JEE(Main)-2024 | 06 April 2024 (Shift-2 Evening) | Question Paper with Solutions | Memory Based

MATHEMATICS

1. Let $f(x)=\frac{1}{7-\sin x}$, then Range of f(x) is

Ans. $\left[\frac{1}{8},\frac{1}{6}\right]$

Sol. $-1\le \sin x\le 1$

$6\le 7-\sin x\le 8$

$\frac{1}{8}\le \frac{1}{7-\sin x}\le \frac{1}{6}$

$\left[\frac{1}{8},\frac{1}{6}\right]$

2. |A| = 3, order = 3

then $|\operatorname{adj}\left(4\operatorname{adj}\left(-3\operatorname{adj}\left(3\operatorname{adj}(2A)^{-1}\right)\right)\right)|=2^m\cdot 3^n$. Find m + n

Ans. 80

Sol. $|\operatorname{adj}\left(4\operatorname{adj}\left(-3\cdot 3^2\right)\operatorname{adj}\operatorname{adj}(2A)^{-1}\right)|$

$|\operatorname{adj}\left(4\left(-3^3\right)^2\operatorname{adj}(\operatorname{adj}(\operatorname{adj}(2A)^{-1}))\right)|$

$|4^2 3^{12}\operatorname{adj}\left(\operatorname{adj}\left(\operatorname{adj}\operatorname{adj}(2A)^{-1}\right)\right)|$

$2^{12}\cdot 3^{36}\left|2A^{-1}\right|^{2^4}$

$2^{12}\cdot 3^{36}\cdot\left(2^3\right)^{16}\left|A^{-1}\right|^{16}$

$2^{12}\times 3^{36}\times 2^{48}\frac{1}{|A|^{16}}$

$=2^{60}\cdot 3^{36}\cdot\frac{1}{3^{16}}$

$=2^{60}\cdot 3^{20}$

$m=60, n=20$

$m+n=80$

3. Let $x^2+\sqrt{2}x-8=0$ and $S_n=\alpha^n+\beta^n$, here α & β are roots of given equation, $(n\ge 1)$. Find value of $\frac{S_{10}+\sqrt{2}S_9}{8S_8}$.

Ans. 1

Sol. $S_n+\sqrt{2}\,S_{n-1}-8S_{n-2}=0$

put $n=10$,

$\frac{S_{10}+\sqrt{2}S_9}{8S_8}=1$

4. $\int \frac{1}{a^2\sin^2 x + b^2\cos^2 x}dx = \frac{1}{12}\tan^{-1}(3\tan x) + c$

Find maximum and minimum value of asinx + bcosx

Ans. maximum value = $\sqrt{40}$, minimum value = $-\sqrt{40}$

Sol. $\int \frac{1}{a^2\sin^2 x + b^2\cos^2 x}dx$

$\int \frac{\sec^2 x}{a^2\tan^2 x + b^2}dx$

$\frac{1}{a^2}\int \frac{\sec^2 x}{\tan^2 x + (b/a)^2}dx$

$\tan x = t$

$\sec^2 x dx = dt$

$\frac{1}{a^2}\int \frac{1}{t^2 + (b/a)^2}dt$

$\frac{1}{a^2}\left(\frac{a}{b}\right)\tan^{-1}\left(\frac{at}{b}\right) + c$

$\frac{1}{ab}\tan^{-1}\left(\frac{a}{b}\tan x\right) + c$

$\frac{a}{b} = 3 \quad ab = 12$

$a = 3b \quad 3b^2 = 12$

$b = 2$

$a = 6$

max value of $a\sin x + b\cos x = \sqrt{a^2 + b^2} = \sqrt{40}$

min value of $a\sin x + b\cos x = -\sqrt{a^2 + b^2} = -\sqrt{40}$

5. $1(1+x) + 2(1+x)^2 + 3(1+x)^3 + \cdots + 60(1+x)^{60}$

Ans. $S = (1+x)^{61}\left(\frac{60}{x} - \frac{1}{x^2}\right) + \frac{(1+x)}{x^2}$

Sol. $S = 1(1+x) + 2(1+x)^2 + 3(1+x)^3 + \cdots + 60(1+x)^{60}$

$(1+x) \quad S = \quad (1+x)^2 + 2(1+x)^3 + \cdots + 59(1+x)^{60} + 60(1+x)^{61}$

$-xS = (1+x) + (1+x)^2 + (1+x)^3 + \cdots + (1+x)^{60} - 60(1+x)^{61}$

$-xS = (1+x)\left(\frac{(1+x)^{60} - 1}{x}\right) - 60(1+x)^{61}$

$S = -(1+x)\left(\frac{(1+x)^{60} - 1}{x^2}\right) + 60\frac{(1+x)^{61}}{x}$

$S = -\frac{(1+x)^{61}}{x^2} + \frac{(1+x)}{x^2} + \frac{60(1+x)^{61}}{x}$

$S = (1+x)^{61}\left(\frac{60}{x} - \frac{1}{x^2}\right) + \frac{(1+x)}{x^2}$

6. $\vec{A} = \hat{i} + \hat{j} - 2\hat{k}$

$\vec{B} = (\vec{A} \times (\hat{i} + \hat{j})) \times \hat{i}$

then find projection of $\vec{A}$ on $\vec{B}$

Ans. 2

Sol. $\vec{A} \times (\hat{i} + \hat{j}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix}$

$\vec{A} \times (\hat{i} + \hat{j}) = 2\hat{i} - 2\hat{j}$

$\vec{B} = (\vec{A} \times (\hat{i} + \hat{j})) \times \hat{j} = 2\hat{k}$

Projection of $\vec{A}$ on $\vec{B} = \left|\frac{\vec{B}.\vec{A}}{|\vec{B}|}\right| = \left|\frac{2\hat{k}.(\hat{i} + \hat{j} - 2\hat{k})}{2}\right|$

