1. If the curve $y^2 = 6x$, $9x^2 + by^2 = 16$ intersect each other at right angles, then the value of b is:

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

(2) 6

(3) $\frac{7}{2}$

(4) 4

Solution:

2yy'= 6

$$y' = \frac{6}{2y} = \frac{3}{y_1}$$

$$18x_1 = \frac{18x_1}{2by_1} = \frac{-9x_1}{by_1} \Rightarrow -\frac{27x_1}{by_1^2} = -1 \Rightarrow b = \frac{27x_1}{y_1^2}$$

$$y_1^2 = 6x_1 \Rightarrow b = \frac{9}{2}$$

2. Let $\vec{u}$ be a vector coplanar with the vectors $\vec{a} = 2\hat{i} + 3j - k$ *and* $\vec{b} = j + k$. If $\vec{u}$ is perpendicular to $\vec{a}$ and $\vec{u}$. $\vec{b}$ = 24, than equal to :

(1) 84

(2) 363

(3) 315

(4) 256

Solution:

$$\vec{u}\left(\vec{a} \times \vec{b}\right) = 0; \quad \vec{u}.\vec{a} = 0 \text{ and } \vec{u}.\vec{b} = 24$$

$$Let\ \vec{b} = \left(\vec{b}.a\right)a. + \left(\vec{b}.u\right)u$$

$$\left|\vec{b}\right|^2 = \left(\vec{b}.a\right)^2 + \left(\vec{b}.u\right)^2$$

$$\left|\vec{b}\right|^2 = \left(\vec{b}.a\right)^2 + \frac{\vec{b}.u}{\left|u\right|^2}^2$$

$$2 = \frac{2}{7} + \frac{(24)^2}{\left|u\right|^2} \Rightarrow \left|u\right|^2 = 336$$

3. For each t $\in$ R, let [t] be the greatest integer less than or equal to t. Than

$$\lim_{x\to 0+} x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+......+\left[\frac{15}{x}\right]\right)$$

(1) Does not exist (in R)
(2) Is equal to 0
(3) Is equal to 15
(4) is equal to 120

Solution:

π

$$\lim_{x\to 0^+} x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+..............+\left[\frac{15}{x}\right]\right)$$

$$= \lim_{x\to 0^+} x\left(\frac{1}{x}-\left\{\frac{1}{x}\right\}+\frac{2}{x}-\left\{\frac{2}{x}\right\}+.........+\frac{15}{x}-\left\{\frac{15}{x}\right\}\right)$$

$$= \lim_{x\to 0^+}(1+2+3+.........+15)+\lim_{x\to 0^+} x\left(\left\{\frac{1}{x}\right\}+\left\{\frac{2}{x}\right\}+.........+\left\{\frac{15}{x}\right\}\right)$$

$$Now\ 0 \le \{x\} < 1\ \forall\ x \in R = 120$$

4. If L_1 is the line of intersection of the planes $2x-2y+3z=0, x-y+z=0$ and L_2 is the line of intersection of the planes $x+2y-z-3=0, 3x-y+2z=0$ then the distance of the origin from the plane, containing the lane L_1 and L_2, is :

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

Solution:

$$(2+\lambda)\ x-(2+\lambda)y+(3+\lambda)z-2+\lambda=0$$

$$(1+3\mu)x+(2-\mu)y+(2\mu-1)z-3-\mu=0$$

$$\Rightarrow \frac{2+\lambda}{1+3\mu}=\frac{-(2+\lambda)}{2-\mu} \quad \Rightarrow \mu-2=1+3\mu \Rightarrow 2\mu=-3 \Rightarrow \mu=\frac{-3}{2}$$

$$7x-7y+8z+3=0$$

$$\left|\frac{3}{\sqrt{7^2+7^2+8^2}}\right|=\frac{1}{3\sqrt{2}}$$

5. The value of $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\sin^2 x}{1+2^x}\, dx$ is:

(1) $\frac{\pi}{4}$

(2) $\frac{\pi}{8}$

(3) $\frac{\pi}{2}$

(4) 4π

Solution:

Given $\int_{-\pi/2}^{\pi/2} \frac{\sin^2 x}{1+2^x} dx$

$$f(x)+f(-x)=\frac{\sin^2 x}{1+2^x}+\frac{2^x\left(\sin^2 x\right)}{1+2^x}=\sin^2 x=\int_0^{\pi/2}\sin^2 x dx=\int_0^{\pi/2}\sin^2 x dx=\frac{\pi}{4}$$

6. Let $g(x)=\cos x^2$, $f(x)=\sqrt{x}$, and $\alpha,\beta(\alpha<\beta)$ be the roots of the quadratic equation $18x^2-9\pi x+\pi^2=0$. Then the area (in sq. units) bounded by the curve $y=(gof)(x)$ and the lines $x=\alpha, x=\beta$ and $y=0$, is :

(1) $\frac{1}{2}\left(\sqrt{2}-1\right)$

(2) $\frac{1}{2}\left(\sqrt{3}-1\right)$

(3) $\frac{1}{2}\left(\sqrt{3}+1\right)$

(4) $\frac{1}{2}\left(\sqrt{3}-\sqrt{2}\right)$

Solution:

$$g(x)=\cos x^2$$
$$f(x)=\sqrt{x}$$
$$g(f(x))=\cos x$$
$$given, 18x^2-9\pi x+\pi^2=0\Rightarrow\ (6x-\pi)(3x-\pi)=0$$
$$x=\frac{\pi}{6},\frac{\pi}{3}$$
$$Area=\int_{\pi/6}^{\pi/3}\cos x\ dx=\frac{\sqrt{3}-1}{2}$$

7. If sum of all the solution of equation $8\cos x.\left(\cos\left(\frac{\pi}{6}+x\right).\cos\left(\frac{\pi}{6}-x\right)-\frac{1}{2}\right)=1$ in $[0,\pi]$is $k\pi$,then k is equal to :

(5) $\frac{20}{9}$

(6) $\frac{2}{3}$

(7) $\frac{2}{3}$

(8) $\frac{8}{9}$

Solution:

$$8\cos\text{x}\left[\left(\cos^2\frac{\pi}{6}-\sin^2\text{x}\right)-\frac{1}{2}\right]=1$$
$$8\cos\text{x}\left(\frac{3}{4}-\frac{1}{2}-1+\cos^2\text{x}\right)=1$$
$$\frac{8\cos\text{x}}{4}\times\left(4\cos^2\text{x}-1-2\right)=1$$
$$\cos 3\text{x}=4\cos^2\text{x}-3\cos\text{x}$$
$$2\times\cos 3\text{x}=1$$
$$\cos 3\text{x}=\frac{1}{2}$$
$$3\text{x}\in[0,3\pi]$$
$$3\text{x}=\frac{\pi}{3},\ 2\pi-\frac{\pi}{3},2\pi+\frac{\pi}{3}\Rightarrow\text{Sum}=\frac{13\pi}{9}$$

8. Let $f(x)=x^2+\dfrac{1}{x^2}$ and $g(x)=x-\dfrac{1}{x}, x\in R-\{-1,0,1\}$. If $h(x)=\dfrac{f(x)}{g(x)}$, then the local minimum value of value of $h(x)$ is :

(1) $\sqrt[2]{2}$
(2) 3
(3) -3
(4) $-2\sqrt{2}$

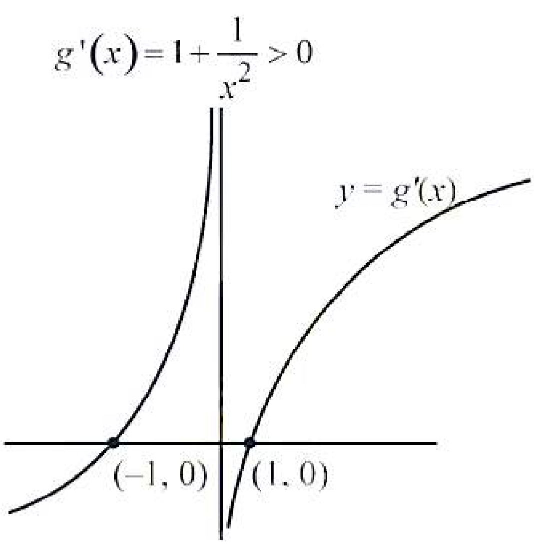
Solution:

Let $g(x)=x-\dfrac{1}{x}=t$

$g'(x)=1+\dfrac{1}{x^2}>0$

$\therefore\ t\in R-\{0\};t^2\in(0,\infty)$

$\therefore\ f(x)=x^2+\dfrac{1}{x^2}=\left(x-\dfrac{1}{x}\right)^2+2=t^2+2\in(2,\infty)$



$\therefore\ h(x)=\dfrac{f(x)}{g(x)}$

$\therefore\ \dfrac{f(x)}{g(x)}=\dfrac{t^2+2}{t}=t+\dfrac{2}{t}$

Let $h(t)=t+\dfrac{2}{t}$

+	−	−	+

$\sqrt{2}$ $\quad$ 0 $\quad$ $\sqrt{2}$

Local − maxima $\quad$ local − minima

$\therefore$ Local minimum value occurs at $t = \sqrt{2}$

$\therefore$ Local minimum value $= h\left(\sqrt{2}\right) = \sqrt{2} + \frac{2}{\sqrt{2}} = 2\sqrt{2}$

9. The integral $\int \frac{\sin^2 x \cos^2 x}{\left(\sin^5 x + \cos^3 x \sin^2 x + \sin^3 x \cos^2 x + \cos^5 x\right)_2} dx$ is equal to :

(1) $\frac{-1}{1+\cot^3 x} + c$

(2) $\frac{1}{3\left(1+\tan^3 x\right)} + c$

(3) $\frac{-1}{3\left(1+\tan^3 x\right)} + c$

(4) $\frac{-1}{1+\cot^3 x} + c$

Solution:

$$\int \frac{\sin^2 x \cos^2 x}{\left(\sin^5 + \cos^3 x \sin^2 x + \sin^3 x \cos^2 x + \cos^2 x + \cos^5 x\right)^2} dx$$

$$\int \frac{\tan^2 x \sec^6 x}{\left(\tan^5 x + \tan^2 x + \tan^3 x + 1\right)} dx$$

Put tanx = t $\Rightarrow \sec^2 x = \frac{dt}{dx}$

$$\int \frac{t^2\left(1+t^2\right)^2}{\left(t^3+1\right)^2\left(t^2+1\right)^2} dt$$

$T^3 + 1 = y$

$3t^2 = \frac{dy}{dt}$

$$\frac{1}{3}\int \frac{dy}{y^2} = -\frac{1}{3(y)} + C = -\frac{1}{3\left(\tan^3 x + 1\right)} + C$$

10. A bag contains 4 red and 6 black v balls. A ball is drawn at random from the bag, its colour is observed and this ball along with two additional balls of the same colour is returned to the bag. If now a ball is drawn at random from the bag, then probability that this drawn ball is red, is:

