॥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

Answer Key & Detailed Solutions · Free practice test

Answer key

Physics								
1 : 1	2 : 1	3 : 4	4 : 1	5 : 3	6 : 4	7 : 3	8 : 1	9 : 4
10 : 2	11 : 3	12 : 1	13 : 4	14 : 2	15 : 4	16 : 4	17 : 2	18 : 1
19 : 3	20 : 2	21 : 3	22 : 2	23 : 4	24 : 4	25 : 4	26 : 2	27 : 2
28 : 1	29 : 1	30 : 3	31 : 4	32 : 4	33 : 3	34 : 3	35 : 4	36 : 2
37 : 3	38 : 4	39 : 3	40 : 3	41 : 1	42 : 3	43 : 2	44 : 4	45 : 1

Chemistry								
46 : 3	47 : 2	48 : 2	49 : 3	50 : 1	51 : 1	52 : 3	53 : 1	54 : 4
55 : 1	56 : 1	57 : 3	58 : 4	59 : 2	60 : 3	61 : 3	62 : 2	63 : 2
64 : 2	65 : 3	66 : 3	67 : 1	68 : 3	69 : 4	70 : 3	71 : 1	72 : 4
73 : 4	74 : 2	75 : 3	76 : 4	77 : 4	78 : 1	79 : 4	80 : 3	81 : 4
82 : 1	83 : 3	84 : 3	85 : 2	86 : 2	87 : 1	88 : 4	89 : 1	90 : 2

Botany								
91 : 3	92 : 2	93 : 2	94 : 4	95 : 4	96 : 2	97 : 2	98 : 1	99 : 4
100 : 4	101 : 2	102 : 3	103 : 3	104 : 2	105 : 1	106 : 4	107 : 2	108 : 1
109 : 1	110 : 1	111 : 4	112 : 2	113 : 2	114 : 3	115 : 1	116 : 3	117 : 1
118 : 1	119 : 4	120 : 1	121 : 4	122 : 4	123 : 1	124 : 4	125 : 2	126 : 2
127 : 2	128 : 1	129 : 2	130 : 4	131 : 2	132 : 4	133 : 4	134 : 4	135 : 2

Zoology								
136 : 2	137 : 4	138 : 2	139 : 1	140 : 4	141 : 4	142 : 2	143 : 1	144 : 2
145 : 1	146 : 4	147 : 2	148 : 1	149 : 1	150 : 2	151 : 3	152 : 3	153 : 3
154 : 1	155 : 2	156 : 4	157 : 3	158 : 2	159 : 3	160 : 3	161 : 3	162 : 3
163 : 3	164 : 2	165 : 1	166 : 1	167 : 3	168 : 1	169 : 1	170 : 3	171 : 2
172 : 3	173 : 1	174 : 4	175 : 1	176 : 2	177 : 1	178 : 4	179 : 3	180 : 3

Chapter, format, difficulty and time map

Q	Chapter / concept	Format	Level	Time (s)
1	Current Electricity – stretched wire, parallel arcs, internal resistance	numerical-mcq	Standard	90
2	Current Electricity – drift speed and Joule power under network change	numerical-mcq	Standard	120
3	Current Electricity – internal resistance from two loads, maximum power transfer	numerical-mcq	Standard	75
4	Current Electricity – Wheatstone bridge, Kirchhoff nodal analysis	numerical-mcq	Standard	120
5	Current Electricity – temperature dependence of resistance, extremum	numerical-mcq	Standard	120
6	Current Electricity – Kirchhoff laws, cell being charged, energy accounting	numerical-mcq	Challenging	150
7	Moving Charges and Magnetism – velocity selector, retarding potential, orbit radius	numerical-mcq	Challenging	150
8	Moving Charges and Magnetism – circular-loop field and magnetic moment with non-ideal supply	numerical-mcq	Challenging	150
9	Moving Charges and Magnetism – forces between parallel currents	numerical-mcq	Standard	120
10	Moving Charges and Magnetism – axial field of coaxial loops, torque on a dipole	numerical-mcq	Challenging	150
11	Moving Charges and Magnetism – Ampère's law, cylinder with off-axis cavity, Lorentz force	numerical-mcq	Challenging	180
12	Moving Charges and Magnetism – solenoid field, inductance and magnetic energy	numerical-mcq	Challenging	150
13	Magnetism and Matter – resultant dipole moment, potential energy and torque	numerical-mcq	Standard	90
14	Magnetism and Matter – Curie law, magnetisation, solenoid circuit	numerical-mcq	Standard	120
15	Magnetism and Matter – oscillating magnetic needle, magnetic potential energy	numerical-mcq	Standard	75
16	Rotational Motion – angular momentum conservation of a subsystem, rotational KE	numerical-mcq	Challenging	150
17	Rotational Motion – ladder equilibrium with limiting friction	numerical-mcq	Challenging	180
18	Rotational Motion – moment of inertia, angular impulse about a fixed axis	numerical-mcq	Standard	75
19	Rotational Motion – rolling on an incline, accelerations of rim points	numerical-mcq	Challenging	150
20	Rotational Motion – rotational kinematics with torque reversal	numerical-mcq	Standard	75
21	Rotational Motion – centre of mass, moment of inertia about parallel axes	numerical-mcq	Standard	60
22	Rotational Motion – angular momentum conservation, inelastic energy loss	numerical-mcq	Standard	60
23	Rotational Motion – rolling friction requirement and energy partition	numerical-mcq	Foundation	60
24	Electromagnetic Waves – superposition of counter-propagating waves, energy density and flux	numerical-mcq	Challenging	150
25	Electromagnetic Waves – displacement current, Ampère–Maxwell law	numerical-mcq	Challenging	150
26	Electromagnetic Waves – intensity of a point source, momentum and radiation pressure	numerical-mcq	Challenging	150
27	Electromagnetic Induction – self-induced emf polarity in an RL segment	numerical-mcq	Foundation	45
28	Electromagnetic Induction – Faraday's law, induced charge and Joule heat	numerical-mcq	Standard	90
29	Electromagnetic Induction – rotating loop, charge vs heat over a half-turn	numerical-mcq	Challenging	150
30	Electromagnetic Induction – average induced current in a rotating coil	numerical-mcq	Standard	75
31	Electromagnetic Induction – mutual inductance, coupled-coil energy rate	numerical-mcq	Challenging	150
32	Electromagnetic Induction – motional emf, terminal velocity	numerical-mcq	Foundation	60
33	Electromagnetic Induction – Lenz's law and interaction of coaxial coils	single	Standard	60
34	Alternating Current – series LCR impedance and average power	numerical-mcq	Standard	90
35	Alternating Current – parallel L and C branches, phasor currents, power	numerical-mcq	Standard	90
36	Alternating Current – ideal transformer with resistive load	numerical-mcq	Foundation	60
37	Alternating Current – resonance, peak energy storage and average power	numerical-mcq	Standard	90
38	Alternating Current – equal-current frequencies and resonance	numerical-mcq	Foundation	60
39	Alternating Current – parallel RL and RC branches, net power factor	numerical-mcq	Standard	120
40	Capacitors – layered dielectrics in series, voltage division	numerical-mcq	Standard	75
41	Capacitors – battery-connected capacitor, battery energy and external work	numerical-mcq	Standard	75
42	Capacitors – dielectric insertion at constant charge	numerical-mcq	Standard	60
43	Capacitors – unbalanced capacitor bridge, node potentials	numerical-mcq	Standard	120
44	Capacitors – capacitor in a DC resistive network at steady state	numerical-mcq	Standard	60
45	Capacitors – charge sharing and energy loss	numerical-mcq	Foundation	60
46	Thermodynamics – entropy production along two paths	single	Challenging	150
47	Thermodynamics – reversible vs irreversible work in a cycle	numerical-mcq	Standard	120
48	Thermodynamics – Hess's law for K, ΔH° and ΔS°	single	Standard	90
49	Thermodynamics – isochoric and isobaric heat	numerical-mcq	Standard	75
50	Thermodynamics – ΔG° vs ΔG	numerical-mcq	Standard	75
51	Thermodynamics – first law with irreversible expansion	numerical-mcq	Challenging	150
52	Thermodynamics – Hess's law, ΔH vs ΔU	numerical-mcq	Standard	90
53	Thermodynamics – Gibbs energy and Q_p after sudden changes	single	Challenging	150
54	Thermodynamics – bond enthalpy estimate	single	Foundation	45
55	p-block (Groups 15–18) – oxoacids of sulphur	numerical-mcq	Challenging	120
56	p-block (Groups 15–18) – group 16 hydride trends	statement	Standard	75
57	p-block (Groups 15–18) – phosphorus oxoacids, basicity and redox	numerical-mcq	Standard	75
58	p-block (Groups 15–18) – chlorine disproportionation	numerical-mcq	Standard	60
59	p-block (Groups 15–18) – PCl5 hydrolysis and structure	numerical-mcq	Standard	60
60	p-block (Groups 15–18) – hypophosphorous acid oxidation	numerical-mcq	Standard	90
61	p-block (Groups 15–18) – ozone and iodometry	single	Standard	45
62	p-block (Groups 15–18) – xenon fluoride hydrolysis	numerical-mcq	Challenging	120
63	p-block (Groups 15–18) – VSEPR shapes of interhalogens and xenon fluorides	single	Foundation	45
64	Equilibrium – buffer adjustment, base addition and dilution	numerical-mcq	Challenging	150
65	Equilibrium – heterogeneous equilibrium, K_p–K_c	numerical-mcq	Standard	60
66	Equilibrium – Q_c after compression and inert-gas addition	single	Standard	90
67	Equilibrium – Q_c vs K_c under selective perturbation	single	Standard	75
68	Equilibrium – degree of dissociation from transferred K	numerical-mcq	Standard	90
69	Equilibrium – Q_p after dilution and selective removal	single	Challenging	120
70	Equilibrium – species ratios of a triprotic acid at fixed pH	single	Standard	60
71	Equilibrium – selective precipitation	numerical-mcq	Standard	75
72	Equilibrium – solubility in a buffer	numerical-mcq	Standard	90
73	GOC – heterolysis, carbocation stability, hyperconjugation	statement	Standard	90
74	GOC – sublimation	single	Foundation	30
75	GOC – steam distillation composition	numerical-mcq	Standard	75
76	GOC – resonance in the enolate ion	statement	Standard	90

Q	Chapter / concept	Format	Level	Time (s)
77	GOC – σ/π bonds and lone pairs in a pyridinium amide	numerical-mcq	Challenging	120
78	GOC – choice of purification technique	single	Foundation	45
79	GOC – stereoisomerism: meso and enantiomers	single	Foundation	45
80	GOC – inductive effect and acid strength	statement	Standard	90
81	GOC – IUPAC nomenclature and conjugation	single	Standard	75
82	Hydrocarbons – ozonolysis, geometrical isomerism, monochlorination	single	Standard	120
83	Hydrocarbons – pentane isomers: symmetry and boiling points	single	Standard	60
84	Hydrocarbons – mixture analysis with Br2 and H2	single	Standard	105
85	Hydrocarbons – oxidation of alkanes with tertiary H	single	Foundation	30
86	Hydrocarbons – hexane isomers: monochlorination and boiling points	single	Standard	90
87	Hydrocarbons – Markovnikov addition of HBr to propyne	single	Foundation	30
88	Hydrocarbons – structure of a diene from ozonolysis	single	Standard	90
89	Hydrocarbons – hydrogenation and combustion of a gas mixture	numerical-mcq	Foundation	60
90	Hydrocarbons – benzene: aromaticity and directing effects	statement	Foundation	40
91	Morphology of Flowering Plants – floral symmetry, placentation	single	Standard	60
92	Morphology of Flowering Plants – stem and leaf modifications	single	Standard	50
93	Morphology of Flowering Plants – aestivation, androecium, placentation	statement	Standard	90
94	Morphology of Flowering Plants – axile, free-central and parietal placentation	single	Standard	60
95	Morphology of Flowering Plants – perigyny, placentation, aestivation, drupe	statement	Standard	75
96	Morphology of Flowering Plants – cohesion and adhesion of stamens	single	Standard	45
97	Morphology of Flowering Plants – simple vs compound leaf, axillary bud	single	Standard	60
98	Morphology of Flowering Plants – monocot (cereal) seed	statement	Standard	75
99	Morphology of Flowering Plants – fruit: simple, true and false fruit	statement	Standard	60
100	Anatomy of Flowering Plants – vascular bundles and organ diagnosis	single	Standard	75
101	Anatomy of Flowering Plants – heartwood and sapwood	statement	Standard	75
102	Anatomy of Flowering Plants – annual rings, spring and autumn wood	statement	Standard	90
103	Anatomy of Flowering Plants – endarch and exarch primary xylem	single	Foundation	35
104	Anatomy of Flowering Plants – bulliform cells vs guard cells	statement	Standard	75
105	Anatomy of Flowering Plants – stomatal apparatus, bulliform cells	statement	Standard	60
106	Anatomy of Flowering Plants – root vs stem, monocot vs dicot, secondary growth	single	Standard	75
107	Anatomy of Flowering Plants – simple and complex permanent tissues	statement	Standard	60
108	Anatomy of Flowering Plants – dorsiventral vs isobilateral leaf	statement	Standard	75
109	Plant Growth and Development – ethylene vs gibberellin in elongation	single	Foundation	40
110	Plant Growth and Development – dedifferentiation and redifferentiation	statement	Standard	75
111	Plant Growth and Development – gibberellin and cytokinin identification	single	Standard	60
112	Plant Growth and Development – auxin, 2,4-D and cytokinin applications	statement	Standard	60
113	Plant Growth and Development – gibberellin, ethylene, cytokinin profiles	statement	Standard	75
114	Plant Growth and Development – ethylene and auxin, stage-dependent responses	single	Standard	50
115	Plant Growth and Development – absolute and relative growth rate	statement	Standard	60
116	Plant Growth and Development – arithmetic vs geometric growth (cell lineages)	numerical-mcq	Challenging	120
117	Plant Growth and Development – plasticity, heterophylly	statement	Standard	75
118	Photosynthesis in Higher Plants – C4 pathway enzymes and acceptors	single	Foundation	35
119	Photosynthesis in Higher Plants – C4 compartmentation, experimental inference	single	Challenging	100
120	Photosynthesis in Higher Plants – chemiosmosis, imposed proton gradient	single	Challenging	90
121	Photosynthesis in Higher Plants – cyclic/noncyclic flow and Calvin stoichiometry	numerical-mcq	Standard	90
122	Photosynthesis in Higher Plants – Calvin cycle limiting resource	numerical-mcq	Standard	75
123	Photosynthesis in Higher Plants – Calvin cycle requirements	single	Foundation	40
124	Photosynthesis in Higher Plants – photorespiration	statement	Standard	50
125	Photosynthesis in Higher Plants – pigments, absorption vs action spectrum	statement	Standard	60
126	Photosynthesis in Higher Plants – limiting factors, gross vs net photosynthesis	numerical-mcq	Standard	75
127	Respiration in Plants – glycolysis and two fermentations, accounting	numerical-mcq	Challenging	100
128	Respiration in Plants – lactic acid fermentation	single	Foundation	35
129	Respiration in Plants – glycolytic entry points, ATP/NADH accounting	numerical-mcq	Challenging	110
130	Respiration in Plants – link reaction, pyruvate dehydrogenase	single	Foundation	40
131	Respiration in Plants – link reaction and TCA accounting, substrate-level phosphorylation	numerical-mcq	Challenging	110
132	Respiration in Plants – ETS: complex II, proton and O2 bookkeeping	numerical-mcq	Standard	90
133	Respiration in Plants – respirometry, RQ of a substrate mixture	numerical-mcq	Challenging	120
134	Respiration in Plants – amphibolic pathway, substrate entry points	single	Standard	75
135	Respiration in Plants – fermentation vs uncoupled respiration	single	Standard	75
136	Structural Organisation in Animals – frog cutaneous respiration	numerical-mcq	Standard	75
137	Structural Organisation in Animals – frog nervous system	statement	Foundation	40
138	Structural Organisation in Animals – frog portal systems	single	Foundation	35
139	Structural Organisation in Animals – frog urinogenital system	statement	Standard	75
140	Structural Organisation in Animals – muscle tissue	statement	Standard	60
141	Structural Organisation in Animals – glandular and compound epithelia	statement	Standard	60
142	Structural Organisation in Animals – connective tissue classification	single	Foundation	40
143	Structural Organisation in Animals – areolar, adipose and ciliated tissues	statement	Standard	60
144	Structural Organisation in Animals – epithelial and connective tissue function	statement	Standard	50
145	Structural Organisation in Animals – cell junctions	single	Standard	60
146	Structural Organisation in Animals – frog sense organs	statement	Standard	55
147	Structural Organisation in Animals – frog circulation and life history	statement	Standard	60
148	Structural Organisation in Animals – frog digestive system	statement	Standard	55
149	Structural Organisation in Animals – epithelium – layers and function	single	Standard	60
150	Structural Organisation in Animals – frog excretion, habitat and reproduction	statement	Standard	55
151	Breathing and Exchange of Gases – respiratory organs in animals	statement	Standard	50
152	Breathing and Exchange of Gases – oxygen–haemoglobin binding factors	single	Standard	60
153	Breathing and Exchange of Gases – lung volumes and capacities	numerical-mcq	Challenging	120
154	Breathing and Exchange of Gases – vital capacity	numerical-mcq	Foundation	40
155	Breathing and Exchange of Gases – oxygen transport	numerical-mcq	Standard	90
156	Breathing and Exchange of Gases – conducting versus exchange zones	statement	Standard	60

Q	Chapter / concept	Format	Level	Time (s)
157	Breathing and Exchange of Gases – respiratory disorders	statement	Standard	50
158	Breathing and Exchange of Gases – lung volumes – measurement errors	numerical-mcq	Standard	90
159	Breathing and Exchange of Gases – steps of respiration	statement	Standard	50
160	Breathing and Exchange of Gases – diffusion – solubility, area and thickness	numerical-mcq	Challenging	120
161	Breathing and Exchange of Gases – mechanism of inspiration	single	Standard	50
162	Breathing and Exchange of Gases – carbon dioxide transport	statement	Standard	50
163	Breathing and Exchange of Gases – tidal volume and alveolar ventilation	numerical-mcq	Standard	90
164	Breathing and Exchange of Gases – regulation of respiration	statement	Standard	45
165	Breathing and Exchange of Gases – direction of gas diffusion	single	Standard	45
166	Excretory Products and their Elimination – loop of Henle mass balance	numerical-mcq	Standard	90
167	Excretory Products and their Elimination – tubular reabsorption and secretion	statement	Standard	50
168	Excretory Products and their Elimination – nephron segments	statement	Standard	55
169	Excretory Products and their Elimination – cortical and juxtamedullary nephrons	statement	Standard	55
170	Excretory Products and their Elimination – excretory structures in animals	statement	Standard	50
171	Excretory Products and their Elimination – cortical and juxtamedullary nephrons	single	Foundation	35
172	Excretory Products and their Elimination – regulation of kidney function	statement	Standard	50
173	Excretory Products and their Elimination – nitrogenous wastes	statement	Standard	45
174	Excretory Products and their Elimination – ADH and medullary gradient	single	Standard	60
175	Excretory Products and their Elimination – filtration, reabsorption and secretion	numerical-mcq	Standard	90
176	Excretory Products and their Elimination – selective reabsorption – urine volume	numerical-mcq	Foundation	40
177	Excretory Products and their Elimination – PCT reabsorption capacity	numerical-mcq	Challenging	105
178	Excretory Products and their Elimination – renin–angiotensin mechanism and ANF	statement	Standard	45
179	Excretory Products and their Elimination – haemodialysis – diffusion gradients	single	Standard	75
180	Excretory Products and their Elimination – filtration, reabsorption and secretion	statement	Standard	45

PHYSICS

Detailed solutions

Q.1

Current Electricity – stretched wire, parallel arcs, internal resistance • Standard • 90 s **Answer: (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) $8\,\text{V}$, $\frac{1}{2}\,\text{A}$

Solution

At constant volume, doubling the length halves the area, so $R' = 4R = 48\,\Omega$. The arcs are $16\,\Omega$ and $32\,\Omega$ in parallel: $\frac{16\times32}{48} = \frac{32}{3}\,\Omega$. Total resistance $= \frac{32}{3} + \frac{4}{3} = 12\,\Omega$, so $I = 1\,\text{A}$ and terminal voltage $= \frac{32}{3}\,\text{V}$. Shorter-arc current $= \frac{32/3}{16} = \frac{2}{3}\,\text{A}$. Option (3) gives the longer-arc current.

