aq)\rightarrow Zn^{2+}(aq)+Cu(s)$, E° = 1.10 V. At 25°C, $[Zn^{2+}]$=1.0 M and $[Cu^{2+}]$=0.010 M. Approximate cell emf is:

A. 0.982 V
B. 1.041 V
C. 1.100 V
D. 1.159 V

CORRECT ANSWER B — 1.041 V

DETAILED SOLUTION

Reaction quotient $Q = [Zn^{2+}]/[Cu^{2+}] = 100$. The Nernst equation is $E = E^\circ - (0.0591/2)\log Q = 1.10 - (0.0591/2)(2) = 1.0409$ V. Electron number n = 2.

EXAM TRAP The logarithm uses reaction quotient, not its reciprocal.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q144 CONCEPT / ANALYSIS

In a first-order decomposition, 75% of reactant disappears in 30 minutes. Its half-life is:

A. 7.5 min
B. 10 min
C. 15 min
D. 20 min

CORRECT ANSWER C — 15 min

DETAILED SOLUTION

If 75% decomposes, 25% = $(1/2)^2$ remains. Two half-lives have therefore passed in 30 min, giving $t_{1/2}$ = 30/2 = 15 min. This works because first-order half-life is concentration independent.

EXAM TRAP Distinguish fraction reacted from fraction remaining.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q145 NUMERICAL / APPLICATION

For $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, equilibrium concentrations are $[N_2O_4]=0.40$ M and $[NO_2]=0.20$ M. Kc is:

A. 0.05
B. 0.10
C. 0.20
D. 0.40

CORRECT ANSWER B — 0.10

DETAILED SOLUTION

Mass-action expression is $K_c = [NO_2]^2/[N_2O_4]$ because the product coefficient is 2. Substitution gives $(0.20)^2/0.40 = 0.04/0.40 = 0.10$.

EXAM TRAP Square the concentration of the species with coefficient 2.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q146 NUMERICAL / APPLICATION

Complete reaction of 0.10 mol $CaCO_3$ with HCl requires how many moles of HCl?

A. 0.05 mol
B. 0.10 mol
C. 0.15 mol
D. 0.20 mol

CORRECT ANSWER D — 0.20 mol

DETAILED SOLUTION

Balanced equation: $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$. The stoichiometric mole ratio $CaCO_3$:HCl is 1:2, so 0.10 mol carbonate consumes 0.20 mol acid.

EXAM TRAP Use balanced coefficients; one carbonate needs two protons.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q147 CONCEPT / ANALYSIS

A salt AgX dissolves readily in dilute ammonia and forms a white precipitate with $AgNO_3$. The halide X^- is most likely:

A. Cl^-
B. Br^-
C. I^-
D. F^-

CORRECT ANSWER A — Cl^-

DETAILED SOLUTION

AgCl is a white precipitate that dissolves in dilute NH_3 through formation of $[Ag(NH_3)_2]^+$. AgBr is cream and typically requires concentrated NH_3; AgI is yellow and does not appreciably dissolve in ammonia.

EXAM TRAP Color and ammonia solubility together identify silver halides.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q148 CONCEPT / ANALYSIS

Equal very dilute molar solutions of ideal urea and fully dissociated $CaCl_2$ are compared for osmotic pressure at the same temperature. Approximate $\pi(CaCl_2):\pi(urea)$ is:

A. 1:1
B. 2:1
C. 3:1
D. 1:3

CORRECT ANSWER C — 3:1

DETAILED SOLUTION

Osmotic pressure of a dilute ideal solution is $\pi = iCRT$. Urea is a nonelectrolyte with $i \approx 1$; complete $CaCl_2$ dissociation produces one Ca^{2+} and two Cl^- ions, giving $i \approx 3$. The ideal pressure ratio is 3:1.

EXAM TRAP Osmotic effects depend on total effective particle count.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q149 CONCEPT / ANALYSIS

Which compound most clearly gives a positive iodoform reaction under standard conditions?

A. Propanal
B. Propanone
C. Methanal
D. Benzaldehyde

CORRECT ANSWER B — Propanone

DETAILED SOLUTION

Iodoform reaction requires a methyl ketone unit ($-COCH_3$) or an alcohol oxidizable to such a group, among common test substrates. Propanone is CH_3COCH_3, so it produces yellow CHI_3 with iodine in alkali.

EXAM TRAP A carbonyl group alone is not sufficient; look for $COCH_3$.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q150 CONCEPT / ANALYSIS

An aqueous buffer contains 0.20 M CH_3COOH and 0.10 M CH_3COONa. With $pK_a = 4.76$, ideal-buffer pH is:

A. 4.16
B. 4.46
C. 4.76
D. 5.06

CORRECT ANSWER B — 4.46

DETAILED SOLUTION

Henderson-Hasselbalch equation: $pH = pK_a + \log([salt]/[acid]) = 4.76 + \log(0.10/0.20)$. $\log 0.5 \approx -0.301$, so $pH \approx 4.46$. Concentrations must be expressed in a consistent unit.

EXAM TRAP More weak acid than conjugate base gives pH below pK_a.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q151 CONCEPT / ANALYSIS

Which species has the smallest radius among O^{2-}, F^{-}, Na^{+} and Mg^{2+}?

A. O^{2-}
B. F^{-}
C. Na^{+}
D. Mg^{2+}

CORRECT ANSWER D — Mg^{2+}

DETAILED SOLUTION

All four ions are isoelectronic with neon (10 electrons). Within an isoelectronic series, increasing nuclear charge draws the same electron cloud more tightly. Z values are O 8, F 9, Na 11, Mg 12; thus Mg^{2+} is smallest.

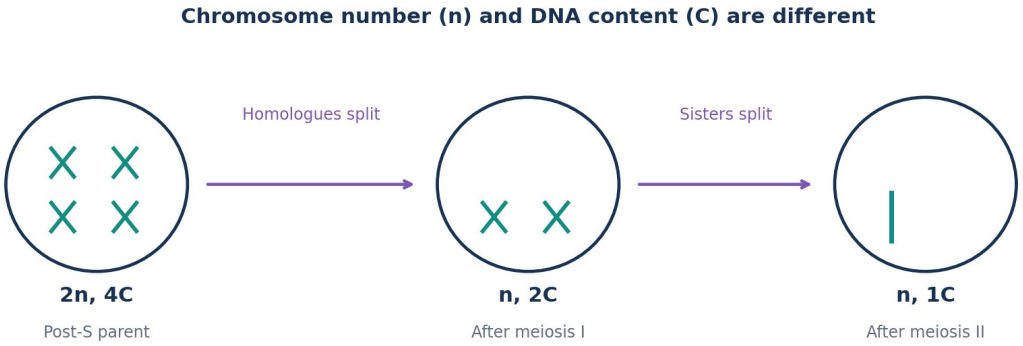
EXAM TRAP Isoelectronic size decreases as nuclear charge increases.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

PART 3 / 61 EXAM-LEVEL QUESTIONS

BOTANY

Genetics, molecular biology, diversity, ecology and advanced plant physiology



Question range: Q152–Q212 • Practice level: concept-rich to application-heavy

Q152 CONCEPT / ANALYSIS

A normal woman whose father is colour-blind marries a normal man. What proportion of their sons is expected to be colour-blind?

A. 0%
B. 25%
C. 50%
D. 100%

CORRECT ANSWER C — 50%

DETAILED SOLUTION

Her father is X^cY; she must inherit X^c. Since she is phenotypically normal, she is X^NX^c (carrier). A normal husband is X^NY. Sons receive Y from father and X^N or X^c equally from mother, giving 50% affected sons.

EXAM TRAP Probability among sons differs from probability among all children.

SOURCE TYPE X-LINKED GENETICS — 2024 memory-based theme

Q153 CONCEPT / ANALYSIS

Number of genetically different gamete types produced by AaBBCcDd (assuming independent assortment) is:

A. 4
B. 6
C. 8
D. 16

CORRECT ANSWER C — 8

DETAILED SOLUTION

The number of heterozygous gene pairs is n=3 (Aa, Cc, Dd). Gamete classes $=2^n=2^3=8$. BB contributes no additional choices.

EXAM TRAP Count heterozygous pairs only.

SOURCE TYPE INDEPENDENT ASSORTMENT — 2024 memory-based theme

Q154 CONCEPT / ANALYSIS

A diploid somatic cell contains 6 pg DNA in G_1. Assuming normal replication and no division, the DNA mass in G_2 is:

A. 3 pg
B. 6 pg
C. 12 pg
D. 24 pg

CORRECT ANSWER C — 12 pg

DETAILED SOLUTION

DNA replicates in S phase. Ploidy remains 2n, but DNA content doubles from 2C to 4C; mass = 12 pg.

EXAM TRAP Ploidy and DNA content are different quantities.

SOURCE TYPE DNA CONTENT DURING CELL CYCLE — 2024 memory-based theme

Q155 CONCEPT / ANALYSIS

In a randomly mating population, an autosomal recessive phenotype has frequency 9%. Assuming H–W equilibrium, heterozygote frequency is:

A. 18%
B. 21%
C. 42%
D. 49%

CORRECT ANSWER C — 42%

DETAILED SOLUTION

$q^2=0.09 \Rightarrow q=0.30$; $p=0.70$. Carrier frequency $2pq=2\times0.70\times0.30=0.42=42\%$. The disease frequency determines q^2, not directly the recessive allele frequency. Taking the square root yields q, and the normal allele fraction $p = 1-q$ must then be found before calculating carriers.

EXAM TRAP Affected q^2 is not allele frequency q.

SOURCE TYPE HARDY–WEINBERG — Advanced PYQ-pattern practice

Q156 CONCEPT / ANALYSIS

In a testcross involving two genes, 86 recombinants are observed among 1,000 offspring. Estimated map distance is:

A. 4.3 cM
B. 8.6 cM
C. 17.2 cM
D. 86 cM

CORRECT ANSWER B — 8.6 cM

DETAILED SOLUTION

Recombination frequency $=86/1000\times100=8.6\%$. Map distance ≈8.6 centimorgans. Map distance is approximately the percentage of recombinant offspring for a relatively short genetic interval. The parental offspring are the remaining 914 and should not appear in the recombination numerator.

EXAM TRAP Divide recombinant offspring by total offspring, not by parental offspring.

SOURCE TYPE LINKAGE MAPPING — Advanced PYQ-pattern practice

Q157 NUMERICAL / APPLICATION

In a tissue culture medium, a high cytokinin-to-auxin ratio generally promotes:

- **A.** Root differentiation
- **B.** Shoot differentiation
- **C.** Embryo abortion
- **D.** Loss of cell division

CORRECT ANSWER B — Shoot differentiation

DETAILED SOLUTION

Relative hormone balance controls organogenesis in plant tissue culture. High cytokinin/auxin favors shoots; high auxin/cytokinin favors roots.

EXAM TRAP The ratio matters more than either hormone in isolation.

SOURCE TYPE PLANT HORMONES — 2022–2025 recurring theme

Q158 NUMERICAL / APPLICATION

A complete ring of bark is removed from a woody stem without injuring xylem. What is the earliest likely change?

- **A.** Water flow stops immediately
- **B.** Sugars accumulate above the ring
- **C.** Sugars accumulate only below the ring
- **D.** Leaf photosynthesis stops at once

CORRECT ANSWER B — Sugars accumulate above the ring

DETAILED SOLUTION

Girdling interrupts phloem, preventing transport of photosynthates past the ring. Sugars accumulate above it, while intact xylem initially continues carrying water upward.

EXAM TRAP Phloem is mainly in bark; xylem is deeper.

SOURCE TYPE PHLOEM TRANSLOCATION — Advanced PYQ-pattern practice

Q159 CONCEPT / ANALYSIS

Which feature directly helps C_4 plants maintain photosynthesis at high temperature and low atmospheric CO_2?

- **A.** Absence of Calvin cycle
- **B.** PEP carboxylase-mediated CO_2 concentration
- **C.** Exclusive night-time stomatal opening
- **D.** No photorespiration-related enzymes

CORRECT ANSWER B — PEP carboxylase-mediated CO_2 concentration

DETAILED SOLUTION

Mesophyll PEP carboxylase fixes HCO_3^- into C_4 acids, which transport carbon to bundle sheath cells where CO_2 is released near Rubisco. This suppresses photorespiration.

EXAM TRAP CAM, not C_4, typically opens stomata primarily at night.

SOURCE TYPE PHOTOSYNTHESIS C_4 — Advanced PYQ-pattern practice

Q160 NUMERICAL / APPLICATION

The pigment chiefly responsible for red coloration and efficient light capture in many Rhodophyceae is:

- **A.** Chlorophyll b
- **B.** Phycoerythrin
- **C.** Fucoxanthin
- **D.** Carotene only

CORRECT ANSWER B — Phycoerythrin

DETAILED SOLUTION

Phycoerythrin is a red phycobiliprotein that absorbs blue-green wavelengths and transfers energy to photosystems, allowing photosynthesis at greater depths.

EXAM TRAP Fucoxanthin is associated with brown algae.

SOURCE TYPE RED ALGAE PIGMENTS — 2024 memory-based theme

Q161 CONCEPT / ANALYSIS

Which pairing is incorrect?

- **A.** Ribosome — translation
- **B.** Golgi apparatus — glycosylation/sorting
- **C.** Mitochondrion — oxidative phosphorylation
- **D.** Lysosome — transcription of nuclear DNA

CORRECT ANSWER D — Lysosome — transcription of nuclear DNA

DETAILED SOLUTION

Nuclear DNA transcription occurs in the nucleus. Lysosomes contain hydrolytic enzymes for intracellular degradation; they are not sites of transcription.

