

$$m = - \left(\frac{a \sin^3 t}{a \cos^3 t} \right)^{1/3}$$

$$m = \frac{-\sin t}{\cos t}$$

Eqn. of tangent at p is

$$y - a \sin^3 t = - \frac{\sin t}{\cos t} (x - a \cos^3 t)$$

$$\Rightarrow y \cos t - a \sin^3 t \cos t = -x \sin t + a \sin t \cos^3 t$$

$$\Rightarrow x \sin t + y \cos t = a \sin t \cos t \quad (1)$$

$$\Rightarrow \frac{x}{a \cos t} + \frac{y}{a \sin t} = 1$$

Length of intercept

$$= \sqrt{a^2 \cos^2 t + a^2 \sin^2 t}$$

$$= a$$

68. The area of the triangle formed by the positive x-axis, the tangent and normal to the curve $x^2 + y^2 = 16a^2$ at the point $(2\sqrt{2}a, 2\sqrt{2}a)$ is

1) a^2

2) $16a^2$

3) $4a^2$

4) $8a^2$

Key: 4

Sol: $2x + 2y \cdot \frac{dy}{dx} = 0$

$$\frac{dy}{dx} = -\frac{x}{y}$$

$$\Rightarrow m = \frac{-2\sqrt{2}a}{2\sqrt{2}a} = -1$$

$$\text{Area} = \frac{\frac{1}{2} |y_1^2| \cdot (1 + m^2)}{|n|}$$

$$\frac{\frac{1}{2} \cdot 8a^2 \times 2}{1}$$

$$= 8a^2$$

69. Define $f(x) = \frac{1}{2} [|\sin x| + \sin x]$, $0 < x \leq 2\pi$. Then, f is

1) increasing in $\left(\frac{\pi}{2}, \frac{3\pi}{2}\right)$

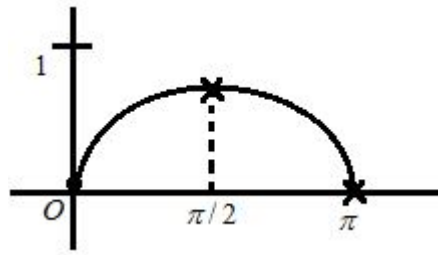
2) decreasing in $\left(0, \frac{\pi}{2}\right)$ and increasing in $\left(\frac{\pi}{2}, \pi\right)$

3) increasing in $\left(0, \frac{\pi}{2}\right)$ and decreasing in $\left(\frac{\pi}{2}, \pi\right)$

4) increasing in $\left(0, \frac{\pi}{4}\right)$ and decreasing in $\left(\frac{\pi}{4}, \pi\right)$

Key: 3

Sol: $f(x) = \frac{1}{2} [|\sin x| + \sin x], 0 < x \leq 2\pi$



$$f(x) = \begin{cases} \frac{1}{2} [\sin x + \sin x], 0 < x \leq \pi \\ \frac{1}{2} [-\sin x + \sin x], \pi < x \leq 2\pi \end{cases}$$

$$f(x) = \begin{cases} \sin x, 0 < x \leq \pi \\ 0, \pi < x \leq 2\pi \end{cases}$$

increasing in $\left(0, \frac{\pi}{2}\right)$

and decreasing in $(\pi/2, \pi)$

70. The smallest value of the constant $m > 0$ for which $f(x) = 9mx - 1 + \frac{1}{x} \geq 0$ for all $x > 0$ is

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

2) $\frac{1}{16}$

3) $\frac{1}{36}$

4) $\frac{1}{81}$

Key: 3

Sol: $f(x) = 9mx - 1 + \frac{1}{x}$

$$\frac{9mx + \frac{1}{x}}{2} = \sqrt{9m}$$

$$9mx + \frac{1}{x} \geq \sqrt{9m}$$

$$9mx + \frac{1}{x} - 1 \geq \sqrt{9m} - 1 \geq 0$$

$$m = \frac{1}{36}$$

71. $\int \frac{(x^2+1)}{x^4+7x^2+1} dx =$

1) $\frac{1}{3} \tan^{-1} \left(\frac{x^2-1}{3x} \right) + c$ 2) $\tan^{-1} \left(\frac{x^2-1}{x} \right) + c$ 3) $\frac{1}{3} \tan^{-1} \left(\frac{x^2-1}{x} \right) + c$ 4) $\frac{1}{\sqrt{3}} \tan^{-1} \left(\frac{x^2-1}{\sqrt{3}x} \right) + c$

Key: 3

Sol: $\int \frac{2^2+1}{x^4+7x^2+1}$

$$\int \frac{x^2(1+\frac{1}{x^2})}{x^2\left[\left(x^2+\frac{1}{x^2}\right)+7\right]} dx$$

$$\int \frac{\left(1+\frac{1}{x^2}\right)}{(x-1/x)^2+9} dx$$

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

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

72. $\int \frac{x^3}{\sqrt{1+x^2}} dx =$

1) $\sqrt{1+x^2} - \frac{x}{3}(1+x^2)^{3/2} + c$

2) $x\sqrt{1+x^2} + \frac{2}{3}(1+x^2)^{3/2} + c$

3) $x^2\sqrt{1+x^2} - \frac{2}{3}(1+x^2)^{3/2} + c$

4) $x^2\sqrt{1+x^2} - \frac{1}{3}(1+x^2)^{1/2} + c$

Key: 3

Sol: $1+x^2 = t$

$$\int \frac{x^2}{2} \cdot \frac{2x}{\sqrt{1+x^2}} dx$$

$$= \frac{x^2}{2} \cdot 2\sqrt{1+x^2} - \int 2\sqrt{1+x^2} \cdot x dx$$

$$= x^2\sqrt{1+x^2} - \int 2x\sqrt{1+x^2} dx$$

$$= x^2\sqrt{1+x^2} - \int t^{\frac{1}{2}} dt$$

$$= x^2\sqrt{1+x^2} - \frac{2}{3}t^{3/2}$$

$$= x^2\sqrt{1+x^2} - \frac{2}{3}(1+x^2)^{3/2} + c$$

73. $\int \frac{dx}{\cos(x+4)\cos(x+2)} =$

1) $\frac{1}{\sin 2} \log |\cos(x+4)|^2 + c$

2) $\frac{1}{2} \log \left| \frac{\sec(x+2)}{\sec(x+4)} \right| + c$

3) $\frac{1}{\sin 2} \log \left| \frac{\sec(x+4)}{\sec(x+2)} \right| + c$

4) $\log \left| \frac{\sec(x+4)}{\sec(x+2)} \right| + c$

Key: 3

Sol: $\frac{1}{\sin 2} \int \frac{\sin[(x+4)-(x+2)]}{\cos(x+4)\cos(x+2)} dx$

$$\frac{1}{\sin 2} \left[\int \tan(x+4) dx - \int \tan(x+2) dx \right]$$

$$\frac{1}{\sin 2} \log \left| \frac{\sec(x+4)}{\sec(x+2)} \right| + c$$

74. $\int \frac{2x+2}{\sqrt{x^2-4x-5}} dx =$

1) $\sqrt{x^2-4x-5} + \log |x + \sqrt{x^2-4x-5}| + c$

2) $\log |\sqrt{x^2-4x-5}| + \sqrt{x^2-4x-5} + c$

3) $\sqrt{x^2-4x-5} + 6 \log |(x-2) + \sqrt{x^2-4x-5}| + c$

4) $2\sqrt{x^2-4x-5} + 6 \log |(x+2) + \sqrt{x^2-4x-5}| + c$

Key: 4

Sol: $\int \frac{2x+2}{\sqrt{x^2-4x-5}} dx$

$$\int \frac{2x-4+6}{\sqrt{x^2-4x-5}} dx$$

$$= 2\sqrt{x^2-4x-5} + 6 \int \frac{1}{\sqrt{(x-2)^2-5-4}} dx$$

$$= 2\sqrt{x^2-4x-5} + 6 \int \frac{1}{\sqrt{(x-2)^2-3^2}} dx$$

$$= 2\sqrt{x^2-4x-5} + 6 \left| \log(x-2) + \sqrt{x^2-4x-5} \right| + c$$

75. $\int_0^{\pi/4} \frac{\sin x + \cos x}{7+9 \sin 2x} dx =$

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

2) $\frac{\log 3}{36}$

3) $\frac{\log 7}{12}$

4) $\frac{\log 7}{24}$

Key: 4

$$\text{Sol: } \int_0^{\pi/4} \frac{\sin x + \cos x}{7 + 9 \sin 2x} dx$$

$$= \int_1^0 \frac{dt}{7 + 9(1+t^2)}$$

$$= \int_1^0 \frac{1}{16 - 9t^2} dt$$

$$= -\left(\frac{1}{9}\right) \int_1^0 \frac{1}{\left(\frac{16}{9}\right) - t^2} dt$$

$$= \left(\frac{1}{9}\right) \int_1^0 \frac{1}{\left(\frac{4}{3}\right)^2 - t^2} dt$$