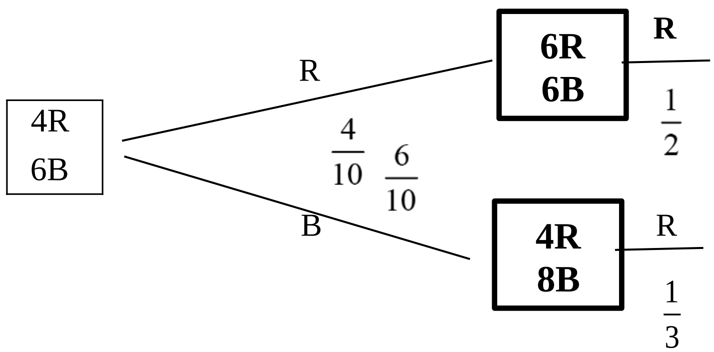
(1) $\frac{3}{4}$

(2) $\frac{3}{10}$

(3) $\frac{2}{5}$

(4) $\frac{1}{5}$

Solution:



Total Probability $=\frac{4}{10}.\frac{1}{2}+\frac{6}{10}.\frac{1}{3}=\frac{2}{5}$

11. Let the orthocenter and centroid of a triangle be A(-3, 5) and B(3, 3) respectively. If C is the circumcentre of this triangle, than the radius of the circle having line segment AC as diameter, is :

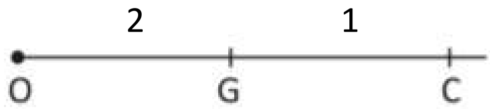
(1) $\frac{3\sqrt{5}}{2}$

(2) $\sqrt{10}$

(3) $\sqrt[2]{10}$

(4) $\sqrt[3]{\frac{5}{2}}$

Solution:



$(-3,5)$ $(3,3)$ (a,b)

$$\frac{2a-3}{3}=3 \Rightarrow 2a=12 \Rightarrow a=6$$

$$\frac{2b+5}{3}=3 \Rightarrow 2b=4 \Rightarrow b=2$$

$$AC=\sqrt{(6+3)^2+3^2}$$

Diameter $=AC=\sqrt{81+9}=\sqrt{90}$

Radius = $=\frac{3\sqrt{10}}{2}=\frac{3\times\sqrt{10}}{\sqrt{2}\times\sqrt{2}} \quad =3\sqrt{\frac{5}{2}}$

12. If the tangent at (1,7) to the curve $x^2=y-6$ touches the circle $x^2+y^2+16x+12y+c=0$ than the value of c is :

(1) 95
(2) 195
(3) 185
(4) 85

Solution:

$$x=\frac{y+7}{2}-6 \Rightarrow 2x=y+7-12 \Rightarrow 2x=y-5$$

Also, centre of the circle $(-8,-6)$ and the radius is $\sqrt{64+36-c}$

$$\Rightarrow \left(\frac{-16+6+5}{\sqrt{5}}\right)=\sqrt{100-c} \Rightarrow \sqrt{5}=\sqrt{100-c} \Rightarrow c=95$$

13. If $\alpha,\beta \in c$ are the distinct roots, of the equation $x^2-x+1=0$, then $\alpha^{101}+\beta^{107}$ is equal to :

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

Solution:

$x^2 - x + 1 = 0$

$$x=\frac{1\pm\sqrt{-3}}{2}=-\omega,-\omega^2$$

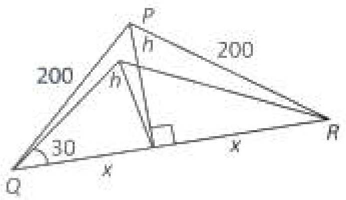
$$\Rightarrow \alpha=-\omega \text{ and } \beta=-\omega^2$$

$$\Rightarrow (-\omega)^{101}+(-\omega^2)^{107}=(\omega^{101}+\omega^{214})=-(\omega^2+\omega)=1$$

14. PQR is a triangular park with PQ=PR=200 m. AT.V. tower stands at the mid-point of QR. If the angle of elevation of the top of the tower at P,Q and R are respectively $45^0, 30^0$ and 30^0 then the height of tower (in m) is :

(1) $50\sqrt{2}$
(2) 100
(3) 50
(4) $100\sqrt{3}$

Solution:



$$\frac{h}{x}=\frac{1}{\sqrt{3}}$$

$$x=\sqrt{3}h$$

$$200=3h^2+h^2$$

$$4h^2=(200)^2$$

$$4h^2=40000$$

$$h=100$$

15. If $\sum_{i=1}^{9}(x_i-5)=9$ and $\sum_{i=1}^{9}(x_i-5)^2=45$, then the standard deviation of the 9 items $x_1, x_2,$ …., x_9 is:

(1) 3
(2) 9
(3) 4
(4) 2

Solution:

Variance $=\frac{45}{9}-(1)^2 \ =5-1=4$

$\sigma=\sqrt{\text{Variance}}=2$

16. The sum of the co-efficients of all odd degree terms in the expansion of $\left(x+\sqrt{x^3-1}\right)^5+\left(x-\sqrt{x^3-1}\right)^5,(x>1)$ is:

(1) 2

(2) -1

(3) 0

(4) 1

Solution:

Let $\sqrt{x^2-1}=y$

$(x+y)^5+(x-y)^5$

$=\left({}^5C_0x^5+{}^5C_1x^4y+........{}^5C_5y^5\right)+\left({}^5C_0x^5-5C_1x^4.y+.......-5C_5y^5\right)$

$=2\left[5C_0x^5+{}^5C_2x^3y^2+{}^5C_4xy^4\right]=2\left[C_0x^5+5C_2x^3y^2+{}^5C_4xy^4\right]$

$=2\left[x^5+10x^3\left(x^3-1\right)+5x\left(x^3-1\right)^2\right]=2\left[x^5+10x^6-10x^3+5x\left(x^6+1-2x^3\right)\right]$

$=2\left[x^5+10x^6-10x^3+5x^7+5x-10x^4\right]=2[1-10+5+5]=2$

17. Tangents are drawn to the hyperbola $4x^2-y^2=36$ at the points P and Q. If these tangents intersects at the point T(0, 3) then the area (in sq. units) of ΔPTQ is :

(1) $36\sqrt{5}$

(2) $45\sqrt{5}$

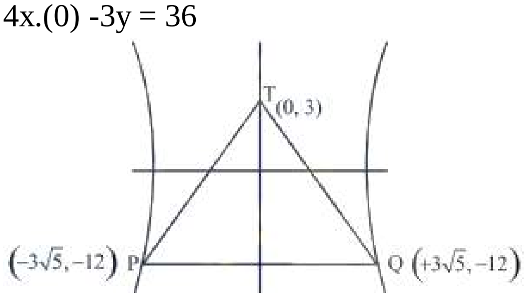
(3) $54\sqrt{3}$

(4) $60\sqrt{3}$

Solution:

Equation of PQ,

4x.(0) -3y = 36



Y = -12

Area of $\Delta TPQ=\dfrac{1}{2}\times 15\times 6\sqrt{5}=45\sqrt{5}$

18. From 6 different novels and 3 different dictionaries, 4 novels and 1 dictionary are to be selected and arranged in a row on a shelf so that the dictionary is always in the middle. The number of such arrangements is :

(1) at least 750 but less than 1000
(2) at least 1000
(3) less than 500
(4) at least 500 but less than 750

Solution:

$^{6}C_4 . ^{3}C_1 \times 1 \times 4!$

$\frac{6\times 5}{2}.3\times 24 = 45\times 24 = \boxed{1080}$

19. If the system of linear equations

$x + ky + 3z = 0$

$3x + ky - 2z = 0$

$2x + 4y - 3z = 0$

has a non-zero solution (x, y, z), then $\frac{xz}{y^2}$ is equal to:

(1) 30
(2) -10
(3) 10
(4) -30

Solution:

$$\begin{vmatrix} 1 & k & 3 \\ 3 & k & -2 \\ 2 & 4 & -3 \end{vmatrix} = 0$$

$\Rightarrow k = \frac{7}{2}$

$x + ky + 3z = 0 \; ....(i)$

$3x + ky - 2z = 0 \; .....(ii)$

$2x + 4y - 3z = 0 \; ......(iii)$

On Solving (i) and (ii)

$4y = -2z \; .....(iv)$

On Solving (iii) and (iv)

$4y = -2z$

$$\frac{xz}{y^2} = \frac{\frac{5}{2}z \times z}{\frac{z^2}{4}} = 10$$

20. If $\begin{vmatrix} x-4 & 2x & 2x \\ 2x & x-4 & 2x \\ 2x & 2x & x-4 \end{vmatrix} = (A+Bx)(x-A)^2$,

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

Solution:

$$\begin{vmatrix} x-4 & 2x & 2x \\ 2x & x-4 & 2x \\ 2x & 2x & x-4 \end{vmatrix} = (A+Bx)(x-A)^2$$

Put $x = 0$

$$\begin{vmatrix} -4 & 0 & 0 \\ 0 & -4 & 0 \\ 0 & 0 & -4 \end{vmatrix} = A^3$$

$\boxed{A = -4}$

Put $x = 1$

$$\begin{vmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{vmatrix} = (A+B)(1-A)^2$$

$-3(9-4) - 2(-6-4) + 2(4+6)$

$-15 + 20 + 20 = (-4+B)25$

$1 = (-4+B)$

$B = 5$

21. Two sets A and B are as under :

A=$\{(a, b) \in R \times R: |a-5| < 1$ and $|b-5| < 1\}$;

B=$\{(a, b) \in R \times R: 4(a-6)^2 + 9(b-5)^2 \le 36\}$. Then :

(1) neither $A \subset B$ nor $B \subset A$

(2) $B \subset A$
(3) $A \subset B$
(4) $A \cap B = \Phi$ (an empty set)

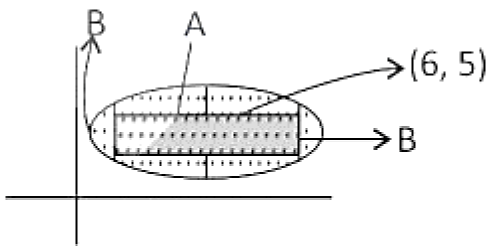
Solution:

Since Set A is, $|a-5|<1$ $4<a<6$

And $|b-5|<1$ $4<b<6$

Now, B is

$$\frac{(a-6)^2}{9}+\frac{(b-5)^2}{4}\le 1$$



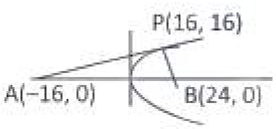
It can be seen that all vertices of rectangle lie inside the ellipse, therefore $A \subset B$

22. Tangent and normal are drawn at P(16, 16) on the parabola $y^2 = 16x$, which intersect the axis of the parabola at A and B, respectively. If C is the centre of the circle through the points P, A and B and $\angle CPB = \theta$, then a value of $\tan\theta$ is :

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

Solution:

The equation of tangent at P



$$y-16=\frac{1}{2}(x-16)\Rightarrow A=(-16, 0)$$

The normal is y = y – 16 = -2(x – 16)
B = (24, 0)

Since $\angle APB = \frac{\pi}{2}$

AB is the diameter
Center of the circle C = (4, 0)
Slope of PB = -2 = m_1

Slope of CP = $\frac{4}{3} = m_2 \Rightarrow \tan\theta = \left|\frac{m_2 - m_1}{1 + m_2 m_1}\right| = 2$