$= \frac{4}{2} = 2$

7. In ΔABC vertices $A(2,5), B(8,3)$ and $C(h,k)$ and orthocenter is $(6,1)$ then value of $2h + k$ is

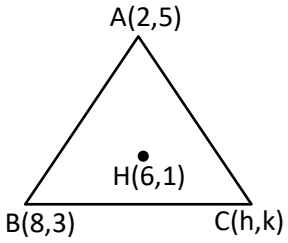
Ans. 13

Sol. $\therefore \quad \frac{4}{-4} \times \frac{k-3}{h-8} = -1 \Rightarrow k - 3 = h - 8 \Rightarrow h - k = 5$

and $\frac{2}{2} \times \frac{k-5}{h-2} = -1 \Rightarrow k - 5 = -h + 2 \Rightarrow h + k = 7$

$\therefore h = 6$

$k = 1$



$2h + k = 13$

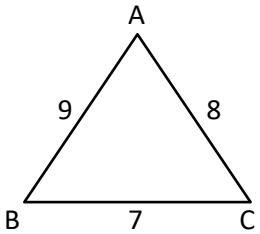
8. Sides of a triangle are AB = 9, BC = 7, AC = 8. Find cos3C.

Ans. $\frac{-262}{343}$

Sol. $\cos c = \frac{7^2 + 8^2 - 9^2}{2(7)(8)} = \frac{2}{7}$

$\cos 3C = 4\cos^3 c - 3\cos c$

$= 4\left(\frac{8}{343}\right) - \frac{6}{7} = -\frac{262}{343}$



9. Find the locus of P such that the ratio of distance of P from A(3, 1) and B(1, 2) is 5 : 4.

Ans. $9x^2 + 9y^2 + 46x - 68y - 35 = 0$

Sol. Let $P(h,k)$ $A(3,1)$, $B(1,2)$

$\frac{PA}{PB} = 5/4$

$\Rightarrow \frac{(h-3)^2 + (k-1)^2}{(h-1)^2 + (k-2)^2} = \frac{25}{16}$

$$\Rightarrow \frac{h^2+k^2-6h-2k+10}{h^2+k^2-2h-4k+5}=\frac{25}{16}$$

$$\Rightarrow 16h^2+16k^2-96h-32k+160=25h^2+25k^2-50h-100k+125$$

$$\Rightarrow 9h^2+9k^2+46h-68k-35=0$$

$$\Rightarrow 9x^2+9y^2+46x-68y-35=0$$

10. If area enclosed by region $\frac{a}{x^2}\le y\le\frac{1}{x}$ between x = 1 and x = 2 (where $a\in(0,1)$) is $\ln 2-\frac{1}{7}$, then find (7a – 3)

Ans. –1

Sol. $\text{Area}=\int_1^2\left(\frac{1}{x}-\frac{a}{x^2}\right)dx$

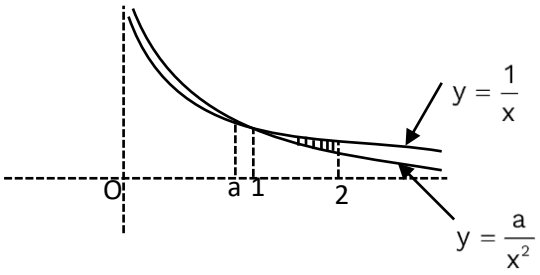
$$=\ln x+\frac{a}{x}\Big|_1^2$$

$$=\ln 2+\frac{a}{2}-a=\ln 2-\frac{1}{7}$$

$$\frac{a}{2}=\frac{1}{7}$$

$$\Rightarrow 7a=2$$

$$\Rightarrow 7a-3=-1$$



11. Let $A=\{1,2,3,4,5\}$, a Relation is defined as $4x\ge 5y$, $x\in A$, $y\in A$. Number of elements in R = m and number of elements in A × A is n, then find m + n

Ans. 35

Sol. Relation is $4x\ge 5y$

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

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

$\therefore$ m = 10

no. of element in $A\times A=5^2=25=n$

$\therefore m+n=35$

12. ${}^{n+1}C_{r+1}:{}^{n}C_{r}:{}^{n-1}C_{r-1}=55:35:21$ then $2n+5r$ is equal to

Ans. 50

Sol. $\frac{{}^{n}c_{r}}{{}^{n+1}c_{r+1}}=\frac{35}{55}\Rightarrow\frac{r+1}{n+1}=\frac{7}{11}$

$$\Rightarrow 11r+11=7n+7$$

$$\Rightarrow 11r=7n-4$$

$$\frac{{}^{n-1}c_{r-1}}{{}^{n}c_{r}}=\frac{r}{n}=\frac{3}{5}\Rightarrow 5r=3n$$

$$\Rightarrow 5r=3n \quad \& \quad 11r=7n-4$$

Solving we get

$$r=n-4$$

$$r=6$$

$n = 10$

So, $2n + 5r = 2 \times 10 + 5 \times 6 = 20 + 30 = 50$

13. If $f(x) = 3 + \left[\frac{x}{2}\right] - [\sqrt{x}]$ and $x \in [0,8]$ then find sum of points of discontinuity of $f(x)$

Ans. 17

Sol. Points to be check $x = 0,1,2,4,6,8$

at $x = 0$ $\quad f(0) = 3 = f(0^+)$ continuous

at $x = 4$ $\quad f(4) = f(4^+) = 3 = f(4^-)$ continuous

$\Rightarrow$ Sum $= 1 + 2 + 6 + 8 = 17$

14. If the function $f(x) = \left(\frac{1}{x}\right)^{2x}$ $x > 0$ attains the maximum value at $x = \frac{1}{e}$ then

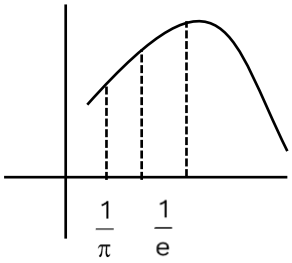
(1) $e^\pi < \pi^e$ (2) $e^{2\pi} < (2\pi)^e$ (3) $(2e)^\pi > (\pi)^{2e}$ (4) $e^\pi > \pi^e$

Ans. (4)

Sol. $f\left(\frac{1}{\pi}\right) < f\left(\frac{1}{e}\right)$

$(\pi)^{2/\pi} < e^{\left(\frac{2}{e}\right)} \Rightarrow \pi^{2e} < e^{2\pi}$

$\pi^e < e^\pi$



15. NAGPUR, Rearrange it and find 315^{th} word in Dictionary.

Ans. 242

Sol.

