IIT JEE MAINS 2016 10TH APRIL 2016
PHYSICS

1. A, B, C and D are four different physical quantities having different dimensions. None of them is dimensionless. But we know that the equation $AD = C\ln(BD)$ holds true. Then which of the combination is not a meaningful quantity?

(1) $A^2 - B^2C^2$

(2) $\frac{(A-C)}{D}$

(3) $\frac{A}{B} - C$

(4) $\frac{C}{BD} - \frac{AD^2}{C}$

2. A particle of mass M is moving in a circle of fixed radius R in such a way that its centripetal acceleration at time t is given by n^2Rt^2 where n is a constant. The power delivered to the particle by the force acting on it, is :

(1) Mn^2R^2t

(2) MnR^2t

(3) MnR^2t^2

(4) $\frac{1}{2}Mn^2R^2t^2$

3. Concrete mixture is made by mixing cement, stone and sand in a rotating cylindrical drum. If the drum rotates too fast, the ingredients remain stuck to the wall of the drum and proper mixing of ingredients does not take place. The maximum rotational speed of the drum in revolutions per minute(rpm) to ensure proper mixing is close to :

(Take the radius of the drum to be 1.25 m and its axle to be horizontal) :

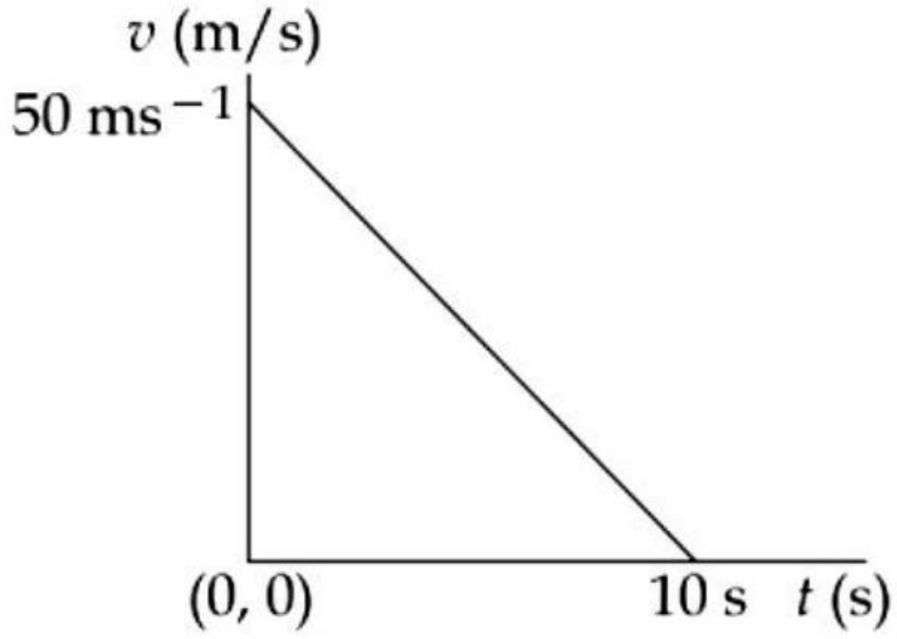
(1) 0.4

(2) 1.3

(3) 8.0

(4) 27.0

4. Velocity-time graph for a body of mass 10 kg is shown in figure. Work-done on the body in first two seconds of the motion is :



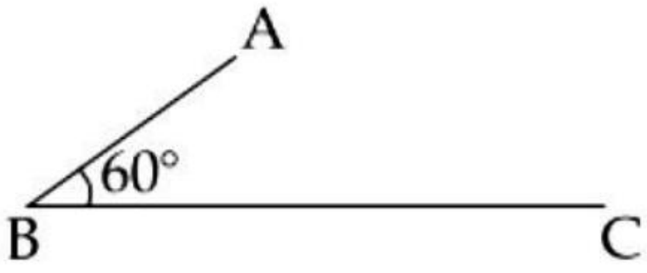
(1) 12000 J

(2) -12000 J

(3) -4500J

(4) -9300 J

5. In the figure shown ABC is a uniform wire. If centre of mass of wire lies vertically below point A, then $\frac{BC}{AB}$ is close to:



(1) 1.85

(2) 1.37

(3) 1.5

(4) 3

6. An astronaut of mass m is working on a satellite orbiting the earth at a distance h from the earth's surface. The radius of the earth is R, while its mass is M. The gravitational pull F_G on the astronaut is :

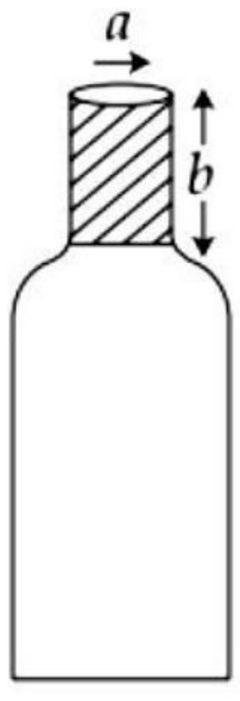
(1) Zero since astronaut feels weightless

(2) $0 < F_G < \frac{GMm}{R^2}$

(3) $\frac{GMm}{(R+h)^2} < F_G < \frac{GMm}{R^2}$

(4) $F_G = \frac{GMm}{(R+h)^2}$

7. A bottle has an opening of radius a and length b. A cork of length b and radius $(a + \Delta a)$ where $(a + \Delta a)$ is compressed to fit into the opening completely (See figure). If the bulk modulus of cork is B and frictional coefficient between the bottle and cork is μ then the force needed to push the cork into the bottle is :



(1) $(\pi\mu Bb)\Delta a$

(2) $(2\pi\mu Bb)\Delta a$

(3) $(\pi\mu Bb)a$

(4) $(4\pi\mu Bb)\Delta a$

8. A Carnot freezer takes heat from water at 0°C inside it and rejects it to the room at a temperature of 27°C. The latent heat of ice is 336×10^3 J kg^{-1} . If 5 kg of water at 0°C is converted into ice at 0°C by the freezer, then the energy consumed by the freezer is close to :

(1) 1.67×10^5 J

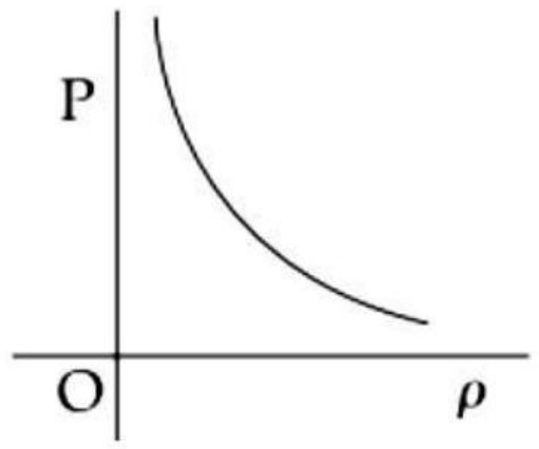
(2) 1.68×10^6 J

(3) 1.51×10^5 J

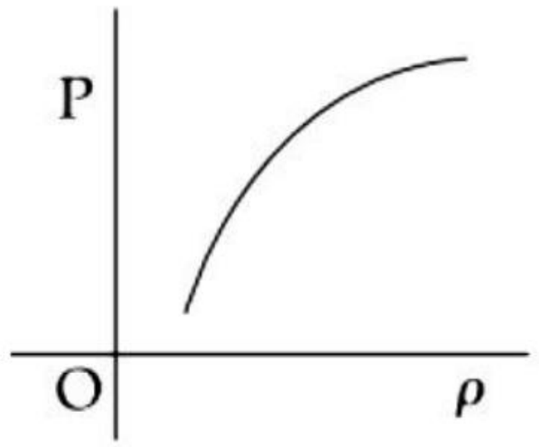
(4) 1.71×10^7 J

9. Which of the following shows the correct relationship between the pressure 'P' and density ρ of an ideal gas at constant temperature?

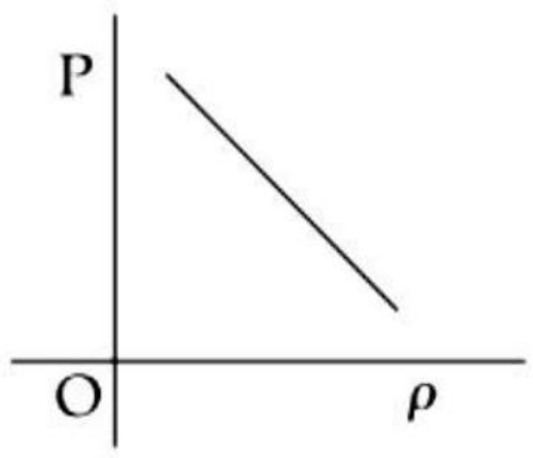
(1)



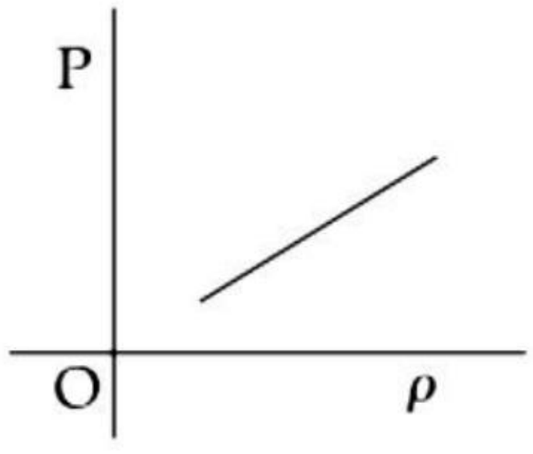
(2)



(3)



(4)



10. In an engine the piston undergoes vertical simple harmonic motion with amplitude 7 cm. A washer rests on top of the piston and moves with it. The motor speed is slowly increased. The frequency of the piston at which the washer no longer stays in contact with the piston, is close to :

(1) 0.1 Hz

(2) 1.2 Hz

(3) 0.7 Hz

(4) 1.9 Hz

11. A toy-car, blowing its horn, is moving with a steady speed of 5 m/s, away from a wall. An observer, towards whom the toy car is moving, is able to hear 5 beats per second. If the velocity of sound in air is 340 m/s, the frequency of the horn of the toy car is close to :

(1) 680 Hz

(2) 510 Hz

(3) 340 Hz

(4) 170 Hz

12. Within a spherical charge distribution of charge density $\rho(r)$, N equipotential surfaces of potential V_0, $V_0+\Delta V$, $V_0+2\Delta V$, ... V 0+NΔV $(\Delta V>0)$, are drawn and have increasing radii $r_0, r_1, r_2, \ldots\ldots r_N$, respectively. If the difference in the radii of the surfaces is constant for all values of V_0 and ΔV then :

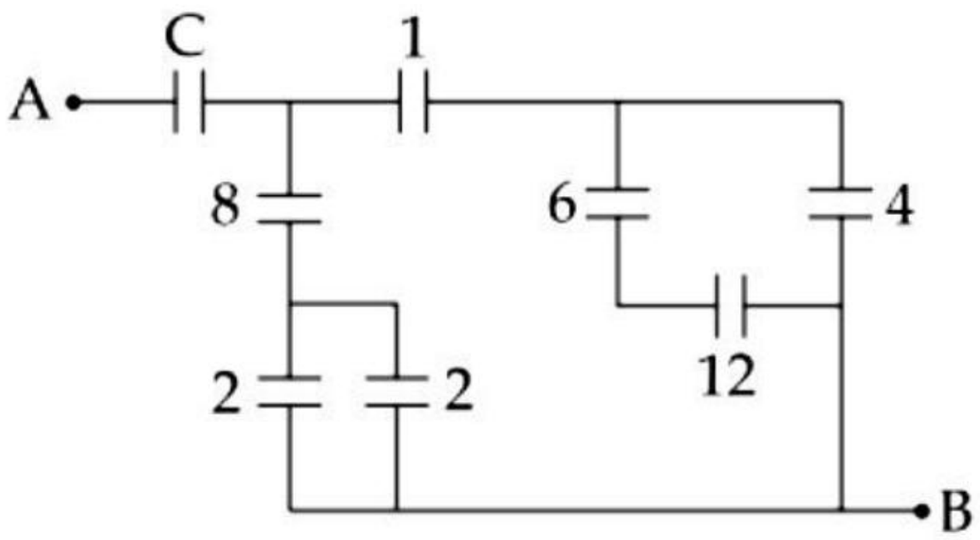
(1) $\rho(r) \alpha r$

(2) $\rho(r) = \text{constant}$

(3) $\rho(r) \alpha \frac{1}{r}$

(4) $\rho(r) \alpha \frac{1}{r^2}$

13. Figure shows a network of capacitors where the numbers indicates capacitances in micro Farad. The value of capacitance C if the equivalent capacitance between point A and B is to be 1 μF is :



(1) $\frac{31}{23}\mu F$

(2) $\frac{32}{23}\mu F$

(3) $\frac{33}{23}\mu F$

(4) $\frac{34}{23}\mu F$

14. The resistance of an electrical toaster has a temperature dependence given by $R(T)=R_0\left[1+\alpha(T-T_0)\right]$ in its range of operation. At T_0=300 K, R=100 Ω and at T=500 K, R=120 Ω. The toaster is connected to a voltage source at 200 V and its temperature is raised at a constant rate from 300 to 500 K in 30 s. The total work done in raising the temperature is :

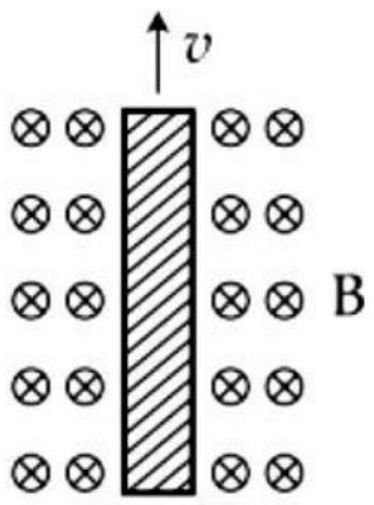
(1) $400\ln\frac{1.5}{1.3}$ J

(2) $200 \ln \frac{2}{3}$ J

(3) $400 \ln \frac{5}{6}$ J

(4) 300 J

15. Consider a thin metallic sheet perpendicular to the plane of the paper moving with speed 'v' in a uniform magnetic field B going into the plane of the paper (See figure). If charge densities σ_1 and σ_2 are induced on the left and right surfaces, respectively, of the sheet then (ignore fringe effects) :



(1) $\sigma_1 = \varepsilon_0 vB, \sigma_2 = -\varepsilon_0 vB$

(2) $\sigma_1 = \frac{\varepsilon_0 vB}{2}, \sigma_2 = \frac{-\varepsilon_0 vB}{2}$

(3) $\sigma_1 = \sigma_2 = -\varepsilon_0 vB$

(4) $\sigma_1 = \frac{-\varepsilon_0 vB}{2}, \sigma_2 = \frac{\varepsilon_0 vB}{2}$

16. A fighter plane of length 20 m, wing span (distance from tip of one wing to the tip of the other wing) of 15 m and height 5 m is flying towards east over Delhi. Its speed is 240 ms^{-1}. The earth's magnetic field over Delhi is 5×10^{-5} T with the declination angle $\sim 0°$ and dip of θ such that $\sin\theta=\frac{2}{3}$. If the voltage developed is V_B between the lower and upper side of the plane and V_W between the tips of the wings then V_B and V_W are close to :

