JEE Main

Sample Paper – 7

Duration: 3 Hours (180 Minutes) **Maximum Marks: 300**

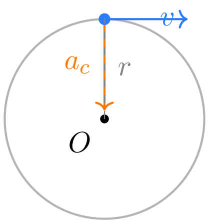
Instructions

- Full-length mock test modelled on **JEE Main** B.E./B.Tech. Paper 1 — **90 questions** (30 each: Physics, Chemistry, Mathematics).
- **Section A** (20 MCQs per subject): $+4$ for correct; -1 for incorrect; 0 for unattempted.
- **Section B** (10 Numerical per subject): attempt **any 5**; $+4$ for correct; no negative marking.
- Total to attempt: **75** (25 per subject). Total available: 90.
- Personal calculators, log tables, and mobile phones are strictly prohibited. A simple on-screen virtual calculator is provided in the CBT interface. Rough sheets will be supplied at the centre.

PHYSICS

Section A — Single Correct MCQ (Q1–Q20) [+4 / −1]

Q1. A particle moves in a horizontal circle of radius $r = 2$ m at a constant speed $v = 4$ m/s. The magnitude of its centripetal acceleration is:



(A) $2\ \mathrm{m/s^2}$

(B) $4\ \mathrm{m/s^2}$

(C) $8\ \mathrm{m/s^2}$

(D) $16\ \mathrm{m/s^2}$

Q2. A vehicle negotiates a circular banked road of radius R with banking angle θ at speed v without any friction. Which relation must hold?

(A) $\sin\theta = \dfrac{v^2}{Rg}$

(B) $\cos\theta = \dfrac{v^2}{Rg}$

(C) $\tan\theta = \dfrac{Rg}{v^2}$

(D) $\tan\theta = \dfrac{v^2}{Rg}$

Q3. A mass $m = 2$ kg is raised from the ground to a height $h = 5$ m (take $g = 10\ \mathrm{m/s^2}$). The increase in gravitational potential energy is:

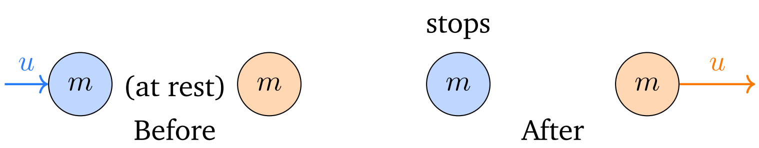
(A) 100 J

(B) 50 J

(C) 20 J

(D) 200 J

Q4. Two equal masses m undergo a perfectly elastic head-on collision. The first mass moves with velocity u while the second is at rest. After the collision:



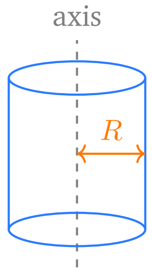
(A) Both masses move together at $u/2$

(B) First mass stops; second mass moves at u

(C) Both masses move at u in the same direction

(D) First mass bounces back at u; second remains at rest

Q5. A hollow cylinder (thin-walled) of mass M and radius R rotates about its own symmetry axis (shown dashed). Its moment of inertia about this axis is:



(A) $\frac{1}{2}MR^2$

(B) $\frac{2}{3}MR^2$

(C) MR^2

(D) $\frac{3}{2}MR^2$

Q6. A geostationary satellite orbits the Earth at an altitude of approximately $36{,}000$ km. Its orbital time period is:

(A) 6 hours

(B) 12 hours

(C) 48 hours

(D) 24 hours

Q7. According to Poiseuille's law, the volume flow rate Q of a viscous fluid through a pipe of radius r, length L, viscosity η, and pressure difference ΔP is:

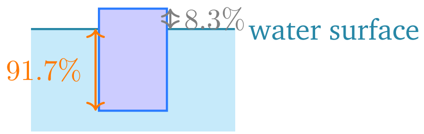
(A) $Q = \dfrac{\pi r^4 \Delta P}{8\eta L}$

(B) $Q = \dfrac{\pi r^2 \Delta P}{8\eta L}$

(C) $Q = \dfrac{\pi r^3 \Delta P}{4\eta L}$

(D) $Q = \dfrac{\pi r^4 \Delta P}{16\eta L}$

Q8. An ice cube (density $\rho_{ice} = 917$ kg/m^3) floats in fresh water (density $\rho_w = 1000$ kg/m^3). The fraction of the ice cube's volume that lies below the water surface is approximately:



(A) 50.0%

(B) 91.7%

(C) 8.3%

(D) 100%

Q9. In a forced oscillation system, the amplitude of oscillation becomes maximum when:

(A) The driving frequency is twice the natural frequency

(B) The driving frequency is half the natural frequency

(C) The driving frequency equals the natural frequency (resonance)

(D) The driving amplitude is doubled

Q10. A source emitting sound of frequency $f_0 = 500$ Hz moves toward a stationary observer at speed $v_s = 10$ m/s. Taking speed of sound $v = 340$ m/s, the observed frequency is approximately:

(A) 485 Hz

(B) 500 Hz

(C) 508 Hz

(D) 515 Hz

Q11. A Carnot engine operates between a hot reservoir at $T_H = 600$ K and a cold reservoir at $T_C = 300$ K. Its maximum (Carnot) efficiency is:

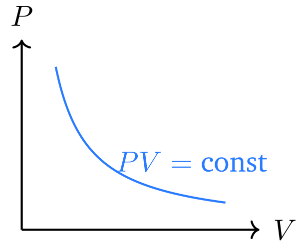
(A) 50%

(B) 25%

(C) 75%

(D) 33%

Q12. On a pressure–volume (P–V) diagram, an isothermal process for an ideal gas is represented by:



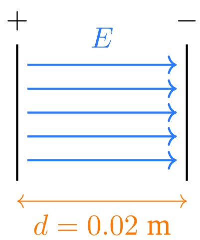
(A) A straight line with positive slope

(B) A hyperbola (PV = constant)

(C) A straight horizontal line

(D) A parabola

Q13. Two large parallel plates are separated by $d = 0.02$ m and maintain a uniform electric field $E = 1000$ V/m between them. The potential difference between the plates is:



(A) 5 V

(B) 50 V

(C) 20 V

(D) 0.02 V

Q14. The energy density (energy per unit volume) stored in an electric field of magnitude E is:

(A) $\varepsilon_0 E^2$

(B) $\frac{1}{4}\varepsilon_0 E^2$

(C) $2\varepsilon_0 E^2$

(D) $\frac{1}{2}\varepsilon_0 E^2$

Q15. A Wheatstone bridge has four resistances P, Q, R, S in the four arms. The bridge is said to be balanced (no current through the galvanometer) when:

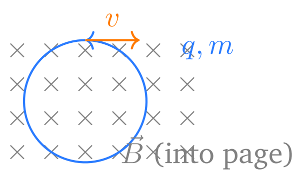
(A) $\frac{P}{Q} = \frac{R}{S}$

(B) $P + Q = R + S$

(C) $\frac{P}{R} = \frac{Q}{S}$

(D) $P \cdot Q = R \cdot S$

Q16. A charged particle of mass m and charge q enters a uniform magnetic field B with speed v perpendicular to $\vec{B}$. It moves in a circle. The radius of this circular orbit is:



(A) $r = \frac{qvB}{m}$

(B) $r = \frac{mv}{qB}$

(C) $r = \frac{mv^2}{qB}$

(D) $r = \frac{qB}{mv}$

Q17. According to Faraday's law of electromagnetic induction, the magnitude of the induced EMF in a circuit is equal to:

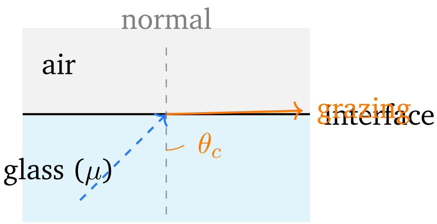
(A) The magnetic flux through the circuit

(B) The product of resistance and current

(C) The rate of change of magnetic flux through the circuit

(D) The integral of the magnetic field over the circuit

Q18. Total internal reflection occurs at a glass–air interface when the angle of incidence in glass exceeds the critical angle θ_c. For glass with refractive index $\mu = 1.5$, which of the following correctly gives the critical angle condition and ray diagram?



(A) $\cos\theta_c = 1/\mu$

(B) $\tan\theta_c = 1/\mu$

(C) $\sin\theta_c = \mu$

(D) $\sin\theta_c = 1/\mu$

Q19. Light of wavelength $\lambda = 500$ nm falls on a diffraction grating with 6000 lines/mm. The grating equation for the m-th order maximum is:

(A) $\sin\theta = m\lambda/d$

(B) $\sin\theta = d/(m\lambda)$

(C) $\cos\theta = m\lambda/d$

(D) $\tan\theta = m\lambda/d$

Q20. In the photoelectric effect, when the intensity of incident light (of fixed frequency above the threshold) is doubled, which of the following correctly describes the change?