EXAM TRAP Membrane-bound digestion and nuclear gene expression are distinct.

SOURCE TYPE CELL ORGANELLES — 2024 memory-based theme

Q162 CONCEPT / ANALYSIS

In flowering plants, the mature embryo sac usually contains:

- **A.** 7 cells and 8 nuclei
- **B.** 8 cells and 8 nuclei
- **C.** 7 cells and 7 nuclei
- **D.** 6 cells and 8 nuclei

CORRECT ANSWER A — 7 cells and 8 nuclei

DETAILED SOLUTION

A typical Polygonum-type embryo sac has egg apparatus (3 cells), antipodals (3 cells), and one central cell with two polar nuclei: 7 cells, 8 nuclei.

EXAM TRAP The central cell holds two nuclei before their fusion in many descriptions.

SOURCE TYPE FLOWER DEVELOPMENT — Advanced PYQ-pattern practice

Q163 CONCEPT / ANALYSIS

A plant cell has Ψs = −0.9 MPa and pressure potential Ψp = +0.3 MPa. Its water potential Ψw is:

A. −1.2 MPa
B. −0.6 MPa
C. +0.6 MPa
D. +1.2 MPa

CORRECT ANSWER B — −0.6 MPa

DETAILED SOLUTION

Ψw = Ψs + Ψp = −0.9 + 0.3 = −0.6 MPa (neglecting gravitational and matric terms). Water moves toward lower Ψw.

EXAM TRAP Solute potential is normally negative.

SOURCE TYPE WATER POTENTIAL — Advanced PYQ-pattern practice

Q164 CONCEPT / ANALYSIS

Heating an enzyme gradually reduces reaction rate even though substrate remains abundant. The best molecular explanation is:

A. substrate becomes an enzyme
B. active-site conformation is disrupted beyond an optimum
C. peptide bonds always hydrolyse at body temperature
D. activation energy becomes zero

CORRECT ANSWER B — active-site conformation is disrupted beyond an optimum

DETAILED SOLUTION

Enzyme activity rises toward an optimum temperature as effective collisions increase. Beyond that optimum, heat can disrupt the tertiary structure of the active site, reducing successful enzyme-substrate binding despite available substrate.

EXAM TRAP High temperature may denature; low temperature usually slows reversibly.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q165 CONCEPT / ANALYSIS

A membrane phospholipid placed in water forms a bilayer because its molecules are:

A. covalently bonded to water
B. entirely hydrophobic
C. amphipathic, with opposing interactions of heads and tails
D. identical to cellulose

CORRECT ANSWER C — amphipathic, with opposing interactions of heads and tails

DETAILED SOLUTION

Phospholipids have polar, water-compatible heads and nonpolar fatty-acid tails. In water, heads face the aqueous surroundings while tails associate inward, minimizing unfavorable contact. This amphipathic organization spontaneously favors bilayers.

EXAM TRAP Amphipathic molecules have both hydrophilic and hydrophobic regions.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q166 CONCEPT / ANALYSIS

A photosynthetic prokaryote releases oxygen but has no membrane-bound organelles. It is most consistent with:

- **A.** cyanobacteria
- **B.** fungi
- **C.** protozoa
- **D.** bryophytes

CORRECT ANSWER A — cyanobacteria

DETAILED SOLUTION

Cyanobacteria are prokaryotes with oxygenic photosynthesis machinery but no membrane-bound chloroplasts. Their photosynthetic pigments are located in specialized internal membrane systems. Bryophytes are eukaryotic plants, and fungi are non-photosynthetic heterotrophs.

EXAM TRAP Photosynthesis does not require eukaryotic chloroplasts.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q167 CONCEPT / ANALYSIS

A fungus obtains carbon from a living host and later produces resistant spores. Which observation best distinguishes it from a green plant?

- **A.** Absorptive heterotrophy with chitinous wall
- **B.** Multicellularity
- **C.** Formation of spores
- **D.** Presence of a cell wall

CORRECT ANSWER A — Absorptive heterotrophy with chitinous wall

DETAILED SOLUTION

Fungi absorb externally digested nutrients and generally have chitinous cell walls. Green plants usually synthesize organic carbon via photosynthesis and possess cellulose-rich walls. Multicellularity, spores and a wall alone cannot reliably separate fungi from plants.

EXAM TRAP Use nutrition mode together with wall composition.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q168 CONCEPT / ANALYSIS

A bryophyte and a fern both require free water for fertilization, but the fern is taller chiefly because it possesses:

- **A.** seeds and flowers
- **B.** vascular tissues and a dominant sporophyte
- **C.** a dominant gametophyte only
- **D.** pollen tubes

CORRECT ANSWER B — vascular tissues and a dominant sporophyte

DETAILED SOLUTION

Ferns possess lignified xylem, phloem and a large independent sporophyte, permitting stronger support and long-distance transport. Mosses lack comparable vascular tissue and have a dominant gametophyte; both groups still need water for motile sperm.

EXAM TRAP Vascular support explains large fern sporophytes.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q169 CONCEPT / ANALYSIS

Which evolutionary transition most reduced dependence of fertilization on external water?

- **A.** Fragmentation in algae
- **B.** Flagellated sperm in moss
- **C.** Pollen formation in seed plants
- **D.** Prothallus formation in fern

CORRECT ANSWER C — Pollen formation in seed plants

DETAILED SOLUTION

Pollen grains transport male gametophytes and generate pollen tubes that carry nonmotile sperm to the ovule. Thus seed plants do not need external free water for sperm to swim between gametangia, unlike bryophytes and most ferns.

EXAM TRAP Pollen tube, not seed coat alone, reduces water dependence.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q170 CONCEPT / ANALYSIS

A gymnosperm seed differs from an angiosperm seed most fundamentally because gymnosperm ovules are:

- **A.** produced inside fruits
- **B.** not enclosed within an ovary
- **C.** always dispersed by water
- **D.** formed without meiosis

CORRECT ANSWER B — not enclosed within an ovary

DETAILED SOLUTION

Gymnosperms bear 'naked' ovules, typically on cone scales, whereas angiosperms enclose ovules in an ovary that later becomes fruit. Both still undergo meiosis during gametophyte formation.

EXAM TRAP Gymnosperm seed does not develop inside an ovary-derived fruit.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q171 CONCEPT / ANALYSIS

A flower has parallel venation, fibrous roots and floral parts in threes. If secondary growth is absent, the combined evidence supports:

- **A.** a bryophyte
- **B.** a typical monocot
- **C.** a typical dicot
- **D.** a gymnosperm

CORRECT ANSWER B — a typical monocot

DETAILED SOLUTION

Parallel venation, fibrous roots and floral organs commonly in threes together support monocotyledonous angiosperms. Typical monocot stems have scattered closed vascular bundles and lack ordinary secondary vascular growth.

EXAM TRAP One trait alone is weaker than a concordant character set.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q172 CONCEPT / ANALYSIS

Lichens colonize bare rock successfully because the association combines:

A. fungal mineral/water retention with photosynthetic carbon gain
B. two autotrophs competing for light
C. a root and mycorrhiza of a vascular plant
D. a virus and bacterium

CORRECT ANSWER A — fungal mineral/water retention with photosynthetic carbon gain

DETAILED SOLUTION

The photobiont fixes carbon, while the fungal partner provides shelter, mineral access and moisture retention. This allows many lichens to persist on nutrient-poor bare surfaces and initiate soil development.

EXAM TRAP Lichen is a symbiotic association, not a root system.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q173 NUMERICAL / APPLICATION

In alternation of generations, meiosis directly produces:

A. gametes in all plants
B. a diploid zygote
C. haploid spores from diploid sporophyte cells
D. a multicellular sporophyte without mitosis

CORRECT ANSWER C — haploid spores from diploid sporophyte cells

DETAILED SOLUTION

In plant alternation of generations, diploid sporocytes undergo meiosis to produce haploid spores. Haploid gametophytes then form gametes by mitosis, and fusion of gametes restores diploidy in the zygote.

EXAM TRAP In most plants, meiosis makes spores rather than gametes.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q174 CONCEPT / ANALYSIS

If archegonia are present but seeds are absent, the plant could belong to:

A. angiosperms only
B. bryophytes or pteridophytes
C. fungi only
D. cyanobacteria only

CORRECT ANSWER B — bryophytes or pteridophytes

DETAILED SOLUTION

Bryophytes and many pteridophytes have archegonia while lacking seeds. Angiosperms lack typical archegonia; fungi and cyanobacteria do not possess the plant sexual structure specified.

EXAM TRAP Archegonia plus no seeds is compatible with mosses and ferns.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q175 CONCEPT / ANALYSIS

Two plant species use the same limiting mineral but different soil depths. Their coexistence is best explained by:

A. identical niches
B. absence of competition
C. resource partitioning
D. primary productivity being zero

CORRECT ANSWER C — resource partitioning

DETAILED SOLUTION

Different rooting depths allow plant species to exploit water or minerals in distinct spatial zones. This divides a limiting resource, decreases niche overlap and permits coexistence even when both use the same chemical nutrient.

EXAM TRAP Coexistence can reflect partitioning, not absence of competition.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q176 CONCEPT / ANALYSIS

Net primary productivity is lower than gross primary productivity because plants:

A. transfer all energy to herbivores
B. consume some fixed carbon in respiration
C. do not photosynthesize
D. convert energy completely into heat before fixation

CORRECT ANSWER B — consume some fixed carbon in respiration

DETAILED SOLUTION

Gross primary productivity (GPP) is total carbon fixation; producers respire some of that carbon. Net primary productivity therefore equals GPP − autotrophic respiration (R_a), representing biomass available for plant growth and higher trophic levels.

EXAM TRAP NPP is lower than GPP because plants respire.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q177 CONCEPT / ANALYSIS

During primary succession on lava, early colonizers facilitate later species mainly by:

A. forming soil and modifying microclimate
B. eliminating nutrient cycles
C. preventing weathering
D. removing all organic matter

CORRECT ANSWER A — forming soil and modifying microclimate

DETAILED SOLUTION

Pioneer organisms weather the surface, trap particles and contribute organic residues. Their activity gradually builds soil and modifies moisture and temperature, permitting more demanding plants to establish during primary succession.

EXAM TRAP Primary succession starts without developed soil.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q178 NUMERICAL / APPLICATION

Biomagnification predicts the highest concentration of a persistent lipid-soluble pesticide in:

- **A.** decomposers regardless of food web
- **B.** top consumers feeding through several trophic levels
- **C.** soil water only
- **D.** producers exposed briefly

CORRECT ANSWER B — top consumers feeding through several trophic levels

DETAILED SOLUTION

Persistent fat-soluble pollutants are stored and eliminated slowly; predators ingest many contaminated prey. Concentrations therefore commonly increase along trophic levels, becoming highest in top consumers of a long food chain.

EXAM TRAP Biomagnification concerns persistent chemicals, not all toxins.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q179 CONCEPT / ANALYSIS

A plant cell in concentrated salt solution loses turgor but its wall retains shape. The immediate event is:

- **A.** rupture caused by turgor
- **B.** active uptake of all salt
- **C.** exosmosis and plasmolysis
- **D.** endosmosis and deplasmolysis

CORRECT ANSWER C — exosmosis and plasmolysis

DETAILED SOLUTION

A hypertonic external solution has lower water potential than the cell. Water leaves by osmosis (exosmosis), the protoplast shrinks away from the wall and turgor falls: plasmolysis. The rigid wall usually retains its outline.

EXAM TRAP Plasmolysis is water loss, not cell-wall rupture.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q180 CONCEPT / ANALYSIS

Blocking spindle formation during mitosis most directly prevents:

- **A.** cell-wall synthesis in every phase
- **B.** chromosome segregation to daughter nuclei
- **C.** DNA replication in interphase
- **D.** transcription permanently

CORRECT ANSWER B — chromosome segregation to daughter nuclei

DETAILED SOLUTION

Mitotic spindle microtubules attach to kinetochores and move sister chromatids toward opposite poles. Blocking spindle formation directly prevents faithful chromosome segregation, while earlier S-phase DNA replication is a distinct process.

EXAM TRAP Spindle inhibition primarily blocks chromosome separation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q181 CONCEPT / ANALYSIS

A secretory plant cell makes large amounts of protein. Which pathway is most directly involved?

A. Rough ER to Golgi to vesicles
B. Smooth ER to centriole only
C. Nucleus to cell wall by diffusion of DNA
D. Chloroplast to vacuole without ribosomes

CORRECT ANSWER A — Rough ER to Golgi to vesicles

DETAILED SOLUTION

Secretory proteins are translated on ribosomes associated with rough ER, folded/modified within its lumen, processed in the Golgi and packaged into export vesicles. Smooth ER specializes more in lipid synthesis and detoxification.

EXAM TRAP Follow secretory proteins: RER → Golgi → vesicle.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q182 CONCEPT / ANALYSIS

If mitochondrial inner membranes lose their proton gradient, the most direct consequence is reduced:

A. light absorption by chlorophyll
B. ATP synthesis by oxidative phosphorylation
C. DNA replication in nucleus
D. cellulose synthesis in wall

CORRECT ANSWER B — ATP synthesis by oxidative phosphorylation

DETAILED SOLUTION

The inner mitochondrial membrane gradient stores electrochemical energy from respiratory electron transport. ATP synthase uses proton flow back into the matrix; collapse of the gradient therefore severely decreases oxidative phosphorylation even when some electron carriers remain.

