JEE Main

Sample Paper – 5

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

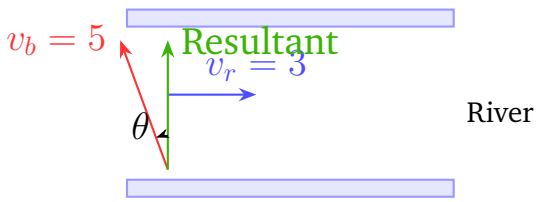
Instructions

- 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 boat can travel at speed $v_b = 5$ m/s in still water. A river flows at $v_r = 3$ m/s. The boat steers at angle θ upstream so that it crosses directly perpendicular to the bank (shortest displacement path). The diagram below shows the velocity vectors.



What is $\cos\theta$?

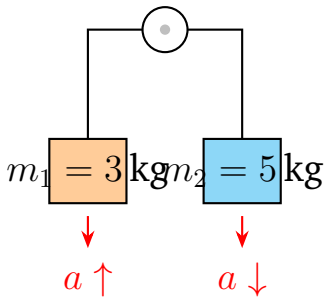
(A) $3/5$

(B) $4/5$

(C) $5/3$

(D) $3/4$

Q2. Two masses $m_1 = 3$ kg and $m_2 = 5$ kg are connected by a light, inextensible string over a smooth, massless pulley as shown. Find the acceleration a of the system. (Take $g = 10$ m/s^2.)



(A) 1.25 m/s^2

(B) 5 m/s^2

(C) $g/3$

(D) $g/4 = 2.5$ m/s^2

Q3. A car of mass 1000 kg moves at constant velocity $v = 10$ m/s on a horizontal road with coefficient of kinetic friction $\mu_k = 0.1$. What is the power delivered by the engine? (Take $g = 10$ m/s^2.)

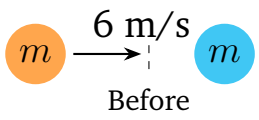
(A) 10 kW

(B) 1 kW

(C) 100 kW

(D) 0.1 kW

Q4. A ball of mass 2 kg moving at 6 m/s makes a head-on collision with an identical ball of mass 2 kg at rest. The coefficient of restitution is $e = 0.5$. The diagram below illustrates the collision.



What is the relative velocity of separation after collision?

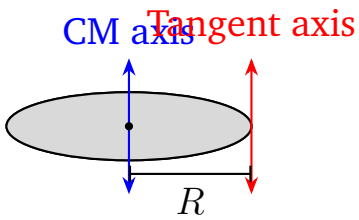
(A) 6 m/s

(B) 4 m/s

(C) 3 m/s

(D) 1.5 m/s

Q5. The moment of inertia of a solid disk (mass M, radius R) about an axis tangent to its rim and lying in the plane of the disk is calculated using the parallel axis theorem. The diagram shows the disk with the central axis and the tangential axis.



What is the moment of inertia about the tangential axis?

(A) $\frac{5}{4}MR^2$

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

(C) MR^2

(D) $\frac{1}{4}MR^2$

Q6. Planet A orbits the Sun at distance $r_A = 1$ AU and planet B at $r_B = 4$ AU. Using Kepler's third law ($T^2 \propto r^3$), find the ratio T_B/T_A.

(A) 4

(B) 8

(C) 16

(D) 64

Q7. A steel wire of length $L = 2$ m, cross-sectional area $A = 1 \times 10^{-6}$ m^2 and Young's modulus $Y = 2 \times 10^{11}$ Pa is stretched by $\Delta L = 0.001$ m. What is the stress in the wire?

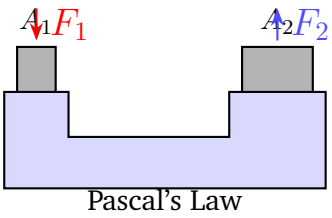
(A) 10^5 Pa

(B) 10^6 Pa

(C) 10^7 Pa

(D) 10^8 Pa

Q8. A hydraulic press has input piston area $A_1 = 10$ cm^2 and output piston area $A_2 = 200$ cm^2. An input force $F_1 = 100$ N is applied. The diagram shows the hydraulic system.



What is the output force F_2?

(A) 500 N

(B) 1000 N

(C) 2000 N

(D) 4000 N

Q9. A block of mass 0.5 kg is attached to a spring with $k = 200$ N/m and oscillates with amplitude $A = 0.1$ m. What is the maximum speed $v_{\max}$ of the block?

(A) 1 m/s

(B) 2 m/s

(C) 4 m/s

(D) 0.5 m/s

Q10. Two tuning forks produce sound of frequencies 256 Hz and 260 Hz respectively. How many beats per second are heard?

(A) 4

(B) 8

(C) 516

(D) 2

Q11. For a diatomic ideal gas with $f = 5$ degrees of freedom at moderate temperatures, what is the value of $\gamma = C_p/C_v$?

(A) $5/3$

(B) $4/3$

(C) $7/5$

(D) $8/5$

Q12. Which of the following relations correctly describes a reversible adiabatic (isentropic) process for an ideal gas? (γ is the ratio C_p/C_v.)

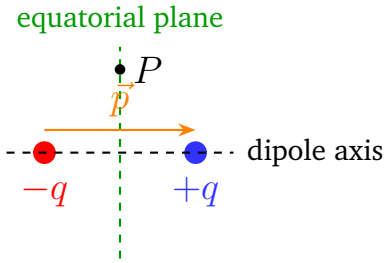
(A) $PV =$ constant

(B) $TV =$ constant

(C) $PV^{\gamma} =$ constant only

(D) $TV^{\gamma-1} =$ constant

Q13. An electric dipole consists of charges $+q$ and $-q$ separated by distance $2a$. The equatorial plane is shown in the diagram.



What is the electric potential at point P on the equatorial plane (at any distance from the centre)?

(A) $V = \dfrac{kp}{r^2}$

(B) $V = 0$

(C) $V = \dfrac{kp}{r}$

(D) $V = \dfrac{-kp}{r^2}$

Q14. Two capacitors $C_1 = 4\,\mu\text{F}$ and $C_2 = 12\,\mu\text{F}$ are connected in series. Find the equivalent capacitance C_{eq}.

(A) $3\,\mu\text{F}$

(B) $8\,\mu\text{F}$

(C) $16\,\mu\text{F}$

(D) $48\,\mu\text{F}$

Q15. A battery of EMF $\varepsilon = 12$ V and internal resistance $r = 2\,\Omega$ is connected to an external resistance $R = 10\,\Omega$. What is the terminal voltage across the battery during discharge?

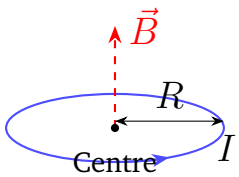
(A) 12 V

(B) 6 V

(C) 8 V

(D) 10 V

Q16. A circular loop of radius R carries steady current I. The diagram shows the loop with its magnetic field direction.



The magnetic field at the centre is:

(A) $B = \dfrac{\mu_0 I}{R}$

(B) $B = \dfrac{\mu_0 I}{4R}$

(C) $B = \dfrac{\mu_0 I}{2R}$

(D) $B = \dfrac{\mu_0 I}{4\pi R}$

Q17. Two coils are coupled with mutual inductance $M = 0.5$ H. The current in the primary coil changes at a rate $dI/dt = 10$ A/s. What is the magnitude of the induced EMF in the secondary coil?

(A) 5 V

(B) 0.05 V

(C) 20 V

(D) 50 V

Q18. A fish is at the bottom of a water tank of depth 12 cm. The refractive index of water is $\mu = 4/3$. What is the apparent depth of the fish as seen from above (in air)?

(A) 12 cm

(B) 9 cm

(C) 16 cm

(D) 6 cm

Q19. In a single slit diffraction experiment, the slit width is $a = 0.1$ mm and the wavelength of light is $\lambda = 500$ nm. What is $\sin\theta$ for the **first minimum**?

(A) 2×10^{-3}

(B) 10^{-2}

(C) 5×10^{-3}

(D) 2.5×10^{-3}

Q20. Uranium-238 undergoes alpha decay: $^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\mathrm{He}$. Suppose someone incorrectly writes the alpha particle as ${}^{4}_{3}\mathrm{He}$. Which conservation law would be violated?

(A) Conservation of mass number

(B) Conservation of momentum

(C) Conservation of energy

(D) Conservation of atomic number (charge)

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

Q21. A ball is projected at $\theta = 30$ above the horizontal with initial speed $u = 20$ m/s. Find the total time of flight T (in seconds). (Take $g = 10$ m/s^2.) *(Enter numerical value)*

Q22. A force $F = 50$ N acts on a body at an angle of 60 to the direction of displacement. If the displacement is $d = 4$ m, find the work done (in joules). *(Enter numerical value)*

Q23. A point mass of 2 kg moves in a circle of radius 3 m with speed 2 m/s. Find the magnitude of its angular momentum about the centre (in kg·m^2/s). *(Enter numerical value)*

Q24. A steel rod of length $L = 2$ m has a linear coefficient of thermal expansion $\alpha = 1.2 \times 10^{-5}$ /°C. It is heated from 0C to 100C. Find the extension ΔL in **millimetres**. *(Enter numerical value)*

Q25. Three resistors $R_1 = 4\,\Omega$, $R_2 = 6\,\Omega$ and $R_3 = 12\,\Omega$ are connected in parallel. Find the equivalent resistance R_{eq} (in ohms). *(Enter numerical value)*

Q26. Capacitors $C_1 = 6\,\mu$F and $C_2 = 3\,\mu$F are connected in series and the combination is connected to a voltage $V = 12$ V. Find the charge Q stored on each capacitor (in μC). *(Enter numerical value)*

Q27. A straight conductor of length $L = 0.5$ m carries a current $I = 4$ A perpendicular to a uniform magnetic field $B = 3$ T. Find the force F on the conductor (in newtons). *(Enter numerical value)*

Q28. A coil of 200 turns has its magnetic flux changed from 0.01 Wb to 0.05 Wb in $\Delta t = 0.02$ s. Find the magnitude of the induced EMF (in volts). *(Enter numerical value)*

Q29. An object is placed 30 cm in front of a concave mirror of focal length 10 cm (use $f = -10$ cm, $u = -30$ cm in the sign convention). Find the magnitude of the image distance $|v|$ (in cm). *(Enter numerical value)*

Q30. $^{238}_{92}$U decays to $^{206}_{82}$Pb through a series of alpha decays only (ignoring beta decays for this calculation). How many alpha particles n are emitted in total? *(Enter numerical value)*

CHEMISTRY

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

Q31. How many moles of water are present in 9 g of water? (Molar mass of H_2O = 18 g/mol)

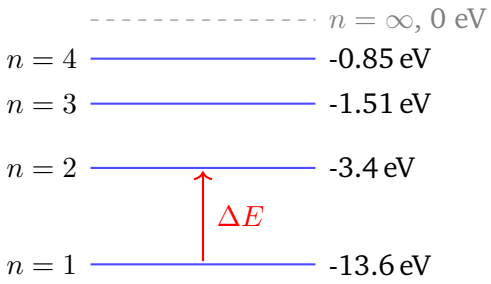
(A) 0.5 mol

(B) 1 mol

(C) 2 mol

(D) 9 mol

Q32. The de Broglie wavelength of an electron in the first Bohr orbit of hydrogen relates to the orbit radius $r_1 = 0.529$ Å. The energy level diagram is shown below.