23. Lets S={t∈ R:f(x)=$|x - \Pi| \bullet (e^{|x|} - 1)\sin|x|$ is not differentiable at t}. Then the set S is equal to:

(1) $\{0, \Pi\}$
(2) Φ
(3) $\{0\}$
(4) $\{\Pi\}$

Solution:

Doubtful point for differentiability are 0 and π At $x = 0$

$$f'(0+) = \lim_{h \to o^+} \frac{|h - \pi| \times \left(e^{|h|} - 1\right) \times \sin|h| - 0}{h}$$

$$= \lim_{h \to o^+} \frac{(\pi - h) \times \left(e^h - 1\right) \times \sin h}{h}$$

$$\because \lim_{h \to o^+} \frac{\sinh}{h} = 1 \text{ and } \lim_{h \to o^+} e^h - 1 = 0$$

$$\therefore f'\left(0^+\right) = \pi \times 0 \times 1 = 0$$

$$f'\left(0^-\right) = \lim_{h \to o^+} \frac{|-h - \pi| \times \left(e^{|h|} - 1\right) \times \sin|-h| - 0}{-h}$$

$$= \lim_{h \to o^+} \frac{(\pi + h) \times \left(e^h - 1\right) \times \sin h}{-h}$$

$$\because \lim_{h \to o^+} \frac{\sinh}{h} = 1 \text{ and } \lim_{h \to o^+} e^h - 1 = 0$$

$$\therefore f'\left(0^-\right) = (-\pi) \times 0 \times 1 = 0$$

$$\therefore f'\left(0^+\right) = f'\left(0^-\right) = 0$$

Similarly $f'\left(\pi^+\right) = f'\left(\pi^-\right) = 0$

Hene $f(x)$ is differentiable $\forall\ x \in R$

24. The Boolean expression $\sim(p \vee q) \vee (\sim p \wedge q)$ is equivalent to:

(1) $\sim p$

(2) $\sim q$
(3) p
(4) q

Solution:

$\sim(p \vee q) \vee (\sim p \wedge q)$

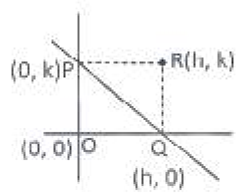
P	q	$\sim(p \vee q)$	$\sim p \wedge q$
T	F	F	F
T	F	F	F
F	T	F	T
F	F	T	F

25. A straight line through a fixed point (2, 3) intersects the coordinate axes at distinct points P and Q. If O is the origin and the rectangle OPRQ is completed, then the locus of R is:

(1) $3x + 2y = 6xy$
(2) $3x + 2y = 6$
(3) $2x + 3y = xy$
(4) $3x + 2y = xy$

Solution:

Let R = (h,k)
P = (0, k)
Q = (h,0)
Equation of line would be,



$$\frac{x}{h} + \frac{y}{k} = 1 \quad ....(i)$$

$$\Rightarrow \frac{2}{h} + \frac{3}{k} = 1$$

2k + 3h = hk
Locus of (h, k) is 2y + 3x = xy

26. Let A be the sum of the first 20 terms and B be the sum of the first 40 terms of the series

$1^2 + 2 \cdot 2^2 + 3^2 + 2 \cdot 4^2 + 5^2 + 2 \cdot 6^2 + ...$

If B-2A=100λ, then λ is equal to:

(1) 496
(2) 232
(3) 248

(4) 464

Solution:

A = $1^2 + 2.2^2 + 3^2 + 2.4^2 + \ldots\ldots\ldots + A^2 + 2.20^2$

= $(1^2 + 2.2^2 + 3^2 + 4^2 + \ldots\ldots\ldots + 20^2) + (2^2 + 4^2 + \ldots\ldots\ldots + 20^2)$

$$=\frac{20\times21\times41}{6}+4\times\frac{10\times11\times21}{6}=2870+1540=4410=2870+1540=4410$$

$$B=\frac{40\times41\times81}{6}+\frac{4\times20\times21\times41}{6}=540\times41+41\times280=41\times820=33620$$

$$33620-8820=100\lambda$$

$$100\lambda=24800$$

$$\lambda=248$$

27. Let y=y(x) be the solution of the differential equation

$\sin x\frac{dy}{dx}+y\cos x=4x,\ x\in(0,\Pi)$. If $y\left(\frac{\Pi}{2}\right)=0$, then $y\left(\frac{\Pi}{6}\right)$ is equal to :

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

(2) $\frac{4}{9\sqrt{3}}\Pi^2$

(3) $\frac{-8}{9\sqrt{3}}\Pi^2$

(4) $-\frac{8}{9}\Pi^2$

Solution:

$$\frac{dy}{dt}+y\cot x=4x\operatorname{cos}ec\,x\Rightarrow d\left(y\sin x\right)=4xdx$$

Intragrating both sides we get $y\sin x=2x^2+C$

$$Also,\ y\left(\frac{\pi}{2}\right)=0\Rightarrow\ c=-\frac{\pi^2}{2}$$

$$\Rightarrow\ y\sin x=2x^2-\frac{\pi^2}{2}\Rightarrow\ y\left(\frac{\pi}{6}\right)=-\frac{8\pi^2}{9}$$

28. The length of the projection of the line segment joiuning the points (5, -1, 4) and (4, -1, 3) on the plane, x+y+z=7 is :

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

(2) $\frac{2}{\sqrt{3}}$

(3) $\frac{2}{3}$

(4) $\frac{1}{3}$

Solution:

$$\frac{x-5}{1}=\frac{y+1}{1}=\frac{z-4}{1}=\lambda$$

$P(\lambda+5,\lambda-1,\lambda+4)$

P is foot of perpendicular from A to plane $3\lambda+8=7$

$$\lambda=-\frac{1}{3}$$

$$p\left(\frac{14}{3},\frac{-4}{3},\frac{11}{3}\right)$$

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

$Q(\lambda+4,\lambda-1,\lambda+3)$

Q is foot of perpendicular from B to plane

$3\lambda+6=7$

$$\lambda=\frac{1}{3}$$

$$Q\left(\frac{13}{3},\frac{-2}{3},\frac{10}{3}\right)$$

$$\therefore PQ=\frac{\sqrt{1+4+1}}{3}=\frac{\sqrt{16}}{3}=\sqrt{\frac{2}{3}}$$

29. Let S= $\{x\in R: x\geq 0$ and $2\left|\sqrt{x}-3\right|+\sqrt{x}(\sqrt{x}-6)+6=0\}$. Then S :

(1) contains exactly four elements.

(2) is an empty set.

(3) contains exactly one element.

(4) contains exactly two element.

Solution:

$$2|\sqrt{x}-3|+\sqrt{x}\left(\sqrt{x}-6\right)+6=0$$

Case-I $\sqrt{x}\geq 3$

$\Rightarrow 2\left(\sqrt{x}-3\right)+x-6\sqrt{x}+6=0 \Rightarrow x-4\sqrt{x}=0 \Rightarrow x=0,6$

$As\ x \geq 9\ \Rightarrow x=16$

$Case-II\ \ \sqrt{x}<3 \Rightarrow -2\sqrt{x}+6+x-6\sqrt{x}+6=0$

$\left(\sqrt{x}-6\right)\left(\sqrt{x}-2\right)=0\ \Rightarrow\ x=36,4$

$As,\ \sqrt{x}<3 \Rightarrow\ x=4$

There are exactly two elements in the given set.

30. Let $a_1, a_2, a_3, ..., a_{49}$ be in A.P. such that $\sum_{k=0}^{12} a_{4k+1} = 416$ and $a_9 + a_{43} = 66$. If $a_1^{\ 2} + a_2^{\ 2} + ... + a_{17}^{\ 2} = 140m$, then m is equal to:

(1) 33
(2) 66
(3) 68
(4) 34.

Solution:

$a_1 + a_5 + a_9 = 416 \Rightarrow\ a + 24d = 32\ \ ....(i)$

$a_9 + a_{43} = 66\ \ \Rightarrow a + 25d = 33\ \ \ ....(ii)$

From (i) and (ii) d = 1 and a = 8

$Now,\ a_1^2 + a_2^2 + ... + a_{17}^2 = 140m$

$\Rightarrow\ \sum_{r=1}^{17}\left(8+\left(r-1\right)\right) \Rightarrow\ \sum_{r=1}^{17}\left(7+r\right)^2 = 140m\ \ \ \Rightarrow\ m = 34$

31. Three concentric metal shells A, B and C of respective radii a, b and c (a < b < c) have surface charge densities $+\sigma, -\sigma$ and $+\sigma$ respectively. The potential of shell B is :

(1) $\frac{\sigma}{\epsilon_0}\left(\frac{b^2-c^2}{c}+a\right)$

(2) $\frac{\sigma}{\epsilon_0}\left(\frac{a^2-b^2}{a}+c\right)$

(3) $\frac{\sigma}{\epsilon_0}\left(\frac{a^2-b^2}{b}+c\right)$

(4) $\frac{\sigma}{\epsilon_0}\left(\frac{b^2-c^2}{b}+a\right)$

Solution:
Charge in sphere

$A = q_A = \sigma \times 4\pi a^2$

$B = q_B = \sigma \times 4\pi b^2$

$C = q_c = \sigma \times 4\pi c^2$

Potential of B:

$$= \frac{q_A}{4\pi \epsilon_0 b} + \frac{q_b}{4\pi \epsilon_0 b} + \frac{q_c}{4\pi \epsilon_0 c}$$

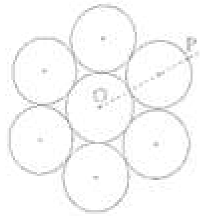
$$= \frac{\sigma a^2}{\epsilon_0 b} + \frac{-\sigma b^2}{\epsilon_0 b} + \frac{\sigma c^2}{\epsilon_0 c}$$

$$= \frac{\sigma}{\epsilon_0}\left(\frac{a^2}{b} - b + c\right)$$

$$= \frac{\sigma}{\epsilon_0}\left(\frac{a^2-b^2}{b} + c\right)$$

Hence the Solution is Option (3)

32. Seven identical circular planar disks, each of mass M and radius R are welded symmetrically as shown. The moment of inertia of the arrangement about the axis normal to the plane and passing through the point P is :



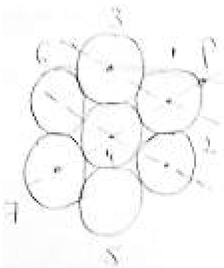
(1) $\frac{181}{2}MR^2$

(2) $\frac{19}{2}MR^2$

(3) $\frac{55}{2}MR^2$

(4) $\frac{73}{2}MR^2$

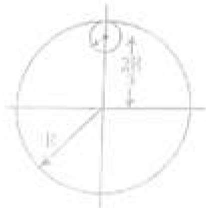
Solution:
Moment of inertia of each disc about the given axis is,



$$I_1 = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2$$
$$I_4 = \frac{1}{2}MR^2 + M\left(3R\right)^2 = \frac{19}{2}MR^2$$
$$I_7 = \frac{1}{2}MR^2 + M\left(3R\right)^2 = \frac{51}{2}MR^2$$
$$I_{net} = I_1 + I_2 + I_3 + I_4 + I_5 + I_6 + I_7$$
$$I_{net} > I_1 + I_4 + I_7$$
$$I_{net} > \frac{73}{2}MR^2$$