(A) The stopping potential doubles

(B) The stopping potential remains unchanged; only the photocurrent increases

(C) Both stopping potential and photocurrent double

(D) The stopping potential halves

Section B — Numerical Answer Type (Q21–Q30) [+4 / 0]

Q21. A ball is dropped from rest at a height of 45 m above the ground (take $g = 10\ \text{m/s}^2$). The speed of the ball (in m/s) just before it hits the ground is ________. *(Enter numerical value)*

Q22. A ball of mass $m_1 = 2$ kg moving at 6 m/s collides and sticks (perfectly inelastic collision) with a stationary ball of mass $m_2 = 4$ kg. The speed of the combined mass (in m/s) after collision is ________. *(Enter numerical value)*

Q23. A force of 10 N acts perpendicularly at a distance of 0.5 m from the pivot point of a rigid body. The torque (in N·m) produced about the pivot is ________. *(Enter numerical value)*

Q24. 2 mol of an ideal gas at STP ($T = 273$ K, $P = 1$ atm) occupies a volume of ________ L. (Molar volume at STP $= 22.4$ L/mol) *(Enter numerical value)*

Q25. A resistor of $R = 8\ \Omega$ carries a current of $I = 5$ A. The power dissipated (in W) in the resistor is ________. *(Enter numerical value)*

Q26. Two capacitors $C_1 = 4\ \mu$F and $C_2 = 6\ \mu$F are connected in parallel across a 20 V supply. The total charge (in μC) stored by the combination is ________. *(Enter numerical value)*

Q27. A proton (charge $q = 1.6 \times 10^{-19}$ C) moves at $v = 10^6$ m/s perpendicular to a magnetic field $B = 0.1$ T. The magnitude of the magnetic force (in units of 10^{-14} N) on the proton is ________. *(Enter numerical value)*

Q28. A conducting rod of length $l = 1$ m moves with velocity $v = 5$ m/s perpendicular to a magnetic field $B = 0.4$ T. The induced EMF (in V) in the rod is ________. *(Enter numerical value)*

Q29. An object is placed 15 cm in front of a concave (diverging) lens of focal length -30 cm. Using the lens formula, the magnitude of the image distance (in cm) is ________. *(Enter numerical value)*

Q30. A radioactive element has a half-life of 10 days. If the initial amount is 80 g, the mass (in g) remaining after 30 days is ________. *(Enter numerical value)*

CHEMISTRY

Section A — Single Correct MCQ (Q31–Q50) [+4 / −1]

Q31. What is the percentage by mass of oxygen in water (H_2O, molar mass $= 18$ g/mol, atomic mass of O $= 16$)?

$$2\,H_2 + O_2 \xrightarrow{\text{combustion}} 2\,H_2O$$

(A) 11.1%

(B) 22.2%

(C) 44.4%

(D) 88.9%

Q32. According to Heisenberg's uncertainty principle, the minimum uncertainty in momentum Δp when the uncertainty in position is $\Delta x = 10^{-10}$ m (taking $h = 6.626 \times 10^{-34}$ J · s) is:

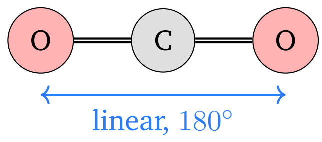
(A) $\dfrac{h}{4\pi\,\Delta x}$

(B) $\dfrac{h}{\Delta x}$

(C) $\dfrac{4\pi\,h}{\Delta x}$

(D) $\dfrac{h}{2\pi\,\Delta x}$

Q33. Carbon dioxide (CO_2) has two $C = O$ double bonds and no lone pairs on the central carbon atom. The geometry of CO_2 is:



(A) Bent (120°)

(B) Linear (180°)

(C) Trigonal planar

(D) Tetrahedral

Q34. The order of thermal stability of the following carbonates is:

(A) $BeCO_3 > MgCO_3 > CaCO_3 > Na_2CO_3$

(B) $MgCO_3 > CaCO_3 > BeCO_3 > Na_2CO_3$

(C) $Na_2CO_3 > CaCO_3 > MgCO_3 > BeCO_3$

(D) $CaCO_3 > Na_2CO_3 > BeCO_3 > MgCO_3$

Q35. As we move down Group 1 (alkali metals) from Li to Cs, the melting point:

(A) Increases steadily

(B) First increases then decreases

(C) Remains approximately constant

(D) Decreases steadily

Q36. Transition metals exhibit variable oxidation states because:

(A) The energy difference between the $(n-1)d$ and ns orbitals is small

(B) Their atomic radii are very large

(C) They have no d-electrons

(D) Their ionisation enthalpies are very high

Q37. The complex $[Co(NH_3)_4Cl_2]^+$ (octahedral) shows geometrical isomerism. The number of geometrical isomers is:

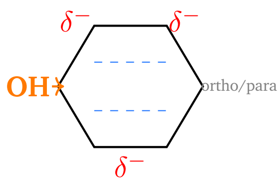
(A) 1

(B) 2

(C) 3

(D) 4

Q38. In phenol (C_6H_5OH), the $-OH$ group donates electron density to the ring through resonance (mesomeric effect). As a result, the electron density in the ring:



(A) Decreases at all positions

(B) Increases only at the meta position

(C) Increases at the ortho and para positions

(D) Increases uniformly at all ring positions

Q39. In an E2 elimination reaction from a cyclohexane derivative, the requirement for the transition state is that:

(A) Only the leaving group needs to be axial

(B) Only the β-H needs to be axial

(C) Both the β-H and leaving group must be equatorial

(D) Both the β-H and the leaving group must be axial (antiperiplanar)

Q40. The rate of SN1 hydrolysis of alkyl halides follows the order:

(A) Tertiary $>$ Secondary $>$ Primary

(B) Primary $>$ Secondary $>$ Tertiary

(C) Secondary $>$ Tertiary $>$ Primary

(D) All hydrolyse at the same rate

Q41. Phenol when treated with chloroform ($CHCl_3$) and concentrated $NaOH$ solution (Reimer–Tiemann reaction) gives:

(A) 2-chlorophenol

(B) Salicylaldehyde (2-hydroxybenzaldehyde)

(C) Phenyl acetate

(D) Catechol

Q42. When methylmagnesium bromide (CH_3MgBr) reacts with acetaldehyde (CH_3CHO) and the product is hydrolysed, the organic product obtained is:

(A) A primary alcohol

(B) A tertiary alcohol

(C) A secondary alcohol

(D) A carboxylic acid

Q43. Saponification is the reaction of an ester with aqueous $NaOH$. The products of saponification of ethyl acetate ($CH_3COOC_2H_5$) are:

(A) CH_3COOH and C_2H_5OH

(B) CH_3OH and C_2H_5COONa

(C) C_2H_5COOH and CH_3OH

(D) CH_3COONa and C_2H_5OH

Q44. When a primary amine (RNH_2) reacts with acetic anhydride $[(CH_3CO)_2O]$, the product formed is:

(A) An amide ($RNHCOCH_3$)

(B) A secondary amine ($RNH\text{-}CH_3$)

(C) A nitrile (RCN)

(D) An imine

Q45. According to Raoult's law, the relative lowering of vapour pressure of a dilute solution is:

(A) $\Delta P/P^{\circ} = x_1$ (mole fraction of solvent)

(B) $\Delta P/P^{\circ} = x_2$ (mole fraction of solute)

(C) $\Delta P/P^{\circ} = x_1 - x_2$

(D) $\Delta P/P^{\circ} = 1/(x_2)$

Q46. For the sparingly soluble salt AgCl dissolving as $\mathrm{AgCl(s)} \rightleftharpoons \mathrm{Ag^+(aq)} + \mathrm{Cl^-(aq)}$, if the solubility product $K_{sp} = 1.6 \times 10^{-10}$, the molar solubility s is:

(A) $s = K_{sp}/2$

(B) $s = K_{sp}^{1/3}$

(C) $s = \sqrt{K_{sp}}$

(D) $s = K_{sp}^2$

Q47. For a first-order reaction $\mathrm{A} \rightarrow \mathrm{products}$, a graph of $\ln[\mathrm{A}]$ versus time t gives a straight line. The rate constant k is related to the slope of this line by:

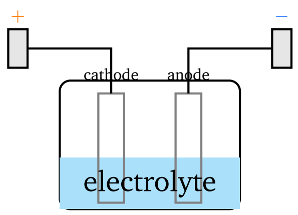
(A) $k =$ slope

(B) $k = 1/\mathrm{slope}$

(C) $k = (\mathrm{slope})^2$

(D) $k = -\mathrm{slope}$

Q48. Faraday's first law of electrolysis states that the mass w of a substance deposited at an electrode is related to the charge $Q = It$ passed by:



(A) $w = \dfrac{M}{nF} \cdot It$

(B) $w = \dfrac{nF}{M} \cdot It$

(C) $w = M \cdot n \cdot F \cdot It$

(D) $w = \dfrac{nF}{MIt}$

Q49. In heterogeneous catalysis (e.g., Haber process for NH_3 synthesis on Fe catalyst), the key step that occurs on the catalyst surface is:

(A) Diffusion of reactants in the gas phase

(B) Adsorption of reactants onto the catalyst surface

(C) Ionisation of reactant molecules

(D) Dissolution of reactants in the catalyst

Q50. Which of the following correctly identifies reducing sugars?

(A) Sucrose and glucose

(B) Sucrose and fructose

(C) Maltose and lactose

(D) Cellulose and starch

Section B — Numerical Answer Type (Q51–Q60) [+4 / 0]

Q51. The mass (in g) of $3\ \mathrm{mol}$ of carbon dioxide ($\mathrm{CO_2}$; molar mass $= 44\ \mathrm{g/mol}$) is ________. *(Enter numerical value)*

Q52. $40\ \mathrm{g}$ of sodium hydroxide (NaOH; molar mass $= 40\ \mathrm{g/mol}$) is dissolved in water to make $1\ \mathrm{L}$ of solution. The molarity (in mol/L) of the solution is ________. *(Enter numerical value)*

Q53. The pH of a $0.01\ \mathrm{M}$ hydrochloric acid (HCl) solution at $25°\mathrm{C}$ is ________. *(Enter numerical value)*

Q54. The standard enthalpy of combustion of carbon is $-393\,\mathrm{kJ/mol}$: $\mathrm{C(s)} + \mathrm{O_2(g)} \rightarrow \mathrm{C}$ The magnitude of heat released (in kJ) when 2 mol of carbon is completely burned is ________. *(Enter numerical value)*

Q55. The solubility of $\mathrm{BaSO_4}$ in water is 10^{-5} mol/L. The value of $-\log K_{sp}$ (i.e., $\mathrm{p}K_{sp}$) of $\mathrm{BaSO_4}$ is ________. *(Enter numerical value)*

Q56. The specific conductance of a 0.1 N KCl solution is $0.0129\ \mathrm{S\,cm^{-1}}$. The equivalent conductance (in $\mathrm{S\,cm^2\,equiv^{-1}}$) is ________. *(Enter numerical value)*

Q57. A first-order reaction has rate constant $k = 1 \times 10^{-2}\ \mathrm{min^{-1}}$. The half-life $t_{1/2}$ (in min, rounded to nearest integer) is ________. (Use $\ln 2 = 0.693$) *(Enter numerical value)*

Q58. The number of faradays of charge required to deposit 2 mol of copper from a $\mathrm{Cu^{2+}}$ solution (each $\mathrm{Cu^{2+}}$ ion requires 2 electrons) is ________. *(Enter numerical value)*

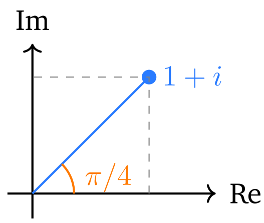
Q59. The oxidation state of cobalt in the complex $[\mathrm{Co(NH_3)_6}]^{3+}$ is ________. *(Enter numerical value)*