EXAM TRAP Electron transport and ATP synthesis are coupled by H^+ gradient.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q183 CONCEPT / ANALYSIS

A cell doubles its DNA content but does not divide. Relative to G1, it is most consistent with:

A. G0 with no replication
B. post-S or G2 phase
C. a haploid gamete necessarily
D. late cytokinesis only

CORRECT ANSWER B — post-S or G2 phase

DETAILED SOLUTION

During S phase the DNA quantity doubles, from 2C to 4C in a typical diploid somatic cell, without immediately altering chromosome number. A cell with doubled DNA before division is therefore compatible with post-S or G_2 phase.

EXAM TRAP DNA content can double without chromosome number doubling.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q184 NUMERICAL / APPLICATION

In AaBb × aabb, genes assort independently. Among offspring showing the dominant phenotype for A, the fraction also dominant for B is:

- **A.** 1/2
- **B.** 3/4
- **C.** 1/4
- **D.** 1

CORRECT ANSWER A — 1/2

DETAILED SOLUTION

In AaBb × aabb with independent assortment, each locus segregates 1:1. Conditioning on an A-dominant offspring does not change the independent B outcome; therefore P(B-dominant given A-dominant) = 1/2.

EXAM TRAP Conditional probability stays 1/2 because loci assort independently.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q185 NUMERICAL / APPLICATION

A testcross yields offspring in a 1:1 ratio of parental types with no recombinants. The most defensible inference is:

- **A.** the two loci are completely linked in that cross
- **B.** both genes are lethal
- **C.** independent assortment produced only parentals
- **D.** the tested individual is homozygous

CORRECT ANSWER A — the two loci are completely linked in that cross

DETAILED SOLUTION

A testcross that yields only parental phenotypes in two equal classes is consistent with complete linkage, provided a heterozygote contains those linked combinations. Independent assortment normally generates four equally likely phenotypic classes in the standard testcross.

EXAM TRAP Absence of observed recombinants supports linkage within that cross.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q186 CONCEPT / ANALYSIS

A point mutation changes a codon but not its amino acid. This illustrates:

- **A.** degeneracy of the genetic code
- **B.** polyploidy
- **C.** absence of translation
- **D.** crossing over

CORRECT ANSWER A — degeneracy of the genetic code

DETAILED SOLUTION

The genetic code is degenerate: several codons can encode the same amino acid. A base substitution that replaces a codon with a synonymous codon therefore does not change the peptide sequence; this is a silent mutation.

EXAM TRAP Silent is not the same as mutation-free.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q187 CONCEPT / ANALYSIS

A carrier female for an X-linked recessive trait mates with a normal male. Which child has the highest specified risk?

A. All sons: affected
B. Any daughter: 50% affected
C. Any son: 50% affected
D. All daughters: carriers

CORRECT ANSWER C — Any son: 50% affected

DETAILED SOLUTION

Carrier mother X^AX^a and normal father X^AY produce sons X^AY or X^aY with equal probability. Thus each son has a 1/2 risk of expressing an X-linked recessive condition; daughters are normally unaffected, with half being carriers.

EXAM TRAP For a son, his single X chromosome comes from his mother.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q188 CONCEPT / ANALYSIS

Two tall pea plants produce a dwarf offspring. Assuming complete dominance, the parents must be:

A. tt and Tt
B. TT and Tt
C. Tt and Tt
D. TT and TT

CORRECT ANSWER C — Tt and Tt

DETAILED SOLUTION

A dwarf offspring has genotype tt and must receive t from each tall parent. Because both parents show the dominant tall phenotype yet carry t, each must be Tt. Their cross gives TT:Tt:tt = 1:2:1.

EXAM TRAP A recessive child from dominant parents identifies both as heterozygotes.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q189 CONCEPT / ANALYSIS

Nondisjunction in meiosis I differs from meiosis II because meiosis I failure separates neither:

A. genes during transcription
B. centromeres during mitosis
C. homologous chromosomes
D. sister chromatids

CORRECT ANSWER C — homologous chromosomes

DETAILED SOLUTION

In meiosis I, homologous chromosomes should separate while sister chromatids remain together. Nondisjunction at this division means homologues fail to disjoin; meiosis II nondisjunction instead concerns sister chromatids.

EXAM TRAP Meiosis I = homologues; meiosis II = sisters.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q190 CONCEPT / ANALYSIS

A ring of bark is removed without damaging wood. Sugar accumulates above the ring while leaves initially remain hydrated. This demonstrates that:

A. phloem translocates organic solutes while xylem still carries water
B. both tissues were removed
C. transpiration stops immediately
D. xylem transports sugar downward

CORRECT ANSWER A — phloem translocates organic solutes while xylem still carries water

DETAILED SOLUTION

Girdling removes phloem while xylem remains intact. Organic sugars transported in the phloem accumulate above the cut, but xylem can still supply water temporarily. This demonstrates differing transport functions of the two vascular tissues.

EXAM TRAP Xylem mainly transports water; phloem transports photosynthate.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q191 CONCEPT / ANALYSIS

Secondary growth increases stem girth because vascular cambium produces:

A. primary xylem outward only
B. secondary xylem inward and secondary phloem outward
C. epidermis inward
D. cortex on both sides

CORRECT ANSWER B — secondary xylem inward and secondary phloem outward

DETAILED SOLUTION

The vascular cambium divides periclinally, producing secondary xylem toward the interior and secondary phloem toward the exterior. Accumulated secondary xylem is a major contributor to increasing stem girth.

EXAM TRAP Remember inside = secondary xylem, outside = phloem.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q192 CONCEPT / ANALYSIS

A xerophyte with sunken stomata and thick cuticle primarily reduces:

A. water-vapour diffusion from moist internal surfaces
B. root pressure
C. CO_2 fixation to zero
D. mineral absorption by roots

CORRECT ANSWER A — water-vapour diffusion from moist internal surfaces

DETAILED SOLUTION

Sunken stomata hold a more humid boundary layer and a thick waxy cuticle reduces uncontrolled evaporation. Both lower transpirational water loss and help xerophytes maintain water balance under arid conditions.

EXAM TRAP These adaptations reduce water loss, not necessarily increase uptake.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q193 CONCEPT / ANALYSIS

Opening stomata requires guard cells to become turgid. Which change most directly promotes this?

- **A.** Solute accumulation followed by water entry
- **B.** Complete loss of guard-cell ions
- **C.** Water leaving guard cells
- **D.** Cell-wall digestion

CORRECT ANSWER A — Solute accumulation followed by water entry

DETAILED SOLUTION

Light stimulates proton pumps and ion accumulation in guard cells, lowering their water potential. Water enters osmotically; guard cells become turgid and the stomatal pore opens because of their unequal wall thickening.

EXAM TRAP K^+ influx and water entry promote opening.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q194 NUMERICAL / APPLICATION

A plant is transferred from humid to dry moving air with soil water initially adequate. Transpiration first rises because:

- **A.** humidity inside leaves falls to zero
- **B.** stomata necessarily close before transfer
- **C.** xylem becomes impermeable
- **D.** the water-vapour gradient and boundary-layer removal increase

CORRECT ANSWER D — the water-vapour gradient and boundary-layer removal increase

DETAILED SOLUTION

Moving dry air removes the humid boundary layer, increasing the leaf-to-air water vapour gradient and hence transpiration, if stomata initially remain open. Later prolonged water stress may cause closure; the stem concerns the initial response.

EXAM TRAP Distinguish short-term physical evaporation from later stomatal regulation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q195 CONCEPT / ANALYSIS

If light intensity rises but CO_2 becomes limiting, the photosynthetic rate will:

- **A.** increase indefinitely in direct proportion to light
- **B.** equal respiration exactly
- **C.** approach a plateau
- **D.** become negative at all intensities

CORRECT ANSWER C — approach a plateau

DETAILED SOLUTION

Light can increase photosynthesis only while photons are limiting. Once carbon dioxide becomes limiting, carbon fixation reaches a plateau despite extra light unless CO_2 supply rises. This illustrates interaction of limiting factors.

EXAM TRAP Increasing one factor cannot override another limiting factor.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q196 CONCEPT / ANALYSIS

A plant supplied nitrate but lacking magnesium develops chlorosis because magnesium is required chiefly for:

- **A.** DNA base pairing only
- **B.** stomatal pores
- **C.** the chlorophyll molecule and enzyme function
- **D.** cellulose monomers

CORRECT ANSWER C — the chlorophyll molecule and enzyme function

DETAILED SOLUTION

Magnesium is the central metal ion in chlorophyll and is also important for several enzymes. With inadequate Mg^{2+}, chlorophyll synthesis and maintenance are impaired, causing leaf yellowing even when nitrate supply is sufficient.

EXAM TRAP Magnesium deficiency often shows interveinal chlorosis in older leaves.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q197 CONCEPT / ANALYSIS

Auxin from the shoot tip promotes phototropic bending because it redistributes toward the shaded side and:

- **A.** inhibits all elongation there
- **B.** moves only through xylem upward
- **C.** promotes greater cell elongation there
- **D.** destroys chloroplasts on lit side

CORRECT ANSWER C — promotes greater cell elongation there

DETAILED SOLUTION

Auxin accumulates more on the shaded side of a shoot and stimulates cell elongation there. The differential growth bends the shoot toward the light; root responses may differ because roots are more sensitive to high auxin levels.

EXAM TRAP Shoot phototropism involves greater shaded-side elongation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q198 CONCEPT / ANALYSIS

During ascent of sap in a tall tree, the continuity of the water column depends most directly on:

- **A.** cohesion among water molecules and tension from transpiration
- **B.** root hairs pushing water to any height without loss
- **C.** active pumping by every vessel element
- **D.** phloem pressure only

CORRECT ANSWER A — cohesion among water molecules and tension from transpiration

DETAILED SOLUTION

Cohesion between water molecules and adhesion to xylem walls maintain a continuous column under transpiration-generated tension. The cohesion-tension model explains ascent of sap without a pump in each vessel element.

EXAM TRAP Transpiration pulls; cohesion prevents column breakage.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q199 NUMERICAL / APPLICATION

Double fertilization produces a zygote and endosperm. The endosperm usually receives nuclei in the ratio:

A. two sperms plus one egg
B. one egg plus one synergid
C. two eggs plus one sperm
D. one sperm plus two polar nuclei

CORRECT ANSWER D — one sperm plus two polar nuclei

DETAILED SOLUTION

One sperm fuses with the egg to form the diploid zygote. The second fuses with two haploid polar nuclei in the central cell, yielding the usually triploid primary endosperm nucleus. Hence the fertilization combination is one sperm plus two polar nuclei.

EXAM TRAP Zygote is usually 2n; primary endosperm nucleus usually 3n.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q200 CONCEPT / ANALYSIS

Removing anthers before dehiscence and then applying selected pollen is useful because it:

A. converts ovules into pollen
B. guarantees apomixis
C. prevents unwanted self-pollination while permitting controlled crossing
D. prevents fertilization completely

CORRECT ANSWER C — prevents unwanted self-pollination while permitting controlled crossing

DETAILED SOLUTION

Emasculation removes anthers before they shed pollen and prevents unintended self-pollination. Placing pollen from a chosen donor onto a receptive stigma then controls the male parent used in a breeding cross.

EXAM TRAP Remove anthers before dehiscence, not after self-pollination.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q201 CONCEPT / ANALYSIS

Micropropagation can produce many uniform plants rapidly because differentiated plant cells often retain:

A. absence of DNA
B. totipotency
C. permanent haploidy
D. obligate heterotrophy

CORRECT ANSWER B — totipotency

DETAILED SOLUTION

Totipotency is the capacity of a plant cell, under appropriate culture conditions, to regenerate an entire plant. Tissue culture exploits this with controlled nutrients and phytohormones to multiply a selected genotype rapidly.

EXAM TRAP Totipotency underlies clonal micropropagation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q202 CONCEPT / ANALYSIS

Crop rotation with legumes can reduce nitrogen fertilizer need primarily through:

A. conversion of nitrate into atmospheric nitrogen only
B. elimination of all soil microbes
C. photosynthesis by roots
D. symbiotic biological nitrogen fixation

CORRECT ANSWER D — symbiotic biological nitrogen fixation

DETAILED SOLUTION

Rhizobium and related nitrogen-fixing bacteria in legume root nodules convert atmospheric N_2 into biologically usable nitrogen compounds. Subsequent crop residues can enrich soil nitrogen, reducing fertilizer requirements for later crops.

EXAM TRAP Rotation benefits depend on effective fixation and residue management.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q203 CONCEPT / ANALYSIS

A genetically engineered insect-resistant crop reduces insecticide use, but resistance management is needed because:

A. all insects mutate only after spraying
B. the transgene disappears in one generation
C. natural selection cannot act on insects
D. selection can increase resistant insect genotypes

CORRECT ANSWER D — selection can increase resistant insect genotypes

DETAILED SOLUTION

Bt toxins or related transgenic defenses impose selection on pest populations. Resistant individuals survive and reproduce, increasing resistance alleles unless strategies such as refuge planting and integrated pest management slow selection.

EXAM TRAP Any strong selective control can evolve resistance.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q204 CONCEPT / ANALYSIS

A tetraploid angiosperm (4n) is the female parent and a diploid (2n) is the male parent. With normal reduced gametes, embryo and endosperm ploidies are respectively:

A. 2n and 3n
B. 3n and 5n
C. 4n and 6n
D. 5n and 7n

CORRECT ANSWER B — 3n and 5n

DETAILED SOLUTION

The tetraploid female makes eggs and polar nuclei of 2n each; diploid male sperm are n. Embryo = egg 2n + sperm n = 3n. Primary endosperm nucleus = two 2n polar nuclei plus one n sperm = 5n.