(1) V_B =45 mV; V_W =120 mV with right side of pilot at higher voltage

(2) V_B =45 mV; V_W =120 mV with left side of pilot at higher voltage

(3) V_B =40 mV; V_W =135 mV with right side of pilot at higher voltage

(4) V_B =40 mV; V_W =135 mV with lrft side of pilot at higher voltage

17. A conducting metal circular-wire-loop of radius r is placed perpendicular to a magnetic field which varies with time as

$B = B_0 e^{-t/\tau}$, where B_0 and τ are constants, at time t=0. If the resistance of the loop is R then the heat generated in the loop after a long time ($t \to \infty$) is :

(1) $\frac{\pi^2 r^4 B_0^4}{2\tau R}$

(2) $\frac{\pi^2 r^4 B_0^2}{2\tau R}$

(3) $\frac{\pi^2 r^4 B_0^4 R}{\tau}$

(4) $\frac{\pi^2 r^4 B_0^4}{\tau R}$

18. Consider an electromagnetic wave propagating in vacuum. Choose the correct statement :

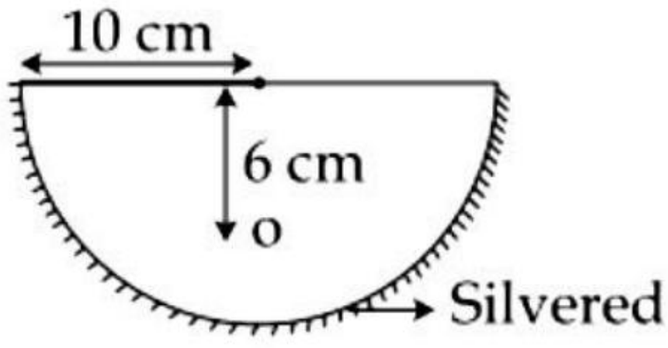
(1) For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E} = \frac{1}{\sqrt{2}} E_{yz}(x,t)(\hat{y} - \hat{z})$ and the magnetic field is $\vec{B} = \frac{1}{\sqrt{2}} B_{yz}(x,t)(\hat{y} + \hat{z})$

(2) For an electromagnetic wave propagating in $+x$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(y,z,t)(\hat{y}+\hat{z})$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(y,z,t)(\hat{y}+\hat{z})$

(3) For an electromagnetic wave propagating in $+y$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(x,t)\hat{y}$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(x,t)\hat{z}$

(4) For an electromagnetic wave propagating in $+y$ direction the electric field is $\vec{E}=\frac{1}{\sqrt{2}}E_{yz}(x,t)\hat{z}$ and the magnetic field is $\vec{B}=\frac{1}{\sqrt{2}}B_{yz}(x,t)\hat{y}$

19. A hemispherical glass body of radius 10 cm and refractive index 1.5 is silvered on its curved surface. A small air bubble is 6 cm below the flat surface inside it along the axis. The position of the image of the air bubble made by the mirror is seen :



(1) 14 cm below flat surface

(2) 30 cm below flat surface

(3) 20 cm below flat surface

(4) 16 cm below flat surface

20. Two stars are 10 light years away from the earth. They are seen through a telescope of objective diameter 30 cm. The wavelength of light is 600 nm. To see the stars just resolved by the telescope, the minimum distance between them should be (1 light year = 9.46×10^{15} m) of the order of :

(1) 10^6 km

(2) 10^8 km

(3) 10^{11} km

(4) 10^{10} km

21. A photoelectric surface is illuminated successively by monochromatic light of wavelengths λ and $\frac{\lambda}{2}$. If the maximum

kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface is :

(1) $\frac{hc}{3\lambda}$

(2) $\frac{hc}{2\lambda}$

(3)

(4) $\frac{3hc}{\lambda}$

22. A neutron moving with a speed 'v' makes a head on collision with a stationary hydrogen atom in ground state. The minimum kinetic energy of the neutron for which inelastic collision will take place is :

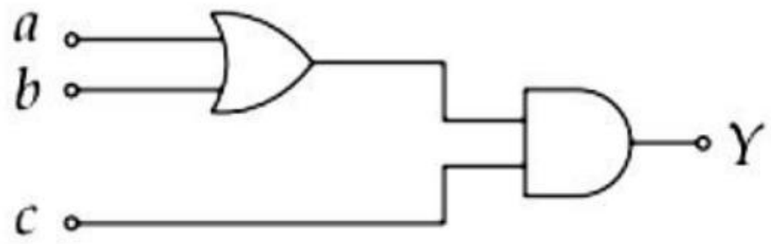
(1) 10.2 eV

(2) 16.8 eV

(3) 12.1 eV

(4) 20.4 eV

23. To get an output of 1 from the circuit shown in figure the input must be :



(1) $a = 0, b = 1, c = 0$

(2) $a = 1, b = 0, c = 0$

(3) $a = 1, b = 0, c = 1$

(4) $a = 0, b = 0, c = 1$

24. A modulated signal $C_m(t)$ has the form $C_m(t) = 30\sin 300\pi t + 10\left(\cos 200\pi t - \cos 400\pi t\right)$. The carrier frequency f_c, the modulating frequency (message frequency) f_ω, and the modulation index μ are respectively given by :

(1) $f_c = 200\ \text{Hz}; f_\omega = 50\ \text{Hz}; \mu = \frac{1}{2}$

(2) $f_c = 150\ \text{Hz}; f_\omega = 50\ \text{Hz}; \mu = \frac{2}{3}$

(3) $f_c = 150\ \text{Hz}; f_\omega = 30\ \text{Hz}; \mu = \frac{1}{3}$

(4) $f_c = 200\ \text{Hz}; f_\omega = 30\ \text{Hz}; \mu = \frac{1}{2}$

25. A particle of mass m is acted upon by a force F given by the empirical law $F = \frac{R}{t^2} v(t)$. If this law is to be tested experimentally by observing the motion starting from rest, the best way is to plot :

(1) $v(t)$ against t^2

(2) $\log v(t)$ against $\frac{1}{t^2}$

(3) $\log v(t)$ against t

(4) $\log v(t)$ against $\frac{1}{t}$

26. A thin 1 m long rod has a radius of 5 mm. A force of 50 πkN is applied at one end to determine its Young's modulus. Assume that the force is exactly known. If the least count in the measurement of all lengths is 0.01 mm, which of the following statements is false ?

(1) $\frac{\Delta Y}{Y}$ gets minimum contribution from the uncertainty in the length.

(2) The figure of merit is the largest for the length of the rod.

(3) The maximum value of Y that can be determined is 10^{14} N/m^2.

(4) $\frac{\Delta Y}{Y}$ gets its maximum contribution from the uncertainty in strain.

27. A galvanometer has a 50 division scale. Battery has no internal resistance. It is found that there is deflection of 40 divisions when R=2400 Ω. Deflection becomes 20 divisions when resistance taken from resistance box is 4900 Ω. Then we can conclude :

(1) Resistance of galvanometer is 200 Ω.

(2) Full scale deflection current is 2 mA.

(3) Current sensitivity of galvanometer is 20 μA/division.

(4) Resistance required on R.B. for a deflection of 10 divisions is 9800 Ω.

28. To determine refractive index of glass slab using a travelling microscope, minimum number of readings required are :

(1) Two

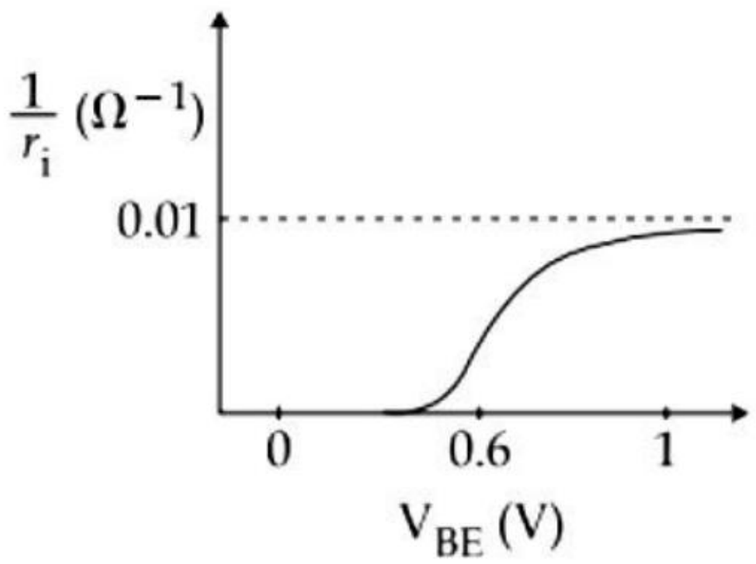
(2) Three

(3) Four

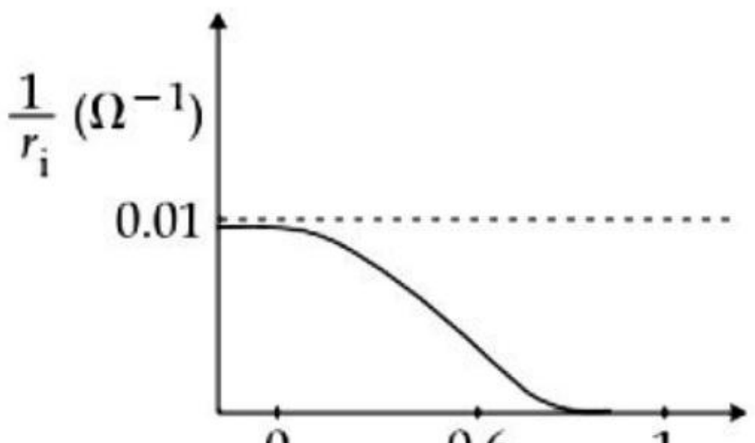
(4) Five

29. A realistic graph depicting the variation of the reciprocal of input resistance in an input characteristics measurement in a common-emitter transistor configuration is :

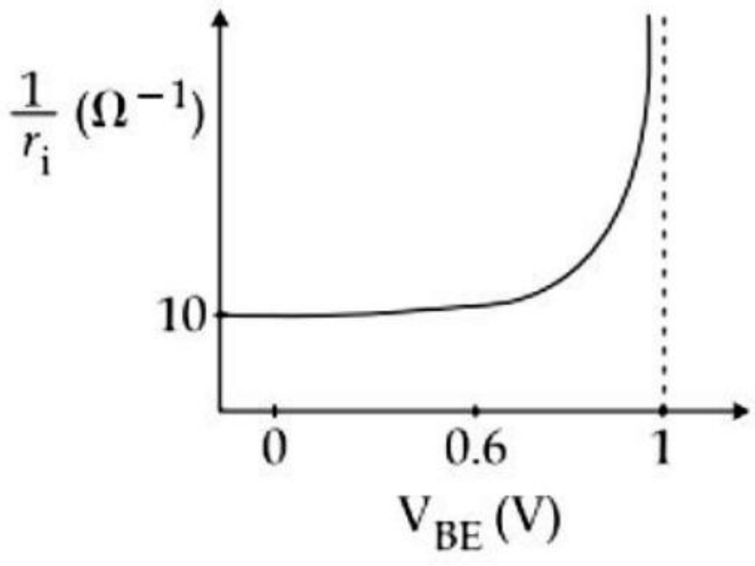
(1)

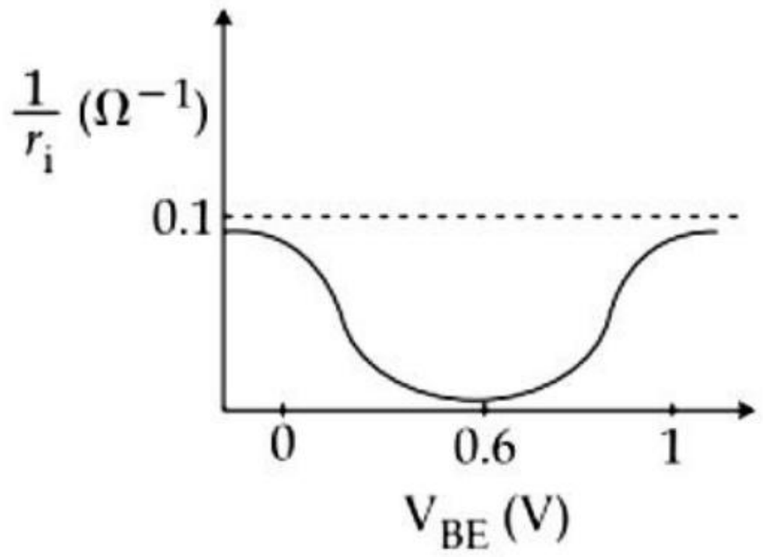


(2)



(3)





(4)

30. The ratio (R) of output resistance r_0, and the input resistance r_i in measurements of input and output characteristics of a transistor is typically in the range :

(1) $R \sim 10^2 - 10^3$

(2) $R \sim 1 - 10$

(3) $R \sim 0.1 - 0.01$

(4) $R \sim 0.1 - 1.0$

SECTION-2

1. The expression is given as,

1.67×10^5 J

Thus, 1.9 Hz is a dimensionless quantity.

Therefore it can be concluded that,

170 Hz ..... (1)

And,

$$\rho(r) \propto \frac{1}{r} \quad \text{..... (2)}$$

Check the first option.

(1) $\frac{32}{23}\,\mu F$

Given that,

$$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$$

Therefore, $400\,\Omega$ and $P_2 > P_1 > P_3$ have the same dimensions.

Check the second option.

(2) $7\,\Omega$ and $45°$

The quantities $\frac{2E_0}{c}\hat{j}\cos kz \cos \omega t$ and 27.5 cm do not have the same dimensions; thus there is no meaning attached to it.

Check the third option.

(3) 9 mm

10^{20}

The quantities $\frac{h^2}{4\pi m^2 r^3}$ and 4×10^{-2} gm have the same dimensions. Thus, this option stands meaningful.

Check the fourth option.

(4) 6.9 mA

This option is meaningful.

2. The centripetal acceleration of the particle is given by,

$$\lambda, P_{eff} = K\left(\frac{1}{\lambda}\right)^2$$

The centripetal acceleration of the particle is also given by,

$$\frac{20}{3}\Omega$$

Equate both the equations stated above.

$0.1\,\text{cm}$

Thus, tangential acceleration is calculated as,

$$P = a^{1/2} b^2 c^3 d^{-4}$$

The power delivered to the particle is given by,

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\frac{\Delta a}{a}\right) + \left(2\frac{\Delta b}{b}\right) + \left(3\frac{\Delta c}{c}\right) + \left(4\frac{\Delta d}{d}\right)\right] \times 100\,\%$$

Substitute the value of

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\times 2\right) + (2\times 1) + (3\times 3) + (4\times 5)\right]\%$$

$$= [1+2+9+20]\%$$, and 32 % in above

$$= 32\,\%$$

expression.

$$s = ut + \frac{1}{2}at^2$$

3. The expression to calculate the velocity to just complete one rotation at the top point is given by,

$$s = (0)t + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

For the drum, the rotational speed is given by,

$(d + 200)$

Substitute the given values of $t = \sqrt{\frac{2d}{2}}$ and $(d + 200)$, that is,

$$\sqrt{\frac{2d}{2}} = \sqrt{\frac{2(d + 200)}{4}}$$

$t = \sqrt{\frac{2(d + 200)}{4}}$ and $d = \frac{(d + 200)}{2}$ in the above

$$d = 200\ \text{m}$$

equation.