Q60. For water, $K_b = 0.52\ \mathrm{K\,kg\,mol^{-1}}$. When 0.5 mol of urea (non-electrolyte) is dissolved in 1 kg of water, the value of $\Delta T_b \times 100$ (i.e., elevation in boiling point multiplied by 100) is ________. *(Enter numerical value)*

MATHEMATICS

Section A — Single Correct MCQ (Q61–Q80) [+4 / −1]

Q61. The argument (principal value) of the complex number $z = 1 + i$ is:



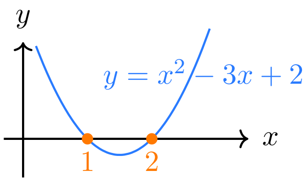
(A) $\pi/4$

(B) $\pi/3$

(C) $\pi/6$

(D) $3\pi/4$

Q62. The roots of the quadratic equation $x^2 - 3x + 2 = 0$ are:



(A) $x = -1, -2$ (real, negative)

(B) $x = 1, 2$ (real, distinct, positive)

(C) $x = 3, 0$ (real, one zero)

(D) Complex (non-real)

Q63. The harmonic mean (HM) of the two numbers 2 and 6 is:

(A) 4

(B) $\sqrt{12}$

(C) 3

(D) 8

Q64. The number of derangements (permutations with no element in its original position) of 3 distinct objects is:

(A) 6

(B) 3

(C) 1

(D) 2

Q65. The coefficient of the term independent of x in the expansion of $\left(x + \frac{1}{x}\right)^6$ is:

(A) 20

(B) 15

(C) 6

(D) 1

Q66. The Cayley–Hamilton theorem states that:

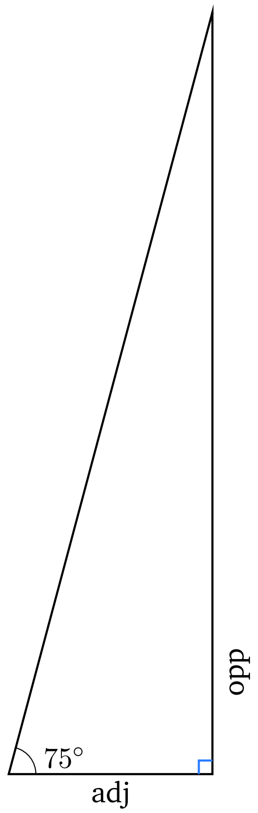
(A) Every matrix has a unique inverse

(B) Every square matrix satisfies its own characteristic equation

(C) The determinant of a product equals the product of determinants

(D) Every symmetric matrix is orthogonal

Q67. The exact value of $\sin 75°$ is:



(A) $\dfrac{\sqrt{6}-\sqrt{2}}{4}$

(B) $\dfrac{\sqrt{3}+1}{2}$

(C) $\dfrac{\sqrt{6}+\sqrt{2}}{4}$

(D) $\dfrac{\sqrt{3}-1}{4}$

Q68. The value of $\tan^{-1}(1)+\tan^{-1}(2)+\tan^{-1}(3)$ equals:

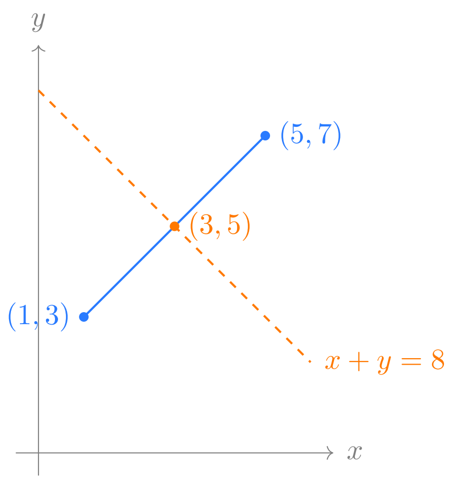
(A) $\dfrac{\pi}{2}$

(B) $\dfrac{3\pi}{4}$

(C) $\dfrac{5\pi}{4}$

(D) π

Q69. The equation of the perpendicular bisector of the segment joining $(1,3)$ and $(5,7)$ is:



(A) $x+y=8$

(B) $x-y=2$

(C) $x+y=6$

(D) $2x+2y=5$

Q70. The equation of the chord of contact of tangents drawn from the point $(3,4)$ to the circle $x^2+y^2=25$ is:

(A) $3x - 4y = 25$

(B) $3x + 4y = 25$

(C) $4x + 3y = 25$

(D) $x + y = 25$

Q71. The equation of the tangent to the parabola $y^2 = 4ax$ at the point $(a, 2a)$ is:

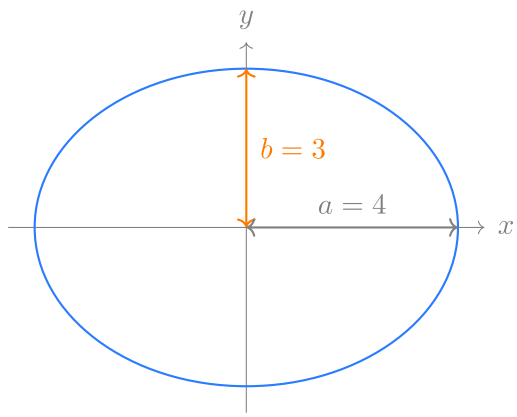
(A) $y = 2x + a$

(B) $y = 2x - a$

(C) $y = x + a$

(D) $y = x - a$

Q72. For the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$, the length of the minor axis is:



(A) 3

(B) 4

(C) 8

(D) 6

Q73. The value of $\lim_{x \to 0} (1 + x)^{1/x}$ is:

(A) e

(B) 1

(C) ∞

(D) 0

Q74. Rolle's theorem states that if f is continuous on $[a, b]$, differentiable on (a, b), and $f(a) = f(b)$, then there exists at least one point $c \in (a, b)$ such that:

(A) $f(c) = 0$

(B) $f'(c) = 0$

(C) $f''(c) = 0$

(D) $f(c) = f(a)$

Q75. The area of a circle $A = \pi r^2$. The rate of change of area with respect to radius at $r = 5$ cm is:

(A) $5\pi\ \text{cm}^2/\text{cm}$

(B) $25\pi\ \text{cm}^2/\text{cm}$

(C) $10\pi\ \text{cm}^2/\text{cm}$

(D) $2\pi\ \text{cm}^2/\text{cm}$

Q76. The standard integral $\displaystyle\int \frac{dx}{\sqrt{1-x^2}}$ equals:

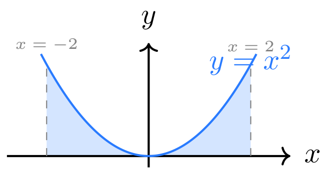
(A) $\cos^{-1} x + C$

(B) $\tan^{-1} x + C$

(C) $\sec^{-1} x + C$

(D) $\sin^{-1} x + C$

Q77. Using the property of even functions, $\displaystyle\int_{-2}^{2} x^2\, dx$ equals:



(A) $\dfrac{16}{3}$

(B) $\frac{8}{3}$

(C) 4

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

Q78. Events A and B are independent with $P(A) = 0.3$ and $P(B) = 0.5$. Then $P(A \cap B)$ equals:

(A) 0.8

(B) 0.15

(C) 0.35

(D) 0.30

Q79. Let $\vec{a} = \hat{i} + \hat{j}$, $\vec{b} = \hat{j} + \hat{k}$, $\vec{c} = \hat{k} + \hat{i}$. The value of the scalar triple product $[\vec{a}\,\vec{b}\,\vec{c}] = \vec{a} \cdot (\vec{b} \times \vec{c})$ is:

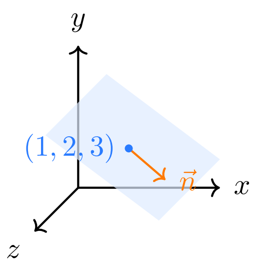
(A) 0

(B) 1

(C) 2

(D) 3

Q80. The equation of the plane passing through the point $(1, 2, 3)$ with normal vector $\vec{n} = 2\hat{i} - \hat{j} + \hat{k}$ is:



(A) $x - y + z = 4$

(B) $2x + y - z = 1$

(C) $x + 2y - z = 2$

(D) $2x - y + z = 3$

Section B — Numerical Answer Type (Q81–Q90) [+4 / 0]

Q81. The modulus $|(1+i)^4|$ equals ________. *(Enter numerical value)*

Q82. In an arithmetic progression (AP) with first term $a = 5$ and common difference $d = 3$, the 20th term a_{20} is ________. *(Enter numerical value)*

Q83. The absolute value $\left|\det\begin{pmatrix} 2 & 3 \\ 4 & 5 \end{pmatrix}\right|$ is ________. *(Enter numerical value)*

Q84. The number of distinct 5-letter words (arrangements) that can be formed using all the letters of the word MATHS (each letter distinct, used exactly once) is ________. *(Enter numerical value)*

Q85. The value of $\int_0^2 (3x^2 + 2x)\,dx$ is ________. *(Enter numerical value)*

Q86. If $f(x) = \sin x + \cos x$, then $f'(\pi/4)$ equals ________. *(Enter numerical value)*

Q87. The area (in sq. units) of the region bounded above by $y = 9$ and below by $y = x^2$, computed as $\int_0^3 (9 - x^2)\,dx$ multiplied by 2 (using symmetry), is ________. *(Enter numerical value)*

Q88. A line makes equal angles with all three coordinate axes. If l, m, n are the direction cosines (so $l = m = n$), then $3l^2$ equals ________. *(Enter numerical value)*

Q89. The mean deviation from the mean of the five observations $3, 5, 7, 9, 11$ is ________. *(Enter numerical value)*

Q90. A bag contains 5 red and 3 blue balls. Two balls are drawn at random without replacement. The probability of drawing 2 red balls is $\frac{p}{28}$. The value of p is ________. *(Enter numerical value)*

Detailed Solutions

Q1.

Solution

Concept — Centripetal Acceleration: For uniform circular motion, the centripetal acceleration always points toward the centre of the circle and has magnitude $a_c = v^2/r$.

Step 1 — Identify given values: $v = 4$ m/s, $r = 2$ m.