EXAM TRAP Triploid endosperm is usual only for diploid-by-diploid crosses.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q205 NUMERICAL / APPLICATION

In a testcross AaBbCc × aabbcc with independent loci, what fraction of progeny displays all three dominant traits?

A. 1/2
B. 1/4
C. 1/8
D. 1/16

CORRECT ANSWER C — 1/8

DETAILED SOLUTION

At each heterozygous testcrossed locus, probability of the dominant phenotype is 1/2. Independent assortment multiplies the probabilities: $(1/2)^3 = 1/8$. There are eight equally likely phenotype combinations.

EXAM TRAP Multiply independent-locus probabilities rather than adding them.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q206 CONCEPT / ANALYSIS

In a linkage testcross, 82% offspring are parental combinations and 18% recombinant. Map distance between loci is approximately:

A. 9 cM
B. 18 cM
C. 36 cM
D. 82 cM

CORRECT ANSWER B — 18 cM

DETAILED SOLUTION

Recombination frequency = recombinant/total ×100 = 18%. At moderate short intervals, a 1% recombinant frequency corresponds to approximately 1 centimorgan, so the estimated distance is 18 cM.

EXAM TRAP Map distances underestimate multiple crossovers over large intervals.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q207 CONCEPT / ANALYSIS

A maize leaf initially fixes CO_2 into oxaloacetate. Where does this primary carboxylation normally occur?

A. Bundle-sheath chloroplasts using RuBisCO
B. Mesophyll cytosol using PEP carboxylase
C. Guard-cell nucleus using carbonic anhydrase
D. Xylem vessels using RuBisCO

CORRECT ANSWER B — Mesophyll cytosol using PEP carboxylase

DETAILED SOLUTION

In C_4 plants such as maize, PEP carboxylase fixes bicarbonate in mesophyll cytosol, generating oxaloacetate (a 4-carbon acid). Carbon is subsequently delivered to bundle-sheath cells, where Calvin-cycle CO_2 fixation by RuBisCO is concentrated.

EXAM TRAP C_4 initial fixation and Calvin-cycle fixation occur in different cell types.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q208 NUMERICAL / APPLICATION

High temperature and closed stomata increase photorespiration in a C_3 plant primarily because:

- **A.** Rubisco oxygenase activity becomes more competitive
- **B.** PEP carboxylase increases CO_2 fixation
- **C.** Mitochondria stop all respiration
- **D.** Chlorophyll converts O_2 into CO_2

CORRECT ANSWER A — Rubisco oxygenase activity becomes more competitive

DETAILED SOLUTION

Stomatal closure reduces internal CO_2 while O_2 remains relatively abundant. Under these conditions and high temperatures, RuBisCO oxygenase activity competes more effectively with carboxylation, increasing photorespiratory carbon and energy losses.

EXAM TRAP Photorespiration is linked to RuBisCO oxygenation, not ordinary dark respiration.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q209 CONCEPT / ANALYSIS

A diploid plant sporocyte just after S phase has DNA content 4C. Immediately after meiosis I, each daughter nucleus typically contains:

- **A.** n, 1C
- **B.** n, 2C
- **C.** 2n, 2C
- **D.** 2n, 4C

CORRECT ANSWER B — n, 2C

DETAILED SOLUTION

Meiosis I separates homologous chromosomes while sister chromatids remain paired. Chromosome number halves from 2n to n, but each chromosome still consists of two chromatids, so each daughter has 2C DNA. After meiosis II the products are n, 1C.

EXAM TRAP Chromosome number and DNA content must be tracked separately.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q210 CONCEPT / ANALYSIS

Two adjacent plant cells have water potentials −0.3 MPa and −0.8 MPa. Net water movement is:

- **A.** From −0.8 to −0.3 MPa
- **B.** From −0.3 to −0.8 MPa
- **C.** Equally in both directions
- **D.** Impossible without knowing solute identity

CORRECT ANSWER B — From −0.3 to −0.8 MPa

DETAILED SOLUTION

Water moves down the water-potential gradient, from higher (less negative) potential to lower (more negative). Since −0.3 MPa is higher than −0.8 MPa, net osmosis moves toward the −0.8 MPa cell until other forces alter the gradient.

EXAM TRAP For negative values, −0.3 is higher than −0.8.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q211 CONCEPT / ANALYSIS

With approximately 10% ecological energy transfer, producers capture 20,000 J. Energy available at tertiary consumers is:

- **A.** 2 J
- **B.** 20 J
- **C.** 200 J
- **D.** 2,000 J

CORRECT ANSWER B — 20 J

DETAILED SOLUTION

The three transfers are producers→primary consumers: 2,000 J; primary→secondary: 200 J; secondary→tertiary: 20 J. Thus tertiary consumers receive about 20 J from 20,000 J captured at producers.

EXAM TRAP Tertiary consumers are three energy-transfer steps above producers.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q212 CONCEPT / ANALYSIS

An ABA-deficient mutant plant is exposed to drought. Compared with wild type, the most immediate likely stomatal response is:

- **A.** More effective closure and reduced water loss
- **B.** Impaired closure and increased water loss
- **C.** Higher CO_2 fixation without any water loss
- **D.** Complete blockage of xylem

CORRECT ANSWER B — Impaired closure and increased water loss

DETAILED SOLUTION

Abscisic acid signalling promotes guard-cell ion efflux and stomatal closure under water stress. An ABA-deficient mutant may fail to close stomata sufficiently, increasing transpiration and wilting risk despite the potential short-term CO_2 uptake.

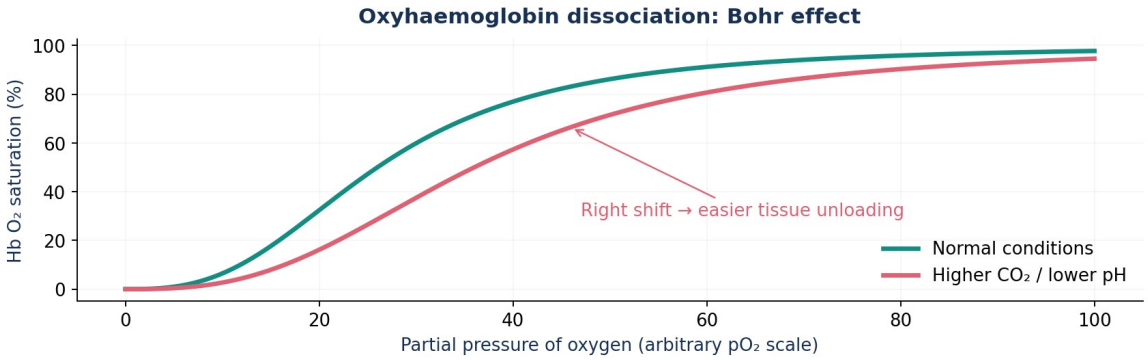
EXAM TRAP ABA is a drought signal, not merely a dormancy hormone.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

PART 4 / 60 EXAM-LEVEL QUESTIONS

ZOOLOGY

Human physiology, molecular immunology, animal systems and medical applications



Question range: Q213–Q272 • Practice level: concept-rich to application-heavy

Q213 CONCEPT / ANALYSIS

During vigorous muscle exercise, increased CO_2, acidity and temperature cause which change in the oxyhaemoglobin dissociation curve?

A. Left shift and tighter binding
B. Right shift and increased unloading
C. No shift
D. Only decreased blood oxygen capacity without shift

CORRECT ANSWER B — Right shift and increased unloading

DETAILED SOLUTION

Bohr effect: CO_2 and H^+ decrease haemoglobin O_2 affinity, shifting the curve right. Higher temperature also promotes oxygen release in metabolically active tissue.

EXAM TRAP Right shift means easier O_2 unloading.

SOURCE TYPE HAEMOGLOBIN AND O_2 UNLOADING — Advanced PYQ-pattern practice

Q214 CONCEPT / ANALYSIS

If afferent arteriole constricts strongly while efferent resistance is unchanged, the immediate effect is most likely:

A. ↑GFR
B. ↓GFR
C. No change in GFR
D. Increased filtration fraction in all circumstances

CORRECT ANSWER B — ↓GFR

DETAILED SOLUTION

Afferent constriction reduces glomerular capillary hydrostatic pressure and plasma flow into the glomerulus, usually decreasing glomerular filtration rate.

EXAM TRAP Afferent and efferent constriction act differently.

SOURCE TYPE RENAL HAEMODYNAMICS — Advanced PYQ-pattern practice

Q215 CONCEPT / ANALYSIS

Removal of extracellular Ca^{2+} at a chemical synapse most directly blocks:

A. Action-potential conduction along entire axon
B. Synaptic vesicle fusion and neurotransmitter release
C. Postsynaptic DNA replication
D. Myelination

CORRECT ANSWER B — Synaptic vesicle fusion and neurotransmitter release

DETAILED SOLUTION

Presynaptic depolarization opens voltage-gated Ca^{2+} channels. Calcium binding to release machinery triggers vesicle fusion; removing extracellular Ca^{2+} impairs neurotransmitter exocytosis.

EXAM TRAP Electrical propagation and chemical transmitter release are separate.

SOURCE TYPE NERVE IMPULSES — Advanced PYQ-pattern practice

Q216 CONCEPT / ANALYSIS

An insect is severely hypoxic despite continuing haemolymph circulation. Which fact best explains this?

A. Blood transports all O_2
B. Tracheal tubes deliver most O_2 directly to tissues
C. Haemolymph has no water
D. Spiracles are involved only in digestion

CORRECT ANSWER B — Tracheal tubes deliver most O_2 directly to tissues

DETAILED SOLUTION

The insect tracheal system moves air through spiracles, tracheae and tracheoles close to cells. Haemolymph is generally not the primary oxygen carrier.

EXAM TRAP Insect haemolymph circulation is not mammalian-style O_2 transport.

SOURCE TYPE ANIMAL RESPIRATION — 2022–2025 recurring theme

Q217 CONCEPT / ANALYSIS

When the SA node fails but the AV junction initiates a stable escape rhythm, the heart rate is typically:

A. Faster than normal sinus rhythm
B. Slower than normal sinus rhythm
C. Always zero
D. Always 200 min^{-1}

CORRECT ANSWER B — Slower than normal sinus rhythm

DETAILED SOLUTION

The SA node normally fires at about 60–100/min at rest. An AV-junctional escape pacemaker has a slower intrinsic rate, roughly 40–60/min, allowing continued but slower contraction.

EXAM TRAP Intrinsic AV rate is generally lower than SA rate.

SOURCE TYPE PACEMAKER PHYSIOLOGY — Advanced PYQ-pattern practice

Q218 NUMERICAL / APPLICATION

A couple are both heterozygous carriers of an autosomal recessive disease. What is the probability their first two children are both affected?

- **A.** 1/4
- **B.** 1/8
- **C.** 1/16
- **D.** 1/2

CORRECT ANSWER C — 1/16

DETAILED SOLUTION

For Aa×Aa, risk of aa per child is 1/4. Independent births: P(both affected)=(1/4)×(1/4)=1/16.

EXAM TRAP Each pregnancy is a new independent event.

SOURCE TYPE HUMAN GENETICS — 2025 memory-based theme

Q219 CONCEPT / ANALYSIS

A cyclone randomly eliminates most members of an isolated population. Which process best explains the immediate loss of rare alleles?

- **A.** Gene flow
- **B.** Genetic drift (bottleneck)
- **C.** Adaptive radiation
- **D.** Directional selection for rare alleles

CORRECT ANSWER B — Genetic drift (bottleneck)

DETAILED SOLUTION

A random sharp reduction in population size creates a bottleneck. Surviving allele frequencies can differ greatly by chance, sometimes eliminating rare alleles.

EXAM TRAP Random survival indicates drift, not necessarily selection.

SOURCE TYPE EVOLUTION BOTTLENECK — Advanced PYQ-pattern practice

Q220 CONCEPT / ANALYSIS

A marked decrease in parathyroid hormone would most directly cause:

- **A.** Hypercalcaemia
- **B.** Hypocalcaemia with increased neuromuscular excitability
- **C.** Persistent hyperglycaemia
- **D.** Increased bone resorption

CORRECT ANSWER B — Hypocalcaemia with increased neuromuscular excitability

DETAILED SOLUTION

PTH normally raises circulating Ca^{2+} via effects on bone, kidney and vitamin-D activation. Reduced PTH can lower Ca^{2+}, increasing neuronal excitability and causing tetany.

EXAM TRAP Low calcium can paradoxically increase excitability.

SOURCE TYPE ENDOCRINOLOGY — Advanced PYQ-pattern practice

Q221 CONCEPT / ANALYSIS

Why is a secondary immune response typically faster than the primary response?

A. Erythrocytes remember antigen
B. Memory B and T cells expand rapidly
C. Skin becomes instantly thicker
D. Antigens are always weaker on second entry

CORRECT ANSWER B — Memory B and T cells expand rapidly

DETAILED SOLUTION

Primary exposure activates naive lymphocytes and generates memory clones. Re-exposure recruits memory cells for faster and stronger antibody/cellular responses.

EXAM TRAP Immune memory depends on lymphocytes.

SOURCE TYPE IMMUNOLOGY — Advanced PYQ-pattern practice

Q222 CONCEPT / ANALYSIS

Which feature best distinguishes adult echinoderms from typical bilateral metazoans?

A. Absence of coelom
B. Water vascular system and pentaradial organization
C. Chitinous exoskeleton
D. Ventral solid nerve cord

CORRECT ANSWER B — Water vascular system and pentaradial organization

DETAILED SOLUTION

Echinoderms possess a distinctive water vascular system and usually pentaradial adult symmetry; their larvae are bilateral, revealing secondary radial organization.

