॥आचार्य सारथी॥
ACHARYA SARTHI
प्रत्येक विद्यार्थ्याचा सारथी
Every Indian student's guide
acharyasarthi.com • Free practice papers for Maharashtra families

NEET Free Practice Test 1

NEET 2027 Pattern · 180 questions · Selected chapters · Free practice test

Date	Practise any day (3 hours)	**Duration**	3 Hours (180 minutes)
Maximum Marks	720 (180 per subject)	**Questions**	180 (45 per subject)

Student Name		**Roll No. / ID**	
School / Class		**Parent's sign**	

Paper pattern and syllabus

Subject	Q. No.	Chapters	Marks
Physics	1–45	Current Electricity (1–6); Moving Charges and Magnetism (7–12); Magnetism and Matter (13–15); Rotational Motion (16–23); EM Waves (24–26); EMI (27–33); Alternating Current (34–39); Capacitors (40–45)	180
Chemistry	46–90	Thermodynamics (46–54); p-Block, Groups 15–18 (55–63); Equilibrium (64–72); GOC (73–81); Hydrocarbons (82–90)	180
Botany	91–135	Morphology (91–99); Anatomy (100–108); Plant Growth and Development (109–117); Photosynthesis (118–126); Respiration (127–135)	180
Zoology	136–180	Structural Organisation in Animals (136–150); Breathing and Exchange of Gases (151–165); Excretory Products (166–180)	180

Instructions

1. All 180 questions are compulsory single-correct MCQs with four options (1)–(4). Marking: $+4$ correct, -1 incorrect, 0 unattempted.
2. In statement questions, judge each statement independently, then choose the option that lists exactly the correct ones.
3. Assertion–Reason questions use the option wording printed with that question.
4. The values and assumptions given in a question are part of the question. Unless stated otherwise take $g = 10\ \text{m s}^{-2}$.
5. No calculator, mobile phone or electronic device is allowed. Use the margins for rough work.

PHYSICS

Q. 1–45 • 45 Questions • 180 Marks

Q.1 A uniform wire initially has resistance $12\,\Omega$. It is stretched uniformly to twice its original length without changing its volume or resistivity, and bent into a circle. Two contacts divide the circumference in the ratio $1:2$. A cell of emf $12\,\text{V}$ and internal resistance $\frac{4}{3}\,\Omega$ is connected between the contacts. The terminal voltage and current through the shorter arc are respectively:

(1) $\frac{32}{3}\,\text{V}$, $\frac{2}{3}\,\text{A}$

(2) $12\,\text{V}$, $\frac{3}{4}\,\text{A}$

(3) $\frac{32}{3}\,\text{V}$, $\frac{1}{3}\,\text{A}$

(4) $8\,\text{V}$, $\frac{1}{2}\,\text{A}$

Q.2 Two cylindrical pieces of the same metal have equal lengths and diameters d and $2d$. At the working temperature the thicker piece has resistance R. A cell of emf E and internal resistance R supplies the pieces, initially in parallel and subsequently in series. Temperature and carrier density remain unchanged. The ratio of the final to initial drift-speed magnitude in the thinner piece, and the ratio of the final to initial heating power in the thicker piece, are respectively:

(1) $\frac{3}{2}$ and $\frac{9}{64}$

(2) $\frac{3}{2}$ and $\frac{9}{16}$

(3) $\frac{2}{3}$ and $\frac{64}{9}$

(4) $\frac{1}{2}$ and $\frac{1}{16}$

Q.3 A cell gives terminal voltages $9\,\text{V}$ and $6\,\text{V}$ when separately connected to resistors of $9\,\Omega$ and $3\,\Omega$. The cell is then connected to a variable resistor R. Which pair gives R for maximum power delivered to R and that maximum power?
(1) $6\,\Omega$, $6\,\text{W}$ (2) $3\,\Omega$, $6\,\text{W}$ (3) $1.5\,\Omega$, $24\,\text{W}$ (4) $3\,\Omega$, $12\,\text{W}$

Q.4 A $12\,\text{V}$ ideal battery is connected across A and C. Two branches A–B–C and A–D–C contain resistances $AB = 2\,\Omega$, $BC = 4\,\Omega$, $AD = 3\,\Omega$ and $DC = 6\,\Omega$. A $5\,\Omega$ resistor joins B to D. Now BC alone is replaced by $2\,\Omega$. Compared with its initial value, the current through the battery:

(1) increases by $\frac{25}{24}\,\text{A}$

(2) increases by $\frac{6}{7}\,\text{A}$

(3) does not change

(4) increases by $\frac{18}{35}\,\text{A}$

Q.5 At temperature T_0, two resistors have resistances R and $2R$. Over the allowed interval $0 \le \alpha(T - T_0) \le 1$, their resistances are $R_1 = R[1 + \alpha(T - T_0)]$ and $R_2 = 2R[1 - \alpha(T - T_0)/2]$, where $\alpha > 0$. They remain in parallel across a cell of emf E and temperature-independent internal resistance $R/4$. At the temperature for which the cell current is minimum, the temperature rise and terminal voltage are:

(1) $\frac{1}{4\alpha}$ and $\frac{3E}{4}$

(2) $\frac{1}{\alpha}$ and $\frac{8E}{11}$

(3) $\frac{1}{2\alpha}$ and $\frac{3E}{4}$

(4) $\frac{1}{2\alpha}$ and $\frac{E}{2}$

Q.6 Three branches connect a node A to a node B. Branch 1 contains a $12\,\text{V}$ cell with internal resistance $1\,\Omega$; branch 2 contains a $6\,\text{V}$ cell with internal resistance $4\,\Omega$; branch 3 is a positive resistance R. Both cells have their positive terminals toward A. In steady state the $6\,\text{V}$ cell is being charged, and the two cells dissipate equal power in their internal resistances. The value of R and the ratio (chemical-energy storage rate in the $6\,\text{V}$ cell)/(chemical-energy delivery rate from the $12\,\text{V}$ cell) are:

(1) $5\,\Omega$ and $\frac{1}{2}$

(2) $10\,\Omega$ and $\frac{1}{2}$

(3) $20\,\Omega$ and $\frac{1}{4}$

(4) $10\,\Omega$ and $\frac{1}{4}$

Q.7 A proton (mass m, charge q) and an alpha particle (mass $4m$, charge $2q$) first pass through the same velocity selector with mutually perpendicular electric and magnetic fields of magnitudes E and B. Each then crosses the same retarding potential difference V and enters a separate uniform magnetic field perpendicular to its velocity; these two orbit fields have equal magnitudes. Both continue forward in the nonrelativistic regime. If the alpha-particle orbit radius is three times the proton orbit radius, V and the final speed ratio v_α/v_p are:

(1) $\frac{3mE^2}{14qB^2}$ and 3

(2) $\frac{5mE^2}{7qB^2}$ and $\frac{3}{2}$

(3) $\frac{5mE^2}{14qB^2}$ and $\frac{3}{2}$

(4) $\frac{mE^2}{4qB^2}$ and $\sqrt{3}$

Q.8 A thin insulated wire of total resistance R is made into one circular turn and connected to a cell of emf E and internal resistance R. Its central magnetic field and magnetic moment are B_1 and μ_1. The same wire is then cut into four equal pieces. Each piece forms one circular turn; the four turns are arranged coaxially and very close together, with their planes parallel; treat their axial separations as zero when calculating the common central field. They are connected in parallel to the same cell so their fields reinforce. Neglect connecting leads, heating changes and turn thickness. The ratios B_2/B_1 and μ_2/μ_1 for the complete four-turn assembly are:

(1) $\frac{128}{17}$ and $\frac{2}{17}$

(2) 16 and $\frac{1}{4}$

(3) $\frac{128}{17}$ and $\frac{8}{17}$

(4) $\frac{32}{17}$ and $\frac{2}{17}$

Q.9 Three very long parallel wires lie at $x = 0$, $x = a$ and $x = 3a$ and are perpendicular to the page. Their currents are I, $2I$ and an adjustable signed current I_3; positive current means out of the page. The first two wires are held fixed. I_3 is chosen so that the net magnetic force per unit length on the middle wire is zero. The third wire, of mass per unit length λ, is then released from rest. Neglect gravity. Its initial acceleration is:

(1) $\frac{2\mu_0 I^2}{3\pi a\lambda}$ toward $-x$

(2) $\frac{\mu_0 I^2}{3\pi a\lambda}$ toward $+x$

(3) $\frac{4\mu_0 I^2}{3\pi a\lambda}$ toward $+x$

(4) $\frac{4\mu_0 I^2}{3\pi a\lambda}$ toward $-x$

Q.10 Two thin circular coils are coaxial and coplanar. Their radii are R and $2R$ and their currents are I and $I/\sqrt{2}$, in opposite senses. Let $B_0 = \mu_0 I/(2R)$, the field the smaller coil alone would produce at the common centre. At what positive axial distance does the net field vanish? Also, what is the maximum torque on a small dipole of moment μ placed at the common centre?

(1) R and $\frac{\mu B_0}{2}$

(2) $\sqrt{2}\,R$ and $\mu B_0\left[1 - \frac{1}{2\sqrt{2}}\right]$

(3) $\sqrt{2}\,R$ and $\frac{\mu B_0}{2\sqrt{2}}$

(4) $2R$ and $\mu B_0\left[1 - \frac{1}{\sqrt{2}}\right]$

Q.11 A long cylindrical conductor has outer radius a. A cylindrical hole of radius $a/2$ is drilled parallel to its axis, with the hole axis displaced by $a/2$ along $+x$. Uniform current density in the remaining metal carries total current I along $+z$. A positive test charge moves along $+z$ with speed v inside the hole. Ignore end effects. What uniform electric field must be added inside the hole so the test charge is undeflected? (Use superposition of a full current cylinder and a negative-current cylinder to represent the hole.)

(1) $-\frac{\mu_0 Iv}{3\pi a}\,\hat{x}$

(2) Zero, because the hole contains no conduction current

(3) $+\frac{\mu_0 Iv}{3\pi a}\,\hat{x}$

(4) $+\frac{\mu_0 Iv}{4\pi a}\,\hat{x}$

Q.12 A long air-core solenoid is wound using a wire of resistance R and is connected to a cell of emf E and internal resistance R. The wire is removed, stretched uniformly to twice its length without changing its volume or resistivity, and rewound into a long solenoid with twice as many turns and half the original solenoid length. Neglect lead lengths and wire thickness. Both solenoids have circular turns; their radii are determined by the available wire length. After steady current is established, the ratio of the new total magnetic energy inside the solenoid to the original is:

(1) $\frac{32}{25}$ (2) $\frac{8}{25}$

(3) $\frac{64}{25}$ (4) $\frac{16}{25}$

Q.13 A thin uniformly magnetised bar has magnetic moment μ. It is cut at its midpoint and the two halves are rigidly joined with their magnetic-moment vectors at 120° to each other. Neglect interaction between the halves. In uniform field B, the assembly is slowly rotated from its stable orientation to an orientation where its resultant moment is perpendicular to B. The required external work and maximum torque are:

(1) $\frac{\sqrt{3}\mu B}{2}$, $\frac{\sqrt{3}\mu B}{2}$ (2) μB, μB

(3) $\frac{\mu B}{4}$, $\frac{\mu B}{2}$ (4) $\frac{\mu B}{2}$, $\frac{\mu B}{2}$

Q.14 A dilute paramagnetic specimen obeys $\chi = C/T$ and $M = \chi H$. It is placed in a long solenoid whose geometry remains fixed. At 300 K the solenoid winding resistance is R and it is supplied by a cell of emf E and internal resistance R. The specimen and winding are heated together to 600 K, doubling the winding resistance, while the cell internal resistance remains R. The emf is adjusted so that the specimen magnetisation returns to its original value. The required new emf and the ratio of final to initial Joule power in the winding are:
(1) $4E$ and 8 (2) $3E$ and 8 (3) $2E$ and 4 (4) $3E$ and 4

Q.15 A magnetic needle of moment μ and rotational inertia I makes small oscillations in a uniform field B with period $T = 2\pi\sqrt{I/(\mu B)}$. A nonmagnetic attachment doubles its rotational inertia without changing μ. The field is also changed so that the new period is $T/2$. The new field and energy required to rotate the needle slowly from parallel to antiparallel are:
(1) $4B$ and $8\mu B$ (2) $2B$ and $4\mu B$ (3) $8B$ and $8\mu B$ (4) $8B$ and $16\mu B$

Q.16 A uniformly dense spherical star of radius R rotates rigidly with period T and rotational kinetic energy K. Its outer material is removed without exerting any torque on the remaining spherical core of radius $R/2$; immediately after removal the core retains the original angular speed and density. This core then contracts, with its own mass unchanged and no external torque, to radius $R/4$ while remaining uniformly dense. The final rotation period and rotational kinetic energy of the core, expressed in terms of the original whole-star quantities, are:

(1) $\frac{T}{16}$ and $\frac{K}{8}$ (2) $\frac{T}{2}$ and $\frac{K}{16}$

(3) $\frac{T}{4}$ and $4K$ (4) $\frac{T}{4}$ and $\frac{K}{8}$

Q.17 A uniform ladder of length L and mass m rests at 60° to the horizontal against a smooth vertical wall. Its base is on a rough horizontal floor with coefficient of static friction $\frac{1}{2\sqrt{3}}$. A person of mass $2m$ climbs slowly. A horizontal rope attached to the top of the ladder pulls it toward the wall with constant tension $mg/4$. What is the greatest distance the person can climb, measured along the ladder from its base, before slipping begins?

