1. Match the following List I with List II. **C**

List-I	List-II
(a) Planks constant (h)	(1) $[M^{-1}L^{-2}A^{2}T^{4}]$
(b) Permeability of free space (μ_0)	(2) $[MLT^{-2}A^{-2}]$
(c) Universal gravitational constant (G)	(3) $[ML^{2}T^{-1}]$
(d) Capacitance	(4) $[M^{-1}L^{3}T^{-2}]$

a-4, b-1, c-3, d-2

a-3, b-1, c-4, d-2

a-3, b-2, c-4, d-1

a-3, b-4, c-1, d-2

Sol.

Planks constant (h) = $\frac{E}{v} = \left[ML^2T^{-1}\right]$

Permeability of free space $(\mu_0) \Rightarrow F = \frac{\mu_0 I_1 I_2}{2r}$

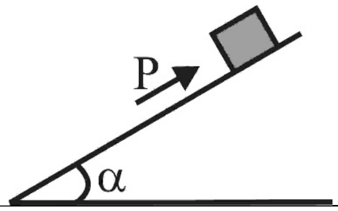
$$\Rightarrow \mu_0 = \frac{F(2r)}{I_1 I_2} = \left[MLT^{-2}A^{-2}\right]$$

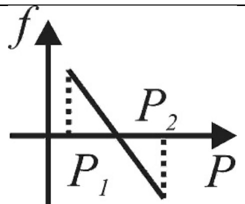
Universal gravitational constant G $\Rightarrow F = \frac{Gm_1m_2}{r^2}$

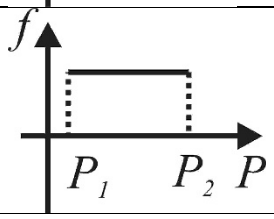
$$\Rightarrow [G] = \frac{Fr^2}{m_1m_2} = \left[M^{-1}L^3T^{-2}\right]$$

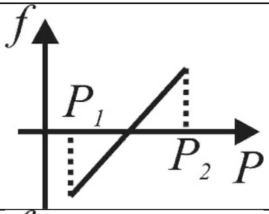
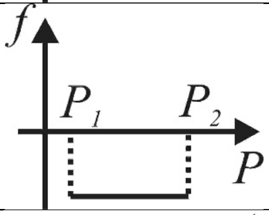
Capacitance C = $\frac{Q}{V} = \frac{[AT]}{\left[ML^2T^{-3}A^{-1}\right]} = \left[M^{-1}L^{-2}T^4A^2\right]$

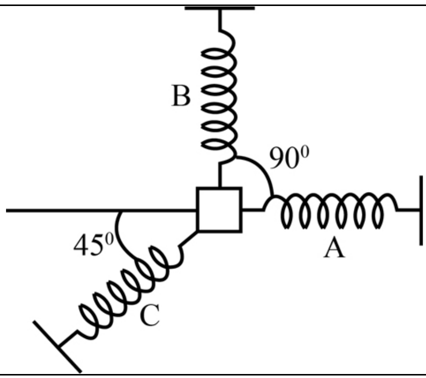
2. Block of mass M is on inclined plane of an angle α The coefficient of friction between the block and plane is μ and tan α> μ. Block is held stationary by applying a force P parallel to the plane. Direction of force pointing up the plane is taken to be positive. As P is varied from P_1 = mg (sin α – μ cosα) to P_2 = mg (sin α + μ cosα), the frictional force f versus P graph looks like: **A**







		
		
Sol.	When $P = mg(\sin\theta - \mu\cos\theta)$ $f = \mu mg\cos\theta$ (upwards) When $P = mg\sin\theta$ $f = 0$ and when $P = mg(\sin\theta + \mu\cos\theta)$ $f = \mu mg\cos\theta$ (downwards) Hence friction is first positive, then zero and then negative.	
3.	Two objects P and Q, travelling in the same direction start from rest. While the object P starts at time t = 0 and object Q starts later at t = 30 min . Object P has an acceleration of 40 km/h^2. To catch P at a distance of 20 km, the acceleration of Q should be	**D**
	40 km/hr^2	
	80 km/hr^2	
	100 km/hr^2	
	160 km/hr^2	
Sol.	P starts $t = 0\ Q_p = 40\ km/hr^2$ Time taken by P to cover 20 km, $S = ut + \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2\times 20}{40}} = 1 hour$ Time taken by $Q = 1 - \frac{1}{2} hour = 30 \min = \frac{1}{2} hr$ $\therefore a_Q = \frac{2s}{t^2} = \frac{2\times 20}{\left(\frac{1}{2}\right)^2} = 160\ km/hr^2$	
4.	A particle of mass m is attached to three springs A, B, C as shown in figure. The force constant (2K) of A, B, C are same. If the particle is pushed slightly against spring C and released, find time period of oscillation	**C**



$2\pi\sqrt{\frac{m}{K}}$

$2\pi\sqrt{\frac{m}{2K}}$

$\pi\sqrt{\frac{m}{K}}$

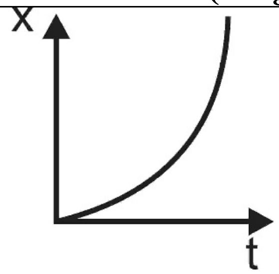
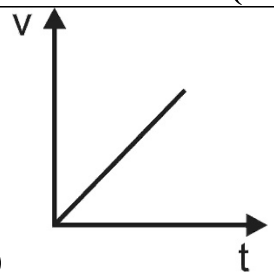
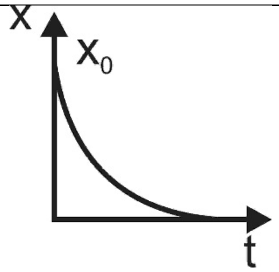
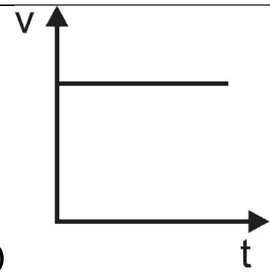
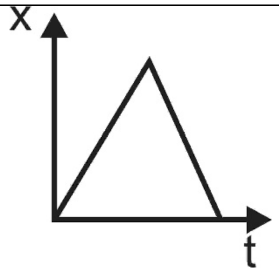
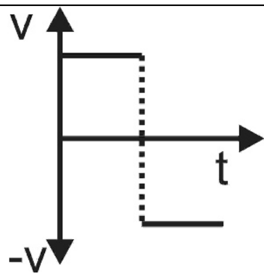
$\pi\sqrt{\frac{m}{2K}}$

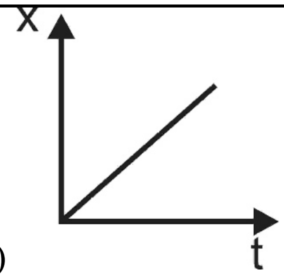
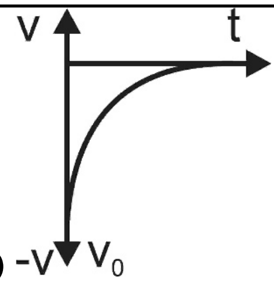
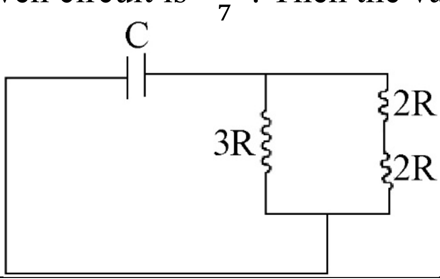
Sol. Let us push particle against spring C through displacement 'x'
Force on particle due to springs A,B,C are

$$F_C = (2K)x;\;\; F_A = F_B = (2K)\frac{x}{\sqrt{2}}$$

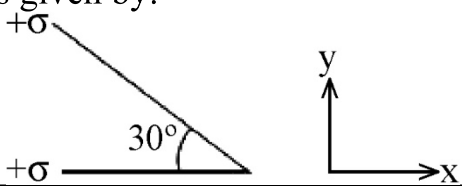
Total resultant force

5. Match Column-I with Column-II **A**

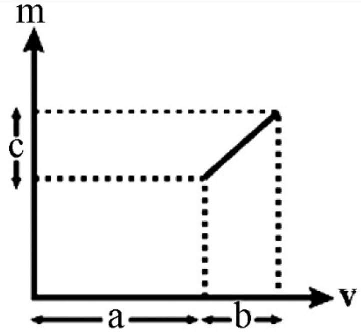
Column-I (x-t graph)	**Column-II (v-t graph)**
 (A)	 (I)
 (B)	 (II)
 (C)	 (III)

	 (D)	
	(IV)  	
	A – I, B – IV, C – III, D – II	
	A – I, B – II, C – III, D – IV	
	A – II, B – III, C – IV, D – I	
	A – I, B – III, C – IV, D – II	
Ans.	A – I, B – IV, C – III, D – II	
6.	The time constant of given circuit is $\frac{KRC}{7}$. Then the value of K is ----------  	**B**
	10	
	12	
	14	
	16	
Sol.	$\therefore R_{eq} = \frac{3R \times 4R}{3R + 4R} = \frac{12R}{7}$ $J = R_{eq} C = \frac{12RC}{7} \Rightarrow K = 12$	
7.	Hydrogen atom from excited state comes to the ground by emitting a photon of wavelength λ. The value of principal quantum number 'n' of the excited state will be (R : Rydberg constant)	**B**
	$\sqrt{\frac{\lambda R}{\lambda - 1}}$	
	$\sqrt{\frac{\lambda R}{\lambda R - 1}}$	
	$\sqrt{\frac{\lambda}{\lambda R - 1}}$	
	$\sqrt{\frac{\lambda R^2}{\lambda R - 1}}$	
Sol.	$\sqrt{\frac{\lambda R}{\lambda R - 1}}$	
8.	A thin circular ring of mass M and radius r is rotating about its axis with angular speed ω. Two particles of mass m each are now attached at	**B**