Order	NAGPUR
A	
G	
N	
P	Rank = 2 × 5! + 1(1!) + 1
R	= 240 + 2 = 242
U	

16. A curve $e^y \sin x\,dy + \cos x\left(e^y + 1\right)dx = 0$ passes through $\left(\frac{\pi}{2}, 0\right)$. then find $e^{y\left(\frac{\pi}{6}\right)}$.

Ans. 3

Sol. $\int \frac{e^y}{e^y + 1}dy = \int -\frac{\cos x}{\sin x}dx$

$\ln\left|e^y + 1\right| = -\ln|\sin x| + c$

$x = \pi/2, y = 0$

$\Rightarrow \quad \ln 2 = 0 + c$

$\Rightarrow \quad c = \ln 2$

$\ln\left|e^y+1\right| = -\ln|\sin x| + \ln 2$

When $x = \frac{\pi}{6}$

$\ln\left(e^y+1\right) = -\ln\left(\frac{1}{2}\right) + \ln 2$

$\ln\left(e^y+1\right) = 2\ln 2$

$e^y + 1 = 4$

$e^y = 3$

$\therefore e^{y\left(\frac{\pi}{6}\right)} = 3$

17. M computers complete a work in 17 days. If 4 Computers decrease everyday then it takes 8 more days to complete the same work. find the value of M.

Ans. 150

Sol. Total work $= 17mx$

$17mx = mx + (m-4)x + (m-8)x + \ldots.25 \text{ terms}$

$\Rightarrow 17m = \frac{25}{2}(2m + 24(-4))$

$\Rightarrow 34m = 25(2m - 96)$

$\Rightarrow 25 \times 96 = 16m$

$\Rightarrow m = \frac{25 \times 96}{16} = 150$

18. Let $g(x) = h\left(e^x\right) \cdot e^{h(x)}$, and it is given that $h(0) = 0, h(1) = 1, h'(0) = h'(1) = 2$, then find $g'(0)$.

Ans. 4

Sol. $g(x) = h\left(e^x\right) \cdot e^{h(x)}$

$\Rightarrow g'(x) = h'\left(e^x\right) \cdot e^x . e^{h(x)} + e^{h(x)} \cdot h'(x) \cdot h\left(e^x\right)$

$\Rightarrow g'(0) = h'(1) \cdot e^0 \cdot e^{h(0)} + e^{h(0)} \cdot h'(0) \cdot h(1)$

$\Rightarrow g'(0) = 2 \times 1 \times 1 + 1 \cdot 2 \cdot 1 = 4$

19. $\int_0^2 \left(\left[x^2\right] + \left[\frac{x^2}{2}\right]\right) dx = a + b\sqrt{2} + c\sqrt{3}$, then find value of $a+b+c$

Ans. 4

Sol. $\int_0^2 \left[x^2\right] dx + \int_0^2 \left[\frac{x^2}{2}\right] dx$

$= 0 + [x]_1^{\sqrt{2}} + 2[x]_{\sqrt{2}}^{\sqrt{3}} + 3[x]_{\sqrt{3}}^2 + 0 + [x]_{\sqrt{2}}^2$

$= (\sqrt{2} - 1) + 2\sqrt{3} - 2\sqrt{2} + 6 - 3\sqrt{3} + 2 - \sqrt{2}$

$= 7 - 2\sqrt{2} - \sqrt{3}$

$a = 7, \quad b = -2, c = -1$

So $a + b + c = 7 - 2 - 1 = 4$

20. $\frac{x-\lambda}{-1}=\frac{y-2}{1}=\frac{z-3}{2}$

$\frac{x-1}{2}=\frac{y-4}{3}=\frac{z-0}{1}$

shortest distance between these two given lines is $\frac{44}{\sqrt{3}}$ find λ.

Ans. -48

Sol. Formula of shortest distance

$$\Rightarrow \frac{\begin{vmatrix} x_2-x_1 & y_2-y_1 & z_2-z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}}{\sqrt{(a_1b_2-b_1a_2)^2+(b_1c_2-b_2c_1)^2+(a_1c_2-a_2c_1)^2}}$$

$$=\frac{\begin{vmatrix} \lambda-1 & -2 & 3 \\ -1 & 1 & 2 \\ 2 & 3 & 1 \end{vmatrix}}{\sqrt{(-5)^2+(-5)^2+(-5)^2}}$$

$$=\frac{-5\lambda+20}{5\sqrt{3}}$$

$$=\frac{-\lambda-4}{\sqrt{3}}=\frac{44}{\sqrt{3}}$$

$-\lambda - 4 = 44$

$-\lambda = 48$

$\lambda = -48$

PHYSICS

1. Energy supplied to 1 mole of monoatomic gas is 48 J and changes its temperature by 2°C. Find the work done by gas.

Ans. 23 J

Sol. By 1st law of thermodynamics

$\Delta Q = \Delta W + \Delta U$

$48 = W_{gas}\ \frac{3}{2} \times 1 \times \frac{25}{3} \times 2$

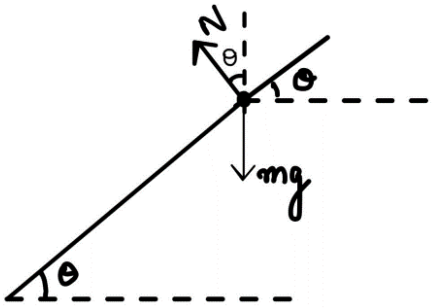
$\Rightarrow W_{gas} = 48 - 25$

$\Rightarrow W_{gas} = 23\ J$

2. If a car is moving on a banked road of radius R = 300 m and angle of banking 30°, then find the safe speed of the car.

Ans. 51.2 m/s

Sol.