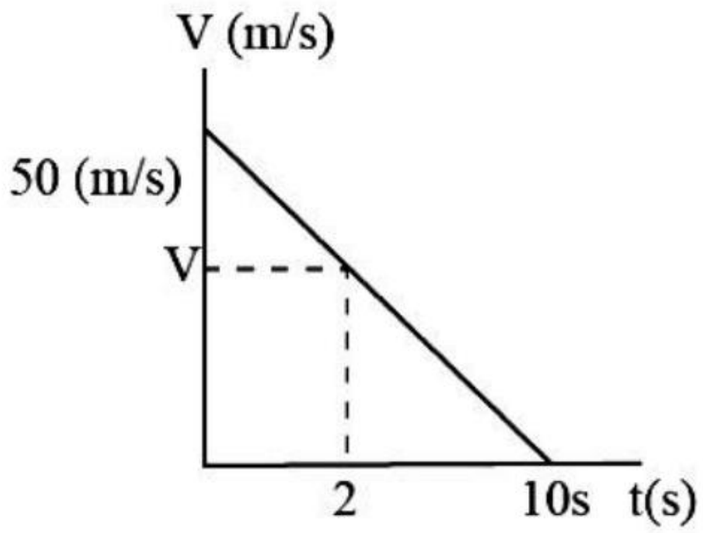
$$t = \sqrt{\frac{2(200\ \text{m})}{2}}$$

$$= 10\sqrt{2}\ \text{s}$$

The maximum rotational speed of the drum in revolution per minute is calculated as,

$10\sqrt{2}$ s

4. The following figure shows the velocity-time graph for the body.



The acceleration of the body is given by,

M'

Substitute the values in the above expression.

υ'

The final velocity at any time

$$2M'\upsilon'\sin\theta = M\upsilon\cos 45° + M\upsilon\cos 30°$$

$$2M'\upsilon'\sin\theta = \frac{M\upsilon}{\sqrt{2}} + \frac{\sqrt{3}M\upsilon}{2}$$

$$2M'\upsilon'\sin\theta = M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)$$ is calculated as,

$$2M'\upsilon'\cos\theta = -M\upsilon\sin 45° + M\upsilon\sin 30°$$

$$2M'\upsilon'\cos\theta = -\frac{M\upsilon}{\sqrt{2}} + \frac{M\upsilon}{2}$$

$$2M'\upsilon'\cos\theta = M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)$$

$$\frac{2M'\upsilon'\sin\theta}{2M'\upsilon'\cos\theta} = \frac{M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)}{M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)}$$

The final velocity at $\tan\theta = \frac{\left(\frac{\sqrt{2}+\sqrt{3}}{2}\right)}{\left(\frac{1-\sqrt{2}}{2}\right)}$ is calculated as,

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

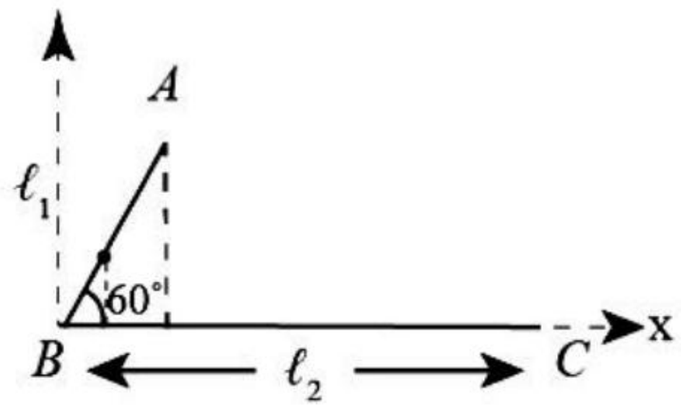
θ

Consider the work energy theorem.

The change in kinetic energy is calculated as,

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

5. The following figure shows the wire ABC.



The center of mass lies vertically below *A*.

Choose the axis in *x*-coordinate equal to ΔPQR.

The centre of mass along the *x*-axis is calculated as,

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

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

Further simplify the above equation.

$$v = \frac{dh}{dt} \qquad \ldots\ldots (1)$$

Use the determinant method to finds the roots of the quadratic equation.

$$\frac{dh}{dt}$$

Consider equation (1). Therefore, the possible value of

$$\frac{dh}{dt} = \frac{d}{dt}\left(\frac{1}{2}\sqrt{4-x^2}\right)$$

$$= \frac{1}{2}\frac{d}{dx}\left(\frac{1}{2}\sqrt{4-x^2}\right)\frac{dx}{dt}$$

are,

$$= \frac{1}{4}\left(\frac{1}{\sqrt{4-x^2}}\right)(-2x)\frac{dx}{dt}$$

$$= -\frac{x}{2\sqrt{4-x^2}}\frac{dx}{dt}$$

$$\frac{dh}{dt} = -\frac{1}{2\sqrt{\frac{4}{x^2}-1}}\frac{dx}{dt}$$

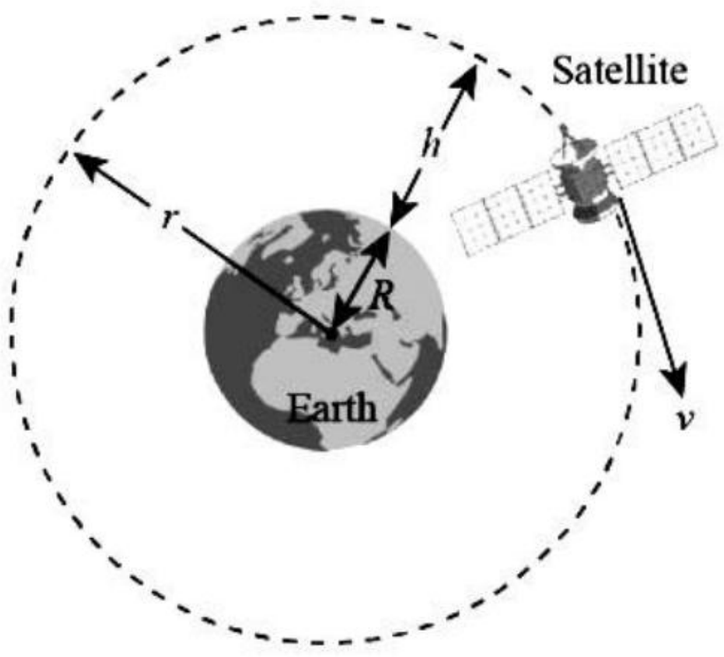
Rationalize the above relation,

$$\sqrt{\frac{4}{x^2}-1}$$

6. The orbital velocity of satellite is given by,

$$\sqrt{\frac{4}{x^2}-1}$$

The following figure shows the orbital path of the satellite.



Here, $\frac{dh}{dt}$ is the radius of the orbital path of the satellite from the centre of earth; that is, $T\cos\theta = mg$, and $T\sin\theta = \frac{mv^2}{r}$ is the orbital velocity.

The Newton's Law of Gravitation is given by,

$$\tan\theta = \frac{v^2}{rg}$$

$$\tan 45° = \frac{v^2}{(0.4\,\text{m})(10\,\text{ms}^{-2})}$$

Here, $v^2 = 4\,\text{m}^2\text{s}^{-2}$ is the gravitational constant.

$$v = \sqrt{4\,\text{m}^2\text{s}^{-2}}$$

$$v = 2\,\text{ms}^{-1}$$

Thus, as per the law of gravitation, the gravitational pull on the astronaut is given by,

$2\,\text{ms}^{-1}$

7. The expression for stress is given by,

$$I_{\text{disc}} = \frac{MR^2}{2} \qquad \ldots\ldots (1)$$

The stress can also be expressed as,

$$I_{\text{removed}} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right) + \left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

$$= \frac{MR^2 + 18MR^2}{512}$$

$$= \frac{19MR^2}{512}$$

$\ldots\ldots (2)$

Here, the strain is given by,

$$I_{remaining} = \frac{MR^2}{2} - \frac{19MR^2}{512}$$

$$= \frac{237MR^2}{512}$$

The change in volume is given by,

$$\frac{237MR^2}{512}$$

The original volume is given by,

$$\rho = \frac{m}{v} = \frac{k}{r}$$

Substitute the values in equation (2).

$$m = \frac{kv}{r}$$

The force required to push the cork into the bottle is calculated as,

$$g_{inside} = \frac{Gmr}{R^3}$$

$$= \left(\frac{Gr}{R^3}\right)\left(\frac{kv}{r}\right)$$

$$= \frac{Gkv}{R^3}$$

8. Heat required to freeze $\frac{Gkv}{R^3}$ water is calculated as,

$$g_{out} = \frac{Gm}{r^2}$$

This heat further acts as $F = Y\alpha_L A\Delta t$.

As per the Carnot's cycle,

$$F = \left(2\times10^{11}\ Nm^{-2}\right)\left(1.2\times10^{-5}\ K^{-1}\right)\left(40\times10^{-4}\ m^2\right)(10)$$

$$= 9.6\times10^{4}\ N$$

$$= 1\times10^{5}\ N$$

The work done is equal to the difference in the heat added to the system and heat rejected by the system.

$$Q = \frac{\pi r^4}{8\eta}\frac{\Delta P}{L}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{P_2 r_2^4}{l_2}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{4P_1 r_2^4}{\frac{I_1}{4}}$$

Thus, the energy consumed by the freezer is .

$$r_2^4 = \frac{r_1^4}{16}$$

$$r_2 = \frac{r_1}{2}$$

9. The expression as per the concept of thermodynamics for an Ideal gas that is at constant temperature is given by,

$$u_{initial} = \frac{5}{2}NRT$$

Thus, it can be concluded that,

$$u_{final} = \frac{3}{2}(2nRT) + \frac{5}{2}(N\text{-}n)RT$$

$$= \frac{1}{2}nRT + \frac{5}{2}NRT$$

Hence, the pressure versus density graph varies linearly, that is the pressure increases with an increase in density.

10. As washer does not stay in contact with the piston any longer.

Hence,
$$U_{total} = \frac{1}{2}nRT + \frac{5}{2}NRT - \frac{5}{2}NRT$$
$$= \frac{1}{2}nRT$$

The frequency is given by,

$$a = a_0 e^{\frac{-bt}{m}}$$

The angular velocity is given by,

$$E \propto a^2$$

$$a \propto E$$

Consider the above two relations to determine the frequency.

The frequency is calculated as,

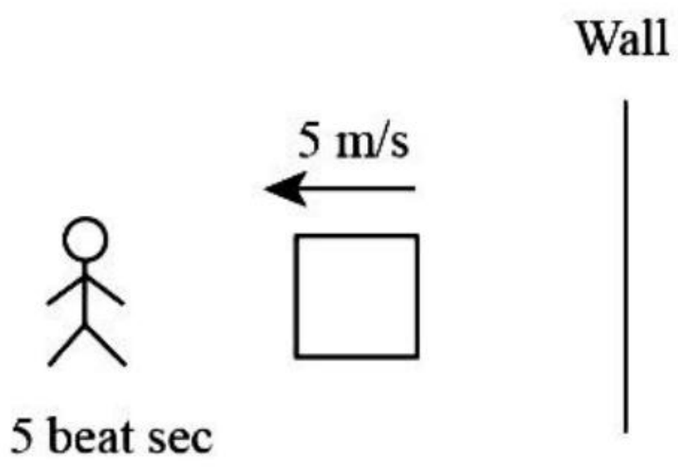
$$a = \frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$

$$\frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$

$$= \frac{10^{-2}t}{0.1}$$

$$= \frac{t}{10}$$

11. The following figure is a pictorial representation of the given case.



Consider the Doppler Effect,

$$\frac{a_0}{\sqrt{2}} = a_0 e^{-\frac{t}{10}}$$

$$\frac{1}{\sqrt{2}} = e^{-\frac{t}{10}} \qquad \ldots\ldots (1)$$

$$\ln\sqrt{2} = \frac{t}{10}$$

$$t = 3.5 \text{ sec}$$

Here, v is the speed of the sound in air and $v = \frac{\omega}{k}$ is the speed of the source moving.

The apparent frequency from the wall is given by,

$$v = \frac{200\pi}{\left(\frac{5\pi}{4}\right)} \qquad \ldots\ldots (2)$$

$$= 160 \text{ m/s}$$

The expression for beat frequency is given by,

$$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4 \qquad \ldots\ldots (3)$$

Form the equation. (1), (2) and (3),

$$C = \frac{\varepsilon_0 A}{3}$$

12. The expression for the electric field is given by:

$$C = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

$$\frac{\varepsilon_0 A}{3} = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

The electric field, $3k = 2.4k + 3$ is constant. This

$$k = 5$$

implies that the change in ratio of $\sigma_1 = \varepsilon_0 \upsilon B$, $\sigma_2 = -\varepsilon_0 \upsilon B$ and $\frac{(A - C)}{D}$ remains the same.

Thus,

MnR^2t

Substitute the values in the above relation.

–4500 J

Further simplify the integral function.

1.37

13. The expression for the capacitors grouped in series is given by,

$$F_G = \frac{GMm}{(R + h)^2}$$

The expression for the capacitors grouped in parallel is given by,

$(4\pi\mu Bb)\Delta n$

Apply the circuit reduction method.

Capacitors 1.67×10^{5} J and 1.9 Hz are parallel to each other.

So, their equivalent capacitance is calculated as,

170 Hz

Similarly, the capacitors $\rho(r)\propto\frac{1}{r}$ and $\frac{32}{23}\mu F$ are in series. Thus, their equivalent capacitance is,

$\sigma_1=\varepsilon_0\upsilon B,\sigma_2=-\varepsilon_0\upsilon B$

The capacitors having the capacitance of $400\,\Omega$ and $P_2>P_1>P_3$ are in series. Thus, their equivalent capacitance is,

$7\,\Omega$ and $45°$

The capacitors having the capacitance of $\frac{2E_0}{c}\hat{j}\cos kz\cos \omega t$ and 27.5 cm are in parallel. Thus, their equivalent capacitance is,

9 mm

In the reduced circuit, the 10^{20} is in series with $\frac{h^2}{4\pi m^2 r^3}$. Thus, their equivalent capacitance is,

4×10^{-2} gm

Finally the net capacitance of the circuit is calculated as,

6.9 mA

Hence, the required circuit equivalent capacitance is calculated as,

$$\lambda, P_{eff} = K\left(\frac{1}{\lambda}\right)^2$$

14. The power dissipated is given by,

$\frac{20}{3}\Omega$

Substitute the given values in the above equation.

$0.1\,\text{cm}$

Here, $P = a^{1/2}b^2c^3d^{-4}$ is the temperature at

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\frac{\Delta a}{a}\right)+\left(2\frac{\Delta b}{b}\right)+\left(3\frac{\Delta c}{c}\right)+\left(4\frac{\Delta d}{d}\right)\right]\times 100\,\% \text{ and}$$

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\times 2\right)+(2\times 1)+(3\times 3)+(4\times 5)\right]\%$$

$$= [1+2+9+20]\%$$

$$= 32\,\%$$

is the temperature at

$32\,\%$.