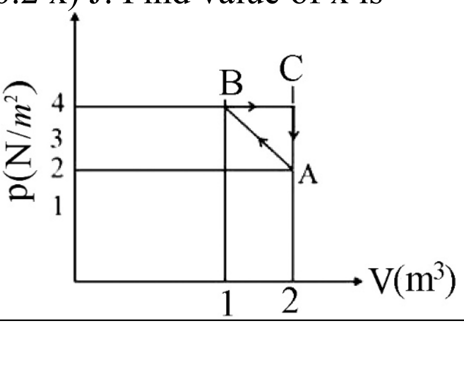
	diametrically opposite points. The angular speed of ring will become	
	$\left(\frac{M-2m}{M+2m}\right)$	
	$\left(\frac{M}{M+2m}\right)\omega$	
	$\frac{M\omega}{M+m}$	
	$\left(\frac{M+2m}{M}\right)\omega$	
Sol.	Conservation of angular momentum $\left(Mr^2\right)\omega=\left(Mr^2+2mr^2\right)\omega^1 \Rightarrow \omega^1=\frac{M\omega}{M+2m}$	
9.	For charging the capacitance of given parallel plate capacitor, a dielectric material of dielectric constant K is used, which has the same area as plates of capacitor. The thickness of dielectric slab is $\frac{3}{4}$d, where d is the separation between the plates of parallel plate capacitor. The new capacitance (C′) in terms of original capacitance (C_0) is given by	**A**
	$C'=\frac{4KC_0}{K+3}$	
	$C'=\frac{(4+K)}{3}C_0$	
	$C'=\frac{4C_0}{3+K}$	
	$C'=\frac{(3+K)}{4K}C_0$	
Sol.	$C_0=\frac{A\in_0}{d}$ $C^1=\frac{C_1C_2}{C_1+C_2}$ (or) $\frac{1}{C^1}=\frac{1}{C_1}+\frac{1}{C_2}$ $\quad C_1=\frac{KA\varepsilon_0}{(3d/4)}\, C_2=\frac{A\varepsilon_0}{(d/4)}$ $\frac{1}{C^1}=\frac{3d/4}{KA\varepsilon_0}+\frac{d/4}{A\varepsilon_0}$ $\quad \Rightarrow C^1=\frac{4KC_0}{3+K}$	
10.	A conducting wire of length '*l*', Area of cross section A and electrical resistivity ρ is connected between the terminals of battery. A potential difference V is developed between its ends, causing an electric current. If the length of wire of same material is doubled and area of cross section is halved, the resultant current would be	**B**
	$\frac{1}{4}\frac{\rho l}{VA}$	
	$\frac{1}{4}\frac{VA}{\rho l}$	
	$\frac{3}{4}\frac{VA}{\rho l}$	
	$4\frac{VA}{\rho l}$	

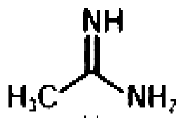
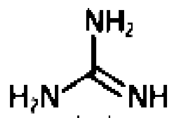
Sol.	Resistance $R = \frac{\rho l}{A}$ (original) A/c to question resistance $= \frac{\rho(2l)}{A/2} = \frac{4\rho l}{A}$ $\Rightarrow I = \frac{V}{R} = \frac{VA}{4\rho l}$	
11.	A particle is displaced from (2,0,2) to (5,4,2) under influence of force $F = 6\hat{\imath} + 8\hat{\jmath}$. If W is work done (in J) then what is value of W/10?	**B**
	3	
	5	
	6	
	7	
Sol.	$W = \overline{F}.\overline{ds}$ $\overline{ds} = (5-2)\hat{i} + (4-0)\hat{j} + (2-2)\hat{k} = 3\hat{i} + 4\hat{j}$ W = $\left(6\hat{i} + 8\hat{j}\right).\left(3\hat{i} + 4\hat{j}\right)$ = 18 + 32 = 50J	
12.	Two infinite sheets each with uniform charge density +σ are kept in such a way that the angle between them is 30º. The electric field in the region shown between them is given by: 	**B**
	$\frac{\sigma}{2\varepsilon_0}\left[(1+\sqrt{3})\hat{y} - \frac{\hat{x}}{2}\right]$	
	$\frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y} - \frac{\hat{x}}{2}\right]$	
	$\frac{\sigma}{\varepsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y} + \frac{\hat{x}}{2}\right]$	
	$\frac{\sigma}{2\varepsilon_0}\left[(1+\sqrt{3})\hat{y} + \frac{\hat{x}}{2}\right]$	
Sol.	Electric field due to infinite sheet $\overline{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}$ $\hat{E}_1 = -\cos 60^0 \hat{x} - \sin 60^0 \hat{y} = -\frac{\hat{x}}{2} - \frac{\sqrt{3}}{2}\hat{y}$ $\hat{E}_2 = \frac{\sigma}{2\varepsilon_0}\hat{y}$ $\overline{E_1} + \overline{E_2} = \frac{\sigma}{2\varepsilon_0}\hat{E} + \frac{\sigma}{2\varepsilon_0}\hat{E}_L = \frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y} - \frac{\hat{x}}{2}\right]$	
13.	A metallic conductor of length 1 m rotates in a vertical plane to East-West direction about one of its end with angular velocity 10 rad/sec. If the horizontal component of earth's magnetic field is 0.2×10^{-4} T, then the emf induced between two ends of conductor is	**D**
	50 μV	

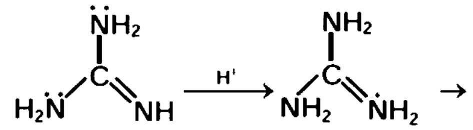
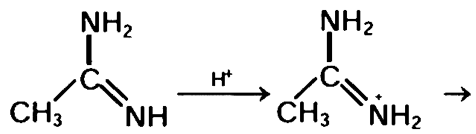
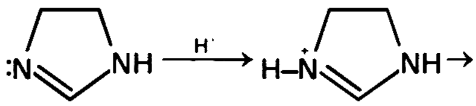
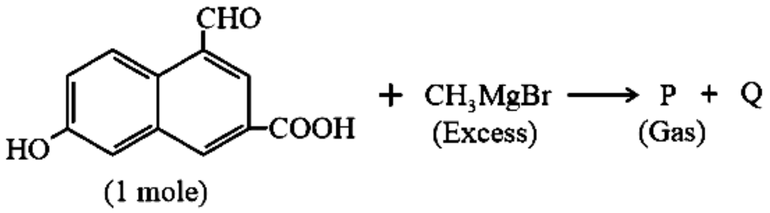
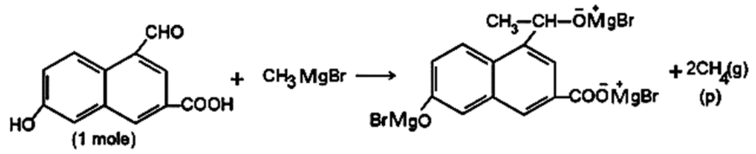
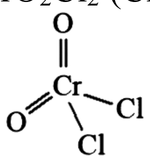
	100 mV	
	50 mV	
	100 μV	
Sol.	$\varepsilon = \frac{1}{2} B \omega l^2 \quad = \frac{1}{2} \times 0.2 \times 10^{-4} \times 10 \times 1^2 = 10^{-4}\text{ V} = 100\ \mu V$	
14.	A polarizer–Analyser set is adjusted such that the intensity of light coming out of analyser is just 10% of original intensity. Assume that polariser–Analyser set doesnot absorb any light, the angle by which analyser need to rotated further to reduce the output intensity to be zero, is :	**C**
	71.6°	
	45°	
	18.4°	
	90°	
Sol.	$I = 10\%\ I_0 \Rightarrow I = \frac{I_0}{10}$ I_0 = Original intensity I = Output intensity But, $I = I_0 \cos^2 \phi$ $\Rightarrow Cos\ \phi = \sqrt{\frac{I}{I_0}} = \sqrt{\frac{I_0}{10 I_0}} = \frac{1}{\sqrt{10}} \simeq \frac{1}{316} \simeq 0.31$ $\Rightarrow \phi = 71.6^0$ Initial angle of angular w.r.t. polarizer is 71.6^0. To get final angle as 90^0. We need to rotate $\left(90^0 - 71.6^0\right) \simeq 18.4^0$ to get $I = 0$	
15.	Visible light of wavelength 6000 A° falls normally on a single slit and produces a diffraction pattern. It is found that second diffraction minimum is at 60° from the central maximum. If the first minimum is produced at θ_1 then θ_1 is close to:	**D**
	30°	
	20°	
	45°	
	25°	
Sol.	For single slit diffraction, $d \sin\theta_n = n\lambda$ (θ_n is large, we can't say $\sin\theta \simeq \theta$) $\Rightarrow Sin\ \theta_2 = \frac{2\lambda}{d}$ $\Rightarrow Sin\ 60^0 = \frac{2 \times 6000 \times 10^{-10}}{d}$ …………(1) $\Rightarrow Sin\ \theta_1 = \frac{\lambda}{d} = \frac{6000 \times 10^{-10}}{d}$ …….(2) $\Rightarrow \frac{(2)}{(1)} \Rightarrow Sin\theta_1 = \frac{Sin 60^0}{2} = \frac{\sqrt{3}}{4} \simeq 0.43 \Rightarrow \theta_1$ is less than 30^0 By using approximation, we can say θ_1 is 25^0	
16.	The graph shows how magnification (m) of thin lens varies with image distance V. What is the focal length used ------- (a = 1, b = 4, c = 2)	**A**

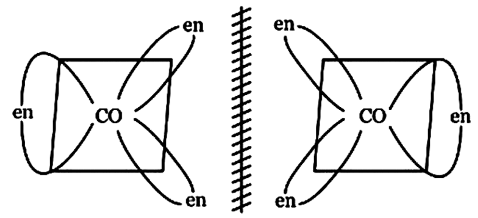
		
	2	
	3	
	4	
	5	
Sol.	$\frac{1}{V}-\frac{1}{u}=\frac{1}{f}\Rightarrow m=\frac{V}{u}=1-\frac{V}{f}$ At $V=a, m_1=1-\frac{a}{f}$ At $V=a+b,\ m_2=1-\frac{a+b}{f}\ \Rightarrow m_2-m_1=c=\frac{b}{f}\Rightarrow f=\frac{b}{c}=\frac{4}{2}=2$	
17.	A wire of length L is hanging from a fixed support. The length changes to L_1 and L_2 when masses 1 Kg and 2 Kg are suspended from its free end. Then, the value of L is equal to	**C**
	$\sqrt{L_1L_2}$	
	$\frac{L_1+L_2}{2}$	
	$2L_1-L_2$	
	$3L_1-L_2$	
Sol.	By Hooke's law So, $F\ \alpha\ \Delta L$ $\frac{F_1}{F_2}=\frac{\Delta L_1}{\Delta L_2}$ $\qquad \frac{10}{20}=\frac{(L_1-L)}{(L_2-L)}$ $\qquad L=2L_1-L_2$	
18.	**Statement-I:** Due to rapid pumping of tyres, air inside the tyre is hotter than atmospheric air **Statement-II:** Adiabatic process occurs at very high rate	**C**
	Statement-I is true; Statement-II is false	
	Statement-I is false; Statement-II is true	
	Statement-I & Statement-II are true	
	Statement-I & Statement-II are false	
Sol.	Conceptual	
19.	**Assertion(A):** Magnetic field cannot change kinetic energy of a moving **charge Reason(R):** Magnetic field can't change velocity vector.	**C**
	A & R is true, R is correct explanation of A	
	A & R is true, R is not correct explanation of A	
	A is true, R is false	
	A is false, R is true	
Sol.	Work done on particle by magnetic force is zero. But, particle direction is changed by magnetic force.	