Step 2 — Apply formula:

$$a_c = \frac{v^2}{r} = \frac{(4)^2}{2} = \frac{16}{2} = 8 \text{ m/s}^2$$

Why other options are wrong:

- Option A (2 m/s^2): This is v/r, not v^2/r.
- Option B (4 m/s^2): This equals $v^2/(2r)$, wrong denominator.
- Option D (16 m/s^2): This equals v^2 alone, without dividing by r.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Banked Road (No Friction): For a vehicle to navigate a banked curve without friction, the horizontal component of the normal force provides the centripetal force.

Step 1 — Force balance: Normal force N acts perpendicular to the banked surface.

$$N\cos\theta = mg \quad \text{(vertical)}, \qquad N\sin\theta = \frac{mv^2}{R} \quad \text{(horizontal/centripetal)}$$

Step 2 — Divide:

$$\tan\theta = \frac{v^2}{Rg}$$

Verification: For $v = 10$ m/s, $R = 50$ m, $g = 10$ m/s²: $\tan\theta = 100/500 = 0.2$.

Why other options are wrong:

- Option A: $\sin\theta$ is not the correct ratio; it involves more complex geometry.
- Option B: $\cos\theta = v^2/(Rg)$ is incorrect; cosine applies to the vertical balance, not its ratio.
- Option C: $\tan\theta = Rg/v^2$ is the reciprocal — wrong.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Gravitational Potential Energy: The change in gravitational PE when a mass m is raised by height h near the Earth's surface is $\Delta U = mgh$.

Calculation:

$$\Delta U = mgh = 2 \text{ kg} \times 10 \text{ m/s}^2 \times 5 \text{ m} = 100 \text{ J}$$

Why other options are wrong:

- Option B (50 J): Uses $m = 1$ kg (wrong mass).
- Option C (20 J): Only accounts for $m \times h$ without g.
- Option D (200 J): Uses $g = 20$ m/s² or doubles the answer incorrectly.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Elastic Collision (Equal Masses): In a perfectly elastic head-on collision between two equal masses, the velocities are exchanged. The first (moving) mass stops completely; the second (stationary) mass acquires the full initial velocity u.

Step 1 — Conservation of momentum: $mu = mv_1 + mv_2 \Rightarrow v_1 + v_2 = u$.

Step 2 — Conservation of kinetic energy: $\frac{1}{2}mu^2 = \frac{1}{2}m(v_1^2 + v_2^2)$.

Step 3 — Solve: $v_1 = 0$, $v_2 = u$.

Why other options are wrong:

- Option A: Perfectly inelastic result ($u/2$ each), not elastic.
- Option C: Both cannot move at u — violates momentum conservation.
- Option D: First cannot bounce back; for equal masses in elastic collision, $v_1 = 0$.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Moment of Inertia: For a thin-walled hollow cylinder (all mass at radius R) rotating about its symmetry axis, every mass element is at distance R from the axis.

$$I = \int r^2\, dm = R^2 \int dm = MR^2$$

Why other options are wrong:

- Option A ($\frac{1}{2}MR^2$): This is the MOI of a *solid* cylinder or disk.
- Option B ($\frac{2}{3}MR^2$): This is the MOI of a solid sphere about a diameter divided differently.
- Option D ($\frac{3}{2}MR^2$): No standard object has this MOI about a central axis.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Geostationary Orbit: A geostationary satellite appears stationary relative to Earth. This is only possible if it completes one orbit in exactly the same time as Earth's rotation period.

Key fact: Earth rotates once every 24 hours (1 sidereal day $\approx$ 23 h 56 min, but the standard answer uses 24 h). The geostationary altitude is $\approx 35{,}786$ km above the equator.

Why other options are wrong:

- Option A (6 h): Too short — corresponds to a much lower orbit.
- Option B (12 h): This is a semi-synchronous orbit (e.g., GPS satellites at ∼20,200 km).
- Option C (48 h): Period would require orbit beyond geostationary distance.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q6

Q7.

Solution

Concept — Poiseuille's Law: For steady viscous (laminar) flow of an incompressible fluid through a long straight pipe:

$$Q = \frac{\pi r^4 \Delta P}{8\eta L}$$

where r = pipe radius, ΔP = pressure difference, η = dynamic viscosity, L = pipe length.

Key point: Flow rate $Q \propto r^4$ — doubling the radius increases flow by $2^4 = 16$ times.

Why other options are wrong:

- Option B: Uses r^2 instead of r^4.
- Option C: Uses r^3 and wrong coefficient.
- Option D: Uses r^4 but wrong coefficient ($16\eta L$ instead of $8\eta L$).

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Archimedes' Principle for Floating Bodies: A floating body displaces water equal to its own weight. The fraction submerged equals the ratio of densities:

$$\text{Fraction submerged} = \frac{\rho_{\text{ice}}}{\rho_{\text{water}}} = \frac{917}{1000} = 0.917 = 91.7\%$$

Why other options are wrong:

- Option A (50%): Would require $\rho_{\text{ice}} = 500$ kg/m³.
- Option C (8.3%): This is the fraction above water, not submerged.
- Option D (100%): Ice would need to be as dense as water (1000 kg/m³) to be fully submerged.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Resonance in Forced Oscillations: When a system is driven at its natural frequency ω_0, the energy transfer from the driver to the system is maximum, resulting in maximum amplitude. This phenomenon is called resonance.

Condition: Driving frequency $\omega_d = \omega_0$ (natural frequency).

Why other options are wrong:

- Option A: Driving at $2\omega_0$ does not produce maximum amplitude.
- Option B: Driving at $\omega_0/2$ also does not maximise amplitude.
- Option D: Doubling amplitude of driving force increases amplitude but is not the resonance condition.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Doppler Effect (Source Moving Toward Observer):

$$f_{\text{obs}} = f_0 \cdot \frac{v}{v - v_s}$$

where v = speed of sound, v_s = speed of source (toward observer).

Calculation:

$$f_{\text{obs}} = 500 \times \frac{340}{340 - 10} = 500 \times \frac{340}{330} = 500 \times 1.0303\ldots \approx 515 \text{ Hz}$$

Why other options are wrong:

- Option A (485 Hz): This would be the observed frequency if the source were moving *away*.
- Option B (500 Hz): This is the emitted frequency — no Doppler shift applied.
- Option C (508 Hz): Arithmetic error; correct value is ≈ 515 Hz.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q10

Q11.

Solution

Concept — Carnot Efficiency: The efficiency of a Carnot (ideal) engine operating between temperatures T_H (hot) and T_C (cold) is:

$$\eta = 1 - \frac{T_C}{T_H} = 1 - \frac{300}{600} = 1 - \frac{1}{2} = 0.5 = 50\%$$

Why other options are wrong:

- Option B (25%): Would require $T_C/T_H = 0.75$, e.g., $T_C = 450$ K.
- Option C (75%): Would require $T_C/T_H = 0.25$, e.g., $T_C = 150$ K.
- Option D (33%): Incorrect calculation; $1 - 300/600 = 0.5$, not $1/3$.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Isothermal Process for Ideal Gas: At constant temperature, the ideal gas law gives $PV = nRT =$ constant. This means $P = \text{const}/V$, which is an equation of a **rectangular hyperbola** on the P–V diagram.

Why other options are wrong:

- Option A (straight line, positive slope): This describes a process where $P \propto V$ — not isothermal.
- Option C (horizontal line): This describes an isobaric (constant pressure) process.
- Option D (parabola): $P \propto V^2$ is not any standard thermodynamic process.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept — Electric Field and Potential: For a uniform electric field between parallel plates:

$$V = E \times d$$

Calculation:

$$V = 1000 \text{ V/m} \times 0.02 \text{ m} = 20 \text{ V}$$

Why other options are wrong:

- Option A (5 V): Uses $d = 0.005$ m.
- Option B (50 V): Uses $d = 0.05$ m.
- Option D (0.02 V): Divides d by E instead of multiplying.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Electrostatic Energy Density: The energy per unit volume stored in an electric field E in vacuum (or approximately in air) is:

$$u = \frac{1}{2}\varepsilon_0 E^2$$

Example: For $E = 10^6$ V/m:

$$u = \frac{1}{2} \times 8.85 \times 10^{-12} \times (10^6)^2 = \frac{1}{2} \times 8.85 \approx 4.43 \text{ J/m}^3$$

Why other options are wrong:

- Option A ($\varepsilon_0 E^2$): Missing the factor of $1/2$.
- Option B ($\frac{1}{4}\varepsilon_0 E^2$): Factor of $1/4$ is incorrect.
- Option C ($2\varepsilon_0 E^2$): Factor of 2 is incorrect.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q14

Q15.

Solution

Concept — Wheatstone Bridge Balance: When no current flows through the galvanometer, the bridge is balanced. This occurs when the ratio of resistances in each branch is equal:

$$\frac{P}{Q} = \frac{R}{S}$$

Why other options are wrong:

- Option B ($P + Q = R + S$): Additive condition, not multiplicative ratio.
- Option C ($P/R = Q/S$): Mixes arms from different branches.
- Option D ($P \cdot Q = R \cdot S$): Multiplicative condition is not the balance criterion.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept — Circular Motion of Charged Particle in Magnetic Field: The magnetic force qvB provides the centripetal force mv^2/r:

$$qvB = \frac{mv^2}{r} \implies r = \frac{mv}{qB}$$

Why other options are wrong:

- Option A ($r = qvB/m$): This is the inverse of the correct formula.
- Option C ($r = mv^2/(qB)$): Has an extra factor of v.
- Option D ($r = qB/(mv)$): Reciprocal of the correct formula.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q16

Q17.

Solution

Concept — Faraday's Law of Electromagnetic Induction: The induced EMF in a circuit equals the negative rate of change of the magnetic flux Φ_B through the circuit:

$$\mathcal{E} = -\frac{d\Phi_B}{dt} \implies |\mathcal{E}| = \left|\frac{d\Phi_B}{dt}\right|$$

Why other options are wrong:

- Option A: The EMF depends on the *rate of change* of flux, not the flux itself.
- Option B: IR gives the voltage across a resistor — Ohm's law, not Faraday's law.
- Option D: Integrating B over the circuit area gives flux, not the EMF.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q17

Q18.

Solution

Concept — Total Internal Reflection (TIR): At the critical angle θ_c, the refracted ray grazes along the interface (refracted angle $= 90°$). Applying Snell's law at the glass–air interface:

$$\mu \sin\theta_c = 1 \times \sin 90° = 1 \implies \sin\theta_c = \frac{1}{\mu}$$

For glass ($\mu = 1.5$): $\sin\theta_c = 1/1.5 = 2/3$, so $\theta_c \approx 41.8°$.