Source: Adapted from NEET 2024 (re-exam) – stretched wire bent into a circle

Common mistake: Taking the stretched resistance as $2R$ (ignoring the area change) instead of $4R$.

Q.2

Current Electricity – drift speed and Joule power under network change • Standard • 120 s **Answer: (1)**

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 $\frac{1}{16}$

Solution

Thin piece: $4R$; thick piece: R. Parallel: load $\frac{4R}{5}$, cell current $\frac{5E}{9R}$, terminal voltage $\frac{4E}{9}$; thin current $\frac{E}{9R}$, thick current $\frac{4E}{9R}$. Series: $I = \frac{E}{6R}$. Drift speed in the same piece $\propto I$: $\frac{E/6R}{E/9R} = \frac{3}{2}$. Thick-piece power $\propto I^2$: $\left(\frac{E/6R}{4E/9R}\right)^2 = \left(\frac{3}{8}\right)^2 = \frac{9}{64}$. Option (2) has the right drift ratio but squares $\frac{3}{4}$ instead of the true thick-piece current ratio $\frac{3}{8}$.

Source: Adapted from NEET 2024 (re-exam) – drift speed with changed wire diameter

Common mistake: Forgetting the internal resistance R when finding the parallel-case terminal voltage.

Q.3

Current Electricity – internal resistance from two loads, maximum power transfer • Standard • 75 s **Answer: (4)**

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) $3\,\Omega$, $12\,\text{W}$

Solution

Currents are $1\,\text{A}$ and $2\,\text{A}$. $E = 9 + r = 6 + 2r \Rightarrow r = 3\,\Omega$, $E = 12\,\text{V}$. Power in R is maximum at $R = r = 3\,\Omega$: $P_{\max} = \frac{E^2}{4r} = \frac{144}{12} = 12\,\text{W}$. Option (2) has the right R but halves the maximum power.

Source: Adapted from NEET 2022 – terminal voltage of a cell with internal resistance

Common mistake: Writing $P_{\max} = E^2/r$ instead of $E^2/(4r)$.

Q.4

Current Electricity – Wheatstone bridge, Kirchhoff nodal analysis • Standard • 120 s **Answer: (1)**

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 $\frac{18}{35}\,\text{A}$

Solution

Initially $\frac{2}{4} = \frac{3}{6}$, so the bridge is balanced: $R_{eq} = 6 \parallel 9 = \frac{18}{5}\,\Omega$, $I = \frac{10}{3}\,\text{A}$. After the change, take $V_C = 0$, $V_A = 12$: $\frac{V_B-12}{2} + \frac{V_B}{2} + \frac{V_B-V_D}{5} = 0$ and $\frac{V_D-12}{3} + \frac{V_D}{6} + \frac{V_D-V_B}{5} = 0$, giving $V_B = \frac{25}{4}\,\text{V}$, $V_D = \frac{15}{2}\,\text{V}$. Battery current $= \frac{12-25/4}{2} +$

$\frac{12-15/2}{3} = \frac{35}{8}$ A. Increase $= \frac{35}{8} - \frac{10}{3} = \frac{25}{24}$ A. Dropping the bridge resistor after the change gives $3 + \frac{4}{3} = \frac{13}{3}$ A (increase 1 A, not offered); the bridge is unbalanced, so the $5\,\Omega$ resistor carries current and must be included.

Source: Original synthesis

Common mistake: Continuing to ignore the $5\,\Omega$ bridge resistor after the bridge has become unbalanced.

Q.5

Current Electricity – temperature dependence of resistance, extremum • Standard • 120 s **Answer: (3)**

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 $\frac{E}{2}$

Solution

Let $x = \alpha(T - T_0)$. $R_1 = R(1 + x)$, $R_2 = R(2 - x)$, $R_1 + R_2 = 3R$, so $R_p = \frac{R(1+x)(2-x)}{3} = \frac{R(2+x-x^2)}{3}$. Minimum cell current means maximum R_p: $x = \frac{1}{2}$, inside the interval, $R_p = \frac{3R}{4}$. Total $= R$, $I = \frac{E}{R}$, terminal voltage $= IR_p = \frac{3E}{4}$. Option (2) evaluates the end point $x = 1$ instead of the interior maximum.

Source: Original synthesis

Common mistake: Checking only the end points of the interval and missing the interior maximum of R_p.

Q.6

Current Electricity – Kirchhoff laws, cell being charged, energy accounting • Challenging • 150 s **Answer: (4)**

Three branches connect a node A to a node B. Branch 1 contains a 12 V cell with internal resistance $1\,\Omega$; branch 2 contains a 6 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 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 V cell)/(chemical-energy delivery rate from the 12 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 $\frac{1}{4}$

Solution

Let $V = V_A - V_B$ with $6 < V < 12$. $I_1 = 12 - V$ (delivered), $I_2 = \frac{V-6}{4}$ (into the 6 V cell). Equal internal heating: $I_1^2(1) = I_2^2(4) \Rightarrow I_1 = 2I_2 \Rightarrow 12 - V = \frac{V-6}{2} \Rightarrow V = 10$ V. Then $I_1 = 2$ A, $I_2 = 1$ A, $I_R = 1$ A, $R = 10\,\Omega$. Storage rate $= 6 \times 1 = 6$ W; delivery rate $= 12 \times 2 = 24$ W; ratio $\frac{1}{4}$. (The other root $V = 18$ V would make both cells absorb energy, impossible.) Option (2) takes the current ratio $\frac{1}{2}$ instead of the power ratio.

Source: Original synthesis

Common mistake: Using the current ratio $I_2/I_1 = \frac{1}{2}$ instead of the emf-weighted power ratio $\frac{6\times1}{12\times2}$.

Q.7

Moving Charges and Magnetism – velocity selector, retarding potential, orbit radius • Challenging • 150 s **Answer: (3)**

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 $\sqrt{3}$

Solution

Both leave the selector with $u = E/B$. After retardation: $v_p^2 = u^2 - \frac{2qV}{m}$, $v_\alpha^2 = u^2 - \frac{qV}{m}$. With $r = \frac{mv}{qB'}$: $\frac{r_\alpha}{r_p} = \frac{(4m)v_\alpha/(2q)}{mv_p/q} = \frac{2v_\alpha}{v_p} = 3 \Rightarrow \frac{v_\alpha}{v_p} = \frac{3}{2}$. Then $u^2 - x = \frac{9}{4}(u^2 - 2x)$ with $x = \frac{qV}{m}$ gives $x = \frac{5u^2}{14}$, so $V = \frac{5mE^2}{14qB^2}$; $v_p^2 = \frac{2u^2}{7} > 0$. Option (1) takes the radius ratio itself as the speed ratio.

Source: Adapted from NEET 2025 – crossed fields for undeflected motion

Common mistake: Equating the radius ratio to the speed ratio, forgetting the alpha particle's m/q is twice the proton's.

Q.8 Moving Charges and Magnetism – circular-loop field and magnetic moment with non-ideal supply • Challenging • 150 s **Answer: (1)**

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 $\frac{2}{17}$

Solution

Original radius a, current $\frac{E}{2R}$. Each new turn: radius $\frac{a}{4}$, resistance $\frac{R}{4}$; four in parallel give $\frac{R}{16}$. Total current $\frac{E}{R+R/16} = \frac{16E}{17R}$; each turn carries $\frac{4E}{17R} = \frac{8}{17} \times \frac{E}{2R}$. Field: $B_2/B_1 = 4 \times \frac{8}{17} \times 4 = \frac{128}{17}$ (four turns, each with $\frac{8}{17}$ current and radius $\frac{1}{4}$). Moment: $\mu_2/\mu_1 = 4 \times \frac{8}{17} \times \frac{1}{16} = \frac{2}{17}$. Option (2) assumes each new turn still carries the original current, ignoring the changed circuit resistance.

Source: Adapted from NEET 2025 – magnetic moments of coils made from equal wire

Common mistake: Assuming each small turn carries the original current, which gives the tempting 16 and $\frac{1}{4}$.

Q.9 Moving Charges and Magnetism – forces between parallel currents • Standard • 120 s **Answer: (4)**

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 $-x$

Solution

Middle wire: attraction to wire 1 (toward $-x$) is $\frac{\mu_0(I)(2I)}{2\pi a}$; it must be balanced by attraction to wire 3 at distance $2a$: $\frac{\mu_0(2I)I_3}{2\pi(2a)} = \frac{\mu_0(2I)I}{2\pi a} \Rightarrow I_3 = 2I$ (out of page; a negative I_3 would repel toward $-x$ and could not balance). Wire 3 is attracted toward $-x$ by both: $\frac{F}{l} = \frac{\mu_0}{2\pi}\left[\frac{(I)(2I)}{3a} + \frac{(2I)(2I)}{2a}\right] = \frac{4\mu_0 I^2}{3\pi a}$. Acceleration $= \frac{4\mu_0 I^2}{3\pi a\lambda}$ toward $-x$. Option (3) has the right magnitude but the wrong direction (parallel currents attract).

Source: Adapted from NEET 2022 (Phase 2) – force between two parallel wires

Common mistake: Taking parallel currents as repelling, giving the right magnitude but direction $+x$.

Q.10 Moving Charges and Magnetism – axial field of coaxial loops, torque on a dipole • Challenging • 150 s **Answer: (2)**

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 $\mu B_0\left[1 - \frac{1}{\sqrt{2}}\right]$

Solution

On the axis, $\frac{IR^2}{(R^2+x^2)^{3/2}} = \frac{(I/\sqrt{2})(4R^2)}{(4R^2+x^2)^{3/2}} \Rightarrow \left(\frac{4R^2+x^2}{R^2+x^2}\right)^{3/2} = 2\sqrt{2} \Rightarrow \frac{4R^2+x^2}{R^2+x^2} = 2 \Rightarrow x = \sqrt{2}R$ (the only positive root). At the centre the larger coil gives $\frac{\mu_0(I/\sqrt{2})}{2(2R)} = \frac{B_0}{2\sqrt{2}}$, opposite to B_0: $B_{net} = B_0\left[1 - \frac{1}{2\sqrt{2}}\right]$, and $\tau_{\max} = \mu B_{net}$. Option (3) uses only the larger coil's field.

Source: Adapted from NEET 2022 (Phase 2) – axial field of a circular loop

Common mistake: Adding the two central fields although the currents are in opposite senses.

Q.11 Moving Charges and Magnetism – Ampère's law, cylinder with off-axis cavity, Lorentz force • Challenging • 180 s **Answer: (3)**

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) $-\frac{\mu_0 I v}{3\pi a}\,\hat{x}$

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

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

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

Solution

Metal area $= \pi a^2 - \frac{\pi a^2}{4} = \frac{3\pi a^2}{4}$, so $J = \frac{4I}{3\pi a^2}$. Inside a full cylinder $\vec{B} = \frac{\mu_0 J}{2}\hat{z} \times \vec{r}$; subtracting the cavity cylinder centred at $\vec{d} = \frac{a}{2}\hat{x}$ gives a uniform $\vec{B} = \frac{\mu_0 J}{2}\hat{z} \times \vec{d} = \frac{\mu_0 I}{3\pi a}\hat{y}$. Magnetic force $q\vec{v} \times \vec{B} = qvB(\hat{z} \times \hat{y}) = -qvB\hat{x}$, so $\vec{E} = -\vec{v} \times \vec{B} = +\frac{\mu_0 I v}{3\pi a}\hat{x}$. Option (4) uses the full-cylinder area πa^2 in J; option (2) forgets that external currents produce a field inside the hole.

Source: Adapted from NEET 2022 (Phase 1) – field inside a current-carrying cylinder

Common mistake: Using $J = I/(\pi a^2)$ (ignoring the removed area), which gives $\frac{\mu_0 I v}{4\pi a}$.

Q.12 Moving Charges and Magnetism – solenoid field, inductance and magnetic energy • Challenging • 150 s **Answer: (1)**

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) $\frac{16}{25}$

Solution

Stretching gives resistance $4R$. Wire length and turns both double, so each turn has the same circumference, radius and area A. $L = \frac{\mu_0 N^2 A}{l}$ becomes $\frac{\mu_0 (2N)^2 A}{l/2} = 8L$. Current changes from $\frac{E}{2R}$ to $\frac{E}{5R}$ (factor $\frac{2}{5}$). Energy ratio $= 8 \times \left(\frac{2}{5}\right)^2 = \frac{32}{25}$. Option (4) takes L to rise only 4-fold (forgetting the halved length) and option (3) 16-fold; the turn area is unchanged, so the factor is exactly 8.

Source: Adapted from NEET 2022 (Phase 1) – field inside a long solenoid

Common mistake: Assuming the turn radius changes, or forgetting that halving the length doubles L again.

Q.13 Magnetism and Matter – resultant dipole moment, potential energy and torque • Standard • 90 s **Answer: (4)**

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) $\mu B, \mu B$

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

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

Solution

Each half has moment $\frac{\mu}{2}$; resultant $= \sqrt{2\left(\frac{\mu}{2}\right)^2(1+\cos 120^\circ)} = \frac{\mu}{2}$. Work $= U(90^\circ) - U(0^\circ) = 0 - \left(-\frac{\mu B}{2}\right) = \frac{\mu B}{2}$. Torque $\frac{\mu B}{2}\sin\theta$ is greatest at 90°: $\frac{\mu B}{2}$. Option (1) uses $\cos 60^\circ$ geometry for a 60° joint, giving $\frac{\sqrt{3}\mu}{2}$.

Source: Adapted from NEET 2024 – bent bar magnet resultant moment

Common mistake: Taking the resultant as $\frac{\sqrt{3}}{2}\mu$ by confusing the 120° angle between moments with 60°.

Q.14

Magnetism and Matter – Curie law, magnetisation, solenoid circuit • Standard • 120 s **Answer: (2)**

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

Solution

Doubling T halves χ, so $H = nI$ and hence I must double: from $\frac{E}{2R}$ to $\frac{E}{R}$. New circuit resistance $= 2R + R = 3R$, so $E' = 3E$. Winding power: $\left(\frac{E}{2R}\right)^2 R = \frac{E^2}{4R} \rightarrow \left(\frac{E}{R}\right)^2 (2R) = \frac{2E^2}{R}$, ratio 8. Option (4) forgets the doubled winding resistance in the power.

Source: Adapted from NEET 2023 (Manipur) – susceptibility vs temperature of a paramagnet

Common mistake: Using $P = I^2R$ with the original R, giving a power ratio of 4.

Q.15

Magnetism and Matter – oscillating magnetic needle, magnetic potential energy • Standard • 75 s **Answer: (4)**

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 $16\mu B$

Solution

$\frac{T'^2}{T^2} = \frac{1}{4} = \frac{2I/B'}{I/B} \Rightarrow B' = 8B$. Work from $\theta = 0$ to π: $\Delta U = 2\mu B' = 16\mu B$. Option (3) uses $\mu B'$ instead of $2\mu B'$.

Source: Adapted from NEET 2024 – magnetic needle oscillations

Common mistake: Taking the parallel-to-antiparallel work as $\mu B'$ instead of $2\mu B'$.

Q.16

Rotational Motion – angular momentum conservation of a subsystem, rotational KE • Challenging • 150 s **Answer: (4)**

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 $\frac{K}{8}$

Solution

Core mass $\frac{M}{8}$, radius $\frac{R}{2}$: $I_c = \frac{2}{5} \cdot \frac{M}{8} \cdot \frac{R^2}{4} = \frac{I_0}{32}$, energy $\frac{K}{32}$ at ω. Contracting to $\frac{R}{4}$ divides I by 4, so $\omega \rightarrow 4\omega$ (period $\frac{T}{4}$) and $K \rightarrow 4 \times \frac{K}{32} = \frac{K}{8}$. Option (3) assumes the core keeps the whole star's energy K and then gains by contraction; the removal itself takes away $\frac{31}{32}$ of the rotational energy.

Source: Adapted from NEET 2025 – Sun's rotation period after change of radius

Common mistake: Conserving the whole star's angular momentum in the core instead of the core's own share.

Q.17 Rotational Motion – ladder equilibrium with limiting friction • Challenging • 180 s **Answer: (2)**

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

Solution

Floor normal $= 3mg$. Horizontal balance: $f = N_w - \frac{mg}{4}$. Moments about the base: $\left(N_w - \frac{mg}{4}\right) L\sin 60^\circ = mg\frac{L}{2}\cos 60^\circ + 2mg\,x\cos 60^\circ$, so $f = \frac{mg}{\sqrt{3}}\left(\frac{1}{2} + \frac{2x}{L}\right)$. Limiting: $f = \frac{3mg}{2\sqrt{3}} \Rightarrow \frac{1}{2} + \frac{2x}{L} = \frac{3}{2} \Rightarrow x = \frac{L}{2}$. The rope term cancels from the friction requirement because rope and wall forces act at the same point along the same line. The tempting error is to think the rope (pulling toward the wall) adds to the friction capacity and lets the person climb higher (options 1 or 4); it only raises the wall reaction by exactly $mg/4$.

Source: Adapted from NEET 2025 – rod against smooth wall and rough floor

Common mistake: Adding the rope tension $mg/4$ to the available friction, as if it relieved the floor directly.

Q.18 Rotational Motion – moment of inertia, angular impulse about a fixed axis • Standard • 75 s **Answer: (1)**

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) $\frac{J}{mL}$

Solution

$I = \frac{mL^2}{12} + m\left(\frac{L}{2}\right)^2 = \frac{mL^2}{3}$. Angular impulse about the axis $= J\frac{L}{2}$ (the axle impulse has no moment). $\omega = \frac{JL/2}{mL^2/3} = \frac{3J}{2mL}$. Option (3) uses the bare-rod inertia $\frac{mL^2}{12}$.

Source: Adapted from NEET 2024 – moment of inertia of a thin rod

Common mistake: Using $\frac{mL^2}{12}$ and forgetting the end mass's $m(L/2)^2$.

Q.19 Rotational Motion – rolling on an incline, accelerations of rim points • Challenging • 150 s **Answer: (3)**

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 $\frac{2g}{3}$

Solution

$a = \frac{2}{3}g\sin 30^\circ = \frac{g}{3}$, $\alpha R = a$. $v^2 = 2a\frac{R}{2} = aR$, so $\omega^2 R = a = \frac{g}{3}$. At P, tangential $-a$ cancels a_{cm}, leaving centripetal $\frac{g}{3}$ normal to the incline: $a_P = \frac{g}{3}$. At Q, $a_{cm} + \alpha R = \frac{2g}{3}$ along the incline plus $\frac{g}{3}$ normal: $a_Q = \sqrt{\frac{4g^2}{9} + \frac{g^2}{9}} = \frac{\sqrt{5}g}{3}$. Option (4) wrongly sets the contact point's acceleration to zero.

Source: Adapted from NEET 2024 – speeds of points on a rolling wheel

Common mistake: Assuming the contact point has zero acceleration because its velocity is zero.