$N \sin\theta + \mu N \cos\theta = \frac{mv^2}{R}$

$N \cos\theta - \mu N \sin\theta = mg$

$V_{max} = \sqrt{\left(\frac{\tan\theta + \mu}{1 - \mu \tan\theta}\right) Rg}$

$V_{max} = \sqrt{\left(\frac{0.2 + \frac{1}{\sqrt{3}}}{1 - \frac{0.2}{\sqrt{3}}}\right) 300 \times 10}$

$V_{max} = \sqrt{\left(\frac{0.2 + 0.577}{1 - 0.1154}\right) 3000}$

$V_{max} \sqrt{\frac{0.777}{0.884} \times 3000} = 51.2\ m/s$

3. If displacement in terms of time is given by $x^2 = 1 + t^2$ and acceleration is a function of x is x^{-n}, then find the value of n.

Ans. 3

Sol. $x^2 = 1 + t^2$

$2x\frac{dx}{dt} = 2t$ ...(i)

$\frac{dx}{dt} = \frac{t}{x}$

Differentiating eq. (i)

$x\frac{d^2x}{dt^2} + \left(\frac{dx}{dt}\right)^2 = 1$

$x\,(a) + \left(\frac{t}{x}\right)^2 = 1$

$a = \frac{1-\left(\frac{t}{x}\right)^2}{x} \Rightarrow \frac{\left(x^2 - t^2\right)}{x^3}$

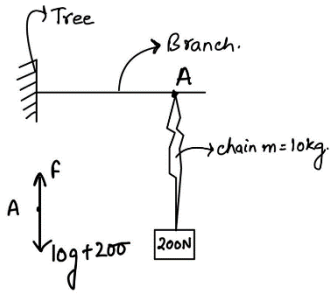
$a = \frac{1}{x^3} = x^{-3}$

$n = 3$

4. There is a block of weight 200N which is hanged from a chain of mass 10 kg which is connected with a tree from top. Find the tension at the topmost point of chain.

Ans. 300 N

Sol.



F = 100 + 200

= 300 N

5. Find the refractive index of a convex lens whose R_1 and R_2 are 15cm and 30cm respectively and its focus is 20cm.

Ans. $\mu = 1.5$

Sol. $R_1 = 15$ cm

$R_2 = 30$ cm

$f = 20$ cm

$\mu = ?$

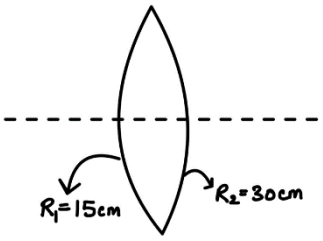
$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{20} = (\mu - 1)\left(\frac{1}{15} - \frac{1}{(-30)}\right)$

$\frac{1}{20} = (\mu - 1)\left(\frac{1}{10}\right)$

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

$\mu = 1.5$



6. If kinetic energy of a particle increases by 36%. What is the percentage change in momentum of the particle?

Ans. 16.62%

Sol. $K = \frac{p^2}{2m}$

$\Rightarrow p = \sqrt{2mk}$

$\Delta p = \frac{p_f - p_i}{p_i} \times 100$

$= \left[\frac{p_f}{p_i} - 1\right] \times 100$

$= \left[\frac{\sqrt{2mk_f}}{\sqrt{2mk_i}} - 1\right] \times 100$

$= \left[\sqrt{\frac{k_F}{k_i}} - 1\right] \times 100 = \left[\sqrt{\frac{136}{100}} - 1\right] \times 100$

= 16.619 %

≃ 16.62% increase

7. Light of wavelength λ = 300 nm incident on a metal surface whose work function ϕ = 2.4eV, then find stopping potential.

Ans. 1.73 V

Sol. $eV_s = \frac{hc}{\lambda} - \phi \quad , \frac{hc}{\lambda} = \frac{12400}{\lambda(\text{in Å})} eV$

Energy of photon = $\frac{12400}{3000} = \frac{124}{30} ev$

$eV_s = \frac{124}{30} eV - 2.4eV$

V_s = 1.73 V

8. If three particles are thrown from same height, 1st vertically up with speed u, second vertically down with speed u and third is released from rest. If time taken by the first particle, second particle and third particle is t_1, t_2 and t_3 respectively. Find relation between t_1, t_2 and t_3.

Ans. $t_3 = \sqrt{t_1 t_2}$

Sol. Case (i) $-H = ut_1 - \frac{1}{2}gt_1^2$ ...(i)

Case (ii) $-H = ut_2 - \frac{1}{2}gt_2^2$ ...(ii)

Case (iii) $-H = 0 - \frac{1}{2}gt_3^2$ ...(iii)

Multiply equation 1 by t_1 and equation 2 by t_2 and add the equations

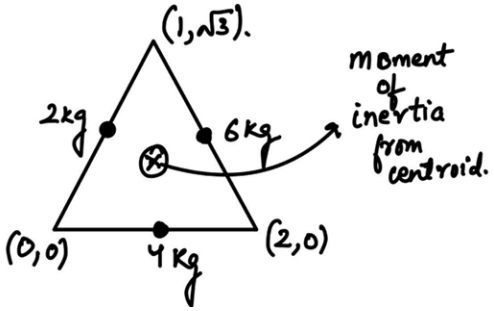
$-Ht_1 - Ht_2 = -\frac{1}{2} g\, t_1 t_2 (t_1 + t_2)$

$H = \frac{1}{2} g\, t_1 t_2$

$\frac{1}{2}gt_3^2 = \frac{1}{2}gt_1 t_2$

$\boxed{t_3 = \sqrt{t_1 t_2}}$

9. Find moment of inertia about an axis passing through centroid and perpendicular to the plane of triangle



Ans. 4 kg m^2

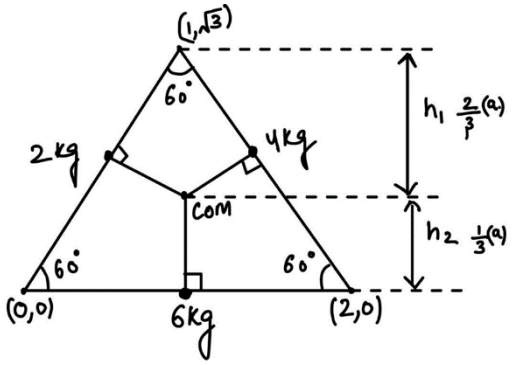
Sol.