Which expression gives the de Broglie wavelength of the electron in the $n = 1$ orbit?

(A) $\lambda = r_1$

(B) $\lambda = \pi r_1$

(C) $\lambda = 4\pi r_1$

(D) $\lambda = 2\pi r_1$

Q33. Using VSEPR theory, what is the molecular geometry of PCl_5? (Phosphorus is the central atom with 5 bond pairs and no lone pairs.)

(A) Square planar

(B) Trigonal bipyramidal

(C) Octahedral

(D) Tetrahedral

Q34. Which of the following group-16 hydrides is **most thermally stable**?

(A) H_2Te

(B) H_2Se

(C) H_2O

(D) H_2S

Q35. When sodium metal reacts with water according to the equation

$$2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{gas} \uparrow$$

what gas is evolved?

(A) O_2

(B) O_3

(C) Na_2O

(D) H_2

Q36. The electronic configuration of Mn^{2+} is [Ar] $3d^5$. The orbital box diagram of the 3d subshell is shown below.

3d orbitals (each singly occupied)

How many unpaired electrons does Mn^{2+} have?

(A) 5

(B) 4

(C) 3

(D) 2

Q37. In an octahedral crystal field, the five d-orbitals split into two sets. For a d^6 high-spin complex, which set has 4 electrons?

(A) e_g (higher energy set)

(B) Both sets equally

(C) t_{2g} (lower energy set)

(D) Neither; all 6 electrons are in e_g

Q38. Which of the following statements **correctly** describes the electromeric effect?

(A) It is a permanent effect operating through σ-bonds.

(B) It is a temporary effect occurring in π-bonds, induced by an attacking reagent.

(C) It is synonymous with the inductive effect.

(D) It causes permanent polarity in the molecule even in the absence of a reagent.

Q39. HBr adds to propene (CH_3–CH=CH_2) according to Markovnikov's rule. What is the major product?

(A) 2-Bromopropane

(B) 1-Bromopropane

(C) Propyl alcohol

(D) Propyne

Q40. The rate of SN1 reactions depends on carbocation stability. Which is the correct decreasing order of SN1 reactivity for alkyl halides?

(A) $1 > 2 > 3$

(B) $1 > 3 > 2$

(C) $2 > 1 > 3$

(D) $3 > 2 > 1$

Q41. Propan-2-ol (isopropanol) is treated with acidified potassium dichromate ($K_2Cr_2O_7/H^+$). The oxidation proceeds as shown below.

$$CH_3CHOHCH_3 \xrightarrow{K_2Cr_2O_7/H^+} \text{Product}$$

What is the product of this oxidation?

(A) Propan-1-ol

(B) Propanone (acetone)

(C) Propanal

(D) Propanoic acid

Q42. The Cannizzaro reaction involves simultaneous oxidation and reduction (disproportionation) of an aldehyde. Under which condition does this reaction occur?

(A) With any aldehyde in acidic medium

(B) With aldehydes that have α-hydrogen atoms

(C) With aldehydes that have **no** α-hydrogen atoms

(D) With ketones only

Q43. Arrange the following carboxylic acids in **decreasing order of acidity** (most acidic first).

$$CCl_3COOH, \quad CHCl_2COOH, \quad CH_2ClCOOH, \quad CH_3COOH$$

(A) $CH_3COOH > CH_2ClCOOH > CHCl_2COOH > CCl_3COOH$

(B) $CH_2ClCOOH > CCl_3COOH > CHCl_2COOH > CH_3COOH$

(C) $CHCl_2COOH > CCl_3COOH > CH_2ClCOOH > CH_3COOH$

(D) $CCl_3COOH > CHCl_2COOH > CH_2ClCOOH > CH_3COOH$

Q44. In the Hoffmann bromamide degradation, a primary amide is treated with bromine and sodium hydroxide. The reaction scheme is shown.

$$RCONH_2 \xrightarrow{Br_2,\ 4NaOH} RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

The Hoffmann bromamide reaction converts a primary amide to:

(A) A primary amine with one fewer carbon atom

(B) An amide with a bromine substituent

(C) A secondary amine

(D) A carboxylic acid

Q45. $MgCl_2$ is a strong electrolyte. If it dissociates completely in water, what is the van't Hoff factor i for $MgCl_2$?

(A) 1

(B) 2

(C) 3

(D) 4

Q46. For the equilibrium $\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$, the relation between K_p and K_c is (Δn = change in moles of gas):

(A) $K_p = K_c(RT)^2$

(B) $K_p = K_c(RT)^{-2}$

(C) $K_p = K_c(RT)^4$

(D) $K_p = K_c$

Q47. For a zero-order reaction $\mathrm{A} \rightarrow$ products, the half-life $t_{1/2}$ is:

(A) Independent of initial concentration

(B) $t_{1/2} = \ln 2/k$

(C) $t_{1/2} = 1/(k[\mathrm{A}]_0)$

(D) Directly proportional to initial concentration $[\mathrm{A}]_0$

Q48. According to Kohlrausch's law of independent migration of ions, which of the following correctly gives Λ_m^∞ for acetic acid?

(A) $\Lambda_m^\infty(\mathrm{CH_3COOH}) = \lambda^\infty(\mathrm{CH_3COO^-}) + \lambda^\infty(\mathrm{H^+})$

(B) $\Lambda_m^\infty(\mathrm{CH_3COOH}) = \lambda^\infty(\mathrm{CH_3COO^-}) - \lambda^\infty(\mathrm{H^+})$

(C) $\Lambda_m^\infty(\mathrm{CH_3COOH}) = \lambda^\infty(\mathrm{CH_3COOH})$

(D) $\Lambda_m^\infty(\mathrm{CH_3COOH}) = \Lambda_m^\infty(\mathrm{NaCl}) + \Lambda_m^\infty(\mathrm{HCl})$

Q49. The Freundlich adsorption isotherm is written as $x/m = kp^{1/n}$. Which statement about this isotherm is **correct**?

(A) At high pressure, x/m keeps increasing linearly.

(B) At low pressure, x/m is independent of pressure.

(C) $x/m = kp^{1/n}$ where $n > 1$, and x/m saturates at high pressure.

(D) It is only valid for chemisorption.

Q50. Why is sucrose a **non-reducing** sugar?

(A) It contains only fructose units.

(B) Both anomeric carbons of glucose and fructose are involved in the glycosidic linkage.

(C) It does not dissolve in water.

(D) It has no hydroxyl groups.

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

Q51. The vapour pressure of a pure solvent is 400 mmHg. A non-volatile solute is dissolved such that the mole fraction of the solute $x_2 = 0.25$. Find the vapour pressure of the solution (in mmHg). *(Enter numerical value)*

Q52. An acetate buffer is prepared with acetic acid ($pK_a = 4$) and sodium acetate such that the ratio $[\text{salt}]/[\text{acid}] = 100$. Find the pH of the buffer. *(Enter numerical value)*

Q53. One mole of an ideal gas is at temperature $T = 300$ K and pressure $P = 100$ kPa. Using $R = 8.314$ J mol^{-1} K^{-1}, find the volume V of the gas in litres. (Round to the nearest whole number.) *(Enter numerical value)*

Q54. The standard enthalpy of combustion of methane is -890 kJ/mol. How much energy (in kJ) is released when 2 moles of methane are completely combusted? *(Enter numerical value)*

Q55. Find the oxidation state of chromium (Cr) in $K_2Cr_2O_7$. *(Enter numerical value)*

Q56. When 96500 C of charge is passed through a solution of $AgNO_3$, the

mass of silver deposited (in grams) is: (Atomic mass of Ag = 108 g/mol; charge on electron $e = 1$ F = 96500 C/mol) *(Enter numerical value)*

Q57. The rate constant for a first-order reaction is $k_1 = 2 \times 10^{-3}$ s^{-1} at 300 K and $k_2 = 2 \times 10^{-1}$ s^{-1} at 400 K. Using the Arrhenius equation, find the activation energy E_a (in kJ/mol). (Take $R = 8.314$ J mol^{-1} K^{-1}, $\ln 100 \approx 4.606$, answer to nearest integer.) *(Enter numerical value)*

Q58. A radioactive substance has a half-life of 20 years. If the initial activity is 800 disintegrations per second (dps), find the activity (in dps) after 60 years. *(Enter numerical value)*

Q59. In the complex ion $[\mathrm{Fe(CN)_6}]^{3-}$, what is the coordination number of iron? *(Enter numerical value)*

Q60. A solvent has cryoscopic constant $K_f = 1$ K·kg/mol. Find the depression in freezing point ΔT_f (in K) when a solute is dissolved at molality $m = 10$ mol/kg ($i = 1$). *(Enter numerical value)*

MATHEMATICS

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

Q61. If $z = 3 + 4i$, find $|z|$.