Q.20 Rotational Motion – rotational kinematics with torque reversal • Standard • 75 s **Answer: (2)**

A flywheel starts at angular speed $20\,\text{rad}\,\text{s}^{-1}$. A constant torque accelerates it to $60\,\text{rad}\,\text{s}^{-1}$ in $10\,\text{s}$. 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) $\frac{3}{4}$

Solution

$\alpha = \frac{60-20}{10} = 4\,\text{rad}\,\text{s}^{-2}$. $\theta_1 = \frac{20+60}{2} \times 10 = 400\,\text{rad}$. $\theta_2 = \frac{60^2}{2\times4} = 450\,\text{rad}$. Ratio $\frac{9}{8}$. Option (1) compares times ($15\,\text{s}$ vs $10\,\text{s}$) instead of displacements.

Source: Adapted from NEET 2022 – uniformly accelerated flywheel

Common mistake: Comparing stage durations ($15\,\text{s} : 10\,\text{s}$) instead of angular displacements.

Q.21 Rotational Motion – centre of mass, moment of inertia about parallel axes • Standard • 60 s **Answer: (3)**

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) $\frac{9}{8}$

Solution

Centre of mass is $\frac{2L}{3}$ from m. $I_{cm} = m\frac{4L^2}{9} + 2m\frac{L^2}{9} = \frac{2}{3}mL^2$; $I_{mid} = 3m\frac{L^2}{4} = \frac{3}{4}mL^2$. Ratio $\frac{8}{9}$ (less than 1, as the parallel-axis theorem requires). Option (4) inverts the ratio.

Source: Adapted from NEET 2022 – centre of mass of two masses on a rod

Common mistake: Inverting the ratio; I_{cm} must be the smaller one.

Q.22 Rotational Motion – angular momentum conservation, inelastic energy loss • Standard • 60 s **Answer: (2)**

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) $\frac{2}{3}$

Solution

$I_0 = \frac{MR^2}{2}$; final $I = \frac{MR^2}{2} + \frac{M}{2}R^2 = MR^2 = 2I_0$. L conserved: $\omega_f = \frac{\omega}{2}$. $\frac{K_f}{K_i} = \frac{2I_0(\omega/2)^2}{I_0\omega^2} = \frac{1}{2}$, so $\frac{1}{2}$ is lost. Option (3) assumes ω halves while I stays the same in $K = \frac{1}{2}I\omega^2$.

Source: Original synthesis

Common mistake: Computing K_f with the halved ω but the original I, giving $\frac{3}{4}$ lost.

Q.23 Rotational Motion – rolling friction requirement and energy partition • Foundation • 60 s **Answer: (4)**

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

Solution

$mg\sin\theta - f = ma$, $fR = \frac{MR^2}{2}\frac{a}{R} \Rightarrow a = \frac{2}{3}g\sin\theta$, $f = \frac{1}{3}mg\sin\theta$. $\mu_{\min} = \frac{\tan 30^\circ}{3} = \frac{1}{3\sqrt{3}}$. $K_{rot} = \frac{1}{4}Mv^2$, $K = \frac{3}{4}Mv^2$, fraction $\frac{1}{3}$. Option (3) takes the translational fraction $\frac{2}{3}$.

Source: Original synthesis

Common mistake: Reporting the translational fraction $\frac{2}{3}$ instead of the rotational fraction.

Q.24 Electromagnetic Waves – superposition of counter-propagating waves, energy density and flux • Challenging • 150 s **Answer: (4)**

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 $\frac{4}{5}$

Solution

$\vec{E}\times\vec{B}$ must point along each propagation direction: $\vec{B}_1 = \frac{60}{c}\hat{z}$, $\vec{B}_2 = -\frac{20}{c}\hat{z}$. Net $E = 80$, $cB = 40$. $\frac{u_E}{u_B} = \frac{80^2}{40^2} = 4$. $u = \frac{\varepsilon_0}{2}(6400 + 1600) = 4000\varepsilon_0$; $S = \varepsilon_0 c(80)(40) = 3200\varepsilon_0 c$; $\frac{S}{cu} = \frac{4}{5}$. Option (3) applies $E = cB$ to the superposed field as if it were one travelling wave.

Source: Adapted from NEET 2023 – magnetic amplitude from electric amplitude

Common mistake: Applying $E = cB$ (equal energy shares) to a superposition of oppositely travelling waves.

Q.25 Electromagnetic Waves – displacement current, Ampère–Maxwell law • Challenging • 150 s **Answer: (4)**

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

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

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

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

Solution

$B\cdot 2\pi r = \mu_0\varepsilon_0\frac{d\Phi_E}{dt}$. At $r = \frac{3a}{2}$: enclosed field area $\pi\left(\frac{9a^2}{4} - a^2\right) = \frac{5\pi a^2}{4}$, so $B_1 = \frac{1}{c^2}\cdot\frac{k}{d}\cdot\frac{5\pi a^2/4}{3\pi a} = \frac{5ak}{12c^2 d}$. At $r = 3a$: area $3\pi a^2$, $B_2 = \frac{1}{c^2}\cdot\frac{k}{d}\cdot\frac{3\pi a^2}{6\pi a} = \frac{ak}{2c^2 d}$. Ratio $\frac{5}{6}$. Option (2) inverts the ratio; option (1) wrongly takes B to be the same at the two radii.

Source: Adapted from NEET 2025 – magnetic field inside a charging circular capacitor

Common mistake: Including the central hole in the enclosed electric flux.

Q.26 Electromagnetic Waves – intensity of a point source, momentum and radiation pressure • Challenging • 150 s **Answer: (2)**

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 m away for 1000 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 J and $\frac{10}{3}\ \mu\mathrm{N\,s}$

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

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

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

Solution

$I = \frac{4\pi\times10^3}{4\pi(10)^2} = 10\,\mathrm{W\,m^{-2}}$. Projected area $0.20\cos60^\circ = 0.10\,\mathrm{m^2}$, so incident energy $= 10\times0.10\times1000 = 1000$ J; absorbed 750 J. Normal impulse: absorbed part $\frac{750}{c}\cos60^\circ$, reflected part $2\cdot\frac{250}{c}\cos60^\circ$; total $\frac{375+250}{c} = \frac{625}{3\times10^8} = \frac{25}{12}\ \mu\mathrm{N\,s}$. Option (1) omits the $\cos60^\circ$ projection on the momentum ($\frac{1000}{c} = \frac{10}{3}\ \mu\mathrm{N\,s}$).

Source: Adapted from NEET 2022 (Phase 1) – energy radiated by a transmitter

Common mistake: Forgetting either the projected collecting area or the factor 2 for the reflected fraction.

Q.27 Electromagnetic Induction – self-induced emf polarity in an RL segment • Foundation • 45 s **Answer: (2)**

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

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

Solution

$V_A - V_B = IR + L\frac{dI}{dt} = 12 + 2(-5) = 2\,\text{V}$. A decreasing current makes the inductor act as a source aiding the current, giving a $10\,\text{V}$ rise. Option (4) adds $|L\,dI/dt|$ with the wrong sign.

Source: Adapted from NEET 2025 – potential difference across an R–L segment

Common mistake: Using $|dI/dt|$ and adding $10\,\text{V}$ to the resistor drop, giving $22\,\text{V}$.

Q.28 Electromagnetic Induction – Faraday's law, induced charge and Joule heat • Standard • 90 s **Answer: (1)**

The externally imposed magnetic flux through a one-turn loop is $\Phi(t) = (t^2 - 4t)\,\text{Wb}$ for $0 \le t \le 4\,\text{s}$. 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) $0\,\text{C}$ and $\frac{32}{3}\,\text{J}$ (2) $8\,\text{C}$ and $0\,\text{J}$

(3) $0\,\text{C}$ and $\frac{16}{3}\,\text{J}$ (4) $4\,\text{C}$ and $\frac{32}{3}\,\text{J}$

Solution

$\varepsilon = -\frac{d\Phi}{dt} = 4 - 2t$. Net charge $= -\frac{\Phi(4)-\Phi(0)}{R} = 0$ (current reverses at $t = 2\,\text{s}$). Heat $= \int_0^4 \frac{(4-2t)^2}{2}dt = \frac{32}{3}\,\text{J}$. Option (3) halves the heat (e.g. by taking only $0 \le t \le 2\,\text{s}$); option (4) gives a nonzero net charge although the end-point fluxes are equal.

Source: Adapted from NEET 2022 (Phase 2) – time-varying flux through a coil

Common mistake: Concluding that zero net charge means zero heat.

Q.29 Electromagnetic Induction – rotating loop, charge vs heat over a half-turn • Challenging • 150 s **Answer: (1)**

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

(3) $\frac{\pi B a^2 \omega}{2}$ (4) $\frac{B a^2 \omega}{\pi}$

Solution

$|\varepsilon| = Ba^2\omega\sin\omega t$ for $0 \le t \le \pi/\omega$. $Q_{\text{abs}} = \frac{Ba^2\omega}{R}\cdot\frac{2}{\omega} = \frac{2Ba^2}{R}$. $H = \frac{B^2a^4\omega^2}{R}\cdot\frac{\pi}{2\omega} = \frac{\pi B^2 a^4 \omega}{2R}$. $\frac{H}{Q_{\text{abs}}} = \frac{\pi B a^2 \omega}{4}$. Option (2) is the rms-like guess $\varepsilon_0/2$; option (4) is the time-average emf divided by 2.

Source: Adapted from NEET 2022 (Phase 1) – flux through a square loop

Common mistake: Assuming H/Q equals the average emf $\frac{2Ba^2\omega}{\pi}$ or the peak emf.

Q.30 Electromagnetic Induction – average induced current in a rotating coil • Standard • 75 s **Answer: (3)**

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

(1) $2\,\text{A}$ (2) $\frac{2}{\pi}\,\text{A}$

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

Solution

$NBA = 100 \times 0.50 \times 0.010 = 0.50\,\text{Wb}$; it falls to zero in $\Delta t = \frac{\pi/2}{20} = \frac{\pi}{40}\,\text{s}$. Charge $= \frac{NBA}{R} = 0.10\,\text{C}$; average current $= \frac{0.10}{\pi/40} = \frac{4}{\pi}\,\text{A}$. Option (1) is the peak current $\frac{NBA\omega}{R}$.

Source: Adapted from NEET 2023 (Manipur) – peak emf of a rotating coil

Common mistake: Giving the peak current $NBA\omega/R = 2\,\text{A}$ instead of the average.

Q.31 Electromagnetic Induction – mutual inductance, coupled-coil energy rate • Challenging • 150 s **Answer: (4)**

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 $-9\,\text{W}$

Solution

$v_1 = L_1\dot{I}_1 + M\dot{I}_2 = 0 \Rightarrow \dot{I}_2 = -\frac{4\times1000}{3} = -\frac{4000}{3}\,\text{A s}^{-1}$. $v_2 = M\dot{I}_1 + L_2\dot{I}_2 = 3 - 12 = -9\,\text{V}$. $\frac{dU}{dt} = 0\times2 + (-9)\times1 = -9\,\text{W}$. Option (2) drops the sign of v_2; option (3) swaps the coefficients ($L_1\dot{I}_2 + M\dot{I}_1 = 0$, giving $-750\,\text{A s}^{-1}$).

Source: Adapted from NEET 2023 – energy stored in an inductor

Common mistake: Swapping L_1 and M in the zero-emf condition, which gives $-750\,\text{A s}^{-1}$.

Q.32 Electromagnetic Induction – motional emf, terminal velocity • Foundation • 60 s **Answer: (4)**

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

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

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

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

Solution

$I = \frac{Blv}{R}$, magnetic force $\frac{B^2l^2v}{R} = mg \Rightarrow v_t = \frac{mgR}{B^2l^2}$. $K = \frac{1}{2}mv_t^2 = \frac{m^3g^2R^2}{2B^4l^4}$. Option (2) omits the $\frac{1}{2}$; option (1) is v_t itself.

Source: Original synthesis

Common mistake: Dropping the factor $\frac{1}{2}$ in $K = \frac{1}{2}mv_t^2$.

Q.33 Electromagnetic Induction – Lenz's law and interaction of coaxial coils • Standard • 60 s **Answer: (3)**

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.

Solution

The flux through coil 2 is decreasing, so coil 2's induced current opposes the decrease by producing a field in the same sense: clockwise from the same side. Parallel (same-sense) currents attract. Option (4) is the behaviour for an increasing current; option (2) ignores that changing current alone changes the flux.

Source: Adapted from NEET 2024 – induced currents in neighbouring coils

Common mistake: Applying the 'opposite current, repulsion' rule that holds only for an increasing primary current.

Q.34 Alternating Current – series LCR impedance and average power • Standard • 90 s **Answer: (3)**

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) $\frac{32}{257}$

Solution

At f: $Z^2 = 20^2 + 20^2 = 800$. At $2f$: $X_L = 90\,\Omega$, $X_C = 12.5\,\Omega$, $Z^2 = 400 + 77.5^2 = 6406.25$. $P = \frac{V^2R}{Z^2}$, so ratio $= \frac{800}{6406.25} = \frac{128}{1025}$. Option (1) assumes $P \propto 1/f^2$; the reactances scale oppositely, so the full impedance must be recomputed.

Source: Adapted from NEET 2025 – series RLC with given reactances

Common mistake: Doubling X_C as well as X_L when frequency doubles.

Q.35 Alternating Current – parallel L and C branches, phasor currents, power • Standard • 90 s **Answer: (4)**

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

Solution

Initially $\omega CV = \frac{V}{\omega L} = I_0$. New: $I_C = (2\omega)C\frac{V}{2} = I_0$, $I_L = \frac{V/2}{2\omega L} = \frac{I_0}{4}$. The branch currents are in antiphase, so the source current is $I_0 - \frac{I_0}{4} = \frac{3I_0}{4}$, capacitive, leading the voltage by $\frac{\pi}{2}$. Ideal reactive elements absorb zero average power. Option (3) gets the magnitude but assigns the phase of the weaker (inductive) branch.

Source: Adapted from NEET 2023 – capacitor current when source frequency changes

Common mistake: Taking the phase from the inductor branch, although the capacitor branch now carries the larger current.

Q.36 Alternating Current – ideal transformer with resistive load • Foundation • 60 s **Answer: (2)**

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) $0.10\,\text{A}$

Solution

$V_s = 24\,\text{V}$. Each lamp: $R = \frac{12^2}{24} = 6\,\Omega$; series load $12\,\Omega$, $I_s = 2\,\text{A}$. $I_p = \frac{I_s}{10} = 0.20\,\text{A}$ (check: $48\,\text{W} = 240 \times 0.20$). Option (1) is the secondary current.

Source: Adapted from NEET 2023 – step-down transformer feeding a lamp

Common mistake: Reporting the secondary current $2\,\text{A}$ instead of transforming it to the primary.

Q.37 Alternating Current – resonance, peak energy storage and average power • Standard • 90 s **Answer: (3)**

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 $500\,\text{W}$

Solution

At resonance $Z = R$: $I_{rms} = 5\,\text{A}$, $I_0 = 5\sqrt{2}\,\text{A}$. $C = \frac{1}{\omega^2 L} = 5 \times 10^{-4}\,\text{F}$; $V_{C,0} = \frac{I_0}{\omega C} = 100\sqrt{2}\,\text{V}$; $U_{C,\max} = \frac{1}{2}CV_{C,0}^2 = 5\,\text{J}$ (equal to $\frac{1}{2}LI_0^2$). $P = I_{rms}^2 R = 500\,\text{W}$. Option (4) uses the rms current in $\frac{1}{2}LI^2$.

Source: Original synthesis

Common mistake: Using I_{rms} instead of the peak current in the maximum-energy formula, giving $2.5\,\text{J}$.

Q.38 Alternating Current – equal-current frequencies and resonance • Foundation • 60 s **Answer: (4)**

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) $200\,\text{rad s}^{-1}$

Solution

Equal currents mean equal $|X_L - X_C|$ with opposite signs: $\omega_1 L - \frac{1}{\omega_1 C} = -\left(\omega_2 L - \frac{1}{\omega_2 C}\right) \Rightarrow LC = \frac{1}{\omega_1\omega_2}$, so $\omega_0 = \sqrt{100 \times 400} = 200\,\text{rad s}^{-1}$. Option (2) is the arithmetic mean.

Source: Original synthesis

Common mistake: Taking the arithmetic mean $250\,\text{rad s}^{-1}$ instead of the geometric mean.

Q.39 Alternating Current – parallel RL and RC branches, net power factor • Standard • 120 s **Answer: (3)**

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 $\frac{1}{\sqrt{5}}$

Solution

At 2ω: $Z_L = R(1+2j)$, $Z_C = R\left(1-\frac{j}{2}\right)$. Admittances $\frac{1-2j}{5R}$ and $\frac{4+2j}{5R}$; sum $= \frac{1}{R}$ (imaginary parts cancel). Source current $\frac{V}{R}$, in phase: power factor 1. Inductive-branch current $\frac{V}{\sqrt{5}R}$; ratio $\sqrt{5}$. Option (2) uses the inductive branch's own power factor $\frac{1}{\sqrt{5}}$ for the whole circuit.

Source: Adapted from NEET 2022 (Phase 2) – phase of capacitive current

Common mistake: Quoting a single branch's power factor instead of the net one from the total admittance.

Q.40 Capacitors – layered dielectrics in series, voltage division • Standard • 75 s **Answer: (3)**

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 $\frac{V}{4}$

Solution

$C = \frac{\varepsilon_0 A}{\sum d_i/K_i}$ with $\sum \frac{d_i}{K_i} = \frac{d}{8}+\frac{d}{8}+\frac{d}{4} = \frac{d}{2}$, so $C = 2C_0$. Voltage shares $\propto d_i/K_i$: air takes $\frac{d/4}{d/2} = \frac{1}{2}$ of V. Option (1) divides voltage by thickness instead of by d_i/K_i.

Source: Adapted from NEET 2025 – dielectric slabs in a parallel-plate capacitor

Common mistake: Splitting the voltage in proportion to layer thickness rather than d_i/K_i.

Q.41 Capacitors – battery-connected capacitor, battery energy and external work • Standard • 75 s **Answer: (1)**

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 $-\frac{CV^2}{2}$

Solution

$C \to 2C$, $\Delta Q = CV$, battery energy $= V\Delta Q = CV^2$. $\Delta U = \frac{1}{2}(2C)V^2 - \frac{1}{2}CV^2 = \frac{CV^2}{2}$. $W_{ext} = \Delta U - W_{batt} = -\frac{CV^2}{2}$: the plates attract, so the agent restrains them. Option (2) assumes the agent must push the plates together.

Source: Adapted from NEET 2024 – plates moved closer with battery connected

Common mistake: Giving the external work a positive sign, forgetting that the plates attract each other.

Q.42 Capacitors – dielectric insertion at constant charge • Standard • 60 s **Answer: (3)**

A 6 μF capacitor is charged to 10 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 μJ and 200 μJ

(2) 100 μJ and −200 μJ

(3) 100 μJ and 200 μJ

(4) 900 μJ and −600 μJ

Solution

$Q = 60\,\mu C$ stays fixed; $U_i = \frac{1}{2}CV^2 = 300\,\mu J$. $C' = 18\,\mu F$, $U_f = \frac{Q^2}{2C'} = 100\,\mu J$. The field pulls the slab in and does $U_i - U_f = +200\,\mu J$. Option (4) holds V fixed instead of Q; option (2) gives the external agent's work.

Source: Adapted from NEET 2024 (re-exam) – energy stored in a capacitor

Common mistake: Keeping V constant after disconnection, which wrongly triples the energy.

