JEE(Main) -2024 | 05 April 2024 (Shift-1 Morning) | Question Paper with Solutions | Memory Based

MATHEMATICS

1. $\frac{dy}{dx}+2y=\sin 2x$ and $y(0)=\frac{3}{4}$ then value of $y\left(\frac{\pi}{2}\right)$ is

Ans. $(\frac{1}{4}+e^{-\pi})$

Sol. $\frac{dy}{dx}+2y=\sin 2x$

$\frac{d}{dx}\left(y\cdot e^{2x}\right)=e^{2x}\sin 2x$

$y\cdot e^{2x}=\int e^{2x}\sin 2x dx+c$

$y\cdot e^{2x}=\frac{1}{2}\left(\frac{e^{2x}(\sin 2x-\cos 2x)}{2}\right)+c$

$y(0)=\frac{3}{4}$

$\Rightarrow \frac{3}{4}=\frac{1}{4}[-1]+c$

$\boxed{c=1}$

$\therefore y=\frac{1}{4}(\sin 2x-\cos 2x)+e^{-2x}$

$y\left(\frac{\pi}{2}\right)=\frac{1}{4}(0-(-1))+e^{-2(\pi/2)}$

$y\left(\frac{\pi}{2}\right)=\frac{1}{4}+e^{-\pi}$

2. Let $f(x)=x^5+x^4+x^3+3x+1$ and $f(g(x))=x$ then value of $\frac{g(7)}{g'(7)}$ is

Ans. (15)

Sol. $f(g(x))=x \quad , \quad f'(x)=5x^4+4x^3+3x^2+3$

$f'(g(x))=\frac{1}{g'(x)} \quad , f'(1)=15$

$g'(7)=\frac{1}{f'(1)}=\frac{1}{15}$

$g(7)=1$

$\therefore \frac{g(7)}{g'(7)}=15$

3. Find term independent of x in $\left(1-x+2x^2\right)\left(3x^2+\frac{1}{x^3}\right)^9$

Ans. $({}^9c_4\times(3)^5\times 2)$

Sol. $T_{r+1}={}^9C_r(3)^{9-r}\frac{x^{18-2r}}{x^{3r}}$

$= {}^{9}C_r (3)^{9-r} x^{18-5r}$

$18 - 5r = 0$,	$18 - 5r = -1$;	$18 - 5r = -2$
$5r = 18$	$5r = 19$	$5r = 20$
		$r = 4$

Term = ${}^{9}c_4 \times (3)^5 \times 2$

4. Area bounded by $Y = x^2 - 5x$ & $Y = 7x - x^2$

Ans. 72

Sol. $x^2 - 5x = 7x - x^2$

$2x^2 - 12x = 0$

x = 0,6

Area = $\left|\int_0^6 \left(x^2 - 5x - 7x + x^2\right)dx\right|$

$= \left|\int_0^6 2x^2 - 12x dx\right|$

$= \left|2 \cdot \frac{x^3}{3} - \frac{12x^2}{2}\right|_0^6 |$

$= \left|2.36 \times 2 - 6.6^2\right|$

$= 6^2 \times 2$

$= 72$

5. Given that $\frac{1}{1.2} + \frac{1}{2.3} + \ldots + \frac{1}{99.100} = n$ and $\frac{1}{\sqrt{1}+\sqrt{2}} + \frac{1}{\sqrt{2}+\sqrt{3}} + \ldots + \frac{1}{\sqrt{99}+\sqrt{100}} = m$ find (m, n)

Ans. $\left(\left(9, \frac{100}{101}\right)\right)$

Sol. $n = \sum \frac{1}{r(r+1)} = \sum_{r=1}^{100} \frac{1}{r} - \frac{1}{r+1}$

$= 1 - \frac{1}{101} = \frac{100}{101}$

$m = \frac{\sqrt{2}-1}{1} + \frac{\sqrt{3}-\sqrt{2}}{1} + \cdots + \frac{\sqrt{100}-\sqrt{99}}{1}$

$= \sqrt{100} - 1 = 9$

$\left(9, \frac{100}{101}\right)$

6. Find the value of $\left|AA^T (\text{adj}4A)^{-1} (\text{adj}4B)(\text{adj}AB)^{-1}\right|$ if $|A| = 2$, $|B| = 3$. (Given A is 3 × 3 matrix)

Ans. $\left(\frac{1}{4}\right)$

Sol. $\left|AA^T (\text{adj}\,4A)^{-1}\right| |\,\text{adj}(4B)\,| \left|\text{adj}(AB)^{-1}\right|$

$\Rightarrow |A|^2 \frac{1}{\left(4^2\right)^3 . |A|^2} . \left(4^2\right)^3 |B|^2$

$$\frac{1}{\left|\text{adj}(AB)\right|}$$

$$= |B|^2 \times \frac{1}{|B|^2 |A|^2} = \frac{1}{4}$$

7. Find the value of I, if $I = \int_{-\pi}^{\pi} \frac{2y \sin y}{1+\cos^2 y}\, dy$

Ans. (π^2)

Sol. $I = \int_{-\pi}^{\pi} \frac{2y \sin y}{1+\cos^2 y} = \int_{0}^{\pi} \frac{4y \sin y}{1+\cos^2 y} dy$

$$I \Rightarrow \int_0^{\pi} \frac{4(\pi - y)\sin y}{1+\cos^2 y} dy$$

$$2I = 4\pi \int_0^{\pi} \frac{\sin y}{1+\cos^2 y} dy$$

$$2I = 4\pi\left(-\tan^{-1}\cos y\right)\Big|_0^{\pi}$$

$$I \Rightarrow -2\pi\left(\tan^{-1}\cos\pi - \tan^{-1}\cos 0\right)$$

$$I \Rightarrow -2\pi(-\pi/4 - \pi/4)$$

$$I \Rightarrow -2\pi\left(-\pi/2\right)$$

$$\boxed{I = \pi^2}$$

8. $I = \int_0^{\frac{\pi}{4}} \frac{136 \sin x}{5\sin x + 3\cos x}\, dx$

Ans. $\left(5\pi - 6\ln\left(\frac{32}{9}\right)\right)$

Sol. $I = \frac{136}{34} \int_0^{\pi/4} \frac{5(5\sin x + 3\cos x) - 3(5\cos x - 3\sin x)}{5\sin x + 3\cos x}$

