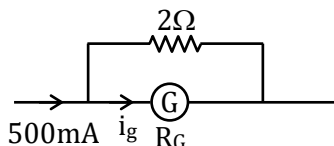
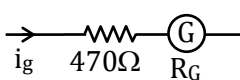


JEE–MAIN EXAMINATION – APRIL 2026

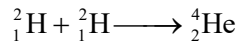
MEMORY BASED QUESTIONS

(HELD ON MONDAY 06th APRIL 2026)

TIME : 3:00 PM TO 6:00 PM

PHYSICS	TEST PAPER WITH SOLUTION																
1. A galvanometer is used for making an ammeter of range 500 mA when a shunt of 2Ω is used. The same galvanometer is used for making a voltmeter of range 10V when a resistance of 470Ω is used in series. Then find resistance of galvanometer. (1) 30Ω (2) 50Ω (3) 10Ω (4) 100Ω Ans. (2) Sol. For ammeter :  $i_g R_G = (500 \times 10^{-3} - i_g) \times 2$ For voltmeter :  $i_g = (470 + R_G) = 10 \quad \dots(ii)$ From (i) & (ii) $470 i_g + 1 - 2i_g = 10$ $i_g = \frac{9}{468} \text{ A}$ $\therefore 470 + R_G = \frac{10}{9} \times 468$ $\therefore R_G = 50\Omega$	3. If minimum deviation for an equilateral prism is 30°, then refractive index of prism is :- (1) $\sqrt{2}$ (2) $\sqrt{3}/2$ (3) 2 (4) 4 Ans. (1) Sol. $A = 60^\circ$ $30 = 2i - 60$ $i = 45$ $r_1 = \frac{A}{2} = 30^\circ$ $\sin i = \mu \times \sin r_1$ $\sin 45^\circ = \mu \times \sin 30^\circ$ $\mu = \sqrt{2}$ 4. Match the following quantities with their dimensions. <table><tr><td>(A)</td><td>Boltzman constant (K)</td><td>(P)</td><td>$[M^{-1}L^3T^{-2}]$</td></tr><tr><td>(B)</td><td>Plank's constant (h)</td><td>(Q)</td><td>$[M^1L^2T^{-1}]$</td></tr><tr><td>(C)</td><td>Stefan's constant (σ)</td><td>(R)</td><td>$[M^1L^2T^{-2}K^{-1}]$</td></tr><tr><td>(D)</td><td>Gravitational constant (G)</td><td>(S)</td><td>$[M^1L^0T^{-3}K^{-4}]$</td></tr></table> (1) A-Q, B-R, C-S, D-P (2) A-P, B-Q, C-S, D-R (3) A-P, B-S, C-R, D-P (4) A-R, B-Q, C-S, D-P Ans. (4) Sol. Boltzman constant (K) $K = \frac{R}{N_A} = \frac{\text{Energy}}{\text{Temperature}} \Rightarrow [M^1L^2T^{-2}K^{-1}]$ Plank's constant (h) = $h = \frac{E}{\nu} \Rightarrow [M^1L^2T^{-1}]$ Stefan's constant (σ) = $P = \sigma AT^4 \Rightarrow [M^1L^0T^{-3}K^{-4}]$ Gravitational constant (G) = $F = \frac{GM_1M_2}{r^2} \Rightarrow [M^{-1}L^3T^{-2}]$	(A)	Boltzman constant (K)	(P)	$[M^{-1}L^3T^{-2}]$	(B)	Plank's constant (h)	(Q)	$[M^1L^2T^{-1}]$	(C)	Stefan's constant (σ)	(R)	$[M^1L^2T^{-2}K^{-1}]$	(D)	Gravitational constant (G)	(S)	$[M^1L^0T^{-3}K^{-4}]$
(A)	Boltzman constant (K)	(P)	$[M^{-1}L^3T^{-2}]$														
(B)	Plank's constant (h)	(Q)	$[M^1L^2T^{-1}]$														
(C)	Stefan's constant (σ)	(R)	$[M^1L^2T^{-2}K^{-1}]$														
(D)	Gravitational constant (G)	(S)	$[M^1L^0T^{-3}K^{-4}]$														

5. For the reaction find energy released



$\frac{BE}{A}$ for ${}^2_1\text{H} = 1.1 \text{ MeV}$ and for ${}^4_2\text{H} = 7.2 \text{ MeV}$:

- (1) 24.4 MeV (2) 6.2 MeV
(3) 6.1 MeV (4) 8 MeV

Ans. (1)

Sol. $Q = BE_{\text{He}} - BE_{\text{H}}$
 $= 4 \times 7.2 - 2(2 \times 1.1) = 24.4 \text{ MeV}$

6. A square loop of side 2 cm makes angle 60° with magnetic field $\vec{B} = 0.4 \sin(300t) \text{ T}$. Find maximum induced EMF (in mV) in loop.

- (1) 24 (2) 36
(3) 48 (4) 16

Ans. (1)

Sol. $E_{\text{max}} = B_0 A N \omega \cos 60^\circ$
 $= 0.4 \times 4 \times 10^{-4} \times 1 \times 300 \times \frac{1}{2} \text{ V}$
 $= 24 \times 10^{-3} \text{ V}$
 $= 24 \text{ mV}$

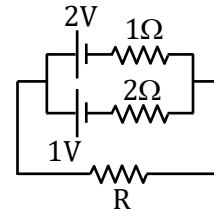
7. A charge particle when accelerated from rest by a potential difference V_1 has a de-Broglie wavelength λ_1 and when accelerated by a potential difference V_2 has a de-Broglie wavelength λ_2 . If $\lambda_2 = \frac{3\lambda_1}{2}$, find ratio $\frac{V_1}{V_2}$.

- (1) $\frac{9}{4}$ (2) $\frac{4}{9}$
(3) $\frac{2}{3}$ (4) $\frac{3}{2}$

Ans. (1)

Sol. $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mq\Delta V}}$
 $\therefore \lambda_1 = \frac{h}{\sqrt{2mqV_1}}$
 $\therefore \lambda_2 = \frac{h}{\sqrt{2mqV_2}}$
 Given, $\lambda_2 = \frac{3\lambda_1}{2}$
 $\therefore \frac{h}{\sqrt{2mqV_2}} = \frac{3}{2} \frac{h}{\sqrt{2mqV_1}}$
 $\therefore \frac{V_1}{V_2} = \frac{9}{4}$

8. In the given circuit, current passing through R is 1 ampere. Now polarity of one cell is reversed, then current through R becomes $\frac{\alpha}{5} \text{ Amp.}$, then find α .



Ans. (3)

Sol. $\varepsilon_{\text{eq}} = \frac{2 \times 2 + 1 \times 1}{3} = \frac{5}{3}$

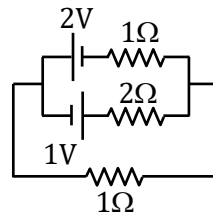
$$r_{\text{eq}} = \frac{2}{3}$$

$$I = \frac{5}{3 \left[R + \frac{2}{3} \right]}$$

$$3R + 2 = 5$$

$$R = 1\Omega$$

Now,



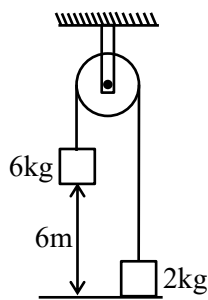
$$\varepsilon_{\text{eq}} = \frac{4 - 1}{3} = 1 \text{ V}$$

$$r_{\text{eq}} = \frac{2}{3}$$

$$I = \frac{1}{1 + \frac{2}{3}} = \frac{3}{5}$$

$$\alpha = 3$$

9. If 6kg block is released from rest as shown in figure then find velocity of 6 kg block just before hitting ground.



- (1) 6.2 m/sec (2) 7.74 m/sec
(3) 4.7 m/sec (4) 3.87 m/sec

Ans. (2)

Sol. $+6 \times 10 \times 6 - 2 \times 10 \times 6$

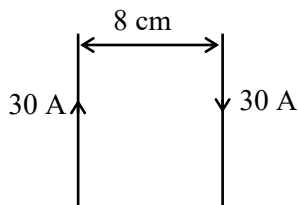
$$= \frac{1}{2}6V^2 + \frac{1}{2}2V^2$$

$$360 - 120 = 4V^2$$

$$4V^2 = 240$$

$$V = 2\sqrt{15}$$

10. Find magnetic field at mid point between two parallel infinite wire carrying current of 30 Amp as shown in figure.



- (1) 0 μ T (2) 300 μ T
(3) 150 μ T (4) 30 μ T

Ans. (2)

Sol. $B_{\text{net}} = B_1 + B_2$ direction of magnetic field due to both wire in same direction.

$$B_{\text{net}} = \frac{\mu_0 30}{2\pi \left(\frac{4}{100}\right)} + \frac{\mu_0 30}{2\pi \left(\frac{4}{100}\right)}$$

$$= \frac{2\mu_0 30}{2\pi \left(\frac{4}{100}\right)} = \frac{2 \times 4\pi \times 10^{-7} \times 30 \times 100}{2\pi \times 4}$$

$$B = 30 \times 10^{-5} \text{ T}$$

$$B = 300 \mu\text{T}$$

11. Consider two spheres A(solid sphere) and B(hollow sphere) each of radius R, kept on perfectly rough surface. Mass of sphere A is 5 m and that of B is 2m. If same force 'F' is applied at the top tangentially, then find the ratio of acceleration of A to acceleration of B.