20.	In a experiment to determine velocity of sound in air at room temperature using a resonance tube, the first resonance is observed when the air column has a length of 20.0 cm for a tuning fork of frequency 400 Hz. Velocity of sound at room temperature is 336 m/s. The third resonance is observed when air column is at length of _____ (in cm)	**C**
	100 cm	
	80 cm	
	104 cm	
	84 cm	
Sol.	$\lambda = \frac{V}{f} = \frac{336}{400} = 84\ cm$ At first resonance, $\frac{\lambda}{4} = l + e \Rightarrow e = 1\ cm$ At 3rd resonance, $l_3 + e = \frac{5\lambda}{4}$ $\Rightarrow l_3 = 5(21) - 1 = 104\ cm$	
21.	A beam of EM radiation of intensity 6.4×10^{-5} W/cm^2 is comprised of wavelength λ = 310 nm It falls normally on a metal (ϕ = 2eV) of surface area 1 cm^2. If one in 10^4 photon, ejects an electron, total number of electrons ejected in 1 sec is $\mathbf{10^x}$, then x is ------- (hc = 1240 eVnm, 1 eV = 1.6×10^{-19} J)	**10**
Sol.	$P = I \times A = 6.4 \times 10^{-5}\ W/cm^2 \times 1\ cm^2 = 6.4 \times 10^{-5}\ W$ Energy = $\frac{hc}{\lambda} = \frac{1240}{310} = 4\ eV$ > (Work function = 2eV) $\Rightarrow$ PEE takes place. If n is no. of photons emitted, $n \times E = I \times A \quad \Rightarrow n = \frac{I \times A}{E} = \frac{6.4 \times 10^{-5}}{6.4 \times 10^{-19}} = 10^{14}$ photons 1 out of 10^4 photons ejects a e^- $\Rightarrow$ no. of $e^- = \frac{10^{14}}{10^4} = 10^{10} \qquad x = 10$	
22.	A shell bursts on contact with ground and pieces from it fly in all directions with a velocity equal to 60 m/s. It is known that a man who is 180 m away is in danger for a time interval of $\sqrt{x}$ sec, Find x? (Neglect height of man).	**72**

Sol.	$u = 60\ m/s\ R = 180\ m/s$ $R = \frac{u^2 \sin 2\theta}{g} \Rightarrow Sin\ 2\theta = \frac{180 \times 10}{60 \times 60} = \frac{1}{2}$ $\Rightarrow 2\theta = 30^0 \Rightarrow \theta = 15^0$ Two directions of projections have same range θ^0 & $90^0 - \theta^0$ Let , T_1 & T_2 are time of flights in 2 cases for $\theta_1 = 15^0$ and $\theta_2 = 90 - 15 = 75^0$ $T_1 = \frac{2u \sin\theta_1}{g}\ T_2 = \frac{2u\sin\theta_2}{g}$ Man is in danger for a time $T_2 - T_1 = \frac{2u}{g}\left(\sin 75^0 - \sin 15^0\right) = \frac{2u}{g}\left(2\cos 45^0 \sin 30^0\right)$ $= \frac{2 \times 60}{10} \times 2 \times \frac{1}{\sqrt{2}} \times \frac{1}{2} = 6\sqrt{2}$ sec $\quad = \sqrt{72}$ sec	
23.	A loop ABCDEFA of straight edges has six corner points A(0,0,0), B(5,0,0), C(5,5,0) D(0,5,0), E(0,5,5), F(0,0,5). Magnetic field in this region is $\bar{B} = 3\hat{\imath} + 2\hat{k}T$. Quantity of flux through loop ABCDEFA is ---------- (in Wb).	**125**
Sol.	$\overline{B} = \left(3\hat{i} + 2\hat{k}\right)T$ Area vectors, $\overline{A}_{ABCD} = \overline{AB} \times \overline{BC} = 25\hat{k}\ m^2$ $\overline{A}_{ADEF} = \overline{AD} \times \overline{DE} = 25\hat{i}\ m^2$ $\overline{A}_{net} = 25\hat{i} + 25\hat{k}\ m^2$ $\phi = \overline{B}.\overline{A} = \left(3\hat{i} + 2\hat{k}\right).\left(25\hat{i} + 25\hat{k}\right)$ $= 25 \times 3 + 25 \times 2 = 125$ Wb	
24.	Magnetic field in a travelling EM wave is having a peak value of 20 nT. Peak value of electric field strength is K V/m. Find K?	**6**
Sol.	$C = \frac{E_0}{B_0} \Rightarrow E_0 = CB_0 = 3 \times 10^8 \times 20 \times 10^{-9} \quad = 6\ V/m$	
25.	Corresponding to the process shown in figure, the heat given to the gas in the process ABCA is (0.2 x) J. Find value of x is--------- 	**5**

Sol.	$\oint dQ = \oint dw \quad \Rightarrow \oint dW =$ Area under P-V graph $= \frac{1}{2} \times (2-1) \times (4-2)\, J = 1$ J $\Rightarrow 0.2\,x = 1 \Rightarrow x = 5$	
26.	A + B $\rightarrow$P, $-\frac{d[A]}{dt} = -\frac{d[B]}{dt} = k[A][B]$ and kt = $\frac{1}{[A]_0 - [B]_0} In \frac{[A][B]_0}{[B][A]_0}$ when $[A]_0 \neq [B]_0$. If $[A]_0 = [B]_0$ then the integrated rate law will be	**D**
	Kt = In$\frac{[A]}{[B]}$	
	$\frac{1}{[B]} = \frac{1}{[A]_0}$ + kt	
	$\frac{1}{[A]} = \frac{1}{[B]_0}$ + kt	
	$\frac{1}{[A]} = \frac{1}{[A]_0}$ + kt or $\frac{1}{[B]} = \frac{1}{[B]_0}$ + kt	
Sol.	For a second order reaction, $\mathrm{A + B \rightarrow P}$, if $[\mathrm{A}]_0 \neq [\mathrm{B}]_0$ then the integrated rate law equation will be $\mathrm{kt} = \frac{1}{[\mathrm{A}]_0 - [\mathrm{B}]_0} \ln \frac{[\mathrm{A}][\mathrm{B}]_0}{[\mathrm{B}][\mathrm{A}]_0}$ where, k = rate constant, t = time If $[\mathrm{A}]_0 = [\mathrm{B}]_0$ then for second order reaction, $\mathrm{A + A \rightarrow P}$, integrated rate law equation will be $\frac{1}{[\mathrm{A}]} = \frac{1}{[\mathrm{A}]_0} + \mathrm{kt}$ or $\frac{1}{[\mathrm{B}]} = \frac{1}{[\mathrm{B}]_0} + \mathrm{kt}$	
27.	The order of basicity among the following compounds is  (I)  (II)  (III)  (IV)	**D**
	II > I > IV > III	
	I > IV > III > II	
	IV > II > III > I	
	IV > I > II > III	

Sol.	 The conjugate acid is stabilized by resonance with two different $-NH_2$ group.  The conjugate acid is stabilized by resonance with one $-NH_2$ group and by hyper conjugation of $-CH_3$ group.  The conjugate acid is stabilized by resonance with only one NH_2 group. (III) Least basic, as the LP is used in aromaticity.	
28.	 How many litres of gas P is formed in above reaction at NTP? (Molar volume of gas at NTP is 22.4)	**C**
	22.4 L	
	33.6 L	
	44.8 L	
	66 L	
Sol.	Grignard's reagent reacts with acidic-H to release methane  Volume of CH_4 at NTP $= 2\times$ molar volume $= 2 \times 22.4 = 44.8$ L	
29.	Number of metal oxygen double bonds in the orange–red coloured compound formed when NaCl reacts with $K_2Cr_2O_7$ and H_2SO_4.	**A**
	2	
	4	
	6	
	0	
Sol.	CrO_2Cl_2 (Chromyl Chloride) will be formed in this reaction. 	

	Orange-red coloured chromyl chloride.	
30.	Which of the following coordination compounds would exhibit optical isomerism?	**D**
	Pentaammineitrocobalt (III) iodide	
	Diamminedichloroplatinum (II)	
	Trans –dicyanobis (ethylenediamine chromium (III) chloride	
	Tris –(ethylenediamine) cobalt (III) bromide	
Sol.	$\left[Ma_5b\right]^{+n}$ → no orbital activity $\left[Ma_2b_2\right]^{+n}$ → plane of symmetry trans-$\left[M\left(AA\right)_2b_2\right]^{+n}$ → plane of symmetry  Enantiomers exist in $\left[M\left(AA\right)_3\right]^{+n}$	
31.	18 g glucose ($C_6H_{12}O_6$) is added to 178.2 g water. The vapour pressure of water (in torr) for this aqueous solution at 373 K is	**D**
	759.0 g	
	739. 6 g	
	746.0 g	
	752.4 g	
Sol.	Relative lowering of vapour pressure Equation $\frac{P^0-P_s}{P^0}=X_{solute}=\frac{n}{n+N}$ Modified forms of equation is $\frac{P^0-P_s}{P_s}=\frac{n}{N}$ n = moles of solute, N = moles of solvent $P^0=760$ torr $P_s=?$ $\frac{760-P_s}{P_s}=\frac{\frac{18}{180}}{\frac{178.2}{18}}$ $P_s=752.4$ torr	
32.	For the following electrochemical cell at 298 K, Pt (s) | H_2 (g, 1 bar)| H^+ (aq, 1 M) ||Mn^{4+} (aq), Mn^{2+} (aq)| Pt (s) E_{cell} = 0.092 V when $\frac{[Mn^{2+}(aq)]}{[Mn^{4+}(aq)]}=10^x$ Given $E^0_{Mn^{4+}\|Mn^{2+}}$ = 0.151 V $2.303\,\frac{RT}{F}$ = 0.059 V The value of x is	**D**
	–2	
	–1	
	1	
	2	