(1) $\frac{3L}{4}$ (2) $\frac{L}{2}$

(3) $\frac{L}{4}$ (4) L

Q.18 A uniform rod has mass m and length L. A point mass m is attached at one end. The assembly can rotate in its plane about a fixed frictionless axis through the rod's centre. Starting from rest, a tangential impulse J is applied at the other end. The angular speed immediately afterwards is:

(1) $\frac{3J}{2mL}$ (2) $\frac{3J}{mL}$

(3) $\frac{6J}{mL}$ (4) $\frac{J}{mL}$

Q.19 A uniform solid cylinder of radius R rolls without slipping from rest down a fixed incline of angle 30°. It has travelled a distance $R/2$ along the incline. At that instant P is the material point on the rim in contact with the incline, and Q is the diametrically opposite rim point. Neglect resistance to rolling. The magnitudes of their accelerations relative to the ground, a_P and a_Q, are respectively (include both tangential and centripetal accelerations relative to the centre):

(1) $\frac{g}{3}$ and $\frac{2g}{3}$ (2) $\frac{g}{6}$ and $\frac{\sqrt{5}\,g}{6}$

(3) $\frac{g}{3}$ and $\frac{\sqrt{5}\,g}{3}$ (4) 0 and $\frac{2g}{3}$

Q.20 A flywheel starts at angular speed $20\,\mathrm{rad\,s^{-1}}$. A constant torque accelerates it to $60\,\mathrm{rad\,s^{-1}}$ in $10\,\mathrm{s}$. The same-magnitude torque is then reversed and maintained until the wheel first stops. The ratio of angular displacements during the second and first stages is:

(1) $\frac{3}{2}$ (2) $\frac{9}{8}$

(3) $\frac{9}{4}$ (4) $\frac{3}{4}$

Q.21 Two point masses m and $2m$ are fixed at the ends of a massless rod of length L. The ratio of the moment of inertia about an axis perpendicular to the rod through its centre of mass to that about a parallel axis through its midpoint is:

(1) $\frac{2}{3}$ (2) $\frac{3}{4}$

(3) $\frac{8}{9}$ (4) $\frac{9}{8}$

Q.22 A horizontal uniform disc of mass M and radius R rotates freely about a fixed vertical central axle with angular speed ω. A small lump of putty of mass $M/2$ is dropped with zero horizontal velocity onto the rim and sticks. The fraction of the initial rotational kinetic energy lost is:

(1) $\frac{1}{4}$ (2) $\frac{1}{2}$

(3) $\frac{3}{4}$ (4) $\frac{2}{3}$

Q.23 A uniform solid cylinder rolls without slipping from rest down an incline of angle 30°. The minimum coefficient of static friction needed to maintain pure rolling and the fraction of its total kinetic energy that is rotational are respectively:

(1) $\frac{1}{2\sqrt{3}}$, $\frac{1}{3}$ (2) $\frac{1}{\sqrt{3}}$, $\frac{1}{2}$

(3) $\frac{1}{3\sqrt{3}}$, $\frac{2}{3}$ (4) $\frac{1}{3\sqrt{3}}$, $\frac{1}{3}$

Q.24 Two plane electromagnetic waves in vacuum propagate along $+x$ and $-x$ respectively. At a specified point and instant, their electric fields are $60\,\hat{y}\ \mathrm{V\,m^{-1}}$ and $20\,\hat{y}\ \mathrm{V\,m^{-1}}$. Superpose their fields at that instant. Let u be the total electromagnetic energy density and S the magnitude of the net energy flux. Use $u_E = \varepsilon_0 E^2/2$, $u_B = B^2/(2\mu_0)$, $S = |\vec{E}\times\vec{B}|/\mu_0$ and $\mu_0\varepsilon_0 c^2 = 1$. The ratios u_E/u_B and $S/(cu)$ are:

(1) $\frac{1}{4}$ and $\frac{4}{5}$ (2) 4 and 1

(3) 1 and 1 (4) 4 and $\frac{4}{5}$

Q.25 An ideal capacitor consists of two parallel annular plates, each with inner radius a and outer radius $2a$, separated by d. The voltage rises at a constant rate $k = dV/dt$. Neglect fringing: the electric field is uniform and equals V/d only over the annular plate area, and is zero in the central hole and outside the outer edge. For circular paths centred on the common axis between the plate planes, let B_1 and B_2 be the magnetic-field magnitudes at radii $3a/2$ and $3a$. With $\mu_0\varepsilon_0 = 1/c^2$, which pair gives B_1 and B_1/B_2?

(1) $\frac{ak}{2c^2d}$ and 1

(2) $\frac{5ak}{12c^2d}$ and $\frac{6}{5}$

(3) $\frac{ak}{4c^2d}$ and $\frac{1}{2}$

(4) $\frac{5ak}{12c^2d}$ and $\frac{5}{6}$

Q.26 A point transmitter radiates uniformly in all directions with constant power 4π kW. A small flat plate of area $0.20\,\mathrm{m}^2$ is held $10\,\mathrm{m}$ away for $1000\,\mathrm{s}$, with its normal at 60° to the incoming ray direction. The plate absorbs 75% of the energy incident on it and reflects the remainder specularly. Ignore diffraction and recoil during exposure. For radiation of energy U use momentum magnitude U/c, with $c = 3\times10^8\,\mathrm{m\,s^{-1}}$. The absorbed energy and the magnitude of the total impulse normal to the plate are:

(1) $750\,\mathrm{J}$ and $\frac{10}{3}\,\mu\mathrm{N\,s}$

(2) $750\,\mathrm{J}$ and $\frac{25}{12}\,\mu\mathrm{N\,s}$

(3) $1000\,\mathrm{J}$ and $\frac{25}{12}\,\mu\mathrm{N\,s}$

(4) $1500\,\mathrm{J}$ and $\frac{25}{6}\,\mu\mathrm{N\,s}$

Q.27 From A to B, a circuit segment contains a $4\,\Omega$ resistor followed by an ideal $2\,\mathrm{H}$ inductor. Current flows from A to B and at an instant is $3\,\mathrm{A}$, decreasing at $5\,\mathrm{A\,s^{-1}}$. At that instant $V_A - V_B$ equals:

(1) $-2\,\mathrm{V}$ (2) $2\,\mathrm{V}$ (3) $-22\,\mathrm{V}$ (4) $22\,\mathrm{V}$

Q.28 The externally imposed magnetic flux through a one-turn loop is $\Phi(t) = (t^2 - 4t)$ Wb for $0 \le t \le 4\,\mathrm{s}$. The loop has resistance $2\,\Omega$ and negligible self-inductance. The net signed charge transported in a chosen direction and the total Joule heat generated over this interval are respectively:

(1) $0\,\mathrm{C}$ and $\frac{32}{3}\,\mathrm{J}$

(2) $8\,\mathrm{C}$ and $0\,\mathrm{J}$

(3) $0\,\mathrm{C}$ and $\frac{16}{3}\,\mathrm{J}$

(4) $4\,\mathrm{C}$ and $\frac{32}{3}\,\mathrm{J}$

Q.29 A single-turn square conducting loop of side a and resistance R rotates at constant angular speed ω through 180° about a central axis lying in its plane, in a uniform magnetic field B. Its normal is initially parallel to B. Self-inductance is negligible. Let Q_{abs} be the time integral of the magnitude of current over the half-turn, and H the Joule heat. The ratio H/Q_{abs} is:

(1) $\frac{\pi Ba^2\omega}{4}$

(2) $\frac{Ba^2\omega}{2}$

(3) $\frac{\pi Ba^2\omega}{2}$

(4) $\frac{Ba^2\omega}{\pi}$

Q.30 A generator coil has 100 turns, area $0.010\,\mathrm{m}^2$ and resistance $5\,\Omega$. It rotates uniformly at $20\,\mathrm{rad\,s^{-1}}$ in a $0.50\,\mathrm{T}$ field, with its normal initially parallel to the field. Neglect self-inductance. During the first quarter-turn, the average induced-current magnitude is:

(1) $2\,\mathrm{A}$

(2) $\frac{2}{\pi}\,\mathrm{A}$

(3) $\frac{4}{\pi}\,\mathrm{A}$

(4) $\frac{\pi}{4}\,\mathrm{A}$

Q.31 Two fixed coupled coils have $L_1 = 4\,\text{mH}$, $L_2 = 9\,\text{mH}$ and mutual inductance $M = 3\,\text{mH}$. Choose current directions so that flux linkages are $\lambda_1 = L_1 I_1 + M I_2$ and $\lambda_2 = M I_1 + L_2 I_2$. Use passive coil voltages $v_j = d\lambda_j/dt$ and $dU/dt = v_1 I_1 + v_2 I_2$; neglect resistance. At an instant $I_1 = 2\,\text{A}$, $I_2 = 1\,\text{A}$ and $dI_1/dt = 1000\,\text{A s}^{-1}$. The source driving coil 2 adjusts dI_2/dt so the induced emf in coil 1 is zero. The value of dI_2/dt and the rate of change of total stored magnetic energy are respectively:

(1) $+\frac{4000}{3}\,\text{A s}^{-1}$ and $+15\,\text{W}$

(2) $-\frac{4000}{3}\,\text{A s}^{-1}$ and $+9\,\text{W}$

(3) $-750\,\text{A s}^{-1}$ and $-3.75\,\text{W}$

(4) $-\frac{4000}{3}\,\text{A s}^{-1}$ and $-9\,\text{W}$

Q.32 A conducting rod of length l and mass m slides down frictionless vertical rails in a uniform magnetic field B perpendicular to the rail plane. The rails are joined at their top through resistance R; rail and rod resistances and self-inductance are negligible. At terminal speed, the rod's kinetic energy is:

(1) $\frac{mgR}{B^2 l^2}$

(2) $\frac{m^3 g^2 R^2}{B^4 l^4}$

(3) $\frac{m^2 gR}{2B^2 l^2}$

(4) $\frac{m^3 g^2 R^2}{2B^4 l^4}$

Q.33 Two stationary coaxial coils face each other. Coil 1 is connected to a variable-current source; coil 2 is a closed resistive loop. Viewed from the same side, current in coil 1 is clockwise and decreasing. Neglect coil 2 self-inductance. Which statement is correct?

(1) The induced current in coil 2 is clockwise, and the coils repel.

(2) No current is induced because neither coil moves.

(3) The induced current in coil 2 is clockwise, and the coils attract.

(4) The induced current in coil 2 is anticlockwise, and the coils repel.

Q.34 At frequency f, a series RLC circuit has $R = 20\,\Omega$, $X_L = 45\,\Omega$ and $X_C = 25\,\Omega$. The same rms voltage is applied after the frequency is doubled. The ratio of average powers $P(2f)/P(f)$ is:

(1) $\frac{1}{4}$

(2) $\frac{16}{65}$

(3) $\frac{128}{1025}$

(4) $\frac{32}{257}$

Q.35 An ideal capacitor C and an ideal inductor L form separate parallel branches across a sinusoidal source of rms voltage V and angular frequency ω. Initially their rms branch currents are equal to I_0, so the net source current is zero. The source voltage is then halved and frequency doubled, with L and C unchanged. The new source-current magnitude, its phase relative to voltage and the total average power are:

(1) $\frac{I_0}{4}$, lagging by $\frac{\pi}{2}$, zero

(2) $\frac{5I_0}{4}$, leading by $\frac{\pi}{2}$, nonzero

(3) $\frac{3I_0}{4}$, lagging by $\frac{\pi}{2}$, zero

(4) $\frac{3I_0}{4}$, leading by $\frac{\pi}{2}$, zero

Q.36 An ideal transformer has primary-to-secondary turn ratio $10:1$. Its primary is connected to $240\,\text{V}$ rms. Two identical resistive lamps, each rated $12\,\text{V}$, $24\,\text{W}$, are connected in series across the secondary. Treat each lamp resistance as its rated resistance. The primary rms current is:

(1) $2.0\,\text{A}$ (2) $0.20\,\text{A}$ (3) $4.0\,\text{A}$ (4) $0.10\,\text{A}$

Q.37 At resonance a series RLC circuit has rms source voltage $100\,\text{V}$, resistance $20\,\Omega$ and inductance $0.20\,\text{H}$. Its angular resonance frequency is $100\,\text{rad s}^{-1}$. The maximum energy in the capacitor and the average power supplied are:

(1) $5\,\text{J}$ and $1000\,\text{W}$

(2) $10\,\text{J}$ and $500\,\text{W}$

(3) $5\,\text{J}$ and $500\,\text{W}$

(4) $2.5\,\text{J}$ and $500\,\text{W}$

Q.38 A fixed series RLC circuit, with finite R and ideal L and C, carries equal rms currents at angular frequencies $100\,\text{rad s}^{-1}$ and $400\,\text{rad s}^{-1}$ when driven by the same rms voltage. The two frequencies lie on opposite sides of resonance. Its resonance angular frequency is:
(1) $150\,\text{rad s}^{-1}$ (2) $250\,\text{rad s}^{-1}$ (3) $300\,\text{rad s}^{-1}$ (4) $200\,\text{rad s}^{-1}$

Q.39 Two branches are connected in parallel to a sinusoidal source of fixed rms voltage V. One branch contains resistance R in series with an ideal inductor; the other contains an equal resistance R in series with an ideal capacitor. At angular frequency ω their reactance magnitudes both equal R. The frequency is doubled. The ratio of the new source-current magnitude to the new current magnitude in the inductive branch, and the new source power factor, are:

(1) 1 and 1 (2) $\sqrt{5}$ and $\frac{1}{\sqrt{5}}$

(3) $\sqrt{5}$ and 1 (4) 2 and $\frac{1}{\sqrt{5}}$

Q.40 A parallel-plate capacitor of area A and separation d is filled over its full area by three layers in series along the field: thickness $d/4$ with dielectric constant 2, thickness $d/2$ with dielectric constant 4, and the remaining thickness with air. Let $C_0 = \varepsilon_0 A/d$. When connected to a battery V, its capacitance and the potential difference across the air layer are:

(1) $2C_0$ and $\frac{V}{4}$ (2) $\frac{8}{3}C_0$ and $\frac{V}{2}$

(3) $2C_0$ and $\frac{V}{2}$ (4) $4C_0$ and $\frac{V}{4}$

Q.41 An air capacitor initially has capacitance C and is connected to an ideal battery V. Its plate separation is slowly halved while it remains connected. Ignoring edge effects, the energy supplied by the battery and the work done by the external agent are respectively:

(1) CV^2 and $-\frac{CV^2}{2}$ (2) CV^2 and $+\frac{CV^2}{2}$

(3) $2CV^2$ and $-CV^2$ (4) $\frac{CV^2}{2}$ and $-\frac{CV^2}{2}$

Q.42 A $6\,\mu\text{F}$ capacitor is charged to $10\,\text{V}$ and disconnected from the battery. A dielectric of relative permittivity 3 completely fills its gap. The final stored energy and the work done by the electric field while drawing in the dielectric are respectively:
(1) $300\,\mu\text{J}$ and $200\,\mu\text{J}$ (2) $100\,\mu\text{J}$ and $-200\,\mu\text{J}$
(3) $100\,\mu\text{J}$ and $200\,\mu\text{J}$ (4) $900\,\mu\text{J}$ and $-600\,\mu\text{J}$

Q.43 Four capacitors form two branches A–X–B and A–Y–B. Their capacitances are $AX = C$, $XB = 2C$, $AY = 2C$ and $YB = C$. A fifth capacitor of capacitance C joins X to Y. All are initially uncharged. A battery sets $V_A = V$ and $V_B = 0$. The charge magnitude on the capacitor joining X and Y is:

(1) $\frac{CV}{3}$ (2) $\frac{CV}{5}$

(3) zero (4) $\frac{CV}{2}$

Q.44 An ideal $12\,\text{V}$ battery is connected across A and B. A resistive branch A–X–B has resistors $2\,\Omega$ and $4\,\Omega$ respectively. Another branch A–Y–B has resistors $3\,\Omega$ and $3\,\Omega$. A $3\,\mu\text{F}$ capacitor connects X to Y. After a long time, the capacitor charge magnitude and battery current are:
(1) zero and $4\,\text{A}$ (2) $6\,\mu\text{C}$ and $2\,\text{A}$ (3) $18\,\mu\text{C}$ and $4\,\text{A}$ (4) $6\,\mu\text{C}$ and $4\,\text{A}$

Q.45 Capacitors C and $2C$ are initially charged to V and $V/2$ respectively. Their positive plates are then connected together and their negative plates connected together through wires of small nonzero resistance. After equilibrium, the common voltage and energy dissipated are:

(1) $\frac{2V}{3}$ and $\frac{CV^2}{12}$ (2) $\frac{3V}{4}$ and $\frac{CV^2}{12}$

(3) $\frac{2V}{3}$ and $\frac{CV^2}{6}$ (4) $\frac{V}{2}$ and $\frac{CV^2}{4}$

CHEMISTRY

Q. 46–90 • 45 Questions • 180 Marks

Q.46 One mole of a monatomic ideal gas initially at (T, V) reaches $(2T, 2V)$ by either route A or B. A: thermally isolated free expansion into vacuum to $2V$, followed by heating at constant volume to $2T$. B: reversible isothermal expansion at T to $2V$ (heat drawn reversibly from a reservoir at T), followed by the same constant-volume heating. In both heating steps a single reservoir at $2T$ supplies heat. Use $\Delta S_{\text{gas}} = C_V \ln(T_f/T_i) + R \ln(V_f/V_i)$, $C_V = 3R/2$, and the chemistry sign convention. Which statement is correct?