$$I = \frac{136}{34}\left(5\frac{\pi}{4} - 3\ln|5\sin x + 3\cos x|\Big|_0^{\pi/4}\right)$$

$$= 4\left(\frac{5\pi}{4} - 3\ln\left(\frac{4\sqrt{2}}{3}\right)\right)$$

$$= 5\pi - 6\ln\left(\frac{32}{9}\right)$$

9. If 4 dice are rolled, then find probability of their sum comes out to be 16.

Ans. $\left(\frac{125}{6^4}\right)$

Sol. x + y + z + w = 16

x' + y' + z' + w' = 12

fav = $^{15}c_3 - \left(^9c_3 \times 4\right) + \left(^4c_2\right) \times 1$

$$= \frac{15c_3 - {}^{9}c_3 \times 4 + {}^{4}c_2}{6^4} = \frac{125}{6^4}$$

10. Let Set $S = \{1,2,3 \ldots 8\}$ and there are multiple quadratic equation of the form of $ax^2 + bx + c = 0$ where $a,b,c \in S$. Find the probability such that a randomly choosen quadratic equation have equal roots.

Ans. $(\frac{1}{64})$

Sol.

a	b	c	
1	2	2	$D = b^2 - 4ac$
2	4	2	$P(A) = \frac{8}{8^3} = \frac{1}{64}$
4	4	1	
1	4	4	
3	6	3	
4	8	4	
8	8	2	
2	8	8	

11. $|x||x-2| - |x-1| - 6 = 0$ and sum of real solution of x.

Ans. (2)

Sol. $x \geq 2$;

$x(x-2) - x + 1 - 6 = 0$

$x^2 - 3x - 5 = 0$

$$x = \frac{3 \pm \sqrt{29}}{2}$$

$$x_1 = \frac{3 + \sqrt{29}}{2}$$

II. $1 < x < 2$

$x(2-x) - x + 1 - 6 = 0$

$-x^2 + x - 5 = 0$

$x^2 - x + 5 = 0$

$D < 0$ (No Solution).

III. $0 < x < 1$

$x(2 - x) + x - 1 - 6 = 0$

$2x - x^2 + x - 7 = 0$

$-x^2 + 3x - 7 = 0$

$x^2 - 3x + 7 = 0$

$D > 0$ (No Solution)

IV. $x < 0$

$x^2 - x - 1 - 6 = 0$

$x^2 - x - 7 = 0$

$x = \frac{+1 \pm \sqrt{29}}{2} \therefore x_2 = \frac{+1 - \sqrt{29}}{2}$,

Hence sum of solution

$= x_1 + x_2$

$= \frac{3 + \sqrt{29} + 1 - \sqrt{29}}{2}$

$= 2$

12. $f(x) = \lim_{t \to x} \frac{t^2 f(x) - x^2 f(t)}{t - x}, f(1) = 1$, find the value of 2f(2) + 3f(3)

Ans. (20)

Sol. $f'(x) = \lim_{t \to x} \frac{2tf(x) - x^2 f'(t)}{1}$

$f'(x) = 2xf(x) - x^2 f'(x)$

$\Rightarrow f'(x) = \frac{2xf(x)}{1 + x^2}$

$\Rightarrow \int \frac{f'(x)}{f(x)} dx = \int \frac{2x}{1 + x^2} dx$

$\Rightarrow \ln(f(x)) = \ln\left|1 + x^2\right| + c$

$c = -\ln 2$

$\Rightarrow \ln(f(x)) = \ln\left(\frac{1 + x^2}{2}\right)$

$\Rightarrow \left\{f(x) = \frac{1}{2}\left(1 + x^2\right)\right\}$

$\Rightarrow f(2) = 5/2, f(3) = \frac{10}{2}$

$\Rightarrow f(2) + 3f(3) = 5 + \frac{30}{2} = 20$

13. $f : A \to B, A = \{1, 2, 3, \ldots, 8\}, B = \{1, 2, \ldots, 8\}$, find the number of one-one function from A to B such that $f(1) + f(3) = 14$.

Ans. (2 × 6!)

Sol. $\{1, 2, \ldots, 8\}$ $\{1, 2, \ldots, 8\}$

f(1) + f(3) = 14

One One

8 6 → 6!

7 7 → ×

6 8 → 6!

= 2 × 6!

14. If lines $\frac{x-3}{3} = \frac{2y-1}{4\lambda+1} = \frac{4-z}{1}$ and $\frac{x-3}{3\mu} = \frac{1-2y}{-4} = \frac{z-4}{7}$ are perpendicular, then find value of $9\mu + 4\lambda$.

Ans. (6)

Sol. D.R's are $< 3, \frac{4\lambda+1}{2}, -1 >$ &

$< 3\mu, 2, 7 >$

$\Rightarrow 9\mu + 4\lambda + 1 - 7 = 0$

$9\mu + 4\lambda = 6$

15. $f(x) = \sin 2x + c + \frac{2}{\pi}\left(x^2 + x\right), x \in \left[0, \frac{\pi}{2}\right]$

Statement-1: f(x) increasing in $(0, \pi/2)$

Statement-2: f'(x) decreasing in $(0, \pi/2)$.

Ans. (1 is right; 2 is wrong)

Sol. $f'(x) = 2\cos 2x + \frac{2}{\pi}(2x+1) \rightarrow$ always positive in $\left(0, \frac{\pi}{2}\right)$

$f''(x) = -4\sin 2x + \frac{4}{\pi}$

$= 4\left(\frac{1}{\pi} - \sin 2x\right) \rightarrow$ Can be positive or negative in $\left(0, \frac{\pi}{2}\right)$

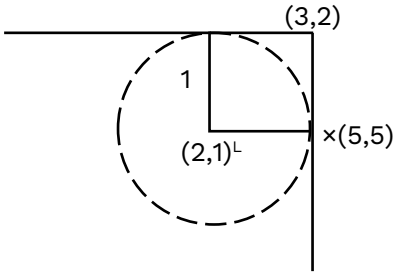
So, Ist is right, IInd is wrong.