Sol.	Anode: $H_2 \rightarrow 2H^+ + 2e^-$ Cathode: $Mn^{4+} + 2e^- \rightarrow Mn^{2+}$ $Mn^{4+} + H_2 \rightarrow Mn^{2+} + 2H^+$ $E = E^\circ - \frac{0.059}{2}\log_{10}\left(\frac{[Mn^{2+}][H^+]^2}{[Mn^{4+}]P_{H_2}}\right)$ $0.092 = 0.151 - \frac{0.059}{2}\log_{10}(10^x)$ $0.092 = 0.151 - \frac{0.059}{2}x$ $x = 2$	
33.	The dissociation equilibrium of a gas AB_2 can be represented as, $2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$. The degree of dissociation is x and is small as compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant k_P and total pressure P is:	**D**
	$(2\ K_P / P)^{1/2}$	
	K_P / P	
	$2K_P / P$	
	$(2K_P / P)^{1/3}$	
Sol.	$2AB_2\ (g) \rightleftharpoons 2\ AB\ (g) + B_2\ (g)$ At equilibrium $2\ (1 - x)$ $2x$ x Total moles = $(2 + x)$ Partial pressures $P_{AB_2} = \frac{2(1-x)}{2+x}P,\ P_{AB} = \left(\frac{2x}{2+x}\right)P,$ $P_{B_2} = \left(\frac{x}{2+x}\right)P$ $K_p = \frac{P_{AB}^2 . P_{B_2}}{(P_{AB_2})^2} = \frac{\left[\left(\frac{2x}{2+x}\right)P\right]^2\left[\frac{xP}{2+x}\right]}{\left[\frac{2(1-x)}{2+x}P\right]^2}$ $K_p = \frac{4x^3P}{4(2+x)(1-x)^2}$ $(2 + x) \rightarrow 2$ (x is small) $(1 - x) \rightarrow 1$ $K_P = \frac{4x^3P}{8} = \frac{x^3P}{2}$ $x = \sqrt[3]{\frac{2k_p}{P}}$	
34.	Match the column I with column II and mark the appropriate choice.	**C**

	Column I		Column II
(p)	3d-transition series	(i)	Z = 58 to Z = 71
(q)	Lanthanoid series	(ii)	Z = 39 to Z = 48
(r)	Actinoid series	(iii)	Z = 21 to Z = 30
(s)	4d-transition series	(iv)	Z = 90 to Z = 103

(p) –(i), q –(ii), (r) –(iii), (s) – (iv)

(p) –(ii), q –(iii), (r) –(iv), (s) – (i)

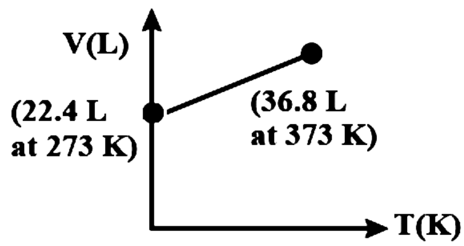
(p) –(iii), q –(i), (r) –(iv), (s) – (ii)

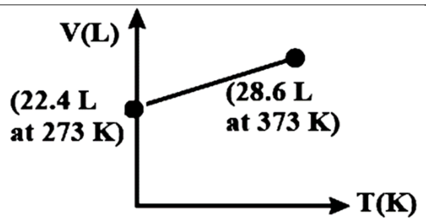
(p) –(iv), q –(iii), (r) –(i), (s) – (ii)

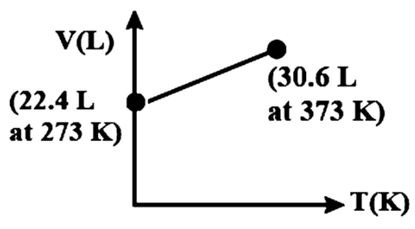
Sol.

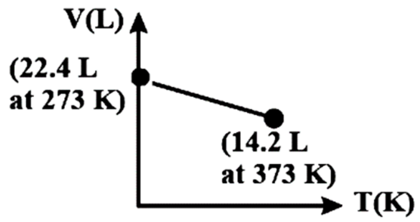
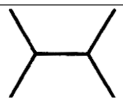
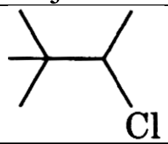
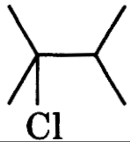
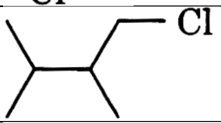
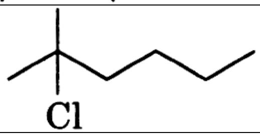
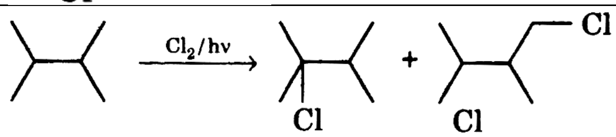
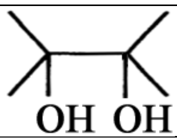
	Column I		Column II
(p)	3d-transition series	(iii)	Z = 21 to Z = 30 (Zn)
(q)	Lanthanoid series	(i)	Z = 58 to Z = 71 (Lu)
(r)	Actinoid series	(iv)	Z = 90 to Z = 103 (Lr)
(s)	4d-transition series	(ii)	Z = 39 to Z = 48 (Cd)

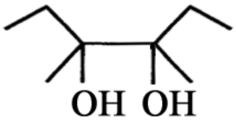
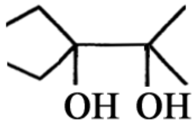
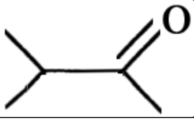
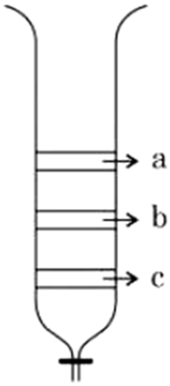
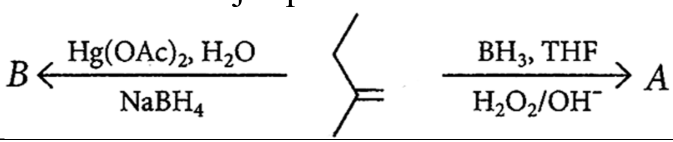
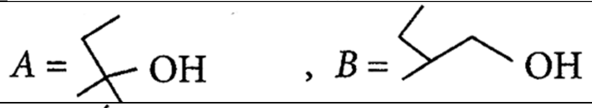
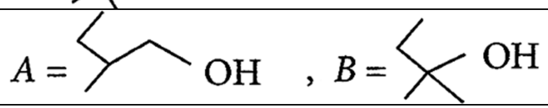
35. Which of the following volume (V), temperature (T) plots represents the behaviour of one mole of an ideal gas at one atmospheric pressure? **C**

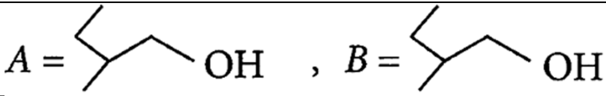
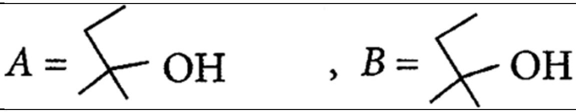
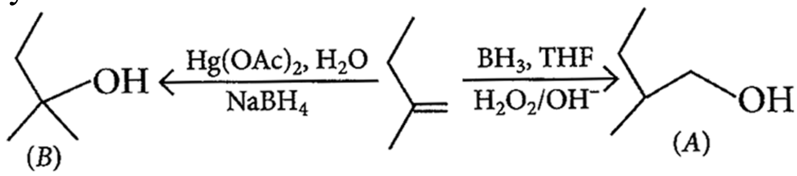
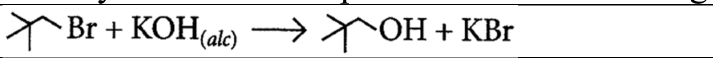
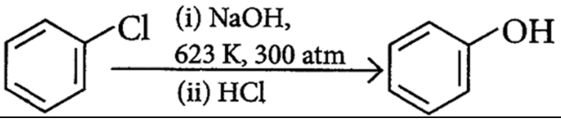
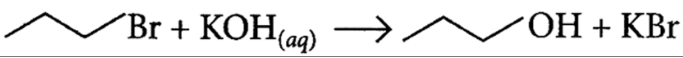
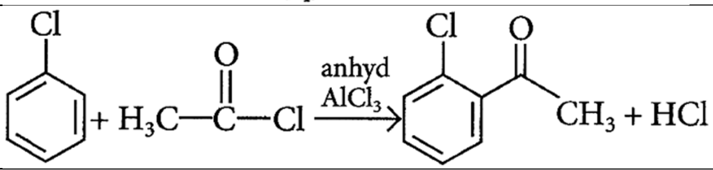
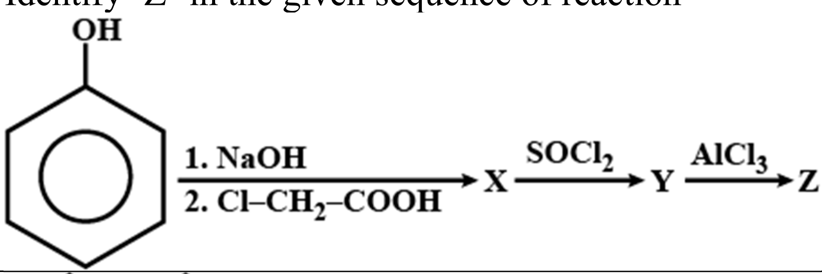
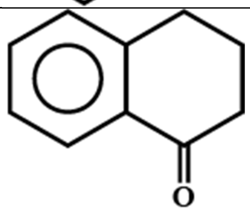


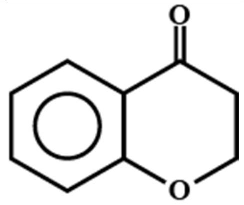


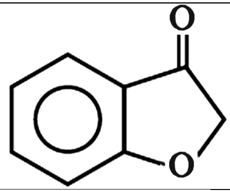


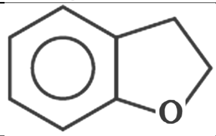
	 	
Sol	Find the volume by either $V = \frac{RT}{P}\ (PV = RT)$ or $P_1V_1 = P_2V_2$ and match it with the values given in graph to find correct. Volume of 1 mole of an ideal gas at 273 K and 1 atm is 22.4 L and that at 373 K and 1 atm pressure is calculated as $V = \frac{RT}{P} = \frac{0.082 \times 373}{1} = 30.58L$ $\simeq 30.6L$	
36.	 $\xrightarrow{Cl_2/h\nu}$ **Monochloro derivative** Major monochloro derivative will be :	**C**
		
		
		
		
Sol.	 **2 × 3.8 = 7.6 12 × 1= 12** **$R_1 : R_2 : R_3$** **1 : 3.8 : 45**	
37.	$H_3C—\underset{}{\overset{C_2H_5}{\overset{\vert}{C}}}=\overset{C_2H_5}{\overset{\vert}{C}}—CH_3 \xrightarrow[\text{(ii) } H_2O/Zn]{\text{(i) } O_3} \xrightarrow[\text{(ii) } H_2O]{\text{(i) Mg(Hg)}}$ Product is :	**B**
		

		
		