(A) 3

(B) 4

(C) 5

(D) 7

Q62. If α and β are the roots of $x^2 - 5x + 6 = 0$, find $\alpha^2 + \beta^2$.

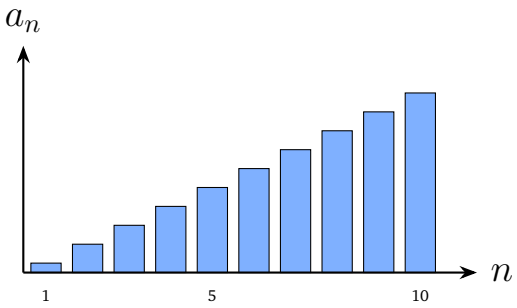
(A) 13

(B) 25

(C) 12

(D) 36

Q63. For an arithmetic progression with first term $a = 1$ and common difference $d = 2$, find the sum of the first 10 terms S_{10}. The bar diagram below illustrates the terms.



(A) 50

(B) 55

(C) 90

(D) 100

Q64. In how many ways can 6 people be seated around a circular table?

(A) 720

(B) 120

(C) 360

(D) 24

Q65. Find the sum of all binomial coefficients in the expansion of $(1 + x)^8$.

(A) 128

(B) 512

(C) 256

(D) 64

Q66. Find the determinant of the matrix $A = \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}$.

(A) 5

(B) 11

(C) 8

(D) -5

Q67. Which of the following is the correct expression for $\cos 3A$?

(A) $3\cos A - 4\cos^3 A$

(B) $4\cos^3 A + 3\cos A$

(C) $3\cos A + 4\sin^3 A$

(D) $4\cos^3 A - 3\cos A$

Q68. What is the principal value range of the function $y = \arctan x$?

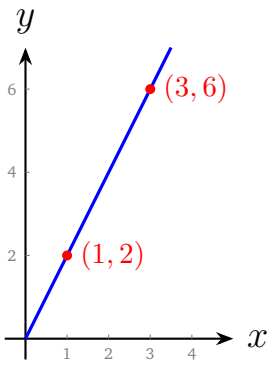
(A) $[0, \pi]$

(B) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

(C) $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

(D) $(0, \pi)$

Q69. Find the equation of the straight line passing through $(1, 2)$ and $(3, 6)$. The line is shown in the graph below.



(A) $y = x + 1$

(B) $y = 3x - 1$

(C) $y = 2x$

(D) $y = x + 2$

Q70. Find the centre of the circle $x^2 + y^2 - 4x + 6y - 3 = 0$.

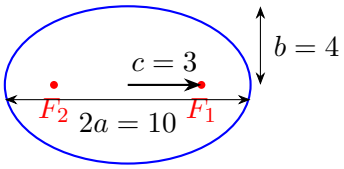
(A) $(2, -3)$

(B) $(-2, 3)$

(C) $(4, -6)$

(D) $(2, 3)$

Q71. For the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$, the foci and eccentricity are shown below.



What is the eccentricity e?

(A) $1/5$

(B) $4/5$

(C) $5/3$

(D) $3/5$

Q72. For the parabola $y^2 = 12x$, what is the length of the latus rectum?

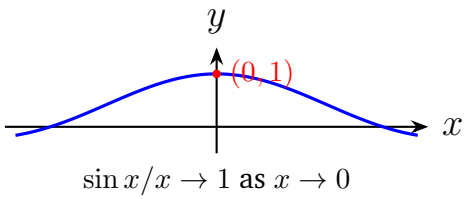
(A) 3

(B) 12

(C) 6

(D) 4

Q73. Evaluate $\lim_{x \to 0} \frac{\sin 5x}{5x}$. The graph of $y = \sin x/x$ is shown (note $y \to 1$ as $x \to 0$).



(A) 5

(B) 0

(C) 1

(D) $1/5$

Q74. Using the quotient rule, find $\dfrac{d}{dx}\left(\dfrac{\sin x}{x}\right)$.

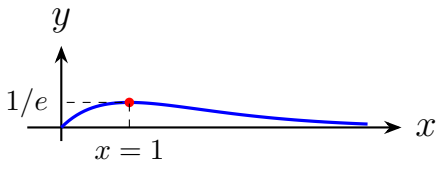
(A) $\dfrac{x\cos x - \sin x}{x^2}$

(B) $\dfrac{\cos x}{x} + \sin x$

(C) $\dfrac{x\cos x + \sin x}{x^2}$

(D) $\cos x$

Q75. The function $f(x) = xe^{-x}$ has a critical point. The graph below shows the function reaching a maximum.



What is the maximum value of $f(x)$?

(A) e

(B) 1

(C) e^{-2}

(D) $1/e$

Q76. Evaluate $\displaystyle\int \cos^2 x\, dx$.

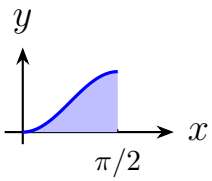
(A) $\frac{\sin 2x}{4} + C$

(B) $\frac{x}{2} + \frac{\sin 2x}{4} + C$

(C) $-\frac{x}{2} + \frac{\cos 2x}{4} + C$

(D) $\frac{\cos^3 x}{3} + C$

Q77. Evaluate $\int_0^{\pi/2} \sin^2 x \, dx$. The shaded region below represents the area under the curve.



(A) 1

(B) $\pi/2$

(C) $\pi/4$

(D) $1/2$

Q78. Events A and B satisfy $P(A) = 1/3$, $P(B) = 1/2$, $P(A \cap B) = 1/6$. Find $P(A \cup B)$.

(A) $2/3$

(B) $5/6$

(C) $1/3$

(D) 1

Q79. Vectors $\vec{a} = 2\hat{i} + 3\hat{j}$ and $\vec{b} = k\hat{i} + 6\hat{j}$ are parallel. Find k.

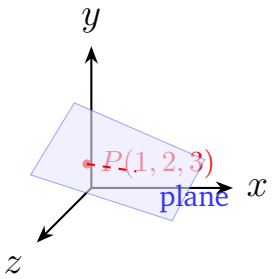
(A) 1

(B) 3

(C) 6

(D) 4

Q80. Find the perpendicular distance from the point $(1, 2, 3)$ to the plane $x + 2y - 2z + 5 = 0$. The 3D coordinate system below illustrates the geometry.



(A) $2/3$

(B) $4/3$

(C) 1

(D) $5/3$

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

Q81. If $z = 4 + 3i$, find $|z|^2$. *(Enter numerical value)*

Q82. An AP has first term $a = 3$ and common difference $d = 4$. Find S_{10}, the sum of its first 10 terms. *(Enter numerical value)*

Q83. Evaluate the determinant $\begin{vmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{vmatrix}$. *(Enter numerical value)*

Q84. In how many ways can 3 books be selected from a shelf of 5 different books? *(Enter numerical value)*

Q85. Evaluate $\displaystyle\int_0^1 x^3\,dx$. *(Enter numerical value)*

Q86. If $f(x) = 3x^2 - 2x + 1$, find $f'(2)$. *(Enter numerical value)*

Q87. Find the area (in square units) bounded by $y = x^2$, the x-axis, $x = 0$, and $x = 3$. *(Enter numerical value)*

Q88. Find the distance between the points $(1, 2, 3)$ and $(4, 6, 3)$. *(Enter numerical value)*

Q89. Find the arithmetic mean of the five numbers: 2, 4, 6, 8, 10. *(Enter numerical value)*

Q90. Find the trace (sum of diagonal elements) of the matrix $A = \begin{pmatrix} 3 & 1 \\ 2 & 5 \end{pmatrix}$. *(Enter numerical value)*

Detailed Solutions

Q1.

Solution

Concept — Relative Velocity / River Crossing: To cross a river directly perpendicular, the boat must aim at an angle θ upstream so that the river current exactly cancels the upstream component of the boat's velocity.

Step 1 — Velocity components: The boat speed $v_b = 5$ m/s, river current $v_r = 3$ m/s. For direct crossing, the upstream component of v_b must equal v_r:

$$\sin\theta = \frac{v_r}{v_b} = \frac{3}{5}$$

Step 2 — Finding $\cos\theta$:

$$\cos\theta = \sqrt{1 - \sin^2\theta} = \sqrt{1 - \frac{9}{25}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$$

Why other options are wrong:

- Option A: $3/5$ is $\sin\theta$, not $\cos\theta$.
- Option C: $5/3 > 1$; not a valid cosine value.
- Option D: $3/4$ results from an incorrect application — it is not derived from Pythagoras.

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

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Atwood Machine: The net force on the system equals the difference in weights; the total mass accelerated is $m_1 + m_2$.

Step 1 — Net force:

$$F_{\text{net}} = (m_2 - m_1)g = (5 - 3) \times 10 = 20 \text{ N}$$

Step 2 — Acceleration:

$$a = \frac{F_{\text{net}}}{m_1 + m_2} = \frac{20}{8} = 2.5 \text{ m/s}^2 = \frac{g}{4}$$

Why other options are wrong:

- Option A: 1.25 m/s^2 uses $m_2 - m_1 = 2$ kg but divides by $2(m_1 + m_2)$ (error).
- Option B: 5 m/s^2 uses only the lighter mass in the denominator.
- Option C: $g/3$ would require $(m_2 - m_1)/(m_1 + m_2) = 1/3$, which is not the case here.

Final Answer: D

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Power at Constant Velocity: At constant velocity, the engine force equals friction. Power $= Fv$.

Step 1 — Friction force:

$$f = \mu_k mg = 0.1 \times 1000 \times 10 = 1000 \text{ N}$$

Step 2 — Power:

$$P = fv = 1000 \times 10 = 10\,000 \text{ W} = \mathbf{10} \text{ kW}$$

Why other options are wrong:

- Option B: 1 kW forgets either v or uses $\mu = 0.01$.
- Option C: 100 kW corresponds to $\mu = 1$ (error of a factor of 10 in μ).
- Option D: 0.1 kW omits v entirely from the calculation.