- (1) $\frac{5}{17}$ (2) $\frac{10}{21}$
(3) $\frac{3}{5}$ (4) $\frac{2}{7}$

Ans. (2)

Sol. Since surface is perfectly rough $\Rightarrow$ sphere will roll

$$\therefore \tau_{\text{contact point}} = F 2R$$

$$I_A = \frac{7}{5} (5m) R^2$$

$$\therefore \alpha_A = \frac{2FR}{7mR^2} = \frac{2}{7} \frac{F}{mR}$$

$$\therefore a_A = \frac{2F}{7m}$$

$$I_B = \frac{5}{3} (2m) R^2$$

$$\alpha_B = \frac{2FR}{10mR^2} = \frac{6F}{10mR} = \frac{3}{5} \frac{F}{mR}$$

$$a_B = \frac{3F}{5m}$$

$$\therefore \frac{a_A}{a_B} = \frac{2 \times 5}{7 \times 3} = \frac{10}{21}$$

12. $C = 100 \text{ pF}$, $V = 100 \text{ V}$ (given spherical capacitor). Identical capacitor is touched with this capacitor. If change in total energy is $\alpha \times 10^{-7} \text{ J}$ then find $\alpha = ?$

{Combined capacitance = 200 PF}

- (1) 2.5 (2) 25
(3) 1 (4) 10

Ans. (1)

Sol. Initial energy $V_i = \frac{1}{2} CV^2$

After connecting with other capacitor

$$V_1 = V_2 = \frac{V}{2} \Rightarrow 50V$$

$$\begin{aligned} \text{Final energy } V_f &\Rightarrow \frac{1}{2} C \left(\frac{V}{2} \right)^2 + \frac{1}{2} \times C \times \left(\frac{V}{2} \right)^2 \\ &= \frac{CV^2}{4} \end{aligned}$$

$$\text{Energy loss} \Rightarrow V_i - V_f$$

$$\Rightarrow \frac{1}{2} CV^2 - \frac{1}{4} CV^2$$

$$= \frac{1}{4} CV^2 = \frac{1}{4} \times 100 \times 10^{-12} \times 10^4$$

$$= 25 \times 10^{-8}$$

$$= 2.5 \times 10^{-7} \text{ J}$$

$$\alpha = 2.5$$

- 13.** On an incline plane of angle 45° time taken by an object is t if it is smooth and $2t$ if it is rough. Find value of α if friction coefficient is $\frac{\alpha}{100}$.

Ans. (75)

Sol. $t = \sqrt{\frac{2h}{g \sin 45^\circ}}$

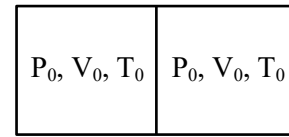
$$2t = \sqrt{\frac{2h}{g \sin 45^\circ - \mu g \cos 45^\circ}}$$

$$\frac{1}{2} = \sqrt{1 - \mu}$$

$$\mu = 1 - \frac{1}{4} = \frac{3}{4} = \frac{\alpha}{100}$$

$$\alpha = 75$$

- 14.** Figure shows an adiabatic container which is divided into two equal parts by an adiabatic freely moving piston



Both sides contain same gas having $\gamma = 1.5$. If heat is supplied to left part such that its pressure becomes $\frac{27P_0}{8}$, find volume of right part

(1) $\frac{3}{5} V_0$

(2) $\frac{2}{9} V_0$

(3) $\frac{4}{9} V_0$

(4) $\frac{V_0}{2}$

Ans. (3)

Sol. $\gamma = \frac{3}{2} = 1 + \frac{2}{f} \Rightarrow f = 4$

At equilibrium, $P_{\text{left}} = P_{\text{right}}$

$$\therefore P_{\text{left}} = \frac{27P_0}{8} = P_{\text{right}}$$

Since no heat is supplied to right chamber.

$$\therefore P_0 V_0^\gamma = P_f V_f^\gamma$$

$$\Rightarrow P_0 V_0^{1.5} = \frac{27}{8} P_0 V_f^{1.5}$$

$$\Rightarrow V_f = \left(\frac{8}{27} \right)^{2/3} V_0 = \frac{4}{9} V_0$$

15. When a mass of 200 gm hangs from ceiling via spring in equilibrium, the extension in the spring is observed to be 2mm. Find angular frequency of its SHM and energy stored in equilibrium position respectively.

- (1) $\omega = 2 \text{ rad/sec. ; } U = 50\sqrt{2} \text{ mJ}$
 (2) $\omega = 50\sqrt{2} \text{ rad/sec. ; } U = 2\text{mJ}$
 (3) $\omega = 100\sqrt{2} \text{ rad/sec. ; } U = 4\text{mJ}$
 (4) $\omega = 25\sqrt{2} \text{ rad/sec. ; } U = 1\text{mJ}$

Ans. (2)

Sol. At equilibrium

$$kx_0 = mg$$

$$k \times 2 \times 10^{-3} = 200 \times 10^{-3} \times 10$$

$$k = 1000 \text{ N/m}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{1000}{200 \times 10^{-3}}} = \sqrt{\frac{1000000}{200}} = \sqrt{5000}$$

$$\omega = 50\sqrt{2}$$

$$U = \frac{1}{2} kx_0^2$$

$$= \frac{1}{2} \times 1000 \times (2 \times 10^{-3})^2$$

$$= 2 \times 10^{-3} \text{ J}$$

$$U = 2\text{mJ}$$

16. An EM wave has angular frequency ω . Propagation constant $\vec{k}$ and electric field vector $\vec{E}$ is given, then $\vec{B}$ can be represented by :

- (1) $\vec{B} = \omega(\vec{K} \times \vec{E})$ (2) $\vec{B} = \omega(\vec{E} \times \vec{K})$
 (3) $\vec{B} = \frac{1}{\omega}(\vec{K} \times \vec{E})$ (4) $\vec{B} = \frac{1}{\omega}(\vec{E} \times \vec{K})$

Ans. (3)

Sol. $\vec{B} = \frac{1}{\omega}(\vec{K} \times \vec{E})$ Theoretical

17. In YDSE intensity of both coherent sources are I_0 . Separation between the two slits is 5 cm and screen is placed at distance of 50 cm from slit. Wavelength of light is $6000\text{\AA}$. If intensity for a point on screen is I_0 then find path difference at point P.

- (1) $1000 \text{\AA}$ (2) $2000 \text{\AA}$
 (3) $3000 \text{\AA}$ (4) $5000 \text{\AA}$

Ans. (2)

Sol. $I_R \Rightarrow 4I_0 \cos^2 \frac{\phi}{2}$

$$I_0 = 4I_0 \cos^2 \frac{\phi}{2}$$

$$\frac{1}{2} = \cos \frac{\phi}{2}$$

$$\frac{\phi}{2} = 60^\circ$$

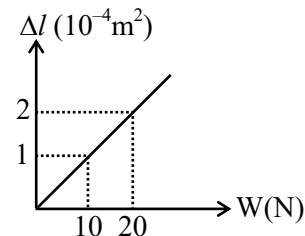
$$\phi = 120^\circ = \frac{2\pi}{3}$$

Path difference

$$\frac{\phi}{2\pi} = \frac{\Delta x}{\lambda}$$

$$\Delta x = \frac{\phi}{2\pi} \times \lambda \Rightarrow \frac{2\pi}{3 \times 2\pi} \times 6000 = 2000 \text{\AA}$$

18. A weight W is connected to one end of a wire and other end is fixed, length of wire is 1m. Area of cross-section is 10^{-5} m^2 , Graph between change in length and weight is shown then calculate Young's modulus.



- (1) 10^{11} N/m^2 (2) 10^9 N/m^2
 (3) 10^8 N/m^2 (4) 10^{10} N/m^2

Ans. (4)

Sol. $\tan \theta = \frac{10^{-4}}{10} = \frac{\Delta l}{W}$

$$\Delta l = 10^{-5} W$$

$$Y = \frac{Wl}{A\Delta l}$$

$$Y = \frac{10^5 \times 1}{10^{-5}}$$

$$Y = 10^{10} \text{ N/m}^2$$

19. 2 moles of monoatomic ideal gas has temperature T and 6 moles of monoatomic ideal gas has temperature $2T$. Find the temperature of mixture.

(1) $\frac{7T}{4}$ (2) $\frac{3T}{4}$
 (3) $\frac{4T}{4}$ (4) $7T$

Ans. (1)

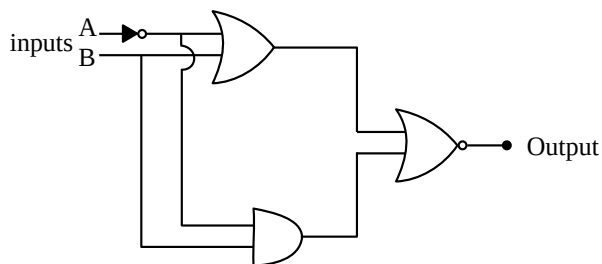
Sol. $Q_1 + Q_2 = Q_{\text{net}}$
 $n_1 C T_1 + n_2 C T_2 = n_1 C T + n_2 C T$
 $T_2 = \frac{n_1 T_1 + n_2 T_2}{n_1 + n_2} = \frac{2T + 6 \times (2T)}{2 + 6}$
 $= \frac{7T}{4}$

20. If error in diameter of a sphere is 2%, then find error in volume of sphere.

Ans. (6)

Sol. $V = \frac{4}{3} \pi r^3$
 $V = \frac{4}{3} \pi \left(\frac{d}{2}\right)^3$
 $V \propto d^3$
 $(\%V) = 3 (\%d)$
 $= 3 \times 2$
 $= 6\%$

21.