		
38.	From the figure of column chromatography given below, identify incorrect statements.  A. Compound ‘c’ is more polar than ‘a’ and ‘b’. B. Compound ‘a’ is least polar C. Compound ‘b’ comes out of the column before ‘c’ and after ‘a’ D. Compound ‘a’ spends more time in the column. Choose the correct answer from the options given below.	**A**
	A, B and C only	
	A, B and D only	
	B, C and D only	
	B and D only	
Sol.	In column chromatography, mixture is dissolved in minimum volume of a suitable highly polar solvent and applied on the top of column of adsorbent. As solution moves down, mixture is adsorbed. The components are adsorbed on the basis of extent of polarity. The polarity order is a > b > c then compound a is strongly adsorbed followed by b and then c. Thus, c is least polar among all (a, b, c) components. Compound a is most polar. Compound b will come out after c before a and compound a will spend more time in column. Thus, the incorrect statements are A, B and C.	
39.	Find out the major products from the following reactions.  	**B**
	 	
	 	

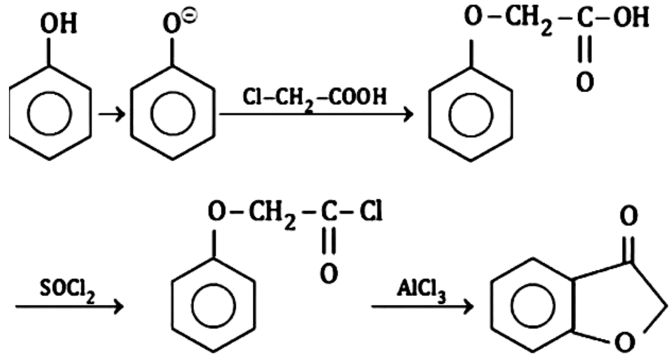
		
		
Sol.	Mercuration-demercuration is a Markowni-koff's addition while hydroboration-oxidation is an anti-Markownikoff's addition. 	
40.	The reaction of zinc with dilute and concentrated nitric acid, respectively produces	**B**
	NO_2 and N_2O	
	N_2O and NO_2	
	NO_2 and NO	
	NO and N_2O	
Sol.	The reaction of zinc with dilute and concentrated nitric acid are respectively as follows $4Zn + \underset{(dil.)}{10HNO_3} \rightarrow 4Zn(NO_3)_2 + N_2O + 5H_2O$ $Zn + \underset{(conc.)}{4HNO_3} \rightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$	
41.	Identify the incorrect option from the following:	**A**
		
		
		
		
Sol.	In presence of alcoholic KOH, elimination takes place.	
42.	Identify 'Z' in the given sequence of reaction 	**C**
		







Sol.

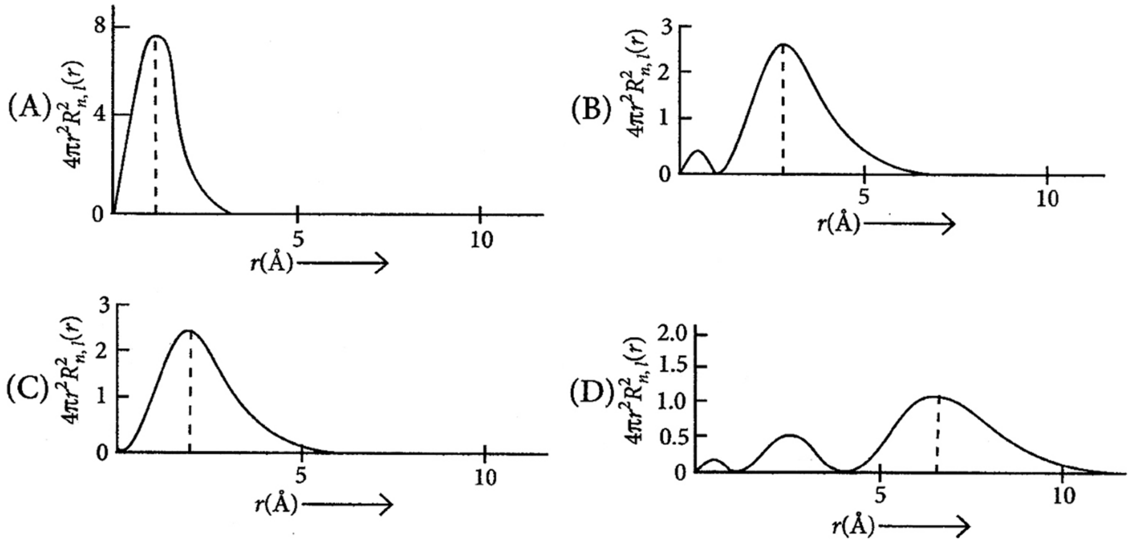
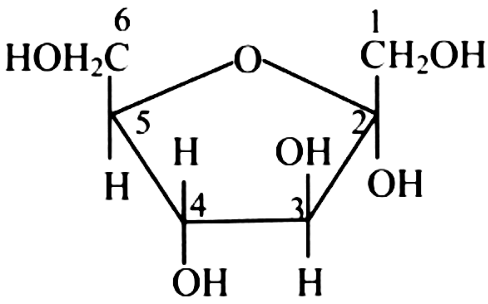


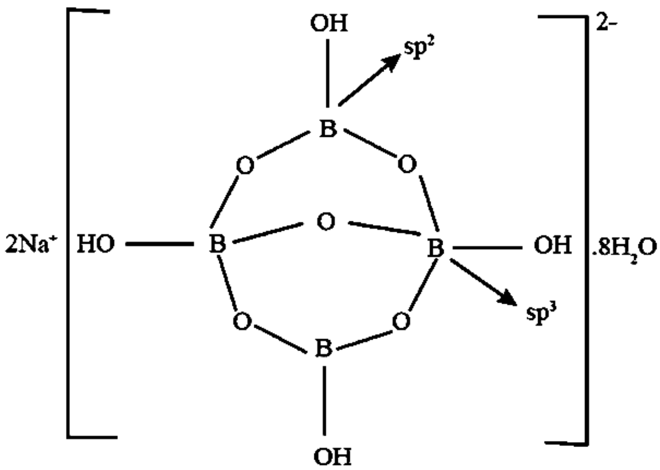
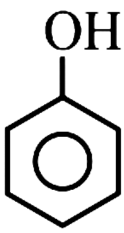
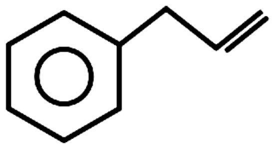
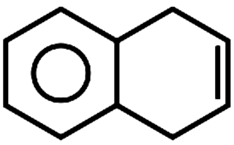
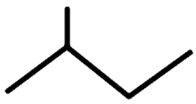
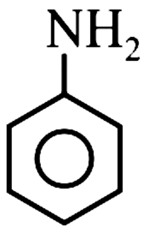
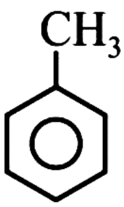
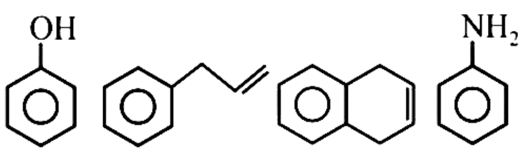
43.	The pair in which phosphorous atom have a formal oxidation state of + 3 is	**B**
	Pyrophosphorous and pyrophosphoric acids	
	Orthophosphorous and pyrophosphorous acids	
	Pyrophosphorous and hypophosphoric acids	
	Orthophosphorous and hypophosphoric acids	
Sol.	Acid Formula Formal oxidation state of phosphorous Pyrophosphorous acids $H_4P_2O_5$ +3 Pyrophosphoric acid $H_4P_2O_7$ +5 Orthophosphorous acid H_3PO_3 +3 Hypophosphoric acid $H_4P_2O_6$ +4 Both pyrophosphorous and orhtophosphorous acids have +3 formal oxidation state.	
44.	Match List I with List II.	**D**

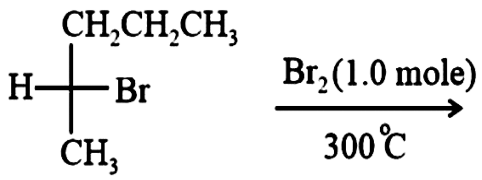
List I (Element detected)		List II (Reagent used/Product formed)	
A.	Nitrogen	I.	$Na_2[Fe(CN)_5NO]$
B.	Sulphur	II.	$AgNO_3$
C.	Phosphorous	III.	$Fe_4[Fe(CN)_6]_3$
D.	Halogen	IV.	$(NH_4)_2MoO_4$

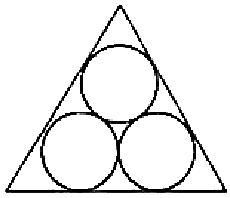
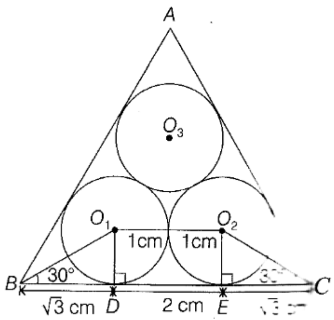
Choose the correct answer from the options given below:

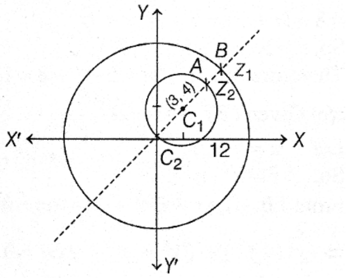
A-IV, B-II, C-I, D-III

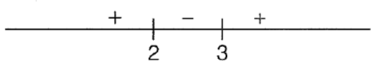
	A-II, B-I, C-IV, D-III	
	A-II, B-IV, C-I, D-III	
	A-III, B-I, C-IV, D-II	
45.	The plots of radial distribution functions for various orbitals of hydrogen atom against 'r' are given below :  The correct plot for 3s-orbital is :	**D**
	C	
	A	
	B	
	D	
Sol.	Number of radial nodes = $n - l - 1$ For 3s-orbital $n = 3, l = 0$ $\therefore$ Number of radial nodes = 3 – 0 – 1 = 2	
46.	The number of – OH group(s) present in α – D – (–) – Fructofuranose structure is :	**5**
Sol.	The structure of $\alpha - \mathrm{D} - (-)$ - Fructofuranose is:  α-D-(–)-Fructofuranose It has 5 $-OH$ groups.	
47.	In Borax ($Na_2B_4O_7$. $10H_2O$) if number of sp^2 hybridised B –atoms are X and number of sp^3 hybridised B – atom are Y. What is the value of X + Y?	**4**

Sol.	In Borax 2-B-atoms are sp^2 and 2-B-atoms are sp^3 hybridised $X = 2, Y = 2$ $X + Y = 4$ 	
48.	(1)  (2)  (3)  (4)  (5)  (6)  (7)  Number of compounds which shows Br_2/H_2O test.	4
Sol.	Highly activated benzene rings like phenol, aniline and unsaturated hydrocarbons like alkenes and alkynes undergo reaction with bromine water. Among the given molecules, the following molecules reacts with bromine water. 	