EXAM TRAP Larval and adult symmetry may differ.

SOURCE TYPE ANIMAL CLASSIFICATION — 2024 memory-based theme

Q223 CONCEPT / ANALYSIS

Which stage of Plasmodium enters a human directly through the bite of an infected female Anopheles mosquito?

A. Merozoite
B. Gametocyte
C. Sporozoite
D. Ookinete

CORRECT ANSWER C — Sporozoite

DETAILED SOLUTION

Mosquito salivary glands inject sporozoites into a human. Sporozoites reach the liver and begin exoerythrocytic development; merozoites subsequently infect RBCs.

EXAM TRAP Mosquito injects sporozoites, not the RBC-invading merozoites.

SOURCE TYPE PARASITE LIFECYCLE — 2023–2025 recurring theme

Q224 CONCEPT / ANALYSIS

In a normal adult, which chamber generates the highest systolic pressure?

A. Right atrium
B. Right ventricle
C. Left atrium
D. Left ventricle

CORRECT ANSWER D — Left ventricle

DETAILED SOLUTION

The left ventricle pumps into high-resistance systemic circulation and produces substantially higher systolic pressures than the right ventricle, which pumps into pulmonary circulation.

EXAM TRAP Chamber wall thickness reflects systemic workload.

SOURCE TYPE HUMAN CIRCULATION — Advanced PYQ-pattern practice

Q225 CONCEPT / ANALYSIS

After selection, a population resumes random mating with recessive-allele frequency q=0.20 and no other evolutionary force. What heterozygote frequency is expected in the next zygotes?

A. 0.64
B. 0.32
C. 0.80
D. 0.04

CORRECT ANSWER B — 0.32

DETAILED SOLUTION

Hardy-Weinberg predicts heterozygotes at frequency 2pq. Here q = 0.20 and p = 1 − q = 0.80, so 2pq = 2 × 0.8 × 0.2 = 0.32. The 0.04 choice is q^2, the recessive homozygote frequency.

EXAM TRAP Do not confuse allele frequency q with genotype frequency q^2.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q226 CONCEPT / ANALYSIS

Miller-Urey type synthesis supports chemical evolution but does not by itself demonstrate:

A. abiotic formation of organic monomers
B. the plausibility of prebiotic chemistry
C. energy-driven atmospheric reactions
D. self-replication and heredity in protocells

CORRECT ANSWER D — self-replication and heredity in protocells

DETAILED SOLUTION

Miller-Urey demonstrated that organic building blocks can arise abiotically under certain simulated prebiotic conditions. Producing amino acids does not establish self-replicating protocells, a genetic system, or actual origin of life. Thus option D is beyond the experimental evidence.

EXAM TRAP A successful synthesis is evidence of possibility, not proof of living cells.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q227 CONCEPT / ANALYSIS

A trait improves survival before reproduction but reduces survival after reproduction. Natural selection will most directly favor it when:

- **A.** its early reproductive gain exceeds its later cost
- **B.** the trait is acquired during life
- **C.** post-reproductive survival determines allele transmission
- **D.** the population is very small only

CORRECT ANSWER A — its early reproductive gain exceeds its later cost

DETAILED SOLUTION

Evolutionary fitness is weighted strongly by contributions to surviving offspring. A survival advantage before reproduction can spread when it increases lifetime reproductive success enough to outweigh a later cost. Merely acquiring a characteristic during life does not make it heritable.

EXAM TRAP Selection acts on heritable differences in reproductive success.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q228 CONCEPT / ANALYSIS

An animal is triploblastic, bilaterally symmetrical, pseudocoelomate and unsegmented. Which comparison is most defensible?

- **A.** It is more consistent with Aschelminthes than Platyhelminthes
- **B.** It must be an annelid because it is triploblastic
- **C.** It is necessarily diploblastic internally
- **D.** It must possess a true coelom lined by mesoderm

CORRECT ANSWER A — It is more consistent with Aschelminthes than Platyhelminthes

DETAILED SOLUTION

A pseudocoelom is not completely lined by mesoderm, unlike a true coelom. Bilateral triploblastic, unsegmented pseudocoelomates are characteristic of nematodes (older classification: Aschelminthes), whereas flatworms are acoelomate.

EXAM TRAP Pseudocoelomate is not synonymous with acoelomate.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q229 CONCEPT / ANALYSIS

Two organisms have radial adults, bilateral larvae and a water vascular system. Their shared larval symmetry most strongly suggests:

- **A.** complete absence of evolutionary relationship
- **B.** secondary radial symmetry in the adult lineage
- **C.** loss of mesoderm during metamorphosis
- **D.** classification with cnidarians solely by adult symmetry

CORRECT ANSWER B — secondary radial symmetry in the adult lineage

DETAILED SOLUTION

Echinoderms have adult pentaradial symmetry, typically bilateral larvae and a water vascular system. Because bilateral organization appears early in development, radial adult symmetry is interpreted as secondary rather than an ancestral diploblastic condition.

EXAM TRAP Larval symmetry helps interpret evolutionary changes in adult symmetry.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q230 CONCEPT / ANALYSIS

Which feature best separates chordates from superficially fish-like non-chordates at some stage of life?

A. Bilateral symmetry
B. Segmented muscles alone
C. A complete digestive tract
D. A dorsal hollow nerve cord associated with a notochord

CORRECT ANSWER D — A dorsal hollow nerve cord associated with a notochord

DETAILED SOLUTION

The chordate diagnostic combination includes a notochord and dorsal hollow nerve cord at some life stage, alongside pharyngeal slits and post-anal tail. Bilaterality and complete gut occur broadly in other animal groups, so neither alone diagnoses Chordata.

EXAM TRAP Look for the notochord-nerve-cord combination.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q231 CONCEPT / ANALYSIS

A specimen has jointed appendages, an open circulation and a chitinous exoskeleton. If gas exchange occurs through book lungs, the strongest placement is:

A. Crustacea
B. Arachnida
C. Insecta
D. Mollusca

CORRECT ANSWER B — Arachnida

DETAILED SOLUTION

Chitinous exoskeleton, jointed appendages and open circulation indicate Arthropoda. Book lungs are characteristic respiratory organs of various arachnids, including spiders and scorpions; insects more commonly use tracheae.

EXAM TRAP Book lungs identify arachnids better than open circulation alone.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q232 CONCEPT / ANALYSIS

A tissue tolerates repeated stretching yet prevents urine from contacting underlying connective tissue. Its function depends chiefly on:

A. keratinized surface cells
B. ciliated pseudostratified cells
C. simple squamous cells with wide intercellular spaces
D. transitional epithelium with shape-changing superficial cells

CORRECT ANSWER D — transitional epithelium with shape-changing superficial cells

DETAILED SOLUTION

Transitional (urothelium) epithelium lines much of the urinary tract. Its umbrella cells change profile during stretch and create a permeability barrier to urine. Keratinized, simple squamous or ciliated types do not have this same stretch-and-seal specialization.

EXAM TRAP Distensibility plus urine barrier points to urothelium.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q233 CONCEPT / ANALYSIS

After damage to a tendon, repair is slow compared with skin. Which tissue property best explains the difference?

A. Tendon lacks extracellular matrix
B. Skin contains no collagen
C. Tendon cells divide faster but migrate poorly
D. Dense regular collagen has limited vascularity and few cells

CORRECT ANSWER D — Dense regular collagen has limited vascularity and few cells

DETAILED SOLUTION

Tendons consist mainly of highly organized, densely packed collagen with relatively few cells and limited blood supply. Nutrients, immune cells and repair precursors reach injured regions less readily, slowing healing compared with vascular skin.

EXAM TRAP Healing rate is affected by vascularity, not just tissue strength.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q234 CONCEPT / ANALYSIS

A gland releases product together with the apical part of its cells. Relative to merocrine secretion, this necessarily involves:

A. diffusion without vesicles
B. complete destruction of every secretory cell
C. loss of some cytoplasm during secretion
D. release only through ducts lined by muscle

CORRECT ANSWER C — loss of some cytoplasm during secretion

DETAILED SOLUTION

Apocrine secretion sheds a portion of the apical cytoplasm with the product. Merocrine secretion uses exocytosis without appreciable cytoplasm loss, whereas holocrine secretion involves breakdown of the entire secretory cell.

EXAM TRAP Apocrine: apex leaves; holocrine: whole cell breaks down.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q235 CONCEPT / ANALYSIS

Loss of myelin around a peripheral axon most directly reduces conduction speed because:

A. the axon loses all ion channels
B. synaptic transmitter cannot be synthesized in the cell body
C. saltatory propagation between nodes is impaired
D. action potentials can no longer change membrane voltage anywhere

CORRECT ANSWER C — saltatory propagation between nodes is impaired

DETAILED SOLUTION

Myelin limits current leakage and causes action potentials to regenerate mainly at nodes of Ranvier. Damage disrupts this saltatory conduction, decreasing speed and potentially causing conduction block. Ion channels remain; their spatial organization and effective insulation change.

EXAM TRAP Loss of myelin does not mean all action potentials are impossible.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q236 NUMERICAL / APPLICATION

In earthworm, closing nephridiopores while filtration continues would initially disturb:

A. locomotion by setae only
B. gas exchange through gills
C. intracellular digestion
D. nitrogenous waste removal and water balance

CORRECT ANSWER D — nitrogenous waste removal and water balance

DETAILED SOLUTION

Earthworm nephridia collect nitrogenous wastes and regulate fluid and ionic balance. Blocking externally opening nephridiopores impairs discharge of excretory fluid even if filtration continues; the resulting disturbance is excretion and osmoregulation.

EXAM TRAP Distinguish excretory nephridia from respiratory skin.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q237 CONCEPT / ANALYSIS

A cockroach is deprived of oxygen while its blood continues to circulate. Tissue hypoxia occurs mainly because:

A. tracheal delivery, not blood transport, supplies most tissues
B. haemolymph normally carries all oxygen
C. Malpighian tubules consume oxygen first
D. its heart stops whenever spiracles close

CORRECT ANSWER A — tracheal delivery, not blood transport, supplies most tissues

DETAILED SOLUTION

Cockroach tissues receive most oxygen directly through spiracles, tracheae and tracheoles. Haemolymph circulates nutrients and other substances but normally has little role in distributing respiratory oxygen. Blocking tracheal ventilation therefore causes tissue hypoxia despite circulation.

EXAM TRAP Insects generally do not rely on haemolymph to deliver oxygen.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q238 NUMERICAL / APPLICATION

A frog remains submerged in cool, well-aerated water. Which change most supports continued respiration?

A. Exclusive positive-pressure lung ventilation
B. Dry keratinized skin
C. Moist vascular skin with reduced metabolic demand
D. Closure of all skin capillaries

CORRECT ANSWER C — Moist vascular skin with reduced metabolic demand

DETAILED SOLUTION

Frogs can exchange gases through thin, moist, richly vascular skin, particularly while submerged. Cool water also reduces metabolic oxygen demand. Dry or poorly perfused skin would impair, not support, cutaneous respiration.

EXAM TRAP Submerged respiration is largely cutaneous, not exclusively pulmonary.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q239 CONCEPT / ANALYSIS

In a bony fish, puncture of the swim bladder would most directly require greater muscular effort to:

A. excrete ammonia
B. maintain depth in water
C. oxygenate blood at gills
D. digest proteins

CORRECT ANSWER B — maintain depth in water

DETAILED SOLUTION

A swim bladder allows many bony fishes to maintain near-neutral buoyancy at a chosen depth. Losing its gas volume increases the effort needed to counter sinking or adjust vertical position; ammonia excretion and digestion are not its main functions.

EXAM TRAP Buoyancy control is distinct from gill ventilation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q240 NUMERICAL / APPLICATION

A pigeon has efficient gas exchange during both inspiration and expiration chiefly because:

A. airflow through parabronchi is largely unidirectional
B. air sacs themselves are the principal exchange surface
C. oxygenated and deoxygenated air mix completely
D. lungs expand like mammalian alveoli

CORRECT ANSWER A — airflow through parabronchi is largely unidirectional

DETAILED SOLUTION

Birds have rigid lungs supplied by air sacs that maintain essentially unidirectional airflow through parabronchi during both phases of breathing. Gas exchange occurs in lung tissue, not within the thin-walled air sacs themselves.

EXAM TRAP Air sacs ventilate; parabronchi exchange gases.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q241 CONCEPT / ANALYSIS

Compared with a frog, a rabbit sustains higher aerobic activity partly because its circulation:

A. uses skin as its only respiratory organ
B. separates pulmonary and systemic blood more completely
C. delivers blood without capillaries
D. has one atrium and one ventricle

CORRECT ANSWER B — separates pulmonary and systemic blood more completely

DETAILED SOLUTION

The mammalian four-chambered heart prevents normal mixing of systemic oxygenated and pulmonary deoxygenated blood. This sustains higher systemic oxygen delivery and supports a higher aerobic metabolic rate than the incompletely separated amphibian double circulation.

EXAM TRAP The key comparison is complete versus incomplete cardiac separation.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q242 CONCEPT / ANALYSIS

A person hyperventilates before holding breath. The delay in urge to breathe is caused mainly by an initial fall in:

A. haemoglobin concentration
B. lung residual volume
C. blood nitrogen
D. arterial carbon dioxide and hydrogen ion drive

CORRECT ANSWER D — arterial carbon dioxide and hydrogen ion drive

DETAILED SOLUTION

Central chemoreceptor drive is strongly linked to arterial CO_2 through its effect on cerebrospinal-fluid hydrogen ions. Hyperventilation reduces CO_2 (hypocapnia), initially delaying the CO_2 rise that triggers breathing discomfort. It does not provide a large oxygen store.