Why other options are wrong:

- Option A ($\cos\theta_c = 1/\mu$): Sine, not cosine, appears in Snell's law.
- Option B ($\tan\theta_c = 1/\mu$): Incorrect trigonometric function.
- Option C ($\sin\theta_c = \mu$): This would give $\sin\theta_c > 1$ for $\mu > 1$, which is impossible.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — Diffraction Grating: The grating equation for constructive interference (maxima) is:

$$d \sin\theta = m\lambda \implies \sin\theta = \frac{m\lambda}{d}$$

where $d = 1/6000$ mm is the grating spacing, λ is the wavelength, and m is the order.

Verification for $m = 1$: $\sin\theta = 1 \times 500 \times 10^{-9} \times 6000 \times 10^{3}\ \text{m}^{-1} = 500 \times 10^{-9} \times 6 \times 10^{6} = 0.3$.

Why other options are wrong:

- Option B: Inverts λ and d — dimensionally incorrect.
- Option C: Uses $\cos\theta$ instead of $\sin\theta$.
- Option D: Uses $\tan\theta$ — not the grating equation.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Photoelectric Effect: The stopping potential V_s is determined by the maximum kinetic energy of photoelectrons:

$$eV_s = h\nu - \phi$$

where $h\nu$ is the photon energy and ϕ is the work function. This depends only on the **frequency** of light, *not* on its intensity.

Effect of doubling intensity: More photons per second $\Rightarrow$ more photoelectrons per second $\Rightarrow$ increased photocurrent. The energy per photon is unchanged, so V_s is unchanged.

Why other options are wrong:

- Option A: Stopping potential does not depend on intensity.
- Option C: Only current doubles; stopping potential stays the same.
- Option D: Stopping potential cannot halve by increasing intensity.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q20

Q21.

Solution

Free Fall Kinematics:

$$v^2 = u^2 + 2gh = 0 + 2 \times 10 \times 45 = 900$$

$$v = \sqrt{900} = 30 \text{ m/s}$$

Final Answer: $\boxed{30}$

Answer: (30) Go Back to Q21

Q22.

Solution

Conservation of Momentum (Inelastic):

$$m_1u_1 = (m_1 + m_2)v \implies v = \frac{m_1u_1}{m_1 + m_2} = \frac{2 \times 6}{2 + 4} = \frac{12}{6} = 2 \text{ m/s}$$

Final Answer: $\boxed{2}$

Answer: (2) Go Back to Q22

Q23.

Solution

Torque:

$$\tau = F \times r_\perp = 10 \text{ N} \times 0.5 \text{ m} = 5 \text{ N} \cdot \text{m}$$

Final Answer: $\boxed{5}$

Answer: (5) Go Back to Q23

Q24.

Solution

Ideal Gas at STP: Molar volume at STP $= 22.4$ L/mol.

$$V = n \times 22.4 = 2 \times 22.4 = 44.8 \text{ L}$$

Final Answer: $\boxed{44.8}$

Answer: (44.8) Go Back to Q24

Q25.

Solution

Joule Heating:

$$P = I^2R = (5)^2 \times 8 = 25 \times 8 = 200 \text{ W}$$

Final Answer: $\boxed{200}$

Answer: (200) Go Back to Q25

Q26.

Solution

Parallel Capacitors:

$$C_{\text{eq}} = C_1 + C_2 = 4 + 6 = 10\ \mu\text{F}$$

$$Q = C_{\text{eq}} \times V = 10\ \mu\text{F} \times 20\text{ V} = 200\ \mu\text{C}$$

Final Answer: $\boxed{200}$

Answer: (200) Go Back to Q26

Q27.

Solution

Lorentz Force on Moving Charge:

$$F = qvB = 1.6 \times 10^{-19} \times 10^6 \times 0.1 = 1.6 \times 10^{-14}\text{ N}$$

In units of 10^{-14} N: $F = 1.6$. **Final Answer:** $\boxed{1.6}$

Answer: (1.6) Go Back to Q27

Q28.

Solution

Motional EMF:

$$\mathcal{E} = Bvl = 0.4 \times 5 \times 1 = 2\text{ V}$$

Final Answer: $\boxed{2}$

Answer: (2) Go Back to Q28

Q29.

Solution

Lens Formula ($u = -15$ cm, $f = -30$ cm):

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-30} + \frac{1}{-15} = -\frac{1}{30} - \frac{2}{30} = -\frac{3}{30} = -\frac{1}{10}$$

$$v = -10 \text{ cm}, \quad |v| = 10 \text{ cm}$$

Final Answer: $\boxed{10}$

Answer: (10) Go Back to Q29

Q30.

Solution

Radioactive Decay: After n half-lives, fraction remaining $= (1/2)^n$.

$$n = \frac{30 \text{ days}}{10 \text{ days}} = 3 \quad \Rightarrow \quad m = 80 \times \left(\frac{1}{2}\right)^3 = 80 \times \frac{1}{8} = 10 \text{ g}$$

Final Answer: $\boxed{10}$

Answer: (10) Go Back to Q30

Q31.

Solution

Concept — Percentage by Mass:

$$\%O = \frac{\text{mass of O in one mol of } H_2O}{\text{molar mass of } H_2O} \times 100 = \frac{16}{18} \times 100 = 88.9\%$$

Why other options are wrong:

- Option A (11.1%): This is the % of hydrogen ($2/18 \times 100$).
- Option B (22.2%): Incorrect; $22.2 \approx 4/18 \times 100$.
- Option C (44.4%): $44.4 \approx 8/18 \times 100$ — half of the correct value.

Final Answer: $\boxed{D}$

Answer: (D) Go Back to Q31

Q32.

Solution

Concept — Heisenberg's Uncertainty Principle:

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

Minimum uncertainty in momentum:

$$\Delta p_{\min} = \frac{h}{4\pi\,\Delta x} = \frac{6.626 \times 10^{-34}}{4\pi \times 10^{-10}} \approx 5.27 \times 10^{-25}\ \mathrm{kg \cdot m/s}$$

Why other options are wrong:

- Option B ($h/\Delta x$): Missing 4π in denominator — too large by factor 4π.
- Option C ($4\pi h/\Delta x$): Numerator and denominator swapped — wildly too large.
- Option D ($h/(2\pi\Delta x)$): Uses 2π instead of 4π — violates the correct form.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept — VSEPR and Hybridisation of CO_2: Carbon in CO_2 forms two double bonds with two oxygen atoms and has no lone pairs. Electron geometry and molecular geometry are both linear with a bond angle of 180°. Carbon is sp hybridised.

Why other options are wrong:

- Option A (bent, 120°): Would require one lone pair on C (like SO_2).
- Option C (trigonal planar): Requires three electron domains around C.
- Option D (tetrahedral): Requires four electron domains around C.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Thermal Stability of Carbonates: For Group 1, Na_2CO_3 does not decompose appreciably even at high temperature. For Group 2 carbonates, stability increases down the group (larger cation polarises the carbonate ion less). Thus: Na_2CO_3 (very stable) $>$ $CaCO_3$ (decomposes $\sim 840°C$) $>$ $MgCO_3$ ($\sim 350°C$) $>$ $BeCO_3$ (least stable).

Why other options are wrong:

- Option A: Reversed order for Group 2; Be compounds are least stable.
- Option B: Puts Na carbonate last — Na_2CO_3 is actually the most stable.
- Option D: Places $CaCO_3$ above Na_2CO_3 — incorrect.

Final Answer: $\boxed{C}$

Answer: (C) Go Back to Q34

Q35.

Solution

Concept — Melting Points of Alkali Metals: As we descend Group 1 (Li $\rightarrow$ Cs), the metallic bonding weakens due to increasing atomic radius and increasing shielding, resulting in progressively lower melting points. Li: $180°C$, Na: $98°C$, K: $63°C$, Rb: $39°C$, Cs: $28°C$.

Why other options are wrong:

- Option A: Melting points clearly decrease, not increase.
- Option B: There is no minimum and rise — trend is monotonically decreasing.
- Option C: Values vary widely (from $180°C$ to $28°C$) — far from constant.

Final Answer: $\boxed{D}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — Variable Oxidation States in Transition Metals: The $(n-1)d$ and ns orbitals are very close in energy for transition metals. As a result, varying numbers of these electrons can be involved in bonding, giving rise to multiple stable oxidation states (e.g., Fe: $+2, +3$; Mn: $+2$ to $+7$).

Why other options are wrong:

- Option B: Large atomic radius is not the reason; main-group large atoms don't show this.
- Option C: Transition metals DO have d-electrons — that is central to the explanation.
- Option D: Ionisation enthalpies of transition metals are moderate, not "very high."

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q36

Q37.

Solution

Concept — Geometrical Isomerism in Octahedral Complexes: For $[Co(NH_3)_4Cl_2]^+$ with two Cl^- ligands and four NH_3 ligands in an octahedral arrangement, the two Cl atoms can be:

- **cis**: Adjacent (90° apart)
- **trans**: Opposite (180° apart)

These are 2 distinct geometrical isomers.

Why other options are wrong:

- Option A (1): There are definitely 2 isomers (cis and trans), not just 1.
- Option C (3) & Option D (4): Only 2 geometrical isomers exist for MA_4B_2.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Mesomeric Effect of −OH in Phenol: The lone pair of oxygen in phenol delocalises into the benzene ring (+M effect), increasing electron density at the ortho and para positions. This makes phenol more reactive toward electrophilic aromatic substitution at ortho/para positions.

Resonance structures show negative charge at o- and p-positions.

Why other options are wrong:

- Option A: Electron density increases (not decreases) due to $+M$ effect of OH.
- Option B: The meta position does NOT receive increased electron density.
- Option D: Electron density does not increase uniformly — only o and p positions are activated.

Final Answer: $\boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ Go Back to Q38

Q39.

Solution

Concept — E2 Elimination Mechanism: E2 is a concerted bimolecular elimination. The base abstracts the β-H simultaneously as the leaving group departs. The mechanism requires the β-H and the leaving group to be **antiperiplanar** (180° to each other). In cyclohexane, antiperiplanar = both substituents axial.

Why other options are wrong:

- Option A: Only having the leaving group axial is insufficient.
- Option B: Only having β-H axial is insufficient.
- Option C: Equatorial positions are gauche (60°), not antiperiplanar (180°).