Which of the following is correct outputs for inputs (1, 1) and (0, 1)

- (1) 1, 1 (2) 0, 0
 (3) 1, 0 (4) 0, 1

Ans. (2)

Sol. Truth table

A	B	Output
1	1	0
0	1	0

22. For a concave mirror of focal length 10cm magnification is 2 for two positions of an object, Find distance between these two positions (in cm).

Ans. (10)

Sol. $\frac{v}{u} = \pm 2 \dots (1)$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{-10} \dots (2)$

$\frac{1}{\pm 2u} - \frac{1}{u} = \frac{-1}{10}$

$\Rightarrow \frac{3}{2u_1} = \frac{1}{10}; \frac{1}{2u_2} = \frac{1}{10}$

$u_1 = 15 \text{ cm}; u_2 = 5 \text{ cm}$

so distance $u_1 - u_2 = 15 - 5 = 10 \text{ cm}$

23. A block of mass 1 kg moving with velocity varies according to position as $v = 2x^2$. If block goes from $x = 0$ to $x = 5$. Find work done by the block

- (1) zero
 (2) 1250 J
 (3) 1000 J
 (4) 750 J

Ans. (2)

Sol. $W = \Delta KE = \frac{1}{2} M [V_2^2 - V_1^2]$

at $x = 0, V_1 = 0$

$x = 5, V_2 = 2 \times (5)^2 = 50$

$W = \frac{1}{2} \times 1 \times 1 \{50^2 - 0^2\}$

$= \frac{2500}{2} = 1250 \text{ J}$

24. Two particles of same masses moving initially with velocity $4\hat{i}$ and $4\hat{j}$ m/s respectively. Acceleration of first is $6\hat{i}+6\hat{j}$ and of second is zero. Find path of centre of mass of the system.

- (1) straight line
(2) circle
(3) parabola
(4) ellipse

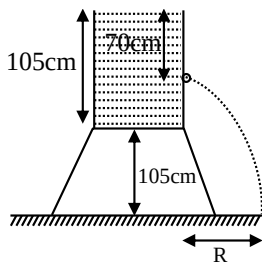
Ans. (1)

Sol. $\vec{V}_{cm} = \frac{m4\hat{i} + m4\hat{j}}{2m} = 2\hat{i} + 2\hat{j}$

$$\vec{a}_{cm} = \frac{2(6\hat{i} + 6\hat{j}) + m(0)}{2m} = 3\hat{i} + 3\hat{j}$$

both have same direction so straight line.

25. A cylindrical container has radius 40 cm and volume 528 (dm)^3 . It is placed on a table of same height as of container. A hole is made 70 cm below from free surface find range of efflux on ground if container filled completely.



- (1) $280\sqrt{2}$ cm (2) $140\sqrt{2}$ cm
(3) 140 (4) 280 cm

Ans. (2)

Sol. $V = \pi r^2 h$

$$528 \times 10^3 = \frac{22}{7} (40)^2 h$$

$$h = 105 \text{ cm}$$

$$t = \sqrt{\frac{2H}{g}}$$

$$= \sqrt{\frac{2 \times 140 \times 10^{-2}}{10}} = \sqrt{28} \times 10^{-1}$$

$$R = ut$$

$$= \sqrt{2 \times 10 \times 70 \times 10^{-2}} \sqrt{28} \times 10^{-1}$$

$$= \sqrt{14} \sqrt{28} \times 10^{-1}$$

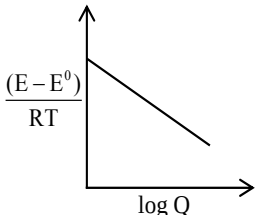
$$= 14\sqrt{2} \times 10^{-1} = 140\sqrt{2} \text{ cm}$$

JEE–MAIN EXAMINATION – APRIL 2026

MEMORY BASED QUESTIONS

(HELD ON MONDAY 06th APRIL 2026)

TIME : 3:00 PM TO 6:00 PM

CHEMISTRY	TEST PAPER WITH SOLUTION				
1. $A_1^{n_1+} + n_1e^- \rightarrow A_1$ $A_2 \rightarrow A_2^{n_2+} + n_2e^-$ Select incorrect option : (1) Overall cell reaction : $n_2A_1^{n_1+} + n_1A_2 \rightarrow n_2A_1 + n_1A_2^{n_2+}$ (2) Electrical work done by the cell = charge $\times$ potential difference. (3)  (4) In the overall cell reaction the number of electrons are not present, as electron liberated at anode, are consumed at cathode. Ans. (3) Sol. $\frac{E - E^0}{RT} = -\frac{2.303}{nF} \log Q$ So graph in option (3) should be straight line passing through origin. 2. For a certain decomposition $X_2Y_{4(g)} \rightleftharpoons 2XY_{2(g)}$ Degree of dissociation of X_2Y_4 is 75% at 1 bar and 600K. Find ΔG° of reaction in kJ/mol^{-1} Given $\left \begin{array}{ll} \ell n 6 = & 1.7918 \\ \ell n 7 = & 1.9459 \\ R = & 8.314 \text{ Jmol}^{-1}\text{K}^{-1} \end{array} \right$ Ans. (8) Sol. $k_p = \frac{4P_0\alpha^2}{1-\alpha^2} = \frac{36}{7}$ $\Delta G^\circ = -RT \ell n k_p$ $\Delta G^\circ = 8.314 \times 600 \ell n \left(\frac{36}{7} \right)$ $= 8169.5 \text{ J mol}^{-1}$ $= 8.169 \text{ kJ/mol}$	3. Total energy of Hydrogen like species is given as -54.4 eV/atom. The value of 'n' and 'Z' respectively are : (1) 1,2 (2) 2,2 (3) 2,1 (4) 1,1 Ans. (1) Sol. $E_n = -13.6 \times \frac{Z^2}{n^2} \text{ eV/atom}$ $-54.4 = -13.6 \left(\frac{Z^2}{n^2} \right)$ $\Rightarrow \frac{Z^2}{n^2} = 4$ $\Rightarrow Z = 2, n = 1$ 4. Consider given apparatus <table border="1" style="margin: auto;"> <thead> <tr> <th>Chamber-I</th> <th>Chamber-II</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">18 g glucose in 100 ml solution</td> <td style="text-align: center;">30 g glucose in 250 ml solution</td> </tr> </tbody> </table> ↑ SPM Statement-I : Water will move from chamber-I to chamber-II. Statement-II : 2.5 mg of 100 ml K_2SO_4 solution has osmotic pressure 0.0107 bar at 300 K ($R = 0.083 \text{ bar-L/mole-K}$). Choose correct statement. (1) Both Statement I and Statement II are correct (2) Statement I is correct but Statement II is incorrect. (3) Statement I is incorrect but Statement II is correct. (4) Both Statement I and Statement II are incorrect Ans. (3)	Chamber-I	Chamber-II	18 g glucose in 100 ml solution	30 g glucose in 250 ml solution
Chamber-I	Chamber-II				
18 g glucose in 100 ml solution	30 g glucose in 250 ml solution				

Sol. On side (I) $C_1 = 1$ molar
On side (II) $C_2 = 2/3$ molar
Hence water will flow from chamber-II to Chamber-I.

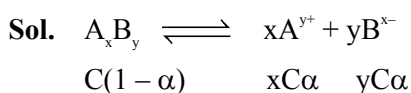
$$\text{And } \left(\pi = 3 \times \frac{2.5 \times 10^{-3} / 174}{100 / 1000} \right) \times 0.083 \times 300 = 0.0107 \text{ bar.}$$

5. For 'C' molar solution of weak electrolyte A_xB_y , dissociation constant is K, then degree of dissociation of A_xB_y at equilibrium is

$$(1) \left(\frac{K}{C^{x+y-1} x^x y^y} \right)^{\frac{1}{x+y}} \quad (2) \left(\frac{K \times C^{x+y-1}}{x^x - y^y} \right)^{\frac{1}{x+y}}$$

$$(3) \left(\frac{K \cdot x^x \cdot y^y}{C^{x+y-1}} \right)^{\frac{1}{x+y}} \quad (4) \left(\frac{K \times C^{x+y-1}}{x^x \times y^y} \right)^{x+y}$$

Ans. (1)



$$K = \frac{(xC\alpha)^x (yC\alpha)^y}{C(1 - \alpha)}$$

$$\text{As } \alpha \ll 1 \Rightarrow (1 - \alpha) \approx 1$$

$$K = x^x y^y C^{x+y-1} \alpha^{x+y}$$

$$\alpha = \left(\frac{K}{C^{x+y-1} x^x y^y} \right)^{\frac{1}{x+y}}$$

6. For a reaction rate constant (k) is given by

$$k = Ae^{-\frac{2800}{T}}$$

Calculate activation energy (E_a)

- (1) 23.28 KJ/mol
(2) 56 KJ/mol
(3) 232.8 KJ/mol
(4) 5600 KJ/mol

Ans. (1)

Sol. As $\frac{E_a}{R} = 2800$

$$E_a = \frac{2800 \times 8.314}{1000} \text{ KJ/mol}$$

$$E_a = 23.28 \text{ KJ/mol}$$

7.