Hence the Solution is Option (4)

33. From a uniform circular disc of radius R and mass 9 M, a small disc of radius $\frac{R}{3}$ is removed as shown in the figure. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through centre of disc is :



(1) $\frac{37}{9}MR^2$

(2) $4MR^2$

(3) $\frac{40}{9}MR^2$

(4) $10MR^2$

Solution:

Mass of disc = Volume x Density

9M = $A \times T \times \rho$ (Area x thickness x density)

9M = $\pi R^2 \times t \times \rho ....(i)$

For the disc which is cut off.

$$M' = \pi\left(\frac{R}{3}\right)^2 \times t \times \rho ......(ii)$$

(i)Divided by (ii)

$$\frac{9M}{M} = 9 \Rightarrow M' = M$$

Moment of inertia of complete disc about an axis passes through O.

$$I_1 = \frac{1}{2}(9M) \times R^2$$

Moment of inertia of cut off disc about an axis passes through O

$$I_2 = \frac{1}{2}M \times \left(\frac{R}{3}\right)^2 + M \times \left(\frac{2R}{3}\right)^2$$

$$= \frac{1}{2}\frac{MR^2}{9} + \frac{4MR^2}{9}$$

So, moment of inertia of remaining disc = $I_1 - I_2$

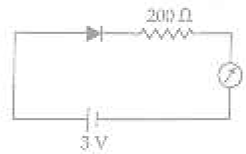
$$= \frac{9MR^2}{2} - \frac{MR^2}{18} - \frac{4MR^2}{9}$$

$$= \left(\frac{81-1-8}{18}\right)MR^2$$

$$= 4MR^2$$

Hence the Solution is Option (2)

34. The reading of the ammeter for a silicon diode in the given circuit is :



(1) 13.5 mA
(2) 0
(3) 15 mA
(4) 11.5 mA

Solution:
The given diode is a forward bias & hence behaves as a perfect conductor i.e., it offers zero resistance.
So,
$$I = \frac{V}{R} = \frac{3}{200} = 1\times10^{-2} A$$
$$= 15mA$$
Hence the Solution is Option (3)

35. Unpolarized light of intensity I passes through an ideal polarizer A. Another identical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{1}{2}$ .Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{1}{8}$.
The angle between polarizer A and C is :
(1) 60^0
(2) 0^0
(3) 30^0
(4) 45^0

Solution:
Unpolarized light of intensity I, when passed through a polarizer A, its intensity becomes $\frac{I}{2}$
Since intensity of light emerging from polarizer B = $\frac{I}{2}$
So, A & B are parallel placed.
Let, C makes angle θ with A.

So,

$\frac{I}{2}\cos^4\theta = \frac{I}{8}$

$\Rightarrow \cos^2\theta = \frac{1}{2}$

$\Rightarrow \cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45^\circ$

Hence the Solution is Option (4)

36. For an RLC circuit driven with voltage of amplitude υ_m and frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ the current exhibits resonance. The quality factor, Q is given by :

(1) $\frac{CR}{\omega_0}$

(2) $\frac{\omega_0 L}{R}$

(3) $\frac{\omega_0 R}{L}$

(4) $\frac{R}{(\omega_0 C)}$

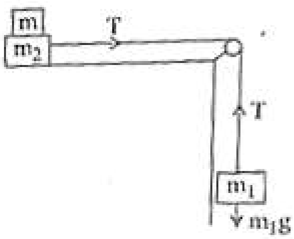
Solution:

Q_{factor} = (voltage across L or C at Resonance)/(voltage across R)

$= \frac{I \times X_L}{I \times R} = \frac{\omega_0 L}{R}$

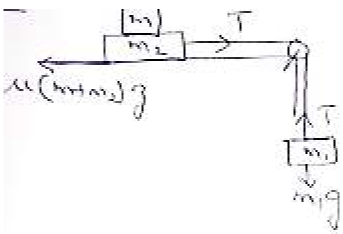
Hence the Solution is Option (2)

37. Two masses m_1 = 5 kg and m_2 = 10 kg, connected by an inextensible string over a frictionless pulley, are moving as shown in the figure. The coefficient of friction of horizontal surface is 0.15. The minimum weight m that should be put on top of m_2 to stop the motion is :



(1) 10.3 kg
(2) 18.3 g
(3) 27.3 kg
(4) 43.3 kg

Solution:



To stop the motion,

$m_1 g = T = \mu\left(m_1 + m_2\right) g$

$\Rightarrow \frac{m_1}{\mu} - m_2 = m$

$\Rightarrow \frac{5}{0.15} - 10 = m$

$\Rightarrow m = 23.3kg$

Hence the nearest Solution is Option (3)

38. In a collinear collision, a particle with an initial speed υ_0 strikes a stationary particle of the same mass. If the final total kinetic energy is 50% greater than the original kinetic energy, the magnitude of the relative velocity between the two particles, after collision, is :

(1) $\frac{\upsilon_0}{\sqrt{2}}$

(2) $\frac{\upsilon_0}{4}$

(3) $\sqrt{2}\upsilon_0$

(4) $\frac{\upsilon_0}{2}$

Solution:

By cons of linear momentum,

$mv_0 = mv_1 + mv_2$

$v_0 = v_1 + v_2 .....(i)$

$$Also, \frac{\left(\frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2\right) - \left(\frac{1}{2}mv_0^2\right)}{\frac{1}{2}mv_0^2} \times 100$$

$= 50$

$$\Rightarrow v_1^2 + v_2^2 - v_0^2 = \frac{1}{2}v_0^2$$

$$\Rightarrow v_1^2 + v_2^2 = \frac{3}{2}v_0^2$$

Using (i)

$$(v_0 - v_2)^2 + v_2^2 = \frac{3}{2}v_0^2$$

$$v_2^2 - 2v_0v_2 + v_1^2 = \frac{1}{2}v_0^2$$

$$2v_2^2 + (-2v_0)v_2 + \left(\frac{-1}{2}v_0^2\right) = 0$$

$$v_2 = \frac{2v_0 \pm \sqrt{4v_0^2 + 4v_0^2}}{4}$$

$$= \frac{v_0 \pm \sqrt{2}v_0}{2}$$

$$If \;\; v_2 = \frac{v_0 \pm \sqrt{2}v_0}{2}$$

$$\Rightarrow v_1 = \frac{v_0 \pm \sqrt{2}v_0}{2}$$

So relative velocity :

$$\Rightarrow v_2 - v_1 = \sqrt{2}v_0$$

Hence the Solution is Option (3)

39. A particle is moving with a uniform speed in a circular orbit of radius R in a central force inversely proportional to the nth power of R. If the period of rotation of the particle is T, then :

(1) $T \alpha R^{n/2}$

(2) $T \alpha R^{3/2}$

(3) $T \alpha R^{\frac{n}{2}+1}$

(4) $T \alpha R^{(n+1)/2}$

Solution:

$F = KR^{n-1}$

$So,\ \frac{mv^2}{R} = \frac{K}{R^n}$

$\Rightarrow v = \sqrt{\frac{K}{M}} \times \frac{1}{R^{(n-1)/2}}$

$Now,\ T = \frac{2\pi R}{v} = \frac{2\pi R}{\sqrt{\frac{K}{M}}} \times R^{\frac{n-1}{2}}$

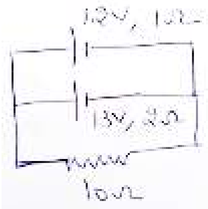
$\Rightarrow T \propto R^{(n+1)/2}$

Hence the Solution is Option (4)

40. Two batteries with e.m.f. 12 V and 13 V are connected in parallel across a load resistor of 10Ω. The internal resistances of the two batteries are 1Ω and 2Ω respectively. The voltage across the load lies between :

(1) 11.7 V and 11.8 V
(2) 11.6 V and 11.7 V
(3) 11.5 V and 11.6 V
(4) 11.4 V and 11.5 V

Solution:



Total

$$emf = \frac{\left(\frac{\rho_1}{r_1} + \frac{\rho_2}{r_2}\right)}{\left(\frac{1}{r_1} + \frac{1}{r_2}\right)}$$

$$= \frac{\left(\frac{12}{1} + \frac{13}{2}\right)}{\left(\frac{1}{1} + \frac{1}{2}\right)}$$

$$= \frac{37}{3} Volt$$

$$So,\ V = \rho - Ir$$

$$= \rho - \frac{\rho r}{R + r}$$

$$= 11.53V$$

Hence the Solution is Option (3)

41. In an a.c. circuit, the instantaneous e.m.f. and current are given by e = 100 sin 30 t $i = 20\sin\left(30t - \frac{\pi}{4}\right)$. In one cycle of a.c., the average power consumed by the circuit and the wattless current are, respectively :

(1) 50, 0

(2) 50, 10

(3) $\frac{1000}{\sqrt{2}}, 10$

(4) $\frac{50}{\sqrt{2}}, 0$

Solution:

$$P_{qv} = \rho_{rms} \times I_{rms} \times \cos\phi$$
$$= \frac{100}{\sqrt{2}} \times \frac{20}{\sqrt{2}} \times \cos\left(\frac{\pi}{4}\right)$$
$$= \frac{2000}{2\sqrt{2}} watt$$
$$= \frac{1000}{\sqrt{2}} w$$
$$I_w = I_{rms} \times \cos\phi$$
$$= \frac{20}{\sqrt{2}} \times \frac{1}{\sqrt{2}}$$
$$= 10A$$

Hence the Solution is Option (3)

42. An EM wave from air enters a medium. The electric fields are $\overrightarrow{E_1} = E_{01}\hat{x}\cos\left[2\pi v\left(\frac{z}{c} - t\right)\right]$ in air and $\overrightarrow{E_2} = E_{02}\hat{x}\cos\left[k(2z - ct)\right]$ in medium, where the wave number k and frequency υ refer to their values in air. The medium is non-magnetic. If $\in_{r_1}$ and $\in_{r_2}$ refer to relative permitivities of air and medium respectively, which of the following options is correct ?

(1) $\frac{\in_{r_1}}{\in_{r_2}} = \frac{1}{2}$

(2) $\frac{\in_{r_1}}{\in_{r_2}} = 4$

(3) $\frac{\in_{r_1}}{\in_{r_2}} = 2$

(4) $\frac{\in_{r_1}}{\in_{r_2}} = \frac{1}{4}$

Solution:

$$\overrightarrow{E_1} = E_{01}\hat{x}\cos\left[2\pi v\left(\frac{z}{c} - t\right)\right]$$
$$\overrightarrow{E_2} = E_{02}\hat{x}\cos\left[k(2z - ct)\right]$$

Where

$$k = \frac{2\pi}{\lambda} \ \& \ \frac{v}{c} = \frac{1}{\lambda}$$

So volume in medium 1 = C

Volume in medium 2 = C/2

$$C = \frac{1}{\sqrt{\mu \in_0 \in_{r_1}}}$$

$$\frac{C}{2} = \frac{1}{\sqrt{\mu \in_0 \in_{r_2}}}$$

$$\Rightarrow 2 = \sqrt{\frac{\in_{r_2}}{\in_{r_1}}}$$

$$\Rightarrow \frac{\in_{r_1}}{\in_{r_2}} = \frac{1}{4}$$

Hence the Solution is Option (4)

43. A telephonic communication service is working at carrier frequency of 10 GHz. Only 10% of it is utilized for transmission. How many telephonic channels can be transmitted simultaneously if each channel requires a bandwidth of 5 kHz ?