Final Answer: $\boxed{\text{D}}$

$\boxed{\textbf{Answer: (D)}}$ Go Back to Q39

Q40.

Solution

Concept — SN1 Reaction Rate: SN1 proceeds via carbocation intermediate. The rate depends only on the stability of the carbocation formed: tertiary > secondary > primary (more substituted = more stable carbocation due to hyperconjugation and inductive effects).

$$\text{Tertiary} > \text{Secondary} > \text{Primary}$$

Why other options are wrong:

- Option B: Reversed — primary would need SN2 mechanism.
- Option C: Secondary before tertiary is incorrect.
- Option D: Rates definitely differ.

Final Answer: $\boxed{\text{A}}$

$\boxed{\text{Answer: (A)}}$ Go Back to Q40

Q41.

Solution

Concept — Reimer–Tiemann Reaction: Phenol reacts with $CHCl_3$ in the presence of concentrated NaOH solution. $CHCl_3$ forms dichlorocarbene ($:CCl_2$) which attacks the phenoxide ion. After hydrolysis, an aldehyde group ($-CHO$) is introduced at the ortho position. The product is **salicylaldehyde** (2-hydroxybenzaldehyde).

Why other options are wrong:

- Option A: 2-Chlorophenol forms in electrophilic chlorination, not Reimer–Tiemann.
- Option C: Phenyl acetate forms by acetylation, not Reimer–Tiemann.
- Option D: Catechol (1,2-dihydroxybenzene) is not the Reimer–Tiemann product.

Final Answer: $\boxed{\text{B}}$

$\boxed{\text{Answer: (B)}}$ Go Back to Q41

Q42.

Solution

Concept — Grignard Reaction with Aldehyde: The Grignard reagent $\mathrm{CH_3MgBr}$ (methyl nucleophile) attacks the carbonyl carbon of acetaldehyde $\mathrm{CH_3CHO}$. After hydrolysis:

$$\mathrm{CH_3MgBr + CH_3CHO \xrightarrow{1.\,add;\,2.\,H_3O^+} CH_3CH(OH)CH_3}$$

The product is **2-propanol** (isopropanol) — a **secondary alcohol** (OH on C bearing two alkyl groups).

Why other options are wrong:

- Option A (primary): Primary alcohol results from Grignard + formaldehyde.
- Option B (tertiary): Tertiary alcohol results from Grignard + ketone.
- Option D (carboxylic acid): Grignard does not give carboxylic acid from aldehyde directly.

Final Answer: $\boxed{\mathrm{C}}$

Answer: (C) Go Back to Q42

Q43.

Solution

Concept — Saponification (Base Hydrolysis of Ester):

$$\mathrm{CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH}$$

The products are **sodium acetate** (carboxylate salt) and **ethanol**.

Why other options are wrong:

- Option A: $\mathrm{CH_3COOH}$ is the product of *acid* hydrolysis, not base hydrolysis.
- Option B: Sodium propanoate and methanol would come from a different ester.
- Option C: Wrong ester identity; propanoate is not produced from ethyl acetate.

Final Answer: $\boxed{\mathrm{D}}$

Answer: (D) Go Back to Q43

Q44.

Solution

Concept — Acetylation of Primary Amine:

$$RNH_2 + (CH_3CO)_2O \rightarrow RNHCOCH_3 + CH_3COOH$$

The nitrogen of the amine attacks acetic anhydride, giving an **N-substituted amide** (acetamide derivative).

Why other options are wrong:

- Option B: N-methylation requires CH_3I or similar methylating agent, not acetic anhydride.
- Option C: Nitrile formation requires dehydration conditions (not acetic anhydride).
- Option D: Imine requires reaction with carbonyl compound (Schiff base formation).

Final Answer: $\boxed{A}$

Answer: (A) Go Back to Q44

Q45.

Solution

Concept — Raoult's Law: For a dilute solution, the relative lowering of vapour pressure equals the mole fraction of the solute x_2:

$$\frac{\Delta P}{P^\circ} = \frac{P^\circ - P}{P^\circ} = x_2$$

where P° = vapour pressure of pure solvent, P = VP of solution.

Why other options are wrong:

- Option A: x_1 is the mole fraction of *solvent*; Raoult's law gives $P = x_1P^\circ$, so $\Delta P/P^\circ = x_2$, not x_1.
- Option C: $x_1 - x_2$ is not the correct expression.
- Option D: $1/x_2$ diverges for dilute solutions.

Final Answer: $\boxed{B}$

Answer: (B) Go Back to Q45

Q46.

Solution

Concept — Solubility Product: For $\mathrm{AgCl} \rightleftharpoons \mathrm{Ag^+} + \mathrm{Cl^-}$:

$$K_{sp} = [\mathrm{Ag^+}][\mathrm{Cl^-}] = s \cdot s = s^2 \implies s = \sqrt{K_{sp}}$$

Calculation: $s = \sqrt{1.6 \times 10^{-10}} \approx 1.265 \times 10^{-5}$ mol/L.

Why other options are wrong:

- Option A ($K_{sp}/2$): Incorrect algebraic derivation.
- Option B ($K_{sp}^{1/3}$): Applies to 1:2 or 2:1 electrolytes (e.g., $\mathrm{PbCl_2}$).
- Option D (K_{sp}^2): No basis for squaring K_{sp}.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q46

Q47.

Solution

Concept — First-Order Kinetics: Integrated rate law: $\ln[\mathrm{A}] = \ln[\mathrm{A}]_0 - kt$. This is $y = c - kx$, so the slope of $\ln[\mathrm{A}]$ vs t is $-k$:

$$k = -(\text{slope})$$

Why other options are wrong:

- Option A ($k = $ slope): Missing the negative sign; slope is $-k$.
- Option B ($k = 1/$slope): Reciprocal relationship does not apply here.
- Option C ($k = $ slope^2): No squared relationship.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q47

Q48.

Solution

Concept — Faraday's First Law of Electrolysis: The mass w of substance deposited is proportional to the charge $Q = It$ passed:

$$w = \frac{M}{nF} \cdot It = \frac{M \cdot I \cdot t}{n \cdot F}$$

where M = molar mass, n = electrons per ion, $F = 96500$ C/mol.

Why other options are wrong:

- Option B: Inverts M and nF.
- Option C: Multiplies all quantities together — gives enormous value.
- Option D: Divides by It — incorrect.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q48

Q49.

Solution

Concept — Heterogeneous Catalysis (Adsorption Theory): In heterogeneous catalysis, the solid catalyst provides a surface on which gaseous (or liquid) reactants adsorb. Steps: (1) Adsorption of reactants onto catalyst surface; (2) Activation and surface reaction; (3) Desorption of products. **Adsorption is the key step** that lowers activation energy.

Why other options are wrong:

- Option A: Gas-phase diffusion is a transport step, not the catalytic step.
- Option C: Ionisation occurs in ionic reactions in solution, not in heterogeneous catalysis.
- Option D: Catalysts are solid and reactants do not dissolve in them.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q49

Q50.

Solution

Concept — Reducing Sugars: A reducing sugar has a free anomeric hydroxyl (hemi-acetal or hemi-ketal) group that can open to give an aldehyde (or α-hydroxyketone), allowing it to reduce Fehling's/Tollens' reagent.

- **Maltose**: α-1,4 glycosidic bond; one free anomeric OH $\Rightarrow$ **reducing**.
- **Lactose**: β-1,4 glycosidic bond; one free anomeric OH $\Rightarrow$ **reducing**.
- Sucrose: glycosidic bond involves both anomeric carbons $\Rightarrow$ **non-reducing**.

Why other options are wrong:

- Option A: Sucrose is non-reducing.
- Option B: Fructose alone is reducing; sucrose is non-reducing.
- Option D: Cellulose and starch are polysaccharides (special considerations apply); maltose and lactose are the better answer here.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q50

Q51.

Solution

Mass of Substance:

$$m = n \times M = 3 \text{ mol} \times 44 \text{ g/mol} = 132 \text{ g}$$

Final Answer: $\boxed{132}$

Answer: (132) Go Back to Q51

Q52.

Solution

Molarity:

$$C = \frac{n}{V} = \frac{m/M}{V} = \frac{40/40}{1} = \frac{1}{1} = 1 \text{ mol/L}$$

Final Answer: $\boxed{1}$

Answer: (1) Go Back to Q52

Q53.

Solution

pH of Strong Acid: HCl is a strong acid and fully dissociates: $[\mathrm{H}^+] = 0.01$ M.

$$\mathrm{pH} = -\log[\mathrm{H}^+] = -\log(0.01) = -\log(10^{-2}) = 2$$

Final Answer: $\boxed{2}$

Answer: (2) Go Back to Q53

Q54.

Solution

Enthalpy Scaling:

$$|\Delta H| = 2 \times 393 = 786 \text{ kJ}$$

Final Answer: $\boxed{786}$

Answer: (786) Go Back to Q54

Q55.

Solution

Solubility Product and pKsp:

$$K_{sp} = s^2 = (10^{-5})^2 = 10^{-10}$$

$$\mathrm{p}K_{sp} = -\log K_{sp} = -\log(10^{-10}) = 10$$

Final Answer: $\boxed{10}$

Answer: (10) Go Back to Q55

Q56.

Solution

Equivalent Conductance:

$$\Lambda_{\mathrm{eq}} = \frac{\kappa \times 1000}{N} = \frac{0.0129 \times 1000}{0.1} = \frac{12.9}{0.1} = 129 \text{ S cm}^2 \text{ equiv}^{-1}$$

Final Answer: $\boxed{129}$

Answer: (129) Go Back to Q56

Q57.

Solution

First-Order Half-Life:

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{1 \times 10^{-2}} = 69.3 \approx 69 \text{ min}$$

Final Answer: $\boxed{69}$

Answer: (69) Go Back to Q57

Q58.

Solution

Faraday's Law: Each Cu^{2+} requires 2 electrons. For 2 mol of Cu:

$$\text{Charge} = 2 \text{ mol} \times 2 \text{ F/mol} = 4 \text{ F}$$

Final Answer: $\boxed{4}$

Answer: (4) Go Back to Q58

Q59.

Solution

Oxidation State: NH_3 is a neutral ligand. Overall charge of complex $= +3$. Therefore Co oxidation state $= +3$. **Final Answer:** $\boxed{3}$

Answer: (3) Go Back to Q59

Q60.