$$= -\frac{1}{9} \left[\frac{1}{2 \times \left(\frac{4}{3}\right)} \log \left| \frac{\frac{4}{3} + t}{\frac{4}{3} - t} \right| \right]_1^0$$

$$= -\frac{1}{9 \times \frac{8}{3}} \left[\log |1| - \log \left| \frac{\frac{7}{3}}{\frac{1}{3}} \right| \right]$$

$$= \left(\frac{1}{24}\right) [\log 7]$$

76. $\int_0^{\pi/4} [\sqrt{\tan x} + \sqrt{\cot x}] dx =$

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

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

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

4) π

Key: 1

$$\text{Sol: } \int_0^{\pi/4} [\sqrt{\tan x} + \sqrt{\cot x}] dx$$

$$= \int_0^{\pi/4} \left[\frac{\sin x + \cos x}{\sqrt{\sin x \cos x}} \right] dx$$

$$\sin x - \cos x = t$$

$$1 - \sin x \cos x = t^2$$

$$2 \sin x \cos x = 1 - t^2$$

$$\sin x \cos x = \frac{1 - t^2}{2}$$

$$= \sqrt{2} \int_{-1}^0 \frac{dt}{\sqrt{1-t^2}}$$

$$= \sqrt{2} (\sin^{-1} t)_{-1}^0$$

$$= \sqrt{2} \left[0 + \frac{\pi}{2} \right]$$

$$= \frac{\pi}{\sqrt{2}}$$

77. If the area bounded by the curves $y = ax^2$ and $x = ay^2$, ($a > 0$) is 3 sq. units, then the value of a is

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

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

3) 1

4) 4

Key: 2

Sol: $x^2 = \frac{1}{a} y$

$$y^2 = \frac{1}{a} x$$

$$x^2 = 4BX$$

$$y^2 = 4AX$$

$$4B = \frac{1}{a}$$

$$4A = \frac{1}{a}$$

$$B = \frac{1}{4a}$$

$$A = \frac{1}{4a}$$

$$\text{Area} = \frac{16AB}{3} = \frac{16}{3} \left(\frac{1}{4a} \right) \left(\frac{1}{4a} \right)$$

$$= \frac{1}{3a^2}$$

$$\text{Area} = 3$$

$$\frac{1}{3a^2} = 3$$

$$a^2 = \frac{1}{9} \Rightarrow a = \frac{1}{3}$$

78. Let $p \in \mathbb{R}$, then the differential equation of the family of curves $y = (\alpha + \beta x)e^{px}$, where α, β are arbitrary constants, is

1) $y'' + 4py' + p^2y = 0$ 2) $y'' - 2py' + p^2y = 0$ 3) $y'' + 2py' - p^2y = 0$ 4) $y'' + 2py' + p^2y = 0$

Key: 2

Sol: $y = (\alpha + \beta x)e^{px}$ (1)

$$y^1 = (\alpha + \beta x)e^{px} \cdot p + e^{px} \beta$$

$$y^1 = py + \beta \cdot e^{px}$$
(2)

$$y^1 - py = \beta e^{px}$$
(3)

$$y^{11} - py^1 = \beta \cdot pe^{px}$$

$$= p(y^1 - py)$$

$$y^{11} - py^1 = py^1 - p^2 y$$

$$y^{11} - 2py^1 + p^2 y = 0$$

79. The solution of the differential equations $3xy' - 3y + (x^2 - y^2)^{1/2} = 0$, satisfying the condition $y(1) = 1$ is

1) $3 \cos^{-1}\left(\frac{y}{x}\right) = \ln|x|$ 2) $3 \cos\left(\frac{y}{x}\right) = \ln|x|$ 3) $3 \cos^{-1}\left(\frac{y}{x}\right) = 2 \ln|x|$ 4) $3 \sin^{-1}\left(\frac{y}{x}\right) = \ln|x|$

Key: 2

Sol: $3x \frac{dy}{dx} - 3y + \sqrt{x^2 - y^2} = 0$

$$3x \frac{dy}{dx} - 3y - \sqrt{x^2 - y^2}$$

$$\frac{dy}{dx} = \frac{3y - \sqrt{x^2 - y^2}}{3x}$$

Let $y=vx \Rightarrow \frac{dy}{dx} = v + x \frac{dv}{dx}$

$$v + x \cdot \frac{dv}{dx} = \frac{3vx - \sqrt{x^2 - v^2 x^2}}{3x}$$

$$= \frac{3v - \sqrt{1 - v^2}}{3}$$

$$x \frac{dv}{dx} = \frac{3v - \sqrt{1 - v^2}}{3} - v$$

$$= \frac{3v - \sqrt{1 - v^2} - 3v}{3}$$

$$= -\sqrt{\frac{1 - v^2}{3}}$$

$$\Rightarrow \frac{-3dv}{\sqrt{1 - v^2}} = \frac{dx}{x}$$

$$\Rightarrow 3 \cos^{-1}(v) = \log x + k$$

$$\Rightarrow 3 \cos^{-1}\left(\frac{y}{x}\right) = \log x + k$$

$$y(1) = 1, 3 \cos^{-1}(1) = 0 + k$$

$$3 \cos^{-1}\left(\frac{y}{x}\right) = \log(x)$$

80. The solution of the differential equation $y' = \frac{1}{e^{-y} - x}$, is

- 1) $x = e^{-y}(y + c)$ 2) $y + e^{-y} = x + c$ 3) $x = e^y(y + c)$ d) $x + y = e^{-y} + c$

Key: 1

$$\text{Sol: } \frac{dy}{dx} = \frac{1}{e^{-y} - x} = \frac{e^y}{1 - xe^y}$$

$$\frac{dx}{dy} + x = e^{-y}$$

$$\text{If } e^{\int 1 \cdot dy} = e^y$$

$$\text{Solution } x \cdot e^y = \int e^{-y} e^y dy = y + c$$

$$x = e^{-y}(y + c)$$

PHYSICS

81. Electron microscope is based on the principle

- 1) Photoelectric effect 2) Wave nature of electron
3) Superconductivity 4) Laws of electromagnetic induction

Key: 1

Sol: Conceptual.

82. Force is given by the expression, $F = A \cos(Bx) + C \cos(Dt)$ where x is displacement and t is

time. The dimension of $\left(\frac{D}{B}\right)$ is same as that of

- 1) Velocity 2) Velocity gradient 3) Angular velocity 4) Angular momentum

Key: 1

Sol: Bx & Dt have no dimension

$$\therefore Bx = m^0 L^0 T^0 \text{ and } Dt = M^0 L^0 T^0$$

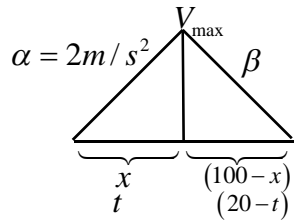
$$B = \frac{1}{x} = \frac{1}{L} = L^{-1} \text{ and } D = \frac{1}{t} = \frac{1}{T} = T^{-1}$$

$$\frac{D}{B} = \frac{T^{-1}}{L^{-1}} = L^1 T^{-1} \rightarrow \text{velocity}$$

83. A car accelerates from rest with 2m/s^2 on a straight line path and then comes to rest after applying brakes. Total distance travelled by the car is 100 m in 20 seconds. Then the maximum velocity attained by the car is

- 1) 10 m/s 2) 20 m/s 3) 15 m/s 4) 5 m/s

Key: 1



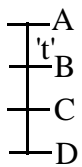
$$\text{Sol: } V_{\max} = \left(\frac{\alpha\beta}{\alpha + \beta} \right) t \rightarrow 1$$

$$S = \frac{1}{2} \left(\frac{\alpha\beta}{\alpha + \beta} \right) t^2 \rightarrow 2$$

$$\frac{V_{\max}}{s} = \frac{\left(\frac{\alpha\beta}{\alpha + \beta} \right) t}{\frac{1}{2} \left(\frac{\alpha\beta}{\alpha + \beta} \right) t^2}$$

$$\frac{V_{\max}}{100} = \frac{2}{t} = \frac{200}{20} = 10 \text{ m/s}$$

84. A body is falling freely from a point A at a certain height from the ground and passes through points B, C and D (vertically as shown below) so that $BC = CD$. The time taken by the particle to move from B to C is 2 seconds and from C to D 1 second. Time taken to move from A to B in seconds is



1) 0.6

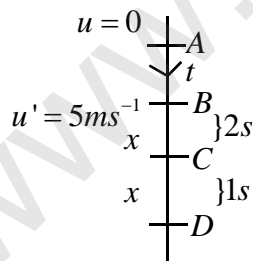
2) 0.5

3) 0.2

4) 0.4

Key:2

Sol:



$$BC = CD = x$$

$$x = (u' \times 2) + \frac{1}{2} g \times 2^2$$

$$x = 2u' + 2g \rightarrow 1$$

$$2x = (u' \times 3) + \frac{1}{2}g \times 3^2$$

$$2x = 3u' + \frac{9g}{2} \rightarrow 2$$

$$2(2u' + 2g) = \frac{6u' + 9g}{2}$$

$$2(4u' + 4g) = 6u' + 9g$$

$$8u' + 8g = 6u' + 9g$$

$$8u' - 6u' = 9g - 8g$$

$$2u' = g$$

$$u' = \frac{10}{2} = 5 \text{ m/s}$$

$$u' - 0 = gt$$

$$u' = gt$$

$$t = 0.5 \text{ sec}$$

85. A particle moves from (1,0,3) to the point (-3,4,5), when a force $\vec{F} = (\hat{i} + 5\hat{k})$ acts on it. amount of work done in Joules is