16. Given a circle of radius 1 such that it touches the normals drawn from (3, 2) to the coordinate axis. Find minimum distance of circle from point (5, 5)

(1) 4 (2) $7\sqrt{2}$ (3) $4\sqrt{2}$ (4) $5\sqrt{2}$

Ans. (1)

Sol.



minimum distance

= CP – r

$= \sqrt{9+16} - 1$

= 4

17. Suppose $\theta \in [0, \pi/4]$ is a solution of $4\cos\theta - 3\sin\theta = 1$, then $\cos\theta$ =

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

Ans. (_)

Sol. $4\cos\theta - 3\sin\theta = 1$

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

$16\cos^2\theta + 1 - 8\cos\theta = 9\sin^2$

$16\cos^2\theta + 1 - 8\cos\theta = 9\left(1 - \cos^2\theta\right)$

$25\cos^2\theta - 8\cos\theta - 8 = 0$

$\cos\theta = \frac{8 \pm \sqrt{64 + 800}}{50}$

$\cos\theta = \frac{8 \pm \sqrt{864}}{50}$

$\cos\theta = \frac{8 + 12\sqrt{6}}{50}$

$\cos\theta = \frac{4 + 6\sqrt{6}}{25}$

$\cos\theta = \frac{-200}{25(4 - 6\sqrt{6})}$

$\boxed{\cos\theta = \frac{4}{3\sqrt{6} - 2}}$

$\cos\theta = \frac{8 - 12\sqrt{6}}{50}$

$\cos\theta = \frac{4 - 6\sqrt{6}}{25}$

$\cos\theta = \frac{-200}{25(4 + 6\sqrt{6})}$

$\boxed{\cos\theta = \frac{-4}{2 + 3\sqrt{6}}}$ Rejected

18. $f(x) = \frac{\sin 3x + \alpha \sin x - \beta \cos 3x}{x^3}; x \in R - \{0\}.$

If f(x) is continuous at x = 0 then find $|\alpha + \beta + f(0)|$.

Ans. (7)

Sol. $\lim\limits_{x \to 0} \frac{\left(3x - \frac{27x^3}{3!}\right) + \left(\alpha x - \frac{\alpha x^3}{3!}\right) - \beta\left(1 - \frac{9x^2}{2!}\right)}{x^3}$

$3 + \alpha = 0 \qquad \alpha = -3$

$\beta = 0$

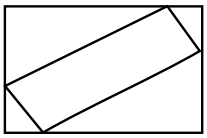
$f(0) = \frac{-27}{6} + \frac{3}{6} = \frac{-24}{6} = -4$

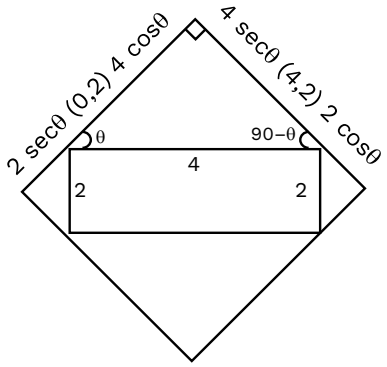
|-3-4|=7

19. A rectangle ABCD is inscribed in another rectangle PQRS Given the length and breadth of the ABCD are 2 & 4 respectively. The length and breadth of rectangle PQRS are a & b respectively. Find $(a + b)^2$ so that area of PQRS is maximum.

Ans. $(3\sqrt{2})$

Sol.





a = 4secθ + 2cosθ, b = 4cosθ + 2secθ

Area of PQRS(A)

= (4sinθ + 2cosθ) × (4cosθ + 2sinθ)

= 8cos2θ + 8sin2θ + 20cosθsinθ

= 8 + 10sin2θ

For 2θ = 90°

A = 18 (a + b) = $6\sqrt{2}$

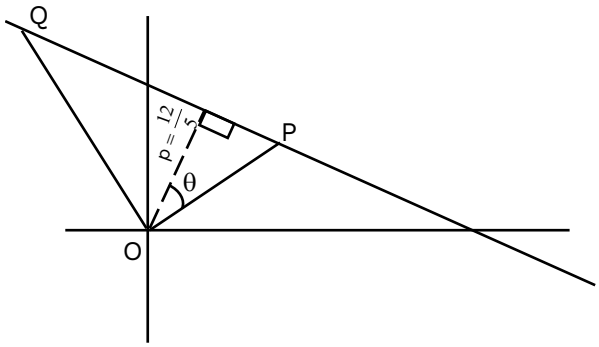
$a = \frac{4}{\sqrt{2}} + \frac{2}{\sqrt{2}} = 3\sqrt{2}$ $(a + b)^2 = 72$

$b = \frac{4}{\sqrt{2}} + \frac{2}{\sqrt{2}} = 3\sqrt{2}$

20. If two lines passing through origin cuts the line 3x + 4y = 12, at P & Q and POQ is right angle triangle, then minimum area is

Ans. $(\frac{144}{25})$

Sol.