Solution

Boiling Point Elevation:

$$\Delta T_b = K_b \times m = 0.52 \times 0.5 = 0.26 \text{ K}$$

$$\Delta T_b \times 100 = 0.26 \times 100 = 26$$

Final Answer: $\boxed{26}$

Answer: (26) Go Back to Q60

Q61.

Solution

Concept — Argument of a Complex Number: For $z = a + ib$ with $a > 0$, $b > 0$ (first quadrant):

$$\arg(z) = \arctan\left(\frac{b}{a}\right) = \arctan\left(\frac{1}{1}\right) = \arctan(1) = \frac{\pi}{4}$$

Why other options are wrong:

- Option B ($\pi/3$): $\arctan(\sqrt{3}) = \pi/3$; here $b/a = 1 \neq \sqrt{3}$.
- Option C ($\pi/6$): $\arctan(1/\sqrt{3}) = \pi/6$; here $b/a = 1 \neq 1/\sqrt{3}$.
- Option D ($3\pi/4$): Argument is in 2nd quadrant ($a < 0, b > 0$); here $a = 1 > 0$.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q61

Q62.

Solution

Concept — Solving Quadratic by Factoring:

$$x^2 - 3x + 2 = 0 \implies (x-1)(x-2) = 0 \implies x = 1 \text{ or } x = 2$$

Discriminant: $D = 9 - 8 = 1 > 0$ (real, distinct). Both roots positive.

Why other options are wrong:

- Option A ($x = -1, -2$): Product $(-1)(-2) = 2$ is correct but sum $= -3 \neq +3$. These satisfy $x^2 + 3x + 2 = 0$.
- Option C ($x = 3, 0$): Sum $= 3$ correct but product $= 0 \neq 2$.
- Option D (complex): $D = 1 > 0$, so roots are real.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q62

Q63.

Solution

Concept — Harmonic Mean: The harmonic mean of two numbers a and b is:

$$\mathrm{HM} = \frac{2ab}{a+b} = \frac{2\times 2\times 6}{2+6} = \frac{24}{8} = 3$$

Why other options are wrong:

- Option A (4): This is the arithmetic mean $(2+6)/2$.
- Option B ($\sqrt{12}$): This is the geometric mean $\sqrt{2\times 6}$.
- Option D (8): $a+b=8$, not the HM.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q63

Q64.

Solution

Concept — Derangements: A derangement is a permutation where no element appears in its original position. For $n=3$:

$$D_3 = 3!\left(1 - 1 + \frac{1}{2!} - \frac{1}{3!}\right) = 6\left(\frac{1}{2} - \frac{1}{6}\right) = 6\times\frac{1}{3} = 2$$

The two derangements of $\{1,2,3\}$ are $(2,3,1)$ and $(3,1,2)$.

Why other options are wrong:

- Option A (6): Total permutations of 3 objects, not derangements.
- Option B (3): Number of permutations with exactly one fixed point.
- Option C (1): Too few; $D_1 = 0$, $D_2 = 1$.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q64

Q65.

Solution

Concept — Binomial Theorem: General term in $(x + 1/x)^6$:

$$T_{r+1} = \binom{6}{r} x^{6-r} \cdot x^{-r} = \binom{6}{r} x^{6-2r}$$

For term independent of x: $6 - 2r = 0 \Rightarrow r = 3$.

$$\text{Coefficient} = \binom{6}{3} = \frac{6!}{3!\,3!} = 20$$

Why other options are wrong:

- Option B (15): $\binom{6}{2} = 15$, corresponding to $r = 2$ (gives x^2, not x^0).
- Option C (6): $\binom{6}{1} = 6$, for $r = 1$.
- Option D (1): $\binom{6}{0} = 1$, for $r = 0$.

Final Answer: $\boxed{\text{A}}$

Answer: (A) **Go Back to Q65**

Q66.

Solution

Concept — Cayley–Hamilton Theorem: Every square matrix A satisfies its own characteristic equation $p(\lambda) = \det(\lambda I - A) = 0$. That is, if $p(\lambda)$ is the characteristic polynomial of A, then $p(A) = 0$ (the zero matrix).

Example: For $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$: $p(\lambda) = \lambda^2 - (a+d)\lambda + (ad - bc)$, and $A^2 - (a+d)A + (ad - bc)I = 0$.

Why other options are wrong:

- Option A: Not all matrices have inverses (singular matrices don't).
- Option C: This is a property of determinants, not the Cayley–Hamilton theorem.
- Option D: Symmetric matrices are not necessarily orthogonal.

Final Answer: $\boxed{\text{B}}$

Answer: (B) **Go Back to Q66**

Q67.

Solution

Concept — Addition Formula: $\sin(75°) = \sin(45° + 30°)$

$$\sin(A+B) = \sin A \cos B + \cos A \sin B$$

$$\sin 75° = \sin 45° \cos 30° + \cos 45° \sin 30° = \frac{\sqrt{2}}{2}\cdot\frac{\sqrt{3}}{2} + \frac{\sqrt{2}}{2}\cdot\frac{1}{2} = \frac{\sqrt{6}}{4} + \frac{\sqrt{2}}{4} = \frac{\sqrt{6}+\sqrt{2}}{4}$$

Why other options are wrong:

- Option A ($\frac{\sqrt{6}-\sqrt{2}}{4}$): This equals $\sin 15°$, not $\sin 75°$.
- Option B ($\frac{\sqrt{3}+1}{2}$): Numerically $\approx 1.37 > 1$ — impossible for sine.
- Option D ($\frac{\sqrt{3}-1}{4}$): Too small; $\sin 75° \approx 0.966$.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q67

Q68.

Solution

Concept — Sum of Inverse Tangents: For $x > 0$, $y > 0$, $xy > 1$: $\tan^{-1} x + \tan^{-1} y = \pi - \tan^{-1}\left(\frac{x+y}{1-xy}\right)$.

Step 1: $\tan^{-1}(2) + \tan^{-1}(3)$: here $xy = 6 > 1$, so:

$$\tan^{-1}(2)+\tan^{-1}(3) = \pi - \tan^{-1}\left(\frac{2+3}{1-6}\right) = \pi - \tan^{-1}\left(\frac{5}{-5}\right) = \pi - \tan^{-1}(-1) = \pi - \left(-\frac{\pi}{4}\right) = \pi + \frac{\pi}{4}$$

Wait, more carefully: $\tan^{-1}(-1) = -\pi/4$, so $\pi - (-\pi/4) = \pi + \pi/4$? That gives $5\pi/4$ for just two terms. Let me use the standard result directly:

Since $\tan^{-1}(1) + \tan^{-1}(2) + \tan^{-1}(3) = \pi$ is a well-known identity, we verify: $\tan^{-1}(2) + \tan^{-1}(3) = 3\pi/4$ (both positive, product > 1, so result $= \pi - \pi/4 = 3\pi/4$). Then: $\tan^{-1}(1) + 3\pi/4 = \pi/4 + 3\pi/4 = \pi$.

Why other options are wrong:

- Option A ($\pi/2$): Too small; just $\tan^{-1}(1) = \pi/4$ already.
- Option B ($3\pi/4$): This equals $\tan^{-1}(2) + \tan^{-1}(3)$ alone, without $\tan^{-1}(1)$.
- Option C ($5\pi/4$): Exceeds π — not possible for this sum of positive arctangents.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q68

Q69.

Solution

Concept — Perpendicular Bisector:

Step 1 — Midpoint: $M = \left(\frac{1+5}{2}, \frac{3+7}{2}\right) = (3, 5)$.

Step 2 — Slope of segment: $m = \frac{7-3}{5-1} = \frac{4}{4} = 1$.

Step 3 — Slope of perpendicular bisector: $m_{\perp} = -1$ (negative reciprocal).

Step 4 — Equation through $(3, 5)$ **with slope** -1**:**

$$y - 5 = -1(x - 3) \implies y - 5 = -x + 3 \implies x + y = 8$$

Why other options are wrong:

- Option B ($x - y = 2$): Slope $= +1$, parallel to segment, not perpendicular.
- Option C ($x+y = 6$): Correct slope but does not pass through midpoint $(3, 5)$ $(3 + 5 = 8 \neq 6)$.
- Option D ($2x + 2y = 5$): Simplifies to $x + y = 2.5$ — wrong constant.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q69

Q70.

Solution

Concept — Chord of Contact: The chord of contact from an external point (x_1, y_1) to the circle $x^2 + y^2 = r^2$ has equation:

$$x \cdot x_1 + y \cdot y_1 = r^2$$

From point $(3, 4)$ to circle $x^2 + y^2 = 25$ ($r^2 = 25$):

$$3x + 4y = 25$$

Why other options are wrong:

- Option A ($3x - 4y = 25$): Wrong sign on y term.
- Option C ($4x + 3y = 25$): x_1 and y_1 coefficients are swapped.
- Option D ($x + y = 25$): Ignores the coordinates of the external point.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q70

Q71.

Solution

Concept — Tangent to Parabola $y^2 = 4ax$: At parameter t (point $(at^2, 2at)$), the tangent is $ty = x + at^2$.

At $(a, 2a)$: we need $at^2 = a \Rightarrow t = 1$ and $2at = 2a$ — consistent with $t = 1$.

$$1 \cdot y = x + a \cdot 1^2 \implies y = x + a$$

Why other options are wrong:

- Option A ($y = 2x + a$): Slope $= 2$ is wrong for $t = 1$.
- Option B ($y = 2x - a$): Same slope error.
- Option D ($y = x - a$): Correct slope but wrong constant; should be $+a$.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q71

Q72.

Solution

Concept — Standard Ellipse $x^2/a^2 + y^2/b^2 = 1$: For $\frac{x^2}{16} + \frac{y^2}{9} = 1$: $a^2 = 16$ (semi-major, along x), $b^2 = 9$ (semi-minor, along y). Semi-minor axis $b = 3$. Length of minor axis $= 2b = 6$.

Why other options are wrong:

- Option A (3): This is the semi-minor axis, not the full length.
- Option B (4): This is the semi-major axis a.
- Option C (8): This is the major axis length $2a$.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q72

Q73.

Solution

Concept — Standard Limit: This is the definition of Euler's number e:

$$\lim_{x\to 0}(1+x)^{1/x} = e \approx 2.718\ldots$$

It can be derived via L'Hôpital's rule or by noting $\ln L = \lim_{x\to 0}\dfrac{\ln(1+x)}{x} = 1$, so $L = e^1 = e$.