1) 14

2) 10

3) 6

4) 15

Key: 3

Sol: $w = \vec{F} \cdot \vec{S}$

$$\vec{S} = \vec{r}_2 - \vec{r}_1$$

$$W = (\hat{i} + 5\hat{k}) \cdot (-4\hat{i} + 4\hat{j} + 2\hat{k}) = (-3\hat{i} + 4\hat{j} + 5\hat{k}) - (\hat{i} + 3\hat{k})$$

$$= -4 + 10$$

$$= -4\hat{i} + 4\hat{j} + 2\hat{k}$$

$$= 6J$$

86. A particle is projected with velocity $2\sqrt{gh}$ and at an angle 60° to the horizontal so that it just clears two walls of equal height 'h' which are at a distance 2h from each other. The time taken by the particle to travel between these two walls is

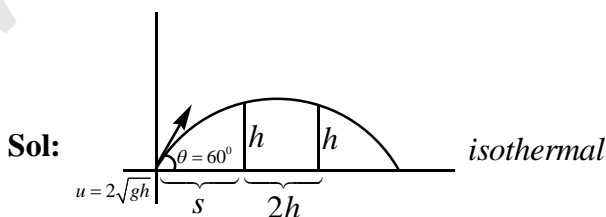
1) $2\sqrt{\frac{2h}{g}}$

2) $\sqrt{\frac{h}{2g}}$

3) $2\sqrt{\frac{h}{g}}$

4) $\sqrt{\frac{h}{g}}$

Key: 3



$$S = u \cos \theta \cdot t_1$$

$$= 2\sqrt{gh} \cos 60 \times t_1$$

$$= \sqrt{gh} t_1 \rightarrow 1$$

$$S + 2h = 2\sqrt{gh} \cos 60 \times t_2$$

$$S + 2h = \sqrt{gh} t_2 \rightarrow 2$$

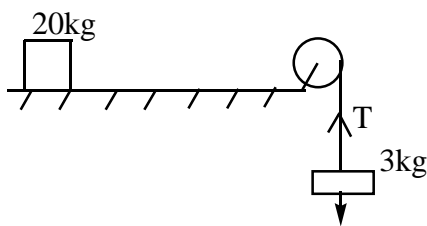
$$\sqrt{gh} t_1 + 2h = \sqrt{gh} t_2$$

$$2h = \sqrt{gh} [t_2 - t_1]$$

$$(t_2 - t_1) = \frac{2h}{\sqrt{gh}} = 2\sqrt{\frac{h^2}{gh}}$$

$$\Delta T = (t_2 - t_1) = 2\sqrt{\frac{h}{g}}$$

87. A body of mass 20 kg is moving on a rough horizontal plane. A block of mass 3 kg is connected to the 20 kg mass by a string of negligible mass through a smooth pulley as shown in the figure. The tension in the string is 27 N. The coefficient of kinetic friction between the heavier mass and the surface is ($g = 10 \text{ m/s}^2$).



1) 0.025

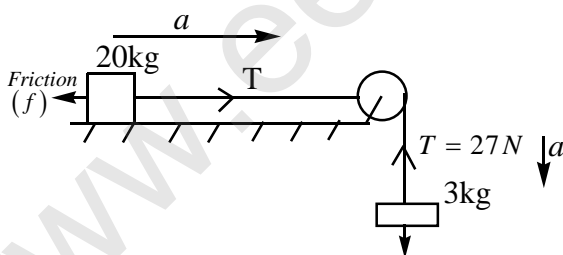
2) 0.035

3) 0.35

4) 0.25

Key: 2

Sol:



For 3kg block

$$3a = 3g - T$$

$$3a = 30 - 27$$

$$a = \frac{3}{3} = 1 \text{ m/s}^2$$

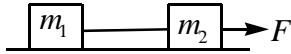
for 20kg block

$$T - f = 20a \Rightarrow 27 - \mu \times 20 \times 10 = 20 \times 1$$

$$27 - 20 = 200\mu$$

$$\mu = \frac{7}{200} = 0.035$$

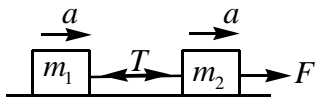
88. Two masses m_1 and m_2 are placed on a smooth horizontal surface and are connected by a string of negligible mass. A horizontal force F is applied on the mass m_2 as shown in the figure. The tension in the string is



- 1) $\left(\frac{m_1}{m_1 + m_2}\right)F$ 2) $\frac{m_2 F}{m_1 + m_2}$ 3) $\left(\frac{m_1}{m_2}\right)F$ 4) $\frac{m_2 F}{m_1}$

Key: 1

Sol:



$$a = \frac{F}{m_1 + m_2}$$

Tension in the string $T = m_1 a$

$$= \frac{m_1 F}{m_1 + m_2}$$

89. A body of mass 3 kg moving with a velocity $(2\hat{i} + 3\hat{j} + 3\hat{k})$ m/s collides with another body of mass 4 kg moving with a velocity $(3\hat{i} + 2\hat{j} - 3\hat{k})$ m/s. The two bodies stick together after collision. The velocity of the composite body is

- 1) $\frac{1}{7}(4\hat{i} + 6\hat{j} - 3\hat{k})$ 2) $\frac{1}{7}(18\hat{i} + 17\hat{j} - 3\hat{k})$ 3) $\frac{1}{7}(6\hat{i} + 4\hat{j} - 6\hat{k})$ 4) $\frac{1}{7}(9\hat{i} + 8\hat{j} - 6\hat{k})$

Key: 2

Sol: $m_1 \vec{u}_1 + m_2 \vec{u}_2 = (m_1 + m_2) \vec{v}$

$$6\hat{i} + 9\hat{j} + 9\hat{k} + 12\hat{i} + 8\hat{j} - 12\hat{k} = 7\vec{v}$$

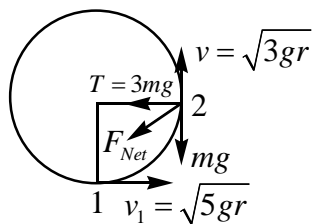
$$\vec{v} = \frac{18\hat{i} + 17\hat{j} - 3\hat{k}}{7}$$

90. A simple pendulum of length L carries a bob of mass m . When the bob is at its lowest position, it is given the minimum horizontal speed necessary for it to move in a vertical circle about the point of suspension. When the string is horizontal the net force on the bob is

- 1) $\sqrt{10}mg$ 2) $\sqrt{5}mg$ 3) $4mg$ 4) $1mg$

Key: 1

Sol:



$$F_{Net} = \sqrt{(3mg)^2 + (mg)^2}$$

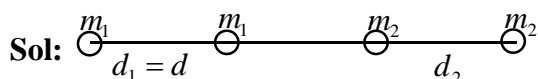
$$= \sqrt{10(mg)^2}$$

$$= \sqrt{10}mg$$

91. A system of two particles is having masses m_1 and m_2 . If the particle of mass m_1 is pushed towards the center of particles through a distance d , by what distance the particle of mass m_2 should be moved so as to keep the centre of mass of particles at the original position?

- 1) $\frac{m_1}{m_1 + m_2}d$ 2) d 3) $\frac{m_1}{m_2}d$ 4) $\frac{m_2}{m_1}d$

Key: 3



$$m_1 d_1 = m_2 d_2$$

$$d_2 = \frac{m_1}{m_2} \cdot d_1 = \frac{m_1}{m_2} d$$

92. A thin uniform circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with an angular velocity ω . Another disc of same thickness and radius but of mass $\frac{1}{8}M$ is placed gently on the first disc co-axially.

The angular velocity of the system is now

- 1) $\frac{8}{9}\omega$ 2) $\frac{5}{9}\omega$ 3) $\frac{1}{3}\omega$ 4) $\frac{2}{9}\omega$

Key: 1

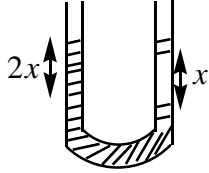
Sol: $I_1 \omega_1 = I_2 \omega_2$

$$\frac{MR^2}{2} \times \omega_1 = \left(M + \frac{M}{8} \right) \frac{R^2}{2} \times \omega_2$$

$$\omega_2 = \frac{8\omega}{9}$$

93. 9 kg solution is poured into a glass U-tube as shown in the figure below. The tube's inner diameter is $2\sqrt{\frac{\pi}{5}}m$ and the solution oscillates freely up and down about its position of equilibrium ($x = 0$).