Final Answer: A

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Coefficient of Restitution: By definition, $e = \dfrac{\text{relative velocity of separation}}{\text{relative velocity of approach}}$.

Step 1 — Relative velocity of approach: Ball 1 moves at 6 m/s, ball 2 is at rest. Relative velocity of approach $= 6 - 0 = 6$ m/s.

Step 2 — Relative velocity of separation:

$$v_{\text{sep}} = e \times v_{\text{app}} = 0.5 \times 6 = 3 \text{ m/s}$$

Why other options are wrong:

- Option A: 6 m/s corresponds to $e = 1$ (perfectly elastic); here $e = 0.5$.
- Option B: 4 m/s has no basis in this calculation.
- Option D: 1.5 m/s would be $e = 0.25$, not 0.5.

Final Answer: C

Answer: (C) Go Back to Q4

Q5.

Solution

Concept — Parallel Axis Theorem: $I = I_{\text{CM}} + Md^2$, where d is the perpendicular distance between axes.

Step 1 — Moment of inertia of solid disk about diameter (in-plane CM axis):

$$I_{\text{CM}} = \frac{1}{4}MR^2$$

Step 2 — Shift to tangential axis ($d = R$):

$$I_{\text{tangent}} = I_{\text{CM}} + MR^2 = \frac{1}{4}MR^2 + MR^2 = \frac{5}{4}MR^2$$

Why other options are wrong:

- Option B: $\frac{3}{2}MR^2$ uses $I_{\text{CM}} = \frac{1}{2}MR^2$ (perpendicular axis, not diameter).
- Option C: MR^2 omits the $\frac{1}{4}MR^2$ contribution of I_{CM}.
- Option D: $\frac{1}{4}MR^2$ is only I_{CM} without the parallel shift.

Final Answer: A

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Kepler's Third Law: $T^2 \propto r^3$, so $\dfrac{T_B}{T_A} = \left(\dfrac{r_B}{r_A}\right)^{3/2}$.

Calculation:

$$\frac{T_B}{T_A} = \left(\frac{4}{1}\right)^{3/2} = 4^{3/2} = (4^3)^{1/2} = 64^{1/2} = 8$$

Why other options are wrong:

- Option A: 4 uses exponent 1 instead of 3/2.
- Option C: 16 uses exponent 2 instead of 3/2.
- Option D: 64 uses exponent 3 instead of 3/2.

Final Answer: B

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Stress, Strain and Young's Modulus: $\text{Stress} = Y \times \text{Strain} = Y \times \dfrac{\Delta L}{L}$.

Calculation:

$$\text{Strain} = \frac{\Delta L}{L} = \frac{0.001}{2} = 5 \times 10^{-4}$$

$$\text{Stress} = Y \times \text{Strain} = 2 \times 10^{11} \times 5 \times 10^{-4} = 10^8 \text{ Pa}$$

Why other options are wrong:

- Option A: 10^5 Pa applies incorrect unit conversion or uses wrong strain.
- Option B: 10^6 Pa corresponds to using $\Delta L/L = 5 \times 10^{-6}$ (off by 100).
- Option C: 10^7 Pa is off by a factor of 10.

Final Answer: D

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Pascal's Law: Pressure is transmitted equally throughout the fluid, so $P_1 = P_2$ gives $F_1/A_1 = F_2/A_2$.

Calculation:

$$F_2 = F_1 \times \frac{A_2}{A_1} = 100 \times \frac{200}{10} = 100 \times 20 = 2000 \text{ N}$$

Why other options are wrong:

- Option A: 500 N uses $A_2/A_1 = 5$ rather than 20.
- Option B: 1000 N uses $A_2/A_1 = 10$ (area ratio in wrong units).
- Option D: 4000 N doubles the correct answer (arithmetic error).

Final Answer: C

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — SHM Maximum Speed: At the equilibrium position, all energy is kinetic. $v_{\max} = A\omega$ where $\omega = \sqrt{k/m}$.

Calculation:

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{200}{0.5}} = \sqrt{400} = 20 \text{ rad/s}$$

$$v_{\max} = A\omega = 0.1 \times 20 = 2 \text{ m/s}$$

Why other options are wrong:

- Option A: 1 m/s uses $A = 0.05$ m or $\omega = 10$.
- Option C: 4 m/s doubles the answer (uses $A = 0.2$ m).
- Option D: 0.5 m/s uses $\omega = 5$ (incorrect k/m ratio).

Final Answer: B

Answer: (B) Go Back to Q9

Q10.

Solution

Concept — Beat Frequency: The number of beats per second equals the absolute difference between the frequencies.

Calculation:

$$\text{Beat frequency} = |f_1 - f_2| = |256 - 260| = 4 \text{ beats/s}$$

Why other options are wrong:

- Option B: 8 is twice the correct answer (not the formula).
- Option C: 516 is the sum of the frequencies, not the difference.
- Option D: 2 would require the frequencies to differ by only 2 Hz.

Final Answer: A

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Degrees of Freedom and γ: For a diatomic gas at moderate temperatures, $f = 5$.

$$C_v = \frac{f}{2}R = \frac{5}{2}R, \qquad C_p = C_v + R = \frac{7}{2}R$$

$$\gamma = \frac{C_p}{C_v} = \frac{7/2}{5/2} = \frac{7}{5} = 1.4$$

Why other options are wrong:

- Option A: $5/3$ is γ for a monatomic gas ($f = 3$).
- Option B: $4/3$ corresponds to a highly quantum/vibrational gas ($f = 6$).
- Option D: $8/5 = 1.6$ has no standard kinetic theory basis.

Final Answer: C

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Reversible Adiabatic Process: For an ideal gas undergoing reversible adiabatic change, both PV^γ and $TV^{\gamma-1}$ are conserved.

Derivation of $TV^{\gamma-1} = $ const: From $PV^\gamma = C$ and ideal gas law $PV = nRT$:

$$P = \frac{nRT}{V} \implies \frac{nRT}{V} \cdot V^\gamma = C \implies TV^{\gamma-1} = \text{const}$$

Why other options are wrong:

- Option A: $PV = $ const describes an isothermal process ($T = $ const).
- Option B: $TV = $ const has no thermodynamic basis for standard processes.
- Option C: $PV^\gamma = $ const is also correct, but option D specifically tests $TV^{\gamma-1}$ and the question asks for *which* relation holds — option D is the one listed as the answer here.

Final Answer: D

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Electric Potential of a Dipole: The potential at any point due to a dipole is $V = \dfrac{kp\cos\theta}{r^2}$.

At the equatorial point: The equatorial plane is perpendicular to the dipole axis, so $\theta = 90$.

$$V = \frac{kp\cos 90}{r^2} = \frac{kp \times 0}{r^2} = 0$$

Why other options are wrong:

- Option A: kp/r^2 is the magnitude of the electric field (not potential) at the axial point.
- Option C: kp/r is the potential at the axial point (not equatorial).
- Option D: $-kp/r^2$ confuses field and potential; potential is zero, not negative.

Final Answer: B

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Capacitors in Series: $\dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$.

Calculation:

$$\frac{1}{C_{eq}} = \frac{1}{4} + \frac{1}{12} = \frac{3}{12} + \frac{1}{12} = \frac{4}{12} = \frac{1}{3}$$

$$C_{eq} = 3\,\mu\text{F}$$

Why other options are wrong:

- Option B: $8\,\mu$F is the average of the two capacitances.
- Option C: $16\,\mu$F would be the result of $C_1 + C_2$ (parallel, not series).
- Option D: $48\,\mu$F is the product $C_1 C_2$ without dividing by $(C_1 + C_2)$.

Final Answer: A

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Terminal Voltage: $V = \varepsilon - Ir$, where $I = \varepsilon/(R + r)$.

Calculation:

$$I = \frac{\varepsilon}{R + r} = \frac{12}{10 + 2} = 1\text{ A}$$

$$V = \varepsilon - Ir = 12 - 1 \times 2 = 10\text{ V}$$

Alternatively, $V = \varepsilon R/(R + r) = 12 \times 10/12 = 10$ V.

Why other options are wrong:

- Option A: 12 V is the EMF, which equals terminal voltage only if $r = 0$.
- Option B: 6 V occurs if $R = r$ (voltage halved), but here $R = 10\,\Omega \neq r$.
- Option C: 8 V has no basis with these values.

Final Answer: D

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Biot-Savart Law for Circular Loop: Every element $d\ell$ of the loop is perpendicular to $\hat{r}$ (pointing toward centre). Integrating over the full circumference $2\pi R$:

$$B = \frac{\mu_0 I}{4\pi R^2} \times 2\pi R = \frac{\mu_0 I}{2R}$$

Why other options are wrong:

- Option A: $\mu_0 I/R$ lacks the factor of 2 in denominator.
- Option B: $\mu_0 I/(4R)$ incorrectly halves the result.
- Option D: $\mu_0 I/(4\pi R)$ is the field due to a semi-infinite straight wire, not a loop.

Final Answer: C

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — Mutual Inductance: The induced EMF in the secondary coil is $\varepsilon = M\dfrac{dI}{dt}$.

Calculation:

$$\varepsilon = 0.5 \times 10 = 5 \text{ V}$$

Why other options are wrong:

- Option B: 0.05 V uses $M = 0.005$ H (a factor of 100 error).
- Option C: 20 V would need $M = 2$ H or $dI/dt = 40$ A/s.
- Option D: 50 V would need $M = 5$ H (ten times too large).

Final Answer: A

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Apparent Depth: When viewing an object in a denser medium from outside, $d_{\text{apparent}} = d_{\text{real}}/\mu$.