(1) $w_A - w_B = RT \ln 2$, but entropy production is larger along B.

(2) Entropy production along A exceeds that along B by $(R/2) \ln 2$.

(3) $\Delta S_{\text{gas}} = (5R/2) \ln 2$ along both routes, and entropy production along A exceeds that along B by $R \ln 2$.

(4) $q_A = q_B$ because their endpoint temperatures are equal.

Q.47 Two moles of ideal gas undergo reversible isothermal expansion at $300\,\text{K}$ from $8\,\text{bar}$ to $2\,\text{bar}$, followed by isothermal compression against constant external pressure $8\,\text{bar}$ back to the initial volume. For the complete cycle, (net w, net q), in units of RT, is:

(1) $(0,\ 0)$ (2) $(+6 - 2\ln 4,\ -6 + 2\ln 4)$

(3) $(+6 + 2\ln 4,\ -6 - 2\ln 4)$ (4) $(-2\ln 4,\ +2\ln 4)$

Q.48 At a fixed temperature, consider ideal gases and dimensionless equilibrium constants with consistent standard states: (I) $\text{A(g)} \rightleftharpoons 2\,\text{B(g)}$, $K_1 = 16$, $\Delta H_1 = +80\,\text{kJ mol}^{-1}$; (II) $\text{C(g)} \rightleftharpoons \text{B(g)}$, $K_2 = 4$, $\Delta H_2 = -20\,\text{kJ mol}^{-1}$. For $\text{A(g)} \rightleftharpoons 2\,\text{C(g)}$, choose the correct conclusion. Assume these enthalpies remain constant over a small temperature interval.

(1) $K = 4$; $\Delta H^\circ = +60\,\text{kJ mol}^{-1}$; ΔS° is necessarily negative.

(2) $K = 1$; $\Delta H^\circ = +120\,\text{kJ mol}^{-1}$; at the stated temperature ΔS° is positive, and K increases on heating.

(3) $K = 1$; $\Delta H^\circ = +40\,\text{kJ mol}^{-1}$; $\Delta S^\circ = 0$ because $K = 1$.

(4) $K = 256$; $\Delta H^\circ = +120\,\text{kJ mol}^{-1}$; K decreases on heating.

Q.49 One mole of a monatomic ideal gas is heated from $300\,\text{K}$ to $600\,\text{K}$ at constant volume, then cooled to $300\,\text{K}$ at constant pressure. If only pressure–volume work occurs, the net heat transferred to the gas is (R in $\text{J K}^{-1}\,\text{mol}^{-1}$):

(1) $+300R\,\text{J}$ (2) $-750R\,\text{J}$ (3) $-300R\,\text{J}$ (4) $+450R\,\text{J}$

Q.50 For $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$ at $300\,\text{K}$, equilibrium concentrations are 0.20, 0.30, 1.00 and $0.60\,\text{mol L}^{-1}$ respectively. A different mixture at the same temperature has reaction quotient $Q = 100$. Which pair gives $(\Delta G^\circ, \Delta G)$ for the forward reaction? Take $RT \ln 10 = 5.74\,\text{kJ mol}^{-1}$.

(1) $(-5.74,\ +5.74)\,\text{kJ mol}^{-1}$ (2) $(+5.74,\ +11.48)\,\text{kJ mol}^{-1}$

(3) $(0,\ +5.74)\,\text{kJ mol}^{-1}$ (4) $(-5.74,\ -5.74)\,\text{kJ mol}^{-1}$

Q.51 A closed cylinder contains one mole of monatomic ideal gas at (P, V, T). Step I: it expands against constant external pressure $P/2$ until mechanical equilibrium, while absorbing heat $q_{\text{I}} = PV/4$. Step II: at the final volume its temperature is restored to T. Neglect piston kinetic energy and use $U = 3RT/2$. Which pair gives the final volume after step I and the net heat supplied over both steps?

(1) $(9V/5,\ 2PV/5)$ (2) $(3V/2,\ PV/4)$ (3) $(2V,\ PV/2)$ (4) $(7V/5,\ PV/5)$

Q.52 At $300\,\text{K}$, $\Delta_c H^\circ$ values for C(graphite), $\text{H}_2\text{(g)}$ and $\text{CH}_4\text{(g)}$ are -394, -286 and $-890\,\text{kJ mol}^{-1}$ respectively, with water liquid in each combustion. For $\text{C(graphite)} + 2\,\text{H}_2\text{(g)} \longrightarrow \text{CH}_4\text{(g)}$, the pair $(\Delta_f H^\circ, \Delta_f U^\circ)$ is approximately:

(1) $(+76,\ +73.5)\,\text{kJ mol}^{-1}$ (2) $(-76,\ -78.5)\,\text{kJ mol}^{-1}$

(3) $(-76,\ -73.5)\,\text{kJ mol}^{-1}$ (4) $(-210,\ -207.5)\,\text{kJ mol}^{-1}$

Q.53 For $\mathrm{A(g)} \rightleftharpoons 2\,\mathrm{B(g)}$, $\Delta H^\circ = +60\,\mathrm{kJ\,mol^{-1}}$ and $\Delta S^\circ = +150\,\mathrm{J\,K^{-1}\,mol^{-1}}$, treated as temperature independent. At $400\,\mathrm{K}$, an equilibrium mixture has partial pressures $p_A = 1\,\mathrm{bar}$ and $p_B = 1\,\mathrm{bar}$ (standard pressure $1\,\mathrm{bar}$). The volume is suddenly doubled at $400\,\mathrm{K}$, and before reaction occurs the temperature is raised to $500\,\mathrm{K}$ at the new fixed volume. Which is correct immediately after both changes? Use $R = 8.314\,\mathrm{J\,mol^{-1}\,K^{-1}}$.

(1) $Q_p = 5/8$ and $\Delta_r G$ is negative.

(2) Q_p remains 1 because the mole fractions have not changed.

(3) $Q_p = 1/2$ and the reaction proceeds backward.

(4) $Q_p = 5/4$ and $\Delta_r G$ is positive.

Q.54 Using average bond enthalpies H—H $= 436$, Cl—Cl $= 242$ and H—Cl $= 431\,\mathrm{kJ\,mol^{-1}}$, estimate the enthalpy change when $0.50\,\mathrm{mol}$ H_2 reacts completely with $0.50\,\mathrm{mol}$ Cl_2 to form gaseous HCl. Which statement also correctly describes the method?

(1) $-184\,\mathrm{kJ}$; average bond enthalpies are exact for every molecule.

(2) $+92\,\mathrm{kJ}$; bond formation absorbs energy.

(3) $-215.5\,\mathrm{kJ}$; only the bonds formed enter the calculation.

(4) $-92\,\mathrm{kJ}$; it is a bond-enthalpy estimate for gas-phase species.

Q.55 An equimolar mixture of H_2SO_4, $H_2S_2O_7$ and $H_2S_2O_8$ contains $0.10\,\mathrm{mol}$ of each acid. Use their NCERT structures. Which ordered triple is correct: (moles of OH^- needed for complete neutralisation; total moles of O–O bonds; total moles of electrons accepted if every sulphur atom is converted to oxidation state $+4$, with no other reduction process counted)?

(1) $(0.60,\ 0.10,\ 1.00)$ (2) $(0.60,\ 0.10,\ 1.20)$

(3) $(0.60,\ 0.20,\ 1.20)$ (4) $(1.00,\ 0.10,\ 1.00)$

Q.56 Three gaseous group-16 hydrides X, Y and Z are selected from H_2S, H_2Se and H_2Te. X is the strongest acid; Y requires the greatest energy to break an E–H bond; Z is the remaining hydride. Which set of statements is correct?

A. Their boiling points increase as Y < Z < X.

B. Their thermal stabilities increase as X < Z < Y.

C. Their reducing strengths increase as Y < Z < X.

D. Adding H_2O to the set preserves the rule that the heaviest hydride has the highest boiling point.

(1) A, B and C only (2) A and B only (3) B, C and D only (4) A and D only

Q.57 A mixture contains $0.10\,\mathrm{mol}$ H_3PO_2, $0.20\,\mathrm{mol}$ H_3PO_3 and $0.10\,\mathrm{mol}$ H_3PO_4. Complete neutralisation of all ionisable hydrogen atoms requires how many moles of NaOH? If every phosphorus atom is then oxidised to $+5$, how many moles of electrons are released in total?

(1) $0.60\,\mathrm{mol}$ NaOH; $1.20\,\mathrm{mol}$ electrons (2) $1.20\,\mathrm{mol}$ NaOH; $0.80\,\mathrm{mol}$ electrons

(3) $0.80\,\mathrm{mol}$ NaOH; $0.80\,\mathrm{mol}$ electrons (4) $0.80\,\mathrm{mol}$ NaOH; $0.40\,\mathrm{mol}$ electrons

Q.58 Equal $0.30\,\mathrm{mol}$ samples of Cl_2 react completely with excess NaOH, one cold and dilute and the other hot and concentrated. What are the moles of chloride ion formed in the two reactions respectively, and what fraction of chlorine atoms is oxidised in the hot reaction?

(1) $0.30\,\mathrm{mol}$, $0.50\,\mathrm{mol}$; $1/3$ (2) $0.50\,\mathrm{mol}$, $0.30\,\mathrm{mol}$; $1/6$

(3) $0.30\,\mathrm{mol}$, $0.30\,\mathrm{mol}$; $1/2$ (4) $0.30\,\mathrm{mol}$, $0.50\,\mathrm{mol}$; $1/6$

Q.59 Complete hydrolysis of $0.10\,\mathrm{mol}$ PCl_5 is followed by complete neutralisation of all resulting acids with NaOH. The NaOH requirement and number of axial P–Cl bonds per isolated gaseous PCl_5 molecule are, respectively:

(1) $0.60\,\mathrm{mol}$ and 2 (2) $0.80\,\mathrm{mol}$ and 2 (3) $0.50\,\mathrm{mol}$ and 2 (4) $0.80\,\mathrm{mol}$ and 3

Q.60 A $0.10\,\mathrm{mol}$ sample of an oxyacid of phosphorus contains, per molecule, two P–H bonds and one P–OH bond. It is completely oxidised to H_3PO_4 by an oxidant that accepts two electrons per formula unit. The product is then completely neutralised. Choose the correct triple: (moles of oxidant consumed; increase in moles of NaOH required relative to complete neutralisation of the original acid; change in phosphorus oxidation state).

(1) $(0.40,\ 0.20,\ +1 \to +5)$ (2) $(0.10,\ 0.20,\ +3 \to +5)$

(3) $(0.20,\ 0.20,\ +1 \to +5)$ (4) $(0.20,\ 0.10,\ +1 \to +3)$

Q.61 One mole of ozone is passed into excess acidified KI, and the liberated iodine is completely titrated with thiosulphate. The moles of $S_2O_3^{2-}$ required and the change in oxidation state of each iodide ion during iodine liberation are:
(1) 3 mol; -1 to 0 (2) 1 mol; -1 to $+1$ (3) 2 mol; -1 to 0 (4) 2 mol; -1 to $+1$

Q.62 A mixture containing a mol XeF_4 and b mol XeF_6 is completely hydrolysed. Use $6\,XeF_4 + 12\,H_2O \longrightarrow 4\,Xe + 2\,XeO_3 + 24\,HF + 3\,O_2$ and $XeF_6 + 3\,H_2O \longrightarrow XeO_3 + 6\,HF$. The products contain 0.20 mol XeO_3 and 1.80 mol HF. Which conclusion is correct?
(1) $a = 0.20$, $b = 0.20$; 0.10 mol O_2 forms.
(2) $a = 0.30$, $b = 0.10$; 0.15 mol O_2 forms, and one-third of the original XeF_4 xenon atoms are oxidised.
(3) $a = 0.30$, $b = 0.10$; 0.15 mol O_2 forms, and two-thirds of the original XeF_4 xenon atoms are oxidised.
(4) $a = 0.15$, $b = 0.15$; 0.075 mol O_2 forms.