The period of oscillation in seconds is ($1m^3$ of solution has a mass $\mu = 900kg$, $g = 10m/s^2$, ignore frictional and surface tension effects)



- 1) 0.1 2) 10 3) $\sqrt{\pi}$ 4) 1

Key: 1

Sol: Net pressure force on liquid = $\rho Ag(2x)$

Equation of SHM

$$ma = -2\rho Agx$$

$$a = -\frac{2\rho Ag}{m}x = -\omega^2x$$

$$\omega = \sqrt{\frac{2\rho Ag}{m}} = \sqrt{\frac{2\rho \times \pi \times D^2 \times g}{4m}} \quad D = \text{diameter of tube}$$

$$\text{or } \omega = \sqrt{\frac{2 \times 900 \times \frac{\pi}{4} \times \frac{\pi}{5} \times 4 \times 10}{4 \times 9}}$$

$$\omega = 20\pi \text{ rad/s}$$

$$T = \frac{2\pi}{\omega} = 0.1s$$

94. The bodies of masses 100kg and 8100 kg are held at a distance of 1m. The gravitational field at a point on the line joining them is zero. The gravitational potential at that point in J/kg is

$$(G = 6.67 \times 10^{-11} N.m^2/kg^2)$$

- 1) -6.67×10^{-7} 2) -6.67×10^{-10} 3) -13.34×10^{-7} 4) -6.67×10^{-9}

Key: 1

Sol: $x = \frac{1}{\sqrt{81+1}} = 0.1m$

$$\therefore V = -\frac{GM_1}{r_1} - \frac{GM_2}{r_2}$$

$$= -6.67 \times 10^{-11} \left[\frac{100}{0.1} + \frac{8100}{0.9} \right]$$

$$= -6.67 \times 10^{-8} [1+9] = -6.67 \times 10^{-7}.$$

95. An elastic spring of unstretched length L and force constant K is stretched by a small length x . It is further stretched by another small length y . Work done during the second stretching is

- 1) $\frac{ky}{2}(x+2y)$ 2) $\frac{k}{2}(2x+y)$ 3) $ky(x+2y)$ 4) $\frac{ky}{2}(2x+y)$

Key: 4

Sol: Work done during second stretching
= Change in elastic PE

$$= \frac{1}{2}k(x+y)^2 - \frac{1}{2}kx^2$$

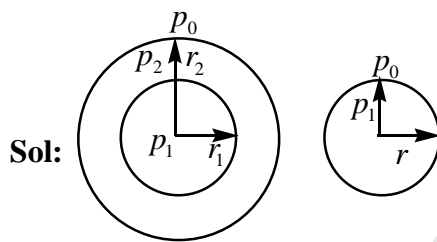
$$= \frac{1}{2}k(2x+y)y$$

$$= \frac{k}{2}y(y+2x)$$

96. A soap bubble of radius 1.0 cm is formed inside another soap bubble of radius 2.0 cm. The radius of an another soap bubble which has the same pressure difference as that between the inside of the smaller and outside of large soap bubble, in meters is

- 1) 6.67×10^{-3} 2) 3.34×10^{-3} 3) 2.23×10^{-3} 4) 4.5×10^{-3}

Key: 1



$$P_1 - P_2 = \frac{4T}{r_1} \text{-----(1)}$$

$$P_2 - P_0 = \frac{4T}{r_2} \text{-----(2)}$$

$$P_1 - P_0 = \frac{4T}{r} \text{-----(3)}$$

$$(1) + (2) \Rightarrow P_1 - P_0 = \frac{4T}{r_1} + \frac{4T}{r_2} \text{-----(4)}$$

From (3) and (4) $\frac{1}{r_1} + \frac{1}{r_2} = \frac{1}{r}$

$$\Rightarrow r = \frac{r_1 r_2}{r_1 + r_2} = \frac{2}{3} = 0.67 \text{ cm}$$

or $r = 6.67 \times 10^{-3} \text{ m}$

97. A slab of stone area 3600 cm^2 and thickness 10 cm is exposed on the lower surface to steam at 100° C . A block of ice at 0° C rests on upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of stone in $\text{JS}^{-1}\text{m}^{-1}\text{k}^{-1}$ is (Latent heat of ice = $3.36 \times 10^5 \text{ J/kg}$)
- 1) 12.0 2) 10.5 3) 1.02 4) 1.24

Key: 4

Sol:
$$\frac{d\theta}{dt} = \frac{KA(\theta_1 - \theta_2)}{L} = \left(\frac{dm}{dt}\right)L$$

$$\frac{k \times 3600 \times 10^{-4} \times (100 - 0)}{0.1} = \left(\frac{4.8}{3600}\right) \times 3.36 \times 10^5$$

$$\Rightarrow k = 1.24 \text{ JS}^{-1}\text{m}^{-1}\text{k}^{-1}$$

98. The surface of a black body is at a temperature 727° C and its cross section is 1 m^2 . Heat radiated from this surface in one minute in Joules is (Stefan's constant = $5.7 \times 10^{-8} \text{ W/m}^2/\text{k}^4$)

- 1) 34.2×10^5 2) 2.5×10^5 3) 3.42×10^5 4) 2.5×10^6

Key: 1

Sol: $\rho = e\sigma AT^4$

$e = 1$ for black body

$$\rho = 5.7 \times 10^{-8} \times 1 \times (727 + 273)^4 \text{ W}$$

\therefore Heat radiated in one minute

$$= 60 \times \rho = 5.7 \times 10^4 \times 60$$

$$= 342 \times 10^4 \text{ Joules}$$

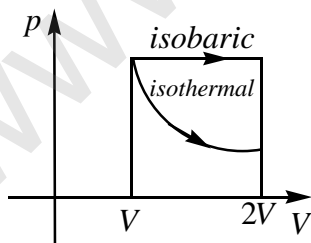
or heat = $34.2 \times 10^5 \text{ J}$

99. Two moles of a gas is expanded to double its volume by two different processes. One is isobaric and the other is isothermal. If w_1 and w_2 are the works done respectively, then

- 1) $w_2 = \frac{w_1}{\ln 2}$ 2) $w_2 = w_1$ 3) $w_2 = w_1 \ln 2$ 4) $w_1^2 = w_2 \ln 2$

Key: 3

Sol:



$$W_1 = p\Delta V$$

$$= pV$$

$$W_2 = nRT \ln\left(\frac{2v}{v}\right)$$

$$W_2 = \rho V \ln 2$$

$$\therefore W_2 = W_1 \ln 2$$

- 100.** Uranium has two isotopes of masses 235 and 238 units. If both of them are present in Uranium hexafluoride gas, find the percentage ratio of difference in rms velocities of two isotopes to the rms velocity of heavier isotope.

- 1) 1.64 2) 0.064 3) 0.64 4) 6.4

Key: 3

Sol: $V_{rms} = \sqrt{\frac{3RT}{m}}$

$$\Rightarrow V_{rms} \propto \frac{1}{\sqrt{m}}$$

$$\% = \frac{V_{rms1} - V_{rms2}}{V_{rms}} \times 100$$

$$\% = \frac{\frac{k}{\sqrt{m_2}} - \frac{k}{\sqrt{m_1}}}{\frac{k}{\sqrt{m_1}}} \times 100$$

$$= \frac{\sqrt{m_1} - \sqrt{m_2}}{\sqrt{m_1}} \times 100$$

$$= \frac{\sqrt{238} - \sqrt{235}}{\sqrt{235}} \times 100$$

$$= \left(\sqrt{\frac{235+3}{235}} - 1 \right) \times 100$$

$$= \left(\left[1 + \frac{1}{2} \times \frac{3}{235} \right] - 1 \right) \times 100$$

$$= \frac{3}{470} \times 100 = 0.64$$

- 101.** A source of frequency 340 Hz is kept above a vertical cylindrical tube closed at lower end. The length of the tube is 120 cm. Water is slowly poured in just enough to produce resonance. Then the minimum height (velocity of sound = 340 m/s) of the water level in the tube for that resonance is

- 1) 0.75 m 2) 0.25 m 3) 0.95 m 4) 0.45

Key: 4

Sol: n = 340 Hz

First resonance = $\frac{V}{4n} = 25 \text{ cm}$

$$\text{Second resonance} = \frac{3V}{4n} = 75\text{cm}$$

$$\text{Third resonance} = \frac{5V}{4n} = 125\text{cm}$$

$$\therefore \text{The minimum height} = (120-75)\text{ cm} = 45\text{ cm} \\ = 0.45\text{ m}$$

102. A thin convex lens of focal length 'f' made of crown glass is immersed in a liquid of refractive index μ_l . ($\mu_l > \mu_c$) where μ_c is the refractive index of the crown glass. Then convex lens now is

- 1) A convex lens of longer focal length 2) A convex lens of shorter focal length
3) A divergent lens 4) A convex lens of focal length $(\mu_c - \mu_l)f$