(1) 2×10^6

(2) 2×10^3

(3) 2×10^4

(4) 2×10^5

Solution:

Required number of channels

$$= \frac{\frac{10}{100}\times10\times10^9}{5\times10^3}$$

$$= 2\times10^5$$

Hence the Solution is Option (4)

44. A gratitude rod of 60 cm length is clamped at its middle point and is set into longitudinal vibrations. The density of granite is $2.7\times10^3\,\text{kg/m}^3$ and its young's modulus is $9.27\times10^{10}\,\text{Pa}$. What will be the fundamental frequency of the longitudinal vibrations ?

(1) 7.5 kHz

(2) 5 kHz

(3) 2.5 kHz

(4) 10 kHz

Solution:

Since rod is clamped at centre. So centre it behaves as node & end it behave as antinode.

So,

$$\frac{\lambda}{4} = 30cm$$

$$\Rightarrow \lambda = 1.2m$$

$$\upsilon = \sqrt{\frac{y}{\rho}} = \sqrt{\frac{9.27\times10^{10}}{2.7\times10^{3}}}$$

$$= 5.85\times10^{3}\, m/s$$

$$So, \upsilon = \frac{5.85\times10^{3}}{1.2}$$

$$= 5kHz$$

Hence the Solution is Option (2)

45. It is found that if a neutron suffers an elastic collinear collision with deuterium at rest, fractional loss of its energy is p_d; while for its similar collision with carbon nucleus at rest, fractional loss of energy is pc. The values of p_d and p_c are respectively :

(1) (0, 1)
(2) (.89, .28)
(3) (.28, .89)
(4) (0, 0)

Solution: U_1 , U_2=0

Since collision is elastic,

$$\upsilon_1 = \frac{u_1(M_1 - M_2) + 2M_1M_2}{M_1 + M_2}$$

$$But, \quad u_2 = 0$$

$$\Rightarrow \frac{\upsilon_1}{u_1} = \frac{M_1 - M_2}{M_1 + M_2} \ldots\ldots\ldots\ldots(i)$$

Fractional loss in kinetic energy of neutron,

$$= \frac{\frac{1}{2}M_1u_1^2 - \frac{1}{2}M_1\upsilon_1^2}{\frac{1}{2}M_1u_1^2}$$

$$= 1 - \left(\frac{\upsilon_1}{u_1}\right)^2$$

So, A.TQ;

$$P_d = 1 - \left(\frac{1-2}{1+2}\right)^2 = \frac{8}{9} = 0.89$$

$$P_c = 1 - \left(\frac{1-12}{1+12}\right)^2 = 0.28$$

Hence the Solution is Option (2)

46. The density of a material in the shape of a cube is determines by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1%, the maximum error in determining the density is :
(1) 6%
(2) 2.5%
(3) 3.5%
(4) 4.5%

Solution:

$$\rho = \frac{M}{L^3}$$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{\Delta} + \frac{3\Delta L}{L}$$

$$= 1.5 + 3 \times 1$$

$$= 4.5\%$$

Hence the Solution is Option (4)

47. Two moles of an ideal monoatomic gas occupies a volume V at 27^0 C. The gas expands adiabatically to a volume 2 V. Calculate (a) the final temperature of the gas and (b) change in its internal energy.
(1) (a) 195 K (b) 2.7 kJ
(2) (a) 189 K (b) 2.7 kJ
(3) (a) 195 K (b) -2.7 kJ
(4) (a) 189 K (b) -2.7 kJ

Solution:
Initially n = 2, v, T= 300k
Finally V_d = 2v
Gas is monoatomic, So, r = 5/3
So,

$$d_w = \frac{nR\left(T_i - T_f\right)}{r-1}$$

$$T_i V_i^{r-1} = T_f V_f^{r-1}$$

$$T_i \times \left(\frac{1}{2}\right)^{2/3} = T_f$$

$$\Rightarrow T_f = \frac{300}{4^{1/3}} = \frac{300}{1.6} \approx 189k$$

Since gas undergoes expensed.

$So, d_w > 0$

& $d_q = d_u + d_w$

$\Rightarrow d_u < 0.$

Hence the Solution is Option (4)

48. A solid sphere of radius r made of a soft material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area a floats on the surface of the liquid, covering entire cross section of cylindrical container. When a mass m is placed on the surface of the piston to compress the liquid, the fractional decrement in the radius of the sphere, $\left(\frac{dr}{r}\right)$ is :

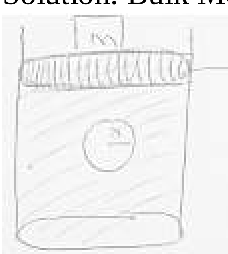
(1) $\frac{mg}{Ka}$

(2) $\frac{Ka}{mg}$

(3) $\frac{Ka}{3mg}$

(4) $\frac{mg}{3Ka}$

Solution: Bulk Modulus,



$$K = \frac{\Delta P}{(\Delta V / V)}$$

$$For \;\; sphere, V = \frac{4}{3}\pi r^3$$

$$\Rightarrow \frac{\Delta V}{V} = \frac{3\Delta r}{r}$$

$$\Rightarrow \frac{\Delta r}{r} = \frac{\Delta P}{3K} = \frac{Mg}{3Ka}$$

Hence the Solution is Option (4)

49. A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20 V. If a dielectric material constant K = $\frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be :

(1) 0.9 n C
(2) 1.2 n C
(3) 0.3 n C
(4) 2.4 n C

Solution:

$$q_i = C_0 V$$
$$= 90 \times 10^{-12} \times 20$$
$$= 1800 \times 10^{-12}$$
$$= 1.8nC$$
$$q_f = \frac{5}{3} \times 1.8nC$$
$$= 3nC$$
$$So,\; q_{ind} = 3nC - 1.8nC$$
$$= 1.2nC$$

Hence the Solution is Option (2)

50. The dipole moment of a circular loop carrying a current I, is m and the magnetic field at the centre of the loop is B_1. When the dipole moment is doubled by keeping the current constant, the magnetic field at the centre of the loop is B_2. The ratio $\frac{B_1}{B_2}$ is :

(1) $\frac{1}{\sqrt{2}}$
(2) 2

(3) $\sqrt{3}$
(4) $\sqrt{2}$

Solution:

Magnetic moment, $M = IA = I \times \pi r^2$ and magnetic field at the centre of circle

$$= B = \frac{\mu_0 I}{2R}$$

$$M_f = I \times \pi r_f^2 = 2M$$

$$M_i = I \times \pi r_i^2 = M$$

$$\Rightarrow \frac{r_f}{r_i} = \sqrt{2}$$

$$So, \frac{B_1}{B_2} = \frac{r_f}{r_i} = \sqrt{2}$$

Hence the Solution is Option (4)

51. An electron from various excited states of hydrogen atom emit radiation to come to the ground state. Let $\lambda_{n,}\lambda_g$ be the de Broglie wavelength of the electron in the nth state and the ground state respectively. Let Λ_n be the wavelength of the emitted photon in the transition from the nth state to the ground state. For large n, (A, B are constants)

(1) $\Lambda_n^2 \approx \lambda$

(2) $\Lambda_n \approx A + \frac{B}{\lambda_n^2}$

(3) $\Lambda_n \approx A + B\lambda_n$

(4) $\Lambda_n^2 \approx A + B\lambda_n^2$

Solution:

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2ME_k}}$$

$$E_k = \frac{h^2}{2m\lambda^2}$$

For emitted photon,

$$E_n - E_1$$

$$= \frac{hc}{\Lambda_n}$$

$$\Rightarrow \frac{h^2}{2m\lambda_n^2} - \frac{h^2}{2m\lambda_g^2} = \frac{hc}{\Lambda_n}$$

$$\Rightarrow \frac{hc}{\Lambda_n} = \frac{h^2}{2m\lambda_n^2} + K \qquad \left[K = \frac{-h^2}{2m\lambda_g^2}\right]$$

$$\Rightarrow \Lambda_n = A + B\lambda_n^2$$

Hence the Solution is Option (4)

52. The mass of a hydrogen molecule is 3.32×10^{-27} kg. If 10^{23} hydrogen molecules strike, per second, a fixed wall of area 2 cm^2 at an angle of 45^0 to the normal, and rebound elastically with a speed of 10^3 m/s, then the pressure on the wall is nearly :

(1) $4.70\times10^2 N/m^2$

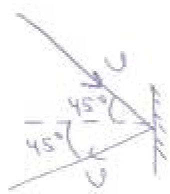
(2) $2.35\times10^3 N/m^2$

(3) $4.70\times10^3 N/m^2$

(4) $2.35\times10^2 N/m^2$

Solution:

Change in momentum normal to the wall



$= 2mv\cos 45^o$

$So,\quad Force = \dfrac{\left(2mv\cos 45^o\right)\times N}{t}$

$\Pr essure = \dfrac{2\times 3.32\times 10^{-27}\times 10^3\times \dfrac{1}{\sqrt{2}}\times 10^{23}}{2\times 10^{-4}\times 1}$

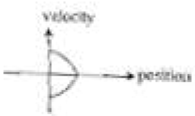
$P = 2.35\times 10^3\ N/m^2$

Hence the Solution is Option (2)

53. All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up.

(1)

(2)



(3)

(4)

Solution:

(1),(2),(4) uniform retardation & then uniform acceleration.

(3) Normal uniform acceleration & retardation.

Hence the Solution is Option (3)

54. An electron, a proton and an alpha particle having the same kinetic energy are moving in circular orbits of radii r_e, r_p, r_α respectively in a uniform magnetic field B. The relation between r_e, r_p, r_α is :

(1) $r_e < r_p < r_\alpha$

(2) $r_e > r_p = r_\alpha$

(3) $r_e < r_p = r_\alpha$
(4) $r_e < r_p < r_\alpha$

Solution:
For change moving in circular orbit is a uniform magnetic field,

$$r = \frac{mv}{Bq} = \frac{\sqrt{2mE_K}}{Bq}$$

$$\Rightarrow E_K = \frac{B^2q^2r^2}{2m}$$

Since all particles came same E_K & B,
So,

$$\frac{q^2r^2}{2m} = Constant$$

$q_e = q_p$ & $m_e < m_p$

$$\Rightarrow r_e < r_p$$

For proton & α-particle

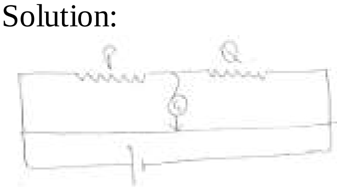
$$\frac{1^2 \times r_p^2}{2 \times 1} = \frac{2^2 \times r_\alpha^2}{2 \times 4}$$

$$\Rightarrow r_p = r_\alpha$$

Hence the Solution is Option (3)

55. On interchanging the resistances, the balane point of a meter bridge shifts to the left by 10 cm. The resistance of their series combinations is 1 kΩ. How much was the resistance on the left slot before interchanging the resistances ?
(1) 910Ω
(2) 990Ω
(3) 505Ω
(4) 550Ω

Solution:



$$\frac{P}{Q}=\frac{l}{100-l}$$

$$\&\frac{Q}{P}=\frac{l-10}{110-l}$$

$$\Rightarrow \frac{l}{100-l}=\frac{110-l}{l-10}$$

$$\Rightarrow l^2-10l=11000-100l-100l+l^2$$

$$\Rightarrow 200l=11000$$

$$\Rightarrow l=55cm$$

$$\frac{\rho l}{A}+\frac{\rho(100-l)}{A}=1000\Omega$$

$$\Rightarrow \frac{\rho}{A}=10$$

$$So,\ \frac{\rho l}{A}=10\times 55$$

$$=550\Omega$$

Hence the Solution is Option (4)

56. In a potentiometer experiment, it is found that no current passes through the galvanometer when the terminals of the cell are connected across 52 cm of the potentiometer wire. If the cell is shunted by a resistance of 5Ω, a balance is found when the cell is connected across 40 cm of the wire. Find the internal resistance of the cell.