$h_2 = \frac{1}{3} \times \sqrt{3} = \frac{1}{\sqrt{3}}$

$I_{com} = 2 \times \left(\frac{1}{\sqrt{3}}\right)^2 4 \times \left(\frac{1}{\sqrt{3}}\right)^2 + 6\left(\frac{1}{\sqrt{3}}\right)^2$

$= \frac{1}{3} \times 12$

$I_{com} = 4$ kg m^2



10. What are the dimensional formula of specific heat and latent heat.

Ans. [S] = $L^2T^{-2}K^{-1}$, [L] = L^2T^{-2}

Sol. $dQ = mSdT$ $\qquad$ $dQ = mL$

$S = \frac{dQ}{mdT}$ $\qquad$ $L = \frac{dQ}{m}$

$[S] = \frac{ML^2T^{-2}}{MK}$ $\qquad$ $[L] = \frac{ML^2T^{-2}}{M}$

$= L^2T^{-2}K^{-1}$ $\qquad$ $[L] = L^2T^{-2}$

11. If the weight of an object at surface of earth is 300 N then find the weight of object at depth R/4 from surface of the earth.

Ans. 225

Sol. $W = mg$ $\qquad$ for depth

$300 = mg_s$ ...(i) $\qquad$ $g' = g_s\left[1 - \frac{d}{R}\right]$

$g' = g_s\left[1 - \frac{R/4}{R}\right]$

$= g_s[1 - 1/4]$

$\boxed{g' = \frac{3}{4}g_s}$

$W' = mg'$

$\Rightarrow W' = m\left(\frac{3}{4}g_s\right)$ ...(2)

Using (1) and (2)

$\frac{W'}{300} = \frac{3}{4} \Rightarrow W' = 225$

12. A helium gas having total number of moles = 10 is kept in an insulated container temperature of gas is given as T. Find out total internal energy of He gas.

Ans. 15 RT

Sol. $U = \frac{f}{2}nRT$

$\Rightarrow \frac{3}{2}(10)\ RT \quad = 15\ RT$

13. An EM wave is travelling along the x-axis, the equation of electric field is $E = 600\sin(kx - \omega t)$. Find out intensity of EM wave.

Ans. 477.9 watt/ m^2

Sol. $I = \frac{1}{2}\varepsilon_0 E_0^2 C$

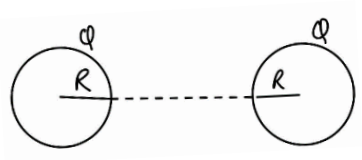
$= \frac{1}{2} \times 8.85 \times 10^{-12} \times (600)^2 \times 3 \times 10^8$

$= \frac{1}{2} \times 8.85 \times 6 \times 6 \times 3 = 477.9$ watt/ m^2.

14. Two identical conducting shell having same charge are placed at finite distance. The force applied by one conductor on another is 16 N. Now an uncharged identical conducting shell is introduced such that it touch one by one the conducting shell respectively. Find out final coloumb force acting between the conducting spheres.

Ans. 6N

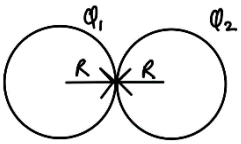
Sol. $F = \frac{kQ^2}{r^2} = 16\ N$



When it is touched with first, charge distributed in both the shell

$\frac{Q_1}{Q_2} = \frac{R_2}{R_1} \Rightarrow 1$

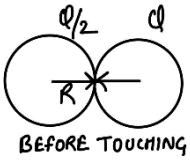
$Q_1 = Q_2 = \frac{Q}{2}$



Now the shell is touched with another

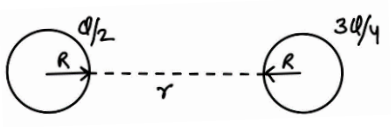
$Q_1' = \frac{Q}{2} + \frac{Q}{4} = \frac{3Q}{4}$

$Q_2' = \frac{3Q}{4}$

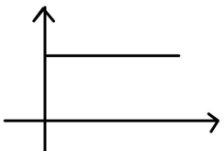
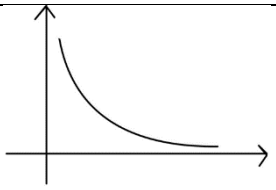
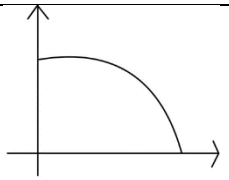
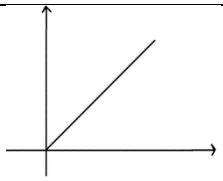


Now force

$F' = \frac{k\left(\frac{Q}{2}\right)\left(\frac{3Q}{4}\right)}{r^2} = \frac{3}{8}\left(\frac{kQ^2}{r^2}\right) \Rightarrow \frac{3}{8} \times 16 = 6N$



15. Match the following

List-1	List-2
(A) y axis represents magnetic field. x axis represents distance from centre of axis of wire [x < a] (a = radius of wire)	(I) 
(B) y axis represents magnetic field. x axis represents distance from centre of axis of wire [x > a] (a = radius of wire)	(II) 
(C) y axis represents magnetic field. x axis represents distance from centre of solenoid	(III) 
(D) y axis represents magnetic susceptibility. x axis represents intensity of magnetisation	(IV) 

Ans. A → IV, B → II, C → III, D → I

Sol. A → IV, B → II, C → III, D → I

Theoretical

16. A bulb is glowing with power equal to 110 W and potential difference 220V. Find the number of electron flowing per unit second