Key: 3

$$\text{Sol: } \frac{1}{f} = (\mu_c - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\text{Let } \frac{1}{R_1} - \frac{1}{R_2} = k$$

$$\Rightarrow \frac{1}{f} = (\mu_c - 1)k$$

$$\text{In liquid, } \frac{1}{f^1} = \left(\frac{\mu_c}{\mu_l} - 1 \right) k$$

$$\mu_l < \mu_c \text{ given}$$

$$\Rightarrow f^1 < 0 \Rightarrow \text{divergent lens}$$

103. Two convex lenses of focal lengths f_1 and f_2 form images with magnification m_1 and m_2 , when used individually for an object kept at the same distance from the lenses. Then f_1 / f_2 is

- 1) $\frac{m_1(1+m_1)}{m_2(1+m_2)}$ 2) $\frac{m_1(1+m_1)}{m_2(1+m_1)}$ 3) $\frac{m_2(1+m_1)}{m_1(1+m_2)}$ 4) $\frac{m_2(1+m_2)}{m_1(1+m_1)}$

Key: 2

$$\text{Sol: } \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$$

$$v = \frac{fu}{u+f}$$

Taking -ve sign for u

$$-m = \frac{f}{u+f}$$

$$-m_1 = \frac{v}{u} = \frac{f}{u + f_1} \text{ ----- (1)}$$

$$-m_2 = \frac{f_2}{u + f_2} \text{ ----- (2)}$$

From (1) $fu + f_1 = -\frac{f_1}{m_1}$

From (2) $fu + f_2 = -\frac{f_2}{m_2}$

$$f_1 - f_2 = -\frac{f_1}{m_1} + \frac{f_2}{m_2}$$

Dividing by f_2

$$\frac{f_1}{f_2} - 1 = \left(\frac{f_1}{f_2}\right)\left(\frac{-1}{m_1}\right) + \frac{1}{m_2}$$

$$\left(\frac{f_1}{f_2}\right)\left(1 + \frac{1}{m_1}\right) = \left(1 + \frac{1}{m_2}\right)$$

$$\frac{f_1}{f_2} = \frac{m_1(m_2 + 1)}{m_2(m_1 + 1)}$$

104. With the help of a telescope that has an objective of diameter 200 cm, it is proved that light of wavelengths of the order of 6400 \AA coming from a star can be easily resolved. Then the limit of resolution is

- 1) $39 \times 10^{-8} \text{ deg}$ 2) $39 \times 10^{-8} \text{ rad}$ 3) $19.5 \times 10^{-8} \text{ rad}$ 4) $19.5 \times 10^{-8} \text{ deg}$

Key: 2

Sol: $\Delta\theta = \frac{1.22\lambda}{a}$

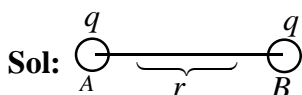
$$\Delta\theta = \frac{1.22 \times 6400 \times 10^{-10}}{200 \times 10^{-2}}$$

$$\Delta\theta = 39 \times 10^{-8} \text{ rad}$$

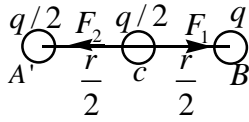
105. Two charged identical metal spheres A and B repel each other with a force of $3 \times 10^{-5} \text{ N}$. Another identical uncharged sphere C is touched with sphere A and then it is placed midway between A and B. Then the magnitude of Net force on C is

- 1) $1 \times 10^{-5} \text{ N}$ 2) $3 \times 10^{-5} \text{ N}$ 3) $2 \times 10^{-5} \text{ N}$ 4) $5 \times 10^{-5} \text{ N}$

Key: 2



$$F = 9 \times 10^9 \times \frac{q^2}{r^2} = 3 \times 10^{-5} \text{ ----- (1)}$$



$$F_1 = \frac{1}{4\pi \epsilon_0} \frac{q^2}{4 \times \frac{r^2}{4}}$$

$$= 9 \times 10^9 \frac{q^2}{r^2} = 3 \times 10^{-5} \text{-----(2)}$$

$$F_2 = 9 \times 10^9 \times \frac{q \times \frac{q}{2}}{\left(\frac{r}{2}\right)^2}$$

$$= q \times \frac{9 \times 10^9 q^2}{r^2}$$

$$= 2 \times 3 \times 10^{-5} N$$

$$(F_{Net})_c = F_2 - F_1 = 2 \times 3 \times 10^{-5} - 1 \times 3 \times 10^{-5}$$

$$= 3 \times 10^{-5} N$$

106. The electrostatic potential inside a charged sphere is given as $V = Ar^2 + B$, where r is the distance from the center of the sphere; A and B are constants. Then the charge density in the sphere is

- 1) $16 A \epsilon_0$ 2) $-6 A \epsilon_0$ 3) $20 A \epsilon_0$ 4) $-15 A \epsilon_0$

Key: 2

Sol: $V = Ar^2 + B$

$$E = \frac{-dv}{dr} = -2Ar$$

$$\int \bar{E} \cdot d\bar{A} = \frac{q_{enc}}{\epsilon_0}$$

$$\Rightarrow -2Ar 4\pi r^2 = \frac{\int \rho 4\pi r^2 dr}{\epsilon_0}$$

as ρ is constant

$$-8A\pi r^3 = \frac{4\pi\rho r^3}{\epsilon_0 3}$$

$$\Rightarrow \rho = -6A \epsilon_0$$

107. Three unequal resistances are connected in parallel. Two of these resistance are in the ratio **1 : 2**. The equivalent resistance value among these three connected in parallel is 1Ω . What is the highest resistance value among these resistances if no resistance is fractional?

- 1) 10Ω 2) 8Ω 3) 15Ω 4) 6Ω

Key: 4

Sol: Let $R_1 = R \Rightarrow R_2 = 2R$ & Let R_3

$$\therefore t = \frac{1}{R} + \frac{1}{2R} + \frac{1}{R_3}$$

$$\Rightarrow 1 = \frac{2R_3 + R_3 + 2R}{2RR_3}$$

$$2RR_3 = 3R_3 + 2R$$

$$\Rightarrow R_3(2R - 3) = 2R$$

$$R_3 = \frac{2R}{2R - 3}$$

Now R_1, R_2 & R_3 are +ve integers

\therefore By trail & error

Let $R = 3$ then $R_1 = 3\Omega$

$$R_2 = 6\Omega \text{ \& } R_3 = \frac{6}{3} = 2\Omega$$

\therefore highest = 6

108. Two electric resistors have equal values of resistance R . Each can be operated with a power of 320 watts (w) at 220 volts. If the two resistors are connected in series to a 110 volts electric supply, then the power generated in each resistor is

- 1) 90 watts 2) 80 watts 3) 60 watts 4) 20 watts

Key: 4

$$\text{Sol: } R = \frac{V^2}{\rho} = \frac{220 \times 22}{320}$$

$$\text{In series } R = \frac{220 \times 11}{16}$$

$$\therefore \rho = \frac{V^2}{R} = \frac{110 \times 110}{220 \times 11} \times 16$$

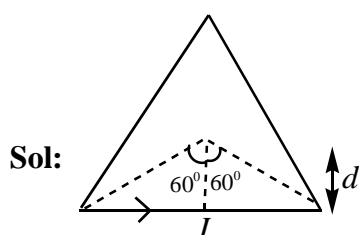
$$= 40 \text{ w together}$$

in each = 20 w

109. A current of 1 A is flowing along the sides of an equilateral triangle of side $4.5 \times 10^{-2} \text{ m}$. The magnetic field at the centroid of the triangle is ($\mu_0 = 4\pi \times 10^{-7} \text{ H / m}$)

- 1) $4 \times 10^{-5} \text{ T}$ 2) $2 \times 10^{-5} \text{ T}$ 3) $4 \times 10^{-4} \text{ T}$ 4) $2 \times 10^{-4} \text{ T}$

Key: 1



$$d = l \sin 60^\circ \times \frac{1}{3} = \frac{l}{2\sqrt{3}}$$

$$B = 3 \times \frac{\mu_0 I}{4\pi d} (\sin 60 + \sin 60)$$

$$= 3 \times 10^{-7} \times \frac{1 \times 2\sqrt{3}}{4.5 \times 10^{-2}} (\sqrt{3}) = 4 \times 10^{-5} T$$

110. A charged particle (charge = q ; mass = m) is rotating in a circle of radius 'R' with uniform speed 'V'. Ratio of its magnetic moment (μ) to the angular momentum (L) is

- 1) $\frac{q}{2m}$ 2) $\frac{q}{m}$ 3) $\frac{q}{4m}$ 4) $\frac{2q}{m}$

Key: 1

Sol: $\frac{\mu}{L} = \frac{q}{2m}$

111. Two small magnets have their masses and lengths in the ratio 1 : 2. The maximum torques experienced by them in a uniform magnetic field are the same. For small oscillations, the ratio of their time period is

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

Key: 1

Sol: $T = 2\pi \sqrt{\frac{I}{\mu B}}$

$$= 2\pi \sqrt{\frac{m(l^2 + b^2)}{\mu B}}$$

$T \propto \sqrt{m} l$ [∵ b is neglected]

$$\frac{T_1}{T_2} = \sqrt{\frac{m_1}{m_2}} \times \frac{l_1}{l_2}$$

$$= \sqrt{\frac{1}{2}} \times \frac{1}{2}$$

$$\frac{T_1}{T_2} = \frac{1}{2\sqrt{2}}$$

112. Two coils have mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10 A$ and $\omega = 100\pi \text{ rad s}^{-1}$. The maximum value of emf in the second coil is