49.	The magnetic moment of a transition metal ions is 3.87 BM. The number of unpaired electron present in it is :	**3**
Sol.	$3.87=\sqrt{n(n+2)}$ $(3.87)^2=n(n+2)$ $\therefore n\simeq 3$	
50.	In the following monobromination reaction, the number of possible chiral products are  **(1.0 mole)** **(enantiomerically pure)**	**5**
51.	Let $A=\begin{bmatrix}1&0&0\\0&\alpha&\beta\\0&\beta&\alpha\end{bmatrix}$ and $\|2A\|^3=2^{21}$ where, $\alpha,\beta\in Z$. Then, a value of α is	**B**
	3	
	5	
	9	
	17	
Sol.	*(b)* We have, $\|2A\|^3=2^{21}$ $\Rightarrow \|2A\|=2^7 \Rightarrow 8\|A\|=2^7$ $\Rightarrow \|A\|=2^4$ Also, $A=\begin{bmatrix}1&0&0\\0&\alpha&\beta\\0&\beta&\alpha\end{bmatrix}$ $\Rightarrow \|A\|=\alpha^2-\beta^2=2^4$ $\Rightarrow(\alpha-\beta)(\alpha+\beta)=16$ $\Rightarrow \alpha-\beta=2$ and $\alpha+\beta=8$ $\Rightarrow \alpha=5$ and $\beta=3$	
52.	If the coponents of $a=\alpha\hat{\mathbf{i}}+\beta\hat{\mathbf{j}}+\gamma\hat{\mathbf{k}}$ along and perpendicular to respectively, are $\frac{16}{11}(3\hat{i}+\hat{j}-\hat{k})$ and $\frac{1}{11}(-4\hat{i}-5\hat{j}-17\hat{k})$, then $\alpha^2+\beta^2+\gamma^2$ is equal to	**C**
	23	
	16	
	26	
	18	

Sol.	*(c)* Given **a** = **a** along **b** + **a** ⊥ **b** $\Rightarrow \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k} = \frac{16}{11}(3\hat{i} + \hat{j} - \hat{k}) + \frac{1}{11}(-4\hat{i} - 5\hat{j} - 17\hat{k})$ $\Rightarrow 4\hat{i} + \hat{j} - 3\hat{k}$ $\Rightarrow \alpha = 4, \beta = 1$ and $\gamma = -3$ $\Rightarrow \alpha^2 + \beta^2 + \gamma^2 = 16 + 1 + 9 = 26$	
53.	The area of the equilateral triangle, in which three coins of radius 1 cm are placed, as shown in the figure, is 	**A**
	$(6 + 4\sqrt{3})$ sq cm	
	$(4\sqrt{3} - 6)$ sq cm	
	$(7 + 4\sqrt{3})$ sq cm	
	$4\sqrt{3}$ sq cm	
Sol.	*(a)* Since, tangents drawn from external points to the circle subtends equal angle at the centre.  $\therefore \quad \angle O_1BD = 30°$ In ΔO_1BD, $\tan 30° = \frac{O_1D}{BD}$ $\Rightarrow \quad BD = \sqrt{3}$ cm Also, $DE = O_1O_2 = 2$ cm and $EC = \sqrt{3}$ cm Now, $BC = BD + DE + EC = (2 + 2\sqrt{3})$ cm $\Rightarrow$ Area of $\Delta ABC = \frac{\sqrt{3}}{4}(BC)^2$ $= \frac{\sqrt{3}}{4} \cdot 4(1 + \sqrt{3})^2 = (6 + 4\sqrt{3})$ sq cm	
54.	For all complex numbers z_1, z_2 satisfying $\|z_1\| = 12$ and $\|z_2 - 3 - 4i\| = 5$, the minimum value of $\|z_1 - z_2\|$ is	**B**
	0	
	2	
	7	
	17	

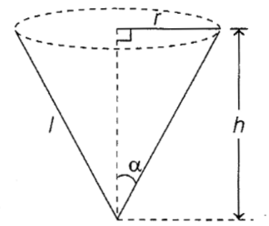
Sol.	*(b)* We know, $\|z_1 - z_2\|$ $= \|z_1 - (z_2 - 3 - 4i) - (3 + 4i)\|$ $\geq \|z_1\| - \|z_2 - 3 - 4i\| - \|3 + 4i\|$ $\geq 12 - 5 - 5$ [Using $\|z_1 - z_2\| \geq \|z_1\| - \|z_2\|$] $\therefore \|z_1 - z_2\| \geq 2$ ***Alternate Solution*** Clearly from the figure $\|z_1 - z_2\|$ is minimum when z_1, z_2 lie along the diameter.  $\therefore \|z_1 - z_2\| \geq C_2B - C_1A \geq 12 - 10 = 2$	
55.	If three distinct numbers are chosen randomly from the first 100 natural numbers, then the probability that all three of them are divisible by both 2 and 3, is	**D**
	$\frac{4}{55}$	
	$\frac{4}{35}$	
	$\frac{4}{33}$	
	$\frac{4}{1155}$	
Sol.	*(d)* Since, three distinct numbers are to be selected from first 100 natural numbers. $\Rightarrow \quad n(S) = {}^{100}C_3$ $E_{\text{(favourable events)}}$ = All three of them are divisible by both 2 and 3 . $\Rightarrow$ Divisible by 6 i.e. $\{6, 12, 18, \ldots, 96\}$ Thus, out of 16 we have to select 3. $\therefore \quad n(E) = {}^{16}C_3$ $\therefore$ Required probability $= \frac{{}^{16}C_3}{{}^{100}C_3} = \frac{4}{1155}$	
56.	Let A be a 3×3 real matrix such that $A^2(A - 2I) - 4(A - I) = O$, where I and O are the identity and null matrices, respectively. If $A^5 = \alpha A^2 + \beta A + \gamma I$, where $\alpha, \beta\ and\ \gamma$ are real constants, then $\alpha + \beta + \gamma$ is equal to	**B**
	76	
	12	
	4	
	20	
Sol.	*(b)* Given, $A^2(A - 2I) - 4(A - I) = 0$ $\Rightarrow A^3 = 2A^2 + 4A - 4I$ $\Rightarrow A^4 = 2(2A^2 + 4A - 4I) + 4A^2 - 4A$ $\Rightarrow A^4 = 8A^2 + 4A - 8I$ $\Rightarrow A^5 = 8(2A^2 + 4A - 4I) + 4A^2 - 8A$ $= 20A^2 + 24A - 32I$ Given, $\quad A^5 = \alpha A^2 + \beta A + \gamma I$ $\Rightarrow \alpha + \beta + \gamma = 20 + 24 - 32 = 12$	

57.	If $f(a) = 2, f'(a) = 1, g(a) = -1, g'(a) = 2$, then the value of $\lim\limits_{x\to a} \frac{g(x)f(a)-g(a)f(x)}{x-a}$ is	**C**
	–5	
	1/5	
	5	
	None of these	
Sol.	(c) Given, $f(a)=2,\ f'(a)=1,$ $g(a)=-1, g'(a)=2$ $\therefore\ \lim\limits_{x\to a}\frac{g(x)f(a)-g(a)f(x)}{x-a}$ $=\lim\limits_{x\to a}\frac{g'(x)f(a)-g(a)f'(x)}{1-0},$ [using L' Hospital's rule] $=g'(a)f(a)-g(a)f'(a)$ $=2(2)-(-1)(1)=5$	
58.	The function $f:[0,3]\to[1,29]$, defined by $f(x) = 2x^3 - 15x^2 + 36x + 1$, is	**B**
	One-one and onto	
	Onto but not one-one	
	One-one but not onto	
	Neither one-one nor onto	
Sol.	(b) **Description of Situation** To find range in given domain $[a,b]$, put $f'(x)=0$ and find $x=\alpha_1, \alpha_2, \ldots, \alpha_n \in[a,b]$ Now, find $\{f(a), f(\alpha_1), f(\alpha_2), \ldots, f(\alpha_n), f(b)\}$ its greatest and least values gives you range. Now, $f:[0,3]\to[1,29]$ $f(x)=2x^3-15x^2+36x+1$ $\therefore\quad f'(x)=6x^2-30x+36$ $=6(x^2-5x+6)$ $=6(x-2)(x-3)$  For given domain [0, 3], $f(x)$ is increasing as well as decreasing $\Rightarrow$ many-one Now, put $\quad f'(x)=0 \Rightarrow x=2,3$ Thus, for range $\quad f(0)=1,\ f(2)=29,$ $f(3)=28$ $\Rightarrow$ Range $\in[1, 29]$ $\therefore$ Onto but not one-one.	
59.	The incentre of the triangle with vertices $(1,\sqrt{3}), (0,0)$ and $(2,0)$ is	**D**
	$\left(1,\frac{\sqrt{3}}{2}\right)$	
	$\left(\frac{2}{3},\frac{1}{\sqrt{3}}\right)$	
	$\left(\frac{2}{3},\frac{\sqrt{3}}{2}\right)$	
	$\left(1,\frac{1}{\sqrt{3}}\right)$	

Sol.	(d) Let the vertices of triangle be $A(1, \sqrt{3}), B(0, 0)$ and $C(2, 0)$. Here, $AB = BC = CA = 2$. Therefore, it is an equilateral triangle. So, the incentre coincides with centroid. $\therefore \quad I \equiv \left(\frac{1+0+2}{3}, \frac{\sqrt{3}+0+0}{3}\right)$ $\Rightarrow \quad I \equiv (1, 1/\sqrt{3})$	
60.	If in the expansion of $(1+x)^m(1-x)^n$, the coefficients of x and x^2 *and* x^3 are 3 and –6 respectively, then m is equal to	**C**
	6	
	9	
	12	
	24	
Sol.	(c) $(1+x)^m(1-x)^n$ $= \left[1 + mx + \frac{m(m-1)}{2}x^2 + \ldots\right]$ $\left[1 - nx + \frac{n(n-1)}{2}x^2 - \ldots\right]$ $= 1 + (m-n)x +$ $\left[\frac{m(m-1)}{2} + \frac{n(n-1)}{2} - mn\right]x^2 + \ldots$ term containing power of $x \geq 3$. Now, $\quad m - n = 3 \quad \ldots$(i) ($\because$ coefficient of $x = 3$ given) and $\frac{1}{2}m(m-1) + \frac{1}{2}n(n-1) - mn = -6$ ($\because$ coefficient of $x^2 = -6$ given) $\Rightarrow m(m-1) + n(n-1) - 2mn = -12$ $\Rightarrow \quad m^2 - m + n^2 - n - 2mn = -12$ $\Rightarrow (m-n)^2 - (m+n) = -12$ $\Rightarrow \quad m + n = 9 + 12 = 21$ $\ldots$(ii) On solving Eqs. (i) and (ii), we get $m = 12$	
61.	If the doimain of the function $f(x) = \frac{1}{\sqrt{10+3x-x^2}} + \frac{1}{\sqrt{x+\lvert x\rvert}}$ is (a, b), then $(1+a)^2 + b^2$ is equal to	**A**
	26	
	30	
	25	
	29	