Ans. 3.2×10^{18}

Sol. $P = VI$

$$I = \frac{P}{V}$$

$$I = \frac{110}{220} = \frac{1}{2}$$

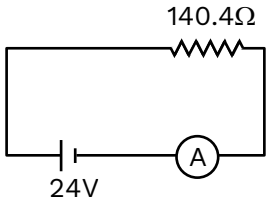
$$\frac{ne}{t} = I$$

$$\frac{n}{t} = \frac{I}{e}$$

$$\frac{n}{t} \quad \frac{10}{2 \times 1.6 \times 10^{-19}}$$

$$\frac{n}{t} = 3.2 \times 10^{18}$$

17. For the given circuit. Find ammeter reading, if shunt = 10Ω and resistance of coil of galvanometer is 240Ω.



Ans. $A = \frac{24}{150}$

Sol. R_{eq} of $A = \frac{2400}{250} = \frac{48}{5}$

R_{eq} of ckt $= 140.4 + \frac{48}{5}$

$= 140.4 + 9.6$

$= 150$

$i_b = \frac{24}{150} A$

Reading $A = \frac{24}{150}$

18. If the maximum current is drawn from a LRC circuit of R = 100 Ω, C = 2.5 nF, L = 100 H then find frequency in rad/sec.

Ans. 2000 rad/sec

Sol. i is max in resonance condition.

$X_L = X_C$

$$\Rightarrow \quad \omega L = \frac{1}{\omega C}$$

$$\Rightarrow \quad \omega^2 = \frac{1}{LC}$$

$$\Rightarrow \quad \omega = \frac{1}{\sqrt{LC}}$$

$$\Rightarrow \quad \omega = \frac{1}{\sqrt{100 \times 2.5 \times 10^{-9}}}$$

$$= \frac{10^5}{50} = \frac{1000}{5}$$

$$\boxed{\omega = 2000 \text{ rad / sec.}}$$

19. Find out the value of maximum wavelength of hydrogen of paschen series in bhor model.

Ans. 18.867×10^{-7} m

Sol. we know

$$\frac{1}{\lambda} = R_H XZ^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = [1.09 \times 10^7] \times (1)^2 \left[\frac{1}{3^2} - \frac{1}{4^2}\right]$$

$$\frac{1}{\lambda} = 0.053 \times 10^7$$

$\lambda = 18.867 \times 10^{-7}$ m

20. Two waves of intensity $I_1 = 4I$ and $I_2 = I$ produces interference, find the ratio of maximum and minimum intensity.

Ans. 8 I

Sol. $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$\left(\sqrt{4I} + \sqrt{I}\right)^2 = 9I$

$I_{min} = \left(\sqrt{4I} - \sqrt{I}\right)^2 = I$

$I_{max} - I_{min} = 9I - I = 8I$

21. The time period of SHM is 3.14 with amplitude 0.06 m and the maximum velocity of particle is $k \times 10^{-2}$ m/s. Find the value of k.

Ans. 12

Sol. $\omega = \frac{2\pi}{T} = \frac{2 \times \pi}{3.14} = 2\,\text{rad/sec}$

$v_{max} = \omega A = 2 \times 0.06 = 12 \times 10^{-2}\,\text{m/s}$

K = 12

CHEMISTRY

1. For any reaction $2P + Q \rightarrow S$

$\Delta H = 400\ kJ/mol$ & $\Delta S = 0.2\ kJ/K$

At what temperature equilibrium is attained?

Ans. (2000K)

Sol. $T = \frac{\Delta H}{\Delta S} = \frac{400}{0.2} = 2000K$

2. An electron present in first excite state in H-atom having energy -3.4 eV. Find its kinetic energy.

Ans. (3.4 eV)

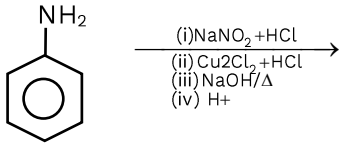
Sol. Kinetic energy = – Total energy = 3.4 eV

3. Total number of molecules in which central atom is sp2 Hybridised

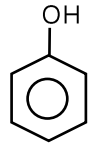
$SiO_2, NH_3, CO_2, SO_2, C_2H_4, C_2H_2, C_6H_6$

Ans. (3)

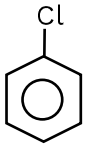
Sol. SO_2, C_2H_4, C_6H_6

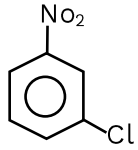
4. 

major product is

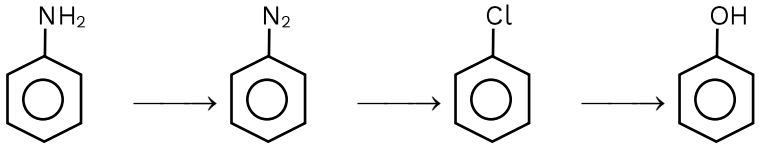
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

5. For reaction

$CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$

Then the value of $\frac{K_P}{K_C}$ will be

(1) $\frac{1}{(RT)^{1/2}}$ (2) $(RT)^{1/2}$ (3) $\frac{1}{RT}$ (4) RT

Ans. (1)

Sol. $K_P = K_C (RT)^{\Delta ng}$

$\Delta ng = -\frac{1}{2}$

$$\frac{K_P}{K_C} = \frac{1}{(RT)^{1/2}}$$

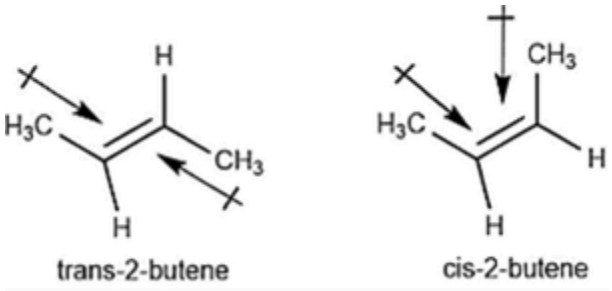
6. Incorrect statement for But-2-ene.

(1) If form two stereo isomer (2) Trans form is more stable than Cis

(3) Dipole - moment of Trans > Cis (4) Melting point of Trans > Cis

Ans. (3)

Sol. cis isomer has more dipole moment than trans isomer, because it has 2 similar groups on same size of double bond.