Q.43 Capacitors – unbalanced capacitor bridge, node potentials • Standard • 120 s **Answer: (2)**

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) $\frac{CV}{2}$

Solution

X and Y are isolated with zero net charge: $C(V_X - V) + 2CV_X + C(V_X - V_Y) = 0 \Rightarrow 4V_X - V_Y = V$; $2C(V_Y - V) + CV_Y + C(V_Y - V_X) = 0 \Rightarrow 4V_Y - V_X = 2V$. So $V_X = \frac{2V}{5}$, $V_Y = \frac{3V}{5}$, and $Q_{XY} = C \cdot \frac{V}{5} = \frac{CV}{5}$. Option (1) uses the potentials without the bridge ($\frac{V}{3}$ and $\frac{2V}{3}$); option (3) wrongly assumes a balanced bridge.

Source: Original synthesis

Common mistake: Computing V_X and V_Y as if the bridge capacitor were absent, giving $\frac{CV}{3}$.

Q.44 Capacitors – capacitor in a DC resistive network at steady state • Standard • 60 s **Answer: (4)**

An ideal 12 V battery is connected across A and B. A resistive branch A–X–B has resistors 2 Ω and 4 Ω respectively. Another branch A–Y–B has resistors 3 Ω and 3 Ω. A 3 μF capacitor connects X to Y. After a long time, the capacitor charge magnitude and battery current are:

(1) zero and 4 A (2) 6 μC and 2 A (3) 18 μC and 4 A (4) 6 μC and 4 A

Solution

In steady state no current flows through the capacitor. Each branch has 6 Ω: 2 A each, battery current 4 A. With $V_B = 0$: $V_X = 2 \times 4 = 8$ V, $V_Y = 2 \times 3 = 6$ V. $Q = 3\,\mu\text{F} \times 2\,\text{V} = 6\,\mu\text{C}$. Option (2) counts only one branch's current.

Source: Adapted from NEET 2024 (re-exam) – steady-state current in a circuit with a capacitor

Common mistake: Taking the battery current as one branch's 2 A.

Q.45 Capacitors – charge sharing and energy loss • Foundation • 60 s **Answer: (1)**

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 $\frac{CV^2}{4}$

Solution

Total charge $CV + 2C\frac{V}{2} = 2CV$ on $3C$: $V_f = \frac{2V}{3}$. $U_i = \frac{1}{2}CV^2 + \frac{1}{2}(2C)\frac{V^2}{4} = \frac{3}{4}CV^2$; $U_f = \frac{1}{2}(3C)\frac{4V^2}{9} = \frac{2}{3}CV^2$. Loss $= \frac{CV^2}{12}$ $\left(= \frac{C_1C_2}{2(C_1+C_2)}(V_1 - V_2)^2\right)$. Option (2) averages the voltages.

Source: Original synthesis

Common mistake: Averaging the two voltages ($\frac{3V}{4}$) instead of conserving charge.

CHEMISTRY

Detailed solutions

Q.46

Thermodynamics – entropy production along two paths • Challenging • 150 s **Answer: (3)**

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.

Solution

$\Delta S_{\text{gas}} = \frac{3R}{2}\ln 2 + R\ln 2 = \frac{5R}{2}\ln 2$ on both routes (state function). Heating step (identical on both routes): $q = C_V T = 3RT/2$ from the $2T$ reservoir, so $\Delta S_{\text{res}} = -3R/4$. Route A: free expansion has $q = w = 0$, so $S_{\text{gen,A}} = \frac{5R}{2}\ln 2 - \frac{3R}{4}$. Route B: the reversible isothermal step takes $RT\ln 2$ from the reservoir at T, $\Delta S_{\text{res}} = -R\ln 2$, so $S_{\text{gen,B}} = \frac{3R}{2}\ln 2 - \frac{3R}{4}$. Difference $= R\ln 2$, larger along A. Option (1) is tempting because $w_A - w_B = 0 - (-RT\ln 2) = RT\ln 2$ is true, but its second clause is false. (4) fails: $q_B - q_A = RT\ln 2$.

Source: Adapted from NEET 2024 (re-exam) – isothermal free expansion into vacuum

Common mistake: Treating free expansion as entropy-neutral for the gas because $q = 0$; ΔS_{gas} depends only on the end states.

Q.47

Thermodynamics – reversible vs irreversible work in a cycle • Standard • 120 s **Answer: (2)**

Two moles of ideal gas undergo reversible isothermal expansion at 300 K from 8 bar to 2 bar, followed by isothermal compression against constant external pressure 8 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) $(-2\ln 4,\ +2\ln 4)$

Solution

$V_1 = 2RT/8$, $V_2 = 2RT/2 = 4V_1$. Reversible expansion: $w_1 = -nRT\ln(V_2/V_1) = -2RT\ln 4$. Irreversible compression: $w_2 = -p_{\text{ext}}(V_1 - V_2) = -8(-3V_1) = 24V_1 = 24\cdot\frac{RT}{4} = +6RT$. Net $w = (6 - 2\ln 4)RT \approx +3.23RT$; cycle $\Delta U = 0$ so $q = -w$. Option (1) wrongly assumes a cycle returns zero work; that holds only for a reversible return path.

Source: Adapted from NEET 2024 – reversible isothermal expansion of hydrogen

Common mistake: Using $p_{\text{ext}} = 2$ bar or $nRT\ln 4$ for the irreversible compression step.

Q.48

Thermodynamics – Hess's law for K, ΔH° and ΔS° • Standard • 90 s **Answer: (2)**

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.

Solution

Target = (I) $-2\times$(II): $K = K_1/K_2^2 = 16/16 = 1$; $\Delta H^\circ = 80 - 2(-20) = +120\ \text{kJ mol}^{-1}$. $K = 1$ gives $\Delta G^\circ = 0$, so $\Delta S^\circ = \Delta H^\circ/T > 0$. Endothermic, so K rises with temperature. Option (3) confuses $\Delta G^\circ = 0$ with $\Delta S^\circ = 0$.

Source: Original synthesis

Common mistake: Multiplying K_1 by K_2^2 (or subtracting ΔH_2 only once) when reversing and doubling reaction II.

Q.49

Thermodynamics – isochoric and isobaric heat • Standard • 75 s **Answer: (3)**

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

(1) $+300R$ J (2) $-750R$ J (3) $-300R$ J (4) $+450R$ J

Solution

$q_1 = C_V\Delta T = \frac{3}{2}R(300) = 450R$; $q_2 = C_p\Delta T = \frac{5}{2}R(-300) = -750R$; net $q = -300R$ J. Check: $\Delta U = 0$ and the isobaric compression does $w = +300R$ on the gas, so $q = -w$. Option (1) has the right magnitude but the wrong sign.

Source: Adapted from NEET 2024 – identifying isothermal/isochoric/isobaric/adiabatic conditions

Common mistake: Using C_V for the constant-pressure step, which gives zero net heat.

Q.50

Thermodynamics – ΔG° vs ΔG • Standard • 75 s **Answer: (1)**

For A + B $\rightleftharpoons$ C + D at 300 K, equilibrium concentrations are 0.20, 0.30, 1.00 and 0.60 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 $RT\ln 10 = 5.74$ kJ mol^{-1}.

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

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

Solution

$K = (1.00\times0.60)/(0.20\times0.30) = 10$, so $\Delta G^\circ = -RT\ln 10 = -5.74$ kJ mol^{-1}. $\Delta G = \Delta G^\circ + RT\ln Q = -5.74 + 2(5.74) = +5.74$ kJ mol^{-1}: forward non-spontaneous. Option (4) treats ΔG as equal to ΔG°.

Source: Adapted from NEET 2023 – ΔG° from equilibrium concentrations of A+B⇌C+D

Common mistake: Writing $\Delta G = 0$ or $\Delta G = \Delta G^\circ$ for a non-equilibrium mixture.

Q.51

Thermodynamics – first law with irreversible expansion • Challenging • 150 s **Answer: (1)**

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 $q_{\mathrm{I}} = PV/4$. 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) $(7V/5,\ PV/5)$

Solution

Let $V_1 = xV$; final pressure $P/2$, so $RT_1 = PVx/2$. First law: $\frac{3}{2}(PVx/2 - PV) = PV/4 - \frac{P}{2}(x-1)V \Rightarrow \frac{5}{4}x = \frac{9}{4}$, $x = 9/5$, $T_1 = 0.9T$. Step II (constant volume) needs $q_{\mathrm{II}} = \frac{3}{2}R(0.1T) = 3PV/20$. Net $q = PV/4 + 3PV/20 = 2PV/5$ (equivalently $-w = \frac{P}{2}\cdot\frac{4V}{5}$). Option (3) assumes the gas stays at T (isothermal) so $V = 2V$, ignoring the given heat.

Source: Adapted from NEET 2022 – isothermal expansion, ΔU of ideal gas

Common mistake: Assuming the expansion is isothermal because the end temperature is later restored.

Q.52

Thermodynamics – Hess's law, ΔH vs ΔU • Standard • 90 s **Answer: (3)**

At 300 K, $\Delta_c H^\circ$ values for C(graphite), $H_2(g)$ and $CH_4(g)$ are -394, -286 and -890 kJ mol^{-1} respectively, with water liquid in each combustion. For C(graphite) + $2\,H_2(g) \longrightarrow CH_4(g)$, the pair $(\Delta_f H^\circ, \Delta_f U^\circ)$ is approximately:

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

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

Solution

$\Delta_f H^\circ = -394 + 2(-286) - (-890) = -76$ kJ mol^{-1}. $\Delta n_g = 1 - 2 = -1$ (graphite is solid), so $\Delta U = \Delta H - \Delta n_g RT = -76 + 2.494 = -73.5$ kJ mol^{-1}. Option (2) applies $\Delta n_g RT$ with the wrong sign.

Source: Original synthesis

Common mistake: Counting graphite as a gas ($\Delta n_g = -2$) or reversing the sign of the $\Delta n_g RT$ correction.

Q.53 Thermodynamics – Gibbs energy and Q_p after sudden changes • Challenging • 150 s **Answer: (1)**

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.

Solution

At $400\,\mathrm{K}$: $\Delta G^\circ = 60 - 400(0.150) = 0$, $K_p = 1$ (consistent with the data). Doubling V halves each pressure to $0.5\,\mathrm{bar}$; heating at fixed V multiplies each by $500/400$: $p_A = p_B = 5/8\,\mathrm{bar}$, $Q_p = (5/8)^2/(5/8) = 5/8$. At $500\,\mathrm{K}$: $\Delta G^\circ = 60 - 75 = -15\,\mathrm{kJ\,mol^{-1}}$, $K_p = e^{15000/(8.314\times500)} \approx 37 > Q_p$, so $\Delta_r G < 0$. Option (3) stops after the volume change ($Q_p = 1/2$) and also gets the direction wrong.

Source: Original synthesis

Common mistake: Forgetting that heating at fixed volume raises every partial pressure by T_2/T_1.

Q.54 Thermodynamics – bond enthalpy estimate • Foundation • 45 s **Answer: (4)**

Using average bond enthalpies H–H = 436, Cl–Cl = 242 and H–Cl = 431 kJ mol^{-1}, estimate the enthalpy change when 0.50 mol H_2 reacts completely with 0.50 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.

Solution

$\Delta H = (436 + 242) - 2(431) = -184\,\mathrm{kJ}$ per mole of $H_2 + Cl_2 \longrightarrow 2\,HCl$; for 0.50 mol of reaction, $-92\,\mathrm{kJ}$. Average bond enthalpies apply to gaseous species and give estimates. Option (1) forgets the 0.50 mol scaling and misdescribes the method.

Source: Original synthesis

Common mistake: Reporting $-184\,\mathrm{kJ}$ without scaling to 0.50 mol of reaction.

Q.55 p-block (Groups 15–18) – oxoacids of sulphur • Challenging • 120 s **Answer: (1)**

An equimolar mixture of H_2SO_4, $H_2S_2O_7$ and $H_2S_2O_8$ contains 0.10 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)

Solution

Each acid has two S–OH groups: $3 \times 0.20 = 0.60$ mol OH^-. Only $H_2S_2O_8$ has a peroxo O–O bond: 0.10 mol. Sulphur is +6 in all three (peroxide O is −1 in $H_2S_2O_8$); total S = 0.10 + 0.20 + 0.20 = 0.50 mol, each accepting $2e^-$: 1.00 mol. Option (2) assigns +7 to S in $H_2S_2O_8$.

Source: Adapted from NEET 2023 – bonds in sulphur oxoacids

Common mistake: Assigning sulphur +7 in peroxodisulphuric acid by treating all oxygens as −2.

Q.56 p-block (Groups 15–18) – group 16 hydride trends • Standard • 75 s **Answer: (1)**

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

Solution

X = H_2Te, Y = H_2S, Z = H_2Se. **A – True.** b.p. $H_2S < H_2Se < H_2Te$ (dispersion forces). **B – True.** E–H bond enthalpy and thermal stability fall down the group. **C – True.** Reducing character rises down the group (NCERT Class 12, p-block, group 16 hydrides). **D – False.** Hydrogen-bonded H_2O has the highest boiling point. Option (2) misses C, which follows from the same weakening of the E–H bond.

Source: Adapted from NEET 2022 – boiling-point order of group 16 hydrides

Common mistake: Applying the water anomaly to statement A or forgetting that reducing strength tracks acid strength down the group.

Q.57

p-block (Groups 15–18) – phosphorus oxoacids, basicity and redox • Standard • 75 s **Answer: (3)**

A mixture contains 0.10 mol H_3PO_2, 0.20 mol H_3PO_3 and 0.10 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 mol NaOH; 1.20 mol electrons
(2) 1.20 mol NaOH; 0.80 mol electrons
(3) 0.80 mol NaOH; 0.80 mol electrons
(4) 0.80 mol NaOH; 0.40 mol electrons

Solution

Basicities 1, 2, 3 (only P–OH hydrogens ionise): $0.10 + 0.40 + 0.30 = 0.80$ mol NaOH. P oxidation states +1, +3, +5: electrons $= 0.10(4) + 0.20(2) + 0 = 0.80$ mol. Option (2) counts all nine hydrogens as acidic $(0.3 + 0.6 + 0.3 = 1.20)$.

Source: Original synthesis

Common mistake: Treating P–H hydrogens as ionisable.

Q.58

p-block (Groups 15–18) – chlorine disproportionation • Standard • 60 s **Answer: (4)**

Equal 0.30 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 mol, 0.50 mol; 1/3
(2) 0.50 mol, 0.30 mol; 1/6
(3) 0.30 mol, 0.30 mol; 1/2
(4) 0.30 mol, 0.50 mol; 1/6

Solution

Cold: $Cl_2 + 2\,NaOH \longrightarrow NaCl + NaOCl + H_2O$ gives 0.30 mol Cl^-. Hot: $3\,Cl_2 + 6\,NaOH \longrightarrow 5\,NaCl + NaClO_3 + 3\,H_2O$ gives 0.50 mol Cl^-; 1 of 6 Cl atoms becomes +5, fraction 1/6. Option (1) counts ClO_3^- per Cl_2 rather than per Cl atom.

Source: Original synthesis

Common mistake: Taking the oxidised fraction as 1/3 (per Cl_2 molecule instead of per Cl atom).

Q.59

p-block (Groups 15–18) – PCl5 hydrolysis and structure • Standard • 60 s **Answer: (2)**

Complete hydrolysis of 0.10 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 mol and 2
(2) 0.80 mol and 2
(3) 0.50 mol and 2
(4) 0.80 mol and 3

Solution

$PCl_5 + 4\,H_2O \longrightarrow H_3PO_4 + 5\,HCl$: NaOH $= 0.10(3 + 5) = 0.80$ mol. Gaseous PCl_5 is trigonal bipyramidal: 2 axial, 3 equatorial bonds. Option (1) treats H_3PO_4 as monobasic $(0.10 + 0.50)$; all three of its O–H hydrogens are neutralised.

Source: Original synthesis

Common mistake: Swapping axial (2) and equatorial (3) bond counts.

Q.60

p-block (Groups 15–18) – hypophosphorous acid oxidation • Standard • 90 s **Answer: (3)**

A $0.10\,\text{mol}$ 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) $(0.20,\ 0.10,\ +1 \to +3)$

Solution

The acid is H_3PO_2 (monobasic, P $= +1$). Oxidation to H_3PO_4 releases $4e^-$ per P: $0.40\,\text{mol}\,e^-$, consuming $0.20\,\text{mol}$ of the $2e^-$ oxidant. NaOH need rises from 0.10 to $0.30\,\text{mol}$: increase 0.20. Option (1) equates moles of oxidant with moles of electrons.

Source: Original synthesis

Common mistake: Identifying the acid as H_3PO_3 because it has three hydrogens bonded in different ways.

Q.61

p-block (Groups 15–18) – ozone and iodometry • Standard • 45 s **Answer: (3)**

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 $+1$

Solution

$O_3 + 2I^- + 2H^+ \longrightarrow I_2 + O_2 + H_2O$: 1 mol I_2 per mol O_3. $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$: 2 mol thiosulphate. Iodide goes from -1 to 0. Option (1) assumes all three ozone O atoms are reduced.

Source: Original synthesis

Common mistake: Assuming each O_3 liberates 3 I_2 (one per oxygen atom).

Q.62

p-block (Groups 15–18) – xenon fluoride hydrolysis • Challenging • 120 s **Answer: (2)**

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 $0.20\,\text{mol}$ XeO_3 and $1.80\,\text{mol}$ HF. Which conclusion is correct?

(1) $a = 0.20$, $b = 0.20$; $0.10\,\text{mol}$ O_2 forms.

(2) $a = 0.30$, $b = 0.10$; $0.15\,\text{mol}$ O_2 forms, and one-third of the original XeF_4 xenon atoms are oxidised.

(3) $a = 0.30$, $b = 0.10$; $0.15\,\text{mol}$ O_2 forms, and two-thirds of the original XeF_4 xenon atoms are oxidised.

(4) $a = 0.15$, $b = 0.15$; $0.075\,\text{mol}$ O_2 forms.

Solution

XeO_3: $a/3 + b = 0.20$; HF: $4a + 6b = 1.80$, so $a = 0.30$, $b = 0.10$. $O_2 = a/2 = 0.15\,\text{mol}$. In XeF_4 hydrolysis, Xe $(+4)$ goes to XeO_3 $(+6$, oxidised) for 2 of 6 atoms and to Xe (0, reduced) for 4 of 6: one-third oxidised. Option (3) reverses the oxidised and reduced fractions.

Source: Original synthesis

Common mistake: Calling the xenon that becomes elemental Xe 'oxidised'.

Q.63

p-block (Groups 15–18) – VSEPR shapes of interhalogens and xenon fluorides • Foundation • 45 s **Answer: (2)**

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

Solution

ClF_3: AX_3E_2, T-shaped. XeF_2: AX_2E_3, linear. XeF_4: AX_4E_2, square planar. Option (1) gives ClF_3 the shape it would have with no lone pairs.

Source: Original synthesis

Common mistake: Describing ClF_3 as trigonal planar by ignoring the two equatorial lone pairs.

Q.64 Equilibrium – buffer adjustment, base addition and dilution • Challenging • 150 s **Answer: (2)**

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)

Solution

Acetate 5.00 mmol, acid 0.50 mmol. pH = pK_a needs $5.00 - x = 0.50 + x$, $x = 2.25$ mmol, leaving 2.75 mmol of each; each half has 1.375 mmol of each. NaOH: salt 1.875, acid 0.875, ratio 15/7, pH = $4.57 + 0.331 = 4.90$. Dilution keeps the ratio: pH 4.57. Option (3) uses the original 10:1 ratio (pH 5.57) for the diluted portion, forgetting the HCl adjustment.