$OP = \frac{12}{5}\sec\theta$

$OQ = \frac{12}{5}\text{cosec}\,\theta$

Area of $\Delta OPQ = \frac{1}{2} \frac{12}{5} \times \frac{12}{5} \frac{1}{\cos\theta\sin\theta}$

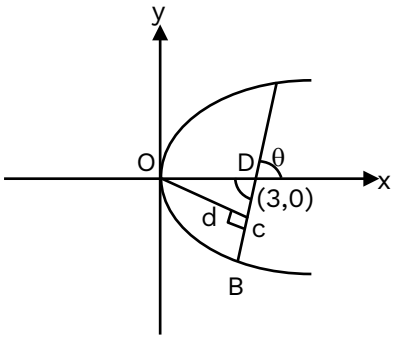
$= \frac{144}{25\sin 2\theta}$

Min area $= \frac{144}{25}$

21. If the length of focal chord of $y^2 = 12x$ is ℓ and if the distance of the focal chord from origin is d, then ℓd^2 is equal to

Ans. (108)

Sol.



length of focal chord $\rightarrow 4a\,\text{cosec}^2\theta$

$4a\,\text{cosec}^2\theta = l$

$12\,\text{cosec}^2\theta = l$

Focal chord equation = $\frac{y}{x-3} = \tan\theta$

$y = x\tan\theta - 3\tan\theta$

$d = \left|\frac{3\tan\theta}{\sqrt{1+\tan^2\theta}}\right|$

$d = 3\sin\theta$

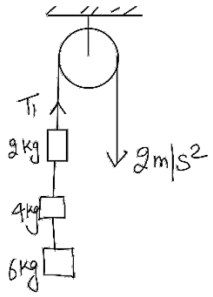
$d^2 = 9\sin^2\theta$

$ld^2 = 9\text{cosec}^2\theta\,\sin^2\theta \times 12$

$ld^2 = 108$

PHYSICS

1. There is a pulley mass system, find tension in the string as shown in figure.



Ans. 144N

Sol. $T_1 - 120 = 12 \times 2$

$T_1 = 144N$

2. Find ratio of electrostatic force and gravitational force between electron and proton.

Ans. 2.27×10^{39}

Sol. $\frac{F_e}{F_g} = \frac{K.e^2}{G.m_e m_1}$

$= \frac{9\times 10^9 \times \left(1.6\times 10^{-19}\right)^2}{6.67\times 10^{-11}\times 9.1\times 10^{-31}\times 1.67\times 10^{-27}} = 2.27\times 10^{39}$

3. If time period of pendulum at R distance from earth surface is 4 units. Find the time period of pendulum at 2R distance from earth's surface. (where R = radius of earth)

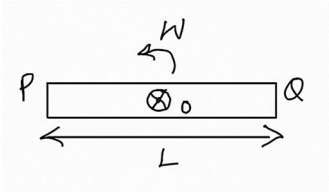
Ans. 6

Sol. $T \propto \frac{1}{\sqrt{g}}$

$\frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}} = \sqrt{\frac{g}{9}\times\frac{4}{g}} = \frac{2}{3}$

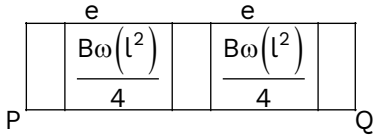
$T_2 = \frac{3T_1}{2} = \frac{3}{2}\times 4 = 6$

4. If magnetic field is perpendicular to the plane of rotation if rod then find potential difference between points P and Q in the given figure.



Ans. 0

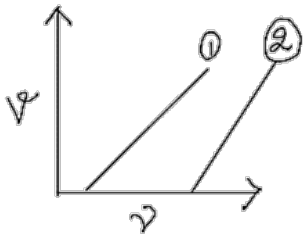
Sol. $V_P = V_Q$



$V_P = V_Q = 0$

5. **Statement-1:** slope is given by $\frac{h}{e}$.

Statement-2: comparison of kinetic energy ($K_1 > K_2$) at constant frequency



Ans. So, statement -1 is correct.

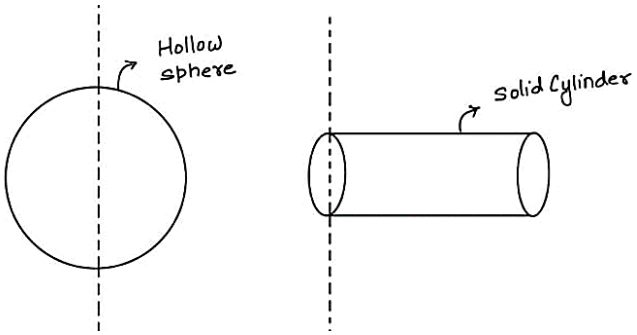
Sol. $eV = h\nu - \phi$

$V = \frac{h}{e}\nu - \phi$

Slope of v vs ν is h/e

So, statement -1 is correct.

6. If the ratio of radius of gyration of hollow sphere and solid cylinder about the axis as shown in the figure is $\sqrt{\frac{8}{x}}$. Then value of x is:



Ans. 67

Sol. $I_1 = \frac{2}{3}mR^2$

$mk_1^2 = \frac{2}{3}mR^2$

$k_1 = \sqrt{\frac{2}{3}}R$

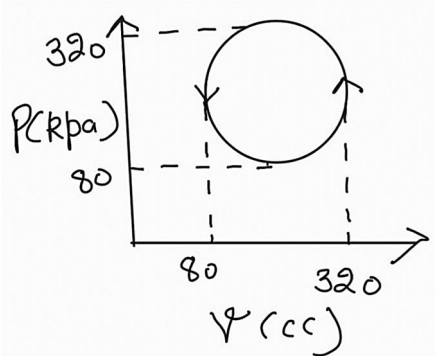
$I_2 = \frac{mR^2}{4} + \frac{m(4R)^2}{3}$

$k_2 = \sqrt{\frac{67}{12}}R$

$\frac{k_1}{k_2} = \sqrt{\frac{8}{67}}$

$x = 67$

7. An ideal gas undergoes a cyclic process given in the P-V curve. Find work done by gas in the given cyclic process.



Ans. $\frac{144\pi}{10}$ J

Sol. Work done = πr^2

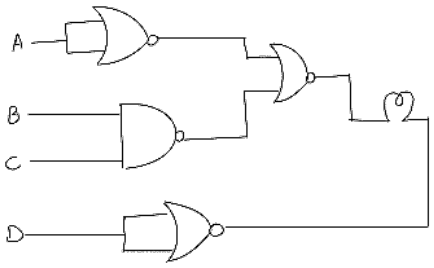
$= \frac{\pi d^2}{4}$

$= \frac{(\pi)(240)^2}{4}$(kPa)(cc)

$= \frac{(\pi)(24)(24)(100)}{4}$kPa(0.001)