EXAM TRAP Prolonged breath-holding after hyperventilation can be dangerous.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q243 CONCEPT / ANALYSIS

If afferent arteriolar resistance increases while other factors remain initially constant, the most likely immediate renal effect is:

A. lower glomerular pressure and lower filtration
B. unchanged filtration with higher urine glucose
C. complete loss of tubular reabsorption
D. higher glomerular pressure and higher filtration

CORRECT ANSWER A — lower glomerular pressure and lower filtration

DETAILED SOLUTION

Increasing afferent arteriolar resistance restricts blood entry into glomerular capillaries. With other factors held constant, glomerular hydrostatic pressure and GFR decrease. Dilation of this arteriole would have the opposite initial effect.

EXAM TRAP Afferent constriction lowers filtration pressure.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q244 NUMERICAL / APPLICATION

A fall in plasma protein concentration, with capillary pressure unchanged, tends to cause edema because it:

A. reduces reabsorption of tissue fluid at the venous end
B. raises plasma oncotic pull
C. closes arterial capillaries
D. increases lymph protein synthesis

CORRECT ANSWER A — reduces reabsorption of tissue fluid at the venous end

DETAILED SOLUTION

Plasma albumin creates capillary colloid osmotic pressure that opposes filtration. Falling protein concentration weakens the inward osmotic force, so more water remains in tissues and oedema may develop. Hydrostatic pressure need not increase to produce this effect.

EXAM TRAP Distinguish osmotic (oncotic) from hydrostatic pressure.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q245 CONCEPT / ANALYSIS

During vigorous exercise, increased CO_2 and temperature in muscle promote oxygen unloading through:

A. conversion of haemoglobin into plasma protein
B. closure of tissue capillaries
C. a left shift of the oxyhaemoglobin curve
D. a right shift and reduced haemoglobin affinity

CORRECT ANSWER D — a right shift and reduced haemoglobin affinity

DETAILED SOLUTION

Active tissues generate more CO_2, H^+ and heat, favouring the T (deoxy) state of haemoglobin. The oxyhaemoglobin dissociation curve shifts right, reducing oxygen affinity at a given partial pressure and improving unloading. This is the Bohr effect.

EXAM TRAP Right shift means easier unloading; left shift means tighter binding.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q246 CONCEPT / ANALYSIS

If the sinoatrial node fails and an atrioventricular pacemaker takes over, which change is most likely?

A. A slower but coordinated rhythm
B. Higher normal heart rate
C. Immediate permanent ventricular tetany
D. No ventricular contraction is possible

CORRECT ANSWER A — A slower but coordinated rhythm

DETAILED SOLUTION

The sinoatrial node usually sets the fastest intrinsic pacemaker rate. If it fails, the atrioventricular junction may generate a slower escape rhythm that can still activate the ventricles. Cardiac contraction does not instantly become impossible.

EXAM TRAP Secondary pacemakers are slower than the SA node.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q247 CONCEPT / ANALYSIS

A meal rich in fat reaches the duodenum. Which coordinated response is most appropriate?

A. Bile delivery plus pancreatic enzyme secretion
B. Less bile and less pancreatic lipase
C. Only salivary amylase secretion
D. Closure of the pylorus forever

CORRECT ANSWER A — Bile delivery plus pancreatic enzyme secretion

DETAILED SOLUTION

Fat entering the duodenum stimulates cholecystokinin (CCK), promoting gallbladder contraction and pancreatic enzyme secretion. Bile salts emulsify lipids, increasing surface area for pancreatic lipase. Secretin additionally promotes bicarbonate-rich pancreatic fluid in response to acid.

EXAM TRAP Bile is not an enzyme; lipase performs hydrolysis.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q248 CONCEPT / ANALYSIS

Damage restricted to pancreatic beta cells would initially produce:

A. loss of thyroxine secretion
B. increased ADH with dilute urine
C. reduced glucagon and persistent hypoglycaemia
D. reduced insulin and impaired cellular glucose uptake

CORRECT ANSWER D — reduced insulin and impaired cellular glucose uptake

DETAILED SOLUTION

Pancreatic beta cells secrete insulin. Their destruction reduces insulin-mediated glucose uptake in muscle and adipose tissue and decreases glycogen synthesis, raising blood glucose. Glucagon is produced mainly by alpha cells and is not the direct product lost.

EXAM TRAP Beta = insulin; alpha = glucagon.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q249 CONCEPT / ANALYSIS

A dehydrated person secretes more ADH. The most direct nephron response is:

A. reduced collecting-duct water permeability
B. complete inhibition of sodium reabsorption
C. increased collecting-duct water permeability and concentrated urine
D. increased glucose filtration only

CORRECT ANSWER C — increased collecting-duct water permeability and concentrated urine

DETAILED SOLUTION

Dehydration raises plasma osmolality and stimulates ADH release. ADH binds V_2 receptors and increases aquaporin-2 insertion in collecting-duct membranes, allowing greater water reabsorption and producing a smaller volume of concentrated urine.

EXAM TRAP ADH changes water permeability, not glucose filtration directly.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q250 CONCEPT / ANALYSIS

When an impulse reaches a chemical synapse, removal of extracellular Ca^{2+} chiefly prevents:

A. myelin formation
B. axon depolarization everywhere
C. synaptic vesicle fusion and transmitter release
D. postsynaptic receptor synthesis

CORRECT ANSWER C — synaptic vesicle fusion and transmitter release

DETAILED SOLUTION

Arrival of an action potential opens presynaptic voltage-gated Ca^{2+} channels. Ca^{2+} influx triggers synaptic vesicle fusion through a calcium-sensitive release apparatus. Removing external calcium therefore suppresses neurotransmitter exocytosis even if the arriving spike remains.

EXAM TRAP Presynaptic calcium is essential for chemical transmitter release.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q251 CONCEPT / ANALYSIS

A lesion damages the dorsal root of a spinal nerve but spares the ventral root. Which deficit is expected in that segment?

A. Loss of sensory input with motor output relatively preserved
B. Enhanced sensory input and paralysis
C. Loss of both cerebral hemispheres
D. Loss of motor output only

CORRECT ANSWER A — Loss of sensory input with motor output relatively preserved

DETAILED SOLUTION

The dorsal root carries sensory afferent fibres and the ventral root carries motor efferents. Damage confined to the dorsal root interrupts incoming sensations from that segment while leaving the outgoing motor route comparatively intact.

EXAM TRAP Dorsal = sensory; ventral = motor.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q252 CONCEPT / ANALYSIS

A person moves suddenly from dim to bright light. The rapid reduction in retinal illumination results from:

A. lens flattening only
B. circular iris muscle contraction and pupil constriction
C. retinal detachment
D. radial muscle contraction and pupil dilation

CORRECT ANSWER B — circular iris muscle contraction and pupil constriction

DETAILED SOLUTION

Bright illumination initiates the pupillary light reflex, activating the circular sphincter pupillae muscles through parasympathetic pathways. The pupil constricts to reduce incoming light. Radial dilator muscles mediate dilation, not constriction.

EXAM TRAP Circular contracts = small pupil.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q253 CONCEPT / ANALYSIS

If parathyroid hormone secretion falls markedly, which sequence is most consistent?

A. Urine becomes dilute because ADH rises
B. Blood Ca^{2+} falls and neuromuscular excitability may rise
C. Blood Ca^{2+} rises and neuromuscular excitability falls
D. Blood glucose falls because insulin disappears

CORRECT ANSWER B — Blood Ca^{2+} falls and neuromuscular excitability may rise

DETAILED SOLUTION

PTH normally increases serum calcium by acting on bone, kidney and indirectly intestinal absorption through active vitamin D. A marked fall can produce hypocalcaemia, increasing neuromuscular excitability, including tetany in severe cases.

EXAM TRAP PTH defends extracellular Ca^{2+} levels.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q254 CONCEPT / ANALYSIS

Failure of negative feedback from thyroxine would most directly disrupt regulation of:

A. ADH action on kidney
B. gastrin action in stomach
C. insulin release after meals
D. TSH secretion from the pituitary

CORRECT ANSWER D — TSH secretion from the pituitary

DETAILED SOLUTION

Thyroid hormones inhibit hypothalamic TRH and anterior-pituitary TSH by negative feedback. Defective feedback would dysregulate TSH release even when thyroxine is high. ADH, gastrin and insulin have different feedback controls.

EXAM TRAP Thyroid axis: TRH → TSH → T_4/T_3 with negative feedback.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q255 CONCEPT / ANALYSIS

A man produces normal testosterone but sperm fail to mature because epididymal function is lost. Which conclusion follows?

A. Androgen production and sperm maturation are distinct functions
B. Testosterone is made only in epididymis
C. Fertilization normally occurs in seminiferous tubules
D. Spermatogenesis occurs in prostate

CORRECT ANSWER A — Androgen production and sperm maturation are distinct functions

DETAILED SOLUTION

Leydig cells in testes synthesize testosterone; spermatogenesis occurs in seminiferous tubules, whereas epididymis is important for sperm maturation and storage. Normal androgen production can coexist with defective sperm maturation after epididymal damage.

EXAM TRAP Testosterone secretion and sperm maturation occur in different structures.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q256 CONCEPT / ANALYSIS

At ovulation, the secondary oocyte has completed:

A. meiosis I but not meiosis II
B. both meiotic divisions regardless of fertilization
C. mitosis only
D. no nuclear division since fetal life

CORRECT ANSWER A — meiosis I but not meiosis II

DETAILED SOLUTION

The LH surge causes the primary oocyte to complete meiosis I, producing a secondary oocyte and first polar body. The ovulated secondary oocyte is arrested in metaphase II; meiosis II typically finishes only after fertilization.

EXAM TRAP Ovulation does not ordinarily release a completed ovum.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q257 CONCEPT / ANALYSIS

A bacterium survives penicillin exposure because it lacks the drug target. This resistance differs from vaccination because vaccination:

A. induces host adaptive immune memory
B. always gives immediate passive antibodies
C. acts directly on bacterial cell walls
D. cannot prevent infectious disease

CORRECT ANSWER A — induces host adaptive immune memory

DETAILED SOLUTION

Vaccination exposes the host to an antigen or antigenic information so adaptive immune memory can develop. A bacterium lacking a penicillin target escapes that drug, but that is not the same as generating host B-cell and T-cell memory.

EXAM TRAP Resistance is a bacterial property; vaccination trains host immunity.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q258 CONCEPT / ANALYSIS

A second exposure to the same antigen produces a faster, stronger response mainly due to:

A. reduced clonal selection
B. loss of all antibodies after first exposure
C. nonspecific skin barriers
D. memory lymphocytes formed after the first exposure

CORRECT ANSWER D — memory lymphocytes formed after the first exposure

DETAILED SOLUTION

Primary immune exposure produces memory B and T cells. On subsequent contact with the same antigen, these clones respond more rapidly and strongly, leading to an accelerated secondary response, often with higher-affinity antibodies.

EXAM TRAP Memory cells explain secondary-response speed.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q259 CONCEPT / ANALYSIS

Antibiotics do not cure influenza primarily because influenza virus:

A. is larger than bacteria
B. uses host-cell machinery and lacks bacterial targets
C. is eliminated only by red cells
D. has a cell wall impermeable to all drugs

CORRECT ANSWER B — uses host-cell machinery and lacks bacterial targets

DETAILED SOLUTION

Antibiotics generally target bacterial pathways such as peptidoglycan wall synthesis or bacterial ribosomes. Influenza is viral, uses host-cell machinery and has neither a bacterial wall nor those target ribosomes. Antiviral drugs work through different mechanisms.

EXAM TRAP Antibacterial drugs do not inherently inhibit viruses.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q260 CONCEPT / ANALYSIS

If helper T-cell numbers fall severely, both antibody and cell-mediated responses weaken because helper T cells:

A. form the skin barrier
B. coordinate activation of multiple immune cell types
C. carry oxygen to lymph nodes
D. directly secrete every antibody

CORRECT ANSWER B — coordinate activation of multiple immune cell types

DETAILED SOLUTION

$CD4^+$ helper T cells coordinate immunity through cytokine signalling and cell-contact support for B cells, cytotoxic T cells and macrophages. Their severe depletion therefore impairs both antibody-mediated and cell-mediated arms of adaptive immunity.

EXAM TRAP Helper T cells coordinate; plasma cells secrete antibodies.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q261 CONCEPT / ANALYSIS

PCR can detect a pathogen before antibodies appear because PCR amplifies:

A. host memory cells
B. whole bacterial colonies only
C. antigen-antibody precipitate
D. a specific nucleic-acid sequence

CORRECT ANSWER D — a specific nucleic-acid sequence

DETAILED SOLUTION

PCR increases the copy number of a defined DNA sequence; RNA viruses require a reverse-transcription step before amplification. Because nucleic acids can be present before seroconversion, PCR can detect infection when antibodies are not yet measurable.

EXAM TRAP PCR detects genetic material, not host antibody memory.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q262 CONCEPT / ANALYSIS

In DNA fingerprinting, two samples matching at many variable loci are more informative than matching at one locus because:

A. one locus contains the entire genome
B. all humans differ at every locus
C. each additional independent match reduces chance coincidence
D. matching proves the samples are from different people

CORRECT ANSWER C — each additional independent match reduces chance coincidence

DETAILED SOLUTION

Each highly variable, independently informative genetic locus reduces the chance that two unrelated individuals match by coincidence. Combining multiple loci makes a DNA profile much more discriminating than using one marker, although relatedness and sampling quality matter.