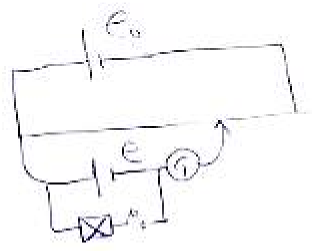
(1) 2.5Ω

(2) 1Ω

(3) 1.5Ω

(4) 2Ω

Solution:



$r = \left(\frac{l_1}{l_2} - 1\right) R$

$= \left(\frac{52}{40} - 1\right) \times 5$

$= \frac{12 \times 5}{40}$

$= 1.5\Omega$

Hence the Solution is Option (3)

57. If the series limit frequency of the Lyman series is υ_L , then the series limit frequency of the Pfund series is :

(1) $\frac{v_L}{25}$

(2) $25v_L$

(3) $16v_L$

(4) $\frac{v_L}{16}$

Solution:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \propto v$$

$$R\left(\frac{1}{1^2}\right) \propto v_l \;\&\; R\left(\frac{1}{5^2}\right) \propto v_p$$

$$\Rightarrow \frac{v_l}{v_p} = \frac{1}{25}$$

$$\Rightarrow v_p = \frac{v_l}{25}$$

Hence the Solution is Option (1)

58. The angular width of the central maximum in a single slit diffraction pattern is 60^0. The width of the slit is 1 μm. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance of 50 cm from the slits. If the observed fringe width is 1 cm, what is slit separation distance ? (i.e. distance between the centres of each slit.)

(1) 100 μm

(2) 25μm

(3) 50μm

(4) 75μm

Solution:

$$\frac{2\lambda}{d} = 60^0 \times \frac{\pi}{180}$$

$$\lambda = \left(\frac{\pi}{3} \times \frac{1}{2}\right) \mu m$$

In Ydse,

$$B' = \frac{\lambda D}{d'} \times 10^{-6}$$

$$\Rightarrow 10^{-2} = \frac{\left(\frac{\pi}{2} \times \frac{1}{2}\right) \times \frac{1}{2}}{d'} \times 10^{-6}$$

$$\Rightarrow d' = \frac{\pi}{10^{-2} \times 12} \times 10^{-6}$$

$$= 26.16 \approx 25 \mu m$$

Hence the Solution is Option (2)

59. A particle is moving in a circular path of radius a under the action of an attractive potential $U = -\frac{k}{2r^2}$. Its total energy is :

(1) $\frac{-3}{2} \frac{k}{a^2}$

(2) $-\frac{k}{4a^2}$

(3) $\frac{k}{2a^2}$

(4) Zero

Solution:

$$u = \frac{-K}{2r^2}$$

$$But \quad F = \frac{-du}{dr} = \frac{-K}{r^3}$$

‘ – ‘ sign of force implies attractive force

So,

$$\frac{K}{r^3} = \frac{mv^2}{r}$$

$$\Rightarrow \frac{mv^2}{2} = \frac{K}{2r^2} = E_K$$

$$U_T = \frac{-K}{2r^2} + \frac{K}{2r^2}$$

$$= 0$$

Hence the Solution is Option (4)

60. A silver atom in a solid oscillates in simple harmonic motion in some direction with a frequency of 10^{12}/sec. What is the force constant of the bonds connecting one atom with the other ? (Mole wt. of silver = 108 and Avagadro number = 6.02 x 10^{23} gm $mole^{-1}$)

(1) 5.5 N/m
(2) 6.44 N/m
(3) 7.1 N/m
(4) 2.2 N/m

Solution:

$$T = 2\pi\sqrt{\frac{M}{K}}$$

$$K = \frac{4\pi^2 \times M}{T^2}$$

$$= 4\pi^2 \times \frac{108\times10^{-3}}{6.023\times10^{23}} \times \left(10^{12}\right)^2$$

$$= 4\pi^2 \times \frac{10.8}{6.023} \times 10^{-2}$$

$$= 7.1 N/m$$

Hence the Solution is Option (3)

61. For 1 molal aqueous solution of the following compounds, which one will show the highest freezing point?

(1) $\left[Co(H_2O)_3Cl_3\right].3H_2O$

(2) $\left[Co(H_2O)_6\right]Cl_3$

(3) $\left[Co(H_2O)_5Cl\right]Cl_2.H_2O$

(4) $\left[Co(H_2O)_4Cl_2\right]Cl.2H_2O$

Solution:

$\Delta Tf = i \times kf \times m$

$\Delta Tf \propto i$

$Tf \propto \frac{1}{i}$

$\left[Co(H_2O)_3Cl_3\right].3H_2O$; i = 1

$\left[Co(H_2O)_6\right]Cl_3$; i = 2

$\left[Co(H_2O)_5Cl\right]Cl_2.H_2O$; i = 4

$\left[Co(H_2O)_4Cl_2\right]Cl.2H_2O$; i = 3

Hence the answer is option (1).

62. Hydrogen peroxide oxides $\left[Fe(CN)_6\right]^{4-}$ to $\left[Fe(CN)_6\right]^{3-}$ in acidic medium but reduces $\left[Fe(CN)_6\right]^{3-}$ to $\left[Fe(CN)_6\right]^{4-}$ in alkaline medium. The other products formed are, respectively:

(1) H_2O and $\left(H_2O + OH^-\right)$

(2) $\left(H_2O + O_2\right)$ and H_2O

(3) $\left(H_2O + O_2\right)$ and $\left(H_2O + OH^-\right)$

(4) H_2O and $\left(H_2O + O_2\right)$

Solution:

$$\left[Fe^{(+2)}(CN)_6\right]^{4-} \xrightarrow[\text{Oxidizing agent}]{H_2O_2} \left[Fe^{(+3)}(CN)_6\right]^{3-} + H_2O$$

reducing agent

$(oxidising\ agent)\ H_2O_2^{-1} \rightarrow H_2O^{-2}\ (\text{Reduction})$

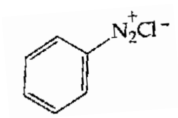
$(\text{Reducing agent})\ H_2O_2^{-1} \rightarrow O_2\ (oxidation)$

$$\left[Fe^{(+3)}(CN)_6\right]^{3-} \xrightarrow[\text{Oxidizing agent}]{H_2O_2} \left[Fe^{(+2)}(CN)_6\right]^{-4} + O_2$$

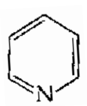
$(oxiding\ agent)$

Hence the answer is option (4).

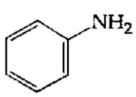
63. Which of the following compounds will be suitable for Kjeldahl's method for nitrogen estimation?

(1) 

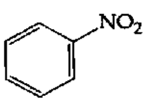
(2)



(3)



(4)



Solution:

Kjeldahl's method:-

Organic compounds nitrogen +

$$Conc.H_2SO_4 \rightarrow (NH_4)_2SO_4 \xrightarrow{\downarrow alkali} NH_3$$

Nitro compounds, A_2O compounds & Nitrogen part of the aromatic ring will not give positive result for Kjeldahl's method.

Aniline is the best suitable to estimate nitrogen using Kjeldahl's method.

Hence the answer is option (3).

64. Glucose on prolonged heating with HI gives :

(1) 6-iodohexanal

(2) n-Hexane

(3) 1-Hexane

(4) Hexanoic acid

Solution:

$$\underset{Glucose}{C_6H_{12}O_6} \xrightarrow{HI} \underset{n-hexane}{CH_3-(CH_2)_4-CH_3}$$

Hence the answer is option (2).

65. An alkali is titrated against an acid with methyl orange as indicator, which of the following is a correct combination?

	Base	Acid	End point
(1)	Strong	Strong	Pink to colourless
(2)	Weak	Strong	Colourless to pink
(3)	Strong	Strong	Pinkish red to yellow
(4)	Weak	Strong	Yellow to pinkish red

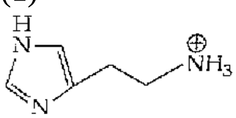
Solution:

When a weak base is titrated with string acid with methyl orange as an indicator then at end point The colour change will be yellow to pinkish red.

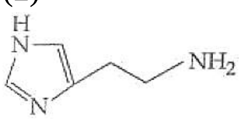
Hence the answer is option (4).

66. The predominant form of histamine present in human blood is (pk_a , Histidine = 6.0)

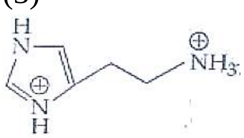
(1)



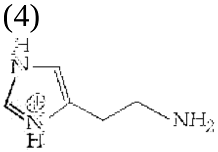
(2)



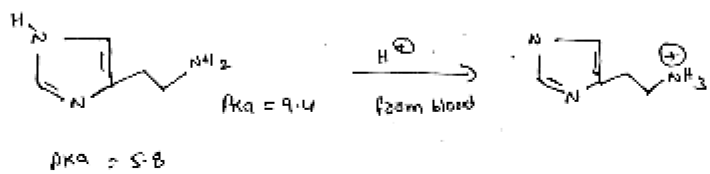
(3)



(4)



Solution:

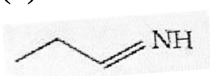


Hence the answer is option (1).

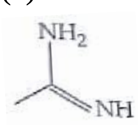
67. The increasing order of basicity of the following compounds is :

(a)

(b)



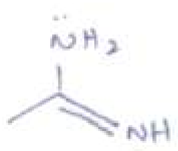
(c)



(d)

(1) (d) < (b) < (a) < (c)
(2) (a) < (b) < (c) < (d)
(3) (b) < (a) < (c) < (d)
(4) (b) < (a) < (d) < (c)

Solution:

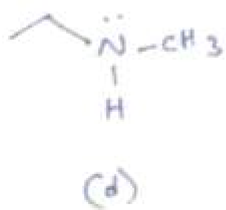


(c)

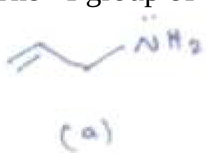
The lone pair on the nitrogen atom is in conjugation with the π bond hence it can involve in resonance.

during resonance the other nitrogen attains a negative charge.

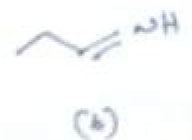
Hence 'c' is a strong base.



The +I group of CH_3 and C_2H_5 makes ‘d’ more basic but less basic than ‘c’

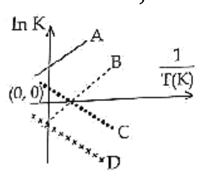


Due to -I of π bond, basic character decreases.