Column-I (Isothermal process)		Column-II	
(P)	Reversible expansion	(i)	$q = 0$
(Q)	Reversible cyclic process	(ii)	$q = nRT \ln \left(\frac{V_2}{V_1} \right)$
(R)	Irreversible compression	(iii)	$W = -P_{\text{ext}}[V_2 - V_1]$
(S)	Free expansion	(iv)	$\frac{q_{\text{rev}}}{T} = 0$

Select the correct option.

- (1) P-(ii) ; Q-(iv) ; R-(iii); S-(i)
(2) P-(iii) ; Q-(ii) ; R-(iv); S-(i)
(3) P-(iv) ; Q-(i) ; R-(ii); S-(iii)
(4) P-(i) ; Q-(iii) ; R-(ii); S-(iv)

Ans. (1)

Sol. (P) For isothermal process, $\Delta U = 0$

$$W = -nRT \ln \left(\frac{V_2}{V_1} \right) \text{ so } q = nRT \ln \left(\frac{V_2}{V_1} \right)$$

(Q) Cyclic process, change in state function (S) so change in entropy must be zero.

(R) Irreversible process $W = -P_{\text{ext}} [V_2 - V_1]$

(S) Free expansion which is isothermal must be adiabatic, so $q = 0$

8. If the Bohr's radius of H-atom is 52.9 pm and radius of H like species is 70.53 pm, then chemical species and orbit number are respectively

- (1) Li^{+2} , 3
(2) Li^{+2} , 2
(3) He^+ , 3
(4) He^+ , 2

Ans. (2)

Sol. $r_{\text{species}} = a_0 \frac{n^2}{Z}$

$$70.53 = 52.9 \left(\frac{n^2}{Z} \right)$$

$$\frac{n^2}{Z} = \frac{70.53}{52.9} = 1.33 = \frac{4}{3}$$

$$(1) \text{Li}^{+2}, 3 \Rightarrow \frac{n^2}{Z} = \frac{9}{3} = 3$$

$$(2) \text{Li}^{+2}, 2 \Rightarrow \frac{4}{3} = 1.33$$

$$(3) \text{He}^+, 3 \Rightarrow \frac{9}{2} = 4.5$$

$$(4) \text{He}^+, 2 \Rightarrow \frac{4}{2} = 2$$

9. 0.2M, 500ml MnO_4^- solution is treated with 1.5M, 500ml KI solution in basic medium. The liberated I_2 required 'X'M, 300ml hypo solution. The value of 'X' is -

Ans. (1)

Sol. gm equivalent of $\text{MnO}_4^- = 0.2 \times \frac{500}{1000} \times 3 = 0.3$

$$\text{gm equivalent of KI} = 1.5 \times \frac{500}{1000} \times 1 = 0.75$$

$$\text{gm equivalent of } \text{MnO}_4^- = \text{gm equivalent of hypo}$$

$$0.3 = x \times \frac{300}{1000} \times 1$$

$$X = 1$$

10. Statement I : Of the following compounds SO_2 , SO_3 , H_2S , SF_4 ; only three compounds have complete octet.

Statement II : For the given set of compounds [SF_4 , BrF_5 , ClF_3]; [NH_3 , BrF_5 , SF_4]; [H_2O , IF_5 , XeF_4] only one set of compound has one lone pair on all central atoms.

- (1) Both Statement I and Statement II are correct
- (2) Statement I is incorrect but Statement II is correct.
- (3) Statement I is correct but Statement II is incorrect.
- (4) Both Statement I and Statement II are incorrect

Ans. (2)

Sol. SO_2 , SO_3 , H_2S , SF_4 all compounds have complete octet.

IF_5 , NH_3 , BrF_5 , SF_4 have one lone pair on central atom

ClF_3 , XeF_4 have two lone pair on central atom.

11. Consider the following ionization energy order

(A) IE_1 : $\text{Cr} > \text{Mn}$

(B) IE_2 : $\text{Cr} < \text{Mn}$

(C) IE_1 : $\text{Cr} < \text{Mn}$

(D) IE_2 : $\text{Cr} > \text{Mn}$

Correct order among the following :

(1) A and B

(2) B and C

(3) C and D

(4) A and D

Ans. (3)

Sol. $\text{Cr} - [\text{Ar}]3d^54s^1$

$\text{Mn} - [\text{Ar}]3d^54s^2$

$\text{IE}_1 - \text{Mn} > \text{Cr}$

$\text{IE}_2 - \text{Mn} < \text{Cr}$

12. 'X' is the nitrogen containing compound which is added to freshly prepared FeSO_4 and dilute H_2SO_4 to form a brown ring complex 'Y'.

Identify X and Y.

(1) NO ; $[\text{Fe}(\text{NO})]\text{SO}_4$

(2) N_2O ; $[\text{Fe}(\text{N}_2\text{O})]\text{SO}_4$

(3) NO_2 ; $[\text{Fe}(\text{NO}_2)]\text{SO}_4$

(4) N_2O_4 ; $[\text{Fe}(\text{N}_2\text{O}_4)]\text{SO}_4$

Ans. (1)

Sol. $\text{NO} + \text{FeSO}_4 \xrightarrow{\text{dil. H}_2\text{SO}_4} [\text{Fe}^{\text{I}}(\text{NO})]\text{SO}_4$

13. Statement I : The bond angle order in OF_2 , H_2O , OCl_2 is $\text{OF}_2 < \text{H}_2\text{O} < \text{OCl}_2$

Statement II : SiF_4 , SnF_4 and PbF_4 are all ionic compounds.

Which of the following option is correct.

(1) Both Statement I and Statement II are correct

(2) Statement I is incorrect but Statement II is correct.

(3) Statement I is correct but Statement II is incorrect.

(4) Both Statement I and Statement II are incorrect

Ans. (3)

Specie Bond angle

OCl_2 111°

H_2O 104.5°

OF_2 103°

SiF_4 is covalent.

14. For the given coordination compounds.

(A) $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is sp^3d^2 , octahedral and paramagnetic.

(B) $[\text{Ni}(\text{CO})_4]$ is sp^3 , tetrahedral and paramagnetic.

(C) $[\text{Ni}(\text{CN})_4]^{2-}$ is dsp^2 , square planar and diamagnetic.

(D) $[\text{NiCl}_4]^{2-}$ is sp^3 , tetrahedral and paramagnetic.

The correct set of coordination compounds against the mentioned properties is

(1) A, B and D

(2) B, C and D

(3) A, C and D

(4) A, B and C

Ans. (3)

Sol. $[\text{Ni}(\text{CO})_4]$ is sp^3 , tetrahedral and diamagnetic

15. In a period, ionization energy of left most element is _____ and $|\Delta H_{\text{eg}}|$ value of right most element is _____. [Except noble gases]

(1) lowest, lowest

(2) lowest, highest

(3) highest, highest

(4) highest, lowest

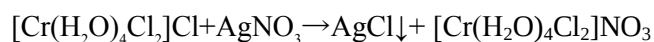
Ans. (2)

Sol. Left most element in a period will be of group 1 which will have lowest IE, while right most element will be of group 17 which will have highest $|\Delta H_{\text{eg}}|$.

16. If excess of AgNO_3 is added to 0.05M, 100ml of Tetraaquadichlorochromium(III) chloride complex aqueous solution, then the number of moles of AgCl precipitated is $x \times 10^{-3}$ moles. Find 'x'

Ans. (5)

Sol.



$\Rightarrow$ 1 mole of complex will precipitate 1 mole of AgCl .

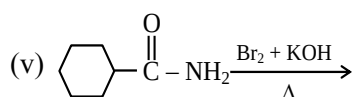
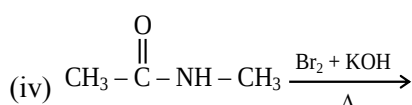
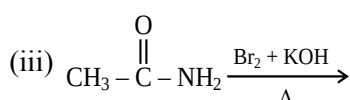
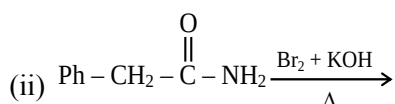
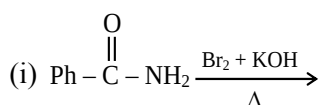
$\Rightarrow$ Given moles of complex =

$$M \times V = (0.05 \times 100 \times 10^{-3}) \text{ moles}$$

$\Rightarrow$ Moles of $\text{AgCl} = 5 \times 10^{-3}$ moles

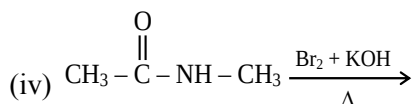
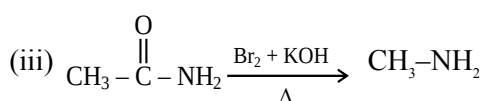
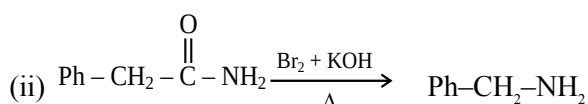
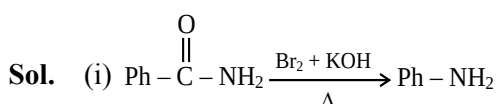
$\Rightarrow x = 5$

17. How many of the following reaction(s) product formed can also be prepared by Gabriel phthalimide synthesis :

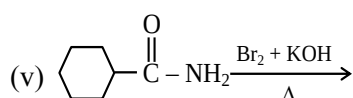


- (1) i, ii, iii
(2) ii, iii, iv
(3) ii, iii, v
(4) i, iii, v

Ans. (3)

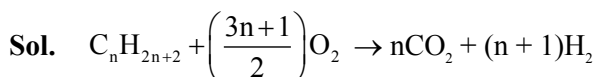


1° amine is not formed



18. 1 mol of alkane (X) for complete combustion required 8 mol of oxygen. When it is brominated in presence of sun light it gives only one product. How many primary carbons are present in alkane (X)?