$= \frac{144\pi}{10}$ J

8. Truth table for a logic gate system is given below. Choose the correct option for which bulb will glow.



	(a)	(b)	(c)	(d)
A	1	0	1	1
B	0	1	1	0
C	0	1	1	1
D	1	1	0	0

Ans. (D)

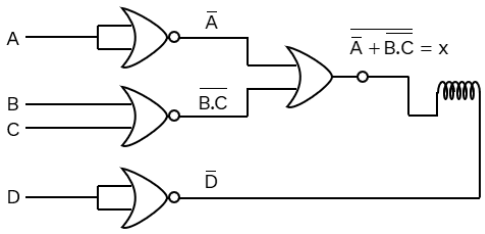
Sol. The bulb will glow if potential difference is 1

So, Potential difference = X–Y

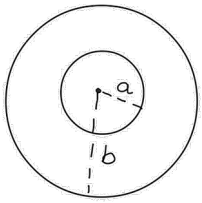
Potential difference = $\left(\overline{\bar{A} + \left(\overline{B \cdot C}\right)}\right)$

$(\text{Potential difference})_D = 1$

So, the bulb will glow in case (D).



9. There are two concentric conducting circular loops of radius a and b. If a << b then find the mutual inductance of the given system.



Ans. $\frac{\mu_0}{2b}.\pi a^2$

Sol. $\phi = B.\pi a^2$

$\phi = \frac{\mu_0.i}{2b}.\pi a^2$

$Mi = \frac{\mu_0.i}{2b}.\pi a^2$

$M = \frac{\mu_0}{2b}.\pi a^2$

10. In YDSE distance between two slits is 0.3 mm and distance of screen from plane of slits is 200 cm. If wavelength of light is used is 5000Å then find the distance of 3rd bright fringe from central maxima.

Ans. 1 cm

Sol. $y = n\frac{D\lambda}{d}$

$= \frac{3 \times 2 \times 5000 \times 10^{-10}}{0.3 \times 10^{-3}}$

$= 10^{-2}m$

$= 1$ cm

11. If a particle starts from rest with constant acceleration. Find the ratio of distance covered by particle in n^{th} second to the distance covered in $(n-1)^{th}$ second.

Ans. $\frac{2n-1}{2n-3}$

Sol. u = 0, a = constant

$S_n = \frac{a}{2}(2n-1)$

$S_{n-1} = \frac{a}{2}(2(n-1)-1)$

$\frac{S_n}{S_{n-1}} = \frac{2n-1}{2n-3}$

12. If μ represents energy density and G represents gravitational constant then find the dimension of $\sqrt{\mu G}$.

Ans. $= LT^{-2}$

Sol. $\sqrt{\frac{ML^2T^{-2}}{L^3}.M^{-1}.L^3.T^{-2}}$

$= \sqrt{L^2.T^{-4}}$

$= LT^{-2}$

13. There is a conducting wire of radius 4 mm whose resistance is given r = 2Ω. Now radius is halved keeping the length of wire same, then find the resistance of new wire.

Ans. 8Ω

Sol. r = 4 mm r = 2mm

R = 2Ω $\rho = \frac{\rho l}{\pi r^2}$

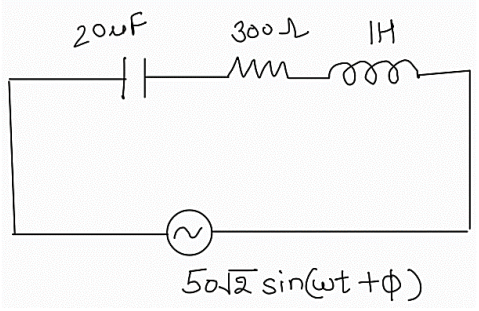
$R = \frac{\rho l}{A}$

$R \alpha \frac{1}{r^2}$

$\frac{R_1}{R_2} = \left(\frac{r_2}{r_1}\right)^2 = \left(\frac{2}{4}\right)^2$

$R_2 = 4R_1 = 8\ \Omega$

14. In the given LCR circuit. Find the voltage across the capacitor. (ω=100)



Ans. 50V

Sol. $X_L = \omega L = 100 \times 1 = 100$

ω= 100, $v_0 = 50\sqrt{2}$ (given)

$X_C = \frac{1}{\omega_C} = \frac{10}{100 \times 200 \times 10^{-6}}$

$= 5 \times 10^2 = 500$

$I_0 = \frac{V_0}{2}$

$Z = \sqrt{(100-500)^2 + (300)^2}$

$Z = \sqrt{400^2 + 300^2} = 500$

$i_0 = \frac{50\sqrt{2}}{500} = 0.141$

$V_{rms)_{Cap.}} = \frac{i_0 \times C}{\sqrt{2}}$

$= \frac{(0.141)(500)}{\sqrt{2}}$

= 50 V.

15. **Statement-1:** Capillary tube is inserted in liquid and the level of liquid does not rise or fall then contact angle may be 0°.
Statement-2: Contant angle depends on property of liquid and solid.
(1) Statement-1 and Statement-2 both are correct but 2nd statements is not correct explanation of 1st statement.
(2) Statement-1 and Statement-2 both are correct but 2nd statements is correct explanation of 1st statement.
(3) Statement-1 is correct and Statement-2 is wrong.
(4) Statement-1 is incorrect and Statement-2 is correct.

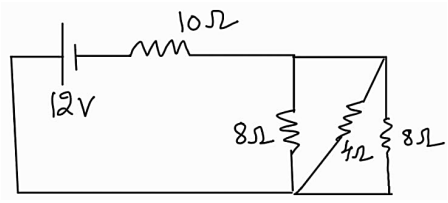
Ans. (4)

Sol. $h = \frac{2T\cos\theta}{\rho r g}$

If $h = 0 \Rightarrow \cos\theta = 0$

$\Rightarrow \theta = \frac{\pi}{2}$

16. In the given circuit find equivalent resistance across the cell and current flowing through the cell (neglect internal resistance of cell).