7. Correct increasing order of no. of unpaired electron

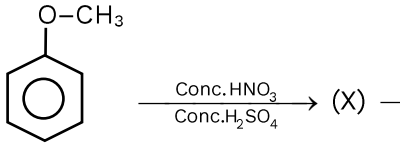
Sc, Ti, Cr, Mn, V

(1) Cr > V > Mn > Ti > Sc (2) Mn > Cr > V > Ti > Sc

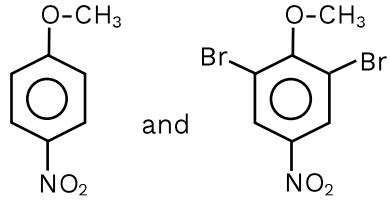
(3) Cr > Mn > V > Ti > Sc (4) Cr > Mn > Ti > V > Sc

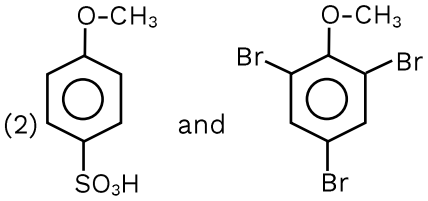
Ans. (3)

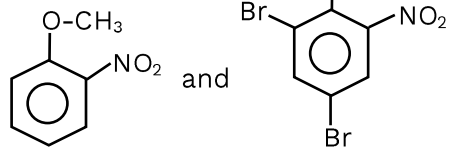
Sol. Cr > Mn > V > Ti > Sc

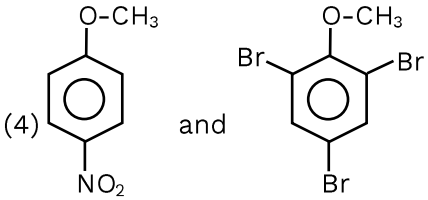
8. 

; (x) and (Y) are respectively-

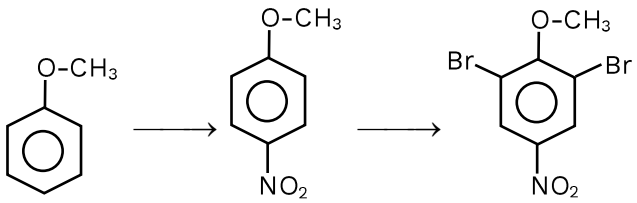
(1) 

(2) 

(3) 

(4) 

Ans. (1)

Sol. 

9. $R-COOH \xrightarrow[(ii)P.C.C\ (iii)HCN\ (iv)H_3O^+]{(i)LiAlH_4}$ major product (x) is

(1) $R-H$ (2) $R-CHO$

(3) $R-\underset{\underset{OH}{|}}{CH}-COOH$ (4) $R-CH_2-COOH$

Ans. (3)

Sol. $R-COOH \longrightarrow R-CH_2OH \longrightarrow R-CHO \longrightarrow R-\underset{\underset{OH}{|}}{CH}-CN \longrightarrow R-\underset{\underset{OH}{|}}{CH}-COOH$

10. Among the VO_2^-, $Cr_2O_7^{2-}$, MnO_4^-, find the magnetic moment of compound having least oxidizing power.

Ans. (3)

Sol. Oxidising power order $\rightarrow MnO_4^- > Cr_2O_7^{2-} > VO_2^-$

VO_2^- have least oxidizing strength

0.5 of V in VO^- $x + 2(-2) = -1$

unpaired $\bar{e} = 2$ $x = +3$

$\mu = 2.87Bm.$

11. Correct increasing order of wavelength of following metals Li, Cs, Rb, K

(1) Li > Cs > Rb > K (2) Rb > K > Li > Cs

(3) Li > Cs > K > Rb (4) Cs > Li > Rb > K

Ans. (2)

Sol. increasing order of wavelength $\rightarrow$ Rb > K > Li > Cs

12. Salt $\xrightarrow{AgNO_3}$ yellow ppt $\xrightarrow{NH_4OH}$ insoluble

Salt may contain anion -

(1) I^- (2) Br^- (3) Cl^- (4) F^-

Ans. (1)

Sol. Yellow ppt = AgI

Therefore, salt contain I^-

13. For the first order reaction

$A + B \rightarrow C$

$P \rightarrow Q$

The ratio of half life is $\frac{1}{2}$ find $\frac{t_{2/3}}{t_{4/5}}$ for both reaction

Ans. **(0.34)**

Sol. $\frac{t_{2/3}}{t_{4/5}} = \frac{\frac{2.303}{k_1}\log 3}{\frac{2.303}{k_2}\log 5} = \frac{k_2}{k_1}\frac{\log 3}{\log 5} = \frac{k_2}{k_1}\frac{\log 3}{\log 5}\left[\frac{k_2}{k_1} = \frac{(t_{1/2})_1}{(t_{1/2})_2} = \frac{1}{2}\right] = 0.34$

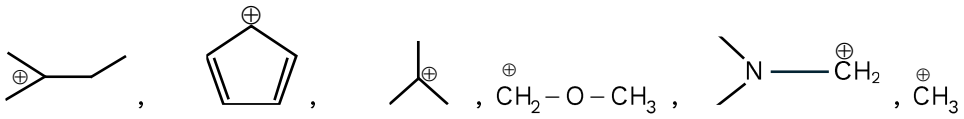
14. For 3M aq NaCl solution (d = 1.25 gm/ml) calculate molality?

(1) 2.17 (2) 2.79 (3) 3.7 (4) 3.17

Ans. (2)

Sol. $m = \frac{3}{(1250 - 3 \times 58.5)/1000} = \frac{3}{1.0745} = 2.79$

15. Number of Carbocation which is not Stabilised by Hyper Conjugation



Ans. (4)

Sol. B,D,E,F

16. Choose correct statement

Statement-I : PCl_5 and BrF_5 are sp^3d hybridised.

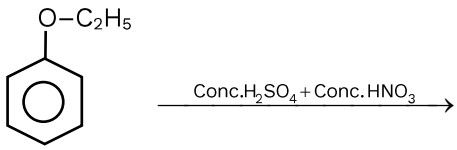
Statement-II : SF_6 and $[Co(NH_3)_6]^{3+}$ are sp^3d^2 hybridised.