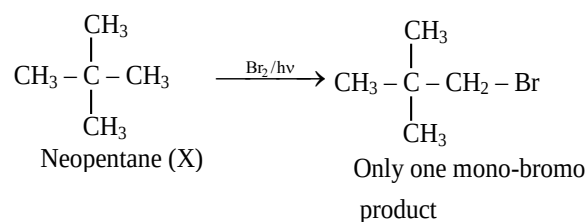
Ans. (4)



$$\frac{3n+1}{2} = 8$$

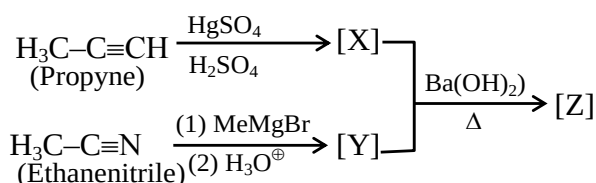
$$3n+1 = 8 \times 2$$

$$n = 5 (\therefore \text{C}_5\text{H}_{12})$$



Number of primary carbons = 4

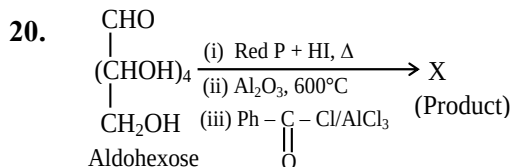
19. Give IUPAC name of the final product Z.



- (1) Mesityl oxide
(2) 4-Methylpent-3-en-2-one
(3) 4,4-Dimethylbut-3-en-2-one
(4) 2-Methylpent-2-en-4-one

Ans. (2)

Sol. X and Y is propanone which undergoes aldol condensation reaction and gives 4-Methylpent-3-en-2-one (Z) as final product

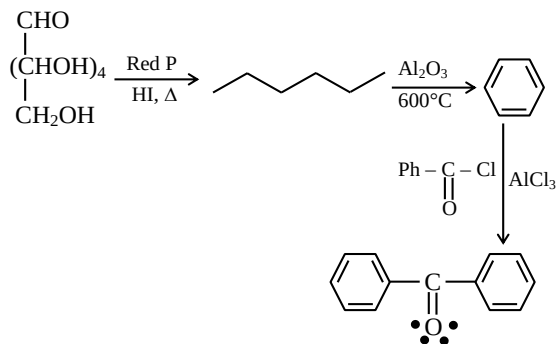


Aldohexose

Count the total number of e⁻ present in lone pair and π bond

- (1) 12 (2) 14
(3) 16 (4) 18

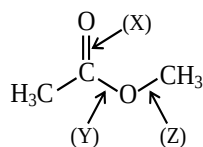
Ans. (4)



Sol.

Total number of lone pair electrons and π electrons in final product = 18

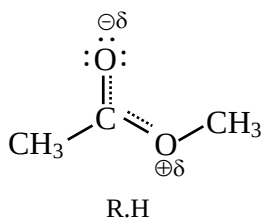
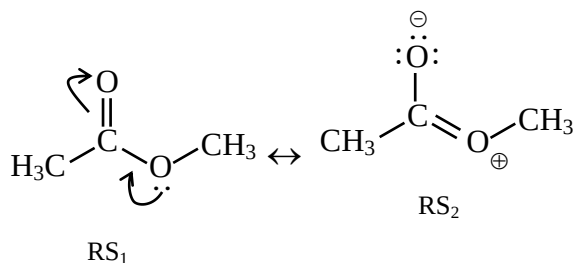
21. Compare the bond length X, Y and Z in the following compound



- (1) $X = Y = Z$ (2) $X = Y < Z$
 (3) $X < Y < Z$ (4) $X < Y = Z$

Ans. (3)

Sol.

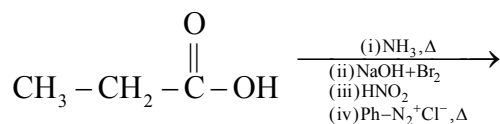


RS1 is more stable than RS2

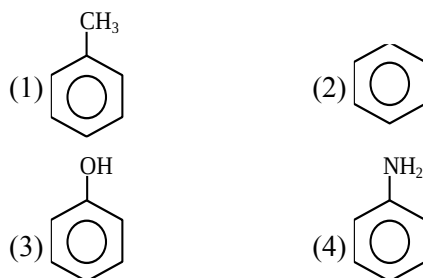
$\therefore$ contribution of RS1 is more than RS2 in its R.H.

$\therefore$ Order of bond length $x < y < z$

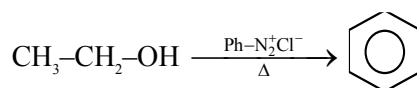
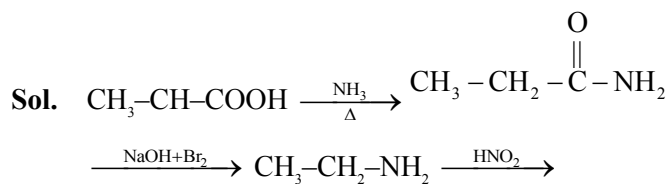
22.



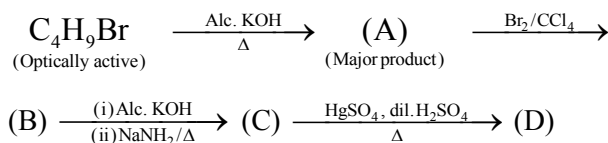
Major product P is :



Ans. (2)



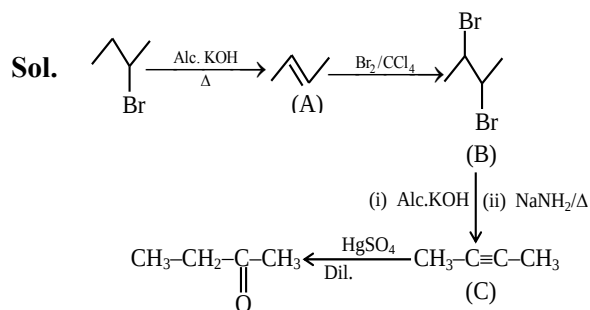
23.



Which of the following test will give confirmation of functional group in (D)

- (1) Haloform test
 (2) Benedict test
 (3) Lucas test
 (4) Tollen's test

Ans. (1)



Final product gives +ve haloform test

24. Statement- I : Mixture of Sugar and NaCl is separated by using ethanol because of difference in their solubility.

Statement-2 : Rose essence from rose petals is separated by steam distillation because of its higher volatility and insolubility in H_2O .

- (1) Both Statement I and Statement II are correct
- (2) Statement I is correct but Statement II is incorrect.
- (3) Statement I is incorrect but Statement II is correct.
- (4) Both Statement I and Statement II are incorrect

Ans. (1)

Sol. Theory based

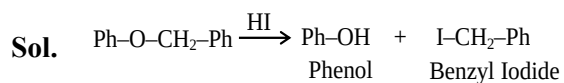
25. Statement – I : $Ph-O-CH_2-Ph \xrightarrow{HI}$

Product is mixture of benzyl alcohol & iodobenzene.

Statement – II : $Ph-O-CH_2-Ph$, $O-CH_2$ bond cleavage takes place during reaction with HI.

- (1) Statement-I is incorrect and statement-II is correct
- (2) Statement-I is correct and statement-II is incorrect
- (3) Both statements are correct
- (4) Both statements are incorrect.

Ans. (1)



JEE–MAIN EXAMINATION – APRIL 2026
MEMORY BASED QUESTIONS

(HELD ON MONDAY 06th APRIL 2026)