- 1) 5 2) 5π 3) 0.5π 4) π

Key: 2

Sol: $\varepsilon = M \frac{di}{dt}$ & $I = I_0 \sin \omega t$

$= -\omega MI_0 \cos \omega t$

$\therefore \varepsilon_{\max} = \omega MI_0$

$= 100\pi \times 0.005 \times 10$

$= 5\pi$

113. A capacitance of $\left(\frac{10^{-3}}{2\pi}\right)F$ and an inductance of $\left(\frac{100}{\pi}\right)mH$ and a resistance of 10Ω are connected in series with an AC voltages source of 220 V, 50 Hz. The phase angle of the circuit is

1) 60°

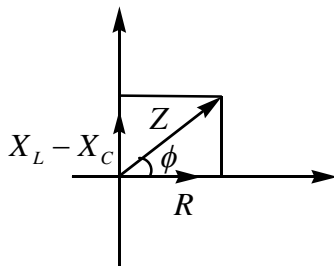
2) 30°

3) 45°

4) 90°

Key: 3

Sol:



$\tan \phi = \frac{X_L - X_C}{R}$

$= \frac{\omega L - \frac{1}{\omega C}}{R}$

$= \frac{10^{-3} \times 2\pi \times 50 \times \frac{100}{\pi} - \frac{1}{2\pi \times 50 \times \frac{10^{-3}}{2\pi}}}{10}$

$= \frac{10 - 20}{10} = -1$

\therefore Current leads voltage by 45° .

114. Two equations are given below :

(A) $\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$; (B) $\oint \vec{B} \cdot d\vec{A} = 0$

They are

1) (A) - Ampere's law

(B) - Gauss law for electricity

2) (A) - Gauss law for electric fields

(B) - Gauss law for magnetic fields

- 3) (A) - Faraday law
 (B) - Gauss law for electric fields
 4) Both (A) and (B) represent Faraday law

Key: 2

Sol: $\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0} \rightarrow$ Gauss law for electric field

$\int \vec{B} \cdot d\vec{A} = 0 \rightarrow$ Gauss law for magnetic field

115. A charged particle is accelerated from rest through a certain potential difference. The de Broglie wavelength is λ_1 when it is accelerated through V_1 and is λ_2 when accelerated through V_2 . The ratio λ_1 / λ_2 is

- 1) $V_1^{3/2} : V_2^{3/2}$ 2) $V_2^{1/2} : V_1^{1/2}$ 3) $V_1^{1/2} : V_2^{1/2}$ 4) $V_1^2 : V_2^2$

Key: 2

Sol: $\lambda = \frac{h}{\sqrt{2mqv}} \Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}}$

116. If the first line of Lyman series has a wavelength 1215.4 \AA , the first line of Balmer series is approximately

- 1) 4864 \AA 2) 1025.5 \AA 3) 6563 \AA 4) 6400 \AA

Key: 3

Sol: $\frac{1}{\lambda_1} = Z^2 \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$

$\frac{1}{\lambda_2} = Z^2 \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$

$\therefore \frac{\lambda_2}{\lambda_1} = \frac{3}{4} \times \frac{36}{5} = \frac{27}{5}$

$\therefore \lambda_2 = \frac{27}{5} \times 1215.4 \text{ \AA}$
 $= 6563.16 \text{ \AA}$

117. A certain radioactive element disintegrates with a decay constant of $7.9 \times 10^{-10} / \text{sec}$. At a given instant of time, if the activity of the sample is equal to 55.3×10^{11} disintegration/sec, then number of nuclei at that instant of time

- 1) 7.0×10^{21} 2) 4.27×10^{13} 3) 4.27×10^3 4) 6×10^{23}

Key: 1

Sol: $\frac{dN}{dt} = \lambda N$

$\therefore N = \frac{dN / dt}{\lambda} = \frac{55.3 \times 10^{11}}{7.9 \times 10^{-10}}$

$$= 7 \times 10^{21}$$

118. The change in current through a junction diode is 1.2 mA when the forward bias voltage is changed by 0.6 V. The dynamic resistance is

- 1) 500 Ω 2) 300 Ω 3) 150 Ω 4) 250 Ω

Key: 1

$$\text{Sol: } r = \frac{\Delta V}{\Delta I} = \frac{0.6}{1.2 \times 10^{-3}}$$
$$= \frac{6000}{12} = 500 \Omega$$

119. A semiconductor has equal electron and hole concentration of $2 \times 10^8 \text{ m}^{-3}$. On doping with a certain impurity, the electron concentration increases to $4 \times 10^{10} \text{ m}^{-3}$, then the new hole concentration of the semiconductor is

- 1) 10^6 m^{-3} 2) 10^8 m^{-3} 3) 10^{10} m^{-3} 4) 10^{12} m^{-3}

Key: 1

$$\text{Sol: } np = n_i^2$$

$$\Rightarrow P = \frac{n_i^2}{n} = \frac{(2 \times 10^8)^2}{4 \times 10^{10}}$$
$$= 10^6 \text{ m}^{-3}$$

120. A message signal of 12 kHz and peak voltage 20 V is used to modulate a carrier wave of frequency 12 MHz and peak voltage 30 V. Then the modulation index is

- 1) 0.32 2) 6.7 3) 0.67 4) 67

Key: 3

$$\text{Sol: } \mu = \frac{A_m}{A_c} = \frac{20}{30} = \frac{2}{3} = 0.67$$

CHEMISTRY

121. Assertion(A) : Atom with completely filled and half filled subshells are stable.

Reason (R) : Completely filled and half filled subshells have symmetrical distribution of electrons and have maximum exchange energy

- 1) (A) and (R) are correct, (R) is the correct explanation of (A)
2) (A) and (R) are correct, (R) is not correct explanation of (A)
3) (A) is correct, (R) is not correct 4) (A) is not correct, but (R) is correct

Key: 1

Sol: Half filled and completely filled subshells are more stable due to symmetrical distribution of electrons and have maximum exchange energy.

122. The element with the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^2 3d^{10} 4s^1$ is

- 1) Cu 2) Ca 3) Cr 4) Co

Key: 1

$$\text{Sol: Cu : } 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$$

This configuration more stable due to completely filled electronic configuration of 'd'-orbital.

123. Among the following, the isoelectronic species is/are

(i) $O^{2-}, F^{-}, Na^{+}, Mg^{2+}$ (ii) $Na^{+}, Mg^{+}, Al^{3+}, F^{-}$ (iii) $N^{3-}, O^{2-}, F^{-}, Ne$

1) (i) & (ii) 2) (i), (ii) & (iii) 3) (ii) & (iii) 4) (i) & (iii)

Key: 4

Sol: $O^{2-} F^{-} Na^{+} Mg^{+2}$
 $(10e^{-}) (10e^{-}) (10e^{-}) (10e^{-})$

$Na^{+} Mg^{+} Al^{+3} F^{-}$
 $(10e^{-}) (11e^{-}) (10e^{-}) (10e^{-})$

$N^{-3} O^{-2} F^{-} Ne$
 $(10e^{-}) (10e^{-}) (10e^{-}) (10e^{-})$

124. What is the atomic number of the element with symbol Uus?

1) 117 2) 116 3) 115 4) 114

Key: 1

Sol: Uus - Un un septium (117).

125. Match the following

List-I

(A) PCl_3

(B) BF_3

(C) ClF_3

(D) XeF_4

List-II

(I) Square planar

(II) T-shape

(III) Trigonal-pyramidal

(IV) See-saw

(V) Trigonal planar

	(A)	(B)	(C)	(D)
1)	(IV)	(II)	(I)	(III)
2)	(III)	(V)	(II)	(IV)
3)	(III)	(V)	(II)	(I)
4)	(II)	(IV)	(III)	(V)

Key: 3

Sol: $PCl_3 (SP^3, 1l.p) - Trigonal - Pyramidal$

$BF_3 (SP^2, 0l.p) - Trigonal - Planar$

$ClF_3 (SP^3 d, 2l.p) - T - Shape$

$XeF_4 (SP^3 d^2, 2l.p) - Square Planar$.

126. The order of covalent character of KF, KI, KCl is

1) $KCl < KF < KI$ 2) $KI < KCl < KF$ 3) $KF < KI < KCl$ 4) $KF < KCl < KI$

Key: 4

Sol: According to FaJan's Rule

Covalent Character \propto Size of Anion

Size of Anions $I^{-} > Br^{-} > Cl^{-} > F^{-}$.