Thus, the temperature difference at time $s = ut + \frac{1}{2}at^2$ is

calculated as,

$$s = (0)t + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

The net work done to raise the temperature is given by,

$(d+200)$

Substitute the values in the above equation.

$$t=\sqrt{\frac{2d}{2}} \qquad \ldots\ldots (1)$$

Determine the value of $(d+200)$ from the following relation.

$$t=\sqrt{\frac{2(d+200)}{4}}$$

Substitute the values in the above relation.

$$\sqrt{\frac{2d}{2}}=\sqrt{\frac{2(d+200)}{4}}$$

$$d=\frac{(d+200)}{2}$$

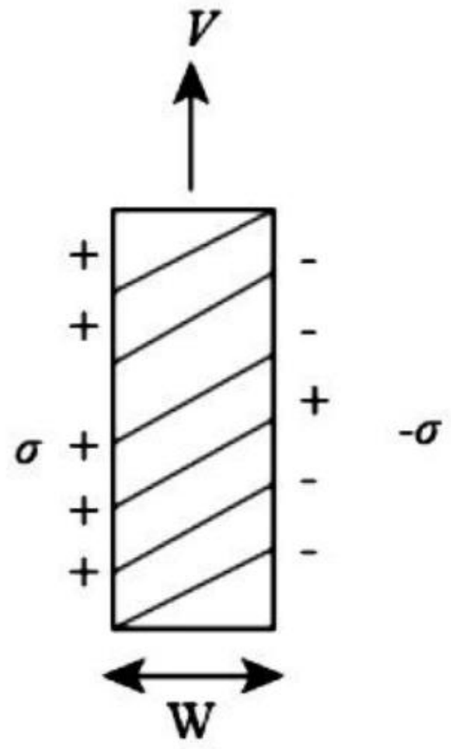
$$d=200\ \text{m}$$

Substitute the value of $t=\sqrt{\frac{2(200\ \text{m})}{2}}$ in equation (1).

$$=10\sqrt{2}\ \text{s}$$

$10\sqrt{2}\ \text{s}$

15. The following figure shows the charge distribution of the sheet.



The force on a charged particle that is placed in a magnetic field is given by,

M'

Here, υ' is the velocity of the particles and

$2M'\upsilon'\sin\theta = M\upsilon\cos45° + M\upsilon\cos30°$

$$2M'\upsilon'\sin\theta = \frac{M\upsilon}{\sqrt{2}} + \frac{\sqrt{3}M\upsilon}{2}$$

$$2M'\upsilon'\sin\theta = M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)$$ is the magnetic field.

For the case when the magnetic fields are mutually perpendicular to each other,

$$2M'\upsilon'\cos\theta = -M\upsilon\sin 45° + M\upsilon\sin 30°$$

$$2M'\upsilon'\cos\theta = -\frac{M\upsilon}{\sqrt{2}} + \frac{M\upsilon}{2}$$

$$2M'\upsilon'\cos\theta = M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)$$

Magnetic force on electron I metal sheet is given by,

$$\frac{2M'\upsilon'\sin\theta}{2M'\upsilon'\cos\theta} = \frac{M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)}{M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)}$$

$$\tan\theta = \frac{\left(\frac{\sqrt{2}+\sqrt{3}}{2}\right)}{\left(\frac{1-\sqrt{2}}{2}\right)}$$

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

At the equilibrium condition,

θ

Thus,

$$\tan\theta = \frac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}} \qquad \ldots\ldots (1)$$

The electric field is given by,

ΔPQR

Thus,

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

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

Thus, the value of $v = \frac{dh}{dt}$ is given by,

$$\frac{dh}{dt}$$

Substitute the above value in the equation (1).

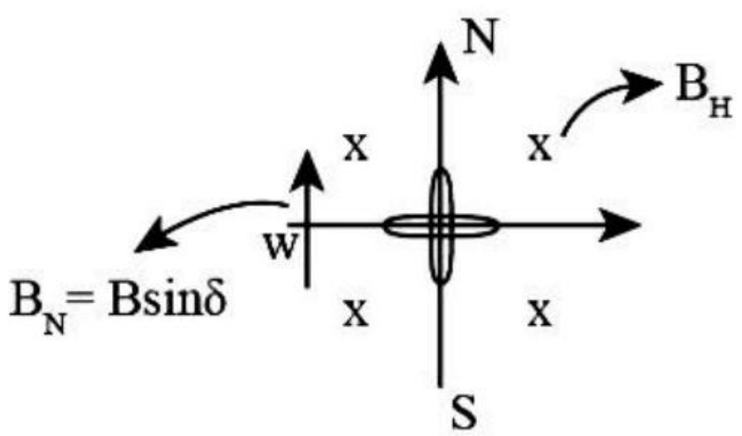
$$\frac{dh}{dt} = \frac{d}{dt}\left(\frac{1}{2}\sqrt{4-x^2}\right)$$

$$= \frac{1}{2}\frac{d}{dx}\left(\frac{1}{2}\sqrt{4-x^2}\right)\frac{dx}{dt}$$

$$= \frac{1}{4}\left(\frac{1}{\sqrt{4-x^2}}\right)(-2x)\frac{dx}{dt}$$

$$= -\frac{x}{2\sqrt{4-x^2}}\frac{dx}{dt}$$

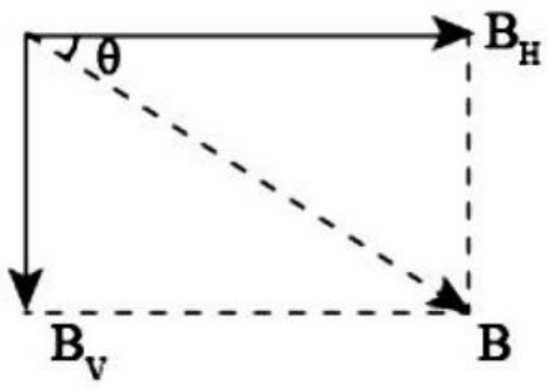
16. The following figure represents the given case.



The expression for the magnetic field is given by,

$$\frac{dh}{dt} = -\frac{1}{2\sqrt{\frac{4}{x^2}-1}}\frac{dx}{dt}$$

Resolve the magnetic field.



Potential difference across wings is given by,

$$\sqrt{\frac{4}{x^2}-1}$$

Substitute the value in the above equation.

$$\sqrt{\frac{4}{x^2}-1}$$

The left side is at high voltage. Therefore, the potential drop between top and bottom of the plane is given by,

$$\frac{dh}{dt}$$

Substitute the values in the above equation.

$$T\cos\theta = mg$$

Therefore, as per the right hand thumb rule, the charge will move to left side of the pilot.

17. The expression for the flow of current into the loop of wire is given by,

$$T\sin\theta = \frac{mv^2}{r}$$

Substitute the values in the above expression.

$$\tan\theta = \frac{v^2}{rg}$$

The heat generated during the phenomenon is calculated as,

$$\tan 45° = \frac{v^2}{(0.4\,\text{m})(10\,\text{ms}^{-2})}$$

$$v^2 = 4\,\text{m}^2\text{s}^{-2}$$

$$v = \sqrt{4\,\text{m}^2\text{s}^{-2}}$$

$$v = 2\,\text{ms}^{-1}$$

Therefore, the heat generated in the loop after a long time, that is at $2\,\text{ms}^{-1}$ is $I_{disc} = \frac{MR^2}{2}$.

18. Considering the case of electromagnetic waves, the electric field and magnetic field have their direction perpendicular to the direction of the propagation, which corresponds to current by right hand rule.

Therefore, both options 1 and 2 are incorrect.

Further, the direction of propagation is obtained from the cross product of the electric field and magnetic field; that is,

$$I_{removed} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right)+\left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

$$= \frac{MR^2+18MR^2}{512}$$

$$= \frac{19MR^2}{512}$$

Thus, from the above two remaining options,

$$I_{remaining} = \frac{MR^2}{2} - \frac{19MR^2}{512}$$

$$= \frac{237MR^2}{512}$$

Hence, if the wave is propagating along the $\frac{237MR^2}{512}$ direction

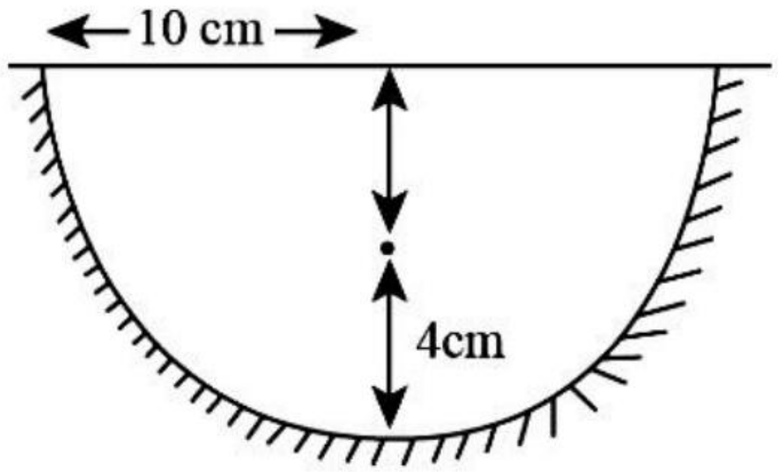
then, $\rho = \frac{m}{v} = \frac{k}{r}$ and $m = \frac{kv}{r}$ must be a function of

$$g_{inside} = \frac{Gmr}{R^3}$$

$$= \left(\frac{Gr}{R^3}\right)\left(\frac{kv}{r}\right), \text{ and must be along the } \frac{Gkv}{R^3} \text{ plane.}$$

$$= \frac{Gkv}{R^3}$$

19. The following figure shows the hemispherical glass body.



The expression for the position of the image formed from the mirror is given by,

$$g_{out} = \frac{Gm}{r^2}$$

Substitute the values with sign convention in the above equation.

$$F = Y\alpha_L A\Delta t$$

The magnification of image is calculated as,

$$F = \left(2\times10^{11}\ \text{Nm}^{-2}\right)\left(1.2\times10^{-5}\ \text{K}^{-1}\right)\left(40\times10^{-4}\ \text{m}^2\right)(10)$$
$$= 9.6\times10^{4}\ \text{N}$$
$$= 1\times10^{5}\ \text{N}$$

Since the value of magnification comes out to be negative, the image is formed below the plane surface.

20. The expression for the angle is given by,

$$Q = \frac{\pi r^4}{8\eta}\frac{\Delta P}{L}$$

Simplify the above expression.

$$\frac{P_1 r_1^4}{l_1} = \frac{P_2 r_2^4}{l_2}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{4P_1 r_2^4}{\frac{I_1}{4}}$$

$$r_2^4 = \frac{r_1^4}{16}$$

$$r_2 = \frac{r_1}{2}$$

Therefore, the minimum distance between the stars and telescope is of the order of $u_{initial} = \frac{5}{2}NRT$.

21. The expression for the energy of the first monochromatoic wave is given by,

$$u_{final} = \frac{3}{2}(2nRT) + \frac{5}{2}(N\text{-}n)RT$$

$$= \frac{1}{2}nRT + \frac{5}{2}NRT$$

The expression for the energy of the second monochromatoic wave is given by,

$$U_{total} = \frac{1}{2}nRT + \frac{5}{2}NRT - \frac{5}{2}NRT$$
$$= \frac{1}{2}nRT$$

Therefore, the kinetic energy of the first monochromatoic wave is calculated as,

$$a = a_0 e^{\frac{-bt}{m}}$$

The kinetic energy of the second monochromatoic wave is calculated as,

$$E \propto a^2$$
$$a \propto E$$

The given relation is,

$$a = \frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$
$$\frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$
$$= \frac{10^{-2}t}{0.1}$$
$$= \frac{t}{10}$$

Substitute the values in the above equation.

$$\frac{a_0}{\sqrt{2}} = a_0 e^{-\frac{t}{10}}$$

$$\frac{1}{\sqrt{2}} = e^{-\frac{t}{10}}$$

$$\ln\sqrt{2} = \frac{t}{10}$$

$$t = 3.5 \text{ sec}$$

22. The a neutron and a hydrogen atom collides, then the collision will be considered inelastic if a potion of the kinetic energy is utilized to excite an atom.

If $v = \frac{\omega}{k}$ is the speed with which the neutron moves after collision, then the hydrogen atom will travel with a velocity of

$$v = \frac{200\pi}{\left(\frac{5\pi}{4}\right)} \quad .\text{with mass } \Phi_1 = \Phi_2 = \Phi_3 = \Phi_4.$$

$$= 160 \text{ m/s}$$

The loss in kinetic energy is calculated as,

$$C = \frac{\varepsilon_0 A}{3}$$

This reduced kinetic energy is utilized in jumping from the 1st orbit to the 2nd orbit.

Thus,

$$C = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

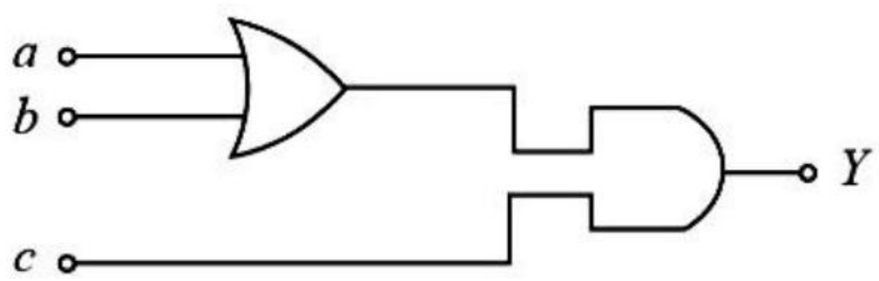
Substitute the value in the above expression.

$$\frac{\varepsilon_0 A}{3} = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

$$3k = 2.4k + 3$$

$$k = 5$$

23. The following figure shows the circuit.



In case the required output has to be $V_B = 45\ mV$, then the following possible equation should be made.

$V_W = 120\ mV$

Consider the above equation. In order to get an output of $V_W = 120\ mV$, substitute,

$$\frac{(A-C)}{D}$$

But it is necessary to put MnR^2t.

Hence, the correct option is (3).

24. The given signal is of the form,

$-4500\ J$

Compare the given signal with the standard signal.

1.37

Also,

$$F_G = \frac{GMm}{(R+h)^2}$$

The expression for the angular frequency of the carrier is given by,

$(4\pi\mu Bb)\Delta n$

Hence, the correct option is (2)

25. The force acting on the particle is given by,

1.67×10^5 J

Therefore,

1.9 Hz

Integrate both sides of the above expression.

170 Hz

Therefore, it can be concluded that,

$$\rho(r) \propto \frac{1}{r}$$

So, graph should be plotted between $\frac{32}{23}\mu F$ against

$\sigma_1 = \varepsilon_0 \upsilon B, \sigma_2 = -\varepsilon_0 \upsilon B.$

26. The Young's modulus is given by,

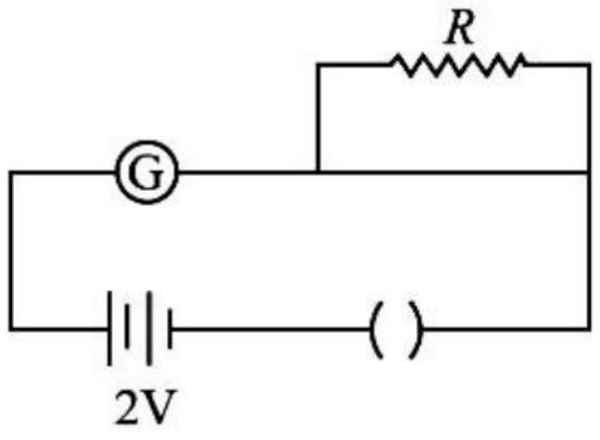
$V_B = 45\ mV$

Substitute the given values in the above expression.