Sol.	(a) $x + \|x\| = \begin{cases} 2x & x \geq 0 \\ 0 & x < 0 \end{cases}$ $\Rightarrow \dfrac{1}{\sqrt{x+\|x\|}}$, domain is $x > 0 \Rightarrow (0, \infty)$ Similarly, $\dfrac{1}{\sqrt{3x+10-x^2}}$ is defined when $3x + 10 - x^2 > 0$ $\Rightarrow x^2 - 3x - 10 < 0$ $\Rightarrow (x-5)(x+2) < 0 \Rightarrow x \in (-2, 5)$ $\Rightarrow$ Domain will be $(0, \infty) \cap (-2, 5)$ $= (0,5)$ $\therefore (1+a)^2 + b^2 = 1 + 25 = 26$	
62.	The function $f(x) = [x]cos\left(\frac{2x-1}{2}\right)\pi, [x]$ denotes the greatest integer function, is discontinuous at	**C**
	all x	
	all integer points	
	no x	
	x which is not an integer	
Sol.	(c) Here, $f(x) = [x]\cos\left(\frac{2x-1}{2}\right)\pi$ $\therefore f(x) = \begin{cases} -\cos\left(\frac{2x-1}{2}\right)\pi & , -1 \leq x < 0 \\ 0 & , 0 \leq x < 1 \\ \cos\left(\frac{2x-1}{2}\right)\pi & , 1 \leq x < 2 \\ 2\cos\left(\frac{2x-1}{2}\right)\pi & , 2 \leq x < 3 \end{cases}$ which shows RHL =LHL at $x = n \in$ Integer as if $x = 1$ $\Rightarrow \lim\limits_{x \to 1^+} \cos\left(\frac{2x-1}{2}\right)\pi = 0$ and $\lim\limits_{x \to 1^-} = 0$ Also, $f(1) = 0$ $\therefore$ Continuous at $x = 1$. Similarly, when $x = 2$, $\lim\limits_{x \to 2^+} f(x) = \lim\limits_{x \to 2^-} f(x) = 0$ Thus, function is discontinuous at no x. Hence, option (c) is the correct answer.	
63.	Let $f(x)$ be a real differentiable function such that $f(0) = 1$ and $f(x + y) = f(x)f'(y) + f'(x)f(y) \forall\ x, y \in R$. Then, $\sum_{n=1}^{100} \log_e f(n)$ is equal to	**A**
	2525	
	2384	
	5220	
	2406	

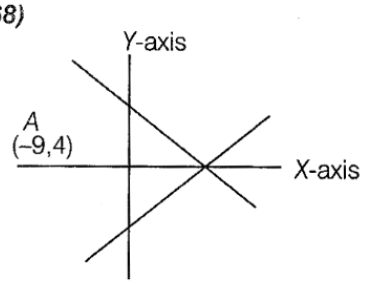
Sol.	(a) Given, $f(x+y)=f(x)\cdot f'(y)+f'(x)\cdot f(y)$ Put $y=0$ $f(x)=f(x)\cdot f'(0)+f'(x)f(0)$ $f(x)=f(x)\cdot f'(0)+f'(x)$ $[\because f(0)=1]$ Put $x=y=0$ $f(0)=f'(0)+f'(0)\Rightarrow f'(0)=\frac{1}{2}$ Hence, equation (i) becomes $f(x)=\frac{f(x)}{2}+f'(x)$ $f'(x)=\frac{f(x)}{2}\Rightarrow\frac{f'(x)}{f(x)}=\frac{1}{2}$ On integrating both sides, we get $\ln f(x)=\frac{x}{2}+C$ Put $x=0\Rightarrow C=0$ $\Rightarrow\ \ln f(x)=\frac{x}{2}\Rightarrow f(x)=e^{\frac{x}{2}}$ $\therefore\ f(n)=e^{\frac{n}{2}}$ $\log_e f(n)=\frac{n}{2}$ $\therefore\ \sum_{n=1}^{100}\log_e f(n)=\frac{1}{2}\sum_{n=1}^{100}n$ $=\frac{1}{2}\sum_{n=1}^{100}n=\frac{1}{2}\left(\frac{100}{2}(100+1)\right)$ $=25\times 101=2525$	
64.	A water tank has the shape of an inverted right circular cone, whose semi-vertical angle is $\tan^{-1}\left(\frac{1}{2}\right)$. Water is poured into it at a constant rate of 5 cu m/min. Then, the rate (in m/min) at which the level of water is rising at the instant when the depth of water in the tank is 10 m, is	**B**
	$\frac{2}{\pi}$	
	$\frac{1}{5\pi}$	
	$\frac{1}{15\pi}$	
	$\frac{1}{10\pi}$	

Sol.	(b) **key idea** Use formula : Volume of cone $= \frac{1}{3}\pi r^2 h$, where r = radius and h = height of the cone Given, semi-vertical angle of right circular cone $= \tan^{-1}\left(\frac{1}{2}\right)$ Let $\alpha = \tan^{-1}\left(\frac{1}{2}\right)$ $\Rightarrow \tan\alpha = 1/2$ $\Rightarrow \frac{r}{h} = \frac{1}{2}$ [from fig. $\tan\alpha = \frac{r}{h}$] $\Rightarrow r = \frac{1}{2}h$ ...(i)  $\because$ Volume of cone is $(V) = \frac{1}{3}\pi r^2 h$ $\therefore V = \frac{1}{3}\pi\left(\frac{1}{2}h\right)^2(h) = \frac{1}{12}\pi h^3$ [from Eq. (i)] On differentiating both sides w.r.t. 't', we get $\frac{dV}{dt} = \frac{1}{12}\pi(3h^2)\frac{dh}{dt} \Rightarrow \frac{dh}{dt} = \frac{4}{\pi h^2}\frac{dV}{dt}$ $\Rightarrow \frac{dh}{dt} = \frac{4}{\pi h^2} \times 5$ [$\because$ given $\frac{dV}{dt} = 5\,m^3/min$] Now, at $h = 10$ m, the rate at which height of water level is rising $= \left.\frac{dh}{dt}\right\|_{h=10}$ $= \frac{4}{\pi(10)^2} \times 5 = \frac{1}{5\pi}$ m/min	
65.	Let $\frac{\pi}{2} < x < \pi$ be such that $cot\ x = \frac{-5}{\sqrt{11}}$. Then, $\left(\sin\frac{11x}{2}\right)(sin\ 6x - cos\ 6x) + \left(cos\frac{11x}{2}\right)(sin\ 6x + cos\ 6x)$ is equal to	**B**
	$\frac{\sqrt{11}-1}{2\sqrt{3}}$	
	$\frac{\sqrt{11}+1}{2\sqrt{3}}$	
	$\frac{\sqrt{11}+1}{3\sqrt{2}}$	
	$\frac{\sqrt{11}-1}{3\sqrt{2}}$	

Sol.	*(b)* **key idea** Let's write $\sin 6x = \cos\left(\frac{\pi}{2} - 6x\right)$ By using $\cos A + \cos B = 2\cos\frac{A+B}{2}\cos\frac{A-B}{2}$ and $\cos A - \cos B = 2\sin\frac{A+B}{2}\sin\frac{B-A}{2}$ We know that $\frac{\pi}{2} < x < \pi$ and $\cot x = \frac{-5}{\sqrt{11}}$ Now, $\sin\left(\frac{11x}{2}\right)(\sin 6x - \cos 6x) + \cos\left(\frac{11x}{2}\right)(\sin 6x + \cos 6x)$ $\Rightarrow \sin\frac{11x}{2}\left(\cos\left(\frac{\pi}{2} - 6x\right) - \cos 6x\right) + \cos\left(\frac{11x}{2}\right)\left(\cos\left(\frac{\pi}{2} - 6x\right) + \cos 6x\right)$ $\Rightarrow \sin\frac{11x}{2}\left(2\sin\frac{\pi}{4}\sin\left(6x - \frac{\pi}{4}\right)\right) + \cos\left(\frac{11x}{2}\right)\left(2\cos\frac{\pi}{4}\cos\left(6x - \frac{\pi}{4}\right)\right)$ $\Rightarrow \sqrt{2}\left[\sin\frac{11x}{2}\sin\left(6x - \frac{\pi}{4}\right) + \cos\frac{11x}{2}\cos\left(6x - \frac{\pi}{4}\right)\right]$ $\Rightarrow \sqrt{2}\cos\left(\frac{11x}{2} - 6x + \frac{\pi}{4}\right)$ $[\because \cos(A-B) = \cos A\cos B + \sin A\sin B]$ $\Rightarrow \sqrt{2}\cos\left(\frac{\pi}{4} - \frac{x}{2}\right)$ $\Rightarrow \sqrt{2}\left(\cos\frac{\pi}{4}\cos\frac{x}{2} + \sin\frac{\pi}{4}\sin\frac{x}{2}\right)$ $\Rightarrow \cos\frac{x}{2} + \sin\frac{x}{2}$ ...(i) Now, if $\cot x = \frac{-5}{\sqrt{11}}$ $\Rightarrow \tan x = \frac{-\sqrt{11}}{5}$ $\Rightarrow \frac{2\tan\frac{x}{2}}{1 - \tan^2\frac{x}{2}} = \frac{-\sqrt{11}}{5}$ On solving, $\tan\frac{x}{2} = \sqrt{11}, -\frac{1}{\sqrt{11}}$ Since, $\frac{\pi}{2} < x < \pi \Rightarrow \frac{\pi}{4} < \frac{x}{2} < \frac{\pi}{2}$ $\Rightarrow \tan\frac{x}{2}$ will be positive. $\therefore \tan\frac{x}{2} = \sqrt{11}$ $\Rightarrow \sin\frac{x}{2} = \frac{\sqrt{11}}{2\sqrt{3}}$ and $\cos\frac{x}{2} = \frac{1}{2\sqrt{3}}$ So, Eq. (i) will becomes, $\Rightarrow \cos\frac{x}{2} + \sin\frac{x}{2} = \frac{1}{2\sqrt{3}} + \frac{\sqrt{11}}{2\sqrt{3}} = \frac{\sqrt{11}+1}{2\sqrt{3}}$	
66.	Let $A = \{1, 2, 3, \ldots\ldots, 10\}$ *and* $B = \left\{\frac{m}{n} : m, n \in A, m < n \text{ and } \gcd(m, n) = 1\right\}$. Then, $n(B)$ is equal to	**C**
	29	