Why other options are wrong:

- Option B (1): $(1+0)^\infty = 1^\infty$ is indeterminate; the limit is $e \neq 1$.
- Option C (∞): The limit is finite ($= e$).
- Option D (0): The expression $(1+x)^{1/x} \to e > 0$.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q73

Q74.

Solution

Concept — Rolle's Theorem: If $f : [a,b] \to \mathbb{R}$ is (i) continuous on $[a,b]$, (ii) differentiable on (a,b), and (iii) $f(a) = f(b)$, then there exists at least one $c \in (a,b)$ such that $f'(c) = 0$.

Geometric meaning: The tangent to the curve is horizontal at some point between a and b.

Why other options are wrong:

- Option A ($f(c) = 0$): Rolle's theorem says $f'(c) = 0$, not $f(c) = 0$.
- Option C ($f''(c) = 0$): This is related to inflection points, not Rolle's theorem.
- Option D ($f(c) = f(a)$): Not the conclusion; $f(a) = f(b)$ is the *hypothesis*.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q74

Q75.

Solution

Concept — Rate of Change: $A = \pi r^2$.

$$\frac{dA}{dr} = 2\pi r$$

At $r = 5$ cm:

$$\left.\frac{dA}{dr}\right|_{r=5} = 2\pi \times 5 = 10\pi \text{ cm}^2/\text{cm}$$

Why other options are wrong:

- Option A (5π): Uses πr instead of $2\pi r$.
- Option B (25π): Uses $\pi r^2 = A$ instead of dA/dr.
- Option D (2π): Omits the factor $r = 5$.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q75

Q76.

Solution

Concept — Standard Integral: This is a standard trigonometric substitution result:

$$\int \frac{dx}{\sqrt{1-x^2}} = \sin^{-1} x + C$$

Verify by differentiating: $\dfrac{d}{dx}\sin^{-1} x = \dfrac{1}{\sqrt{1-x^2}}$. ✓

Why other options are wrong:

- Option A $(\cos^{-1} x + C)$: $\dfrac{d}{dx}\cos^{-1} x = -\dfrac{1}{\sqrt{1-x^2}}$ (negative sign).
- Option B $(\tan^{-1} x + C)$: $\dfrac{d}{dx}\tan^{-1} x = \dfrac{1}{1+x^2}$ (different integrand).
- Option C $(\sec^{-1} x + C)$: $\dfrac{d}{dx}\sec^{-1} x = \dfrac{1}{|x|\sqrt{x^2-1}}$ (different integrand).

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q76

Q77.

Solution

Concept — Even Function Property: $f(x) = x^2$ is an even function $[f(-x) = f(x)]$. Therefore:

$$\int_{-2}^{2} x^2\,dx = 2\int_{0}^{2} x^2\,dx = 2\left[\frac{x^3}{3}\right]_0^2 = 2 \times \frac{8}{3} = \frac{16}{3}$$

Why other options are wrong:

- Option B $(8/3)$: This is $\int_0^2 x^2\,dx$ — half the correct answer.
- Option C (4): $\int_{-2}^{2} x\,dx = 0$ (odd function); x^2 gives $16/3 \approx 5.33 \neq 4$.
- Option D $(4/3)$: This is $\int_0^1 x^2\,dx \times 4/3$ — wrong limits.

Final Answer: $\boxed{\text{A}}$

Answer: (A) Go Back to Q77

Q78.

Solution

Concept — Independence: For independent events:

$$P(A \cap B) = P(A) \times P(B) = 0.3 \times 0.5 = 0.15$$

Why other options are wrong:

- Option A (0.8): This is $P(A) + P(B) = 0.3 + 0.5$ — addition, not multiplication.
- Option C (0.35): $P(A \cup B) = P(A) + P(B) - P(A \cap B) = 0.8 - 0.15 = 0.65$; not this.
- Option D (0.30): This is $P(A)$ alone.

Final Answer: $\boxed{\text{B}}$

Answer: (B) Go Back to Q78

Q79.

Solution

Concept — Scalar Triple Product: $[\vec{a}\;\vec{b}\;\vec{c}] = \det\begin{pmatrix}1 & 1 & 0\\ 0 & 1 & 1\\ 1 & 0 & 1\end{pmatrix}$ (rows are components of $\vec{a}$, $\vec{b}$, $\vec{c}$).

Calculation:

$$\det = 1(1\cdot 1 - 1\cdot 0) - 1(0\cdot 1 - 1\cdot 1) + 0(0\cdot 0 - 1\cdot 1) = 1(1) - 1(-1) + 0 = 1 + 1 = 2$$

Why other options are wrong:

- Option A (0): Would mean $\vec{a}$, $\vec{b}$, $\vec{c}$ are coplanar — they are not.
- Option B (1): Off-by-one; determinant evaluation gives 2.
- Option D (3): Over-counts; correct computation gives 2.

Final Answer: $\boxed{\text{C}}$

Answer: (C) Go Back to Q79

Q80.

Solution

Concept — Equation of Plane: A plane through point (x_0, y_0, z_0) with normal $\vec{n} = (A, B, C)$ satisfies:

$$A(x - x_0) + B(y - y_0) + C(z - z_0) = 0$$

With $(x_0, y_0, z_0) = (1, 2, 3)$ and $(A, B, C) = (2, -1, 1)$:

$$2(x-1) - 1(y-2) + 1(z-3) = 0 \implies 2x - 2 - y + 2 + z - 3 = 0 \implies 2x - y + z = 3$$

Why other options are wrong:

- Option A ($x - y + z = 4$): Normal vector would be $(1, -1, 1)$, not $(2, -1, 1)$.
- Option B ($2x + y - z = 1$): Normal vector $(2, 1, -1) \neq (2, -1, 1)$.
- Option C ($x + 2y - z = 2$): Normal vector $(1, 2, -1) \neq (2, -1, 1)$.

Final Answer: $\boxed{\text{D}}$

Answer: (D) Go Back to Q80

Q81.

Solution

Complex Modulus: $|z^n| = |z|^n$. $|1+i| = \sqrt{1^2+1^2} = \sqrt{2}$.

$$|(1+i)^4| = (\sqrt{2})^4 = 4$$

Final Answer: $\boxed{4}$

Answer: (4) Go Back to Q81

Q82.

Solution

AP General Term:

$$a_{20} = a + (20-1)d = 5 + 19 \times 3 = 5 + 57 = 62$$

Final Answer: $\boxed{62}$

Answer: (62) Go Back to Q82

Q83.

Solution

Determinant:

$$\det \begin{pmatrix} 2 & 3 \\ 4 & 5 \end{pmatrix} = 2 \times 5 - 3 \times 4 = 10 - 12 = -2$$

$$|\det| = |-2| = 2$$

Final Answer: $\boxed{2}$

Answer: (2) Go Back to Q83

Q84.

Solution

Permutations of Distinct Letters: MATHS has 5 distinct letters. Number of arrangements $= 5! = 120$. **Final Answer:** $\boxed{120}$

Answer: (120) Go Back to Q84

Q85.

Solution

Definite Integration:

$$\int_0^2 (3x^2 + 2x)\,dx = \left[x^3 + x^2\right]_0^2 = (8+4) - (0+0) = 12$$

Final Answer: $\boxed{12}$

Answer: (12) Go Back to Q85

Q86.

Solution

Derivative: $f'(x) = \cos x - \sin x$.

$$f'\left(\frac{\pi}{4}\right) = \cos\frac{\pi}{4} - \sin\frac{\pi}{4} = \frac{\sqrt{2}}{2} - \frac{\sqrt{2}}{2} = 0$$

Final Answer: $\boxed{0}$

Answer: (0) Go Back to Q86

Q87.

Solution

Area Between Curves: Intersection at $x^2 = 9 \Rightarrow x = \pm 3$. Using symmetry:

$$\text{Area} = 2\int_0^3 (9 - x^2)\,dx = 2\left[9x - \frac{x^3}{3}\right]_0^3 = 2\,(27-9) = 2 \times 18 = 36$$

However, the question specifies computing $\int_0^3 (9-x^2)\,dx$ and multiplying by 2:

$$\int_0^3 (9 - x^2)\,dx = \left[9x - \frac{x^3}{3}\right]_0^3 = 27 - 9 = 18$$

$$2 \times 18 = 36$$

Final Answer: $\boxed{36}$

Answer: (36) Go Back to Q87

Q88.

Solution

Direction Cosines: $l^2 + m^2 + n^2 = 1$. With $l = m = n$: $3l^2 = 1$. **Final Answer:** $\boxed{1}$

Answer: (1) Go Back to Q88

Q89.

Solution

Mean Deviation: Mean $= (3 + 5 + 7 + 9 + 11)/5 = 35/5 = 7$.

$$\text{MD} = \frac{|3-7| + |5-7| + |7-7| + |9-7| + |11-7|}{5} = \frac{4+2+0+2+4}{5} = \frac{12}{5} = 2.4$$

Final Answer: $\boxed{2.4}$

Answer: (2.4) Go Back to Q89

Q90.

Solution

Probability without Replacement:

$$P(2\text{ red}) = \frac{\binom{5}{2}}{\binom{8}{2}} = \frac{10}{28} = \frac{5}{14}$$

The numerator when expressed with denominator 28 is $p = 10$. **Final Answer:** $\boxed{10}$

Answer: (10) Go Back to Q90

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	D	3	A	4	B	5	C
6	D	7	A	8	B	9	C	10	D
11	A	12	B	13	C	14	D	15	A
16	B	17	C	18	D	19	A	20	B
21	30	22	2	23	5	24	44.8	25	200
26	200	27	1.6	28	2	29	10	30	10
31	D	32	A	33	B	34	C	35	D
36	A	37	B	38	C	39	D	40	A
41	B	42	C	43	D	44	A	45	B
46	C	47	D	48	A	49	B	50	C
51	132	52	1	53	2	54	786	55	10
56	129	57	69	58	4	59	3	60	26
61	A	62	B	63	C	64	D	65	A
66	B	67	C	68	D	69	A	70	B
71	C	72	D	73	A	74	B	75	C
76	D	77	A	78	B	79	C	80	D
81	4	82	62	83	2	84	120	85	12
86	0	87	36	88	1	89	2.4	90	10