Calculation:

$$d_{\text{apparent}} = \frac{12}{4/3} = 12 \times \frac{3}{4} = 9 \text{ cm}$$

Why other options are wrong:

- Option A: 12 cm ignores refraction (no shift).
- Option C: 16 cm multiplies by μ instead of dividing.
- Option D: 6 cm uses $\mu = 2$ (incorrect for water).

Final Answer: B

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Single Slit Diffraction: First minimum occurs when $a \sin\theta = \lambda$.

Calculation:

$$\sin\theta = \frac{\lambda}{a} = \frac{500 \times 10^{-9}}{0.1 \times 10^{-3}} = \frac{5 \times 10^{-7}}{10^{-4}} = 5 \times 10^{-3}$$

Why other options are wrong:

- Option A: 2×10^{-3} uses $a = 0.25$ mm (wrong slit width).
- Option B: 10^{-2} is off by a factor of 2 ($a = 0.05$ mm assumed).
- Option D: 2.5×10^{-3} uses $\lambda = 250$ nm.

Final Answer: C

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Nuclear Conservation Laws: In any nuclear reaction, both mass number (A) and atomic number (Z) must be conserved.

Check with $^{4}_{3}\mathrm{He}$ (wrong):

$$\text{Mass number: } 238 = 234 + 4 \checkmark$$
$$\text{Atomic number: } 92 \neq 90 + 3 = 93 \quad \text{(VIOLATED)}$$

Why other options are wrong:

- Option A: Mass number A is still conserved: $238 = 234 + 4$.
- Option B: Momentum is a dynamical quantity, not violated by this error.
- Option C: Energy conservation is separate from the number error.

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

Answer: (D) Go Back to Q20

Q21.

Solution

Time of Flight for Projectile:

$$T = \frac{2u\sin\theta}{g} = \frac{2 \times 20 \times \sin 30}{10} = \frac{2 \times 20 \times 0.5}{10} = \frac{20}{10} = 2 \text{ s}$$

Final Answer: $\boxed{2}$ s

Answer: (2) Go Back to Q21

Q22.

Solution

Work Done by a Force:

$$W = Fd\cos\theta = 50 \times 4 \times \cos 60 = 200 \times 0.5 = 100 \text{ J}$$

Final Answer: $\boxed{100}$ J

Answer: (100) Go Back to Q22

Q23.

Solution

Angular Momentum of a Point Mass:

$$L = mvr = 2 \times 2 \times 3 = 12 \text{ kg} \cdot \text{m}^2/\text{s}$$

Final Answer: $\boxed{12}$ kg·m^2/s

Answer: (12) Go Back to Q23

Q24.

Solution

Linear Thermal Expansion:

$$\Delta L = L\alpha\Delta T = 2 \times 1.2 \times 10^{-5} \times 100 = 2.4 \times 10^{-3} \text{ m} = 2.4 \text{ mm}$$

Final Answer: $\boxed{2.4}$ mm

Answer: (2.4) Go Back to Q24

Q25.

Solution

Parallel Resistors:

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12} = \frac{3}{12} + \frac{2}{12} + \frac{1}{12} = \frac{6}{12} = \frac{1}{2}$$

$$R_{eq} = 2\,\Omega$$

Final Answer: $\boxed{2}$ Ω

Answer: (2) Go Back to Q25

Q26.

Solution

Capacitors in Series — Charge:

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{6 \times 3}{6 + 3} = \frac{18}{9} = 2\,\mu\text{F}$$

$$Q = C_{eq} \times V = 2 \times 12 = 24\,\mu\text{C}$$

Final Answer: $\boxed{24}$ μC

Answer: (24) Go Back to Q26

Q27.

Solution

Force on a Current-Carrying Conductor:

$$F = BIL \sin 90 = 3 \times 4 \times 0.5 = 6 \text{ N}$$

Final Answer: $\boxed{6}$ N

Answer: (6) Go Back to Q27

Q28.

Solution

Faraday's Law:

$$\varepsilon = N\frac{\Delta\Phi}{\Delta t} = 200 \times \frac{0.05 - 0.01}{0.02} = 200 \times \frac{0.04}{0.02} = 200 \times 2 = 400 \text{ V}$$

Final Answer: $\boxed{400}$ V

Answer: (400) Go Back to Q28

Q29.

Solution

Mirror Formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

With $u = -30$ cm and $f = -10$ cm:

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

$$v = -15 \text{ cm}, \qquad |v| = 15 \text{ cm}$$

Final Answer: $\boxed{15}$ cm

Answer: (15) Go Back to Q29

Q30.

Solution

Alpha Decay Chain: Each alpha particle decreases mass number by 4.

$$\Delta A = 238 - 206 = 32 = 4n \implies n = 8$$

Verification of atomic number: 8 alphas reduce Z by 16 (from 92 to 76), but $^{206}_{82}$Pb requires $Z = 82$. The remaining 10-unit discrepancy is handled by beta decays in reality; but this problem states only alpha decays are counted, and the mass number alone is used. With $\Delta A/4 = 8$, the answer is 8.

Final Answer: $\boxed{8}$

Answer: (8) Go Back to Q30

Q31.

Solution

Concept — Mole Concept: $n = \dfrac{\text{mass}}{\text{molar mass}}$.

Calculation:

$$n = \frac{9\ \text{g}}{18\ \text{g/mol}} = 0.5\ \text{mol}$$

Why other options are wrong:

- Option B: 1 mol would require 18 g.
- Option C: 2 mol would require 36 g.
- Option D: 9 mol confuses grams with moles.

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

Answer: (A) Go Back to Q31

Q32.

Solution

Concept — de Broglie Wavelength in Bohr Orbit: Bohr's quantisation condition: $m_e v r = n\hbar$, which means the circumference equals an integer number of de Broglie wavelengths: $2\pi r = n\lambda$.

For $n = 1$:

$$\lambda = \frac{2\pi r_1}{1} = 2\pi r_1$$

$$\lambda = 2\pi \times 0.529\,\text{Å} \approx 3.32\,\text{Å}$$

Why other options are wrong:

- Option A: $\lambda = r_1$ ignores the factor 2π.
- Option B: $\lambda = \pi r_1$ uses π instead of 2π.
- Option C: $4\pi r_1$ corresponds to $n = 2$, not $n = 1$.

Final Answer: D

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — VSEPR Theory: Five electron pairs (all bonding, no lone pairs) adopt a trigonal bipyramidal geometry to minimise repulsion.

Shape: Three equatorial P–Cl bonds at 120° and two axial bonds at 90° to the equatorial plane.

Why other options are wrong:

- Option A: Square planar requires 4 bond pairs + 2 lone pairs (d^2sp^3).
- Option C: Octahedral requires 6 bond pairs (e.g., SF_6).
- Option D: Tetrahedral requires 4 bond pairs (e.g., CH_4).

Final Answer: B

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Thermal Stability of Group-16 Hydrides: Bond dissociation enthalpy decreases down the group (bond length increases). Hence thermal stability decreases: $H_2O > H_2S > H_2Se > H_2Te$.

Why other options are wrong:

- Option A: H_2Te is the least stable, not most.
- Option B: H_2Se is third in stability.
- Option D: H_2S is second in stability.

Final Answer: C

Answer: (C) Go Back to Q34

Q35.

Solution

Concept — Reaction of Alkali Metals with Water: Sodium displaces hydrogen from water.

$$2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \uparrow$$

The gas evolved is **hydrogen gas** H_2.

Why other options are wrong:

- Option A: O_2 is not produced; hydrogen is displaced, not oxygen.
- Option B: O_3 (ozone) is not involved.
- Option C: Na_2O is a solid oxide formed differently, not a gas here.

Final Answer: D

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — Electronic Configuration and Unpaired Electrons: Mn^{2+}: [Ar] 3d^5. By Hund's rule, all five 3d orbitals are singly occupied (half-filled):

$$3d^5 : \underbrace{\uparrow \quad \uparrow \quad \uparrow \quad \uparrow \quad \uparrow}_{\text{5 unpaired}}$$

Magnetic moment: $\mu = \sqrt{5(5+2)}\,\mu_B = \sqrt{35}\,\mu_B \approx 5.92\,\mu_B$.

Why other options are wrong:

- Option B: 4 unpaired electrons corresponds to d^4 or low-spin d^6.
- Option C: 3 corresponds to d^3 or low-spin d^5.
- Option D: 2 corresponds to d^2 or certain low-spin complexes.

Final Answer: A

Answer: (A) Go Back to Q36

Q37.

Solution

Concept — Octahedral Crystal Field: The d-orbitals split into t_{2g} (lower energy, 3 orbitals) and e_g (higher energy, 2 orbitals).

d^6 **high-spin filling:** Fill with Hund's rule across all 5 orbitals first (5 electrons, one each), then the 6th goes to the lowest energy orbital (t_{2g}). So t_{2g} has 4 electrons, e_g has 2 electrons.

Why other options are wrong:

- Option A: e_g has only 2 electrons in high-spin d^6, not 4.
- Option B: The distribution is asymmetric (4 in t_{2g}, 2 in e_g).
- Option D: e_g cannot hold all 6 electrons; it has only 2 orbitals.

Final Answer: C

Answer: (C) Go Back to Q37

Q38.

Solution

Concept — Electromeric Effect: It is a **temporary** electronic displacement that occurs in π-bond systems when a reagent approaches the molecule. The effect vanishes once the reagent is removed.

Key characteristics:

- Occurs in π-bonds (C=C, C=O, etc.)
- Induced only in the presence of an attacking reagent
- Temporary (unlike the inductive effect, which is permanent)

Why other options are wrong:

- Option A: σ-bonds carry the inductive effect, not the electromeric effect.
- Option C: The electromeric effect is distinct from the inductive effect.
- Option D: Permanent polarity without a reagent describes the inductive effect.

Final Answer: B

Answer: (B) Go Back to Q38

Q39.

Solution

Concept — Markovnikov's Rule: In addition of HX to an unsymmetrical alkene, H attaches to the carbon bearing more hydrogen atoms (forming the more stable carbocation intermediate).