EXAM TRAP More independent loci generally improve identification specificity.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q263 CONCEPT / ANALYSIS

Removal of a top predator causes herbivores to increase and plant biomass to decline. This is best interpreted as:

A. a trophic cascade
B. competitive exclusion among plants only
C. primary succession
D. nitrogen fixation

CORRECT ANSWER A — a trophic cascade

DETAILED SOLUTION

Removing a predator can release herbivores from predation, increasing grazing pressure and reducing plant biomass. Effects transmitted through more than one trophic level are a trophic cascade, not merely a direct predator-prey change.

EXAM TRAP Track indirect effects across food-web levels.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q264 CONCEPT / ANALYSIS

A small isolated population loses alleles after a random cyclone. The immediate process is:

A. adaptive radiation caused by mutation alone
B. directional selection for cyclone resistance
C. gene flow into the population
D. genetic drift through a bottleneck

CORRECT ANSWER D — genetic drift through a bottleneck

DETAILED SOLUTION

A sudden random reduction in a population can remove alleles through chance rather than adaptive advantage. This is a bottleneck form of genetic drift; its impact is especially strong when effective population size becomes small.

EXAM TRAP Random allele loss is drift, not necessarily natural selection.

SOURCE TYPE USER-SUPPLIED ADVANCED MOCK — not a historical examination claim

Q265 CONCEPT / ANALYSIS

A healthy person ascends to high altitude and remains there for several weeks. Which sequence best explains rising red-cell mass?

A. Lower oxygen → higher renal EPO → increased erythropoiesis
B. Higher oxygen → lower renal EPO → more RBCs
C. Lower oxygen → immediate RBC multiplication in blood
D. Higher CO_2 → RBC division in capillaries

CORRECT ANSWER A — Lower oxygen → higher renal EPO → increased erythropoiesis

DETAILED SOLUTION

Reduced arterial oxygenation stabilizes hypoxia-responsive pathways in renal cells, increasing erythropoietin (EPO). EPO stimulates erythroid precursors in bone marrow and gradually raises red-cell mass; mature circulating RBCs do not divide.

EXAM TRAP Acclimatization is a marrow response occurring over days to weeks.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q266 NUMERICAL / APPLICATION

The Na^+/K^+-ATPase pumps ions per ATP hydrolysed in which direction and ratio?

A. 3 K^+ out, 2 Na^+ in
B. 2 Na^+ out, 3 K^+ in
C. 3 Na^+ out, 2 K^+ in
D. 3 Na^+ in, 2 K^+ out

CORRECT ANSWER C — 3 Na^+ out, 2 K^+ in

DETAILED SOLUTION

Each pump cycle ordinarily exports three Na^+ ions and imports two K^+ ions at the cost of one ATP. This net movement of one positive charge outward contributes to electrogenicity and sustains Na^+/K^+ electrochemical gradients.

EXAM TRAP The membrane pump is 3 Na^+ out and 2 K^+ in.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q267 NUMERICAL / APPLICATION

Renal plasma flow is 600 mL/min and GFR is 120 mL/min. What is the filtration fraction?

A. 10%
B. 15%
C. 20%
D. 25%

CORRECT ANSWER C — 20%

DETAILED SOLUTION

Filtration fraction is the fraction of renal plasma flow entering the Bowman space: FF = GFR/RPF = 120/600 = 0.20 = 20%. Renal blood flow should not be substituted directly for plasma flow.

EXAM TRAP Use plasma flow, not whole-blood flow, in the denominator.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q268 CONCEPT / ANALYSIS

An AB-blood-group mother (I^AI^B) and an O-blood-group father (ii) have a child. Which phenotype is possible in their child?

A. Group O only
B. Group AB only
C. Group A or Group B
D. All four ABO groups

CORRECT ANSWER C — Group A or Group B

DETAILED SOLUTION

The mother transmits either I^A or I^B; the father always transmits i. Possible offspring are I^Ai (group A) and I^Bi (group B), each with probability one-half. Genotypes ii (O) and I^AI^B (AB) cannot form in this cross.

EXAM TRAP A child of AB × O parents can be A or B, not AB or O.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q269 NUMERICAL / APPLICATION

A carrier woman for an X-linked recessive disorder marries an affected man. What fraction of their daughters is expected to be affected?

- **A.** 0
- **B.** 1/4
- **C.** 1/2
- **D.** All

CORRECT ANSWER C — 1/2

DETAILED SOLUTION

Mother X^AX^a makes equal X^A and X^a eggs; father X^aY always transmits X^a to daughters. Half their daughters will be X^aX^a affected and half X^AX^a carriers.

EXAM TRAP An affected father passes his X to every daughter, never to sons.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q270 CONCEPT / ANALYSIS

Which lung volume cannot be directly measured by ordinary simple spirometry?

- **A.** Tidal volume
- **B.** Inspiratory reserve volume
- **C.** Expiratory reserve volume
- **D.** Residual volume

CORRECT ANSWER D — Residual volume

DETAILED SOLUTION

Ordinary spirometry records air entering or leaving through the mouth. Residual volume remains in the lungs after maximal expiration and cannot be exhaled into the instrument; indirect methods estimate it.

EXAM TRAP Capacities containing residual volume also require additional techniques.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q271 CONCEPT / ANALYSIS

A second injection of the same protein antigen elicits a rapid IgG-dominated response. The most direct explanation is:

- **A.** Greater red-cell oxygen capacity
- **B.** Memory B cells and prior class switching
- **C.** Loss of helper T cells
- **D.** Reduced antigen recognition

CORRECT ANSWER B — Memory B cells and prior class switching

DETAILED SOLUTION

Primary exposure produces antigen-specific memory B cells, often with somatic hypermutation and immunoglobulin class switching. On re-exposure, these cells rapidly differentiate into antibody-secreting plasma cells, giving faster and frequently high-affinity IgG responses.

EXAM TRAP An accelerated secondary response reflects adaptive memory.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q272 CONCEPT / ANALYSIS

A patient has raised arterial CO_2 and lower pH during exercise. Relative to resting conditions, haemoglobin tends to:

A. Shift left and bind O_2 more strongly
B. Shift right and release O_2 more readily
C. Lose all oxygen-binding capacity
D. Become independent of partial pressure

CORRECT ANSWER B — Shift right and release O_2 more readily

DETAILED SOLUTION

CO_2 and H^+ bind or influence haemoglobin to stabilize its lower-affinity state. The oxygen dissociation curve shifts right (Bohr effect), allowing greater oxygen unloading in active tissue at a given pO_2.

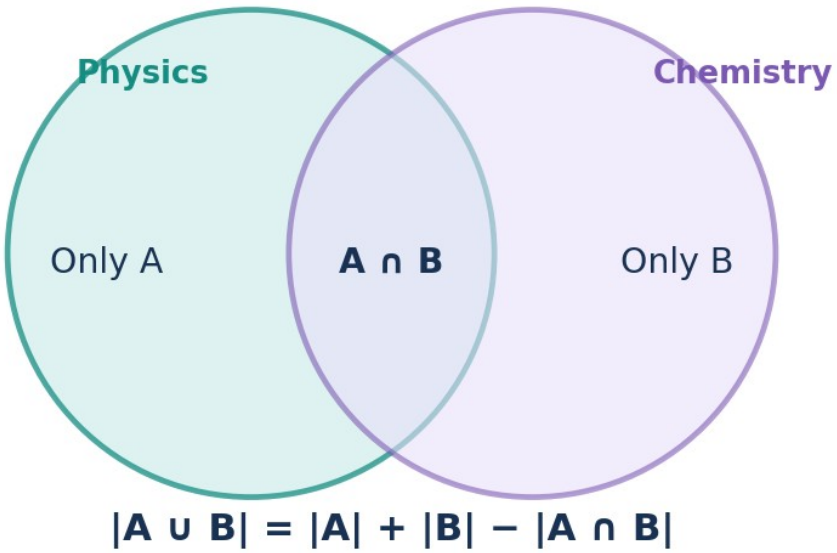
EXAM TRAP Right shift improves tissue unloading but does not eliminate binding.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

PART 5 / 28 EXAM-LEVEL QUESTIONS

MENTAL AGILITY (MAT)

Logic, set theory, probability, spatial thinking and time-efficient reasoning



Question range: Q273–Q300 • Practice level: concept-rich to application-heavy

Q273 NUMERICAL / APPLICATION

Find the next number: 4, 9, 19, 39, 79, ?

A. 119
B. 139
C. 159
D. 169

CORRECT ANSWER C — 159

DETAILED SOLUTION

Every term follows $a_{n+1} = 2a_n + 1$: 4→9→19→39→79→159. The differences 5,10,20,40 double at every step, so the next difference is 80. Adding it to 79 also gives 159, confirming the recurrence.

EXAM TRAP Check multiplicative relationships when differences double.

SOURCE TYPE SERIES AND DIFFERENCES — 2022–2024 MAT theme

Q274 CONCEPT / ANALYSIS

In a code, MONKEY is written as NPOLFZ (every letter shifted forward by one). How is TIGER written?

A. UJHFS
B. SHFDQ
C. UJHFR
D. VJHFS

CORRECT ANSWER A — UJHFS

DETAILED SOLUTION

Apply the uniform Caesar shift +1 to each letter: T→U, I→J, G→H, E→F, R→S; result UJHFS.

EXAM TRAP Shift each character separately; never reverse order unless specified.

SOURCE TYPE CODING / DECODING — 2022–2024 MAT theme

Q275 NUMERICAL / APPLICATION

Six identical machines complete 24 parts in 8 h. At constant efficiency, how many parts can nine machines complete in 6 h?

A. 18
B. 24
C. 27
D. 36

CORRECT ANSWER C — 27

DETAILED SOLUTION

Rate per machine-hour =24/(6×8)=0.5 part. Nine machines in 6 h supply 54 machine-hours and produce 54×0.5=27 parts.

EXAM TRAP Output ∝ machines × working hours.

SOURCE TYPE WORK AND RATES — 2024 MAT theme

Q276 NUMERICAL / APPLICATION

Two fair dice are thrown. Probability that their sum equals 9 is:

A. 1/6
B. 1/9
C. 1/12
D. 5/36

CORRECT ANSWER B — 1/9

DETAILED SOLUTION

Favorable ordered pairs: (3,6),(4,5),(5,4),(6,3), four outcomes among 36 equally likely outcomes. Probability=4/36=1/9.

EXAM TRAP Ordered dice outcomes are distinct.

SOURCE TYPE PROBABILITY — Advanced PYQ-pattern practice

Q277 CONCEPT / ANALYSIS

If 5 (31) 6 and 7 (57) 8 follow a consistent rule based on the outer numbers, what belongs in 9 (?) 10?

A. 81
B. 89
C. 91
D. 101

CORRECT ANSWER C — 91

DETAILED SOLUTION

Center = product of outer numbers +1: 5×6+1=31, 7×8+1=57, 9×10+1=91. The operation is multiplication of outer numbers followed by addition of one. Using addition of the outer numbers instead would fail for both supplied examples, so 9×10+1 is the consistent choice.

EXAM TRAP Seek a rule that satisfies both examples.

SOURCE TYPE NUMBER RELATIONS — Advanced PYQ-pattern practice

Q278 NUMERICAL / APPLICATION

Among 120 students, 70 study Physics, 65 study Chemistry and 25 study neither. How many study both?

A. 15
B. 30
C. 40
D. 55

CORRECT ANSWER C — 40

DETAILED SOLUTION

At least one =120−25=95. Inclusion–exclusion: 95=70+65−both ⇒ both=40. Use the complement of neither to find the union first. Subtracting the union from the sum of the two subject totals corrects for double-counted students who chose both.

EXAM TRAP Subtract the overlap once.

SOURCE TYPE SET THEORY — Advanced PYQ-pattern practice

Q279 CONCEPT / ANALYSIS

All doctors are graduates. Some graduates are researchers. Which conclusion must follow?

A. Some doctors are researchers
B. All researchers are doctors
C. All doctors are graduates
D. No graduate is a doctor

CORRECT ANSWER C — All doctors are graduates

DETAILED SOLUTION

Only the universal premise “All doctors are graduates” is logically guaranteed. The intersection of doctors and researchers is unspecified; it could be empty.

EXAM TRAP Some A are B does not imply some C are B.

SOURCE TYPE LOGICAL IMPLICATIONS — Advanced PYQ-pattern practice

Q280 CONCEPT / ANALYSIS

A 150 m train moving at 25 m s^{-1} overtakes a 100 m train moving at 15 m s^{-1} in the same direction. Time for complete overtaking is:

A. 10 s
B. 15 s
C. 25 s
D. 40 s

CORRECT ANSWER C — 25 s

DETAILED SOLUTION

To completely pass, the relative distance is 150+100=250 m. Relative speed=25−15=10 m s^{-1}. Time=250/10=25 s.

EXAM TRAP Use the sum of lengths even for trains moving in same direction.

SOURCE TYPE RELATIVE SPEEDS — 2024 MAT theme

Q281 NUMERICAL / APPLICATION

From a bag containing 3 red and 2 blue balls, two are drawn without replacement. What is the probability of getting one of each color?

A. 1/5
B. 2/5
C. 3/5
D. 4/5

CORRECT ANSWER C — 3/5

DETAILED SOLUTION

There are C(5,2) = 10 equally likely unordered pairs. One red and one blue can be selected in C(3,1)×C(2,1) = 6 ways. Therefore the probability is 6/10 = 3/5.