$V_W = 120\ mV$

Therefore, the maximum value of $P_2 > P_1 > P_3$ that can be determined is $7\ \Omega$ and $45°$.

27. The following figure shows the circuit arrangement.



The current through the galvanometer if the deflection is of

$\frac{2E_0}{c}\hat{j}\cos kz \cos \omega t$ is calculated as,

27.5 cm ..... (1)

The current through the galvanometer if the resistance is taken from the resistance box is calculated as,

9 mm ..... (2)

Simplify equation (2).

10^{20}

Consider equation (1).

$$\frac{h^2}{4\pi m^2 r^3}$$

The full scale deflection of current through galvanometer is calculated as,

4×10^{-2} gm

For 10 divisions the value of 6.9 mA is calculated as,

$$\lambda, P_{eff} = K\left(\frac{1}{\lambda}\right)^2$$

So, only option (3) is correct.

28. Determining the refractive index of a glass slab with the help of a travelling microscope requires the readings

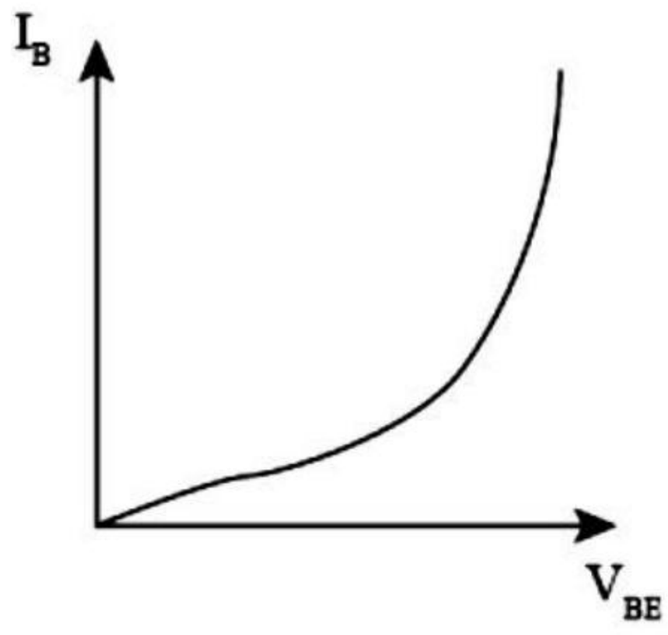
(1). without glass slab

(2). with glass slab

(3). with saw dust

Hence, the correct option is (2).

29. The following figure shows the input characteristics graph for the common emitter configuration,



Here,

$$\frac{20}{3}\Omega$$

Hence, the correct option is (1).

30. The ratio $0.1\,\text{cm}$ is given by,

$$P = a^{1/2}b^2c^3d^{-4}$$

Typically, the value of is approximately

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\frac{\Delta a}{a}\right) + \left(2\frac{\Delta b}{b}\right) + \left(3\frac{\Delta c}{c}\right) + \left(4\frac{\Delta d}{d}\right)\right] \times 100\,\%.$$

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\times 2\right) + (2\times 1) + (3\times 3) + (4\times 5)\right]\%$$

Therefore, $= [1+2+9+20]\,\%$ usually adopt a value of the

$= 32\,\%$

order of 100 to 1000 or $32\,\%$.

31. The volume of 0.1N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of OH^- in aqueous solution is :

(1) 200 mL

(2) 400 mL

(3) 600 mL

(4) 800 mL

32. Initially, the *root mean square (rms)* velocity of N_2 molecules at certain temperature is u. If this temperature is doubled and all the nitrogen molecules dissociate into nitrogen atoms, then the new *rms* velocity will be :

(1) u / 2

(2) $2u$

(3) $4u$

(4) $14u$

33. Aqueous solution of which salt will not contain ions with the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6$?

(1) NaF

(2) NaCl

(3) KBr

(4) CaI_2

34. The bond angle H-X-H is the greatest in the compound :

(1) CH_4

(2) NH_3

(3) H_2O

(4) PH_3

35. If 100 mole of H_2O_2 decompose at 1 bar and 300 K, the work done (kJ) by one mole of $O_2(g)$ as it expands against 1 bar pressure is :

$$2H_2O_2(l) \rightleftharpoons 2H_2O(l) + O^2(g)$$

$$(R = 8.3\ JK^{-1}\ mol^{-1})$$

(1) 62.25

(2) 124.50

(3) 249.00

(4) 498.00

36. An aqueous solution of a salt MX_2 at certain temperature has a van't Hoff factor of 2. The degree of dissociation for this solution of the salt is :

(1) 0.33

(2) 0.50

(3) 0.67

(4) 0.80

37. A solid XY kept in an evacuated sealed container undergoes decomposition to form a mixture of gases X and Y at temperature T. The equilibrium pressure is 10 bar in this vessel. K_p for this reaction is :

(1) 5

(2) 10

(3) 25

(4) 100

38. Oxidation of succinate ion produces ethylene and carbon dioxide gases. On passing 0.2 Faraday electricity through an aqueous solution of potassium succinate, the total volume of gases (at both cathode and anode) at STP (1 atm and 273 K) is :

(1) 2.24 L

(2) 4.48 L

(3) 6.72 L

(4) 8.96 L

39. The rate law for the reaction below is given by the expression $k[A][B]$

$A+B \rightarrow$ Product

If the concentration of B is increased from 0.1 to 0.3 mole, keeping the value of A at 0.1 mole, the rate constant will be :

(1) k

(2) $k/3$

(3) $3k$

(4) $9k$

40. Gold numbers of some colloids are : Gelatin : 0.005 - 0.01, Gum Arabic : 0.15 - 0.25; Oleate : 0.04 - 1.0; Starch : 15 - 25. Which among these is a better protective colloid ?

(1) Gelatin

(2) Gum Arabic

(3) Oleate

(4) Strach

41. The following statements concern elements in the periodic table. Which of the following is true?

(1) All the elements in Group 17 are gases.

(2) The Group 13 elements are all metals.

(3) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.

(4) For Group 15 elements, the stability of +5 oxidation state increases down the group.

42. Extraction of copper by smelting uses silica as an additive to remove :

(1) Cu_2S

(2) FeO

(3) FeS

(4) Cu_2O

43. Identify the reaction which does not liberate hydrogen:

(1) Reaction of zinc with aqueous alkali

(2) Electrolysis of acidified water using Pt electrodes.

(3) Allowing a solution of sodium in liquid ammonia to stand.

(4) Reaction of lithium hydride with B_2H_6.

44. The commercial name for calcium oxide is : (1) (2) (3) Limestone (4)

(1) Milk of lime

(2) Slaked lime

(3) Limestone

(4) Quick lime

45. **Assertion**: Among the carbon allotropes, diamond is an insulator, whereas, graphite is a good conductor of electricity.
Reason: Hybridization of carbon in diamond and graphite are sp^3 and sp^2, respectively.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion.

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect statement, but the reason is correct.

(4) Both assertion and reason are incorrect.

46. Identify the incorrect statement:

(1) S_2 is paramagnetic like oxygen.

(2) Rhombic and monoclinic sulphur have S_8 molecules.

(3) S_8 ring has a crown shape.

(4) The S-S-S bond angles in the S_8 and S_6 rings are the same.

47. Identify the correct statement:

(1) Iron corrodes in oxygen-free water.

(2) Iron corrodes more rapidly in salt water because its electrochemical potential is higher.

(3) Corrosion of iron can be minimized by forming a contact with another metal with a higher reduction potential.

(4) Corrosion of iron can be minimized by forming an impermeable barrier at its surface

48. Which of the following is an example of homoleptic complex ?

(1) $[Co(NH_3)_6]Cl_3$

(2) $[Pt(NH_3)_2]Cl_2$

(3) $[Co(NH_3)_4]Cl_2$

(4) $[Co(NH_3)_5Cl]Cl_3$

49. The transition metal ions responsible for color in ruby and emerald are, respectively :

(1) Cr^{3+} and Co^{3+}

(2) Co^{3+} and Cr^{3+}

(3) Co^{3+} and Co^{3+}

(4) Cr^{3+} and Cr^{3+}

50. Which one of the following substances used in dry cleaning is a better strategy to control environmental pollution?

(1) Tetrachloroethylene

(2) Carbon dioxide

(3) Sulphur dioxide

(4) Nitrogen dioxide

51. Sodium extract is heated with concentrated HNO_3 before testing for halogens because :

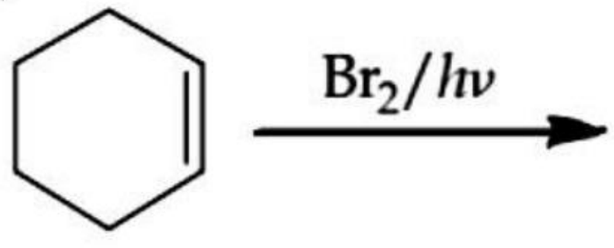
(1) Silver halides are totally insoluble in nitric acid.

(2) Ag_2S and AgCN are soluble in acidic medium.

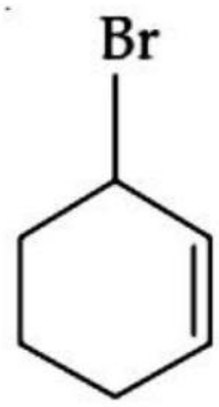
(3) S^{2-} and CN^-, if present, are decomposed by conc. HNO_3 and hence do not interfere in the test.

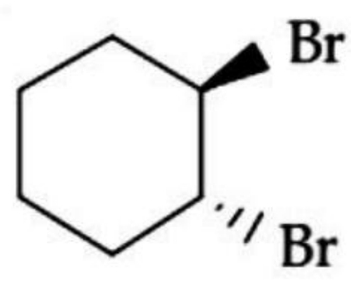
(4) Ag reacts faster with halides in acidic medium.

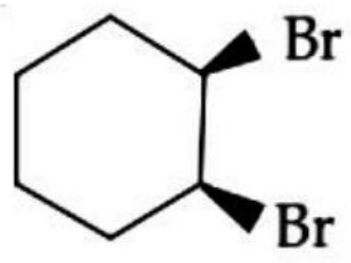
52. Bromination of cyclohexene under conditions given below yields :



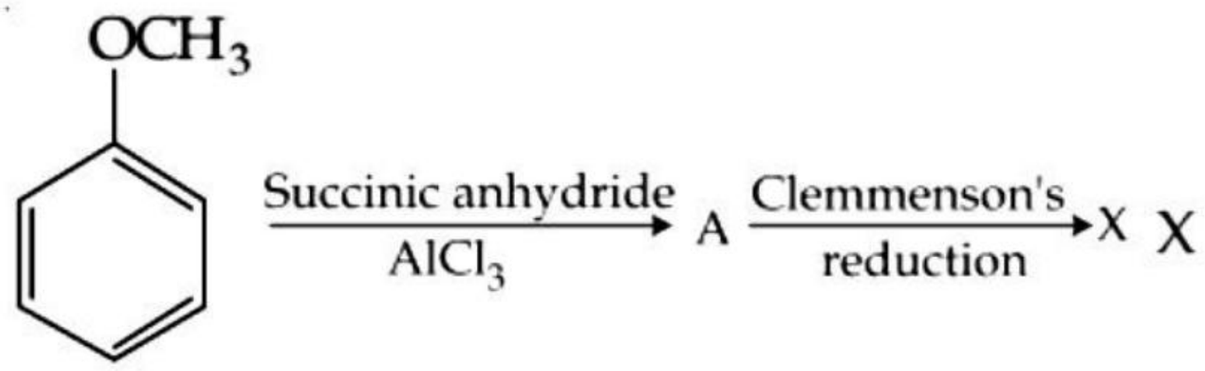
(1) 

(2) 

(3) 

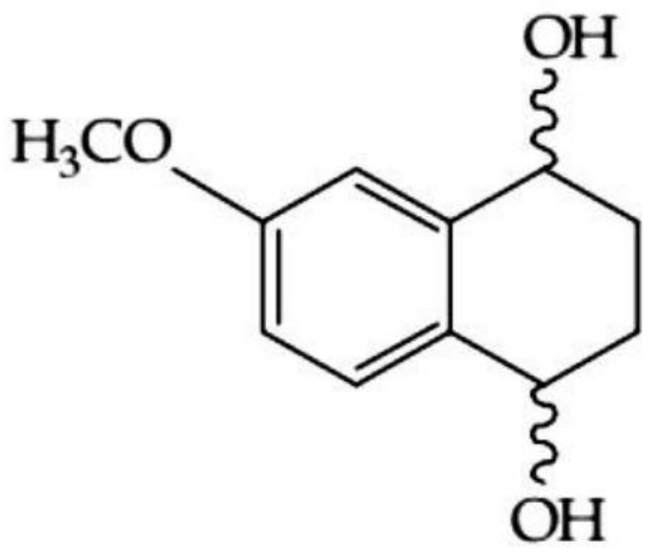
(4) 

53. Consider the reaction sequence below :

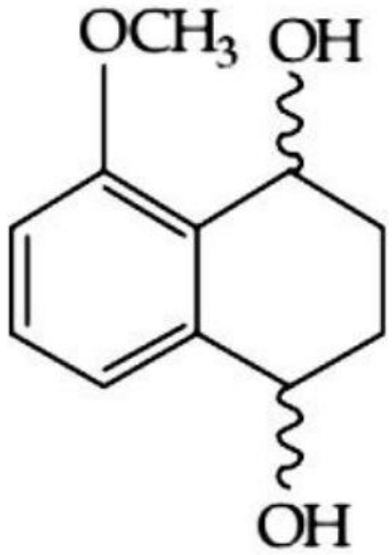


is:

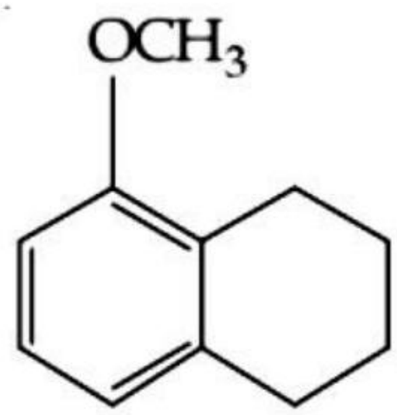
(1)

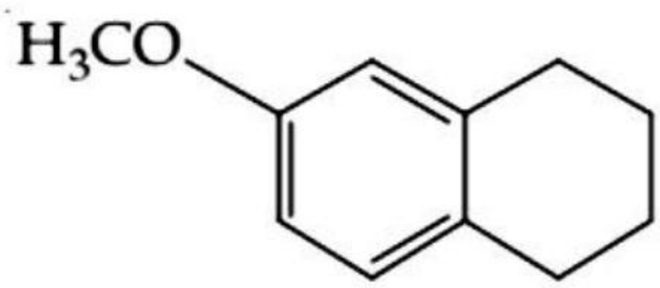


(2)

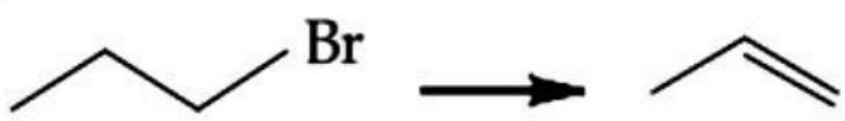


(3)



(4) 

54. Which one of the following reagents is not suitable for the elimination reaction?



(1) $NaOH/H_2O$

(2) NaOEt/EtOH

(3) $NaOH/H_2O$-EtOH

(4) NaI

55. The correct statement about the synthesis of erythritol ($C(CH_2OH)_4$) used in the preparation of PETN is:

(1) The synthesis requires four aldol condensations between methanol and ethanol.