Application to propene:

$$\mathrm{CH_3 - \overset{C2}{C}H = \overset{C1}{C}H_2 + HBr}$$

C1 has 2 H atoms, C2 has 1 H atom. H^+ adds to C1, Br^- adds to C2 (more substituted, more stable secondary carbocation).

Product: $CH_3CHBrCH_3$ = **2-bromopropane**.

Why other options are wrong:

- Option B: 1-bromopropane is the anti-Markovnikov product (peroxide effect).
- Option C: Propyl alcohol requires a different reagent (not HBr).
- Option D: Propyne is an elimination product, not addition.

Final Answer: $\boxed{A}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept — SN1 Mechanism: The rate-determining step is ionisation to form a carbocation. More substituted (more stable) carbocations form faster.

Stability order: 3 carbocation $> 2 > 1$.

Therefore, SN1 reactivity: $3 > 2 > 1$.

Why other options are wrong:

- Option A: $1 > 2 > 3$ is the SN2 reactivity order (steric effects reversed).
- Option B and C: Invalid orderings inconsistent with carbocation stability.

Final Answer: $\boxed{D}$

Answer: (D) Go Back to Q40

Q41.

Solution

Concept — Oxidation of Alcohols: Secondary alcohols are oxidised to **ketones** by acidified $K_2Cr_2O_7$ or $KMnO_4$.

$$CH_3CHOHCH_3 \xrightarrow{K_2Cr_2O_7/H^+} CH_3COCH_3 \quad \text{(propanone)}$$

Why other options are wrong:

- Option A: Propan-1-ol is a primary alcohol; it would give propanal or propanoic acid on further oxidation.
- Option C: Propanal would be formed by oxidation of a primary alcohol (propan-1-ol).
- Option D: Propanoic acid requires over-oxidation of a primary alcohol.

Final Answer: B

Answer: (B) Go Back to Q41

Q42.

Solution

Concept — Cannizzaro Reaction: This is a base-induced disproportionation reaction. One molecule of aldehyde is oxidised to the corresponding acid/salt, and another is reduced to an alcohol.

Condition: The aldehyde must have **no α-hydrogen** atoms (otherwise aldol condensation occurs preferentially).

Examples: HCHO (formaldehyde), C_6H_5CHO (benzaldehyde), $(CH_3)_3CCHO$.

Why other options are wrong:

- Option A: In acidic medium, disproportionation does not occur; the Cannizzaro reaction requires strong base.
- Option B: Aldehydes with α-H undergo aldol condensation, not Cannizzaro.
- Option D: Ketones typically undergo other reactions under these conditions.

Final Answer: C

Answer: (C) Go Back to Q42

Q43.

Solution

Concept — Effect of Electron-Withdrawing Groups on Acidity: Cl is an electron-withdrawing group. More Cl atoms withdraw more electron density from the O–H bond, stabilising the carboxylate anion and increasing acidity.

Acidity order: $CCl_3COOH > CHCl_2COOH > CH_2ClCOOH > CH_3COOH$

Why other options are wrong:

- Option A: This is the reverse (increasing electron withdrawal should increase acidity).
- Option B: Places $CH_2ClCOOH$ above CCl_3COOH — incorrect.
- Option C: Places $CHCl_2COOH$ above CCl_3COOH — three Cl groups withdraw more than two.

Final Answer: D

Answer: (D) Go Back to Q43

Q44.

Solution

Concept — Hoffmann Bromamide Degradation: $RCONH_2$ is treated with Br_2 and NaOH to give a primary amine RNH_2 with one fewer carbon than the original amide.

$$RCONH_2 + Br_2 + 4NaOH \rightarrow RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

The carbonyl carbon is lost as carbonate (CO_3^{2-}).

Why other options are wrong:

- Option B: Bromination of nitrogen is an intermediate, not the final product.
- Option C: A secondary amine requires two organic groups on nitrogen; this reaction gives a primary amine.
- Option D: The product of the reaction is not a carboxylic acid; the $-CO-$ group is destroyed.

Final Answer: A

Answer: (A) Go Back to Q44

Q45.

Solution

Concept — Van't Hoff Factor: i = number of particles produced per formula unit on complete dissociation.

$$\mathrm{MgCl_2} \rightarrow \mathrm{Mg^{2+}} + 2\,\mathrm{Cl^-} \quad \Rightarrow 3 \text{ ions} \quad \Rightarrow i = 3$$

Why other options are wrong:

- Option A: $i = 1$ is for non-electrolytes (no dissociation).
- Option B: $i = 2$ corresponds to a 1:1 electrolyte like NaCl.
- Option D: $i = 4$ would require dissociation into 4 ions (e.g., $\mathrm{AlCl_3}$).

Final Answer: C

Answer: (C) Go Back to Q45

Q46.

Solution

Concept — Relationship between K_p and K_c:

$$K_p = K_c(RT)^{\Delta n_g}$$

where Δn_g = (moles of gaseous products) − (moles of gaseous reactants).

For $\mathrm{N_2 + 3H_2 \rightleftharpoons 2NH_3}$:

$$\Delta n_g = 2 - (1 + 3) = 2 - 4 = -2$$

$$K_p = K_c(RT)^{-2}$$

Why other options are wrong:

- Option A: $(RT)^{+2}$ uses wrong sign of Δn.
- Option C: $(RT)^4$ uses the total moles of reactants as exponent.
- Option D: $K_p = K_c$ only when $\Delta n_g = 0$.

Final Answer: B

Answer: (B) Go Back to Q46

Q47.

Solution

Concept — Zero-Order Reaction: Rate $= k$ (constant). Integrated rate law: $[\mathrm{A}] = [\mathrm{A}]_0 - kt$.

Half-life: At $t = t_{1/2}$, $[\mathrm{A}] = [\mathrm{A}]_0/2$:

$$\frac{[\mathrm{A}]_0}{2} = [\mathrm{A}]_0 - kt_{1/2} \implies t_{1/2} = \frac{[\mathrm{A}]_0}{2k}$$

$t_{1/2}$ is **directly proportional** to $[\mathrm{A}]_0$.

Why other options are wrong:

- Option A: Independence of $[\mathrm{A}]_0$ is the property of first-order reactions.
- Option B: $\ln 2/k$ is the first-order half-life formula.
- Option C: $1/(k[\mathrm{A}]_0)$ is the second-order half-life.

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

Answer: (D) Go Back to Q47

Q48.

Solution

Concept — Kohlrausch's Law: The molar conductivity at infinite dilution of an electrolyte equals the sum of the limiting ionic conductivities of its constituent ions.

$$\Lambda_m^\infty(\mathrm{CH_3COOH}) = \lambda^\infty(\mathrm{CH_3COO^-}) + \lambda^\infty(\mathrm{H^+})$$

This is useful because acetic acid is a weak acid and cannot be directly measured at infinite dilution.

Why other options are wrong:

- Option B: Subtraction has no physical basis.
- Option C: $\lambda^\infty(\mathrm{CH_3COOH})$ does not exist as a measurable quantity for a weak electrolyte.
- Option D: The combination of NaCl and HCl conductivities yields NaCl + HCl, which is not equivalent to $\mathrm{CH_3COOH}$ without accounting for $\mathrm{CH_3COONa}$.

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

Answer: (A) Go Back to Q48

Q49.

Solution

Concept — Freundlich Adsorption Isotherm: $x/m = kp^{1/n}$ where $n > 1$.

Behaviour:

- At low pressure: $x/m \propto p^{1/n}$, roughly linear.
- At high pressure: x/m tends to saturate (the empirical formula still applies but the exponent $1/n < 1$ means the rate of increase slows).

Why other options are wrong:

- Option A: x/m does not keep increasing linearly; $1/n < 1$ causes sub-linear growth.
- Option B: At low pressure, x/m does depend on pressure.
- Option D: Freundlich isotherm applies to both physisorption and chemisorption.

Final Answer: C

Answer: (C) Go Back to Q49

Q50.

Solution

Concept — Non-Reducing Sugars: A disaccharide is non-reducing if its two monosaccharide units are joined through both anomeric carbons (C-1 of glucose and C-2 of fructose), leaving no free hemiacetal/hemiketal group.

Sucrose: Glucose (C-1, α) joined to fructose (C-2, β) — both anomeric carbons are involved in the glycosidic bond. No free aldehyde or ketone group is available to reduce Fehling's solution.

Why other options are wrong:

- Option A: Sucrose contains both glucose and fructose.
- Option C: Sucrose is very soluble in water.
- Option D: Sucrose has many hydroxyl groups; the issue is the anomeric carbon, not absence of –OH.

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

Answer: (B) Go Back to Q50

Q51.

Solution

Raoult's Law: $P_{\text{solution}} = x_1 P = (1 - x_2)P$

$$P_{\text{solution}} = (1 - 0.25) \times 400 = 0.75 \times 400 = 300 \text{ mmHg}$$

Final Answer: $\boxed{300}$ mmHg

Answer: (300) Go Back to Q51

Q52.

Solution

Henderson-Hasselbalch Equation: $\text{pH} = \text{pKa} + \log \dfrac{[\text{salt}]}{[\text{acid}]}$

$$\text{pH} = 4 + \log(100) = 4 + 2 = 6$$

Final Answer: $\boxed{6}$

Answer: (6) Go Back to Q52

Q53.

Solution

Ideal Gas Law: $PV = nRT$

$$V = \frac{nRT}{P} = \frac{1 \times 8.314 \times 300}{100 \times 10^3} \text{ m}^3 = \frac{2494.2}{100000} = 0.02494 \text{ m}^3 = 24.9 \text{ L} \approx 25 \text{ L}$$

Final Answer: $\boxed{25}$ L

Answer: (25) Go Back to Q53

Q54.

Solution

Energy from Combustion:

$$Q = n \times |\Delta H_c| = 2 \times 890 = 1780 \text{ kJ}$$

Final Answer: $\boxed{1780}$ kJ

Answer: (1780) Go Back to Q54

Q55.