(1) Both statements are correct. (2) Both statements are incorrect

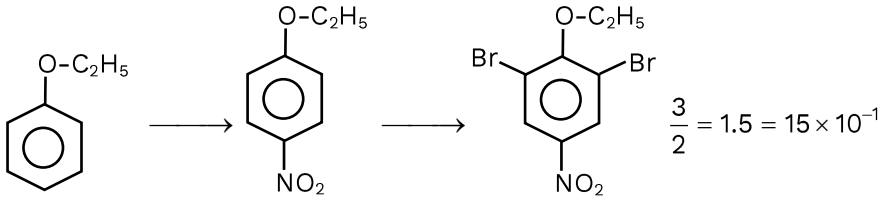
(3) Only statement-I is correct (4) Only statement-II is correct

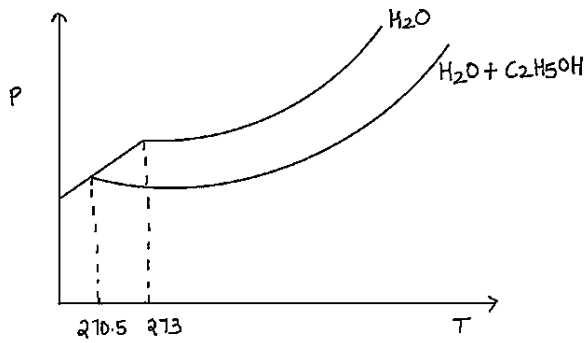
Ans. (2)

Sol. Both statement are incorrect.

17.  $\xrightarrow{Conc.H_2SO_4 + Conc.HNO_3}$ (X) $\xrightarrow[FeBr_3]{Br_2(2\,eq)}$ (Y); In [Y], ratio of oxygen and Bromine is n × 10^{-1}, then find out the value of (n)-

Ans. (15)

Sol.  $\frac{3}{2} = 1.5 = 15 \times 10^{-1}$

18. 

In 100 ml H_2O, x × 10^{-3} ml of EtOH (d = 0.8 g/ml) is added and following graph is observed x is

$(K_f)_{H_2O} = 1.86 K - kg/mol$

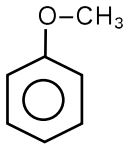
Ans. (7728 ml)

Sol. $\Delta T_f = K_f.m$

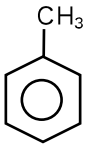
$$2.5 = 1.86 \times \frac{x \times 10^{-3} \times 0.8 \times 46}{0.1}$$

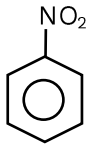
$$x = 7728.495 \simeq 7728 \text{ ml}$$

19. Rate of E.A.S.R is for given compound

(I) 

(II) 

(III) 

(IV) 

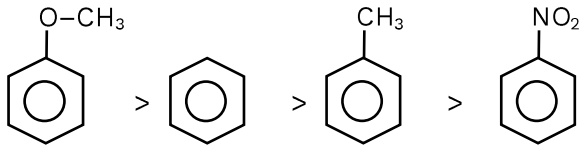
(1) I > III > II > IV

(2) I > II > III > IV

(3) IV > III > I > II

(4) I = III > II > IV

Ans. (2)

Sol. 

20. Find out the shortest wavelength of paschen series for H-atom

(1) 9/R (2) 16/R (3) 144/7R (4) 7R/144

Ans. (1)

Sol. $$\frac{1}{\lambda} = R.Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = R.(1)^2\left[\frac{1}{(3)^2} - \frac{1}{(\infty)^2}\right]$$

$$\frac{1}{\lambda} = R\left(\frac{1}{9}\right)$$

$$\lambda = \frac{9}{R}$$

21. Correct statement about enzymes.

(1) Enzyme is bio catalyst

(2) Enzyme are non specific for different reaction

(3) Most of the enzyme are globular protein.

(4) Enzyme oxidase interconvert maltose into Glucose

Ans. (2)

Sol. 1,3

22. Match the column -

Reaction	**Name**
(A) $Na^+ + H_2O \rightarrow NaOH + H_2$	(P) Decompostion
(B) $N_2 + O_2 \rightarrow 2NO$	(Q) Displacement
(C) $NO_2 \rightarrow NO_2^- + NO_3^-$	(R) Combination
(D) $PbCO_3 \rightarrow PbO + CO_2$	(S) Disproportionation

(1) A→Q; B→S; C→R; D→P (2) A→P; B→R; C→S; D→Q
(3) A→Q; B→R; C→S; D→P (4) A→P; B→S; C→R; D→Q

Ans. **(3)**

Sol. (P) Decompostion, $PbCO_3 \rightarrow PbO + CO_2$
(Q) Displacement, $Na^+ + H_2O \rightarrow NaOH + H_2$
(R) Combination, $N_2 + O_2 \rightarrow 2NO$
(S) Disproportionation, $NO_2 \rightarrow NO_2^- + NO_3^-$

23. How can we convert electrochemical cell into electrolytic cell
(1) By changing electrodes
(2) By reversing movement of ions in salt bridge
(3) By applying opposite lower potential
(4) By applying opposite higher potential

Ans. (4)

Sol. By applying opposite higher potential.

24. In 14^{th} group of periodic table, find correct option
(A) Covalent radius decreases down the group
(B) Down the group pπ-pπ bond strength decreases
(C) Electronegativity decreases down the group
(D) Carbon do not show negative oxidation state
(1) A, B, C (2) A, B, C, D (3) B, C (4) B, C, D

Ans. (3)

Sol. (B) Down the group pπ-pπ bond strength decreases
(C) Electronegativity decreases down the group

25. IUPAC name of $[PtBr_2(PMe_3)_2]$
(1) Dibromido(trimethylphosphine)platinum(II)
(2) Dibromido(trimethylphosphine)platinum(IV)
(3) Dibromido(trimethylphosphine)platinate(IV)
(4) (trimethylphosphine)Dibromidoplatinum(IV)

Ans. (1)

Sol. Dibromido(trimethylphosphine)platinum(II)