Source: Adapted from NEET 2022 – pH of sodium acetate/acetic acid mixture, pK_a 4.57

Common mistake: Thinking that dilution changes buffer pH in the Henderson–Hasselbalch approximation.

Q.65 Equilibrium – heterogeneous equilibrium, K_p–K_c • Standard • 60 s **Answer: (3)**

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 bar, 4/83) (2) (2.0 bar, 4)
(3) (2.0 bar, 4/83) (4) (2.0 bar, 332)

Solution

$K_p = p_{CO}^2/p_{CO_2}$, so $p_{CO} = 2.0$ bar. $\Delta n_g = 2 - 1 = 1$, $K_c = K_p/(RT) = 4/83$ mol L^{-1}. Option (4) multiplies by RT instead of dividing; option (2) counts C(s) as a gas ($\Delta n_g = 0$).

Source: Adapted from NEET 2022 – $CO_2 + C \rightleftharpoons 2\,CO$, K_p to K_c

Common mistake: Including solid carbon in Δn_g.

Q.66 Equilibrium – Q_c after compression and inert-gas addition • Standard • 90 s **Answer: (3)**

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.

Solution

Scaling all concentrations by f multiplies Q_c by $f^{2-3} = 1/f$. I: $f = 2$, $Q_c/K_c = 1/2$, forward (fewer moles). II: $f = 1/2$, $Q_c/K_c = 2$, backward. Option (4) wrongly applies the constant-volume inert-gas rule; at constant total pressure the reactant concentrations fall.

Source: Adapted from NEET 2022 – $3\,O_2 \rightleftharpoons 2\,O_3$ equilibrium

Common mistake: Assuming inert gas never shifts an equilibrium, regardless of whether volume or pressure is held constant.

Q.67 Equilibrium – Q_c vs K_c under selective perturbation • Standard • 75 s **Answer: (1)**

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.

Solution

Initially $Q_c = (0.10)(0.10)/(0.10)^2 = 1$. (1): $0.010/0.25 = 0.040$ (matches). (2), (3): $\Delta n_g = 0$, so uniform scaling leaves $Q_c = 1$. (4): $(0.05)(0.10)/0.010 = 0.50$. Option (2) is tempting if one forgets that Q_c is unchanged when $\Delta n_g = 0$.

Source: Adapted from NEET 2024 – 2A⇌B+C, Q vs K direction

Common mistake: Thinking that compressing by a factor of 5 changes Q_c by a factor of 5 or 25 when $\Delta n_g = 0$.

Q.68

Equilibrium – degree of dissociation from transferred K • Standard • 90 s **Answer: (3)**

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) $\sqrt{3}/(1+\sqrt{3})$

Solution

$K_c = (0.0020)^2/(0.0030 \times 0.0040) = 1/3$; for $2\,NO \rightleftharpoons N_2 + O_2$, $K' = 3$. With $[NO] = c(1-\alpha)$, $[N_2] = [O_2] = c\alpha/2$: $(\alpha/2)^2/(1-\alpha)^2 = 3 \Rightarrow \alpha = 2\sqrt{3}(1-\alpha)$, $\alpha = 2\sqrt{3}/(1+2\sqrt{3}) \approx 0.776$. Option (4) omits the factor $1/2$ in $[N_2] = c\alpha/2$.

Source: Adapted from NEET 2024 – NO dissociation from N2/O2/NO equilibrium data

Common mistake: Writing $[N_2] = [O_2] = c\alpha$ instead of $c\alpha/2$.

Q.69

Equilibrium – Q_p after dilution and selective removal • Challenging • 120 s **Answer: (4)**

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 $(Q_I/K_I,\ Q_{II}/K_{II})$ 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) $(1/8,\ 1/4)$

Solution

I: halving all partial pressures multiplies Q_p by $(1/2)^{\Delta n} = 1/2$; halving p_B multiplies by $(1/2)^2 = 1/4$: total $1/8$. II: $\Delta n = 0$, so dilution by inert gas gives factor 1; halving p_E gives $1/4$. Both then proceed forward. Option (2) applies the $\Delta n = 1$ dilution factor to II as well.

Source: Adapted from NEET 2024 – equilibrium with $K_p \neq K_c$

Common mistake: Applying a dilution factor to reaction II although $\Delta n_g = 0$.

Q.70

Equilibrium – species ratios of a triprotic acid at fixed pH • Standard • 60 s **Answer: (3)**

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) $1 : 10^{-5} : 10^{-10}$

Solution

$[HA^{2-}]/[H_2A^-] = K_{a2}/[H^+] = 10^{-7}/10^{-7} = 1$; $[A^{3-}]/[HA^{2-}] = K_{a3}/[H^+] = 10^{-12}/10^{-7} = 10^{-5}$. Ratio $1 : 1 : 10^{-5}$. Option (4) divides by successive K_a ratios instead of using $[H^+]$.

Source: Adapted from NEET 2025 – stepwise ionisation of phosphoric acid

Common mistake: Using K_{a1} for the H_2A^-/HA^{2-} ratio.

Q.71

Equilibrium – selective precipitation • Standard • 75 s **Answer: (1)**

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}

Solution

Onset $[OH^-]$: M, $\sqrt{4 \times 10^{-18}/0.01} = 2 \times 10^{-8}\,M$; N, $\sqrt{10^{-12}/0.01} = 10^{-5}\,M$. M precipitates first. At N onset, $[M^{2+}] = 4 \times 10^{-18}/10^{-10} = 4 \times 10^{-8}\,M$; fraction $= 4 \times 10^{-6}$. Option (4) gives the concentration, not the fraction.

Source: Original synthesis

Common mistake: Reporting the remaining concentration $(4 \times 10^{-8}\,M)$ as the fraction.

Q.72 Equilibrium – solubility in a buffer • Standard • 90 s **Answer: (4)**

Equal volumes of $0.020\,\text{M}$ weak acid HA and $0.010\,\text{M}$ NaOH are mixed. $K_a(\text{HA}) = 1.0 \times 10^{-5}$. 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 $K_{sp}[\text{M(OH)}_2] = 4.0 \times 10^{-24}$. Which pair gives the equilibrium pH and molar solubility of M(OH)_2? Neglect metal hydrolysis.

(1) $(5.00,\ 4.0\,\text{M})$ (2) $(5.00,\ 4.0 \times 10^{-9}\,\text{M})$

(3) $(9.00,\ 4.0 \times 10^{-8}\,\text{M})$ (4) $(5.00,\ 4.0 \times 10^{-6}\,\text{M})$

Solution

After mixing: HA 0.010, NaOH $0.005\,\text{M}$, leaving HA $=$ A^- $= 0.005\,\text{M}$; pH $=$ pK_a $= 5.00$, $[\text{OH}^-] = 10^{-9}\,\text{M}$. $s = K_{sp}/[\text{OH}^-]^2 = 4 \times 10^{-24}/10^{-18} = 4 \times 10^{-6}\,\text{M}$ (consumes only $\sim 8 \times 10^{-6}\,\text{M}$ acid, so the assumption holds). Option (3) confuses pH with pOH.

Source: Original synthesis

Common mistake: Using $K_{sp} = 4s^3$ (pure-water solubility) and ignoring the fixed buffer $[\text{OH}^-]$.

Q.73 GOC – heterolysis, carbocation stability, hyperconjugation • Standard • 90 s **Answer: (4)**

Consider heterolytic cleavage of the indicated C–Br bond in (i) $(\text{CH}_3)_3\text{C}-\text{Br}$, (ii) $(\text{CH}_3)_2\text{CH}-\text{Br}$ and (iii) $\text{CH}_2{=}\text{CH}-\text{CH}_2-\text{Br}$, 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

Solution

A – False. 9 and 6 are right, but in the allyl cation the only adjacent carbon is sp^2 (=CH–), so there are 0, not 2, adjacent sp^3 C–H bonds. **B – True.** $\text{CH}_2{=}\text{CH}-\text{CH}_2^{+} \longleftrightarrow {}^{+}\text{CH}_2-\text{CH}{=}\text{CH}_2$. **C – True.** The sp^2 tert-butyl cation has a vacant p orbital. **D – False.** Heterolysis gives both electrons to Br. Option (3) is tempting if one counts the two CH_2^{+} hydrogens in A.

Source: Adapted from NEET 2024 (re-exam) – methyl stabilises carbocations by +I and hyperconjugation

Common mistake: Counting C–H bonds on the cationic carbon itself as hyperconjugating.

Q.74 GOC – sublimation • Foundation • 30 s **Answer: (2)**

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.

Solution

Naphthalene sublimes and NaCl does not (NCERT Class 11, Organic Chemistry – Some Basic Principles, §8.8 Sublimation). Sublimation is a physical change, so the compound is unchanged. Option (3) fails because naphthalene is insoluble in water.

Source: Adapted from NEET 2024 – sublimation in purification

Common mistake: Choosing crystallisation because NaCl is water-soluble, without noting that this needs a further step.

Q.75 GOC – steam distillation composition • Standard • 75 s **Answer: (3)**

An organic liquid X, molar mass $180\,\text{g mol}^{-1}$, 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) $0.72\,\text{g}$ (2) $72\,\text{g}$ (3) $7.2\,\text{g}$ (4) $4.5\,\text{g}$

Solution

$n_\text{w}/n_X = 600/150 = 4$; $m_\text{w}/m_X = 4 \times 18/180 = 0.4$; $m_\text{w} = 7.2\,\text{g}$. Option (2) uses moles of water $= 4 \times 0.1 = 0.4$ but multiplies by 180 instead of 18.

Source: Adapted from NEET 2024 (re-exam) – boiling temperature in steam distillation

Common mistake: Inverting the pressure ratio so that X is taken as the major vapour component.

Q.76

GOC – resonance in the enolate ion • Standard • 90 s **Answer: (4)**

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

Solution

A – False. Resonance contributors differ only in electron placement; they are not separate compounds. **B – True.** Same atoms, same positions, same electron count. **C – True.** Both have complete octets; negative charge on O is preferred (NCERT resonance rules). **D – True.** C-protonation gives CH_3CHO; O-protonation gives $CH_2=CHOH$, a constitutional isomer (the enol). Option (3) omits D because the enol is less stable, but stability does not affect the isomer relationship.

Source: Original synthesis

Common mistake: Treating resonance contributors as tautomers (A), which needs movement of an atom.

Q.77

GOC – σ/π bonds and lone pairs in a pyridinium amide • Challenging • 120 s **Answer: (4)**

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)

Solution

Pyridine: 11 σ (6 ring + 5 C–H), 3 π, 1 lone pair. Substitution: −1 C–H, + C–C, C–O, C–N, 2 N–H ⇒ 15 σ; +1 π (C=O) ⇒ 4 π; +3 lone pairs (2 on O, 1 on amide N) ⇒ 4. Protonating ring N adds one σ (N–H) and removes its lone pair: (16, 4, 3). Option (1) is the neutral amide before protonation.

Source: Adapted from NEET 2023 – σ, π bonds and lone pairs in pyridine

Common mistake: Forgetting that the ring-N lone pair becomes the new N–H bond on protonation.

Q.78

GOC – choice of purification technique • Foundation • 45 s **Answer: (1)**

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

Solution

NCERT Class 11 §8.8: glycerol is separated from spent lye by distillation under reduced pressure; aniline is separated from aniline–water by steam distillation; petroleum fractions are separated by fractional distillation. Option (3) puts fractional distillation first, but glycerol would decompose at its normal boiling point.

Source: Adapted from NEET 2023 (Manipur) – match mixtures to purification techniques

Common mistake: Choosing simple distillation for glycerol, which decomposes at its normal boiling point.

Q.79

GOC – stereoisomerism: meso and enantiomers • Foundation • 45 s **Answer: (4)**

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.

Solution

$2^2 = 4$ formal combinations; (2R,3S) and (2S,3R) are the same meso compound because of internal symmetry. (2R,3R) and (2S,3S) form an enantiomeric pair. Total 3. The meso form is a diastereomer of each chiral form, so (1) fails; (2) and (3) ignore the meso form.

Source: Adapted from NEET 2022 – chirality, enantiomers and racemic mixtures

Common mistake: Using 2^n without checking for an internal plane of symmetry.

Q.80

GOC – inductive effect and acid strength • Standard • 90 s **Answer: (3)**

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

Solution

Acid strength C > B > A (–I effect weakens with distance). **I – True.** For 1:1 buffers pH = pK_a, so C < B < A. **II – True.** Basicity of conjugate bases is the reverse of acid strength. **III – False.** The inductive effect diminishes with distance. **IV – True.** Proton transfer favours the weaker acid/weaker base pair (C^- + A). Option (1) omits IV, a direct consequence of I.

Source: Original synthesis

Common mistake: Believing that the inductive effect grows as the substituent moves away from the reaction centre.

Q.81

GOC – IUPAC nomenclature and conjugation • Standard • 75 s **Answer: (4)**

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) $CH_3COCH{=}CHCH_3$

Solution

(1) pent-2-enal: conjugated, but an aldehyde. (2) 3-methylbut-3-en-2-one: conjugated ketone, but the parent chain has only four carbons. (3) pent-4-en-2-one: five-carbon ketone at C2, but the C=C is separated from C=O by a CH_2 (not conjugated). (4) pent-3-en-2-one: five-carbon chain, ketone at C2, C3=C4 conjugated with C2=O (matches). Option (2) is the tempting conjugated ketone, but branching shortens its parent chain.

Source: Original synthesis (revised to GOC nomenclature)

Common mistake: Counting the methyl branch in $CH_2{=}C(CH_3)COCH_3$ as part of a five-carbon parent chain.

Q.82

Hydrocarbons – ozonolysis, geometrical isomerism, monochlorination • Standard • 120 s **Answer: (1)**

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.

Solution

A = $CH_2{=}CHCH(CH_3)_2$ (3-methylbut-1-ene); B = $(CH_3)_2C{=}CHCH_3$ (2-methylbut-2-ene). A has a terminal $CH_2{=}$; B has two methyls on one alkene carbon: neither shows geometrical isomerism. Both give 2-methylbutane, with four H environments (two equivalent CH_3 on CH, CH, CH_2, the other CH_3): 4 monochloro products. Option (3) is tempting because B is internal, but its $(CH_3)_2C{=}$ end has identical groups.

Source: Adapted from NEET 2022 – alkene giving methanal + 2-methylpropanal on ozonolysis

Common mistake: Assuming every internal alkene shows cis–trans isomerism.

Q.83 Hydrocarbons – pentane isomers: symmetry and boiling points • Standard • 60 s **Answer: (3)**

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.

Solution

Neopentane: 1; n-pentane: 3; 2-methylbutane: 4. So A = neopentane, B = n-pentane, C = 2-methylbutane. Branching lowers boiling point: neopentane (A) is lowest. Option (4) reverses the identities of B and C.

Source: Adapted from NEET 2024 – pentane-isomer boiling points and branching

Common mistake: Assigning four products to n-pentane by counting every carbon separately.

Q.84 Hydrocarbons – mixture analysis with Br2 and H2 • Standard • 105 s **Answer: (3)**

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.

Solution

Cyclohexene $= 0.10$ mol. H_2: $0.10 + 3n_{\text{benzene}} = 0.25 \Rightarrow n_{\text{benzene}} = 0.05$; cyclohexane $= 0.15$. All three become cyclohexane: 0.30 mol, one monochloro derivative. Option (1) has the right benzene amount but benzene is not attacked by cold Baeyer's reagent.

Source: Original synthesis

Common mistake: Using one H_2 per benzene ring instead of three.

Q.85 Hydrocarbons – oxidation of alkanes with tertiary H • Foundation • 30 s **Answer: (2)**

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

Solution

The alkane is 2-methylpropane, $(CH_3)_3CH$; NCERT: $(CH_3)_3CH \xrightarrow{KMnO_4} (CH_3)_3COH$, i.e. 2-methylpropan-2-ol. Option (1) oxidises a primary C–H instead of the tertiary one.

Source: Adapted from NEET 2024 (re-exam) – KMnO4 oxidation of an alkane with tertiary H

Common mistake: Picking 2-methylpropan-1-ol because it keeps the branched skeleton, ignoring that the tertiary C–H is attacked.

Q.86 Hydrocarbons – hexane isomers: monochlorination and boiling points • Standard • 90 s **Answer: (2)**

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.

Solution

P: C1, C2, C3 classes $\rightarrow 3$. Q: the two CH_3 on C2, C2, C3, C4, C5 $\rightarrow 5$. R: four equivalent CH_3, two equivalent CH $\rightarrow 2$. Branching lowers boiling point: n-hexane (342 K) > 2-methylpentane (333 K) > 2,3-dimethylbutane (331 K). Option (4) has the right counts but a wrong boiling-point order.

Source: Adapted from NEET 2022 – boiling-point order of alkanes

Common mistake: Counting the C2-methyl and C1 of 2-methylpentane as different positions.

Q.87 Hydrocarbons – Markovnikov addition of HBr to propyne • Foundation • 30 s **Answer: (1)**

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

Solution

Markovnikov addition: $CH_3C{\equiv}CH + HBr \longrightarrow CH_3CBr{=}CH_2$; a second HBr gives the geminal $CH_3CBr_2CH_3$ (NCERT Class 11 Hydrocarbons). Option (4) gets the first step right but gives a vicinal dibromide, which comes from adding Br_2 to propene.

Source: Original synthesis

Common mistake: Placing the second Br on the adjacent carbon (vicinal) instead of the same carbon (geminal).

Q.88 Hydrocarbons – structure of a diene from ozonolysis • Standard • 90 s **Answer: (4)**

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.

Solution

Two HCHO mean two terminal $CH_2{=}$ groups; joining them to $CH_3COCOCH_3$ gives 2,3-dimethylbuta-1,3-diene. Terminal double bonds cannot show geometrical isomerism. Hydrogenation gives 2,3-dimethylbutane: 2 monochloro products. Option (1) would give butanedial, not butanedione, on ozonolysis.

Source: Original synthesis

Common mistake: Accepting the alkyne option because 2 mol H_2 are consumed, without checking the ozonolysis products.

Q.89 Hydrocarbons – hydrogenation and combustion of a gas mixture • Foundation • 60 s **Answer: (1)**

A mixture of ethene and ethyne occupies 10.0 L at fixed temperature and pressure. Complete hydrogenation requires 16.0 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 L
(2) 24.0 L
(3) 32.0 L
(4) 30.0 L

Solution

$x + y = 10$, $x + 2y = 16 \Rightarrow$ ethene 4 L, ethyne 6 L. $C_2H_4 + 3\,O_2$, $C_2H_2 + \frac{5}{2}\,O_2$: $12 + 15 = 27.0$ L. Option (4) uses 3 O_2 for each gas.

Source: Original synthesis

Common mistake: Using 3 volumes of O_2 for ethyne (as for ethene).

Q.90 Hydrocarbons – benzene: aromaticity and directing effects • Foundation • 40 s **Answer: (2)**

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

Solution

A – True. Substitution restores the aromatic sextet. **B – False.** $-NO_2$ deactivates the ring. **C – True.** Methyl is activating, ortho/para-directing. **D – True.** All C–C bonds are 139 pm (NCERT). Option (4) is tempting if A is misread as 'addition', but substitution is the characteristic reaction.

Source: Original synthesis

Common mistake: Calling nitrobenzene more reactive than benzene, forgetting that $-NO_2$ withdraws electron density from the ring.

BOTANY — Detailed solutions

Q.91

Morphology of Flowering Plants – floral symmetry, placentation • Standard • 60 s **Answer: (3)**

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.

Solution

NCERT lists mustard, Datura and chilli as actinomorphic and pea, Gulmohar, bean and Cassia as zygomorphic. Symmetry and placentation are independent characters: mustard is parietal, while Datura and chilli are axile. So option (1) names the right actinomorphic trio but wrongly forces one placentation on all three, which makes it the most tempting wrong option. Option (2) wrongly puts Datura among the zygomorphic flowers, and option (4) wrongly puts Cassia among the actinomorphic ones.