(2) The synthesis requires two aldol condensations and two Cannizzaro reactions.

(3) The synthesis requires three aldol condensations and one Cannizzaro reaction.

(4) Alpha hydrogens of ethanol and methanol are involved in this reaction.

56. Fluorination of an aromatic ring is easily accomplished by treating a diazonium salt with HBF_4. Which of the following conditions is correct about this reaction?

(1) Only heat

(2) $NaNO_2/Cu$

(3) $Cu_2O/H2O$

(4) NaF/Cu

57. Which of the following polymers is synthesized using a free radical polymerization technique ?

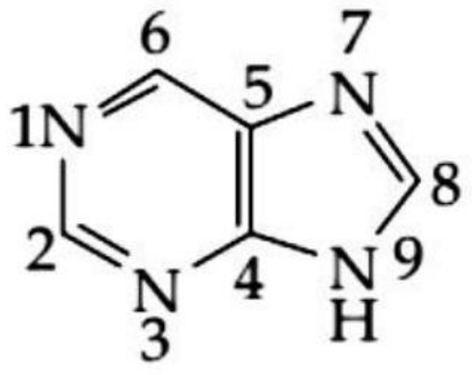
(1) Teflon

(2) Terylene

(3) Melamine polymer

(4) Nylon 6,6

58. The "N" which does not contribute to the basicity for the compound is :



(1) N 7

(2) N 9

(3) N 1

(4) N 3

59. Which of the following is a bactericidal antibiotic ?

(1) Erythromycin

(2) Tetracycline

(3) Chloramphenicol

(4) Ofloxacin

60. Observation of "Rhumann's purple" is a confirmatory test for the presence of:

(1) Reducing sugar

(2) Cupric ion

(3) Protein

(4) Starch

PART-2

31. The law of equivalence states that the equivalence of acid is equal to the equivalence of base.

$$s = ut + \frac{1}{2}at^2$$

Therefore, the volume required is calculated as,

$$s = (0)t + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

32. The root mean square velocity for nitrogen initially is calculated as,

$$(d + 200)$$

The dissociation of all the nitrogen molecules into nitrogen atoms results in the new root mean square velocity, that is,

$$t = \sqrt{\frac{2d}{2}}$$

33. The ions $(d+200)$ and $t = \sqrt{\frac{2(d+200)}{4}}$ are the ones that are

$$\sqrt{\frac{2d}{2}} = \sqrt{\frac{2(d+200)}{4}}$$

present in $d = \frac{(d+200)}{2}$ compound.

$$d = 200\ m$$

The ion $t = \sqrt{\frac{2(200\ m)}{2}}$ has an electronic configuration of

$$= 10\sqrt{2}\ s$$

$10\sqrt{2}$ s.

The ion M′ has an electronic configuration of υ′.

Therefore, configuration of sodium and fluoride ion does not match with the configuration given in the question.

$$2M'\upsilon'\sin\theta = M\upsilon\cos 45° + M\upsilon\cos 30°$$

$$2M'\upsilon'\sin\theta = \frac{M\upsilon}{\sqrt{2}} + \frac{\sqrt{3}M\upsilon}{2}$$

34. In case of $2M'\upsilon'\sin\theta = M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)$, the bond angle

$$2M'\upsilon'\cos\theta = -M\upsilon\sin 45° + M\upsilon\sin 30°$$

$$2M'\upsilon'\cos\theta = -\frac{M\upsilon}{\sqrt{2}} + \frac{M\upsilon}{2}$$

has a value of $2M'\upsilon'\cos\theta = M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)$. While for

$$\frac{2M'\upsilon'\sin\theta}{2M'\upsilon'\cos\theta}=\frac{M\upsilon\left(\frac{1}{\sqrt{2}}+\frac{\sqrt{3}}{2}\right)}{M\upsilon\left(-\frac{1}{\sqrt{2}}+\frac{1}{2}\right)}$$

$$\tan\theta=\frac{\left(\frac{\sqrt{2}+\sqrt{3}}{2}\right)}{\left(\frac{1-\sqrt{2}}{2}\right)}$$, θ, and $\tan\theta=\frac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}}$, the bond

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

angles are ΔPQR, $h=\sqrt{l^2-\left(\frac{x}{2}\right)^2}$, and $v=\frac{dh}{dt}$ respectively.

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

35. The decomposition of $\frac{dh}{dt}$ is given by,

$$\frac{dh}{dt} = \frac{d}{dt}\left(\frac{1}{2}\sqrt{4-x^2}\right)$$

$$= \frac{1}{2}\frac{d}{dx}\left(\frac{1}{2}\sqrt{4-x^2}\right)\frac{dx}{dt}$$

$$= \frac{1}{4}\left(\frac{1}{\sqrt{4-x^2}}\right)(-2x)\frac{dx}{dt}$$

$$= -\frac{x}{2\sqrt{4-x^2}}\frac{dx}{dt}$$

From the given data, $\frac{dh}{dt} = -\frac{1}{2\sqrt{\frac{4}{x^2}-1}}\frac{dx}{dt}$ of $\sqrt{\frac{4}{x^2}-1}$ on decomposition gives $\sqrt{\frac{4}{x^2}-1}$ of $\frac{dh}{dt}$.

Thus, the work done by one mole of oxygen is calculated as,

$$T\cos\theta = mg$$

Therefore, the word done by oxygen gas is $T\sin\theta = \frac{mv^2}{r}$.

36. The decomposition of $\tan\theta = \frac{v^2}{rg}$ is given by,

$$\tan 45^\circ = \frac{v^2}{(0.4\,\text{m})(10\,\text{ms}^{-2})}$$

$$v^2 = 4\,\text{m}^2\text{s}^{-2}$$

$$v = \sqrt{4\,\text{m}^2\text{s}^{-2}}$$

$$v = 2\,\text{ms}^{-1}$$

Therefore, the total number of particles after dissociation is calculated as,

$2\,\text{ms}^{-1}$

The number of particles before dissociation is $I_{disc} = \frac{MR^2}{2}$.

The expression to calculate the Van't Hoff factor is given by,

$$I_{removed} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right) + \left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

$$= \frac{MR^2 + 18MR^2}{512}$$

$$= \frac{19MR^2}{512}$$

Therefore, for the given solution the degree of dissociation is calculated as,

NaI

37. The solid NaI undergoes a decomposition as follows:

$$CH_3CH_2CH_2Br + NaI \rightarrow CH_3CH_2CH_2I$$

Therefore, the total pressure is calculated as,

$$\tan 45° = \frac{v^2}{(0.4\,\text{m})(10\,\text{ms}^{-2})}$$

$$v^2 = 4\,\text{m}^2\text{s}^{-2}$$

$$v = \sqrt{4\,\text{m}^2\text{s}^{-2}}$$

$$v = 2\,\text{ms}^{-1}$$

Thus, the pressure $2\,\text{ms}^{-1}$ is calculated as,

$$I_{disc} = \frac{MR^2}{2}$$

$$I_{removed} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right) + \left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

Therefore, the value of $= \frac{MR^2 + 18MR^2}{512}$ for

$$= \frac{19MR^2}{512}$$

the given reaction is calculated as,

$$I_{remaining} = \frac{MR^2}{2} - \frac{19MR^2}{512}$$

$$= \frac{237MR^2}{512}$$

38. Ethylene and carbon dioxide gases is evolved during the oxidation of succinate ion.

The ideal gas equation is given by,

$$\frac{237MR^2}{512}$$

Rewrite the above formula.

$$\rho = \frac{m}{v} = \frac{k}{r}$$

Substitute all the values in the above formula.

$$m = \frac{kv}{r}$$

39. With the change in the concentration, the rate of reaction changes, whereas, the rate constant remains same. Thus, the rate constant for the given reaction is

$$g_{inside} = \frac{Gmr}{R^3}$$

$$= \left(\frac{Gr}{R^3}\right)\left(\frac{kv}{r}\right).$$

$$= \frac{Gkv}{R^3}$$

40. The relation between gold number and protective power is given by,

$$\frac{Gkv}{R^3}$$

This implies that gelatin proves to be the better protective colloid among all the given colloids.

41. The group $g_{out} = \frac{Gm}{r^2}$ elements have ionization energy that is much higher than that of the elements if group $F = Y\alpha_L A\Delta t$ as

$$F = \left(2\times10^{11}\ Nm^{-2}\right)\left(1.2\times10^{-5}\ K^{-1}\right)\left(40\times10^{-4}\ m^2\right)(10)$$

the group $= 9.6\times10^4\ N$

$= 1\times10^5\ N$

elements have half-filled configuration.

42. The reaction involved in the smelting process is given by,

$$Q = \frac{\pi r^4}{8\eta}\frac{\Delta P}{L}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{P_2 r_2^4}{l_2}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{4P_1 r_2^4}{\frac{I_1}{4}}$$

In this process, forms the flux and $u_{initial} = \frac{5}{2}NRT$

$$r_2^4 = \frac{r_1^4}{16}$$

$$r_2 = \frac{r_1}{2}$$

forms the gangue which results in the formation of

$$u_{final} = \frac{3}{2}(2nRT) + \frac{5}{2}(N\text{-}n)RT$$

$$= \frac{1}{2}nRT + \frac{5}{2}NRT$$

$$U_{total} = \frac{1}{2}nRT + \frac{5}{2}NRT - \frac{5}{2}NRT$$

43. Lithium hydride reacts with

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

and the reaction is expressed as follows,

$$a = a_0 e^{\frac{-bt}{m}}$$

The above reaction proves that the liberation of hydrogen gas is not possible.

44. Calcium oxide has the chemical formula $\begin{matrix} E \propto a^2 \\ a \propto E \end{matrix}$ and is commercially called quick lime.

45. Diamond has carbon atoms that are bonded via a covalent bond to four other carbon atoms in a tetrahedral manner. The hybridization of carbon atom in diamond is $\begin{matrix} a = \frac{a_0}{\sqrt{2}} = \frac{bt}{m} \\ \frac{a_0}{\sqrt{2}} = \frac{bt}{m} \\ = \frac{10^{-2}t}{0.1} \\ = \frac{t}{10} \end{matrix}$. In diamond, carbon utilizes its unpaired electrons in the formation of the bond. Therefore, it is a poor conductor of electricity.

A trigonal geometry is obtained when a carbon atom in graphite is bonded via a covalent bond to three other carbon atoms. The

hybridization of carbon atom in graphite is $\frac{a_0}{\sqrt{2}} = a_0 e^{-\frac{t}{10}}$ $\frac{1}{\sqrt{2}} = e^{-\frac{t}{10}}$. In

$$\ln\sqrt{2} = \frac{t}{10}$$

$$t = 3.5 \text{ sec}$$

graphite, the three unpaired electrons of carbon is utilized in the formation of the bond. Therefore, it is a good conductor of electricity.

46. The statement "The $v = \frac{\omega}{k}$ bond angle in the $v = \frac{200\pi}{\left(\frac{5\pi}{4}\right)}$ and

$= 160 \text{ m/s}$

$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$ rings are the same." is incorrect.

Both $C = \frac{\varepsilon_0 A}{3}$ and $C = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$ molecule have the same

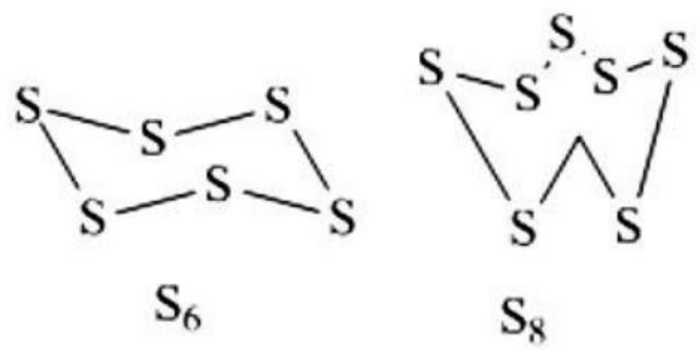
bond length but different bond angles. The

$$\frac{\varepsilon_0 A}{3} = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

$3k = 2.4k + 3$ molecule has a puckered ring with crown

$k = 5$

conformation, whereas $\frac{(A-C)}{D}$ molecule has a chair conformation as shown below.



S_6 S_8

47. The statement "corrosion of iron can be minimized by forming an impermeable barrier at its surface." is correct.

48. Those complexes that contain only one type of ligand that are bound to the central metal atom are termed as Homoleptic complexes. Therefore, the complex MnR^2t is a homoleptic complex that has six ammonia ligands bound to the central metal atom cobalt.

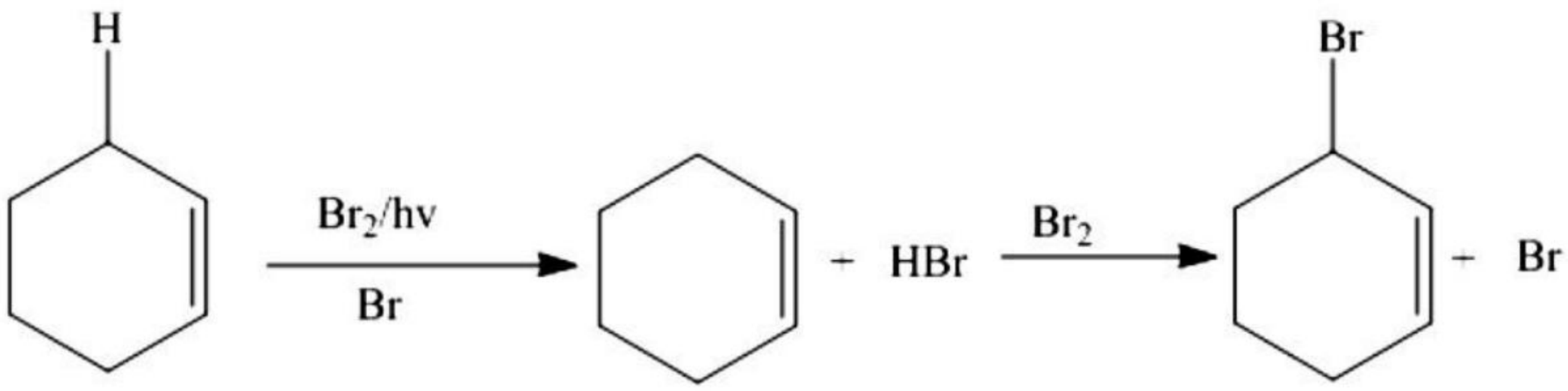
49. The transition metal ions $-4500\ J$ is responsible for color in ruby and emerald.

Aluminum oxide is also known as ruby. It consists of chromium ions. Each aluminum and chromium ion is surrounded by six oxide ions in an octahedral manner. Emerald is composed of beryllium aluminum silicate in which chromium ions is surrounded by six silicate ions. Thus, in both the cases, chromium is responsible for color.

50. The use of carbon dioxide in dry cleaning does not increase environmental pollution and thus is considered as a better strategy to control environmental pollution. On the other hand, the substances such as tetrachloroethylene, sulfur dioxide and nitrogen dioxide on being used in dry cleaning, pollute the environment because of which their use is not a better strategy. Thus, carbon dioxide is the substance which can be used in dry cleaning to control environmental pollution.