Q.63 Which set correctly pairs each species with its shape and the number of lone pairs on the central atom, using the NCERT VSEPR treatment?
(1) ClF_3: trigonal planar, 2; XeF_2: linear, 3; XeF_4: square planar, 2
(2) ClF_3: T-shaped, 2; XeF_2: linear, 3; XeF_4: square planar, 2
(3) ClF_3: T-shaped, 1; XeF_2: bent, 2; XeF_4: tetrahedral, 0
(4) ClF_3: T-shaped, 2; XeF_2: linear, 2; XeF_4: square planar, 3

Q.64 Mix 50.0 mL of 0.10 M sodium acetate with 50.0 mL of 0.010 M acetic acid ($pK_a = 4.57$). Add x mmol HCl without appreciable volume change so that the resulting pH is 4.57. Divide this solution into two equal portions. To one portion add 0.50 mmol NaOH; dilute the other portion tenfold with water. Use the Henderson–Hasselbalch buffer approximation with stoichiometric acid/salt amounts, neglecting further acid dissociation, water ionisation and activity changes. Which pair gives the approximate final pH values (NaOH-treated portion; diluted portion)? Use $\log(15/7) = 0.331$.
(1) $(4.72;\ 5.57)$ (2) $(4.90;\ 4.57)$ (3) $(4.90;\ 5.57)$ (4) $(4.24;\ 4.57)$

Q.65 For $CO_2(g) + C(s) \rightleftharpoons 2\,CO(g)$, $K_p = 4.0$ at 1000 K, using pressures numerically in bar. At equilibrium, $p_{CO_2} = 1.0$ bar. Taking $R = 0.083$ L bar mol^{-1} K^{-1}, which pair (p_{CO}, K_c) is correct in the corresponding conventional units?
(1) $(4.0\,\text{bar},\ 4/83)$ (2) $(2.0\,\text{bar},\ 4)$
(3) $(2.0\,\text{bar},\ 4/83)$ (4) $(2.0\,\text{bar},\ 332)$

Q.66 An ideal-gas equilibrium $3\,O_2(g) \rightleftharpoons 2\,O_3(g)$ is established in a cylinder at fixed temperature. Operation I suddenly halves the volume. After equilibrium is restored, operation II introduces an inert gas while holding total pressure constant until the volume doubles. At the instant after each operation, before the reaction can respond, what are Q_c/K_c and the ensuing directions?
(1) I: 2, forward; II: 1/2, backward. (2) I: 2, backward; II: 1/2, forward.
(3) I: 1/2, forward; II: 2, backward. (4) I: 1/2, forward; II: 1, no shift.

Q.67 At a certain temperature, $2\,A(g) \rightleftharpoons B(g) + C(g)$ has $K_c = 0.040$. A mixture initially has $[A] = [B] = [C] = 0.10$ M. Which operation, applied instantaneously before reaction, makes Q_c equal to K_c? Assume fixed temperature.
(1) Add A to make $[A] = 0.50$ M while leaving [B] and [C] unchanged.
(2) Compress to one-fifth of the original volume.
(3) Double the volume.
(4) Remove half of B while leaving A and C unchanged.

Q.68 For $N_2(g) + O_2(g) \rightleftharpoons 2\,NO(g)$, equilibrium concentrations at a fixed temperature are 0.0030, 0.0040 and $0.0020\,M$. Pure NO is placed in a second vessel at the same temperature. Its equilibrium degree of dissociation into N_2 and O_2 is:
(1) $1/3$ (2) $1/(1+2\sqrt{3})$ (3) $2\sqrt{3}/(1+2\sqrt{3})$ (4) $\sqrt{3}/(1+\sqrt{3})$

Q.69 Two ideal-gas equilibrium mixtures at the same temperature involve the reactions I: $A(g) \rightleftharpoons 2\,B(g)$ and II: $C(g) + D(g) \rightleftharpoons 2\,E(g)$. Initially each has $Q_p = K_p$. In I the volume is doubled. In II an inert gas is added at constant total pressure until the volume is doubled. Then, before chemical change, half the moles of B are removed from I and half the moles of E from II, with each final volume held fixed. Which pair $(Q_{\mathrm{I}}/K_{\mathrm{I}},\ Q_{\mathrm{II}}/K_{\mathrm{II}})$ is correct? All Q and K in the options are pressure based.
(1) $(1/2,\ 1)$ (2) $(1/8,\ 1/8)$ (3) $(1/4,\ 1/4)$ (4) $(1/8,\ 1/4)$

Q.70 For a triprotic acid H_3A, $K_{a1} = 10^{-2}$, $K_{a2} = 10^{-7}$ and $K_{a3} = 10^{-12}$. At a pH maintained at 7.00, which ratio $[H_2A^-] : [HA^{2-}] : [A^{3-}]$ is correct?
(1) $1 : 10^5 : 1$ (2) $10^{-5} : 1 : 1$ (3) $1 : 1 : 10^{-5}$ (4) $1 : 10^{-5} : 10^{-10}$

Q.71 A solution contains $0.010\,M$ each of M^{2+} and N^{2+}. Their hydroxides have K_{sp} values 4.0×10^{-18} and 1.0×10^{-12} respectively. As OH^- is slowly added with negligible volume change, which hydroxide precipitates first, and what fraction of the original M^{2+} remains dissolved just as $N(OH)_2$ starts precipitating?
(1) $M(OH)_2$; 4.0×10^{-6} (2) $N(OH)_2$; 4.0×10^{-6}
(3) $N(OH)_2$; 4.0×10^{-4} (4) $M(OH)_2$; 4.0×10^{-8}

Q.72 Equal volumes of $0.020\,M$ weak acid HA and $0.010\,M$ NaOH are mixed. $K_a(HA) = 1.0 \times 10^{-5}$. A sparingly soluble salt $M(OH)_2$ is then introduced into this buffer. Assume dissolution does not appreciably change the buffer composition, $K_w = 10^{-14}$, and $K_{sp}[M(OH)_2] = 4.0 \times 10^{-24}$. Which pair gives the equilibrium pH and molar solubility of $M(OH)_2$? Neglect metal hydrolysis.
(1) $(5.00,\ 4.0\,M)$ (2) $(5.00,\ 4.0 \times 10^{-9}\,M)$
(3) $(9.00,\ 4.0 \times 10^{-8}\,M)$ (4) $(5.00,\ 4.0 \times 10^{-6}\,M)$

Q.73 Consider heterolytic cleavage of the indicated C–Br bond in (i) $(CH_3)_3C-Br$, (ii) $(CH_3)_2CH-Br$ and (iii) $CH_2=CH-CH_2-Br$, with bromine taking the bonding electron pair. Evaluate:
A. The directly formed carbon cations have respectively 9, 6 and 2 adjacent C–H bonds on sp^3 carbons available for ordinary alkyl hyperconjugation.
B. The cation from (iii) has resonance contributors with the positive charge on either terminal carbon.
C. The directly formed cation from (i) has an empty p orbital.
D. Cleavage transfers one electron to each fragment.
Which statements are correct?
(1) C and D only (2) A and B only (3) A, B and C only (4) B and C only

Q.74 A solid mixture contains naphthalene and sodium chloride. Which procedure gives the most direct separation, and what statement about the recovered naphthalene is correct?
(1) Steam distillation; sodium chloride must also vaporise.
(2) Sublimation; its molecular identity is unchanged by the phase transitions.
(3) Crystallisation from water; both components dissolve equally well.
(4) Simple distillation; naphthalene is converted into a new compound.

Q.75 An organic liquid X, molar mass $180\,g\,mol^{-1}$, is immiscible with water and steam distilled. At the boiling temperature, vapour pressures of water and X are 600 and $150\,mmHg$ respectively, whose sum equals the external pressure. What mass of water accompanies $18\,g$ of X in the distillate?
(1) $0.72\,g$ (2) $72\,g$ (3) $7.2\,g$ (4) $4.5\,g$

Q.76 Base removes an α-hydrogen from CH_3CHO, giving an anion represented by contributors I: $^{-}CH_2-CH=O$ and II: $CH_2=CH-O^{-}$. Which assessment is correct?
A. I and II are different compounds interconverting by motion of atoms.
B. The carbon skeleton and total electron count are identical in I and II.
C. II is favoured over I among these two contributors because both satisfy octets but II places negative charge on the more electronegative atom.
D. Protonation at the carbon bearing negative charge in I regenerates CH_3CHO, whereas protonation at oxygen in II gives a constitutional isomer of CH_3CHO.
(1) A, B and D only (2) A and C only (3) B and C only (4) B, C and D only

Q.77 In pyridine, replace one ring hydrogen by $-C(=O)NH_2$. The ring nitrogen is then protonated without changing the atom connectivity elsewhere. Count bonds by atomic connections (a double bond has one σ and one π bond). Use the usual neutral-amide Lewis structure for the $-C(=O)NH_2$ substituent, but evaluate all bonds and lone pairs after ring-nitrogen protonation; disregard alternative resonance drawings. Which ordered triple (σ bonds, π bonds, lone pairs) describes the resulting cation?
(1) $(15,\ 4,\ 4)$ (2) $(16,\ 3,\ 4)$ (3) $(15,\ 4,\ 3)$ (4) $(16,\ 4,\ 3)$

Q.78 A chemist must isolate (i) glycerol from spent lye without excessive heating, (ii) aniline from water, and (iii) close-boiling hydrocarbon fractions of petroleum. Which ordered set of techniques is appropriate?
(1) Reduced-pressure distillation; steam distillation; fractional distillation
(2) Simple distillation at high pressure; crystallisation; steam distillation
(3) Fractional distillation; reduced-pressure distillation; sublimation
(4) Steam distillation; sublimation; simple distillation

Q.79 Which statement is correct for 2,3-dichlorobutane? Assume ordinary configurations about the two stereogenic carbons.
(1) Its meso form and either chiral form are enantiomers.
(2) It has four configurational stereoisomers and all are optically active.
(3) Every molecule with two stereogenic carbons must be chiral.
(4) It has three configurational stereoisomers; one is meso and two form an enantiomeric pair.

Q.80 Let A = CH_3CH_2COOH, B = $ClCH_2CH_2COOH$ and C = $CH_3CHClCOOH$. Each is separately mixed with the same dilute solution of its own sodium salt in a 1:1 acid:salt mole ratio. Evaluate:
I. pH(C buffer) < pH(B buffer) < pH(A buffer).
II. The conjugate-base basicities increase as $C^{-} < B^{-} < A^{-}$.
III. Moving chlorine from the α to the β carbon increases the magnitude of its inductive effect at the carboxyl group.
IV. In a mixture of C and A^{-}, proton transfer toward C^{-} and A is favoured.
Which set is correct?
(1) I and II only (2) II and III only
(3) I, II and IV only (4) I, III and IV only

Q.81 An acyclic compound has formula C_5H_8O and contains exactly one carbonyl group and one C=C bond. Its IUPAC name has a five-carbon parent chain, its principal characteristic group is a ketone carbonyl with locant 2, and its C=C bond is conjugated with the C=O bond. Which structure satisfies all the constraints?
(1) $CH_3CH_2CH=CHCHO$ (2) $CH_2=C(CH_3)COCH_3$
(3) $CH_2=CHCH_2COCH_3$ (4) $CH_3COCH=CHCH_3$

Q.82 A mixture contains 0.20 mol of alkene A and 0.30 mol of alkene B, each with formula C_5H_{10}. Complete reductive ozonolysis produces 0.20 mol methanal, 0.20 mol 2-methylpropanal, 0.30 mol propanone and 0.30 mol ethanal, with no other organic products. Both alkenes hydrogenate to the same alkane. Which statement is correct?

(1) Neither A nor B shows geometrical isomerism; the common alkane gives four constitutional monochloro products.

(2) Neither A nor B shows geometrical isomerism; the common alkane gives five constitutional monochloro products.

(3) Only B shows geometrical isomerism; the common alkane gives four constitutional monochloro products.

(4) A and B each show geometrical isomerism; their common alkane gives three constitutional monochloro products.

Q.83 Three C_5H_{12} isomers A, B and C give respectively one, three and four constitutionally distinct monochloro derivatives. Which statement is correct?

(1) C is neopentane and has the lowest boiling point.

(2) B has the lowest boiling point; A is n-pentane.

(3) A has the lowest boiling point; B is n-pentane; C is 2-methylbutane.

(4) A has the highest boiling point; B is 2-methylbutane; C is n-pentane.

Q.84 A 0.30 mol mixture contains only cyclohexane, cyclohexene and benzene. Under conditions where only the alkene reacts, it consumes 0.10 mol Br_2. A separate identical sample consumes 0.25 mol H_2 on complete catalytic hydrogenation of both unsaturated components. Which statement is correct?

(1) The original mixture contains 0.05 mol benzene; cold dilute alkaline $KMnO_4$ oxidises both benzene and cyclohexene to the same diol.

(2) The original mixture contains 0.15 mol benzene; after hydrogenation it contains 0.20 mol cyclohexane.

(3) The original mixture contains 0.05 mol benzene; after hydrogenation it contains 0.30 mol cyclohexane, which has only one constitutional monochloro derivative.

(4) The original mixture contains 0.10 mol benzene; cyclohexane immediately decolourises bromine water in the dark.

Q.85 An alkane contains exactly one tertiary hydrogen and has molecular formula C_4H_{10}. According to the NCERT oxidation observation for alkanes containing a tertiary hydrogen, oxidation with $KMnO_4$ can give which alcohol without changing the carbon skeleton?

(1) 2-Methylpropan-1-ol (2) 2-Methylpropan-2-ol

(3) Butan-1-ol (4) Butan-2-ol

Q.86 Three C_6H_{14} isomers are P = n-hexane, Q = 2-methylpentane and R = 2,3-dimethylbutane. A student assigns each its number of constitutionally distinct monochlorination products (ignore stereoisomers), then orders their boiling points. Which combined assignment is correct?

(1) P: 3, Q: 4, R: 2; boiling points R > Q > P. (2) P: 3, Q: 5, R: 2; boiling points P > Q > R.

(3) P: 6, Q: 5, R: 3; boiling points P > Q > R. (4) P: 3, Q: 5, R: 2; boiling points Q > P > R.

Q.87 Propyne is treated separately with (i) one equivalent HBr without peroxide and (ii) excess HBr without peroxide. The principal products are respectively:

(1) 2-Bromoprop-1-ene and 2,2-dibromopropane (2) 1-Bromoprop-1-ene and 1,2-dibromopropane

(3) 1-Bromoprop-1-ene and 1,1-dibromopropane (4) 2-Bromoprop-1-ene and 1,2-dibromopropane

Q.88 An acyclic hydrocarbon X has formula C_6H_{10}. One mole of X consumes exactly 2 mol H_2 on complete hydrogenation. Reductive ozonolysis of one mole of X gives exactly 2 mol methanal and 1 mol $CH_3COCOCH_3$. Which statement about X is correct?

(1) X is $CH_2{=}CH{-}CH_2{-}CH_2{-}CH{=}CH_2$; its hydrogenation product gives three constitutional monochloro derivatives.

(2) X is an alkyne; it gives a precipitate with ammoniacal silver nitrate.