Source: Adapted from NEET 2022 – zygomorphy among named flowers

Common mistake: Accepting option (1) because the actinomorphic trio is right, without checking that mustard (parietal) and chilli (axile) differ in placentation.

Q.92

Morphology of Flowering Plants – stem and leaf modifications • Standard • 50 s **Answer: (2)**

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

Solution

Bougainvillea thorns and cucumber tendrils develop from axillary buds, so they are stem modifications (A, B). Pea tendrils are modified leaflets and *Opuntia* spines are modified leaves (C, D). Option (1) is tempting because all tendrils look alike, but similar function does not mean the same organ origin. The flattened green part of *Opuntia* is its stem, not its spine.

Source: Adapted from NEET 2022 – thorns, tendrils and Opuntia

Common mistake: Grouping both tendrils together because they do the same job, ignoring that the pea tendril is leaf-derived and the cucumber tendril is stem-derived.

Q.93

Morphology of Flowering Plants – aestivation, androecium, placentation • Standard • 90 s **Answer: (2)**

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

Solution

A – True. Vexillary aestivation together with diadelphous (9)+1 stamens is the pea pattern. **B – False.** A monocarpellary ovary with ovules along the ventral suture has marginal placentation, not free-central. **C – True.** Pea is marginal and R is marginal, but nothing given fixes R's stamens. **D – False.** Q is axile and P (pea) is marginal; union or attachment of floral parts is not a placentation criterion. So A and C. Option (4) is the tempting one, but it adds D, which ignores that Q's placentation is stated to be axile.

Source: Adapted from NEET 2022 – vexillary aestivation and diadelphous stamens

Common mistake: Choosing option (4) because Q and P both show fusion of floral parts, though placentation is a separate character.

Q.94 Morphology of Flowering Plants – axile, free-central and parietal placentation • Standard • 60 s **Answer: (4)**

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.

Solution

A central axis joined by septa is axile placentation (P). A central column without septa is free-central (Q). Ovules on the inner wall are parietal (R). Placentation describes the ovary's own organisation, so surgically removing septa makes P look like Q but does not change its type. Option (3) is the trap: it classifies the altered specimen instead of the original ovary.

Source: Adapted from NEET 2023 – axile-placentation examples

Common mistake: Classifying P as free-central from its appearance after dissection rather than from its original septate structure.

Q.95 Morphology of Flowering Plants – perigyny, placentation, aestivation, drupe • Standard • 75 s **Answer: (4)**

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

Solution

I – True. Rose is perigynous: the other whorls arise from the rim of the thalamus; this says nothing about placentation. **II – True.** This is marginal placentation. **III – True.** Cotton shows twisted aestivation. **IV – False.** In the mango drupe the stone is the hard endocarp, part of the ovary-derived pericarp; the integuments form the seed coat. So I, II and III. The second half of IV (mesocarp from the ovary wall) is correct, which makes IV, and the options containing it, tempting.

Source: Adapted from NEET 2024 – rose, pea, cotton and mango matching

Common mistake: Accepting IV because its second half is correct, without noticing that the stone is the endocarp, not the integuments.

Q.96 Morphology of Flowering Plants – cohesion and adhesion of stamens • Standard • 45 s **Answer: (2)**

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

Solution

China rose has filaments united into one bundle, which is monadelphous cohesion. Brinjal has stamens attached to petals, which is epipetalous adhesion. Pea is diadelphous, *Citrus* is polyadelphous, and lily is epiphyllous (attached to the perianth). Option (4) mixes the terms: epipetalous describes adhesion, not cohesion.

Source: Adapted from NEET 2024 – stamen type and plant example matching

Common mistake: Treating 'epipetalous' as a kind of union among stamens rather than attachment of stamens to petals.

Q.97 Morphology of Flowering Plants – simple vs compound leaf, axillary bud • Standard • 60 s **Answer: (2)**

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

Solution

A leaf is simple when its incisions do not reach the midrib, so P is simple. A compound leaf has a bud only in the axil of the whole leaf, not in the axils of its leaflets, so Q is compound. When every blade has its own axillary bud, each blade is a whole leaf on a stem, so R is a leafy shoot. Option (1) swaps Q and R; that is the classic confusion between a pinnate leaf and a twig.

Source: Original synthesis

Common mistake: Calling P compound because the incisions are deep, without checking whether they reach the midrib.

Q.98 Morphology of Flowering Plants – monocot (cereal) seed • Standard • 75 s **Answer: (1)**

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

Solution

I – True. P is the scutellum, the single cotyledon of the embryo; Q is the proteinaceous aleurone layer of the endosperm. **II – True.** The coleorhiza sheathes the radicle and the coleoptile sheathes the plumule. **III – False.** A monocot has one cotyledon; aleurone is endosperm tissue. **IV – True.** The coleorhiza is a sheath, not the radicle itself. So I, II and IV. Option (4) is tempting to anyone who treats the aleurone as a second cotyledon.

Source: Original synthesis

Common mistake: Counting the aleurone layer as a second cotyledon in a cereal grain.

Q.99 Morphology of Flowering Plants – fruit: simple, true and false fruit • Standard • 60 s **Answer: (4)**

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

Solution

A – True. It develops from one ovary of one flower, so it is a simple fruit (e.g. apple). **B – False.** Syncarpy does not decide true versus false. **C – True.** NCERT calls fruits in which the thalamus also contributes (apple, strawberry, cashew) false fruits. **D – False.** The ovary wall forms the pericarp; the integuments form the seed coat. So A and C. Option (1) is tempting if one confuses the pericarp with the seed coat.

Source: Original synthesis

Common mistake: Assuming 'simple' and 'false' are mutually exclusive, so rejecting A once C is accepted.

Q.100 Anatomy of Flowering Plants – vascular bundles and organ diagnosis • Standard • 75 s **Answer: (4)**

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.

Solution

P (radial bundles, exarch xylem) is a root, but both monocot and dicot roots share that pattern; deciding which needs the xylem-patch count and pith size. Q (ring of open conjoint bundles, endarch xylem) is a dicot stem. R (scattered closed bundles, protoxylem cavity) is a monocot stem with no cambium. Option (2) is tempting because Q and R both have conjoint bundles, but a ring of open bundles versus scattered closed bundles is exactly what separates a dicot stem from a monocot stem.

Source: Adapted from NEET 2022 – radial, conjoint, open and closed bundles

Common mistake: Thinking the radial arrangement alone tells a dicot root from a monocot root.

Q.101 Anatomy of Flowering Plants – heartwood and sapwood • Standard • 75 s **Answer: (2)**

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

Solution

P is heartwood and Q is sapwood. **I – True.** Mature vessel elements are dead even while they conduct, so being dead does not identify heartwood. **II – True.** Heartwood gives mechanical support; sapwood conducts water and minerals. **III – True.** Both come from the vascular cambium, so both are secondary xylem. **IV – False.** 'Secondary' refers to origin from the cambium, not to loss of conduction. So I, II and III. Option (3) is the tempting under-selection: it drops III because heartwood and sapwood do different jobs.

Source: Adapted from NEET 2022 – dark central secondary xylem

Common mistake: Assuming that a dead vessel must be nonconducting heartwood.

Q.102 Anatomy of Flowering Plants – annual rings, spring and autumn wood • Standard • 90 s **Answer: (3)**

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

Solution

The cambium adds secondary xylem on its inner side, so tissue nearer the pith is older: A, then B, then C, then D. **I – True. II – False.** An annual ring is the spring wood plus autumn wood of one year (A+B or C+D); B+C straddle two years. **III – True.** Spring wood (A) forms when cambial activity is high. **IV – True.** D is the year-2 autumn wood and C the year-2 spring wood, so going from D to C moves inward to older tissue. So I, III and IV. Option (2) is tempting because B and C are adjacent and contrasting, but they belong to different years.

Source: Adapted from NEET 2022 – features of springwood

Common mistake: Taking any adjacent dark-light pair (B+C) as one annual ring instead of the spring+autumn wood of the same year.

Q.103 Anatomy of Flowering Plants – endarch and exarch primary xylem • Foundation • 35 s **Answer: (3)**

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.

Solution

NCERT: in stems the protoxylem lies towards the pith (endarch); in roots it lies towards the periphery (exarch). The organ labels are right; the terms describe primary xylem, not cambial production of secondary xylem. Option (2) is tempting, but it reverses labels that were already correct.

Source: Adapted from NEET 2023 – endarch/exarch

Common mistake: Linking endarch/exarch with secondary growth instead of the position of protoxylem in primary xylem.

Q.104 Anatomy of Flowering Plants – bulliform cells vs guard cells • Standard • 75 s **Answer: (2)**

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

Solution

I – True. X closes its stomata without rolling and Y rolls without closing them, so the two responses separate. **II – True.** Y has less exposed surface but open pores, and X is flat but has closed pores; total water loss was not measured. **III – False.** X's stomata were observed to close. **IV – True.** NCERT: flaccid bulliform cells make the leaf curl inwards. So I, II and IV. Option (1) is tempting if one equates 'no rolling' with 'no drought response'.

Source: Adapted from NEET 2024 – bulliform-cell function

Common mistake: Assuming the rolled leaf must lose less water overall, although its stomata stay open.

Q.105 Anatomy of Flowering Plants – stomatal apparatus, bulliform cells • Standard • 60 s **Answer: (1)**

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

Solution

I – True. Guard cells are bean-shaped in dicots and dumb-bell-shaped in grasses. **II – True.** NCERT: the stomatal aperture, the guard cells and the surrounding subsidiary cells together form the stomatal apparatus. **III – False.** S are subsidiary cells; bulliform cells are the large, empty, colourless cells of the grass adaxial epidermis. **IV – True.** Guard cells and mesophyll both contain chloroplasts but belong to different tissue systems. So I, II and IV. Option (4) is tempting to anyone who confuses subsidiary cells with bulliform cells.

Source: Adapted from NEET 2024 – guard-cell wall structure

Common mistake: Confusing subsidiary cells around the guard cells with bulliform cells.

Q.106 Anatomy of Flowering Plants – root vs stem, monocot vs dicot, secondary growth • Standard • 75 s **Answer: (4)**

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

Solution

Radial exarch xylem marks P and Q as roots. P (2–4 xylem patches, small pith) is a dicot root; Q (polyarch, large pith) is a monocot root. R is a monocot stem and S is a dicot stem. Normal cambial secondary growth occurs in the dicot root and dicot stem, i.e. P and S. Option (2) is tempting because it gets the roots right, but it gives secondary growth to the monocot root Q.

Source: Original synthesis

Common mistake: Giving secondary growth to the polyarch monocot root because it is a root, like P.

Q.107 Anatomy of Flowering Plants – simple and complex permanent tissues • Standard • 60 s **Answer: (2)**

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

Solution

I – True. Corner thickening of cellulose, hemicellulose and pectin is collenchyma, which supports growing parts. **II – True.** Telling fibres from sclereids needs cell shape. **III – True.** Vessels are dead, perforated tubes that conduct water. **IV – False.** Sclerenchyma mainly supports, while vessels conduct; shared wall chemistry does not fix function. So I, II and III. Option (3) is tempting if one argues from 'dead + lignified' to 'same function'.

Source: Original synthesis

Common mistake: Inferring identical function from shared lignification and lack of protoplast.

Q.108 Anatomy of Flowering Plants – dorsiventral vs isobilateral leaf • Standard • 75 s **Answer: (1)**

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

Solution

I – True. Palisade lies on the adaxial side of a dorsiventral leaf, and xylem faces the adaxial side. **II – True.** A grass leaf is isobilateral but has bulliform cells only on the adaxial epidermis. **III – False.** Stomatal distribution does not decide mesophyll differentiation; isobilateral leaves have stomata on both surfaces and no palisade/spongy distinction. **IV – False.** Xylem towards the adaxial side is already correct. So I and II. Option (4) is tempting to anyone who thinks phloem should face the upper surface.

Source: Original synthesis

Common mistake: Believing that phloem, not xylem, lies towards the adaxial side of a leaf vein.

Q.109 Plant Growth and Development – ethylene vs gibberellin in elongation • Foundation • 40 s **Answer: (1)**

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.

Solution

NCERT: ethylene promotes rapid internode/petiole elongation in deep-water rice, and gibberellins promote bolting in rosette plants such as cabbage. Option (4) is tempting because GA is the classic elongation hormone, but ethylene is not always inhibitory.

Source: Adapted from NEET 2023 – deep-water rice elongation

Common mistake: Attributing all stem elongation to gibberellin.

Q.110 Plant Growth and Development – dedifferentiation and redifferentiation • Standard • 75 s **Answer: (1)**

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

Solution

I – True. A differentiated cell regaining the ability to divide is dedifferentiation. **II – True.** Its derivatives maturing into specialised cells is redifferentiation. **III – False.** Q already contains dividing cells, so callus does not prove that mature cells dedifferentiated. **IV – True.** Developmental state changes along a lineage. So I, II and IV. Option (2) is the trap, because callus is the textbook example of dedifferentiation.

Source: Adapted from NEET 2023 – mesophyll-to-callus culture

Common mistake: Treating callus from any explant as automatic proof of dedifferentiation.

Q.111 Plant Growth and Development – gibberellin and cytokinin identification • Standard • 60 s **Answer: (4)**

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.

Solution

Hastening maturity in juvenile conifers and bolting are both gibberellin effects. Delayed senescence through nutrient mobilisation and lateral-shoot growth are cytokinin effects. Ethylene also causes rapid elongation (deep-water rice), so elongation alone cannot exclude it. Option (1) has the right identities but an invalid 'exclusively' inference.

Source: Adapted from NEET 2023 – gibberellin in juvenile conifers

Common mistake: Choosing option (1) on correct identities without reading its overgeneralised second clause.

Q.112 Plant Growth and Development – auxin, 2,4-D and cytokinin applications • Standard • 60 s **Answer: (2)**

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

Solution

I – True. Root initiation in cuttings and prevention of early fruit drop are auxin uses; lateral shoots and delayed senescence are cytokinin uses. **II – True.** 2,4-D is a synthetic auxin that kills dicot weeds without affecting mature monocots. **III – False.** A shared 'growth-promoting' label does not make the two interchangeable for rooting. **IV – False.** Lawn selectivity is the auxin herbicide action of 2,4-D. So I and II. Option (3) is tempting to anyone unaware that 2,4-D is an auxin.

Source: Adapted from NEET 2024 – auxin treatment of lawns

Common mistake: Forgetting that the weedicide 2,4-D is itself a synthetic auxin.

Q.113 Plant Growth and Development – gibberellin, ethylene, cytokinin profiles • Standard • 75 s **Answer: (2)**

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

Solution

P is gibberellin, Q is ethylene and R is cytokinin. **I – True.** NCERT: spraying sugarcane with gibberellins increases stem length and yield. **II – False.** Ethylene promotes elongation in deep-water rice, so it is not inhibitory everywhere. **III – True.** Cytokinins help overcome apical dominance; malting is a gibberellin effect. **IV – False.** A shared elongation response does not make two hormones the same class. So I and III. Option (1) is tempting to anyone who files ethylene purely as a 'growth inhibitor'.

Source: Adapted from NEET 2024 – sugarcane stem elongation and yield

Common mistake: Labelling ethylene an inhibitor in every context.

Q.114 Plant Growth and Development – ethylene and auxin, stage-dependent responses • Standard • 50 s **Answer: (3)**

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.

Solution

Female flowers in cucumber, synchronised fruit set in pineapple and fruit ripening are ethylene effects. NCERT: auxins prevent fruit and leaf drop at early stages but promote abscission of older mature leaves and fruits, so the response depends on stage. Option (4) has the right identities but wrongly calls this stage dependence a contradiction.

Source: Adapted from NEET 2022 – female flowers in cucumber

Common mistake: Rejecting auxin for A because one hormone 'cannot' both prevent and promote abscission.

Q.115 Plant Growth and Development – absolute and relative growth rate • Standard • 60 s **Answer: (1)**

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

Solution

I – True. Both gain 5 cm^2. **II – True.** $5 \to 10$ and $10 \to 20$ are each 100%. **III – False.** Q gains $5/50 = 10\%$ and then $5/55 \approx 9.09\%$. **IV – True.** Three points fit doubling but cannot fix the trajectory between them. So I, II and IV. Option (2) is the trap: a constant absolute gain looks like a constant percentage.

Source: Original synthesis

Common mistake: Assuming equal absolute increments mean equal relative (percentage) growth.

Q.116 Plant Growth and Development – arithmetic vs geometric growth (cell lineages) • Challenging • 120 s **Answer: (3)**

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

Solution

P (active, total): $(8, 8) \to (16, 16) \to (32, 32)$, then one daughter of each active cell stays active: $(32, 64) \to (32, 96)$. Q: $(8, 16) \to (8, 24)$, then geometric: $(16, 32) \to (32, 48)$. So P = 96, Q = 48, with 32 active cells in each. Option (2) gets P right but treats Q's late doubling as acting on the whole population rather than only on the 8 active cells.

Source: Original synthesis

Common mistake: Doubling the whole population of Q in the geometric phase, though its differentiated cells no longer divide.

Q.117 Plant Growth and Development – plasticity, heterophylly • Standard • 75 s **Answer: (1)**

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

Solution

I – True. A differs from C in water and B differs from C in air. **II – True.** Juvenile leaves differ between water and air (A versus B), but mature leaves are C in both. **III – False.** Genetic identity does not force equal environmental responses at every phase, and the data show otherwise. **IV – True.** Different leaf forms are plasticity (heterophylly); nothing shows mature cells dividing again. So I, II and IV. Option (2) is tempting to anyone who thinks identical genotype means identical responses.

Source: Original synthesis

Common mistake: Concluding that genetically identical plants must respond identically to environment at every phase.

Q.118 Photosynthesis in Higher Plants – C4 pathway enzymes and acceptors • Foundation • 35 s **Answer: (1)**

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

Solution

PEP carboxylase in mesophyll fixes CO_2 onto the three-carbon PEP to give four-carbon OAA. In the bundle sheath the released CO_2 is fixed by RuBisCO onto RuBP, giving PGA through the Calvin cycle. Option (3) has the right enzymes in the right cells but swaps their substrates.

Source: Adapted from NEET 2022 – PEP carboxylase and RuBisCO location

Common mistake: Pairing the correct enzyme with the wrong acceptor (e.g. PEP carboxylase with RuBP).

Q.119 Photosynthesis in Higher Plants – C4 compartmentation, experimental inference • Challenging • 100 s **Answer: (4)**

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.

Solution

Normal labelling of mesophyll C4 acids shows that PEP carboxylation works. Rescue by direct bundle-sheath CO_2 shows that RuBisCO, RuBP regeneration and the ATP supply all work. What remains is failure to deliver CO_2 to the bundle sheath, either by blocked transport of the C4 acid or by blocked decarboxylation; direct CO_2 bypasses both, so the experiment cannot tell them apart. Option (1) is tempting, but the rescue already shows the Calvin enzymes are active.

Source: Adapted from NEET 2022 – role of bundle-sheath cells in C4 plants

Common mistake: Choosing option (1) without noticing that the CO_2 rescue already shows the Calvin enzymes are active.

Q.120 Photosynthesis in Higher Plants – chemiosmosis, imposed proton gradient • Challenging • 90 s **Answer: (1)**

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

Solution

ATP synthesis needs a gradient that is maintained and a working ATP synthase. P loses the gradient at once; Q keeps it but cannot use it. R keeps the imposed gradient and has active ATP synthase; electron transport normally only builds the gradient, so blocking it does not matter once a gradient is supplied. So R only. Option (3) is tempting because P has an intact ATP synthase.