127. If the kinetic energy in J. of CH_4 (molar mass = $16g\ mol^{-1}$) at T(K) is X, the kinetic energy in J, of O_2 (molar mass = $32g\ mol^{-1}$) at the same temperature is

- 1) X 2) 2X 3) X^2 4) $\frac{X}{2}$

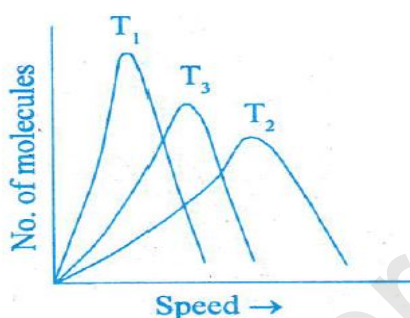
Key: 1

Sol: Average Kinetic Energy = x

$$KE = \frac{3}{2}RT$$

Average Kinetic Energy $\propto T$.

128. The given figure shows the Maxwell distribution of molecular speeds of a gas at three different temperatures T_1, T_2 and T_3 . The correct order of temperatures is



- 1) $T_1 > T_2 > T_3$ 2) $T_1 > T_3 > T_2$ 3) $T_3 > T_2 > T_1$ 4) $T_2 > T_3 > T_1$

Key: 4

Sol: Conceptual .

129. In Haber's process 50.0 g of $N_2(g)$ and 10.0 g of $H_2(g)$ are mixed to produce $NH_3(g)$. What is the number of moles of $NH_3(g)$ formed ?

- 1) 3.33 2) 2.36 3) 2.01 4) 5.36

Key: 1

Sol: $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$\frac{50}{28} \text{ moles } \frac{10}{2} \text{ moles}$$

1.785 moles 5 moles

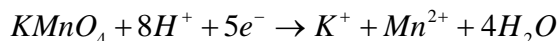
Limiting reagent is H_2

3 moles of $H_2 \rightarrow 2$ moles NH_3

5 moles of $H_2 \rightarrow ?$.

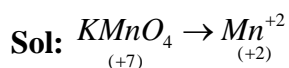
$$\frac{5 \times 2}{3} = 10/3 = 3.33$$

130. The following reaction occurs in acidic medium



- 1) 79.0 2) 31.6 3) 158.0 4) 39.5

Key: 2



n-factor (or) valency factor = 7 - 2 = 5

$$\text{Equivalent weight} = \frac{\text{Molecular weight}}{n - \text{factor}} = 158/5 = 31.6.$$

131. Given that $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g); \Delta_r H^\ominus = -92 \text{ kJ}$, **the standard molar enthalpy of formation in kJ mol⁻¹ of NH₃(g) is**

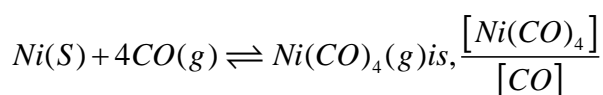
- 1) -92 2) +46 3) +92 4) -46

Key: 4

Sol: Standard molar enthalpy (for 1 mole) = -92/2 = -46 kJ/mole.

132. Which one of the following is correct ?

- 1) The equilibrium constant (K_c) is independent of temperature
- 2) The value of K_c is independent of initial concentrations of reactants and products
- 3) At equilibrium, the rate of the forward reaction is twice the rate of the backward reaction
- 4) The equilibrium constant (K_c) for the reaction



Key: 2

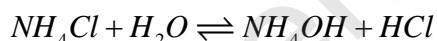
Sol: Equilibrium Constant (K_c) is only dependent on temperature but not on initial and final concentrations of reactants and products respectively.

133. pH of an aqueous solution of NH₄Cl is

- 1) 7 2) >7 3) <7 4) 1

Key: 3

Sol: This is formed from strong acid and weak base



Cationic hydrolysis so solution is acidic

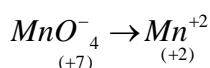
$$P^H < 7$$

134. What is the change in the oxidation state of Mn, in the reaction of MnO_4^- with H_2O_2 in acidic medium ?

- 1) 7 → 4 2) 6 → 4 3) 7 → 2 4) 6 → 2

Key: 3

Sol: In Acidic medium



135. Which one of the following will not give flame test ?

- 1) Ca 2) Ba 3) Sr 4) Be

Key: 4

Sol: Berilium does not give flame test in II(A) group elements

136. Which one of the following forms a basic oxide ?

- 1) B 2) Tl 3) Al 4) Ga

Key: 2

Sol: $B_2O_3 \rightarrow$ Acidic oxide

$Al_2O_3 \rightarrow$ Amphoteric oxide

$Ga_2O_3 \rightarrow$ Amphoteric oxide

$Tl_2O_3 \rightarrow$ Basic oxide

137. The gas produced by the passage of air over hot coke is

- 1) Carbon monoxide 2) Carbon dioxide 3) Producer gas 4) Water gas

Key: 3

Sol: Producer gas ($CO + N_2$)

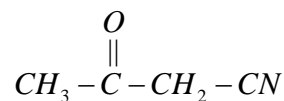
138. In environmental chemistry the medium which is affected by a pollutant is called as the _____

- 1) Sink 2) Slag 3) Solvent 4) Receptor

Key: 4

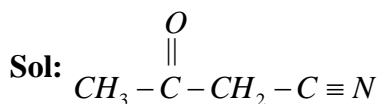
Sol: Conceptual

139. The hybridisation of each carbon in the following compound is



- | | | | | | | | |
|-----------|--------|--------|--------|-----------|--------|--------|--------|
| i | ii | iii | iv | i | ii | iii | iv |
| 1) sp^3 | sp^2 | sp^3 | sp | 2) sp^3 | sp^3 | sp^2 | sp |
| 3) sp^3 | sp | sp^3 | sp^2 | 4) sp^3 | sp^2 | sp | sp^3 |

Key: 1



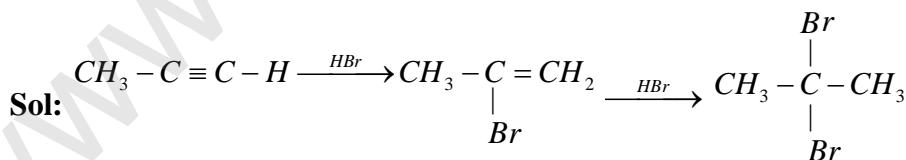
$(sp^3) (sp^2) (sp^2) (sp)$

140. The product Z of the following reaction is:

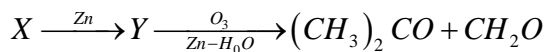


- 1) $H_3CCH_2CHBr_2$ 2) $H_3CCBr_2CH_3$ 3) $H_3CCHBrCH_2Br$ 4) $BrCH_2CH_2CH_2Br$

Key: 2

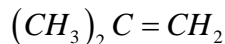
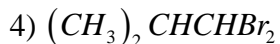
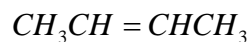
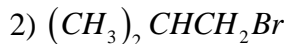
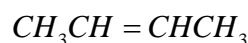
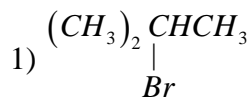


141. Identify X and Y in the following reaction sequence

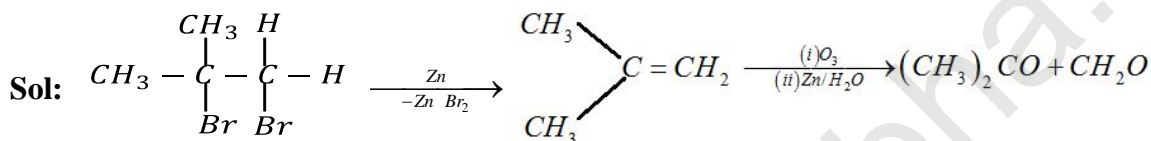


X

Y



Key: 3



142. The packing efficiency of simple cubic (sc), body centred cubic (bcc) and cubic close packing (ccp) lattices follow the order

1) $bcc < ccp < sc$

2) $ccp < bcc < sc$

3) $sc < ccp < bcc$

4) $sc < bcc < ccp$

Key: 4

Sol: Packing efficiency of

(i) Simple cubic lattice (sc)52.4%

(ii) Body centred cubic lattice (bcc)68%

Cubic close packing (ccp).....74%

143. The experimental depression in freezing point of a dilute solution is 0.025 K. If the van't Hoff factor (i) is 2.0, the calculated depression in freezing point (in K) is

1) 0.00125

2) 0.025

3) 0.0125

4) 0.05

Key: 3

Sol:
$$i = \frac{\text{Experimental colligative Property}}{\text{Calculated colligative Property}}$$

$$2 = \frac{0.025}{(\Delta T_f)_{cal}}$$

$$(\Delta T_f)_{cal} = \frac{0.025}{2} = 0.0125$$

144. The molality of an aqueous dilute solution containing non-volatile solute is 0.01 M. What is the boiling temperature (in °C) of solution? (Boiling point elevation constant, $K_b = 0.52 \text{ Kg mol}^{-1} \text{ K}$; boiling temperature of water = 100°C).