(3) X is $CH_2{=}C(CH_3){-}C(CH_3){=}CH_2$; it has one pair of geometrical isomers.

(4) X is $CH_2{=}C(CH_3){-}C(CH_3){=}CH_2$; it has no geometrical isomers, and its hydrogenation product gives two constitutional monochloro derivatives.

Q.89 A mixture of ethene and ethyne occupies $10.0\,\text{L}$ at fixed temperature and pressure. Complete hydrogenation requires $16.0\,\text{L}$ H_2 measured at the same conditions. If the same initial mixture is completely burnt, what volume of O_2 is required at those conditions?

(1) $27.0\,\text{L}$ (2) $24.0\,\text{L}$ (3) $32.0\,\text{L}$ (4) $30.0\,\text{L}$

Q.90 Choose the correct statements.

A. Benzene normally undergoes electrophilic substitution, preserving aromaticity in the final product.
B. Nitrobenzene is more reactive than benzene towards electrophilic substitution.
C. A methyl group directs subsequent electrophilic substitution mainly to ortho and para positions.
D. All six C–C bonds in benzene have identical bond length.

(1) A and B only (2) A, C and D only (3) B, C and D only (4) C and D only

BOTANY

Q. 91–135 • 45 Questions • 180 Marks

Q.91 A student sorts mustard, Gulmohar, Cassia, Datura and chilli first by floral symmetry and then asks whether symmetry alone establishes placentation. Which record is correct?

(1) The three actinomorphic flowers are mustard, Datura and chilli; all must have parietal placentation.

(2) The two zygomorphic flowers are Gulmohar and Datura; both must have marginal placentation.

(3) The two zygomorphic flowers are Gulmohar and Cassia; their symmetry alone does not establish placentation.

(4) The three actinomorphic flowers are mustard, Cassia and chilli; all must have axile placentation.

Q.92 Four plant structures are labelled by their origin: A, a thorn of *Bougainvillea*; B, a tendril of cucumber; C, a tendril of pea; D, a spine of *Opuntia*. Which pair shares shoot-bud origin, while the other pair represents leaf modifications?

(1) A and C; B and D (2) A and B; C and D (3) B and D; A and C (4) C and D; A and B

Q.93 Three flowers P, Q and R are recorded. P has a large posterior petal overlapping two lateral petals, which overlap two anterior petals, and stamens in a (9)+1 arrangement. Q has stamens attached to petals and an axile, multicarpellary syncarpous ovary. R has a monocarpellary ovary with ovules along its ventral suture. Consider:

A. P can be identified with the NCERT pea pattern.

B. R must have a free-central placenta because it has only one carpel.

C. P and R can share marginal placentation even though the information does not establish that R has the same androecium as P.

D. Q and P must have the same placentation because both show union of floral parts.

Which are justified?

(1) B and D only (2) A and C only (3) A and B only (4) A, C and D only

Q.94 Before dissection, ovary P has complete septa meeting a central ovule-bearing axis; ovary Q has a central ovule-bearing column but no septa; ovary R bears ovules on the inner ovary wall. A technician then removes all septa from P without moving its ovules. Which conclusion is correct?

(1) P and Q were both axile originally; the only distinction between them was carpel number.

(2) P was parietal and R axile; removing septa converts P into marginal placentation.

(3) After dissection P and Q are both botanically free-central because classification depends only on the altered section.

(4) Before dissection P was axile and Q free-central; after septum removal their superficial resemblance does not erase the original distinction.

Q.95 Consider four descriptions used to identify plant specimens.

I. In rose, the peripheral floral whorls arise from the rim of a cup-like thalamus; this does not by itself establish its placentation.

II. In pea, ovules occur along a ridge on the ventral suture of a monocarpellary ovary.

III. In cotton, each petal overlaps the next in a regular direction.

IV. In mango, the hard stone is formed from the integuments, while the edible mesocarp develops from the ovary wall.

Which are correct?

(1) II, III and IV only (2) I, II and IV only

(3) I, III and IV only (4) I, II and III only

Q.96 A botanist distinguishes cohesion among stamens from adhesion of stamens to another floral whorl. Which pair of records correctly makes this distinction?

(1) Pea: polyadelphous cohesion; lily: epipetalous adhesion

(2) China rose: monadelphous cohesion; brinjal: epipetalous adhesion

(3) *Citrus*: diadelphous cohesion; brinjal: epiphyllous adhesion

(4) China rose: epipetalous cohesion; lily: monadelphous adhesion

Q.97 Three specimens are traced to their point of attachment. P has one axillary bud at its base; its blade is deeply incised, but the cuts stop short of the midrib. Q has one axillary bud at its base and a rachis bearing separate blades; none of those blades has a bud at its base. R is an axis bearing separate blades, each with an axillary bud at its own base. Which classification respects all three observations?

(1) P: simple leaf; Q: leafy shoot; R: compound leaf

(2) P: simple leaf; Q: compound leaf; R: leafy shoot

(3) P: compound leaf; Q: compound leaf; R: simple leaf

(4) P: compound leaf; Q: simple leaf; R: compound leaf

Q.98 A cereal grain is dissected. P is the single shield-shaped structure beside the embryo axis; Q is the protein-rich layer outside the starchy endosperm; R encloses the radicle and root cap; S encloses the shoot apex and leaf primordia. Consider:
I. P belongs to the embryo, whereas Q is associated with endosperm.
II. R is the coleorhiza and S is the coleoptile.
III. P and Q are two cotyledons differentiated for different storage roles.
IV. Removing R removes a protective covering; it is not equivalent to identifying R itself as the embryonic root.
Which are correct?
(1) I, II and IV only (2) I and III only
(3) II, III and IV only (4) I, II and III only

Q.99 A fruit develops from a single flower with a syncarpous ovary. Its fleshy edible tissue includes a substantial contribution from the thalamus. Consider:
A. It can still be a simple fruit.
B. It must be a true fruit because its ovary is syncarpous.
C. Contribution of thalamus makes it a false fruit.
D. The ovary wall forms the seed coat.
Which statements are correct?
(1) C and D only (2) A and B only (3) B and D only (4) A and C only

Q.100 A laboratory class receives three young axes: P has radial bundles with peripheral protoxylem; Q has conjoint bundles arranged in a ring, cambium between xylem and phloem, and protoxylem towards the centre (pith); R has scattered conjoint bundles without cambium and a cavity in the protoxylem region. Which pair of claims is supported?

(1) P is a stem; R is the axis most clearly equipped for normal cambial secondary growth.

(2) Q and R are both monocot stems; ring versus scattered arrangement does not bear on their identification.

(3) R is a typical dicot root; the cavity establishes an exarch condition.

(4) Q is a typical dicot stem; the radial arrangement in P alone does not decide whether P is a monocot or dicot root.

Q.101 Two xylem zones from an old trunk are compared. P is inner, dark and impregnated with deposited substances; Q is outer and lighter. Microscopy shows that many vessel elements in both zones lack living protoplasts. Consider:
I. The absence of a living protoplast alone cannot distinguish conducting Q vessels from nonconducting P vessels.
II. P can provide support while Q conducts water.
III. P and Q are different in function but both belong to secondary xylem.
IV. Q must be primary xylem because secondary xylem is defined as the nonconducting part of a trunk.
Which are correct?
(1) I, III and IV only (2) I, II and III only
(3) I and II only (4) II, III and IV only

Q.102 A radial strip of a temperate dicot trunk is read from pith toward cambium. Four successive bands are A: wide vessels with relatively thin walls; B: narrower vessels with thicker walls; C: wide thin-walled vessels; D: narrow thick-walled vessels. A and B formed in one year; C and D formed in the next. No anomalous growth occurred. Which statements are correct?
I. The oldest of the four bands is A.
II. B and C together necessarily constitute one annual ring.
III. Cambial activity was generally greater during formation of A than B.
IV. Reading D to C moves toward older tissue within the younger annual ring.
(1) I and II only
(2) I, II, III and IV
(3) I, III and IV only
(4) II, III and IV only

Q.103 A student uses the label endarch for a dicot stem and exarch for a root, then claims these labels describe the direction in which vascular cambium produces secondary xylem. Which correction preserves the valid observations?
(1) Both labels refer only to the position of the endodermis.
(2) Reverse the organ labels; keep the explanation.
(3) Keep the organ labels, but apply them to relative positions of protoxylem and metaxylem in primary xylem.
(4) Keep the explanation, but substitute phloem for xylem.

Q.104 In a supplied controlled experiment on grass leaves, treatment X keeps bulliform cells turgid during water shortage but leaves guard-cell responses intact; the leaf remains unrolled while its stomata close. Treatment Y permits bulliform-cell water loss but keeps stomata open; the leaf rolls inward. Consider:
I. Rolling and stomatal closure are separable responses involving distinct epidermal cell types.
II. Rolling in Y reduces exposed surface, but these observations alone do not establish that Y loses less total water than X.
III. Failure to roll in X proves that its stomata cannot respond to water shortage.
IV. The results are consistent with loss of bulliform turgor driving rolling.
Which are justified?
(1) I, III and IV only
(2) I, II and IV only
(3) II and III only
(4) I, II and III only

Q.105 A labelled epidermal diagram includes G, the two chloroplast-bearing cells with uneven inner/outer wall thickness bordering a pore; S, specialised epidermal cells immediately around G; and B, larger colourless cells in the adaxial epidermis of a grass leaf. Consider:
I. G can differ in shape between typical dicots and grasses without losing its stomatal role.
II. G, S and the pore together constitute the stomatal apparatus.
III. B is a second name for S because every specialised epidermal cell surrounding a pore is a bulliform cell.
IV. A chloroplast-containing cell in an epidermal peel and a chloroplast-containing mesophyll cell cannot be identified as the same tissue type from chloroplast presence alone.
Which are correct?
(1) I, II and IV only
(2) II, III and IV only
(3) I, III and IV only
(4) I, II and III only

Q.106 Four young axes are described using typical NCERT anatomy. P has radial exarch xylem, four xylem patches and a small pith. Q has radial exarch xylem, many xylem patches and a large pith. R has scattered closed conjoint bundles and a protoxylem cavity. S has ring-arranged open conjoint bundles and endarch xylem. Which row correctly gives (a) the two roots and (b) the two axes expected to show normal cambial secondary growth in the standard comparison?
(1) Roots Q and R; secondary growth P and S
(2) Roots P and Q; secondary growth Q and S
(3) Roots P and S; secondary growth Q and R
(4) Roots P and Q; secondary growth P and S

Q.107 Three tissues are sampled. P consists of living cells thickened at corners by cellulose, hemicellulose and pectin. Q consists of dead cells with heavily lignified walls and a narrow lumen, but no information on cell shape is supplied. R consists of dead elongated tubular elements with perforated end walls. Consider:
I. P is consistent with collenchyma supporting a growing organ.
II. Q is consistent with sclerenchyma, but the observations alone do not choose between fibres and sclereids.
III. R can conduct water despite lacking a living protoplast.
IV. The shared lignification and dead condition prove that Q and R perform the same principal function.
Which are justified?
(1) I and IV only
(2) I, II and III only
(3) I, III and IV only
(4) II, III and IV only

Q.108 Two leaf sections are coded P and Q. P has palisade next to surface X, spongy tissue next to surface Y, and xylem toward X. Q has undifferentiated mesophyll, stomata on both surfaces, and large colourless cells restricted to surface U; xylem is nearer U. Consider:
I. P is consistent with a dorsiventral leaf and X its adaxial side.
II. Q is consistent with an isobilateral grass leaf even though its two epidermises need not be identical in every specialisation.
III. Stomata on both surfaces alone require a leaf to have palisade and spongy mesophyll.
IV. Interchanging the xylem and phloem labels in P would make its anatomical interpretation more consistent.
Which are justified?
(1) I and II only
(2) I and III only
(3) II and IV only
(4) I, II and IV only

Q.109 A deep-water rice plant and a bolting rosette plant both show rapid internode elongation. Which statement correctly avoids assuming that identical growth responses always identify the same regulator?
(1) Ethylene promotes the rice response, whereas gibberellin promotes bolting in the rosette plant.
(2) Both responses specifically identify auxin.
(3) Abscisic acid promotes the rice response, whereas cytokinin promotes bolting.
(4) Gibberellin must be the sole regulator of both responses because ethylene always inhibits growth.

Q.110 Two cultures are compared. In P, a single individually tracked, mature mesophyll cell re-enters division; some descendants later form mature tracheary elements. In Q, an untracked mixed explant containing both mature cells and already-dividing cells produces callus. Consider:
I. The tracked starting cell in P demonstrates dedifferentiation.
II. Formation of mature tracheary elements from the dividing lineage in P illustrates redifferentiation.
III. Callus formation in Q alone establishes that its cells arose by dedifferentiation of mature cells.
IV. Loss of division capacity in mature tracheary descendants does not contradict the earlier dedifferentiation of their ancestor.
Which are correct?
(1) I, II and IV only
(2) I, II and III only
(3) II and III only
(4) I, III and IV only

Q.111 A nursery identifies two unknown regulators using independent trials. X hastens seed production in juvenile conifers and promotes bolting in rosette plants. Y delays senescence of detached leaves through nutrient mobilisation and promotes lateral-bud growth after apical dominance is reduced. Which prediction is consistent with both identities, while avoiding an unjustified one-effect-one-hormone inference?
(1) X is gibberellin and Y cytokinin; every rapid stem-elongation response must therefore be due exclusively to X.
(2) X is auxin and Y cytokinin; the conifer and rosette responses identify the same auxin-specific pathway.
(3) X is cytokinin and Y gibberellin; the leaf response alone establishes that Y also induces stomatal closure in drought.
(4) X is gibberellin and Y cytokinin; observing rapid stem elongation in another species would not by itself exclude ethylene involvement.