TIME : 3:00 PM TO 6:00 PM

MATHEMATICS	TEST PAPER WITH SOLUTION
1. Let $(n^2 - 2n + 2)x^2 - 3x + (n^2 - 2n + 2)^2 = 0$ be a quadratic equation. If α is the minimum value of product of roots and β is the maximum value of sum of roots, then the sum of first six terms of geometric progression whose first term is α and common ratio is $\left(\frac{\alpha}{\beta}\right)$, is (1) $\frac{364}{243}$ (2) $\frac{343}{243}$ (3) $\frac{256}{81}$ (4) $\frac{364}{81}$ Ans. (1) Sol. $\alpha = n^2 - 2n + 2$ $\alpha = (n - 1)^2 + 1$ $\therefore$ minimum value of α is 1 Similarly $\beta = \frac{3}{(n - 1)^2 + 1}$ $\therefore$ maximum value of β is 3 required G.P. is $1, \frac{1}{3}, \frac{1}{3^2}, \dots$ $S_6 = \frac{1\left(1 - \left(\frac{1}{3}\right)^6\right)}{1 - \frac{1}{3}} = \frac{3}{2}\left[1 - \left(\frac{1}{3}\right)^6\right] = \frac{364}{243}$ 2. The sum of series $1 + \frac{1}{2}(1^2 + 2^2) + \frac{1}{3}(1^2 + 2^2 + 3^2) + \dots$ upto 10 terms is (1) $\frac{313}{2}$ (2) $\frac{315}{2}$ (3) $\frac{325}{2}$ (4) $\frac{335}{2}$ Ans. (2)	Sol. $T_n = \frac{1}{n}(1^2 + 2^2 + \dots + n^2)$ $T_n = \frac{n(n+1)(2n+1)}{6n}$ $T_n = \frac{1}{6}[2n^2 + 3n + 1]$ $S_n = \Sigma T_n = \frac{1}{6}[2\Sigma n^2 + 3\Sigma n + \Sigma 1]$ $\Sigma T_n = \frac{1}{6}\left[2 \cdot \frac{n(n+1)(2n+1)}{6} + \frac{3n(n+1)}{2} + n\right]$ $S_{10} = \frac{1}{6}\left[\frac{2 \times 10 \times 11 \times 21}{6} + \frac{3}{2} \times 10 \times 11 + 10\right]$ $= \frac{10}{6}\left[77 + \frac{33}{2} + 1\right] = \frac{315}{2}$ 3. $\int_{-1}^1 \frac{x^3 + x + 1}{x^2 + x + 1} dx$ is equal to (1) $\ln 3 - \frac{\pi}{3\sqrt{3}}$ (2) $\frac{\pi}{3\sqrt{3}}$ (3) $\ln 3 + \frac{\pi}{3\sqrt{3}}$ (4) $\frac{-\pi}{3\sqrt{3}}$ Ans. (1) Sol. $\int_{-1}^1 \frac{x^3 + x + 1}{x^2 + x + 1} dx$ $= \int_{-1}^1 \frac{x^3}{x^2 + x + 1} dx + \int_{-1}^1 \frac{ x + 1}{x^2 + x + 1} dx$ $= 0 + 2 \int_0^1 \frac{x + 1}{x^2 + x + 1} dx$ $= \int_0^1 \frac{(2x + 1) + 1}{x^2 + x + 1} dx$ $= \int_0^1 \frac{2x + 1}{x^2 + x + 1} dx + \int_0^1 \frac{1}{x^2 + x + 1} dx$

$$\begin{aligned}
&= [\ln|x^2 + x + 1|]_0^1 + \left[\frac{2}{\sqrt{3}} \tan^{-1} \left(\frac{2x+1}{\sqrt{3}} \right) \right]_0^1 \\
&= \ln 3 - \frac{2}{\sqrt{3}} \left[\tan^{-1} \sqrt{3} - \tan^{-1} \frac{1}{\sqrt{3}} \right] \\
&= \ln 3 - \frac{2}{\sqrt{3}} \left(\frac{\pi}{3} - \frac{\pi}{6} \right) \\
&= \ln 3 - \frac{\pi}{3\sqrt{3}}
\end{aligned}$$

4. Let $\lim_{x \rightarrow 2} \frac{\tan(x-2)[rx^2 + (p-2)x - 2p]}{(x-2)^2} = 5$ for some

$r, p \in \mathbb{R}$. If the set of all possible values of q , such that the roots of the equation $rx^2 - px + q = 0$ lie in $(0, 2)$ be the interval $(\alpha, \beta]$, then $4(\alpha + \beta)$ is equal to

- (1) 11 (2) 21
(3) 17 (4) 13

Ans. (3)

Sol. $\lim_{x \rightarrow 2} \frac{\tan(x-2)}{x-2} \cdot \frac{[rx^2 + (p-2)x - 2p]}{x-2} = 5$

$$\Rightarrow \lim_{x \rightarrow 2} \frac{rx^2 - 2x + p(x-2)}{x-2} = 5$$

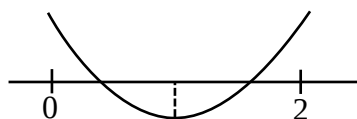
$$\because D^r \rightarrow 0 \therefore N^r \rightarrow 0 \Rightarrow r = 1$$

$$\Rightarrow \lim_{x \rightarrow 2} \frac{x(x-2) + p(x-2)}{x-2} = 5$$

$$\Rightarrow 2 + p = 5$$

$$\Rightarrow p = 3$$

Now, quadratic equation is $x^2 - 3x + q = 0$
its both roots lie in $(0, 2)$



$$D \geq 0, \quad 0 < \frac{-b}{2a} < 2, \quad f(0) > 0, \quad f(2) > 0$$

$$\Rightarrow 9 - 4q \geq 0 \text{ and } q > 2$$

$$\Rightarrow q \in \left(2, \frac{9}{4} \right]$$

$$\alpha = 2, \beta = \frac{9}{4} \Rightarrow 4 \left(2 + \frac{9}{4} \right) = 17$$

5. If matrix $\begin{bmatrix} 1 & 3 & 1 \\ 2 & 1 & \alpha \\ 0 & 1 & -1 \end{bmatrix}$ is singular. Given a function

$$f(x) = \int_0^x (t^2 + 2t + 3) dt \quad \forall x \in [1, \alpha] \text{ \& m and n are}$$

maximum and minimum value of function $f(x)$, then the value of $3(m - n)$ is

- (1) 550 (2) 510
(3) 490 (4) 540

Ans. (4)

Sol. $|m| = 7 - \alpha = 0 \Rightarrow \alpha = 7$

$$\text{given } f(x) = \int_0^x (t^2 + 2t + 3) dt$$

$$\Rightarrow f(x) = \frac{x^3}{3} + x^2 + 3x \text{ and}$$

$$f'(x) = x^2 + 2x + 3 > 0 \quad \forall x$$

$\therefore y = f(x)$ is strictly increasing function

$$\Rightarrow m = f(7) = \frac{553}{3}$$

$$\& n = f(1) = \frac{13}{3}$$

$$\therefore 3(m - n) = 540$$

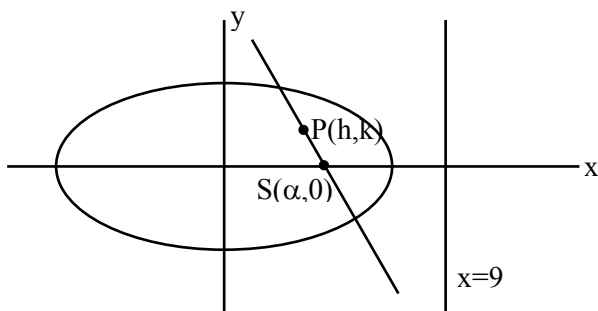
6. Let $x = 9$ be a directrix of an ellipse centred at $(0, 0)$ and having eccentricity $\frac{1}{3}$. If focus at $(\alpha, 0)$

$(\alpha > 0)$, then locus of the mid-point of the chord passing through the focus $(\alpha, 0)$ is

- (1) $8y^2 = 9x(1+x)$ (2) $9y^2 = 8x(1+x)$
(3) $9y^2 = 8x(1-x)$ (4) $8y^2 = 9x(1-x)$

Ans. (3)

Sol.



$$\frac{a}{e} = 9 \Rightarrow a = 3$$

$$b^2 = a^2(1 - e^2) = 9\left(1 - \frac{1}{9}\right) = 8$$

$$\frac{x^2}{9} + \frac{y^2}{8} = 1$$

$$S(\alpha, 0) \equiv S(1, 0)$$

$$T = S_1 \Rightarrow \frac{hx}{9} + \frac{ky}{8} = \frac{h^2}{9} + \frac{k^2}{8}$$

$$(1, 0) \Rightarrow \frac{h}{9} + 0 = \frac{h^2}{9} + \frac{k^2}{8}$$

$$h = h^2 + \frac{9}{8}k^2$$

$$9y^2 = 8x(1 - x)$$

7. The value of x which satisfies the equation

$$\sin^{-1}\left(\frac{2}{3}\sqrt{1-x^2}\right) = \cot^{-1}(2\sqrt{x}), \text{ is}$$

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

$$(3) \frac{1}{8} \quad (4) \frac{1}{9}$$

Ans. (1)

Sol. Taking sine on both the sides,

$$\sin\left(\sin^{-1}\frac{2}{3}\sqrt{1-x^2}\right) = \sin\left(\cot^{-1}2\sqrt{x}\right)$$

$$\Rightarrow \frac{2}{3}\sqrt{1-x^2} = \frac{1}{\sqrt{1+4x}}$$

$$\Rightarrow (1-x^2)(1+4x) = \frac{9}{4}$$

$$\Rightarrow x = \frac{1}{2}$$

8. Let $f: \mathbb{R} \rightarrow \mathbb{R}$, $f(x) = \frac{2x^2 - 3x + 2}{3x^2 + x + 3}$, then $f(x)$ is

- (1) one-one and onto (2) one-one and into
(3) many-one and into (4) many-one and onto

Ans. (3)

$$\text{Sol. } \frac{2x^2 - 3x + 2}{3x^2 + x + 3} = y$$

$$(3y-2)x^2 + (y+3)x + (3y-2) = 0$$

$$D \geq 0$$

$$(7y-1)(5y-7) \leq 0$$

$$y \in \left[\frac{1}{7}, \frac{7}{5}\right]$$

Hence $f(x)$ is into

obviously $f(x)$ is many-one because $f(x)$ is non-monotonic

9. An ellipse has directrix $x = 9$ & eccentricity $= \frac{1}{3}$.

If one of its focus is $(\alpha, 0)$, $\alpha > 0$, then locus of the mid-point of the chord passing through $P(\alpha, 0)$ is

$$(1) \frac{x^2}{9} + \frac{y^2}{8} = \frac{x}{9} \quad (2) \frac{x^2}{9} + \frac{y^2}{2} = \frac{x}{9}$$

$$(3) \frac{x^2}{8} + \frac{y^2}{2} = \frac{x}{8} \quad (4) \frac{x^2}{9} + \frac{y^2}{8} = \frac{x}{4}$$