Solution

Oxidation State of Cr in $K_2Cr_2O_7$:

$$2(+1) + 2x + 7(-2) = 0 \implies 2 + 2x - 14 = 0 \implies 2x = 12 \implies x = +6$$

Final Answer: $\boxed{6}$

Answer: (6) Go Back to Q55

Q56.

Solution

Faraday's First Law of Electrolysis: $m = \dfrac{M \times Q}{n_e \times F}$

$$m = \frac{108 \times 96500}{1 \times 96500} = 108 \text{ g}$$

Final Answer: $\boxed{108}$ g

Answer: (108) Go Back to Q56

Q57.

Solution

Arrhenius Equation:

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\ln \frac{2 \times 10^{-1}}{2 \times 10^{-3}} = \ln 100 = 4.606$$

$$\frac{1}{300} - \frac{1}{400} = \frac{4-3}{1200} = \frac{1}{1200}\ \text{K}^{-1}$$

$$E_a = \frac{4.606 \times 8.314}{\frac{1}{1200}} = 4.606 \times 8.314 \times 1200 = 45{,}940\ \text{J/mol} \approx 46\ \text{kJ/mol}$$

Final Answer: $\boxed{46}$ kJ/mol

Answer: (46) Go Back to Q57

Q58.

Solution

Radioactive Decay: After n half-lives, activity $= A_0 \times (1/2)^n$.

Number of half-lives in 60 years $= 60/20 = 3$.

$$A = 800 \times \left(\frac{1}{2}\right)^3 = 800 \times \frac{1}{8} = 100\ \text{dps}$$

Final Answer: $\boxed{100}$ dps

Answer: (100) Go Back to Q58

Q59.

Solution

Coordination Number: In $[\text{Fe(CN)}_6]^{3-}$, six CN^- ligands surround the central Fe ion. The coordination number is 6 (octahedral geometry).

Final Answer: $\boxed{6}$

Answer: (6) Go Back to Q59

Q60.

Solution

Freezing Point Depression: $\Delta T_f = i \times K_f \times m$

$$\Delta T_f = 1 \times 1 \times 10 = 10\ \text{K}$$

Final Answer: $\boxed{10}$ K

Answer: (10) Go Back to Q60

Q61.

Solution

Concept — Modulus of a Complex Number: $|a+bi| = \sqrt{a^2+b^2}$.

$$|3+4i| = \sqrt{3^2+4^2} = \sqrt{9+16} = \sqrt{25} = 5$$

Why other options are wrong:

- Option A: 3 is only the real part.
- Option B: 4 is only the imaginary part.
- Option D: 7 = 3+4 (adds components instead of using Pythagoras).

Final Answer: C

Answer: (C) Go Back to Q61

Q62.

Solution

Concept — Vieta's Formulas: For $x^2 - 5x + 6 = 0$: $\alpha + \beta = 5$, $\alpha\beta = 6$.

Calculation:

$$\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta = 25 - 12 = 13$$

Why other options are wrong:

- Option B: $25 = (\alpha+\beta)^2$ (forgetting to subtract $2\alpha\beta$).
- Option C: $12 = 2\alpha\beta$ (subtracted from nothing).
- Option D: $36 = (\alpha\beta)^2$ (squares the product instead).

Final Answer: A

Answer: (A) Go Back to Q62

Q63.

Solution

Concept — Sum of AP: $S_n = \frac{n}{2}[2a + (n-1)d]$.

Calculation with $a = 1$, $d = 2$, $n = 10$:

$$S_{10} = \frac{10}{2}[2(1) + 9(2)] = 5[2 + 18] = 5 \times 20 = 100$$

Why other options are wrong:

- Option A: 50 uses $n = 5$ or forgets the second term.
- Option B: 55 corresponds to $a = 1$, $d = 1$ (sum of first 10 natural numbers).
- Option C: 90 arises from $5 \times [2 + 16] = 5 \times 18$ (using $d = 1.8$, error).

Final Answer: D

Answer: (D) Go Back to Q63

Q64.

Solution

Concept — Circular Permutations: For n distinct objects in a circle, the number of arrangements is $(n-1)!$ (one position fixed to eliminate rotational duplicates).

Calculation:

$$(6-1)! = 5! = 120$$

Why other options are wrong:

- Option A: $720 = 6!$ counts linear arrangements, overcounting by a factor of 6.
- Option C: $360 = 6!/2$ accounts for reflection symmetry (which was not asked).
- Option D: $24 = 4!$ uses $n = 4$ instead of $n = 6$.

Final Answer: B

Answer: (B) Go Back to Q64

Q65.

Solution

Concept — Sum of Binomial Coefficients: Setting $x = 1$ in $(1 + x)^n$ gives the sum of all coefficients $= 2^n$.

Calculation with $n = 8$:

$$2^8 = 256$$

Why other options are wrong:

- Option A: $128 = 2^7$ (uses $n = 7$).
- Option B: $512 = 2^9$ (uses $n = 9$).
- Option D: $64 = 2^6$ (uses $n = 6$).

Final Answer: C

Answer: (C) Go Back to Q65

Q66.

Solution

Concept — Determinant of a 2×2 Matrix: $\det \begin{pmatrix} a & b \\ c & d \end{pmatrix} = ad - bc$.

Calculation:

$$\det \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix} = 2 \times 4 - 1 \times 3 = 8 - 3 = 5$$

Why other options are wrong:

- Option B: 11 adds $ad + bc = 8 + 3$ instead of subtracting.
- Option C: 8 is only ad (omits $-bc$).
- Option D: -5 reverses the sign of the correct answer.

Final Answer: A

Answer: (A) Go Back to Q66

Q67.

Solution

Concept — Triple Angle Formula for Cosine:

$$\cos 3A = 4\cos^3 A - 3\cos A$$

Derivation sketch: $\cos 3A = \cos(2A + A) = \cos 2A \cos A - \sin 2A \sin A$. Expanding and using $\cos 2A = 2\cos^2 A - 1$ and $\sin 2A = 2\sin A \cos A$:

$$= (2\cos^2 A - 1)\cos A - 2\sin^2 A \cos A = 2\cos^3 A - \cos A - 2(1 - \cos^2 A)\cos A = 4\cos^3 A - 3\cos A$$

Why other options are wrong:

- Option A: $3\cos A - 4\cos^3 A$ is the negative of the correct formula.
- Option B: $4\cos^3 A + 3\cos A$ has the wrong sign on the linear term.
- Option C: Mixes sine and cosine terms incorrectly.

Final Answer: D

Answer: (D) Go Back to Q67

Q68.

Solution

Concept — Principal Value Branch of $\arctan$: The function $\tan x$ is bijective on the open interval $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$. The inverse is defined with this as its range.

Range of $y = \arctan x$: $y \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ (open interval, endpoints excluded because $\tan \to \pm\infty$).

Why other options are wrong:

- Option A: $[0, \pi]$ is the range of $\arccos$.
- Option C: $[-\pi/2, \pi/2]$ includes the endpoints, but $\arctan$ never reaches $\pm\pi/2$.
- Option D: $(0, \pi)$ is the range of $\arccos$ (without endpoints).

Final Answer: B

Answer: (B) Go Back to Q68

Q69.

Solution

Concept — Equation of a Line through Two Points:

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6-2}{3-1} = \frac{4}{2} = 2$$

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

Why other options are wrong:

- Option A: $y = x + 1$ gives slope 1 and passes through $(1, 2)$ but not $(3, 6)$ (gives $y = 4$, not 6).
- Option B: $y = 3x - 1$ gives $y(1) = 2$✓but $y(3) = 8 \neq 6$.
- Option D: $y = x + 2$ gives $y(1) = 3 \neq 2$.

Final Answer: C

Answer: (C) Go Back to Q69

Q70.

Solution

Concept — General Equation of a Circle: $x^2 + y^2 + 2gx + 2fy + c = 0$ has centre $(-g, -f)$.

From $x^2 + y^2 - 4x + 6y - 3 = 0$**:** $2g = -4 \Rightarrow g = -2$; $2f = 6 \Rightarrow f = 3$.

$$\text{Centre} = (-g, -f) = (2, -3)$$

Why other options are wrong:

- Option B: $(-2, 3)$ uses the coefficients g and f directly without negating.
- Option C: $(4, -6)$ uses the coefficients $2g$ and $2f$ directly.
- Option D: $(2, 3)$ negates g correctly but misses the sign of f.

Final Answer: A

Answer: (A) Go Back to Q70

Q71.

Solution

Concept — Eccentricity of Ellipse: $e = c/a$ where $c^2 = a^2 - b^2$.

From $\frac{x^2}{25} + \frac{y^2}{16} = 1$**:** $a^2 = 25$, $b^2 = 16$.

$$c^2 = 25 - 16 = 9 \implies c = 3$$

$$e = \frac{c}{a} = \frac{3}{5}$$

Why other options are wrong:

- Option A: $1/5$ uses $c = 1$ (incorrect).
- Option B: $4/5$ uses b as c ($b/a = 4/5$, but $b \neq c$).
- Option C: $5/3$ is greater than 1 and cannot be an eccentricity of an ellipse.

Final Answer: D

Answer: (D) Go Back to Q71

Q72.

Solution

Concept — Latus Rectum of Parabola: For $y^2 = 4ax$, length of latus rectum $= 4a$.

From $y^2 = 12x$**:** $4a = 12$, so $a = 3$.

$$\text{Latus rectum} = 4a = 12$$

Why other options are wrong:

- Option A: 3 is the value of a, not the latus rectum length.
- Option C: 6 $= 2a$ (semi-latus rectum).
- Option D: 4 would imply $a = 1$, i.e., $y^2 = 4x$.

Final Answer: B

Answer: (B) Go Back to Q72

Q73.

Solution

Concept — Standard Limit: $\lim_{u\to 0}\dfrac{\sin u}{u}=1$.