Source: Adapted from NEET 2023 – requirements for chemiosmosis

Common mistake: Excluding R because its electron transport is blocked, forgetting that the gradient was supplied artificially.

Q.121 Photosynthesis in Higher Plants – cyclic/noncyclic flow and Calvin stoichiometry • Standard • 90 s **Answer: (4)**

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

Solution

Cyclic flow uses only PS I, whose reaction centre is P700. 6 mmol O_2 gives 12 mmol NADPH and 12 mmol ATP. 12 NADPH fixes $12/2 = 6$ mmol CO_2, which needs $6 \times 3 = 18$ mmol ATP, so cyclic flow must supply $18 - 12 = 6$ mmol. Option (1) counts the total ATP needed (or doubles the shortfall) instead of the extra amount.

Source: Adapted from NEET 2023 – PSII absorption maximum

Common mistake: Reporting the total ATP required (18) or the noncyclic ATP (12) instead of the shortfall that cyclic flow must make up.

Q.122

Photosynthesis in Higher Plants – Calvin cycle limiting resource • Standard • 75 s **Answer: (4)**

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

Solution

A has $30 - 6 = 24$ ATP and 24 NADPH. ATP allows $24/3 = 8$ and NADPH allows $24/2 = 12$, so ATP limits A to 8 mmol CO_2, using 16 NADPH and leaving 8. B has 36 ATP, allowing 12, and NADPH allows 12, so B fixes 12. Option (1) ignores the 6 mmol diversion ($30/3 = 10$).

Source: Adapted from NEET 2024 – ATP and NADPH per CO2 fixed

Common mistake: Forgetting to subtract the 6 mmol ATP diverted before fixation.

Q.123

Photosynthesis in Higher Plants – Calvin cycle requirements • Foundation • 40 s **Answer: (1)**

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.

Solution

The Calvin cycle in the stroma needs CO_2, ATP and NADPH, not direct light absorption. So fixation continues until the supplied ATP and NADPH run out. Photolysis of water and regeneration of ATP and NADPH need the thylakoid light reactions. Option (3) is the common misconception that the 'dark reaction' itself needs light.

Source: Adapted from NEET 2024 – requirements of the dark reaction

Common mistake: Believing each Calvin-cycle step needs light absorbed directly by chlorophyll.

Q.124

Photosynthesis in Higher Plants – photorespiration • Standard • 50 s **Answer: (4)**

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

Solution

A – True. NCERT: RuBP + O_2 gives phosphoglycerate + phosphoglycolate. **B – False.** NCERT: the photorespiratory pathway synthesises neither sugar nor ATP, and it releases CO_2 while using ATP. **C – True.** Oxygenation competes with carboxylation and lowers fixation even in light. So A and C. Option (3) is tempting because of the word 'respiration', which suggests ATP is made.

Source: Original synthesis

Common mistake: Assuming photorespiration makes ATP, like mitochondrial respiration.

Q.125 Photosynthesis in Higher Plants – pigments, absorption vs action spectrum • Standard • 60 s **Answer: (2)**

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

Solution

I – True. NCERT: chlorophyll *a* is bright or blue-green and chlorophyll *b* yellow-green; xanthophylls are yellow and carotenoids yellow to yellow-orange. **II – True.** Accessory pigments absorb other wavelengths and pass the energy on to chlorophyll *a*. **III – False.** Only chlorophyll *a* forms the reaction centre; accessory pigments act as antennae. **IV – True.** Colour shows only the reflected light, not the full spectrum. So I, II and IV. Option (4) is tempting to anyone who thinks absorbing light makes a pigment a reaction centre.

Source: Original synthesis

Common mistake: Treating every light-absorbing pigment as a reaction-centre pigment.

Q.126 Photosynthesis in Higher Plants – limiting factors, gross vs net photosynthesis • Standard • 75 s **Answer: (2)**

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.

Solution

Gross = net + respiration: $4+2=6$ and $11+2=13$. At low light, enrichment changes nothing (4 to 4), so light limits. At high light, enrichment raises uptake (7 to 11), so CO_2 limits. Option (1) has the right numbers, but no higher light level was tested, so 'never' is unsupported.

Source: Original synthesis

Common mistake: Subtracting respiration from net uptake (giving 2 and 9) instead of adding it.

Q.127 Respiration in Plants – glycolysis and two fermentations, accounting • Challenging • 100 s **Answer: (2)**

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

Solution

Glycolysis of 5 mmol glucose gives 10 pyruvate, 10 net ATP and 10 NADH. Lactate formation uses 3 pyruvate and 3 NADH. Alcoholic fermentation uses 2 pyruvate and 2 NADH and releases 2 CO_2. Neither fermentation makes ATP. Net: 10 ATP, $10-5=5$ NADH, $10-5=5$ pyruvate, 2 CO_2. Option (1) forgets that both fermentations reoxidise NADH.

Source: Adapted from NEET 2022 – net ATP of glycolysis

Common mistake: Not subtracting the NADH consumed in lactate and ethanol formation.

Q.128 Respiration in Plants – lactic acid fermentation • Foundation • 35 s **Answer: (1)**

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.

Solution

NADH reduces pyruvate to lactate and is reoxidised to NAD^+, which keeps glycolysis running. That step makes no ATP; the only ATP is the 2 net ATP from glycolysis. NCERT notes that less than 7% of the energy in glucose is released. Option (4) inverts the coenzyme (it is NAD^+, not NADH, that is regenerated) and invents ATP.

Source: Adapted from NEET 2022 – energy released in lactic acid fermentation

Common mistake: Thinking the conversion of pyruvate to lactate itself yields ATP.

Q.129 Respiration in Plants – glycolytic entry points, ATP/NADH accounting • Challenging • 110 s **Answer: (2)**

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

Solution

Glucose: 2 mmol gives 4 pyruvate, $2 \times 2 = 4$ net ATP and 4 NADH. Fructose-1,6-bisphosphate: 3 mmol gives 6 trioses, so 6 pyruvate, 12 ATP (no investment left) and 6 NADH. G3P: 4 mmol gives 4 pyruvate, 8 ATP and 4 NADH. Totals: 14 pyruvate, 24 net ATP, 14 NADH. Option (1) gives the gross ATP (28) and forgets the 4 ATP invested by the glucose.

Source: Adapted from NEET 2023 – ATP-consuming steps of glycolysis

Common mistake: Charging the 2-ATP investment to fructose-1,6-bisphosphate as well, or forgetting it for glucose.

Q.130 Respiration in Plants – link reaction, pyruvate dehydrogenase • Foundation • 40 s **Answer: (4)**

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.

Solution

Pyruvate dehydrogenase catalyses the oxidative decarboxylation of pyruvate to acetyl-CoA, the link between glycolysis and the TCA cycle. Glycolysis is unaffected, and supplied acetyl-CoA can enter through citrate synthase. Option (1) is tempting only if one mislocates PDH within the EMP pathway.

Source: Adapted from NEET 2023 – respiration stages matched to enzymes

Common mistake: Placing pyruvate dehydrogenase inside glycolysis rather than at the link reaction.

Q.131 Respiration in Plants – link reaction and TCA accounting, substrate-level phosphorylation • Challenging • 110 s **Answer: (2)**

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.

Solution

Link reaction: 3 pyruvate give 3 NADH and 3 CO_2. TCA: 4 acetyl-CoA give $4 \times 3 = 12$ NADH, 4 $FADH_2$, 8 CO_2

and 4 GTP/ATP. Totals: 15 NADH, 4 $FADH_2$, 11 CO_2. GTP forms when succinyl-CoA is converted to succinate, a substrate-level phosphorylation in which nothing is oxidised. Option (1) omits the link reaction's 3 NADH and 3 CO_2 and mislabels the step as oxidative.

Source: Adapted from NEET 2024 – non-oxidative TCA step

Common mistake: Forgetting the NADH and CO_2 from the link reaction when pyruvate, not acetyl-CoA, is the input.

Q.132

Respiration in Plants – ETS: complex II, proton and O2 bookkeeping • Standard • 90 s **Answer: (4)**

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.

Solution

Complex II is succinate dehydrogenase. P: $6 \times 10 + 2 \times 6 = 72$ protons, $72/4 = 18$ ATP. Q: $2 \times 10 + 6 \times 6 = 56$ protons, $56/4 = 14$ ATP. Each has 8 two-electron donors, i.e. 16 electrons, so each reduces $16/4 = 4$ O_2. Option (1) assumes that equal O_2 use means equal ATP, but $FADH_2$ bypasses complex I and pumps fewer protons.

Source: Adapted from NEET 2025 – identity of mitochondrial complex II

Common mistake: Counting one O_2 per electron pair (giving 8 O_2) instead of four electrons per O_2.

Q.133

Respiration in Plants – respirometry, RQ of a substrate mixture • Challenging • 120 s **Answer: (4)**

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

Solution

P measures O_2 uptake: 20 mL. In Q the volume falls by O_2 taken in minus CO_2 released, so $CO_2 = 20 - 3 = 17$ mL. If x mL of O_2 goes to lipid: $0.7x + 1.0(20 - x) = 17$, so $0.3x = 3$ and $x = 10$ mL. Option (2) mistakes the CO_2 released (17 mL) for the answer.

Source: Original synthesis

Common mistake: Reporting the CO_2 released (17 mL) rather than solving for the O_2 share used by lipid.

Q.134

Respiration in Plants – amphibolic pathway, substrate entry points • Standard • 75 s **Answer: (4)**

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.

Solution

Glycerol enters as triose phosphate, so the ATP-forming steps from triose phosphate to pyruvate still run; only its conversion to acetyl-CoA is blocked. Fatty acids enter directly as acetyl-CoA and bypass the block. Drawing intermediates off for synthesis is the anabolic side of the amphibolic pathway. Option (3) is tempting, but glycerol enters upstream of the block, not downstream.

Source: Original synthesis

Common mistake: Assuming fatty acids pass through pyruvate before reaching acetyl-CoA.

Q.135 Respiration in Plants – fermentation vs uncoupled respiration • Standard • 75 s **Answer: (2)**

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.

Solution

P: glycolysis gives 2 net ATP and 2 NADH per glucose, and reducing the 2 pyruvate to lactate reoxidises both NADH, so no NADH builds up. Q: electron flow to O_2 (at complex IV, not at ATP synthase) can continue, but the leak dissipates the proton gradient, so little ATP is made; the ETS is uncoupled. Option (4) is tempting to anyone who assumes O_2 consumption guarantees ATP synthesis.

Source: Original synthesis

Common mistake: Assuming that oxygen consumption guarantees normal ATP synthesis.

ZOOLOGY Detailed solutions

Q.136 Structural Organisation in Animals – frog cutaneous respiration • Standard • 75 s **Answer: (2)**

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

Solution

For P: $k(0.75A)\Delta p' = 1.20\,kA\Delta p$, so $\Delta p'/\Delta p = 1.20/0.75 = 1.60$. For Q: uptake $= kA(0.80\Delta p) = 0.80D$. Hence 1.60 and 0.80. Option (1) uses $1/0.80$ and ignores the demand rise; option (3) quotes the two percentage changes as ratios without combining them.

Source: Adapted from NEET 2026 (21 June re-exam) – respiratory surface of submerged frog

Common mistake: Dividing only by the area factor ($1/0.75 \approx 1.33$) or quoting 1.25 while forgetting that P's demand has also risen by 20%.

Q.137 Structural Organisation in Animals – frog nervous system • Foundation • 40 s **Answer: (4)**

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

Solution

i – True. NCERT gives ten pairs of cranial nerves, i.e. 20 individual nerves. **ii – True.** The midbrain is characterised by a pair of optic lobes. **iii – False.** The cerebellum is part of the hindbrain. **iv – True.** Brain and spinal cord form the CNS. Hence i, ii and iv. Option (3) tempts students who read '20' as a wrong count of pairs.

Source: Adapted from NEET 2026 (21 June re-exam) – number of cranial nerve pairs in frog

Common mistake: Treating '20 cranial nerves' as an error by confusing 10 pairs with 10 nerves.

Q.138 Structural Organisation in Animals – frog portal systems • Foundation • 35 s **Answer: (2)**

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

Solution

NCERT: the hepatic portal system connects intestine and liver; the renal portal system connects the lower parts of the body and the kidneys. So R: kidney, lower body; H: liver, intestine. Option (1) keeps the correct target organs but swaps the source regions.

Source: Adapted from NEET 2025 Q134 – renal portal connection in frog

Common mistake: Matching target organs correctly but swapping the source regions of the two portal systems.

Q.139 Structural Organisation in Animals – frog urinogenital system • Standard • 75 s **Answer: (1)**

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

Solution

X is male (copulatory pad, vocal sacs). **A – True.** Vasa efferentia enter the kidney, open into Bidder's canal and communicate with the urinogenital duct (ureter). **B – False.** Oviducts open into the cloaca separately from the ureters; ova do not pass through the kidney. **C – True.** In males the ureter is a urinogenital duct, so its blockage obstructs both. **D – False.** The female ureter and oviduct are separate. Hence A and C. Option (2) fails because the shared cloaca does not make the female ducts shared upstream.

Source: Adapted from NEET 2025 Q146 – male frog copulatory pad

Common mistake: Extending the male 'urinogenital duct' arrangement to females and assuming the oviduct joins the ureter.

Q.140

Structural Organisation in Animals – muscle tissue • Standard • 60 s **Answer: (4)**

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

Solution

A – True. Skeletal and cardiac muscles are striated; smooth and cardiac are involuntary. **B – False.** Cardiac fibres are branched. **C – True.** NCERT places smooth muscle in blood-vessel walls; intercalated discs (communication junctions) let cardiac cells contract as a unit. **D – False.** Spindle (fusiform) shape belongs to smooth muscle, not skeletal fibres. Hence A and C. Option (3) tempts students who forget cardiac branching.

Source: Adapted from NEET 2024 Q161 – three muscle types and locations

Common mistake: Forgetting that cardiac fibres are branched and so accepting B.

Q.141

Structural Organisation in Animals – glandular and compound epithelia • Standard • 60 s **Answer: (4)**

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

Solution

A – True. Goblet cells are unicellular glands; salivary glands are multicellular. **B – True.** Exocrine (Q) glands use ducts; endocrine (R) glands are ductless. **C – False.** S (compound epithelium) is multilayered, not unicellular. **D – False.** Compound epithelium is multicellular but protective, not glandular. Hence A and B. Option (1) fails on D, which confuses cell number with function.

Source: Adapted from NEET 2024 Q192 – glandular and compound epithelium matching

Common mistake: Assuming 'multicellular' automatically means 'gland'.

Q.142

Structural Organisation in Animals – connective tissue classification • Foundation • 40 s **Answer: (2)**

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

Solution

P is a ligament: dense regular. Q is cartilage (chondrocytes in lacunae, firm pliable matrix): specialised connective tissue. R is dermis: NCERT places dense irregular tissue in the skin. Option (4) mislabels cartilage as dense irregular.

Source: Adapted from NEET 2023 Q161 – ligament/cartilage classification

Common mistake: Calling cartilage dense connective tissue because its matrix is firm.

Q.143 Structural Organisation in Animals – areolar, adipose and ciliated tissues • Standard • 60 s **Answer: (1)**

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

Solution

A – True. Areolar tissue contains fibroblasts, macrophages and mast cells and serves as a support framework for epithelium. **B – True.** Cilia move particles or mucus in a specific direction over the surface. **C – False.** Parallel bundles define dense regular tissue. **D – True.** NCERT calls adipose 'another type of loose connective tissue'. Hence A, B and D. Option (4) tempts students who forget that adipose is loose connective tissue.

Source: Adapted from NEET 2023 Q198 – mast cells and bronchiolar epithelium

Common mistake: Classifying adipose tissue as specialised or dense connective tissue.

Q.144 Structural Organisation in Animals – epithelial and connective tissue function • Standard • 50 s **Answer: (2)**

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

Solution

i – Valid. Ciliary transport and secretion are separate functions. **ii – Valid.** Goblet cells are unicellular glands within the epithelium. **iii – Valid.** Tendons are dense regular connective tissue. **iv – Invalid.** The premise is true but adipose is loose connective tissue. Hence i, ii and iii. Option (1) accepts iv because its premise is correct.

Source: Adapted from NEET 2022 Q198 – bronchioles, goblet cells, tendons and adipose

Common mistake: Accepting iv because the premise (lipid storage) is true, without checking the deduction.

Q.145 Structural Organisation in Animals – cell junctions • Standard • 60 s **Answer: (1)**

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.

Solution

Retained attachment shows adhering junctions work; loss of direct ion passage shows gap junctions failed; paracellular leakage shows tight junctions failed. Restoring only the leakage barrier restores tight-junction function; gap function stays impaired. Option (3) swaps which junction stops leakage.

Source: Original synthesis

Common mistake: Thinking gap junctions prevent leakage; tight junctions do that, gap junctions connect cytoplasm.

Q.146 Structural Organisation in Animals – frog sense organs • Standard • 55 s **Answer: (4)**

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

Solution

A – True. NCERT lists touch (sensory papillae), taste (taste buds), smell (nasal epithelium), vision (eyes) and hearing (tympanum with internal ears); of these, only the eyes and internal ears are well-organised, the rest being cellular aggregations around nerve endings. **B – False.** Frog eyes are a pair of spherical structures in the orbits, but each is a simple eye possessing only one unit; being paired says nothing about being compound. **C – True.** External ear is absent and only the tympanum is visible; NCERT calls the ear an organ of hearing as well as balancing (equilibrium). **D – True.** The eyes are bulged and covered by a nictitating membrane that protects them in water. Hence A, C and D. Option (3) tempts students who equate 'paired' eyes with compound eyes.

Source: Original synthesis (NCERT-based)

Common mistake: Inferring that the frog's paired eyes are compound eyes; NCERT describes them as simple eyes with only one unit each.

Q.147 Structural Organisation in Animals – frog circulation and life history • Standard • 60 s **Answer: (2)**

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

Solution

A – True. The frog has a three-chambered heart and is poikilothermic. **B – True.** NCERT: the sinus venosus joins the right atrium and receives blood through the venae cavae. **C – False.** The ventricle opens into the conus arteriosus on the ventral side; it is the sinus venosus that feeds the right atrium. **D – True.** Frog RBCs are nucleated and development includes a tadpole. Hence A, B and D. Option (1) confuses the conus arteriosus with the sinus venosus.

Source: Original synthesis

Common mistake: Swapping the roles of the sinus venosus (dorsal, venous inflow) and the conus arteriosus (ventral, ventricular outflow).

Q.148 Structural Organisation in Animals – frog digestive system • Standard • 55 s **Answer: (1)**

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

Solution

A – True. NCERT: the duodenum receives bile and pancreatic juice through a common bile duct. **B – True.** The alimentary lumen is stated to be intact. **C – False.** The hepatic portal vein is a blood vessel, not this duct, and its flow is stated to be intact. **D – True.** Liver secretes bile; the gall bladder stores it. Hence A, B and D. Option (3) wrongly rejects B by assuming any duct block stops food passage.

Source: Original synthesis

Common mistake: Confusing the common bile duct with the hepatic portal vein, so accepting C.

Q.149 Structural Organisation in Animals – epithelium – layers and function • Standard • 60 s **Answer: (1)**

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.

Solution

P: $2A/(4d) = 0.5\,A/d$. Q: $0.5A/d$. Both are half the original. P has several layers, as in protective compound epithelium; equal rates do not imply equal organisation. Option (3) uses the area ratio (4) but ignores P's fourfold thickness.

Source: Original synthesis

Common mistake: Comparing areas only and forgetting that four layers quadruple the thickness.