Ans. (1)

Sol. $e = 1/3$

$x = 9$ is the directrix

$$\therefore \frac{a}{e} = 9$$

$$a = 3$$

$$\text{focus } (\alpha, 0) \equiv (ae, 0) \equiv (1, 0)$$

let mid-point of the chord is $m(h, k)$

$$\text{Also } b^2 = a^2(1 - e^2) = 9\left(1 - \frac{1}{9}\right) = 8$$

$$\text{Eqn. of ellipse is } \frac{x^2}{9} + \frac{y^2}{8} = 1$$

By $T = S_1$

$$\frac{hk}{9} + \frac{ky}{8} - 1 = \frac{h^2}{9} + \frac{k^2}{8} - 1$$

$$\Rightarrow 1 \frac{hk}{9} + \frac{ky}{8} = \frac{h^2}{9} + \frac{k^2}{8}$$

It is passing through P(1, 0)

$$\therefore \frac{h}{9} + 0 = \frac{h^2}{9} + \frac{k^2}{8}$$

$$\therefore \text{Req. locus is } \frac{h^2}{9} + \frac{y^2}{8} = \frac{x}{9}$$

- 10.** A lift of a 10 floor building contains 9 persons and group of 4 and 5 leave the lift on different floor and there is no stoppage of lift at 1st and 2nd floor, then find number of ways this can be done.

- (1) 7056 (2) 7656
(3) 7066 (4) 7057

Ans. (1)

Sol. Form group of 4 and 5 person $\frac{9!}{4!5!} = 126$

choose two floor out of 8 floor ${}^8C_2 = 28$

Total ways in which 4 & 5 persons can leave at different floor $126 \times 28 \times 2 = 7056$

- 11.** Let R be a relation such that

$$R = \{ \ell n(x+y) \leq 2, (x,y) \in \mathbb{N} \times \mathbb{N} \}.$$

Minimum no. of elements to be added in R so that it becomes transitive is _____

- (1) 10 (2) 15
(3) 14 (4) 16

Ans. (2)

Sol. $x + y \leq e^2$ ($e^2 \approx 7.29$)

$$R = \{(1, 1), (1, 2), (1, 4), (1, 5), (1, 6)\}$$

$$(2, 1), (2, 2), (2, 3), (2, 4), (2, 5)$$

$$(3, 1), (3, 2), (3, 3), (3, 4)$$

$$(4, 1), (4, 2), (4, 3)$$

$$(5, 1), (5, 2)$$

$$(6, 1)$$

For R to be transitive we have to add

$$(6, 2), (6, 3), (6, 4), (6, 5), (6, 6)$$

$$(5, 3), (5, 4), (5, 5), (5, 6)$$

$$(4, 4), (4, 5), (4, 6)$$

$$(3, 5), (3, 6)$$

$$(2, 3)$$

= 15 elements

- 12.** The shortest distance between the lines

$$\frac{x-3}{-1} = \frac{y-2}{4} = \frac{z-1}{2} \quad \& \quad \frac{x-1}{2} = \frac{y-1}{1} = \frac{z-2}{5}$$

- (1) $\sqrt{6}$ (2) $6\sqrt{6}$
(3) $\sqrt{5}$ (4) $5\sqrt{5}$

Ans. (1)

Sol. $\vec{a} = 3\mathbf{i} + 2\mathbf{j} + \mathbf{k}$ & $\vec{b} = \mathbf{i} + \mathbf{j} + 2\mathbf{k}$

$$\vec{r}_1 = -\hat{\mathbf{i}} + 4\mathbf{j} + 2\mathbf{k}$$

$$\vec{r}_2 = 2\mathbf{i} + \mathbf{j} + 5\mathbf{k}$$

$$\vec{r}_1 \times \vec{r}_2 = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -1 & 4 & 2 \\ 2 & 1 & 5 \end{vmatrix} = 18\mathbf{i} + 9\mathbf{j} - 9\mathbf{k}$$

$$\Rightarrow |\vec{r}_1 \times \vec{r}_2| = 9\sqrt{6}$$

Now

$$[\vec{a} - \vec{b} \quad \vec{r}_1 \quad \vec{r}_2] = \begin{vmatrix} 2 & 1 & -1 \\ -1 & 4 & 2 \\ 2 & 1 & 5 \end{vmatrix} = 54$$

$$\text{shortest distance} = \frac{[\vec{a} - \vec{b} \quad \vec{r}_1 \quad \vec{r}_2]}{|\vec{r}_1 \times \vec{r}_2|} = \frac{54}{9\sqrt{6}} = \sqrt{6}$$

- 13.** A bag contains 6 Red and 6 black balls. 6 pair of balls are selected one by one without replacement then the probability that each of the 6 pairs contains 1 red and 1 black ball.

- (1) $\frac{15}{231}$ (2) $\frac{14}{231}$
(3) $\frac{13}{231}$ (4) $\frac{16}{231}$

Ans. (4)

Sol. probability = $\frac{|6 \times 6|}{\left(\frac{12}{(2)^6} \times 6\right)} = \frac{16}{231}$

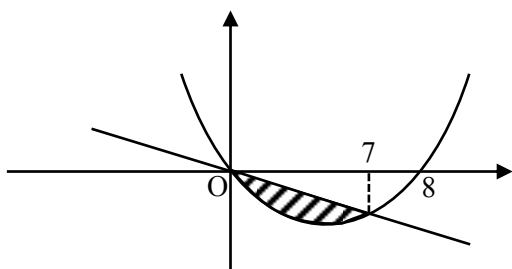
14. The area (in square units) of the region $\{(x, y) : x^2 - 8x \leq y \leq -x\}$, is

- (1) $\frac{343}{6}$ (2) $\frac{343}{2}$
 (3) $\frac{1715}{6}$ (4) $\frac{340}{3}$

Ans. (1)

Sol. Required area = $\int_0^7 (7x - x^2) dx$

$$= \left[\frac{7x^2}{2} - \frac{x^3}{3} \right]_0^7 = \frac{343}{6}$$



15. If system of equations
 $x \cos 3\theta - 8y - 12z = 0$
 $x \cos 2\theta + y + 3z = 0$
 $x + y + 3z = 0$ has non-trivial solution, then find sum of values of θ (where $\theta \in [0, 2\pi]$)

- (1) π (2) 2π (3) 3π (4) 4π

Ans. (3)

Sol. For Non-trivial solution

$$\begin{vmatrix} \cos 3\theta & -8 & -12 \\ \cos 2\theta & 1 & 3 \\ 1 & 1 & 3 \end{vmatrix} = 0$$

$$\Rightarrow \begin{vmatrix} \cos 3\theta & -8 & 12 \\ \cos 2\theta & 1 & 0 \\ 1 & 1 & 0 \end{vmatrix} = 0$$

$$\cos 2\theta = 1$$

$$\theta = 0, \pi, 2\pi$$

$\therefore$ sum of values of θ is 3π

16. Let $\vec{a} = 2\hat{i} + 3\hat{j} + 3\hat{k}$, $\vec{b} = 6\hat{i} + 3\hat{j} + 3\hat{k}$. If $2\vec{a} + 3\vec{b}$ and

$\vec{a} - \vec{b}$ are two adjacent sides of a triangle then square of area of the triangle is

- (1) 1800 (2) 1600
 (3) 2000 (4) 2200

Ans. (1)

Sol. $2\vec{a} + 3\vec{b} = 2(2\hat{i} + 3\hat{j} + 3\hat{k}) + 3(6\hat{i} + 3\hat{j} + 3\hat{k})$

$$\Rightarrow 22\hat{i} + 15\hat{j} + 15\hat{k}$$

$$\vec{a} - \vec{b} = -4\hat{i}$$

$$\text{Area} = \frac{1}{2} |(2\vec{a} + 3\vec{b}) \times (\vec{a} - \vec{b})|$$

$$= \frac{1}{2} |-60\hat{j} + 60\hat{k}| = \frac{1}{2} \sqrt{(60)^2 \times 2}$$

$$A = \frac{60}{\sqrt{2}}$$

Square of area is $A^2 = 1800$

17. Consider the observations : 2, 4, α , β , 6, 12, 14. If their mean is 8 and variance = 16, then the quadratic equation whose roots are $3\alpha + 2$ & $2\beta + 1$, is

$$(1) x^2 - 49x + 544 = 0 \quad (2) x^2 - 49x - 544 = 0$$

$$(3) x^2 - 23x - 512 = 0 \quad (4) x^2 + 23x - 512 = 0$$

Ans. (1)