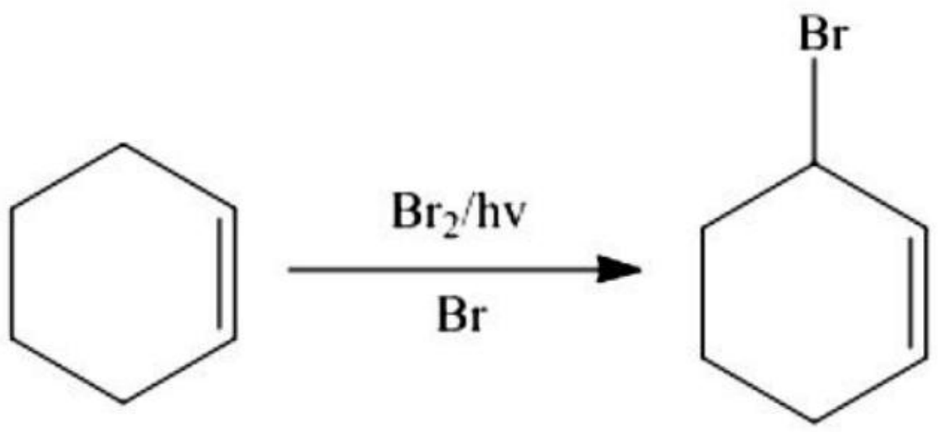
51. Sodium cyanide or sodium sulphide is formed during the fusion process and they interfere with the testing of halogens. In order to prevent this, nitric acid is used to decompose both sodium cyanide or sodium sulphide.

52. The given reaction follows the mechanism as shown below.

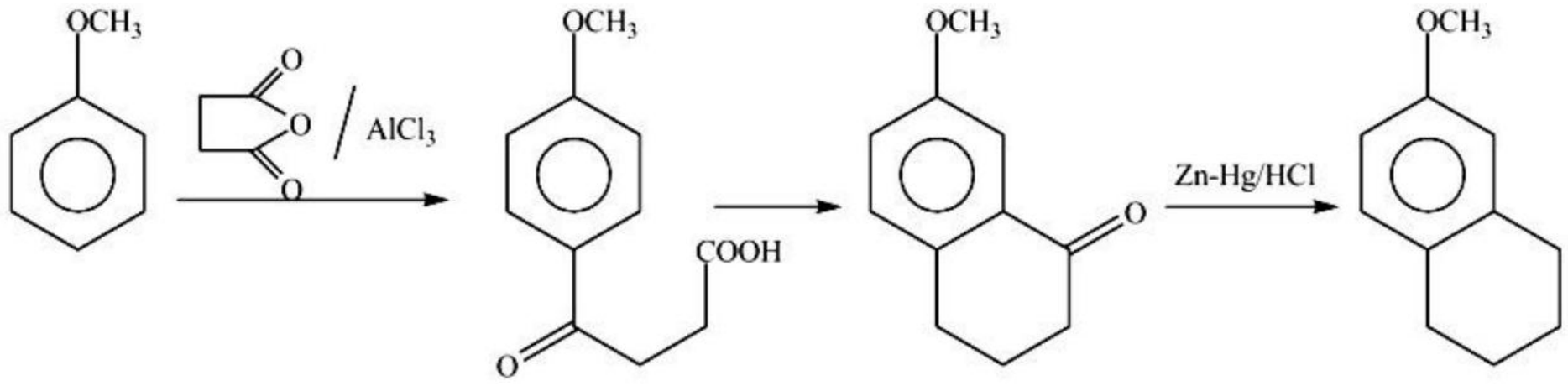


This reaction undergoes free radical substitution.

In case of bromination of cyclohexene in the presence of light, the product formed is shown below.



53. The complete sequence of reaction is given below.



A X

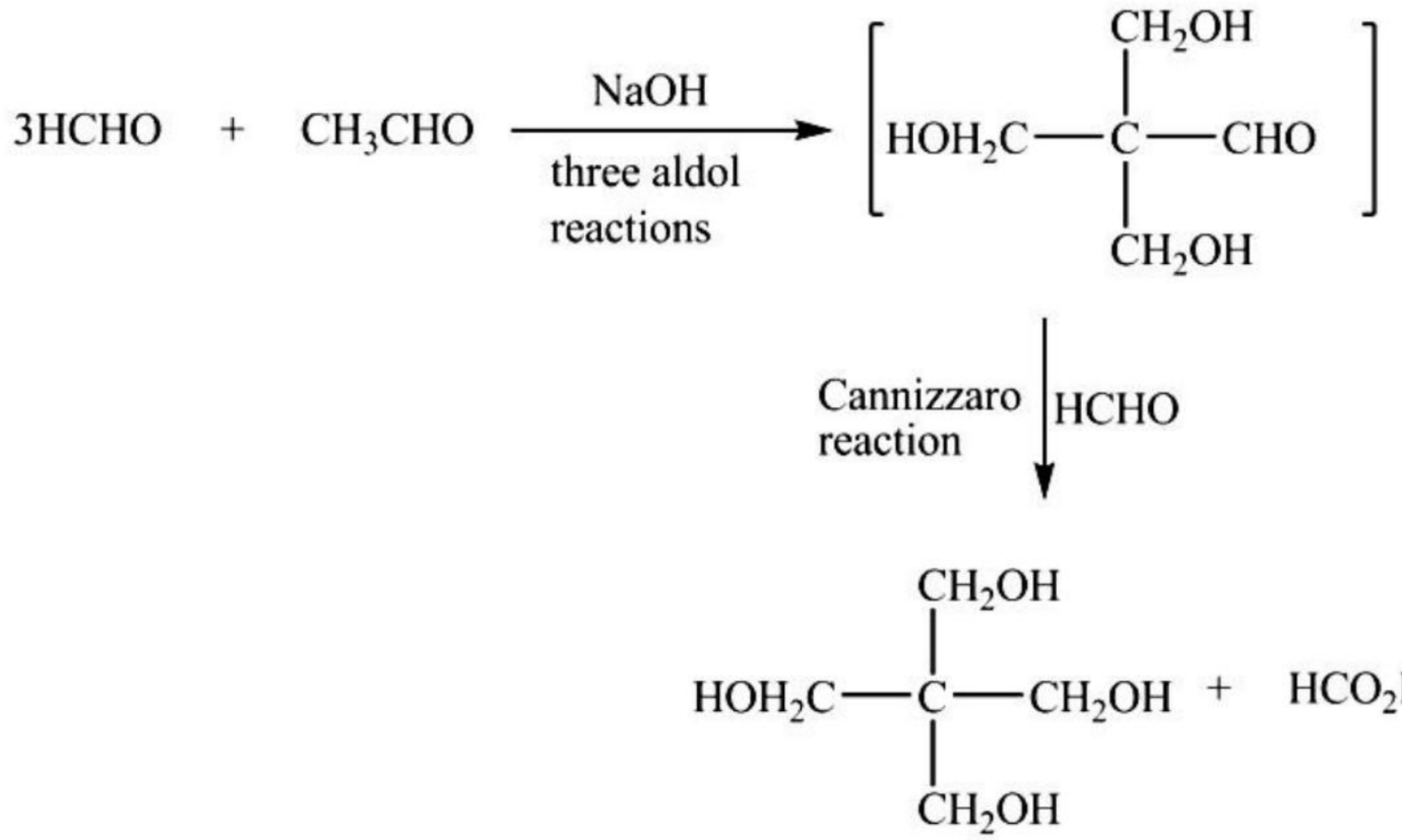
54. The given conversion is carried out in the absence of 1.37.

Bromopropane reacts with $F_G = \frac{GMm}{(R+h)^2}$ and yields

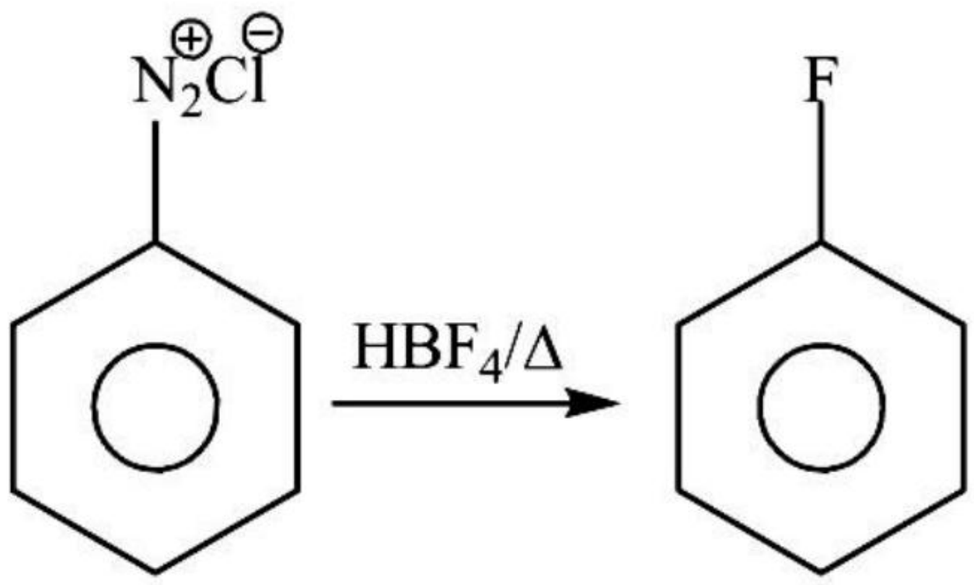
iodopropane.

$(4\pi\mu Bb)\Delta n$

55. The synthesis of erythritol 1.67×10^5 J involves first three aldol reactions between formaldehyde and acetaldehyde and then one Cannizzaro reaction with formaldehyde. It can be expressed as,

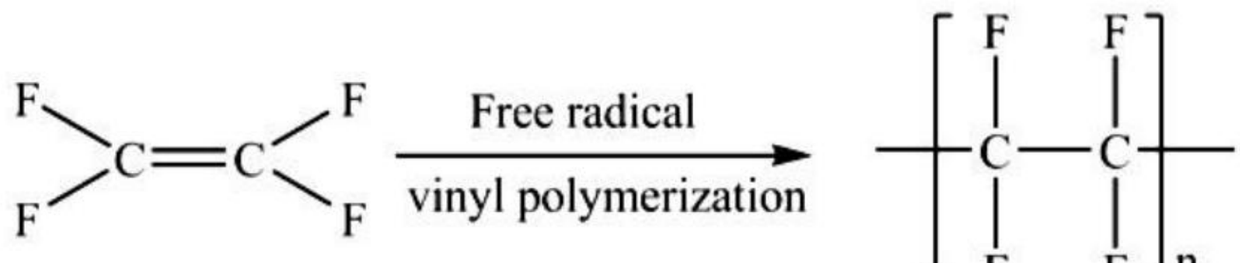


56. An aromatic ring undergoes fluorination reaction under the following reaction.



Heat is necessary for the reaction to take place. Thus, the first condition is correct for the given reaction.

57. The free radical polymerization of tetrafluoroethylene synthesizes Teflon. This polymerization is a type of vinyl polymerization and proceeds via free radical mechanism.



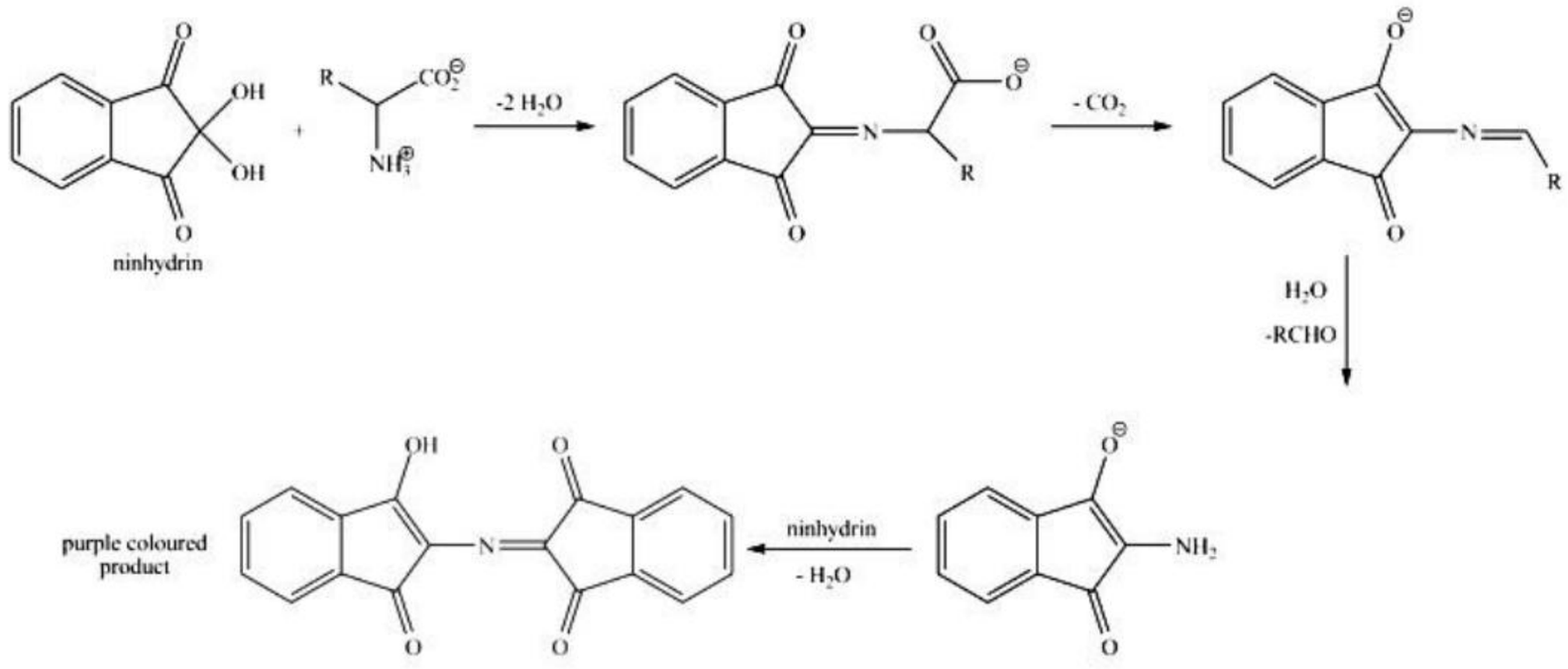
Tetrafluoroethylene Teflon

Thus, out of all the given polymers, Teflon is the only polymer which is synthesized using free radical polymerization.

58. Nitrogen number 1.9 Hz has a lone pair of electrons which is involved in the resonance and is thus involved in basicity also.

59. Ofloxacin is a bactericidal antibiotic. On the other hand, erythromycin, tetracycline and chloramphenicol are bacteriostatic antibiotic.

60. The Ninhydrin test helps in detecting the presence of 170 Hz.



The purple colored product is also known as “Rhumann’s purple”.