EXAM TRAP Use combinations rather than treating the two draws as independent.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q282 NUMERICAL / APPLICATION

In a group of 150 students, 95 take Physics, 78 Chemistry, and 34 take neither. How many take both?

A. 23
B. 39
C. 57
D. 73

CORRECT ANSWER C — 57

DETAILED SOLUTION

The number taking at least one subject is 150−34 = 116. By inclusion–exclusion, 95+78−both =116, hence both = 173−116 = 57.

EXAM TRAP Subtract students who take neither before applying inclusion–exclusion.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q283 NUMERICAL / APPLICATION

Find the next term of the series 5, 12, 26, 54, 110, ...

A. 220
B. 222
C. 224
D. 226

CORRECT ANSWER B — 222

DETAILED SOLUTION

Each term is twice the previous term plus 2: 5×2+2=12, 12×2+2=26, and so on. Thus the next is 110×2+2 = 222.

EXAM TRAP The first differences double, but the exact recurrence is ×2+2.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q284 CONCEPT / ANALYSIS

If every CHEMIST is a SCIENTIST and no SCIENTIST is a POET, which conclusion must be true?

A. Some poets are chemists
B. No chemist is a poet
C. All scientists are chemists
D. Some chemists are poets

CORRECT ANSWER B — No chemist is a poet

DETAILED SOLUTION

The set of chemists lies entirely inside the scientist set. Scientists have no overlap with poets; therefore the chemist subset also has no overlap with poets. Reverse inclusion is not justified.

EXAM TRAP Universal statements do not imply their converse.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q285 NUMERICAL / APPLICATION

A clock shows 3:20. What is the smaller angle between the hour and minute hands?

A. 10°
B. 20°
C. 30°
D. 40°

CORRECT ANSWER B — 20°

DETAILED SOLUTION

At 20 minutes, the minute hand is 20×6° = 120° from 12. The hour hand has moved 3×30°+20×0.5° = 100°. Their smaller separation is |120−100| = 20°.

EXAM TRAP The hour hand moves continuously, 0.5° per minute.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q286 CONCEPT / ANALYSIS

A person walks 3 km east, 4 km north, and 6 km west. How far and in what direction is the person from the start?

A. 5 km northwest
B. 7 km northwest
C. 5 km northeast
D. 7 km southwest

CORRECT ANSWER A — 5 km northwest

DETAILED SOLUTION

Net east-west displacement is $3-6 = -3$ km (west), and northward displacement is $+4$ km. Distance $= \sqrt{(3^2+4^2)} = 5$ km. Since the components are west and north, direction is northwest.

EXAM TRAP Use displacement components, not path length 13 km.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q287 NUMERICAL / APPLICATION

A box contains 3 defective and 7 working kits. Two are chosen without replacement. Probability both are defective?

A. 1/15
B. 1/10
C. 1/12
D. 2/15

CORRECT ANSWER A — 1/15

DETAILED SOLUTION

The first defective probability is 3/10. After that, two defective remain among nine kits, giving 2/9. Multiplying conditional probabilities gives $(3/10)(2/9) = 6/90 = 1/15$.

EXAM TRAP Without replacement changes the second probability.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q288 NUMERICAL / APPLICATION

How many arrangements of five different students in a row place A and B adjacent?

A. 24
B. 36
C. 48
D. 60

CORRECT ANSWER C — 48

DETAILED SOLUTION

Treat adjacent A and B as a single block: this block plus three others form 4! arrangements. Inside the block AB or BA are possible, so the number is $2\times4! = 48$.

EXAM TRAP Multiply by 2 for the internal order of the pair.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q289 NUMERICAL / APPLICATION

In a circular row, how many distinct seatings are there for four different people if rotations are treated as identical?

A. 6
B. 12
C. 18
D. 24

CORRECT ANSWER A — 6

DETAILED SOLUTION

For n distinct people around a round table, fixing one seat or person removes rotational duplicates. Arrangements = (n−1)! = 3! = 6. Reflections remain different if clockwise versus counterclockwise order matters.

EXAM TRAP Circular permutations are not generally n!.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q290 CONCEPT / ANALYSIS

If x > y, y ≥ z, and z > w, what is necessarily true?

A. x ≤ w
B. x = w
C. x > w
D. w > x

CORRECT ANSWER C — x > w

DETAILED SOLUTION

Combine the inequalities transitively: x > y ≥ z > w. Even though y may equal z, the strict inequalities on either side force x > w.

EXAM TRAP A non-strict step does not erase other strict inequalities.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q291 NUMERICAL / APPLICATION

A laboratory processed 300 samples: 40% in Unit A and the rest equally between B and C. How many samples are in Unit C?

A. 60
B. 80
C. 90
D. 120

CORRECT ANSWER C — 90

DETAILED SOLUTION

Unit A processes 0.40×300 = 120 samples. The remainder is 180, split equally between B and C, so C receives 180/2 = 90.

EXAM TRAP Equal division applies to the remainder, not to all 300.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q292 CONCEPT / ANALYSIS

A non-leap year begins on Monday. What weekday is March 1 of that year?

A. Tuesday
B. Wednesday
C. Thursday
D. Friday

CORRECT ANSWER C — Thursday

DETAILED SOLUTION

January has 31 days, advancing the weekday by 3: February 1 is Thursday. February in a non-leap year has 28 days (four complete weeks), so March 1 is also Thursday.

EXAM TRAP Reduce month lengths modulo 7.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q293 CONCEPT / ANALYSIS

Which number does not belong to the pattern 31, 63, 95, 127, 255?

A. 31
B. 63
C. 95
D. 255

CORRECT ANSWER C — 95

DETAILED SOLUTION

$31 = 2^5-1$; $63 = 2^6-1$; $127 = 2^7-1$; and $255 = 2^8-1$. The number 95 is not one less than a power of 2 and breaks the pattern.

EXAM TRAP Look for nearby powers of two rather than only differences.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q294 NUMERICAL / APPLICATION

A test's average marks were 60 for 20 students and 75 for 30 others. What is the combined average?

A. 66
B. 67
C. 68
D. 69

CORRECT ANSWER D — 69

DETAILED SOLUTION

The combined total = $20\times60 + 30\times75 = 1200+2250 = 3450$ marks. With 50 students, the combined average is $3450/50 = 69$, not the unweighted mean 67.5.

EXAM TRAP For unequal group sizes use a weighted mean.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q295 CONCEPT / ANALYSIS

If P implies Q and Q implies R, but R is false, which must follow?

A. P is true
B. Q is true
C. P is false
D. R is true

CORRECT ANSWER C — P is false

DETAILED SOLUTION

By contraposition, not-R implies not-Q because Q→R. Then not-Q implies not-P because P→Q. Therefore P must be false. This is a chain of modus tollens.

EXAM TRAP Do not infer P from Q; use contraposition.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q296 CONCEPT / ANALYSIS

In a coding system, a word is reversed and each letter is moved one place forward cyclically (Z→A). How is LAMP coded?

A. QNBM
B. QOBM
C. QOCM
D. PMBM

CORRECT ANSWER A — QNBM

DETAILED SOLUTION

Reverse LAMP to PMAL. Shift letters forward: P→Q, M→N, A→B, L→M; the result is QNBM. Thus the correct code is QNBM.

EXAM TRAP Apply the operations in the stated order: reverse, then shift.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q297 NUMERICAL / APPLICATION

Three independent events have probabilities 1/2, 1/3 and 1/4. Probability none occurs is:

A. 1/4
B. 1/3
C. 1/2
D. 3/4

CORRECT ANSWER A — 1/4

DETAILED SOLUTION

For independent events, the chance of no occurrence is the product of complement probabilities: $(1-1/2)(1-1/3)(1-1/4) = (1/2)(2/3)(3/4) = 1/4$.

EXAM TRAP Multiplying probabilities of occurrence is not the same as none occurring.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q298 NUMERICAL / APPLICATION

A medicine stock rises by 20% in the first month then falls by 20% next month. What is the net change?

A. No change
B. 4% increase
C. 4% decrease
D. 8% decrease

CORRECT ANSWER C — 4% decrease

DETAILED SOLUTION

Let initial stock index be 100. After the rise it is 120; a 20% decrease then gives 120×0.80 = 96. The net movement is 96−100 = −4, a 4% fall.

EXAM TRAP Successive percentage changes use the new base.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q299 NUMERICAL / APPLICATION

The ratio of ages of two siblings is 5:3. In 8 years it will be 7:5. What is the younger sibling's present age?

A. 10
B. 12
C. 15
D. 18

CORRECT ANSWER B — 12

DETAILED SOLUTION

Let present ages be 5x and 3x. Then (5x+8)/(3x+8) = 7/5. Cross multiplication gives 25x+40 = 21x+56, so x=4. The younger is 3x = 12 years.

EXAM TRAP Always apply the same number of years to both ages.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

Q300 NUMERICAL / APPLICATION

Five doctors each shake hands with every other doctor exactly once. How many handshakes occur?

A. 10
B. 15
C. 20
D. 25

CORRECT ANSWER A — 10

DETAILED SOLUTION

Each handshake corresponds to an unordered pair of people. Thus the count is C(5,2) = 5×4/2 = 10. Multiplying 5×4 without dividing by two counts each handshake twice.

EXAM TRAP Pair-counting uses n(n−1)/2.

SOURCE TYPE NEW 2026 EXPECTED PRACTICE — original CEE-style question

QUICK ANSWER INDEX

Use this only after completing a section; every answer has a full explanation beside the question itself.

PHYSICS

001 B	002 C	003 B	004 A	005 B	006 C	007 A	008 B
009 B	010 C	011 B	012 B	013 A	014 B	015 D	016 C
017 C	018 A	019 D	020 C	021 B	022 C	023 A	024 D
025 B	026 D	027 C	028 A	029 D	030 A	031 B	032 D
033 B	034 C	035 C	036 B	037 C	038 D	039 C	040 A
041 B	042 D	043 B	044 A	045 C	046 B	047 D	048 B
049 C	050 B	051 D	052 B	053 D	054 D	055 D	056 C
057 B	058 C	059 D	060 B	061 C	062 D	063 C	064 D
065 C	066 A	067 D	068 B	069 A	070 C	071 B	072 C
073 B	074 D	075 A	076 C				

CHEMISTRY

077 B	078 C	079 B	080 C	081 B	082 D	083 C	084 A
085 B	086 B	087 D	088 B	089 C	090 B	091 D	092 D
093 C	094 C	095 A	096 B	097 A	098 C	099 D	100 A
101 C	102 A	103 D	104 B	105 D	106 D	107 B	108 A
109 A	110 A	111 A	112 A	113 D	114 C	115 C	116 D
117 B	118 B	119 B	120 D	121 D	122 D	123 D	124 C

125	126	127	128	129	130	131	132
B	A	C	B	A	B	C	A
133	134	135	136	137	138	139	140
D	B	D	C	C	D	A	C
141	142	143	144	145	146	147	148
B	A	B	C	B	D	A	C
149	150	151					
B	B	D					

BOTANY

152	153	154	155	156	157	158	159
C	C	C	C	B	B	B	B
160	161	162	163	164	165	166	167
B	D	A	B	B	C	A	A
168	169	170	171	172	173	174	175
B	C	B	B	A	C	B	C
176	177	178	179	180	181	182	183
B	A	B	C	B	A	B	B
184	185	186	187	188	189	190	191
A	A	A	C	C	C	A	B
192	193	194	195	196	197	198	199
A	A	D	C	C	C	A	D
200	201	202	203	204	205	206	207
C	B	D	D	B	C	B	B
208	209	210	211	212			
A	B	B	B	B			

ZOOLOGY

213	214	215	216	217	218	219	220
B	B	B	B	B	C	B	B
221	222	223	224	225	226	227	228
B	B	C	D	B	D	A	A
229	230	231	232	233	234	235	236
B	D	B	D	D	C	C	D
237	238	239	240	241	242	243	244
A	C	B	A	B	D	A	A
245	246	247	248	249	250	251	252
D	A	A	D	C	C	A	B
253	254	255	256	257	258	259	260
B	D	A	A	A	D	B	B

261 D	262 C	263 A	264 D	265 A	266 C	267 C	268 C
269 C	270 D	271 B	272 B				

MENTAL AGILITY (MAT)

273 C	274 A	275 C	276 B	277 C	278 C	279 C	280 C
281 C	282 C	283 B	284 B	285 B	286 A	287 A	288 C
289 A	290 C	291 C	292 C	293 C	294 D	295 C	296 A
297 A	298 C	299 B	300 A				

SOURCES & PUBLICATION NOTE

OFFICIAL SYLLABUS

Medical Education Commission, Nepal. Syllabus for Bachelor Level Common Entrance Examination, 2020 (Revised 2026), published April 29, 2026. https://mec.gov.np/en/detail/syllabus-for-bachelor-level-common-entrance-examination-2020-revised-2026

USER-PROVIDED HISTORICAL COLLECTIONS

CEE MBBS 2021, 2022, 2023, 2024 and 2025 memory-based PDFs, and CEE MBBS 2026 (identified within the upload as a model set). These may not reproduce official examination text accurately.

QUESTION BANKS USED

CEE_Advanced_PYQ_Pattern_Handbook_2026.docx (63 adapted questions) and 180 Marks CEE Based QNS.pdf (180 practice questions). Additional 57 questions were originally drafted for this edition.

IMPORTANT CORRECTNESS LIMIT

Questions, answer letters, and numerical derivations underwent editorial checks and a structural validity audit. The book has not undergone independent subject-expert peer review; please conduct that review before publication or paid distribution.

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