Q.112 A nursery codes three regulators P, Q and R. P promotes rooting in suitable stem cuttings and prevents early fruit drop. Q promotes lateral shoot growth and delays leaf senescence through nutrient mobilisation. R controls broad-leaved weeds in a mature grass lawn. Using NCERT applications, consider:
I. P fits auxin, whereas Q fits cytokinin.
II. R may be 2,4-D, so P and R can belong to the same broad regulator class despite different applications.
III. Replacing P by Q in a rooting protocol is justified solely because both can promote growth in some contexts.
IV. Preferential survival of mature grass after R establishes that R is a cytokinin rather than an auxin-type compound.
Which are correct?
(1) I and III only (2) I and II only (3) II and IV only (4) III and IV only

Q.113 Three independently tested pure regulators are coded P, Q and R. P induces bolting in a rosette plant and accelerates malting; Q promotes fruit ripening and rapid internode elongation in deep-water rice; R promotes lateral shoot growth and delays leaf senescence. Consider:
I. P is the regulator class NCERT associates with increased sugarcane stem length and yield.
II. Q must be an inhibitor of elongation in every tissue because it is also associated with senescence.
III. R can oppose apical dominance without being the regulator responsible for the malting result.
IV. The elongation response to Q establishes that P and Q are the same regulator class.
Which are correct?
(1) I and II only (2) I and III only (3) II and IV only (4) III and IV only

Q.114 A grower records three observations after treatment with regulator E: more female flowers in cucumber, synchronised flowering/fruit set in pineapple, and faster ripening in responsive fruits. A second regulator A prevents early fruit drop but can promote abscission of older mature leaves. Which interpretation is correct?
(1) E is auxin and A is ethylene; prevention of early fruit drop establishes that A is always a growth promoter.
(2) E is cytokinin and A is ABA; the three E responses all demonstrate a direct increase in mitotic rate.
(3) E is ethylene and A is auxin; the abscission observations show that developmental stage can change the response to a regulator.
(4) E is ethylene and A is auxin; the older-leaf response contradicts auxin identity because one regulator cannot have opposite effects at different stages.

Q.115 Leaf areas are recorded at three equally spaced times: P: 5, 10, 20 cm^2; Q: 50, 55, 60 cm^2. Assume only these observations are known. Consider:
I. During the first interval the absolute gains are equal.
II. During both intervals P has a 100% increase relative to its area at the start of that interval.
III. Q has the same percentage increase in both intervals.
IV. P's three observations fit a geometric-growth model, but do not prove that this model describes every unobserved time.
Which are correct?
(1) I, II and IV only (2) I, II, III and IV
(3) I and III only (4) II, III and IV only

Q.116 Two populations start with eight actively dividing cells and no differentiated cells. In each interval, every active cell divides once; differentiated cells do not divide and none dies. P follows geometric growth for two intervals, then for each of the next two intervals only one daughter of each active cell remains active. Q follows the one-active-daughter rule for two intervals, then both daughters of each active cell remain active for the next two intervals. After four intervals, which record gives total cells in P, total cells in Q, and active cells in each?
(1) P=128, Q=64; all cells in each remain active (2) P=96, Q=64; P has 32 active and Q has 64
(3) P=96, Q=48; 32 active in each (4) P=64, Q=48; 32 active in each

Q.117 Genetically identical cuttings produce these leaf forms: in water, juvenile leaves have form A and mature leaves form C; in air, juvenile leaves have form B and mature leaves form C. Forms A, B and C are distinct. All other conditions are matched. Consider:
I. A phase-associated difference occurs in each environment.
II. An environmental association is detected in juvenile leaves but not in mature leaves in this experiment.
III. The effect of environment must be identical at both life phases because the cuttings are genetically identical.
IV. The observations illustrate plasticity but do not establish dedifferentiation of already mature leaf cells.
Which are supported?
(1) I, II and IV only
(2) II, III and IV only
(3) I, III and IV only
(4) I and III only

Q.118 In the NCERT C_4 pathway, enzyme A fixes carbon in mesophyll cells and enzyme B fixes carbon released in bundle-sheath cells. Which assignment correctly includes the acceptor/product relationships?
(1) A: PEP carboxylase, PEP to OAA; B: RuBisCO, RuBP to PGA
(2) A: RuBisCO, PEP to PGA; B: PEP carboxylase, RuBP to OAA
(3) A: PEP carboxylase, RuBP to PGA; B: RuBisCO, PEP to OAA
(4) A: RuBisCO, RuBP to OAA; B: PEP carboxylase, PEP to PGA

Q.119 A C_4-leaf mutant incorporates supplied labelled carbon normally into mesophyll four-carbon acids, but little label appears in bundle-sheath PGA. ATP/NADPH supply is normal. Directly supplying CO_2 to the bundle-sheath cells restores PGA production. Which explanation remains unresolved by these observations?
(1) Whether the bundle-sheath Calvin enzymes are entirely inactive or whether their local CO_2 supply is inadequate.
(2) Whether the defect is in initial mesophyll PEP carboxylation or in RuBisCO carboxylation.
(3) Whether the defect removes RuBP-regeneration capacity or eliminates the supply of ATP to the bundle-sheath Calvin reactions.
(4) Whether the defect prevents movement of four-carbon acids to the bundle sheath or prevents their decarboxylation there.

Q.120 Three illuminated thylakoid preparations receive ADP and phosphate. P has a selective proton leak but intact ATP synthase. Q has an intact proton-tight membrane but ATP synthase is inhibited. R has a proton-tight membrane and active ATP synthase, but light-driven electron transfer is blocked. Each is then given a brief artificial lumen-to-stroma proton gradient; a leak dissipates this imposed gradient immediately, whereas a proton-tight membrane retains it long enough for ATP synthase to act. With the original treatments still present, which preparation can produce a transient burst of ATP from the imposed gradient?
(1) R only
(2) P only
(3) P and R only
(4) Q only

Q.121 Two chloroplast reaction centres absorb maximally near 680 and 700 nm. Use this supplied model: for every 1 mmol O_2 released by noncyclic electron flow, 2 mmol NADPH and 2 mmol ATP are made; cyclic flow adds ATP but no NADPH or O_2. The Calvin cycle requires 3 ATP and 2 NADPH per CO_2 fixed. A preparation releases 6 mmol O_2. Which row identifies the reaction centre used in cyclic flow, the minimum extra cyclic ATP needed to use all newly made NADPH, and the resulting CO_2 fixation?
(1) 700 nm centre; 12 mmol ATP; 6 mmol CO_2
(2) 700 nm centre; 6 mmol ATP; 4 mmol CO_2
(3) 680 nm centre; 6 mmol ATP; 6 mmol CO_2
(4) 700 nm centre; 6 mmol ATP; 6 mmol CO_2

Q.122 Two chloroplast preparations each begin with 30 mmol ATP and 24 mmol NADPH. Before Calvin-cycle fixation, 6 mmol ATP is used in another process. Preparation A receives no replenishment; B then receives an additional 12 mmol ATP but no additional NADPH. Assume excess CO_2, conventional Calvin accounting including RuBP regeneration, and continuous amounts. Which row gives maximum CO_2 fixation in A and B and the NADPH left in A?
(1) A: 10 mmol; B: 12 mmol; 4 mmol NADPH left in A
(2) A: 12 mmol; B: 12 mmol; 0 mmol NADPH left in A
(3) A: 8 mmol; B: 10 mmol; 8 mmol NADPH left in A
(4) A: 8 mmol; B: 12 mmol; 8 mmol NADPH left in A

Q.123 An isolated, enzyme-active stromal preparation is supplied with CO_2, ATP and NADPH but contains no thylakoids. Ignoring enzyme light-activation effects, which result is consistent with the biochemical requirements of the Calvin cycle?

(1) It can support fixation while supplied ATP and NADPH last; it cannot regenerate these supplies by light reactions without thylakoids.

(2) It can regenerate NADPH indefinitely from CO_2 alone.

(3) It cannot fix CO_2 because chlorophyll must directly absorb light at every carboxylation.

(4) It can split water and release oxygen because all photosynthetic steps occur in stroma.

Q.124 A C_3 leaf is exposed to high oxygen and low carbon dioxide at a temperature favouring photorespiration. Consider:
A. RuBisCO oxygenation can yield one three-carbon PGA and one two-carbon phosphoglycolate from RuBP.
B. Photorespiration synthesises sugar and conserves the released energy as ATP.
C. Carbon fixation efficiency can decline although light is available.
Which statements are correct?
(1) A only (2) B and C only (3) A, B and C (4) A and C only

Q.125 A chloroplast pigment mixture separates into blue-green, yellow-green, yellow and yellow-orange bands. The intact leaf shows appreciable photosynthetic activity at some wavelengths where isolated chlorophyll *a* absorbs weakly. Consider:
I. The blue-green band is consistent with chlorophyll *a* and the yellow-green band with chlorophyll *b*.
II. Accessory pigments can help account for the difference between the intact system's action spectrum and isolated chlorophyll-*a* absorption.
III. Every pigment that absorbs light must itself function as a reaction centre.
IV. A pigment's visible colour alone is insufficient to reconstruct its complete absorption spectrum or quantify its contribution to the action spectrum.
Which are justified?
(1) I, III and IV only (2) I, II and IV only
(3) II, III and IV only (4) I, II and III only

Q.126 Net CO_2 uptake is measured at one temperature in the same type of leaf. At low light the rates are 4 units with ambient CO_2 and 4 with enriched CO_2; at high light they are 7 and 11, respectively. Ignore photorespiration. Respiratory CO_2 release is independently measured as 2 units in all treatments; no other process releases CO_2. Which conclusion is supported?

(1) Gross fixation is 6 at low light and 13 at high light with enriched CO_2; the result proves that further light can never increase the enriched-CO_2 rate.

(2) Gross fixation is 6 at low light and 13 at high light with enriched CO_2; CO_2 enrichment reveals a limitation at high light but not at low light.

(3) Gross fixation is 2 at low light and 9 at high light with enriched CO_2; light is the sole limiting factor in every treatment.

(4) Gross fixation is 4 at low light and 11 at high light with enriched CO_2; respiration need not enter a gross-versus-net comparison.

Q.127 A cell-free system first converts 5 mmol glucose completely into pyruvate by glycolysis. Of the resulting pyruvate, 3 mmol is reduced to lactate and 2 mmol undergoes alcoholic fermentation; the rest remains pyruvate. No electron transport or other reaction occurs, and all needed cofactors are initially sufficient. Count net changes across both phases. Which output is correct?

(1) 10 mmol net ATP; 10 mmol net NADH; 5 mmol pyruvate remaining; 2 mmol CO_2 released

(2) 10 mmol net ATP; 5 mmol net NADH; 5 mmol pyruvate remaining; 2 mmol CO_2 released

(3) 10 mmol net ATP; 5 mmol net NADH; 3 mmol pyruvate remaining; 2 mmol CO_2 released

(4) 15 mmol net ATP; 5 mmol net NADH; 5 mmol pyruvate remaining; 5 mmol CO_2 released

Q.128 In lactic acid fermentation, most of the original chemical energy remains in the organic end product. Which pair correctly explains continued glycolysis and its limited energy yield?

(1) Pyruvate reduction regenerates NAD^+; no additional ATP is produced in that reduction.

(2) Oxygen accepts the final electrons; lactate formation is therefore oxidative phosphorylation.

(3) Lactate is completely oxidised to CO_2; this directly regenerates NAD^+.

(4) Pyruvate reduction regenerates NADH; four additional ATP are produced in that reduction.

Q.129 A cell-free mixture contains 2 mmol glucose, 3 mmol fructose-1,6-bisphosphate and 4 mmol glyceraldehyde-3-phosphate. All are completely converted to pyruvate, with sufficient enzymes, NAD^+ and ADP and no further pyruvate oxidation. Count ATP only after the supplied substrates enter: ignore the earlier cost of making the supplied intermediates. Which totals are correct?

(1) 14 mmol pyruvate; 28 mmol net ATP; 14 mmol NADH

(2) 14 mmol pyruvate; 24 mmol net ATP; 14 mmol NADH

(3) 14 mmol pyruvate; 24 mmol net ATP; 10 mmol NADH

(4) 10 mmol pyruvate; 20 mmol net ATP; 10 mmol NADH

Q.130 A selective defect prevents pyruvate dehydrogenase from acting, but glycolysis and citrate synthase remain functional. Acetyl-CoA can be supplied experimentally. Which prediction is justified?

(1) Glucose cannot be converted into pyruvate because pyruvate dehydrogenase is an EMP enzyme.

(2) Citrate synthase must stop functioning even when acetyl-CoA and oxaloacetate are supplied.

(3) The defect directly removes the final oxygen acceptor of the electron transport chain.

(4) The normal link from glycolysis to the TCA cycle is blocked; supplying acetyl-CoA can bypass this particular entry defect.

Q.131 A mitochondrial preparation completely processes 3 mmol pyruvate through the link reaction and TCA cycle, and also processes 1 mmol acetyl-CoA supplied directly into the TCA cycle. Assume sufficient oxidised coenzymes are available. Exclude electron-transport-chain outputs from the accounting. Which combined output is correct, and which substrate-level phosphorylation statement applies?

(1) 12 mmol NADH, 4 mmol $FADH_2$ and 8 mmol CO_2; four ATP/GTP equivalents form at an oxidative succinyl-CoA step.

(2) 15 mmol NADH, 4 mmol $FADH_2$ and 11 mmol CO_2; four ATP/GTP equivalents form at the non-oxidative succinyl-CoA-to-succinate step.

(3) 18 mmol NADH, 4 mmol $FADH_2$ and 12 mmol CO_2; the succinyl-CoA step directly reduces molecular oxygen.

(4) 15 mmol NADH, 3 mmol $FADH_2$ and 11 mmol CO_2; three ATP/GTP equivalents form because direct acetyl-CoA cannot complete a turn.

Q.132 Use a supplied simplified mitochondrial model: each NADH donates two electrons through complexes I, III and IV and drives 10 protons outward; each $FADH_2$ enters via complex II, bypasses I and drives 6 protons outward. Four protons returning through ATP synthase support one ATP. Four electrons reduce one O_2. Preparation P oxidises 6 NADH and 2 $FADH_2$; Q oxidises 2 NADH and 6 $FADH_2$. Ignore all other costs and ATP sources. Which row correctly identifies complex II and compares the two preparations?

(1) Succinate dehydrogenase; P forms 16 ATP and Q 16 ATP; both consume 4 O_2.

(2) Succinate dehydrogenase; P forms 14 ATP and Q 18 ATP; both consume 8 O_2.

(3) NADH dehydrogenase; P forms 18 ATP and Q 14 ATP; P consumes 6 O_2 and Q 2 O_2.

(4) Succinate dehydrogenase; P forms 18 ATP and Q 14 ATP; both consume 4 O_2.

Q.133 Two matched seed samples respire identically in calibrated gas-displacement respirometers that allow volume change at constant temperature and pressure. In P, CO_2 is absorbed and gas volume decreases 20 mL; in Q, CO_2 is not absorbed and volume decreases 3 mL. Assume only O_2/CO_2 change and substrate oxidation is complete. A supplied two-substrate model has RQ = 1.0 for carbohydrate and 0.7 for lipid. What volume of the total O_2 uptake is attributable to lipid oxidation?