1) 100.0052

2) 100.052

3) 100.0

4) 100.52

Key: 2

Sol: $\Delta T_b = K_b \text{ molality}$

$$(T_s - T_0) = K_b \text{ molality}$$

$$T_s - 373 = 0.52 \times 0.1$$

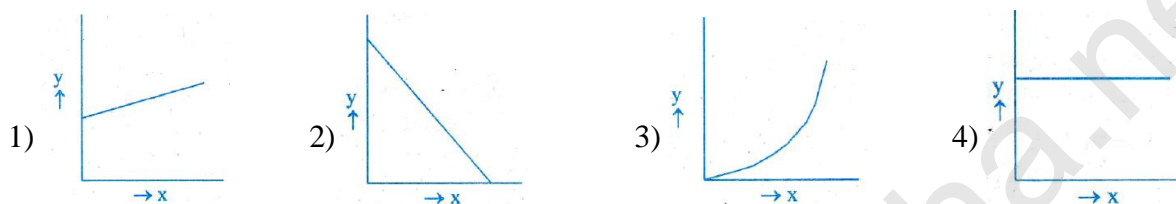
$$T_s = 0.052 + 373$$

$$T_s = 373.052 \text{ K}$$

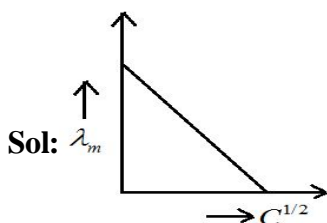
$$T_s = 373.052 - 273$$

$$T_s = 100.052^\circ \text{C}$$

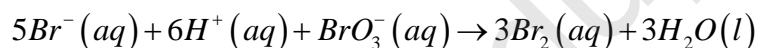
145. Which one of the following is the correct plot of \wedge_m (in $S \text{ cm}^2 \text{ mol}^{-1}$) and \sqrt{c} (in mol / L)^{1/2} for KCl solution? ($y = \wedge_m; x = \sqrt{c}$).



Key: 2



146. For the reaction



if, $-\frac{\Delta[BrO_3^-]}{\Delta t} = 0.01 \text{ mol L}^{-1} \text{ min}^{-1}$,

$-\frac{\Delta[Br_2]}{\Delta t}$ in $\text{mol L}^{-1} \text{ min}^{-1}$ is

- 1) 0.01 2) 0.3 3) 0.03 4) 0.005

Key: 3

Sol: Rate of reaction

$$\frac{-1 \Delta(Br^-)}{5 \Delta t} = \frac{-1 \Delta(H^+)}{6 \Delta t} = -1 \frac{\Delta(BrO_3^-)}{\Delta t} = \frac{1 \Delta(Br_2)}{3 \Delta t}$$

$$\frac{\Delta(Br_2)}{\Delta t} = -3 \frac{\Delta(BrO_3^-)}{\Delta t} = 3 \times 0.01 = 0.03$$

147. Which one of the following is an emulsion?

- 1) Milk 2) Soap lather 3) Butter 4) Vanishing Cream

Key: 1, 4

Sol: Conceptual

148. Copper matte contains _____

- 1) Cu_2O, Cu_2S 2) Cu_2O, FeO 3) Cu_2S, FeS 4) Cu_2S, FeO

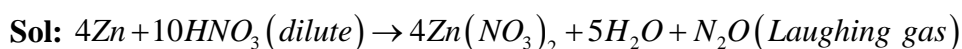
Key: 3

Sol: $Cu_2S + FeS$ is called copper matte.

149. X reacts with dilute nitric acid to form 'laughing gas'. What is X ?

- 1) Cu 2) P_4 3) S_8 4) Zn

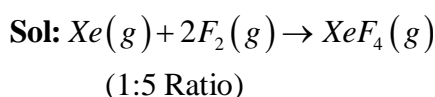
Key: 4



150. Xenon reacts with fluorine at 873 K and 7 bar to form XeF_4 . In this reaction the ratio of Xenon and fluorine required is:

- 1) 1:5 2) 10:1 3) 1:3 4) 5:1

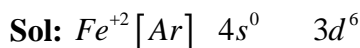
Key: 1



151. Which of the following metal ions has a calculated magnetic moment value of $\sqrt{24}$ B.M.?

- 1) Mn^{2+} 2) Fe^{+2} 3) Fe^{3+} 4) Co^{2+}

Key: 2



4- unpaired electrons $n=4$

magnetic momentum (μ) = $\sqrt{n(n+2)}$

= $\sqrt{4(4+2)} = \sqrt{24}$ B. M.

152. Which one of the following does not exhibit geometrical isomerism?

- 1) Octahedral complex with formula $[MX_2L_4]$
2) Square planar complex with formula $[MX_2L_2]$
3) Tetrahedral complex with formula $[MABXL]$
4) Octahedral complex with formula $[MX_2(L-L)_2]$

Key: 3

Sol: Conceptual

153. The P Dispersity Index (PDI) of a polymer is (\bar{M}_w = weight average molecular mass and \bar{M}_n = number average molecular mass)

- 1) The product of \bar{M}_n and \bar{M}_w 2) The sum of \bar{M}_n and \bar{M}_w
3) The difference between \bar{M}_w and \bar{M}_n 4) The ratio between \bar{M}_w and \bar{M}_n

Key: 4



154. Hormone that maintains the blood glucose level within the limit is:

- 1) Thyroxine 2) Insulin 3) Testosterone 4) Epinephrine

Key: 2

Sol: Insulin maintains glucose level in blood.

155. Chloroxylenol is an example of _____

- 1) Antiseptic 2) Antipyretic 3) Analgesic 4) Tranquilizer

Key: 1

Sol: Chloroxylenol is a constituent in dettol which is Anti septic

156. Which one of the following has highest boiling point?


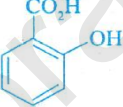
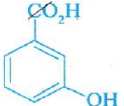

- 1) $H_3CCH_2CH_2CH_2Cl$ 2) $(H_3C)_2CHCH_2Cl$
 3) $(H_3C)_3CCl$ 4) $\begin{matrix} H_3CCH_2CHCH_3 \\ | \\ Cl \end{matrix}$

Key: 1

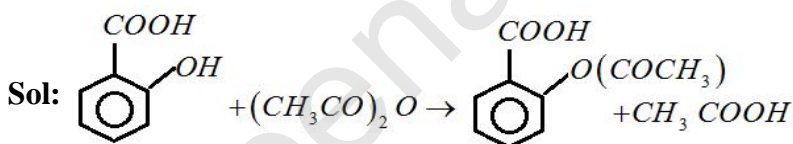
Sol: Boiling point \propto length of chain.

157. $X + Y \xrightarrow{H^+} \text{Aspirin} + H_3CCOOH$

Identify X and Y from the following:

- | X | Y | X | Y |
|--|-------------|--|---------------|
| 1)  | H_3CCOCl | 2)  | $(H_3CCO)_2O$ |
| 3)  | H_3CCO_2H | 4)  | H_3CCOCH_3 |

Key: 2



Ortho - Acetyl Salicylic acid (aspirin)

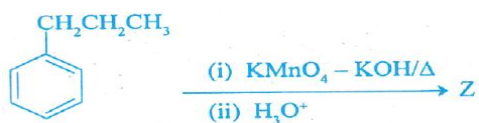
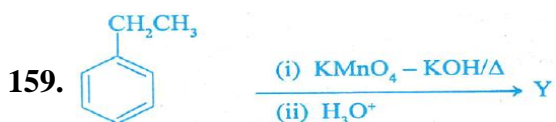
158. $R-CN \xrightarrow[(ii)H_3O^+]{(i)SnCl_2+HCl} R-CHO$

What is the name of the above reaction?

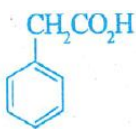
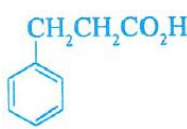
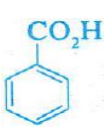
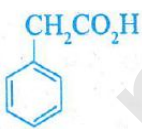

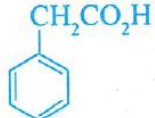
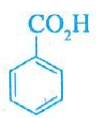
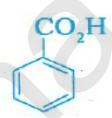
- 1) Resenmund 2) Williamson
 3) Stephen 4) Kolbe

Key: 3

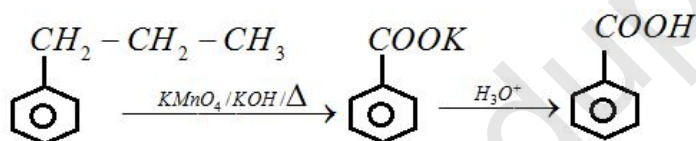
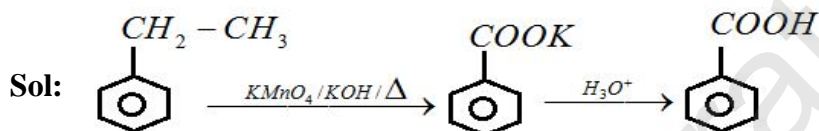
Sol: Conceptual



What are the structures of Y and Z?

- | | | | | |
|----|---|---|---|---|
| | Y | Z | Y | Z |
| 1) |  |  |  |  |
| 3) |  |  |  |  |

Key: 4



160. Which is the strongest base among the following?

- 1) H_3CNH_2 2)  3)  4) 

Key: 1

Sol: Aliphatic amines are more basic than aromatic amines.