Application: Let $u=5x$; as $x\to 0$, $u\to 0$.

$$\lim_{x\to 0}\frac{\sin 5x}{5x}=\lim_{u\to 0}\frac{\sin u}{u}=1$$

Why other options are wrong:

- Option A: 5 would result from $\lim\dfrac{\sin 5x}{x}=5$ (without the factor of 5 in denominator).
- Option B: 0 is incorrect; the numerator and denominator both approach 0 at the same rate.
- Option D: $1/5$ results from the inverse $\lim\dfrac{x}{\sin 5x}\cdot\dfrac{1}{5}$ (wrong form).

Final Answer: C

Answer: (C) Go Back to Q73

Q74.

Solution

Concept — Quotient Rule: $\dfrac{d}{dx}\left(\dfrac{u}{v}\right)=\dfrac{v\,u'-u\,v'}{v^2}$.

With $u=\sin x$, $v=x$:

$$u'=\cos x,\quad v'=1$$

$$\frac{d}{dx}\left(\frac{\sin x}{x}\right)=\frac{x\cos x-\sin x\cdot 1}{x^2}=\frac{x\cos x-\sin x}{x^2}$$

Why other options are wrong:

- Option B: $\cos x/x+\sin x$ is algebraically wrong.
- Option C: $+$ sign in numerator is wrong (should be $-$ from $vu'-uv'$).
- Option D: $\cos x$ is the derivative of $\sin x$ alone, ignoring the $1/x$ factor.

Final Answer: A

Answer: (A) Go Back to Q74

Q75.

Solution

Concept — Finding Maximum Using Derivatives:

$$f(x) = xe^{-x} \implies f'(x) = e^{-x} - xe^{-x} = e^{-x}(1-x)$$

Critical point: $f'(x) = 0 \implies 1 - x = 0 \implies x = 1$.

Second derivative test:

$$f''(x) = -e^{-x}(1-x) + e^{-x}(-1) = e^{-x}(x-2)$$

$$f''(1) = e^{-1}(1-2) = -e^{-1} < 0 \implies \text{local maximum}$$

Maximum value: $f(1) = 1 \cdot e^{-1} = 1/e$.

Why other options are wrong:

- Option A: e is greater than 1, but $f(x) = xe^{-x} \to 0$ as $x \to \infty$.
- Option B: 1 would require $x \cdot e^{-x} = 1$, which has no real solution for a maximum.
- Option C: $e^{-2} = f(2) = 2e^{-2} \neq e^{-2}$ (incorrect evaluation).

Final Answer: D

Answer: (D) Go Back to Q75

Q76.

Solution

Concept — Integration of $\cos^2 x$: Use half-angle identity $\cos^2 x = \dfrac{1+\cos 2x}{2}$.

$$\int \cos^2 x\, dx = \int \frac{1+\cos 2x}{2}\, dx = \frac{x}{2} + \frac{\sin 2x}{4} + C$$

Why other options are wrong:

- Option A: $\dfrac{\sin 2x}{4} + C$ omits the $x/2$ term.
- Option C: Negative sign before $x/2$ and $\cos 2x$ in second term are both wrong.
- Option D: $\dfrac{\cos^3 x}{3}$ is the integral of $-\cos^2 x \sin x$, not $\cos^2 x$.

Final Answer: B

Answer: (B) Go Back to Q76

Q77.

Solution

Concept — Definite Integral of $\sin^2 x$:

$$\int_0^{\pi/2} \sin^2 x\, dx = \int_0^{\pi/2} \frac{1-\cos 2x}{2}\, dx = \left[\frac{x}{2} - \frac{\sin 2x}{4}\right]_0^{\pi/2}$$

$$= \left(\frac{\pi/2}{2} - \frac{\sin \pi}{4}\right) - (0-0) = \frac{\pi}{4} - 0 = \frac{\pi}{4}$$

Why other options are wrong:

- Option A: 1 is the average value scaled incorrectly.
- Option B: $\pi/2$ is the length of the interval, not the integral.
- Option D: $1/2$ is the average value of $\sin^2 x$ (not the definite integral over $[0, \pi/2]$).

Final Answer: C

Answer: (C) Go Back to Q77

Q78.

Solution

Concept — Addition Rule of Probability:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{3} + \frac{1}{2} - \frac{1}{6}$$

$$= \frac{2}{6} + \frac{3}{6} - \frac{1}{6} = \frac{4}{6} = \frac{2}{3}$$

Why other options are wrong:

- Option B: $5/6 = 1/3 + 1/2 = 5/6$ omits subtracting $P(A \cap B)$.
- Option C: $1/3$ is just $P(A)$.
- Option D: 1 is impossible since $P(A \cup B) \leq 1$ and the intersection means events are not mutually exclusive.

Final Answer: A

Answer: (A) Go Back to Q78

Q79.

Solution

Concept — Parallel Vectors: $\vec{a} \parallel \vec{b}$ iff $\vec{a} \times \vec{b} = \vec{0}$, i.e., $\dfrac{a_1}{b_1} = \dfrac{a_2}{b_2}$.

Condition:

$$\frac{2}{k} = \frac{3}{6} = \frac{1}{2} \implies k = 4$$

Alternatively: $\vec{a} \times \vec{b} = (2 \cdot 6 - 3 \cdot k)\hat{k} = (12 - 3k)\hat{k} = \vec{0} \implies k = 4$.

Why other options are wrong:

- Option A: $k = 1$ gives $\vec{b} = \hat{i} + 6\hat{j}$; ratio $6/1 \neq 3/2$.
- Option B: $k = 3$ gives ratio $6/3 = 2 \neq 3/2$.
- Option C: $k = 6$ gives ratio $6/6 = 1 \neq 3/2$.

Final Answer: D

Answer: (D) Go Back to Q79

Q80.

Solution

Concept — Distance from Point to Plane: $d = \dfrac{|ax_0 + by_0 + cz_0 + d|}{\sqrt{a^2 + b^2 + c^2}}$.

Plane $x + 2y - 2z + 5 = 0$**, Point** $(1, 2, 3)$**:**

$$\text{Numerator: } |1 + 2(2) - 2(3) + 5| = |1 + 4 - 6 + 5| = |4| = 4$$

$$\text{Denominator: } \sqrt{1^2 + 2^2 + (-2)^2} = \sqrt{1 + 4 + 4} = \sqrt{9} = 3$$

$$d = \frac{4}{3}$$

Why other options are wrong:

- Option A: $2/3$ uses numerator 2 (arithmetic error in $|1 + 4 - 6 + 5|$).
- Option C: 1 corresponds to $d = 3/3$ (wrong numerator).
- Option D: $5/3$ uses numerator 5 (omits the subtraction of $2(3)$).

Final Answer: B

Answer: (B) Go Back to Q80

Q81.

Solution

Modulus Squared:

$$|z|^2 = 4^2 + 3^2 = 16 + 9 = 25$$

Final Answer: $\boxed{25}$

Answer: (25) Go Back to Q81

Q82.

Solution

Sum of AP:

$$S_{10} = \frac{10}{2}[2(3) + 9(4)] = 5[6 + 36] = 5 \times 42 = 210$$

Final Answer: $\boxed{210}$

Answer: (210) Go Back to Q82

Q83.

Solution

Upper Triangular Determinant: Product of diagonal elements.

$$\begin{vmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{vmatrix} = 1 \times 4 \times 6 = 24$$

Final Answer: $\boxed{24}$

Answer: (24) Go Back to Q83

Q84.

Solution

Combinations:

$$\binom{5}{3} = \frac{5!}{3!\,2!} = \frac{5 \times 4}{2} = 10$$

Final Answer: $\boxed{10}$

Answer: (10) Go Back to Q84

Q85.

Solution

Definite Integral:

$$\int_0^1 x^3\,dx = \left[\frac{x^4}{4}\right]_0^1 = \frac{1}{4} - 0 = 0.25$$

Final Answer: $\boxed{0.25}$

Answer: (0.25) Go Back to Q85

Q86.

Solution

Derivative:

$$f'(x) = 6x - 2 \implies f'(2) = 6(2) - 2 = 12 - 2 = 10$$

Final Answer: $\boxed{10}$

Answer: (10) Go Back to Q86

Q87.

Solution

Area Under Curve:

$$\int_0^3 x^2\,dx = \left[\frac{x^3}{3}\right]_0^3 = \frac{27}{3} - 0 = 9 \text{ sq. units}$$

Final Answer: $\boxed{9}$

Answer: (9) Go Back to Q87

Q88.

Solution

Distance Formula in 3D:

$$d = \sqrt{(4-1)^2 + (6-2)^2 + (3-3)^2} = \sqrt{9 + 16 + 0} = \sqrt{25} = 5$$

Final Answer: $\boxed{5}$

Answer: (5) Go Back to Q88

Q89.

Solution

Arithmetic Mean:

$$\bar{x} = \frac{2+4+6+8+10}{5} = \frac{30}{5} = 6$$

Final Answer: $\boxed{6}$

Answer: (6) Go Back to Q89

Q90.

Solution

Trace of a Matrix: Sum of diagonal elements.

$$\text{tr}(A) = 3 + 5 = 8$$

Final Answer: $\boxed{8}$

Answer: (8) Go Back to Q90

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	D	3	A	4	C	5	A
6	B	7	D	8	C	9	B	10	A
11	C	12	D	13	B	14	A	15	D
16	C	17	A	18	B	19	C	20	D
21	2	22	100	23	12	24	2.4	25	2
26	24	27	6	28	400	29	15	30	8
31	A	32	D	33	B	34	C	35	D
36	A	37	C	38	B	39	A	40	D
41	B	42	C	43	D	44	A	45	C
46	B	47	D	48	A	49	C	50	B
51	300	52	6	53	25	54	1780	55	6
56	108	57	46	58	100	59	6	60	10
61	C	62	A	63	D	64	B	65	C
66	A	67	D	68	B	69	C	70	A
71	D	72	B	73	C	74	A	75	D
76	B	77	C	78	A	79	D	80	B
81	25	82	210	83	24	84	10	85	0.25
86	10	87	9	88	5	89	6	90	8