Sol. $S = 2 + 4 + \alpha + \beta + 6 + 12 + 14$
 $= \alpha + 38 + \beta$

$$\text{Mean} = \frac{\alpha + \beta + 38}{7} = 8$$

$$\alpha + \beta = 18$$

$$\text{Variance} = \sum \frac{x_i^2}{n} - \left(\frac{\sum x_i}{n} \right)^2$$

$$\Rightarrow \frac{1}{7}(4 + 16 + \alpha^2 + \beta^2 + 36 + 144 + 196) - 64 = 16$$

$$\Rightarrow \frac{1}{7}(\alpha^2 + \beta^2 + 396) = 80$$

$$\alpha^2 + \beta^2 + 396 = 560$$

$$\alpha^2 + \beta^2 = 164$$

$$(\alpha + \beta)^2 - 2\alpha\beta = 164$$

$$324 - 164 = 2\alpha\beta \Rightarrow \alpha\beta = 80$$

$$\alpha = 10, \beta = 8$$

$$\text{Sum} = (3\alpha + 2) + (2\beta + 1) = 32 + 17 = 49$$

$$\text{Product} = (3\alpha + 2) + (2\beta + 1) = 32 \times 17 = 544$$

$$\text{Required quadratic equation is } x^2 - 49x + 544 = 0$$

18. Let a hyperbola be $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ & ellipse be

$$\frac{x^2}{9} + \frac{y^2}{8} = 1. \text{ If length of latus rectum of hyperbola}$$

is equal to minor axis of ellipse & eccentricity of hyperbola is equal to semi-major axis of ellipse, then $2ae$ is equal to

(where 'e' is the eccentricity of hyperbola)

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

Ans. (2)

Sol. $\frac{2b^2}{a} = 4\sqrt{2} = b^2 = 2\sqrt{2}a$

$$e_H = \sqrt{1 + \frac{b^2}{a^2}} = 3 \Rightarrow 1 + \frac{b^2}{a^2} = 9 \Rightarrow b^2 = 8a^2$$

$$a = \frac{\sqrt{2}}{4}, b^2 = 1 \Rightarrow b = 1$$

$$\therefore 2ae = 2 \times \frac{\sqrt{2}}{4} \times 3 = \frac{3\sqrt{2}}{2}$$

19. Let $f(x)$ be a function satisfying the functional rule $f(xy) = f(x)f(y)$, $f(0) \neq 0$.

If $x^2 g(x) = \int_1^x (t^2 f(t) + t g(t)) dt$, then $g(2)$ is equal to

$$(1) \frac{15}{32} \quad (2) \frac{3}{4} \quad (3) \frac{4}{3} \quad (4) \frac{32}{15}$$

Ans. (2)

Sol. $\therefore f(xy) = f(x)f(y)$

$$\therefore f(x) = x^n \text{ or } f(x) = k$$

$$\text{But } f(0) \neq 0 \Rightarrow f(x) \neq x^n$$

$$\text{For } f(x) = k \Rightarrow k = k.k \Rightarrow k = 1 (\because f(0) \neq 0)$$

$$f(x) = 1$$

$$\text{Now, } x^2 \cdot g(x) = \int_1^x (t^2 \cdot 1 + t \cdot g(t)) dt$$

Differentiating both the sides

$$x^2 \cdot g'(x) + g(x) \cdot 2x = x^2 + xg(x)$$

$$x^2 g'(x) + xg(x) = x^2$$

$$xg'(x) + g(x) = x$$

$$x \cdot g(x) = \frac{x^2}{2} + c$$

$$\therefore g(1) = 0 \Rightarrow c = -\frac{1}{2}$$

$$\Rightarrow x \cdot g(x) = \frac{x^2 - 1}{2}$$

$$\Rightarrow g(2) = \frac{3}{4}$$

SECTION-B

1. Let $A = \begin{bmatrix} 1 & 0 & 0 \\ 3 & 1 & 0 \\ 9 & 3 & 1 \end{bmatrix}$. If $B = [b_{ij}]_{3 \times 3}$ and $B = A^{99} - I$,

then find $\frac{b_{31} - b_{21}}{b_{32}}$.

Ans. (149)

Sol. $A = P + I$

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 3 & 0 & 0 \\ 9 & 3 & 0 \end{bmatrix} + \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$A = P + I \text{ where } P^3 = 0$$

$$A^{99} = I + {}^{99}P + {}^{99}C_2 P^2$$

$$A^{99} - I = 99 \begin{bmatrix} 0 & 0 & 0 \\ 3 & 0 & 0 \\ 9 & 3 & 0 \end{bmatrix} + {}^{99}C_2 \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 9 & 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ 99 \times 3 & 0 & 0 \\ 44550 & 99 \times 3 & 0 \end{bmatrix}$$

$$b_{31} = 44550, \quad b_{21} = 99 \times 3, \quad b_{32} = 99 \times 3$$

$$\frac{44550 - 297}{297} = 149$$

2. If $(1 - x^3)^{10} = \sum_{r=0}^{10} a_r x^r \cdot (1 - x)^{30-2r}$, then find $\frac{9a_9}{a_{10}}$.

Ans. (30)

Sol. $(1 - x)^3 = 1 - x^3 - 3x(1 - x)$

$$(1 - x)^3 = 1 - x^3 - 3x + 3x^2$$

$$(1 - x)^3 + 3x - 3x^2 = 1 - x^3$$

$$(1 - x^3)^{10} = [(1 - x)^3 + 3x(1 - x)]^{10}$$

$$\Rightarrow {}^{10}C_r (3x(1 - x))^r \cdot ((1 - x)^3)^{10-r}$$

$$(1 - x^3)^{10} = {}^{10}C_r \cdot 3^r \cdot x^r \cdot (1 - x)^{30-2r}$$

$$\therefore a_r = {}^{10}C_r \cdot 3^r$$

$$\frac{a_9}{a_{10}} = \frac{{}^{10}C_9 \cdot 3^9}{{}^{10}C_{10} \cdot 3^{10}}$$

$$\frac{a_9}{a_{10}} = \frac{10}{3}$$

$$\therefore \frac{9a_9}{a_{10}} = 30$$

3. If α & β are the roots of the equation

$$z^2 - \sqrt{6}i z - 3 = 0, \text{ then find } \alpha^8 + \beta^8.$$

Ans. (162)

Sol. $z = \frac{\sqrt{6}i \pm \sqrt{-6 + 12}}{2}$

$$= \frac{\sqrt{6}i \pm \sqrt{6}}{2}$$

$$= \frac{\sqrt{6}}{2} (\pm 1 + i)$$

$$\alpha = \frac{\sqrt{6}}{2} (1 + i), \beta = \frac{-\sqrt{6}}{2} (1 - i)$$

$$\alpha = \frac{\sqrt{6}}{2} \times \sqrt{2} e^{i\pi/4}, \beta = -\frac{\sqrt{6}}{2} \times \sqrt{2} e^{-i\pi/4}$$

$$\alpha = \sqrt{3} e^{i\pi/4}, \beta = -\sqrt{3} e^{-i\pi/4}$$

$$\alpha^8 + \beta^8 = 81 \cdot e^{i2\pi} + 81 \cdot e^{i(-2\pi)}$$

$$= 81 (1 + 1) = 162$$

4. The line $x - y = 4$ is a chord of the circle

$$(x - 4)^2 + (y + 3)^2 = 9, \text{ which cuts the circle at points Q \& R. If P}(\alpha, \beta) \text{ lies on the circle such that}$$

$$PQ = PR, \text{ then find } (6\alpha + 8\beta)^2.$$

Ans. (18)

Sol. Solving $x - y = 4$ & $(x - 4)^2 + (y + 3)^2 = 9$

$$\text{We get } Q(4, 0) \text{ \& } R(1, -3)$$

$$PQ^2 = PR^2$$

$$\Rightarrow (\alpha - 4)^2 + \beta^2 = (\alpha - 1)^2 + (\beta + 3)^2$$

$$\Rightarrow \alpha + \beta = 1 \quad \dots (1)$$

$$\text{Also } (\alpha - 4)^2 + (\beta + 3)^2 = 9 \quad \dots (2)$$

Solving (1) & (2), we get

$$\alpha = 4 + \frac{3}{\sqrt{2}}, \beta = -3 - \frac{3}{\sqrt{2}}$$

and $\alpha = 4 - \frac{3}{\sqrt{2}}, \beta = -3 + \frac{3}{\sqrt{2}}$

For both pairs we get $(6\alpha + 8\beta)^2 = 18$

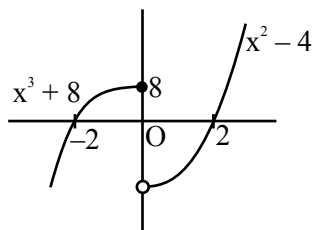
5. Let $f(x) = \begin{cases} x^3 + 8 & x < 0 \\ x^2 - 4 & x \geq 0 \end{cases}$

and $g(x) = \begin{cases} (x-8)^{1/3} & x < 0 \\ (x+4)^{1/2} & x \geq 0 \end{cases}$

then find number of points of discontinuity of $g(f(x))$.

Ans. (3)

Sol. $g(f(x)) = \begin{cases} (f(x)-8)^{1/3} & f(x) < 0 \\ (f(x)+4)^{1/2} & f(x) \geq 0 \end{cases}$



$$g(f(x)) = \begin{cases} (x^3)^{1/3}, & x < -2 \\ (x^2 - 12)^{1/3}, & 0 < x < 2 \\ (x^3 + 12)^{1/2}, & -2 \leq x \leq 0 \\ (x^2)^{1/2}, & x \geq 2 \end{cases}$$

$$g(f(x)) = \begin{cases} x, & x < -2 \\ (x^3 + 12)^{1/2}, & -2 \leq x \leq 0 \\ (x^2 - 12)^{1/3}, & 0 < x < 2 \\ x, & x \geq 2 \end{cases}$$

Number of points of discontinuity is equal to 3.