	36	
	31	
	37	
Sol.	(c) $A = \{1, 2, 3, ..., 10\}$ $B = \left\{\frac{m}{n} : m, n \in A, m < n \text{ and } \gcd(m,n) = 1\right\}$ $m = 1 \Rightarrow n = 2, 3, 4, ..., 10 \rightarrow 9$ elements $m = 2 \Rightarrow n = 3, 5, 7, 9 \rightarrow 4$ elements $m = 3 \Rightarrow n = 4, 5, 7, 8, 10 \rightarrow 5$ elements $m = 4 \Rightarrow n = 5, 7, 9 \rightarrow 3$ elements $m = 5 \Rightarrow n = 6, 7, 8, 9 \rightarrow 4$ elements $m = 6 \Rightarrow n = 7 \rightarrow 1$ element $m = 7 \Rightarrow n = 8, 9, 10 \rightarrow 3$ elements $m = 8 \Rightarrow n = 9 \rightarrow 1$ element $m = 9 \Rightarrow n = 10 \rightarrow 1$ element $\therefore\ n(B) = 31$	
67.	A line makes the same angle θ, with each of the X and Z-axes. If the angle β, which it makes with Y-axis, is such that the $\sin^2\beta = 3\sin^2\theta$, then $\cos^2\theta$ equals	**C**
	2/5	
	1/5	
	3/5	
	2/3	
Sol.	(c) As per question the direction cosines of the line are $\cos\theta, \cos\beta, \cos\theta$. $\therefore \cos^2\theta + \cos^2\beta + \cos^2\theta = 1$ $\Rightarrow 2\cos^2\theta = \sin^2\beta = 3\sin^2\theta$ (given) $\Rightarrow 2\cos^2\theta = 3 - 3\cos^2\theta$ $\therefore\ \cos^2\theta = 3/5$	
68.	The mean of a set of 30 observations is 75. If each other observation is multiplied by a non-zero number λ and then each of them is decreased by 25, their mean remains the same. Then λ is equal to	**B**
	10/3	
	4/3	
	1/3	
	2/3	
Sol.	(b) As, mean is a linear operation, so if each observation is multiplied by λ and decreased by 25, then the mean becomes $75\lambda - 25$. According to the question, $75\lambda - 25 = 75$ $\Rightarrow \lambda = 4/3$	
69.	The number of arrangements of the letters of the word BANANA in which the two N's do not appear adjacently, is	**A**
	40	
	60	
	80	
	100	

Sol.	*(a)* Total number of arrangements of word BANANA $= \dfrac{6!}{3!\,2!} = 60$ The number of arrangements of words BANANA in which two N's appear adjacently $= \dfrac{5!}{3!} = 20$ Required number of arrangements $= 60 - 20 = 40$	
70.	If the sum of the first $2n$ terms of the AP series 2, 5, 8, …, is equal to the sum of the first n terms of the AP series 57, 59, 61, …., then n equals	**C**
	10	
	12	
	11	
	13	
Sol.	According to given condition, $S_{2n} = S_n$ $\Rightarrow \dfrac{2n}{2}[2\times 2 + (2n-1)\times 3]$ $= \dfrac{n}{2}[2\times 57 + (n-1)\times 2]$ $\Rightarrow (4 + 6n - 3) = \dfrac{1}{2}(114 + 2n - 2)$ $\Rightarrow 6n + 1 = 57 + n - 1 \;\Rightarrow\; 5n = 55$ $\therefore n = 11$	
71.	Let $\alpha, \beta \in N$ be the roots of the equation $x^2 - 70x + \lambda = 0$, where $\frac{\lambda}{2}, \frac{\lambda}{3} \notin N$. If λ assumes the minimum possible value, then $\frac{(\sqrt{\alpha-1}+\sqrt{\beta-1})(\lambda+35)}{\lvert\alpha-\beta\rvert}$ is equal to………. .	**60**
Sol.	*(60)* We have, $x^2 - 70x + \lambda = 0$ Now, sum of roots i.e. $\alpha + \beta = 70$ and product of roots $\alpha\beta = \lambda$ where λ is not multiple of 2 and 3 and minimum value of λ. $\because$ Possible value of α, β $\alpha = 5, \beta = 65$ $5 + 65 = 70$ and $5 \times 65 = 325$ $\therefore \quad \lambda = 325$ Now, $\dfrac{(\sqrt{\alpha-1}+\sqrt{\beta-1})(\lambda+35)}{\lvert\alpha-\beta\rvert}$ $= \dfrac{(2+8)(360)}{60} = 60$	
72.	The absolute difference between the squares of the radii of the two circles passing through the point $(-9, 4)$ and touching the lines $x + y = 3$ and $x - y = 3$, is equal to ………	**768**

Sol.	*(768)*  $\because \quad x+y=3$ and $\quad x-y=3$ are tangents $\therefore$ Both circles centre will lies on X-axis $\therefore \quad (x-\alpha)^2+y^2=r^2$ Hence, centre is $C(\alpha,0)$ $\Rightarrow \quad r=\sqrt{(\alpha+a)^2+16} \qquad \ldots\text{(i)}$ Also, $\left\|\dfrac{\alpha-3}{\sqrt{2}}\right\|=k \qquad \ldots\text{(ii)}$ From Eqs. (i) and (ii), we get $\sqrt{(\alpha+9)^2+16}=\left\|\dfrac{\alpha-3}{\sqrt{2}}\right\| \Rightarrow \alpha=-5,-37$ $r_1\,(\text{when } \alpha=-5)=4\sqrt{2}$ $r_2\,(\text{when } \alpha=-37)=20\sqrt{2}$ $\left\|r_1^2-r_2^2\right\|=\|32-800\|=768$	
73.	Let the inverse trigonometric function take principal values. The number of real solution of the equation $2\sin^{-1}x+3\cos^{-1}x=\frac{2\pi}{5}$, is …….	**0**
Sol.	*(0)* $2\sin^{-1}x+3\cos^{-1}x=\dfrac{2\pi}{5}$ $\pi+\cos^{-1}x=\dfrac{2\pi}{5} \Rightarrow \cos^{-1}x=\dfrac{-3\pi}{5}$ Not possible. Thus, there are zero solution.	
74.	If $\int\left(\frac{1}{x}+\frac{1}{x^3}\right)\left(\sqrt[23]{3x^{-24}+x^{-26}}\right)dx=-\frac{\alpha}{3(\alpha+1)}\left(3x^{\beta}+x^{\gamma}\right)^{\frac{\alpha+1}{\alpha}}+C, x>0, (\alpha,\beta,\gamma \in Z)$, where C is the constant of integration, then $\alpha+\beta+\gamma$ is equal to……….. .	**19**

Sol.	(19) $\int\left(\frac{1}{x}+\frac{1}{x^3}\right)\left(\sqrt[23]{3x^{-24}+x^{-26}}\right)dx$ $=\int\left(\frac{1}{x}+\frac{1}{x^3}\right)\left(\frac{3}{x^{24}}+\frac{1}{x^{26}}\right)^{\frac{1}{23}}dx$ $=\int\frac{1}{x}\left(\frac{1}{x}+\frac{1}{x^3}\right)\left(\frac{3}{x}+\frac{1}{x^3}\right)^{\frac{1}{23}}dx$ $=\int\left(\frac{1}{x^2}+\frac{1}{x^4}\right)\left(\frac{3}{x}+\frac{1}{x^3}\right)^{\frac{1}{23}}dx$ Let $\frac{3}{x}+\frac{1}{x^3}=t\Rightarrow\left(-\frac{3}{x^2}-\frac{3}{x^4}\right)dx=dt$ $\Rightarrow -3\left(\frac{1}{x^2}+\frac{1}{x^4}\right)dx=dt$ $=-\frac{1}{3}\int t^{1/23}dt=-\frac{t^{\frac{24}{23}}}{\frac{24}{23}}+C$ $=-\frac{1}{3}\frac{23}{24}\left(\frac{3}{x}+\frac{1}{x^3}\right)^{\frac{24}{23}}+C$ $=-\frac{1}{3}\frac{23}{24}\left(\frac{3x^2+1}{x^3}\right)^{\frac{24}{23}}+C$ $=-\frac{1}{3}\frac{23}{24}(3x^{-1}+x^{-3})^{\frac{24}{23}}+C$ Compare with $-\frac{\alpha}{3(\alpha+1)}(3x^{\beta}+x^{\gamma})^{\frac{\alpha+1}{\alpha}}+C$ We get $\alpha=23,\beta=-1,\gamma=-3$ Thus, $\alpha+\beta+\gamma=23-1-3=19$	
75.	A card from a pack of 52 cards is lost. From the remaining 51 cards, n cards are drawn and are found to be spades. If the probability of the lost card to be a spade is $\frac{11}{50}$, then n is equal to …………	**2**

Sol.	(2) $E_1 =$ lost card is spade $E_2 =$ lost card is not spade $A = n$ drawing cards are spade $P\left(\frac{E_1}{A}\right)=\frac{11}{50}$ $\Rightarrow \frac{P(E_1)P\left(\frac{A}{E_1}\right)}{P(E_1)\cdot P\left(\frac{A}{E_1}\right)+P(E_2)\cdot P\left(\frac{A}{E_2}\right)}=\frac{11}{50}$ $\Rightarrow \frac{\frac{13}{52}\cdot\frac{^{12}C_n}{^{51}C_n}}{\frac{13}{52}\cdot\frac{^{12}C_n}{^{51}C_n}+\frac{39}{52}\cdot\frac{^{13}C_n}{^{51}C_n}}=\frac{11}{50}$ $\Rightarrow \frac{12C_n}{12C_n+3\cdot{}^{13}C_n}=\frac{11}{50}$ $\Rightarrow \frac{1}{1+3\frac{^{13}C_n}{^{12}C_n}}=\frac{11}{50}$ $\Rightarrow 1+3\frac{^{13}C_n}{^{12}C_n}=\frac{50}{11}$ $\Rightarrow \frac{^{13}C_n}{^{12}C_n}=\frac{39}{11}\times\frac{1}{3}\Rightarrow\frac{^{13}C_n}{^{12}C_n}=\frac{13}{11}$ $\therefore n=2$	