(1) 14 mL (2) 17 mL (3) 6 mL (4) 10 mL

Q.134 For this experiment use the supplied entry map: glycerol → triose phosphate → pyruvate → acetyl-CoA; fatty acids → acetyl-CoA; acetyl-CoA enters the TCA cycle. A treatment blocks only pyruvate-to-acetyl-CoA conversion. Consider the initial period with sufficient oxidised coenzymes available. Which prediction respects the map and the amphibolic nature of respiration?

(1) Glycerol can still support ATP formation before the block, but fatty-acid carbon cannot enter the TCA cycle because it must first pass through pyruvate.

(2) Fatty-acid carbon can still reach the TCA cycle, but glycerol cannot support any ATP formation before the block because all ATP-forming steps lie beyond acetyl-CoA.

(3) Both inputs can still form acetyl-CoA because glycerol enters the supplied route downstream of the blocked pyruvate step.

(4) Glycerol can still support ATP formation through the downstream glycolytic segment, while fatty-acid carbon can still reach the TCA cycle; withdrawal of TCA intermediates for synthesis remains an anabolic use of the pathway.

Q.135 Two glucose-fed cells initially respire aerobically. In P, oxygen is removed and a suitable lactate-fermentation pathway maintains NAD^+ regeneration. In Q, oxygen remains available but the inner mitochondrial membrane becomes strongly proton-leaky; electron carriers are initially functional. Which comparison is correct?

(1) P gains 4 net ATP per glucose because fermentation adds two ATP; Q must stop O_2 consumption immediately because oxygen reduction occurs in ATP synthase.

(2) P can gain 2 net ATP per glucose through glycolysis with no net accumulation of the glycolytic NADH after lactate formation; Q may continue consuming O_2 while oxidative ATP production becomes inefficient.

(3) P and Q must produce exactly the same total ATP per glucose because both have impaired oxidative phosphorylation.

(4) P cannot regenerate NAD^+ without oxygen; Q necessarily maintains its original ATP yield as long as electrons reach O_2.

ZOOLOGY

Q. 136–180 • 45 Questions • 180 Marks

Q.136 Two adult frogs remain completely submerged. In a supplied model their oxygen uptake through moist skin equals $kA\Delta p$, and lungs contribute no oxygen while submerged. Initially both have the same area A, gradient Δp and demand $D = kA\Delta p$. Frog P then loses 25% of exposed skin area while its demand rises by 20%; Q retains full skin area while its oxygen gradient falls by 20%. Which pair gives the minimum gradient required by P, relative to its original gradient, and the fraction of its original demand currently supplied to Q?
(1) 1.25 and 0.80 (2) 1.60 and 0.80 (3) 1.20 and 0.75 (4) 1.60 and 1.20

Q.137 A frog dissection record contains four entries:
i. cranial nerves = 20 individual nerves;
ii. paired optic lobes belong to the midbrain;
iii. cerebellum belongs to the forebrain;
iv. spinal cord belongs to the central nervous system.
Which entries can be retained without correction?
(1) ii, iii and iv (2) i, ii and iii (3) i and iv only (4) i, ii and iv

Q.138 In a frog, tracer R enters the renal portal vein and tracer H enters the hepatic portal vein. Assume each tracer follows that vein to its named target organ before returning to the general circulation. Which ordered pair of target organs and source regions is correct?
(1) R: kidney, intestine; H: liver, lower body (2) R: kidney, lower body; H: liver, intestine
(3) R: liver, intestine; H: kidney, lower body (4) R: liver, lower body; H: kidney, intestine

Q.139 Two mature frogs X and Y are examined. X has a copulatory pad on the first digit of each forelimb and vocal sacs; Y has neither. A tracer enters a sperm duct connecting X's testis with its kidney, while another enters Y's oviduct. Consider:
A. the first tracer can subsequently reach a ureter;
B. the second must pass through a kidney before reaching the cloaca;
C. blocking one ureter in X can obstruct both urinary and reproductive passage on that side;
D. blocking one ureter in Y directly blocks that side's oviduct.
Which statements follow from NCERT anatomy?
(1) A and C only (2) A, C and D only (3) A, B and C only (4) B and D only

Q.140 Three muscle samples are identified as P, skeletal; Q, smooth; R, cardiac. Evaluate these statements.
A. The presence of striations groups P with R, whereas involuntary control groups Q with R.
B. Both P and R have long, unbranched fibres arranged parallel throughout the tissue.
C. Q can occur in blood-vessel walls, while R contains junctions permitting neighbouring cells to coordinate contraction.
D. P and Q both have spindle-shaped cells, but only P is striated.
Which statements are correct?
(1) B and C only (2) C and D only (3) A and B only (4) A and C only

Q.141 An intestinal lining contains scattered mucus-secreting cells P; a salivary gland is Q; a hormone-secreting ductless gland is R; a many-layered buccal lining is S. Consider:
A. P and Q are glandular epithelia, although P is unicellular and Q multicellular.
B. Q and R differ in whether their secretions are conveyed through ducts.
C. The main distinction between Q and S is that Q is multicellular whereas S is unicellular.
D. A multicellular arrangement alone is sufficient to classify an epithelial sample as a gland.
Which statements are correct?
(1) B and D only (2) A and C only (3) C and D only (4) A and B only

Q.142 Specimen P links two bones and has fibres arranged regularly. Q contains cells in small cavities within a firm, pliable matrix. R is dermis with differently oriented fibres. Which classification is correct?

(1) P specialised connective; Q dense regular; R dense irregular

(2) P dense regular; Q specialised connective; R dense irregular

(3) P dense irregular; Q dense regular; R specialised connective

(4) P dense regular; Q dense irregular; R specialised connective

Q.143 Four claims are made after examining a loose connective-tissue sample containing fibroblasts, macrophages and mast cells, and a bronchiolar ciliated epithelial sample.
A. The connective sample is consistent with areolar tissue and can support nearby epithelium.
B. The ciliated sample's chief transport mechanism is movement of material along its free surface.
C. Regular parallel fibre bundles are the defining arrangement of the described loose tissue.
D. Adipose tissue belongs to the same broad loose-connective category, although its predominant specialised cells differ.
Which claims are correct?
(1) A, B and D only (2) A, C and D only (3) B, C and D only (4) A, B and C only

Q.144 Four proposed observation–deduction pairs are listed:
i. bronchiolar cilia are paralysed, so surface transport can fail even when secretion continues;
ii. goblet cells are lost, so unicellular glandular secretion can fall without conversion of the whole lining into connective tissue;
iii. tendon fibres are regularly arranged, so it is dense regular connective tissue;
iv. adipocytes store lipid, so adipose tissue is classified as dense regular connective tissue.
Which pairs are valid?
(1) ii, iii and iv (2) i, ii and iii (3) i, ii and iv (4) i and iii only

Q.145 An epithelial sheet has tight, adhering and gap junctions. After treatment, mechanical attachment is retained, small ions no longer pass directly between cells, and a solute placed on one side leaks between cells to the other side. A proposed repair restores only the leakage barrier. Which final condition follows, assuming every intervention is selective?

(1) Tight-junction function is restored; adhering function remains; direct gap-junction exchange is still impaired.

(2) Adhering junctions must have failed initially, and restoring tight junctions necessarily repairs them.

(3) Gap-junction function is restored; adhering function remains; tight-junction leakage persists.

(4) Tight and gap functions must both recover because the cells remain attached.

Q.146 After examining the head of an adult frog, a student records four inferences about its sense organs.
A. Eyes and internal ears are well-organised sense organs, whereas the organs of touch (sensory papillae), taste (taste buds) and smell (nasal epithelium) are cellular aggregations around nerve endings.
B. Because the eyes are paired, each eye must be a compound eye made up of many units.
C. As the external ear is absent, only the tympanum is seen externally; the ear serves for balancing (equilibrium) as well as hearing.
D. The bulging eyes are covered by a nictitating membrane, which protects them while the frog is in water.
Which inferences are correct?
(1) A and B only (2) B, C and D only (3) A, B and C only (4) A, C and D only

Q.147 A student compares frog structures with their functions.
A. The heart has two atria and one ventricle, but its chamber count does not make the animal homeothermic.
B. The sinus venosus receives blood from major veins and joins the right atrium.
C. The conus arteriosus receives venous blood before it enters the right atrium.
D. Nucleated erythrocytes and a tadpole stage are compatible with the same frog life history.
Which statements can be retained?
(1) A, C and D only (2) A, B and D only (3) A, B and C only (4) B, C and D only

Q.148 In a frog, the common bile duct (hepato-pancreatic duct) is selectively obstructed near its entry into the intestine; alimentary passage and hepatic portal blood flow remain intact. Consider:
A. Delivery of both bile and pancreatic juice to the intestine can be impaired.
B. Food can still pass from stomach to intestine despite this secretory obstruction.
C. The obstruction necessarily prevents intestinal blood from reaching the liver through the hepatic portal system.
D. The liver is the bile-producing organ, while the gall bladder chiefly stores bile.
Which statements are justified?
(1) A, B and D only (2) A, B and C only (3) A and D only (4) B, C and D only

Q.149 An epithelial barrier initially consists of one cell layer, with area A and layer thickness d. Two replacement sheets are compared using the stipulated relation transfer rate $\propto$ area/thickness at unchanged concentration gradient. Sheet P has four times as many equally thick cell layers and twice the total exposed area; sheet Q remains one cell thick but has half the exposed area. Which conclusion is justified?

(1) Both have half the original predicted transfer rate, but P's layered organisation is more consistent with a protective compound epithelium.

(2) Equal predicted transfer rates establish identical tissue organisation and primary function.

(3) P has twice Q's transfer rate because its area is four times Q's area.

(4) Q has the lower rate, because single-layered epithelium is specialised only for protection.

Q.150 Four statements link a frog's physiology with its way of life.
A. Excretory wastes carried by blood are separated in the kidneys, and since the main nitrogenous waste excreted is urea, the frog is ureotelic.
B. A frog kept on a dry surface cannot make good its water loss by drinking, because frogs never drink water but absorb it through the skin.
C. Since frogs lay their eggs in water, fertilisation must take place inside the female's body before the ova are released.
D. Being cold-blooded, frogs shelter in deep burrows to escape extreme heat and cold—summer sleep (aestivation) and winter sleep (hibernation).
Which statements are correct?
(1) A, C and D only (2) A, B and D only (3) A and B only (4) B, C and D only

Q.151 Compare respiratory arrangements using NCERT.
A. Sponges exchange gases by diffusion over their body surface without specialised respiratory organs.
B. Earthworms and insects both rely on a moist body surface as their principal respiratory mechanism.
C. Specialised vascular gills occur in many aquatic arthropods and molluscs, whereas reptiles, birds and mammals use lungs.
D. An adult frog's ability to use lungs on land excludes cutaneous exchange when submerged.
Which statements are correct?
(1) A and B only (2) C and D only (3) A and C only (4) B and C only

Q.152 Three equal haemoglobin samples are compared at the same pO_2. Relative to P, Q has lower pCO_2 and lower H^+ concentration at the same temperature; R has lower pCO_2 but higher temperature, with H^+ unchanged. Using only NCERT's qualitative effects and without numerical binding curves, which conclusion is justified?

(1) Q must bind less oxygen than P because H^+ is lower; R must bind more.

(2) All three must bind equally because their pO_2 values are equal.

(3) Q has conditions favouring greater oxygen binding than P; the direction of R versus P cannot be fixed from the opposing changes alone.

(4) Both Q and R must bind more oxygen than P because pCO_2 is lower.

Q.153 A subject has TLC $= 6000$ mL and TV $= 500$ mL. The measured residual volume equals the expiratory reserve volume, and inspiratory capacity is twice expiratory capacity. What volume can be expired maximally after a normal inspiration, and what is the vital capacity?
(1) 1500 mL and 4500 mL (2) 1750 mL and 4250 mL
(3) 1750 mL and 4750 mL (4) 3500 mL and 4750 mL

Q.154 Two measurements on the same subject give TLC $= 5800$ mL and RV $= 1300$ mL. After maximal expiration the subject inspires 3000 mL but stops before maximal inspiration. How much additional air could still be inspired, and which capacity measures the full possible inspiration from maximal expiration?
(1) 1500 mL; vital capacity
(2) 2800 mL; inspiratory capacity
(3) 1300 mL; vital capacity
(4) 1500 mL; inspiratory capacity

Q.155 In a supplied model, 100 mL blood contains 20 mL oxygen when haemoglobin is fully saturated; ignore dissolved oxygen. At rest, arterial and venous saturations are 95% and 70%, and tissue flow is 5 L min^{-1}. During activity they are 90% and 50%, and flow is 8 L min^{-1}. Which pair gives the change in arterial oxygen carried per 100 mL blood and the change in oxygen delivered (unloaded) to tissues per minute?
(1) -2 mL and $+150$ mL min^{-1}
(2) -1 mL and $+390$ mL min^{-1}
(3) $+1$ mL and $+390$ mL min^{-1}
(4) -1 mL and $+640$ mL min^{-1}

Q.156 Three interventions are considered separately: P bypasses the conducting airways while delivering equally warm, humid, particle-free air to alveoli; Q prevents mucus transport along conducting epithelium but leaves gas-pressure gradients intact; R thickens only the alveolar diffusion barrier.
A. P does not by itself prove that the alveolar exchange surface has failed.
B. Q can impair particle clearance without directly removing an alveolar oxygen gradient.
C. R primarily substitutes for the normal air-conditioning role of the conducting region.
D. Preserving the air-conditioning functions in P guarantees normal blood oxygenation even if alveolar diffusion is independently impaired.
Which conclusions are justified?
(1) A and C only
(2) C and D only
(3) B and D only
(4) A and B only

Q.157 Three respiratory cases are described: P has damaged alveolar walls and reduced exchange area; Q has inflamed bronchi and bronchioles with difficulty breathing and wheezing; R has long exposure to workplace dust followed by inflammation and fibrosis. Consider:
A. P is consistent with emphysema rather than merely reduced conducting-airway diameter.
B. Q is consistent with asthma, and its primary description is identical to alveolar-wall destruction in P.
C. R is compatible with an occupational respiratory disorder, for which protective masks can reduce dust exposure.
D. A normal total exchange area by itself excludes the mechanism described in Q.
Which are correct?
(1) A and B only
(2) B and C only
(3) A and C only
(4) C and D only

Q.158 For one subject, four measurements are recorded: A, maximal expiration after normal inspiration $= 1500$ mL; B, maximal inspiration after normal expiration $= 3000$ mL; C, tidal volume $= 500$ mL; D, lung volume after maximal expiration $= 1200$ mL. A technician reports VC $= 4500$ mL and TLC $= 5700$ mL. Which correction is necessary?
(1) VC should be 4500 mL and TLC 4500 mL, because residual volume never contributes to TLC.
(2) VC should be 4000 mL and TLC 5200 mL, because adding A and B counts TV twice.
(3) VC should be 3500 mL and TLC 4700 mL, because both A and B exclude TV.
(4) VC should remain 4500 mL but TLC should be 5200 mL, because RV is already in A.