Ans. 1A

Sol. $\frac{1}{R_{eq}'} = \frac{1}{8} + \frac{1}{4} + \frac{1}{8}$

$\frac{1}{R_{eq}'} = \frac{4}{8}$

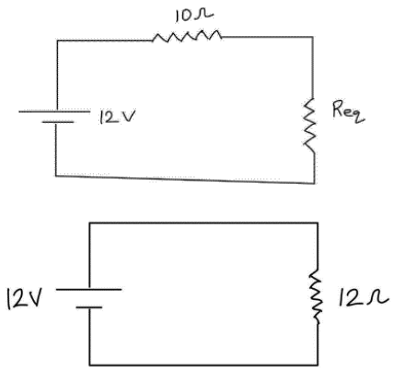
$R_{eq}' = 2$

$R_{eq_{net}} = 12\Omega$

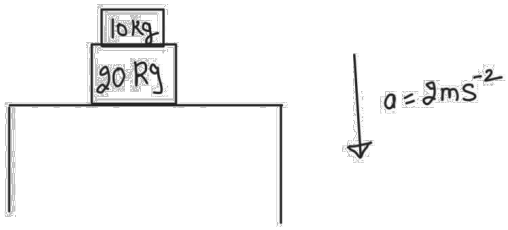
$V = IR$

$\Rightarrow I = \frac{12}{12}$

$\Rightarrow I = 1A$



17. There is a two-block system placed on a platform which is moving downward with an acceleration of 2 m/s² then find the normal force on block by the platform.



Ans. 240 N

Sol. 30 g – N = (30 × 2)
300 – N = 60
N = 240 N

18. If $2\vec{P}+2\vec{Q}=\vec{r}_1$ and $2\vec{Q}-2\vec{P}=\vec{r}_2$ then angle between the resultant vector of $\vec{r}_1+\vec{r}_2$ and $\vec{Q}$ is:

Ans. 0

Sol. $\vec{r}_1+\vec{r}_2=4\vec{Q}$

$\left(\vec{r}_1+\vec{r}_2\right)$ is parallel to $\vec{Q}$

Hence angle is = 0°

19. An electron is moving in an orbit, total energy of electron is E, then find the potential energy

Ans. 2E

Sol. $\text{T.E.}=-\frac{kze^2}{2r}$

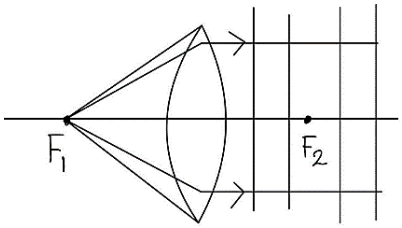
$\text{P.E.}=-\frac{kze^2}{r}$

P.E. = 2T.E.

20. A point source is placed at the first principal focus of a convex lens. The shape of the wave front of light emerging from the convex lens is:

Ans. Planar wavefront

Sol. planar light emerging out of convex lens when a point source is placed at its focus.



21. Three capacitors having capacitance 25μF, 45μF and 30μF are connect in parallel and energy stored in the given combination is E.
Now the given capacitors are connected in series and energy stored in the given combination is $\frac{9E}{x}$. Find the value of x (consider same power supply in both cases).

Ans. 86

Sol. $E=\frac{1}{2}C_{eq}v^2$

For parallel combination, C_{eq} = 25 + 45 + 30 = 100 μF

$E=\frac{1}{2}\times 100\times v^2=50v^2\ \mu J$

For series combination

$\frac{1}{C_{eq}}=\frac{1}{25}+\frac{1}{45}+\frac{1}{30}$

$C_{eq}=\frac{450}{43}$

$E'=\frac{1}{2}C_{eq}V^2$

$E'=\frac{1}{2}\times\frac{450}{43}V^2$

$\frac{E'}{E}=\frac{450}{43\times 100}$

$$E' = \frac{9}{86}E$$

$$E' = \frac{9E}{x} \Rightarrow \boxed{x = 86}$$

22. Collision frequency of gas particles at 27°C is 2. What is the collision frequency of the gas particles at 127°C?

Ans. $\frac{8}{\sqrt{3}}$

Sol. $f \alpha \sqrt{T}$

$Z \alpha \sqrt{300K}$

$Z' \alpha \sqrt{400K}$

$$\frac{Z}{Z'} = \frac{\sqrt{300}}{\sqrt{400}}$$

$$Z' = \frac{2}{\sqrt{3}} \times Z$$

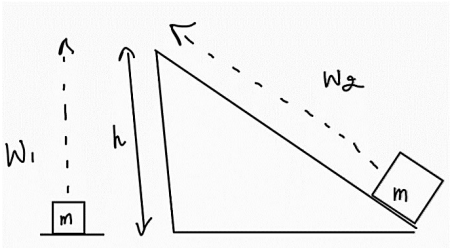
23. Sun of mass M is at a distance a from earth surface. The mass and radius of earth are m and R respectively. Then chose the appropriate option. Match the column.

Column-I	**Column-II**
(1) Escape velocity	(a) $-\frac{GMm}{2a}$
(2) Kinetic energy	(b) $\frac{GMm}{2a}$
(3) Gravitational potential energy	(c) $\sqrt{\frac{2GM}{a}}$
(4) Total energy	(d) $-\frac{GMm}{a}$

Ans. (1) → c, (2) → a, (3) → b, (4) → d

Sol. Formula Based

24. A block is moved up on a smooth wedge inclined at 60° and another block is moved vertically upward upto same height, find the ratio of work done by gravitational force in both the cases.



Ans. 1

Sol. $w_1 = mgh$

$w_2 = mgh$

$$\frac{w_1}{w_2} = 1$$

25. Potential difference between the plates of capacitor of capacitance 12μF is 40V. The frequency is 40 KHZ. Find displacement current.