The nitrogen involves sp^2 hybridization which is highly electro negative have least basic.
Hence the answer is option (4).

68. Which of the following lines correctly show the temperature dependence of equilibrium constant K, for an exothermic reaction?



(1) A and D
(2) A and B
(3) B and C
(4) C and D

Solution:

$$\ln K = \frac{-\Delta H^o}{RT} + \frac{\Delta S^o}{R} (\text{Relation between Rate constant})$$

For exothermic reaction ΔH = -ve.

$$Slope = \frac{-\Delta H^o}{R} > 0$$

Hence the answer is option (2).

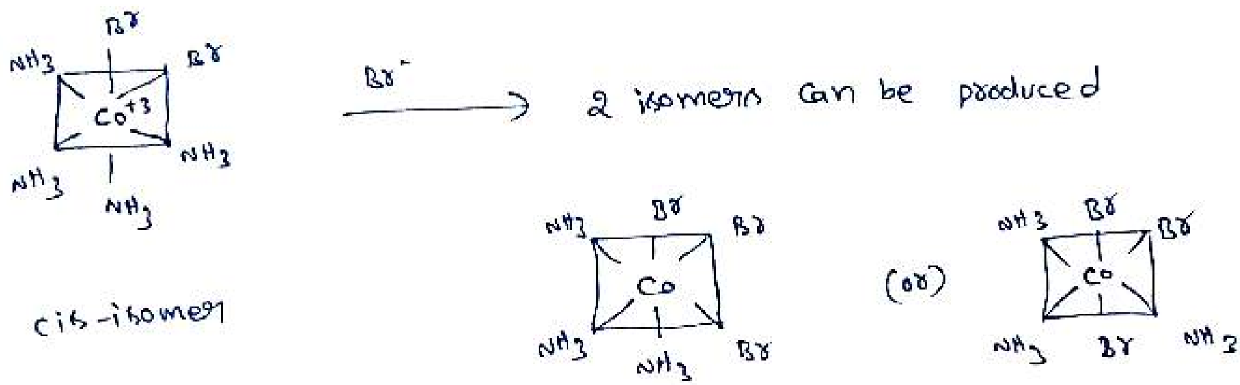
69. How long (approximate) should water be electrolysed by passing through 100 amperes current so that the oxygen released can completely burn 27.66 g of diborane?
(Atomic weight of B = 10.8 u)
(1) 1.6 hours
(2) 6.4 hours
(3) 0.8 hours
(4) 3.2 hours

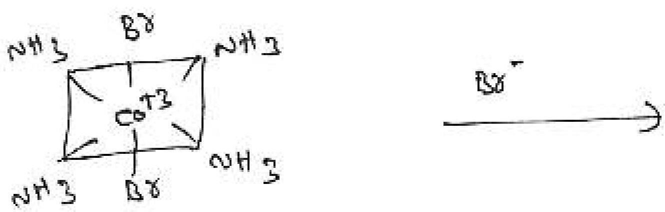
Solution:
Cathode: $H_2O + 2e^- \rightarrow H_2 + 2OH^- (\mathrm{Re}duction)$
Anode:
$$2H_2O \rightarrow 4H^+ + O_2 + 4e^- (oxidation)$$
$$B_2H_6 + 3O_2 \rightarrow B_2O_3 + 3H_2O$$
$$27.66g$$
$$n = \frac{27.66}{276} \approx 1$$
Moles of O_2 required = 3
Gram equivalent of O_2 = $3 \times 4 = 12$
Gram equivalent
$$w = \frac{it}{96500}$$
$$12 = \frac{100 \times t}{96500}$$
$$t = \frac{12 \times 965}{60 \times 60}\text{sec}$$
$$t = 3.2hr$$
Hence the answer is option (4).

70. Consider the following reaction and statements:
$$\left[Co(NH_3)_4 Br_2\right]^+ + Br^- \rightarrow \left[Co(NH_3)_3 Br_3\right] + NH_3$$
(I) Two isomers are produced if the reactant complex ion is a cis-isomer.
(II) Two isomers are produced if the reactant complex ion is a trans-isomer.
(III)Only one isomer is produced if the reactant complex ion is a trans-isomer.
(IV) Only one isomer is produced if the reactant complex ion is a cis-isomer.
The correct statements are :

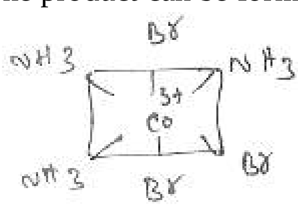
(1) (II) and (IV)
(2) (I) and (II)
(3) (I) and (III)
(4) (III) and (IV)

Solution:





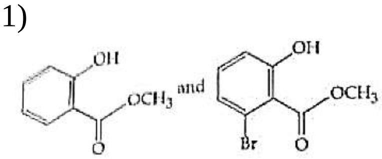
As all the NH_3 positions are identical only one product can be formed.



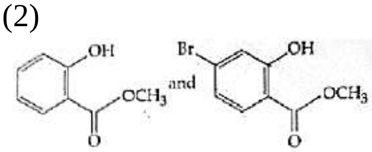
Hence the answer is option (3).

71. Phenol reacts with methyl chloroformate in the presence of *NaOH* to form product A. A reacts with Br_2 to form product B. A and B are respectively :

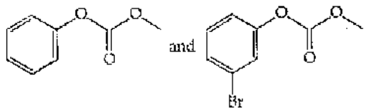
(1)



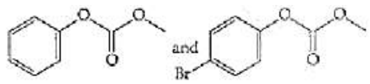
(2)



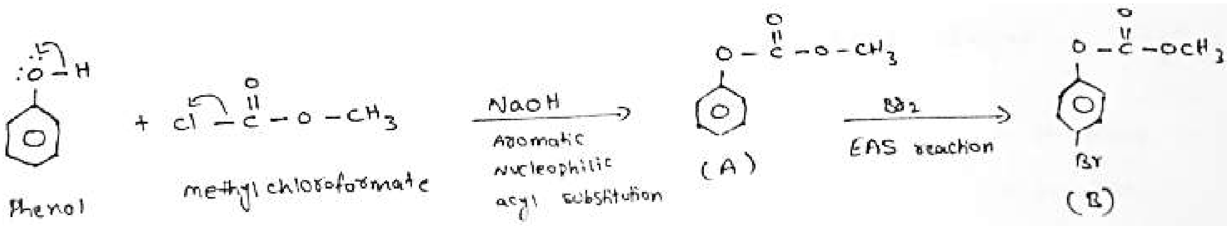
(3)



(4)



Solution:



Hence the answer is option (4).

72. An aqueous solution contains an unknown concentration of Ba^{2+}. When 50 mL of a 1M solution of Na_2SO_4 is added, $BaSO_4$ just begins to precipitate. The final volume is 500 mL. The solubility product of $BaSO_4$ is 1 x 10^{-10}. What is the original concentration of Ba^{2+} ?

(1) 1.0 x 10^{-10} M

(2) 5 x 10^{-9} M

(3) 2 x 10^{-9} M

(4) 1.1 x 10^{-9} M

Solution:

$KS_p\left(BaSO_4\right)=10^{-10}$

$QS_p = KS_p$

$\left(Ba^{2+}\right)\left(SO_4^{2-}\right)=10^{-10}$

$Ba^{2+}\dfrac{50}{500}=10^{-10}$

$\therefore\left(Ba^{2+}\right)=10^{-9}$

$m_1v_1 = m_2v_2$

$m\times 450=10^{-9}\times 500$

$\therefore m=\dfrac{500}{450}\times 10^{-9}$

$m=1.1\times 10^{-9}$

Hence the answer is option (4).

73. At 518^0 C, the rate of decomposition of a sample of gaseous acetaldehyde, initially ar a pressure of 363 Torr, was 1.00 Torr s^{-1} when 5% had reacted and 0.5 Torr s^{-1} when 33% had reacted. The order of the reaction is :
(1) 0
(2) 2
(3) 3
(4) 1

Solution:

$r = k(p)^m$ m = order of reaction

$$1 = k\left[363 \times \frac{95}{100}\right]^m \text{ ....}(1)$$

$$0.5 = k\left(362 \times \frac{67}{100}\right) \text{ ....}(2)$$

$$equation - 1/Equation - 2$$

$$\frac{1}{0.5} = \left[\frac{95}{67}\right]^m$$

$$2 = \left(\frac{95}{67}\right)^m$$

$$2 = (0.4)^m$$

$$\log 2 = m \log 1.4$$

$$\frac{0.3010}{\log 1.4} = m$$

$$m \approx \frac{0.3010}{0.15}$$

$$m = 2$$

Hence the answer is option (2).

74. The combustion of benzene (1) gives $CO_2(g)$ and $H_2O(I)$. Given that heat of combustion of benzene at constant volume is -3263.9 kJ mol^{-1} at 25^0 C; heat of combustion (in kJ mol^{-1}) of benzene at constant pressure will be :

(1) -3267.6
(2) 4152.6
(3) -452.46
(4) 3260

Solution:

$$C_6H_6\left(l\right)+\frac{15}{2}O_2\left(g\right)\rightarrow 6CO_2+3H_2O\left(l\right)$$
$$\Delta ng=6-7.5=-1.5$$
$$\Delta H=\Delta U+\Delta ngRT$$
$$=-3263.9-1.5\times 8.134\times 10^{-3}\times 298$$
$$=-3267.6$$

Hence the answer is option (1).

75. The ratio of mass present of C and H of an organic compound *($C_XH_YO_Z$)* is 6 : 1. If one molecule of the above compound *($C_XH_YO_Z$)* contains half as much oxygen as required to burn one molecule of compound C_XH_Y completely to CO_2 and H_2O. The empirical formula of compound $C_XH_YO_Z$ is :
(1) $C_2H_4O_3$
(2) $C_3H_6O_3$
(3) C_2H_4O
(4) $C_3H_4O_2$

Solution:
$C_xH_yO_z$ – Organic compound

$$\frac{mass\ of\ C}{mass\ of\ H}=6:1$$
$$\frac{mass\ of\ C/12}{mass\ of\ H/1}=\frac{6}{12}:\frac{1}{2}$$
$$\therefore \frac{No.of\ moles\ of\ C}{No.of\ moles\ of\ H}=\frac{1}{2}:1$$
$$C_xH_yO_z=\frac{moles\ of\ C}{Moles\ of\ H}$$

$$C_xH_y + \left(x + \frac{y}{x}\right)o_2 \rightarrow xco_2 + \frac{y}{2}H_2o$$

$$c_xh_yo_z\left(x + \frac{y}{4} - \frac{x}{2}\right)o_2 \rightarrow x\text{co}_2 + \frac{y}{x}H_2O$$

$$\frac{1}{2}\left(x + \frac{y}{4}\right) = x + \frac{y}{4} - \frac{z}{2}$$

$$\frac{x+y}{4} = 2x + \frac{y}{2} - Z$$

$$Z = x + \frac{y}{4}$$

$$c_2h_4o_3 \quad Z = 2 + \frac{4}{4} = 3$$

Hence the answer is option (1).