Q.159 A tracer study distinguishes ventilation, alveolar diffusion, blood transport, tissue diffusion and cellular use.
A. An inhaled oxygen tracer destined for muscle must enter blood before its circulation-mediated transport to that muscle.
B. Once blood transport is intact, failure of alveolar oxygen diffusion cannot reduce delivery of newly inhaled tracer.
C. Carbon dioxide produced in tissues reaches alveolar air by first entering blood, being transported to lungs, and then diffusing across the alveolar barrier.
D. Ventilation and both gas-diffusion steps are the same process because each moves a gas.
Which statements are correct?
(1) A and B only
(2) C and D only
(3) A and C only
(4) B and C only

Q.160 A lung region initially has alveolar $pO_2 = 104$ and incoming-blood $pO_2 = 40$ mmHg; blood $pCO_2 = 45$ and alveolar $pCO_2 = 40$ mmHg. In a supplied model, transfer magnitude is proportional to area × solubility × pressure difference / thickness. CO_2 solubility is 20 times O_2 solubility. Later, common area is halved and barrier thickness doubles; alveolar pO_2 becomes 72 mmHg while the other pressures remain unchanged. Which pair gives later CO_2:O_2 transfer magnitude and later O_2 transfer as a fraction of its own initial value?
(1) $25:16$ and $1/8$ (2) $25:8$ and $1/4$ (3) $25:8$ and $1/8$ (4) $25:16$ and $1/4$

Q.161 Three proposed explanations for normal inspiration are evaluated. A: diaphragm and external intercostal contraction increases thoracic volume. B: expansion lowers intrapulmonary pressure below atmospheric pressure. C: air flows inward because that pressure difference exists. In an isolated model the muscles contract, but thoracic expansion is prevented and no other pressure-changing process is allowed. Which assessment is correct?

(1) C must precede B: inward air necessarily produces the subatmospheric pressure that starts inspiration.

(2) The intervention directly proves that oxygen cannot cross an alveolar membrane, even if an oxygen gradient persists.

(3) The intervention prevents the expansion described in A, so the normal pressure fall and inward airflow do not follow from muscle contraction alone.

(4) A, B and C must still occur because inspiratory muscle contraction is the definition of inward airflow.

Q.162 Consider gas handling at systemic tissues and alveoli.
A. High tissue pCO_2 favours formation of bicarbonate, with carbonic anhydrase facilitating the reversible reaction.
B. The same reversible reaction can favour CO_2 release in the alveolar region under the local pCO_2 conditions.
C. Because most CO_2 is carried as bicarbonate, haemoglobin has no role in CO_2 transport.
D. Conditions favouring oxygen loading in alveoli also favour dissociation of CO_2 from carbaminohaemoglobin.
Which statements are correct?
(1) B, C and D only (2) A, B and C only (3) A, B and D only (4) A and B only

Q.163 Two breathing patterns each give total ventilation 6000 mL min^{-1}. Pattern P has frequency 12 min^{-1} and pattern Q 20 min^{-1}. Conducting-airway volume is 150 mL per breath, and fresh alveolar ventilation is $(\text{frequency}) \times (\text{TV} - 150)$. Keeping Q's frequency unchanged, what tidal volume would make its alveolar ventilation equal to P's original value, and what total ventilation would then be required?
(1) 300 mL and 6000 mL min^{-1} (2) 350 mL and 7000 mL min^{-1}
(3) 360 mL and 7200 mL min^{-1} (4) 500 mL and 10000 mL min^{-1}

Q.164 Evaluate four statements on breathing regulation.
A. The respiratory rhythm centre is in the medulla, while a pontine centre can moderate its activity.
B. Signals that shorten inspiration can alter respiratory rate rather than merely changing haemoglobin's oxygen capacity.
C. The chemosensitive region near the rhythm centre is chiefly described by NCERT as responding to O_2, with no important CO_2/H^+ response.
D. Receptors associated with the aortic arch and carotid artery can detect changes in CO_2/H^+ and signal the rhythm centre.
Which statements are correct?
(1) B, C and D only (2) A, B and D only (3) A, C and D only (4) A and B only

Q.165 In an isolated exchange model, alveolar pO_2 is 80 mmHg and incoming blood pO_2 is 60 mmHg; alveolar pCO_2 is 45 mmHg and blood pCO_2 is 40 mmHg. Membranes remain permeable. Later only the two alveolar values change, to 50 mmHg for O_2 and 35 mmHg for CO_2. Which pair correctly gives the initial and later net diffusion directions?

(1) Initially both gases: alveolus → blood; later both gases: blood → alveolus

(2) O_2 reverses direction, but CO_2 remains alveolus → blood in both states

(3) Initially O_2: alveolus → blood and CO_2: blood → alveolus; later both reverse

(4) Initially both gases: blood → alveolus; later both gases: alveolus → blood

Q.166 In a supplied nephron model, 300 solute units in 1.0 L water enter the descending limb. At the loop bend, concentration is 600 units L^{-1} with no solute loss. During ascent water volume stays fixed, but the final concentration becomes 240 units L^{-1}. Which ordered pair gives water removed during descent and solute removed during ascent, and which permeability statement is consistent?

(1) 0.50 L and 180 units; descending water permeability with ascending water impermeability

(2) 0.40 L and 180 units; the ascending limb dilutes by adding water

(3) 0.50 L and 120 units; all initial solute remains in the ascending limb

(4) 0.50 L and 360 units; both limbs are water permeable

Q.167 Four proposed transport arrows for a nephron are:
i. PCT lumen to blood: glucose;
ii. PCT blood to lumen: H^+ and ammonia;
iii. DCT lumen to blood: bicarbonate;
iv. DCT blood to lumen: K^+ under appropriate conditions.
Which arrow set is compatible with NCERT?

(1) i and iii only (2) i, ii and iii only

(3) i, ii, iii and iv (4) ii and iv only

Q.168 A histological sample X has brush-border simple cuboidal cells. A loop segment Y loses water while becoming more concentrated; a later segment Z loses electrolytes while retaining water. Evaluate:
A. X is consistent with PCT, where nutrient recovery can coexist with selective H^+ and ammonia secretion.
B. Y is consistent with the ascending limb because its concentration rises.
C. Dilution in Z can result from solute removal without addition of water.
D. Extensive reabsorption in X means every transported substance must move from lumen to blood.
Which statements are correct?

(1) A and C only (2) B and C only (3) A and B only (4) C and D only

Q.169 Two nephron groups have short versus long loops. Consider:
A. Both groups can have renal corpuscles in the cortex, although long-loop juxtamedullary corpuscles lie nearer the medulla.
B. Vasa recta are absent or highly reduced in cortical nephrons, while long loops and associated vasa recta contribute to the counter-current arrangement.
C. A long loop implies that its renal corpuscle itself lies deep in the medulla.
D. Counter-current flow and exchanges involving NaCl and urea help maintain a gradient rising towards the inner medulla.
Which statements are correct?

(1) A, B and D only (2) A and B only (3) B, C and D only (4) A, C and D only

Q.170 Four comparative claims link organism, structure and function.
A. Taenia's flame-cell system belongs to the protonephridial type, associated chiefly with osmoregulation in the NCERT account.
B. Paramoecium uses contractile vacuoles, whereas Taenia is assigned nephridia rather than flame cells.
C. Periplaneta has Malpighian tubules, whereas Pheretima has nephridia; both are excretory structures despite their different organisation.
D. The presence of an excretory structure establishes that every animal possessing it eliminates nitrogen chiefly as ammonia.
Which statements are correct?

(1) C and D only (2) A and B only (3) A and C only (4) B and C only

Q.171 A proposed classification rule says: "Any nephron whose loop enters the medulla is juxtamedullary; its corpuscle must lie in the medulla." Which replacement is valid?

(1) Both nephron types have medullary corpuscles; only cortical nephrons have long loops.

(2) Both types have cortical corpuscles; relative corpuscle position and loop length distinguish them, and juxtamedullary loops extend much deeper.

(3) Cortical nephrons lack all loops; juxtamedullary corpuscles are confined to the renal pelvis.

(4) Both types have equally long loops; the names refer only to collecting-duct position.

Q.172 Separate disturbances activate renal feedback.
A. Water loss can activate osmoreceptors and ADH release; recovery of fluid volume can inhibit further ADH release through feedback.
B. A fall in glomerular pressure can trigger renin, and angiotensin II can both constrict vessels and stimulate aldosterone release.
C. ANF released after increased atrial filling reinforces angiotensin II's vasoconstrictor action.
D. ADH and aldosterone have identical immediate reabsorptive effects: neither specifically promotes Na^+ recovery.
Which statements are correct?
(1) C and D only (2) A and C only (3) A and B only (4) B and D only

Q.173 Compare the nitrogenous wastes of an ammonotelic aquatic animal, a ureotelic mammal and a uricotelic bird.
A. The bird can eliminate nitrogen with comparatively little water as a paste-like waste.
B. The mammal forms urea mainly in the kidneys, the same organs that remove it from blood.
C. High ammonia toxicity and its high water requirement are compatible with ammonotelism in many aquatic animals.
D. The bird's uric acid has a higher elimination-water requirement than ammonia because it is less toxic.
Which statements are correct?
(1) A and C only (2) A and B only (3) C and D only (4) B and C only

Q.174 Three kidney models have equal filtration and initially receive the same ADH concentration. In P, the medullary gradient and late-nephron response to ADH are intact. In Q, the gradient is intact but the ADH response is absent. In R, the response is intact but the medullary gradient is abolished. ADH concentration is then increased without repairing either defect. Which conclusion is justified?
(1) Q must regain normal concentration because an intact gradient removes the need for ADH responsiveness.
(2) R must regain normal concentration because hormone responsiveness removes the need for an osmotic gradient.
(3) Q and R must have identical urine volumes because each lacks exactly one of the two requirements.
(4) P retains both requirements for ADH-assisted concentration; increasing ADH alone cannot be assumed to restore normal maximal concentration in Q or R.

Q.175 A freely filtered solute has plasma concentration $2\ \text{mg mL}^{-1}$ and GFR $100\ \text{mL min}^{-1}$. Initially $150\ \text{mg min}^{-1}$ is reabsorbed, $20\ \text{mg min}^{-1}$ is secreted and urine flow is $2\ \text{mL min}^{-1}$. An intervention leaves filtration and secretion unchanged, lowers reabsorption to $130\ \text{mg min}^{-1}$, and raises urine flow to $3\ \text{mL min}^{-1}$. Which pair gives the changes in solute excretion rate and urine solute concentration?
(1) Excretion rises by $20\ \text{mg min}^{-1}$, but concentration falls by $5\ \text{mg mL}^{-1}$.
(2) Excretion rises by $20\ \text{mg min}^{-1}$ and concentration remains $35\ \text{mg mL}^{-1}$.
(3) Both excretion rate and concentration rise, by $20\ \text{mg min}^{-1}$ and $5\ \text{mg mL}^{-1}$.
(4) Excretion falls by $20\ \text{mg min}^{-1}$ while concentration falls by $5\ \text{mg mL}^{-1}$.

Q.176 Use a daily filtration volume of 180 L. Initially 99.0% is reabsorbed. In a supplied model filtration stays constant while reabsorption rises to 99.5%. What happens to urine volume and the percentage reduction in that volume?
(1) 1.8 L to 1.71 L; 5% decrease (2) 1.8 L to 0.9 L; 50% decrease
(3) 1.8 L to 0.9 L; 0.5% decrease (4) 180 L to 179.1 L; 0.5% decrease

Q.177 A model nephron normally filters a useful nutrient and reabsorbs all of it in the PCT, with no secretion. Initially its plasma concentration is $1\ \text{mg mL}^{-1}$ and GFR is $100\ \text{mL min}^{-1}$. A selective intervention halves the PCT's maximum nutrient-reabsorption rate from 120 to $60\ \text{mg min}^{-1}$, without changing filtration, plasma concentration or urine flow of $2\ \text{mL min}^{-1}$. Assume actual reabsorption equals the smaller of filtered load and the stated maximum rate. Which pair gives the nutrient's urinary concentration after intervention and the smallest percentage reduction in GFR that would prevent its urinary loss while the impaired PCT remains unchanged?
(1) $20\ \text{mg mL}^{-1}$ and 40% (2) $20\ \text{mg mL}^{-1}$ and 60%
(3) $40\ \text{mg mL}^{-1}$ and 50% (4) $30\ \text{mg mL}^{-1}$ and 40%

Q.178 After a fall in glomerular blood pressure, four proposed statements are considered:
i. JG cells release renin;
ii. angiotensin II promotes vasoconstriction;
iii. aldosterone increases distal Na^+ and water reabsorption;
iv. increased atrial filling subsequently promotes ANF, which reinforces renin–angiotensin action.
Which sequence of True/False judgements is correct?
(1) True, false, true, false (2) True, true, false, true
(3) False, true, true, true (4) True, true, true, false

Q.179 A dialysis membrane passes urea and useful solute X but retains proteins and cells. Equal fixed blood and dialysate volumes V are closed to other exchange; ignore metabolism and water transfer. Initially blood concentrations are urea 30 and X 5 units, while dialysate concentrations are urea 0 and X 3. After complete diffusive equilibration, the dialysate is replaced by fresh equal volume with urea 0 and X 5. Immediately after replacement, which directions are correct?
(1) Urea moves into blood; X has no net gradient.
(2) Urea has no net gradient; X moves from dialysate to blood.
(3) Urea moves from blood to dialysate; X moves from dialysate to blood.
(4) Both urea and X move from blood to dialysate.

Q.180 A tracer experiment distinguishes three processes: P, plasma solute entering Bowman's space across the glomerular barrier; Q, a filtered nutrient moving from tubule lumen to surrounding blood; R, selected H^+ moving from blood into tubule lumen. Consider:
A. P is filtration, and podocyte slits participate in its barrier.
B. Q is secretion because the nutrient has left the tubule.
C. R can help acid–base regulation even while Q occurs elsewhere in the same nephron.
D. The final amount excreted of a freely filtered substance equals filtered amount plus reabsorbed amount minus secreted amount.
Which statements are correct?
(1) A and B only (2) C and D only (3) A and C only (4) B and C only

— END OF PAPER —