Ans. 0.0381A

Sol. C = 12 μf

V = 40 V

f = 40kHz = 40 × 10^3 Hz

$$\frac{dv}{dt} = 2\pi fV$$

$$\frac{dv}{dt} = 2\pi \times 40 \times 10^3 \times 40$$

$$\frac{dv}{dt} = 3200\pi$$

$$I_d = c\frac{dv}{dt}$$

I_d = 12 × 10^{-6} ×3000π

Id ≈0.0381A

26. Find arithmetic mean of 4.623, 4.6, 4.62 and 4.69. (Using significant figures)

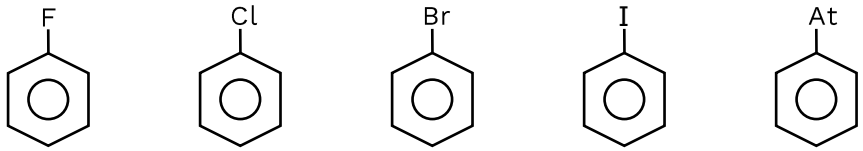
Ans. 4.6

Sol. $$\frac{4.623 + 4.6 + 4.62 + 4.69}{4} = 4.633$$

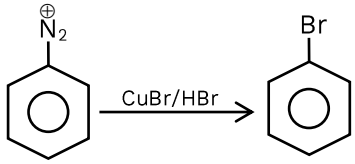
= 4.6 Ans.

CHEMISTRY

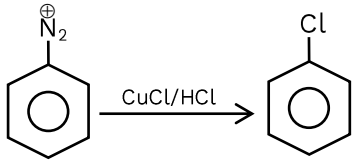
1. How many of the following can be prepared by Sandmeyer reaction:



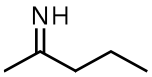
Ans. (02.00)

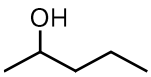


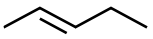
Sol.



2. Which of the following is the correct product for the given reaction

(1)
(2) 

(3) 

(4) 

Ans. (1)

Sol. -Wolff- kishner reduction it reduces aldehyde & ketone into corresponding alkane.

3. Which of the following element show maximum oxidation state

(1) Mn (2) Ti (3) Co (4) Na

Ans. (1)

Sol. Mn show maximum oxidation state +7.

4. Which of the following has lowest paramagnetic character in +2 oxidation state with water

(1) Fe (2) Co (3) Ni (4) Mn

Ans. (3)

Sol. $Fe^{2+} \rightarrow d^6 \quad n = 4$

$Co^{2+} \rightarrow d^7 \quad n = 3$

$Ni^{2+} \rightarrow d^8 \quad n = 2$

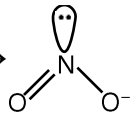
$Mn^{2+} \rightarrow d^5 \quad n = 5$

Where n is number of unpaired electrons. So, Ni^{2+} has lowest paramagnetic character.

5. In the lewis dot structure for NO_2^- total numbers of valance electron around nitrogen is:

Ans. (08.00)

Sol. lewis dot structure for NO_2^- →



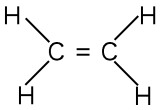
Total valance electron around nitrogen = 8

6. Find the total numbers of σ and π bond in ethylene respectively

(1) 4,1 (2) 5,1 (3) 4,0 (4) 5,0

Ans. (06.00)

Sol.



Total σ bond = 5, Total π bond = 1

7. Which of the following are correct statement(s) for given species.

O^{2-}, F^-, Na^+, Mg^{2+}.

(a) O^{2-} is largest in size

(b) Mg^{2+} is smallest in size

(c) All have same effective nuclear charge

(d) All are isoelectronic

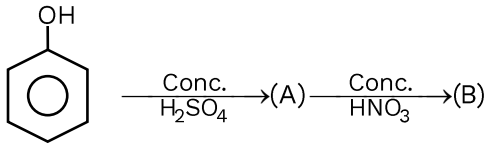
(1) a, b and c (2) a, b and d (3) b,c and d (4) a, c and d

Ans. (2)

Sol. All have same number of electrons so they are isoelectronic

Order of ionic radii $O^{2-} > F^- > Na^+ > Mg^{2+}$.

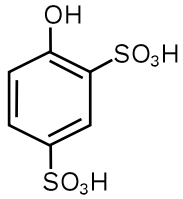
8.



Find sum of total number of O atom(s) in A and B

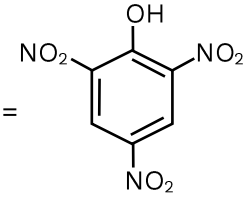
Ans. (14.00)

Sol. A =

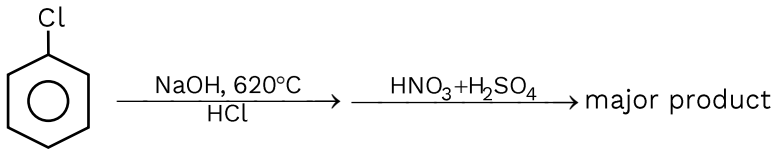


Total O atoms in A = 7

B =



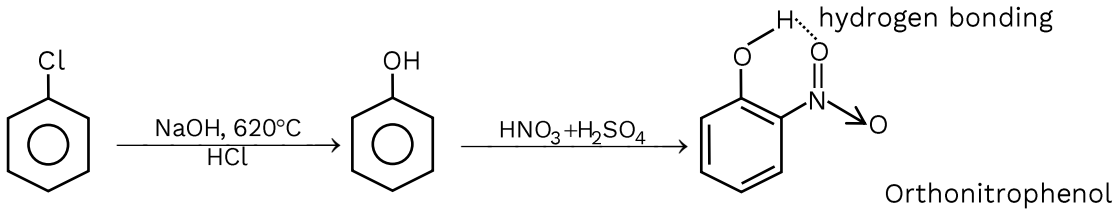
Total O atoms in B = 7

9. 

(1) Orthonitrophenol (2) Paranitrophenol

(3) Picric acid (4) Metanitrophenol

Ans. (1)

Sol. 

Orthonitrophenol

10. Which will give +ve Ninhydrin test

(1) Cellulose (2) Starch

(3) Polyvinyl chloride (4) Egg albumin

Ans. (4)

Sol. Ninhydrin test is given by amino acids and proteins.