76. The trans-alkenes are formed by the reduction of alkynes with :
(1) *Sn-HCl*
(2) $H_2 - pd/C, BaSO_4$
(3) $NaBH_4$
(4) $Na/liq.\ NH_3$

Solution:
Trans alkenes are formed by the reaction of alkynes with $Na/liq.\ NH_3$
(birch Reduction)
Hence the answer is option (4).

77. Which of the following are Lewis acids ?
(1) BCl_3 and $AlCl_3$
(2) PH_3 and BCl_3
(3) $AlCl_3$ and $SiCl_4$
(4) PH_3 and $SiCl_4$

Solution:

BCl_3 and $AlCl_3$ are electron deficient compounds. Boron and aluminium has 6 electrons in their valence shell in BCl_3 & $AlCl_3$,. PH_3, $SiCl_4$ have 8 electrons in their valence shell. They are not Lewis acids.
Hence the answer is option (1).

78. When metal 'M' is treated with NaOH, a white gelatinous precipitate 'X' is obtained, which is soluble in excess of *NaOH*. Compound 'X' when heated strongly gives an oxide which is used in chromatography as an adsorbent. The metal 'M' is :
(1) Fe
(2) Zn
(3) Ca
(4) Al

Solution:
The Gelatinous precipitate formed in $Al(OH)_3$; $Al(OH)_3$ on strong heating gives Al_2O_3 which is used in chromatography as an adsorbent. So the metal is Al.
Hence the answer is option (4).

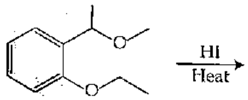
79. According to molecular orbital theory, which of the following will not be a viable molecule ?
(1) H_2^{2-}
(2) H_2^{2+}
(3) He_2^{+}
(4) H_2^{-}

Solution :
H_2^{2-} electronic configuration $\sigma 1S^2, \overset{*}{\sigma} 1S^2$

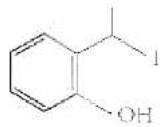
Number of electrons = 4 ; $Bo = \frac{1}{2}(N_b - N_a) = \frac{1}{2}(2-2) = 0$

Molecule does not exist.
Hence the answer is option (1).

80. The major product formed in the following reaction is :



(1)



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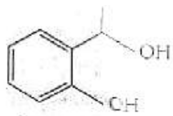

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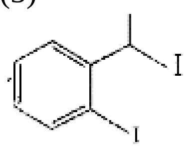

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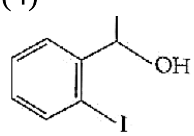
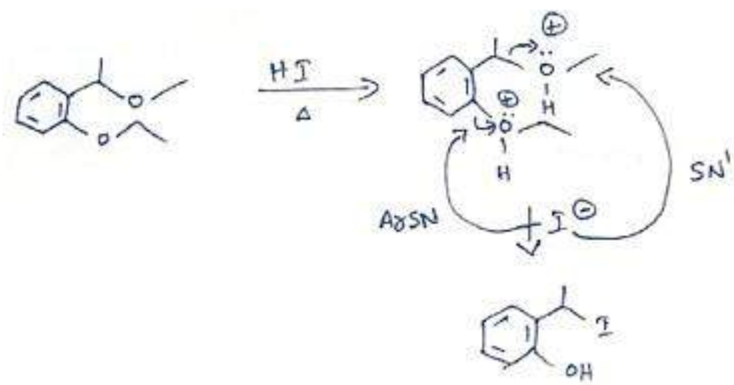


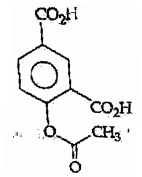
Solution:



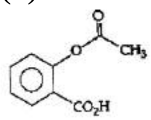
Hence the answer is option (1).

81. Phenol on treatment with CO_2 in the presence of *NaOH* followed by acidification produces compound X as the major product. X on treatment with $(CH_3CO)_2O$ in the presence of catalytic amount of H_2SO_4 produces :

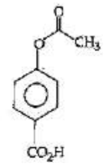
(1)



(2)



(3)



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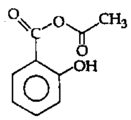
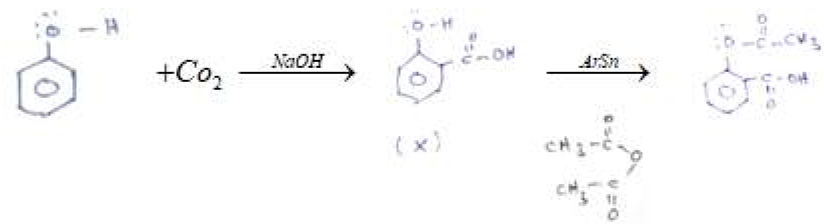


Solution:



Hence the answer is option (2).

82. Which of the following compounds contain(s) no covalent bond(s) ?

KCl, PH_3, O_2, B_2H_6, H_2SO_4

(1) KCl, B_2H_6

(2) KCl, B_2H_6, PH_3

(3) KCl, H_2SO_4

(4) KCl

Solution:

KCl is an ionic compound. It cannot from covalent bond. Elements of s – block & p – block combine to form ionic compounds.

Hence the answer is option (4).

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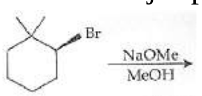
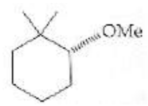
83. Which type of ‘defect’ has the presence of cations in the interstitial sites ?
(1) Metal deficiency defect
(2) Schottky defect
(3) Vacancy defect
(4) Frenkel defect

Solution:
Frankel defect has the presence of cation in interstitial site.
Hence the answer is option (4).

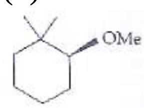
84. The major product of the following reaction is :



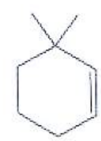
(1)



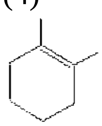
(2)



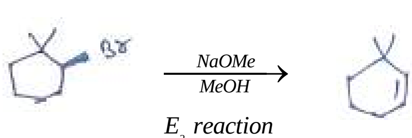
(3)



(4)



Solution:



Hence the answer is option (3).

85. The compound that does not produce nitrogen gas by the thermal decomposition is :

(1) $(NH_4)_2SO_4$
(2) $Ba(N_3)_2$
(3) $(NH_4)_2Cr_2O_7$
(4) NH_4NO_2

Solution:

$$NH_4NO_2 \xrightarrow{\Delta} N_2 + H_2O$$
$$\left(NH_4\right)_2 Cr_2O_7 \xrightarrow{\Delta} N_2 + H_2O + Cr_2O_3$$
$$Ba\left(N_3\right)_2 \xrightarrow{\Delta} Ba + N_2$$

Hence the answer is option (1).

86. An aqueous solution contains 0.10 M H_2S and 0.20 M HCl. If the equilibrium constants for the formation of HS^- from H_2S is 1.0 x 10^{-7} and that of S^{2-} from HS^- ions is 1.2 x 10^{-13} then the concentration of S^{2-} ions in aqueous solution is :
(1) 5 x 10^{-19}
(2) 5 x 10^{-8}
(3) 3 x 10^{-20}
(4) 6 x 10^{-21}

Solution:

$$H_2S \underset{ka_1.ka_2}{\rightleftarrows} 2H^+ + S^{2-}$$
$$0.1 - x \qquad 0.2 \quad x$$
$$ka_1.ka_2 = \frac{(0.2)^2 \times 5^2}{0.1}$$
$$\frac{1.2\times10^{-2}\times0.1}{0.04} = \left[S^{2-}\right]$$
$$\left[S^{2-}\right] = 3\times10^{-20}$$

Hence the answer is option (3).

87. The oxidation states of Cr in $\left[Cr\left(H_2O\right)_6\right]Cl_3$, $\left[Cr\left(C_6H_6\right)_2\right]$, and $K_2\left[Cr\left(CN\right)_2\left(O\right)_2\left(O_2\right)NH_3\right]$ respectively are :
(1) +3, 0, and +4
(2) +3, +4, and +6
(3) +3, +2, and +4
(4) +3, 0, and +6

Solution:
The Oxidation state of Cr in

$\left[Cr\left(H_2O\right)_6\right]Cl_3$

$x+6(0)-3=0$.

$x=+3$

$\left[Cr\left(C_6H_6\right)_2\right]$

$x+2(0)=0$

$x=0$

$K_2\left[Cr\left(CN\right)_2\left(O\right)_2\left(O_2\right)NH_3\right]$

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

$=6$

$\therefore x=+6$

Hence the answer is option (4).

88. The recommended concentration of fluoride ion in drinking water is up to 1 ppm as fluoride ion is required to make teeth enamel harder by converting $\left[3Ca_3\left(PO_4\right)_2.Ca\left(OH\right)_2\right]$:

(1) $\left[3\left\{Ca\left(OH\right)_2\right\}.CaF_2\right]$

(2) $\left[CaF_2\right]$

(3) $\left[3\left(CaF_2\right).Ca\left(OH\right)_2\right]$

(4) $\left[3Ca_3\left(PO_4\right)_2.CaF_2\right]$

Solution:

$\left[3Ca_3\left(PO_4\right)_2.CaF_2\right]$

Hence the answer is option (4).

89. Which of the following salts is the most basic in aqueous solution?

(1) $Pb(CH_3COO)_2$

(2) $Al(CN)_3$

(3) CH_3COOK

(4) $FeCl_3$

Solution: CH_3COOK is a salt of weak acid and strong base
Hydrolysis of potassium acetate gives strong base KOH
Hence the answer is option (3).

90. Total number of lone pair of electrons in I_3^- ion is :

(1) 12
(2) 3
(3) 6
(4) 9

Solution:

The total number of lone pair of electrons is I_3^- $is 9$

Hence the answer is option (4).

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BOOKLET CODE : D

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
1.	(1)	31.	(3)	61.	(1)
2.	(2)	32.	(1)	62.	(4)
3.	(4)	33.	(2)	63.	(3)
4.	(3)	34.	(4)	64.	(2)
5.	(1)	35.	(4)	65.	(4)
6.	(2)	36.	(2)	66.	(1)
7.	(3)	37.	(3)	67.	(4)
8.	(1)	38.	(3)	68.	(2)
9.	(3)	39.	(4)	69.	(4)
10.	(3)	40.	(3)	70.	(3)
11.	(4)	41.	(3)	71.	(4)
12.	(1)	42.	(4)	72.	(4)
13.	(4)	43.	(4)	73.	(2)
14.	(2)	44.	(2)	74.	(1)
15.	(4)	45.	(2)	75.	(1)
16.	(1)	46.	(4)	76.	(4)
17.	(2)	47.	(4)	77.	(1)*
18.	(2)	48.	(4)	78.	(4)
19.	(3)	49.	(2)	79.	(1)
20.	(4)	50.	(4)	80.	(1)
21.	(3)	51.	(2)	81.	(2)
22.	(3)	52.	(2)	82.	(4)
23.	(2)	53.	(3)	83.	(4)
24.	(2)	54.	(3)	84.	(3)
25.	(4)	55.	(4)	85.	(1)
26.	(3)	56.	(3)	86.	(3)
27.	(4)	57.	(1)	87.	(4)
28.	(1)	58.	(2)	88.	(4)
29.	(4)	59.	(4)	89.	(3)
30.	(4)	60.	(3)	90.	(4)