Q.150 Structural Organisation in Animals – frog excretion, habitat and reproduction • Standard • 55 s **Answer: (2)**

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

Solution

A – True. NCERT: excretory wastes are carried by blood into the kidney, where they are separated and excreted; frogs excrete urea and are thus ureotelic. **B – True.** NCERT: frogs never drink water but absorb it through the skin, which is kept moist. **C – False.** Fertilisation in frogs is external and takes place in water; laying eggs in water does not imply internal fertilisation. **D – True.** Frogs are cold-blooded (poikilothermic) and take shelter in deep burrows against extreme heat and cold—aestivation and hibernation. Hence A, B and D. Option (1) tempts students who assume egg-laying animals must have internal fertilisation.

Source: Original synthesis (NCERT-based)

Common mistake: Assuming fertilisation is internal in frogs; NCERT states it is external and takes place in water.

Q.151 Breathing and Exchange of Gases – respiratory organs in animals • Standard • 50 s **Answer: (3)**

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

Solution

A – True. Sponges, coelenterates and flatworms use simple diffusion over the body surface. **B – False.** Earthworms use the moist cuticle, but insects use tracheal tubes. **C – True.** NCERT: aquatic arthropods and molluscs use gills; reptiles, birds and mammals use lungs. **D – False.** Frogs respire through the skin in water. Hence A and C. Option (1) lumps insects with earthworms.

Source: Adapted from NEET 2026 (21 June re-exam) – gas exchange in sponges

Common mistake: Grouping insects with earthworms as cutaneous breathers.

Q.152 Breathing and Exchange of Gases – oxygen–haemoglobin binding factors • Standard • 60 s **Answer: (3)**

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.

Solution

NCERT: high pO_2, low pCO_2, low H^+ and lower temperature favour oxyhaemoglobin formation. Q has two favourable changes. R has one favourable (low pCO_2) and one unfavourable (high temperature) change, and NCERT gives no relative sizes, so R versus P cannot be fixed. Option (4) ignores R's temperature rise.

Source: Adapted from NEET 2024 Q153 – alveolar conditions favouring oxyhaemoglobin

Common mistake: Looking only at pCO_2 and ignoring the opposing temperature effect in R.

Q.153 Breathing and Exchange of Gases – lung volumes and capacities • Challenging • 120 s **Answer: (3)**

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

Solution

Let RV = ERV = x. EC = TV + ERV = $500 + x$; IC = 2 EC = $1000 + 2x$. TLC = IC + ERV + RV = $1000 + 4x = 6000$, so $x = 1250$ mL and IRV = 3000 mL. Maximal expiration after normal inspiration = EC = 1750 mL. VC = TLC − RV = 4750 mL. Option (4) reports IC (3500) instead of EC.

Source: Adapted from NEET 2024 Q155 – respiratory capacities and component volumes

Common mistake: Reporting inspiratory capacity instead of expiratory capacity for 'maximal expiration after a normal inspiration'.

Q.154 Breathing and Exchange of Gases – vital capacity • Foundation • 40 s **Answer: (1)**

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

Solution

VC = TLC − RV = 4500 mL; this is the maximum inspired after a forced expiration. Remaining = 4500 − 3000 = 1500 mL. Option (4) has the right volume but IC starts from a normal, not a maximal, expiration.

Source: Adapted from NEET 2023 Q154 – definition of vital capacity

Common mistake: Naming inspiratory capacity, which starts from the end of a normal expiration.

Q.155 Breathing and Exchange of Gases – oxygen transport • Standard • 90 s **Answer: (2)**

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}

Solution

Arterial content: $20 \times 0.95 = 19$ to $20 \times 0.90 = 18$ mL per 100 mL, change −1 mL. Unloading: rest $20(0.95 - 0.70) = 5$ mL/100 mL × 50 = 250 mL min^{-1}; activity $20(0.90 - 0.50) = 8 \times 80 = 640$ mL min^{-1}. Change = +390 mL min^{-1}. Option (4) gives the new value, not the change.

Source: Adapted from NEET 2022 Q151 – 5 mL O2 delivered per 100 mL blood

Common mistake: Quoting the activity delivery (640) instead of its change from rest (390).

Q.156 Breathing and Exchange of Gases – conducting versus exchange zones • Standard • 60 s **Answer: (4)**

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

Solution

A – True. Bypassing the conducting zone says nothing about alveolar failure. **B – True.** Mucociliary clearance and alveolar gradients are separate. **C – False.** R affects the exchange membrane, not air conditioning. **D – False.** Conditioning air cannot compensate for impaired diffusion. Hence A and B. Option (3) accepts D's 'guarantees'.

Source: Adapted from NEET 2022 Q156 – function not assigned to conducting part

Common mistake: Accepting D: air conditioning by the conducting zone cannot rescue impaired alveolar diffusion.

Q.157 Breathing and Exchange of Gases – respiratory disorders • Standard • 50 s **Answer: (3)**

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

Solution

A – True. NCERT: emphysema damages alveolar walls and decreases respiratory surface. **B – False.** Asthma is bronchial/bronchiolar inflammation with wheezing, not alveolar destruction. **C – True.** Occupational dust exposure causes inflammation and fibrosis; NCERT advises protective masks. **D – False.** Asthma is an airway problem and can occur with normal alveolar area. Hence A and C. Option (1) accepts the 'identical' clause in B.

Source: Adapted from NEET 2025 Q101 (Code 45) – emphysema among disorder matches

Common mistake: Reading only the first half of B ('consistent with asthma') and missing the false 'identical' clause.

Q.158 Breathing and Exchange of Gases – lung volumes – measurement errors • Standard • 90 s **Answer: (2)**

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.

Solution

A = EC = TV + ERV; B = IC = TV + IRV. A + B = VC + TV, so VC = 1500 + 3000 − 500 = 4000 mL. D = RV, so TLC = 4000 + 1200 = 5200 mL. Option (3) subtracts TV twice.

Source: Adapted from NEET 2024 re-exam – RV, VC, EC and TV definitions (question number code-dependent)

Common mistake: Adding EC and IC directly and so counting tidal volume twice.

Q.159 Breathing and Exchange of Gases – steps of respiration • Standard • 50 s **Answer: (3)**

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

Solution

A – True. Oxygen must diffuse into blood before transport. **B – False.** Transport cannot bypass a failed loading step. **C – True.** This is the NCERT sequence in reverse for CO_2. **D – False.** Ventilation is bulk flow; the exchange steps are diffusion. Hence A and C. Option (4) accepts B.

Source: Adapted from NEET 2023 (Manipur) – sequence of steps in respiration

Common mistake: Treating the steps of respiration as independent, so that transport can compensate for failed alveolar diffusion.

Q.160 Breathing and Exchange of Gases – diffusion – solubility, area and thickness • Challenging • 120 s **Answer: (3)**

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 $1/4$

Solution

Later gradients: O_2 $72-40=32$; CO_2 $45-40=5$. Ratio $=(20\times5)/32=25/8$; the common area/thickness factor cancels. O_2 over time: area/thickness factor $(1/2)/2=1/4$, gradient $32/64=1/2$, so $1/8$. Option (2) applies only the geometry factor.

Source: Original synthesis

Common mistake: Applying the area/thickness factor but forgetting the halved O_2 gradient (giving $1/4$).

Q.161 Breathing and Exchange of Gases – mechanism of inspiration • Standard • 50 s **Answer: (3)**

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.

Solution

Normal sequence: contraction → thoracic (and pulmonary) volume rises → intrapulmonary pressure falls below atmospheric → air flows in. Blocking expansion breaks the chain after contraction. Option (1) reverses cause and effect; option (2) confuses ventilation with diffusion.

Source: Original synthesis

Common mistake: Equating muscle contraction itself with inspiration, ignoring that the volume change creates the pressure gradient.

Q.162 Breathing and Exchange of Gases – carbon dioxide transport • Standard • 50 s **Answer: (3)**

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

Solution

A – True. At tissues, high pCO_2 drives $CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow HCO_3^- + H^+$ via carbonic anhydrase. **B – True.** At alveoli, low pCO_2 reverses it, releasing CO_2. **C – False.** NCERT: 20–25% of CO_2 travels as carbaminohaemoglobin. **D – True.** Low pCO_2 and high pO_2 in alveoli favour dissociation of carbaminohaemoglobin. Hence A, B and D. Option (4) rejects D.

Source: Original synthesis

Common mistake: Thinking the 70% bicarbonate route means haemoglobin carries no CO_2.

Q.163 Breathing and Exchange of Gases – tidal volume and alveolar ventilation • Standard • 90 s **Answer: (3)**

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 (frequency) $\times$ (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}

Solution

P: TV $= 6000/12 = 500$ mL; alveolar ventilation $= 12(500 - 150) = 4200$ mL min^{-1}. Q: $20(\text{TV} - 150) = 4200 \Rightarrow$ TV $=$ 360 mL; total $= 20 \times 360 = 7200$ mL min^{-1}. Option (1) keeps Q's original TV of 300 mL.

Source: Original synthesis

Common mistake: Assuming equal total ventilation means equal alveolar ventilation.

Q.164 Breathing and Exchange of Gases – regulation of respiration • Standard • 45 s **Answer: (2)**

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

Solution

A – True. Rhythm centre in medulla; pneumotaxic centre in pons moderates it. **B – True.** NCERT: pneumotaxic signals reduce inspiratory duration and alter rate. **C – False.** The chemosensitive area is highly sensitive to CO_2 and H^+; NCERT says the role of oxygen is quite insignificant. **D – True.** Aortic-arch and carotid receptors detect CO_2/H^+ changes. Hence A, B and D. Option (3) accepts C.

Source: Original synthesis

Common mistake: Believing oxygen is the main chemical drive on the medullary chemosensitive area.

Q.165 Breathing and Exchange of Gases – direction of gas diffusion • Standard • 45 s **Answer: (1)**

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 $\rightarrow$ blood; later both gases: blood $\rightarrow$ alveolus

(2) O_2 reverses direction, but CO_2 remains alveolus $\rightarrow$ blood in both states

(3) Initially O_2: alveolus $\rightarrow$ blood and CO_2: blood $\rightarrow$ alveolus; later both reverse

(4) Initially both gases: blood $\rightarrow$ alveolus; later both gases: alveolus $\rightarrow$ blood

Solution

Each gas follows its own partial-pressure gradient. Initially $80 > 60$ (O_2) and $45 > 40$ (CO_2): both move alveolus $\rightarrow$ blood. Later $50 < 60$ and $35 < 40$: both move blood $\rightarrow$ alveolus. Option (3) substitutes the usual physiological direction of CO_2 for the stated values.

Source: Original synthesis

Common mistake: Answering from the normal physiological direction of CO_2 instead of the given partial pressures.

Q.166

Excretory Products and their Elimination – loop of Henle mass balance • Standard • 90 s **Answer: (1)**

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

Solution

At the bend, volume $= 300/600 = 0.50$ L, so 0.50 L water left. After ascent solute $= 240 \times 0.50 = 120$ units, so $300 - 120 = 180$ units removed with no water change. This matches a water-permeable descending limb and a water-impermeable ascending limb. Option (3) gives the solute remaining, not removed.

Source: Adapted from NEET 2026 (21 June re-exam) – descending/ascending limb reabsorption

Common mistake: Reporting the solute remaining (120) instead of the solute removed (180).

Q.167

Excretory Products and their Elimination – tubular reabsorption and secretion • Standard • 50 s **Answer: (3)**

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

Solution

i – True. PCT reabsorbs nearly all essential nutrients. **ii – True.** PCT selectively secretes H^+, ammonia and K^+. **iii – True.** DCT can reabsorb HCO_3^-. **iv – True.** DCT selectively secretes H^+, K^+ and NH_3. All four are correct. Option (2) wrongly assumes K^+ secretion is absent in DCT.

Source: Adapted from NEET 2025 Q161 – PCT/DCT transport-arrow diagrams

Common mistake: Assuming a segment either reabsorbs or secretes, never both.

Q.168 Excretory Products and their Elimination – nephron segments • Standard • 55 s **Answer: (1)**

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

Solution

A – True. PCT has simple cuboidal brush-border epithelium; it reabsorbs nutrients and secretes H^+ and ammonia. **B – False.** Water loss with concentration rise is the descending limb. **C – True.** The ascending limb is water-impermeable and dilutes by removing electrolytes. **D – False.** PCT also secretes. Hence A and C. Option (2) assigns concentration to the ascending limb.

Source: Adapted from NEET 2024 Q157 – descending-limb permeability and PCT epithelium

Common mistake: Swapping the permeability properties of the descending and ascending limbs.

Q.169 Excretory Products and their Elimination – cortical and juxtamedullary nephrons • Standard • 55 s **Answer: (1)**

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

Solution

A – True. NCERT: Malpighian corpuscle, PCT and DCT lie in the cortex. **B – True.** NCERT: vasa recta are absent or highly reduced in cortical nephrons. **C – False.** Loop length does not place the corpuscle in the medulla. **D – True.** Counter-current flow with NaCl and urea exchange maintains increasing medullary osmolarity. Hence A, B and D. Option (2) misses D.

Source: Adapted from NEET 2024 Q186 – long loop of juxtamedullary nephron

Common mistake: Placing juxtamedullary corpuscles in the medulla because their loops go deep.

Q.170 Excretory Products and their Elimination – excretory structures in animals • Standard • 50 s **Answer: (3)**

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

Solution

A – True. Flatworms have protonephridia (flame cells), primarily for ionic and fluid-volume regulation (osmoregulation). **B – False.** The Paramoecium part is right, but Taenia has flame cells. **C – True.** Cockroach: Malpighian tubules; earthworm: nephridia. **D – False.** Waste type is not fixed by the presence of an excretory organ. Hence A and C. Option (4) accepts B on the strength of its first half.

Source: Adapted from NEET 2023 Q166 – Taenia/Paramoecium/Periplaneta/Pheretima structures

Common mistake: Accepting a two-part statement because its first half (Paramoecium) is correct.

Q.171 Excretory Products and their Elimination – cortical and juxtamedullary nephrons • Foundation • 35 s **Answer: (2)**

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.

Solution

Corpuscles of both types lie in the cortex. Cortical nephrons have short loops that dip only a little into the medulla; juxtamedullary nephrons have very long loops running deep into the medulla. Only option (2) states this.

Source: Adapted from NEET 2023 Q185 – nephron classification assertion–reason

Common mistake: Assuming 'juxtamedullary' means the corpuscle lies inside the medulla.

Q.172 Excretory Products and their Elimination – regulation of kidney function • Standard • 50 s **Answer: (3)**

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

Solution

A – True. NCERT: rising fluid volume switches off osmoreceptors and suppresses ADH. **B – True.** JGA renin → angiotensin II, a vasoconstrictor that also activates aldosterone release. **C – False.** ANF causes vasodilation and checks the renin–angiotensin mechanism. **D – False.** Aldosterone specifically promotes Na^+ (and water) reabsorption. Hence A and B. Option (2) accepts C.

Source: Adapted from NEET 2023 Q188 – osmoreceptors, ADH and ANF

Common mistake: Thinking ANF supports RAAS rather than opposing it.

Q.173 Excretory Products and their Elimination – nitrogenous wastes • Standard • 45 s **Answer: (1)**

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

Solution

A – True. Uric acid is excreted as pellet or paste with minimum water loss. **B – False.** Urea is formed in the liver; kidneys remove it. **C – True.** Ammonia is highly toxic and needs much water, suiting aquatic animals. **D – False.** It reverses the water relation. Hence A and C. Option (2) places urea synthesis in the kidney.

Source: Adapted from NEET 2022 Q152 – Pavo excretes waste as pellet/paste

Common mistake: Placing urea synthesis in the kidney rather than the liver.

Q.174 Excretory Products and their Elimination – ADH and medullary gradient • Standard • 60 s **Answer: (4)**

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.

Solution

ADH-assisted concentration needs both water permeability in late nephron segments (ADH response) and an osmotic gradient in the medulla. Q lacks the response; R lacks the gradient; more hormone repairs neither. Nothing fixes Q and R to equal volumes, so (3) is unjustified.

Source: Adapted from NEET 2024 re-exam – hormone preventing diuresis

Common mistake: Assuming more ADH can compensate for an absent gradient or an absent response.

Q.175 Excretory Products and their Elimination – filtration, reabsorption and secretion • Standard • 90 s **Answer: (1)**

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 $5\ \text{mg mL}^{-1}$.

Solution

Filtered load $= 2 \times 100 = 200\ \text{mg min}^{-1}$. Initially excreted $= 200 - 150 + 20 = 70$, concentration $70/2 = 35\ \text{mg mL}^{-1}$. Later $200 - 130 + 20 = 90$, concentration $90/3 = 30\ \text{mg mL}^{-1}$. Excretion $+20$, concentration -5. Option (3) assumes concentration follows excretion rate.

Source: Original synthesis

Common mistake: Assuming higher excretion rate must mean higher urinary concentration, ignoring the larger urine flow.

Q.176 Excretory Products and their Elimination – selective reabsorption – urine volume • Foundation • 40 s **Answer: (2)**

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

Solution

Urine $= 180 \times 0.010 = 1.8$ L initially and $180 \times 0.005 = 0.9$ L later: a 50% fall. Option (3) quotes the percentage-point change in reabsorption as the percentage change in urine.

Source: Original synthesis

Common mistake: Confusing a 0.5 percentage-point rise in reabsorption with a 0.5% fall in urine volume.

Q.177 Excretory Products and their Elimination – PCT reabsorption capacity • Challenging • 105 s **Answer: (1)**

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%

Solution

Filtered load $= 1 \times 100 = 100\ \text{mg min}^{-1}$; reabsorbed $= \min(100, 60) = 60$; excreted $= 40\ \text{mg min}^{-1}$; concentration

$= 40/2 = 20\ \text{mg mL}^{-1}$. No loss needs filtered load ≤ 60, i.e. GFR $\leq 60\ \text{mL min}^{-1}$: a 40% reduction. Option (2) gives the new GFR value (60) as the reduction.

Source: Original synthesis

Common mistake: Giving the new GFR (60) instead of the reduction (40%), or forgetting to divide the excreted amount by urine flow.

Q.178 Excretory Products and their Elimination – renin–angiotensin mechanism and ANF • Standard • 45 s **Answer: (4)**

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

Solution

i – True. JG cells release renin when GFR falls. **ii – True.** Angiotensin II is a powerful vasoconstrictor. **iii – True.** Aldosterone causes Na^+ and water reabsorption from distal parts of the tubule. **iv – False.** ANF checks the renin–angiotensin mechanism. Hence T, T, T, F. Option (2) accepts iv.

Source: Original synthesis

Common mistake: Treating ANF as a partner of the renin–angiotensin mechanism instead of its check.

Q.179 Excretory Products and their Elimination – haemodialysis – diffusion gradients • Standard • 75 s **Answer: (3)**

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.

Solution

With equal volumes, equilibrium gives urea $(30 + 0)/2 = 15$ and X $(5 + 3)/2 = 4$ on both sides. After replacement: blood urea 15 vs dialysate 0, so urea leaves blood; blood X 4 vs dialysate 5, so X enters blood. Option (2) forgets that blood urea is still 15.

Source: Original synthesis

Common mistake: Assuming the first equilibration removed all urea from blood.

Q.180 Excretory Products and their Elimination – filtration, reabsorption and secretion • Standard • 45 s **Answer: (3)**

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

Solution

A – True. Glomerular filtration crosses endothelium, basement membrane and podocyte filtration slits. **B – False.** Lumen-to-blood movement is reabsorption. **C – True.** Tubular secretion of H^+ helps maintain pH. **D – False.** Excreted = filtered − reabsorbed + secreted. Hence A and C. Option (4) mislabels Q as secretion.

Source: Original synthesis

Common mistake: Reversing the signs of reabsorption and secretion in the excretion balance.