(1) Cellulose → Carbohydrate (2) Starch → Carbohydrate

(3) Polyvinyl chloride→ Polymer (4) Egg albumin → Protein

11. Correct order of boiling point for

(P) Diethyl ether

(Q) n-butanol

(R) n-butane

(S) ethylmethyl ketone

(1) P > Q > R > S (2) Q > S > P > R (3) S > R > Q > P (4) S > Q > P > R

Ans. (2)

Sol. (P) Diethyl ether - dipole moment is not 0

(Q) n-butanol – Hydrogen bonding

(R) n-butane - dipole moment is 0

(S) ethylmethyl ketone - dipole-dipole interaction

12. **Assertion:** Cis-but-2-ene is polar while trans but-2-ene is non polar.

Reason: Dipole moment of trans but-2-ene is zero.

(1) Both A and R are correct and R is the correct explanation of A.

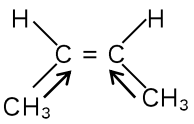
(2) Both A and R are correct, but R is not the correct explanation of A.

(3) A is correct but, R is incorrect.

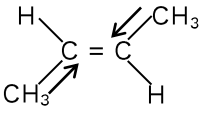
(4) R is correct but, A is incorrect.

Ans. (1)

Sol.



Cis But-2-ene
Dipole moment ≠ 0
Non-polar



Trans But-2-ene
Dipole moment = 0
Polar

13. **Assertion :** For group 13 element stability of +1 oxidation state increases down the group
Reason : Atomic size of Ga is greater than Al.
(1) Both, A and R, are true and R is the correct explanation of A
(2) Both, A and R, are true but R is not the correct explanation of A
(3) If A is true but R is false
(4) If A is false but R is true

Ans. (3)

Sol. Due to inert pair effect +1 oxidation state increases down the group for group 13 element

14. $Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$
Equilibrium does not shift according to Le-chatelier's principle
(1) Removal of CO_2
(2) Addition of CO_2
(3) Removal of CO
(4) Addition of Fe_2O_3

Ans. (4)

Sol. Equilibrium does not shift according to Le-chatelier's principle by Addition of Fe_2O_3

15. Predict correct order of strength of ligands Br^- , F^- H_2O, NH_3
(1) $Br^- < H_2O < F^- < NH_3$
(2) $H_2O < Br^- < F^- < NH_3$
(3) $Br^- < F^- < H_2O < NH_3$
(4) $Br^- < H_2O < NH_3 < F^-$

Ans. (3)

Sol. order of strength $Br^- < F^- < H_2O < NH_3$

16. Molar conductivity of divalent cation and anion are 57 and 73 S cm^{-1} mol^{-1}. The molar conductivity of solution is_____

Ans. (130)

Sol. $\wedge_m = \wedge_{cation} + \wedge_{anion}$

17. For the reaction $2A + B \rightarrow C$ is given

$[A_\circ]$	$[B_\circ]$	Rate
0.1	0.1	6×10^{-3}
0.4	0.1	12×10^{-3}
0.4	0.2	48×10^{-3}

Find order reaction

Ans. (2.5)

Sol. Rate = k $[A]^x[B]^y$

$$\frac{6\times10^{-3}}{12\times10^{-3}}=\frac{[0.1]^x[0.1]^y}{[0.4]^x[0.1]^y}$$

$$\frac{1}{2}=\left[\frac{0.1}{0.4}\right]^x$$

$$\frac{1}{2}=\left(\frac{1}{4}\right)^x$$

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

$$\frac{12\times10^{-3}}{48\times10^{-3}}=\frac{[0.4]^x[0.1]^y}{[0.4]^x[0.2]^y}$$

$$\frac{1}{4}=\left(\frac{1}{2}\right)^y$$

$$y=2$$

So, order of reaction is 2.5

18. Most abundant isotopes of boron has X number of neutrons

$B + O_2 \rightarrow$ Oxidation number of boron (Y)

Find X + Y?

Ans. (9)

Sol. Isotope of B = $_5B^{11}$

Oxidation No. = +3

X = 6

Y = 3

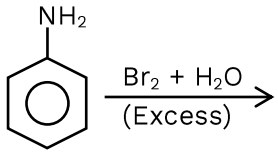
X + Y = 9

19. Find the spin only magnetic moment of strongest oxidizing Agent ?

(1) Ti^{+2} (2) V^{+2} (3) Mn^{+2} (4) Co^{+3}

Ans. (4)

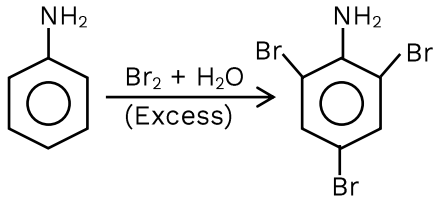
Sol. $S=\sqrt{n(n+2)}$

20. 

9.3 gm 24.6 gm

Find out % yield of white ppt product

Ans. (70%)



Sol.

9.3 gm 24.6 gm

Moles = 0.1 Moles = 0.07

$$\% \text{ yield} = \frac{0.07}{0.1} \times 100 = 70\%$$

21. Which of the following cation will give green colour in reducing flame in borax bead test

(1) Iron (2) Cobalt (3) Manganese (4) Nickel

Ans. (1)

Sol. Iron cation will give green colour in reducing flame in borax bead test

22. Which postulate of Dalton's theory is wrong

(1) Matter consist of indivisible atoms

(2) All atoms of a given element have identical properties but different masses

(3) Compounds are formed when atoms of different elements combines in a fixed ratio

(4) Chemical reaction involves reorganisation of atoms

Ans. (2)

Sol. Theory Based

23. The heat of combustion of solid benzoic acid at constant volume is –321.30K at 27°C. The heat of combustion at constant pressure (–321.30–x)KJ the value of x is.

Ans. (1.25)

Sol. $C_6H_5COOH(s) + \frac{15}{2} O_2 \longrightarrow 7CO_2(g) + 3H_2O(l)$

$\Delta H = \Delta U + \Delta n_g RT$

$$= -321.3 + \left(-\frac{1}{2}\right) \times \frac{8.314}{1000} \times 300$$

$$= -321.3 - 1.25$$

$$= -322.55 \frac{KJ}{mol}$$