IIT JEE MAINS 2016 10TH APRIL 2016
MATHEMATICS

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61. Let $P = \{\theta : \sin\theta - \cos\theta = \sqrt{2}\cos\theta\}$ and

$Q = \{\theta : \sin\theta + \cos\theta = \sqrt{2}\sin\theta\}$ be two sets. Then:

(1) $P \subset Q$ and $Q - P \neq \phi$

(2) $Q \not\subset P$

(3) $P \not\subset Q$

(4) $P = Q$

62. If x is a solution of the equation, $\sqrt{2x+1} - \sqrt{2x-1} = 1, \left(x \geq \frac{1}{2}\right)$,

then $\sqrt{4x^2 - 1}$ is equal to:

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

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

(3) 2

(4) $2\sqrt{2}$

63. Let $z = 1 + ai$ be a complex number, $a > 0$, such that z^3 is a real number. Then the sum $1+z+z^2+.....+z^{11}$ is equal to :

(1) $-1250\sqrt{3}i$

(2) $1250\sqrt{3}i$

(3) $1365\sqrt{3}i$

(4) $-1365\sqrt{3}i$

64. Let A be a 3×3 matrix such that $A^2-5A+7I=O$.

Statement –I: $A^{-1} = \frac{1}{7}(5I - A)$

Statement –II: The polynomial $A^3 - 2A^2 - 3A + I$ can be reduced to $5(A - 4I)$.

Then

(1) Statement-I is true, but Statement-II is false.

(2) Statement-I is false, but Statement-II is true.

(3) Both the statements are true.

(4) Both the statements are false.

65. If $A = \begin{bmatrix} -4 & -1 \\ 3 & 1 \end{bmatrix}$, then the determinant of the matrix $(A^{2016} - 2A^{2015} - A^{2014})$ is:

(1) 2014

(2) -175

(3) 2016

(4) -25

66. If $\frac{^{n+2}C_6}{^{n-2}C_6} = 11$, then n satisfies the equation:

(1) $n^2 + 3n - 108 = 0$

(2) $n^2 + 5n - 84 = 0$

(3) $n^2 + 2n - 80 = 0$

(4) $n^2 + n - 110 = 0$

67. If the coefficients of x^{-2} and x^{-4} in the expansion of $\left(x^{\frac{1}{3}} + \frac{1}{2x^{\frac{1}{3}}}\right)^{18}, (x > 0)$, are m and n respectively, then $\frac{m}{n}$ is equal to:

(1) 182

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

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

(4) 27

68. Let $a_1, a_2, a_3, \ldots\ldots, a_n, \ldots\ldots$ be in A.P. If $a_3 + a_7 + a_{11} + a_{15} = 72$, then the sum of its first 17 terms is equal to :

(1) 306

(2) 153

(3) 612

(4) 204

69. The sum $\sum_{r=1}^{10}\left(r^2+1\right)\times(r!)$ is equal to:

(1) (11)!

(2) $10\times(11!)$

(3) $101\times(10!)$

(4) $11\times(11!)$

70. $\lim\limits_{x\to 0}\dfrac{(1-\cos 2x)^2}{2x\tan x - x\tan 2x}$ is:

(1) -2

(2) $-\dfrac{1}{2}$

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

(4) 2

71. Leta, b $\in$ R, $(a \neq 0)$. If the function f defined as

$$f(x)=\begin{cases}\dfrac{2x^2}{a} & ,0 \le x \le 1\\ a & ,1 \le x < \sqrt{2}\\ \dfrac{2b^2-4b}{x^3} & ,\sqrt{2} \le x < \infty\end{cases}$$

Is continuous in the interval $[0,\infty)$, then an ordered pir (a,b) is:

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

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

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

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

72. Let $f(x)=\sin^4 x+\cos^4 x$. Then f is an increasing function in the interval :

(1) $\left]0,\frac{\pi}{4}\right[$

(2) $\left]\frac{\pi}{4},\frac{\pi}{2}\right[$

(3) $\left]\frac{\pi}{2},\frac{5\pi}{8}\right[$

(4) $\left]\frac{5\pi}{8},\frac{3\pi}{4}\right[$

73. Let C be a curve given by $y(x)=1+\sqrt{4x-3}, x>\frac{3}{4}$. If P is a point on C, such that the tangent at P has lope $\frac{2}{3}$, then a point through which the normal at P passes, is:

(1) (2,3)

(2) (4,-3)

(3) (1,7)

(4) (3,-4)

74. The inegeral $\int\frac{dx}{(1+\sqrt{x})\sqrt{x-x^2}}$ is equal to:

(where C is a constant of integration.)

(1) $-2\sqrt{\frac{1+\sqrt{x}}{1-\sqrt{x}}}+C$

(2) $-2\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}+C$

(3) $-\sqrt{\frac{1-\sqrt{x}}{1+\sqrt{x}}}+C$

(4) $2\sqrt{\frac{1+\sqrt{x}}{1-\sqrt{x}}}+C$

75. The value of the integral $\int_4^{10}\frac{\left[x^2\right]dx}{\left[x^2-28x+196\right]+\left[x^2\right]}$, where $[x]$ denotes the greatest integer less than or equal to x, is :

(1) 6

(2) 3

(3) 7

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

76. For $x\in R,\ x\neq 0$, if $y(x)$ is a differentiable function such that $x\int_1^x y(t)dt=(x+1)\int_1^x ty(t)dt$, then $y(x)$ equals:

(where C is a constant.)

(1) $\frac{C}{x}e^{-\frac{1}{x}}$

(2) $\frac{C}{x^2}e^{-\frac{1}{x}}$

(3) $\frac{C}{x^3}e^{-\frac{1}{x}}$

(4) $Cx^3e^{-\frac{1}{x}}$

77. The solution of the differential equation $\frac{dy}{dx}+\frac{y}{2}\sec x=\frac{\tan x}{2y}$, where $0\le x\le\frac{\pi}{2}$, and $y(0)=1$, is given by:

(1) $y=1-\frac{x}{\sec x+\tan x}$

(2) $y^2=1+\frac{x}{\sec x+\tan x}$

(3) $y^2=1-\frac{x}{\sec x+\tan x}$

(4) $y=1+\frac{x}{\sec x+\tan x}$

78. A ray of light is incident along a line which meets another line, $7x-y+1=0$, at the point (0, 1). The ray is then reflected from this point along the line, $y+2x=1$. Then the equation of the line of incidence of the ray of light is :

(1) $41x-38y+38=0$

(2) $41x-25y+25=0$

(3) $41x+38y-38=0$

(4) $41x-25y+25=0$

79. A straight line through origin O meets the lines $3y=10-4x$ and $8x+6y+5=0$ at points A and B respectively. Then O divides the segment AB in the ratio :

(1) 2:3

(2) 1:2

(3) 4:1

(4) 3:4

80. Equation of the tangent to the circle, at the point (1, −1), whose centre is the point of intersection of the straight lines $x-y=1$ and $2x+y=3$ is :

(1) $4x+y-3=0$

(2) $x + 4y+3=0$

(3) $3x- y-4=0$

(4) $x- 3y -4=0$

81. P and Q are two distinct points on the parabola, $y^2=4x$, with parameters t and t_1 respectively. If the normal at P passes through Q, then the minimum value of t_1^2 is :

(1) 2

(2) 4

(3) 6

(4) 8

82. A hyperbola whose transverse axis is along the major axis of the conic, $2\frac{x^2}{3}+\frac{y^2}{4}=4$ and has vertices at the foci of this conic. If the eccentricity of the hyperbola is $\frac{3}{2}$, then which of the following points does NOT lie on it ?

(1) (0,2)

(2) $\left(\sqrt{5},2\sqrt{2}\right)$

(3) $\left(\sqrt{10},2\sqrt{3}\right)$

(4) $\left(5, 2\sqrt{3}\right)$

83. ABC is a triangle in a plane with vertices A(2, 3, 5), B(−1, 3, 2) and C(λ, 5, μ). If the median through A is equally inclined to the coordinate axes, then the value of ($\lambda^3+\mu^3+5$) is :

(1) 1130

(2) 1348

(3) 676

(4) 1077

84. The number of distinct real values of λ for which the lines $\frac{x-1}{1}=\frac{y-2}{2}=\frac{z-3}{\lambda^2}$ and $\frac{x-3}{1}=\frac{y-2}{\lambda^2}=\frac{z-1}{2}$ are coplanar is:

(1) 4

(2) 1

(3) 2

(4) 3

85. Let ABC be a triangle whose circumcentre is at P. If the position vectors of A, B, C and P are $\vec{a}, \vec{b}, \vec{c}$ and $\frac{\vec{a}+\vec{b}+\vec{c}}{4}$ respectively, then the position vector of the orthocentre of this triangle, is :

(1) $\vec{a}+\vec{b}+\vec{c}$

(2) $-\left(\frac{\vec{a}+\vec{b}+\vec{c}}{2}\right)$

(3) $\vec{0}$

(4) $\left(\frac{\vec{a}+\vec{b}+\vec{c}}{2}\right)$

86. The mean of 5 observations is 5 and their variance is 124. If three of the observations are 1, 2 and 6 ; then the mean deviation from the mean of the data is :

(1) 2.4

(2) 2.8

(3) 2.5

(4) 2.6

87. An experiment succeeds twice as often as it fails. The probability of at least 5 successes in the six trials of this experiment is :

(1) $\frac{240}{729}$

(2) $\frac{192}{729}$

(3) $\frac{256}{729}$

(4) $\frac{496}{729}$

88. If $A>0$, $B>0$ and $A+B=\frac{\pi}{6}$, then the minimum value of tanA+tanB is :

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

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

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

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

89. The angle of elevation of the top of a vertical tower from a point A, due east of it is 45°. The angle of elevation of the top of the same tower from a point B, due south of A is 30°. If the distance between A and B is $54\sqrt{2}$ m , then the height of the tower (in metres), is :

(1) $36\sqrt{3}$

(2) 54

(3) $54\sqrt{3}$

(4) 108

90. The contrapositive of the following statement,

"If the side of a square doubles, then its area increases four times", is:

(1) If the side of a square is not doubled, then its area does not increase four times.

(2) If the area of a square increases four times, then its side is doubled.

(3) If the area of a square increases four times, then its side is not doubled.

(4) If the area of a square does not increase four times, then its side is not doubled.

PART-2

61. Solve for the set P as follows,

$$\rho(r) \propto \frac{1}{r}$$

Solve for the set Q as follows,

$$\frac{32}{23}\mu F$$

Therefore, both the sets are equal to each other.

62. The given equation is as follows,

$$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$$

Rewrite the above equation and square both the sides.

$400\,\Omega$

Solve for $P_2 > P_1 > P_3$ at $7\,\Omega$ and $45°$.

$\frac{2E_0}{c}\hat{j}\cos kz\cos \omega t$

63. The value of 27.5 cm is calculated as,

9 mm

It is given that the variable 10^{20} is a real number. Thus, the imaginary part of $\frac{h^2}{4\pi m^2 r^3}$ will be zero.

4×10^{-2} gm

The complex number is written as follows,

6.9 mA

The sum of given geometric series is,

$\lambda, P_{eff} = K\left(\frac{1}{\lambda}\right)^2$

$$\frac{20}{3}\Omega$$

Further, substitute the above expression,

$0.1\,\text{cm}$

$$P = a^{1/2}b^2c^3d^{-4}$$

Therefore, the required value is,

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\frac{\Delta a}{a}\right)+\left(2\frac{\Delta b}{b}\right)+\left(3\frac{\Delta c}{c}\right)+\left(4\frac{\Delta d}{d}\right)\right]\times 100\,\%$$

64. The given function is as follows.

$$\frac{\Delta P}{P} = \left[\left(\frac{1}{2}\times 2\right)+(2\times 1)+(3\times 3)+(4\times 5)\right]\%$$

$$= [1+2+9+20]\,\%$$

$$= 32\,\%$$

Solve the given equation.

$32\,\%$

Therefore, statement-I is true.

Solve the equation in statement-II,

$$s = ut + \frac{1}{2}at^2$$

Further solve the above equation.

$$s = (0)t + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2s}{a}}$$

Therefore, statement-II is also true.

65. The given matrix is as follows,

$$(d + 200)$$

The determinant of given expression is calculated as,

$$t = \sqrt{\frac{2d}{2}} \qquad \ldots\ldots (1)$$

The square of matrix A is calculated as,

$(d+200)$

$$\sqrt{\frac{2d}{2}} = \sqrt{\frac{2(d+200)}{4}}$$

Substitute $t = \sqrt{\frac{2(d+200)}{4}}$ for $d = \frac{(d+200)}{2}$ and

$d = 200\ m$

$t = \sqrt{\frac{2(200\ m)}{2}}$ for A in equation (1).

$= 10\sqrt{2}\ s$

$10\sqrt{2}\ s$

66. The given expression is as follows,

M'

Solve the given expression.

υ'

Further solve the above equation.

$$2M'\upsilon'\sin\theta = M\upsilon\cos 45^\circ + M\upsilon\cos 30^\circ$$

$$2M'\upsilon'\sin\theta = \frac{M\upsilon}{\sqrt{2}} + \frac{\sqrt{3}M\upsilon}{2}$$

$$2M'\upsilon'\sin\theta = M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)$$

Among the options, n satisfies the equation

$$2M'\upsilon'\cos\theta = -M\upsilon\sin 45^\circ + M\upsilon\sin 30^\circ$$

$$2M'\upsilon'\cos\theta = -\frac{M\upsilon}{\sqrt{2}} + \frac{M\upsilon}{2}$$

$$2M'\upsilon'\cos\theta = M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right) \quad .$$

$$\frac{2M'\upsilon'\sin\theta}{2M'\upsilon'\cos\theta}=\frac{M\upsilon\left(\frac{1}{\sqrt{2}}+\frac{\sqrt{3}}{2}\right)}{M\upsilon\left(-\frac{1}{\sqrt{2}}+\frac{1}{2}\right)}$$

$$\tan\theta=\frac{\left(\frac{\sqrt{2}+\sqrt{3}}{2}\right)}{\left(\frac{1-\sqrt{2}}{2}\right)}$$

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

67. The expansion of the expression s

is written as follows.

θ

The value of r is calculated for the coefficient of

$$\tan\theta=\frac{\sqrt{3}+\sqrt{2}}{1-\sqrt{2}}.$$

ΔPQR

The value of r is calculated for the coefficient of $h = \sqrt{1^2 - \left(\frac{x}{2}\right)^2}$

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

.

$$v = \frac{dh}{dt}$$

$$\frac{dh}{dt} = \frac{d}{dt}\left(\frac{1}{2}\sqrt{4 - x^2}\right)$$

$$= \frac{1}{2}\frac{d}{dx}\left(\frac{1}{2}\sqrt{4 - x^2}\right)\frac{dx}{dt}$$

The coefficient of $\frac{dh}{dt}$ and $= \frac{1}{4}\left(\frac{1}{\sqrt{4 - x^2}}\right)(-2x)\frac{dx}{dt}$ are m

$$= -\frac{x}{2\sqrt{4 - x^2}}\frac{dx}{dt}$$

and n respectively. So, the ratio is,

$$\frac{dh}{dt} = -\frac{1}{2\sqrt{\frac{4}{x^2} - 1}}\frac{dx}{dt}$$

68. The given series is as follows,

$$\sqrt{\frac{4}{x^2}-1}$$

The numbers $\sqrt{\frac{4}{x^2}-1}$ are the terms in an A.P. Thus,

$$\frac{dh}{dt}$$

The sum of first 17 terms of A.P. series is calculated as,

$$T\cos\theta = mg$$

69. The sum of expression is calculated as,

$$T\sin\theta = \frac{mv^2}{r}$$

Further solve the above equation.

$$\tan\theta = \frac{v^2}{rg}$$

70. The given expression with the limits is calculated as follows.

$$\tan 45^\circ = \frac{v^2}{(0.4\ \text{m})(10\ \text{ms}^{-2})}$$

$$v^2 = 4\ \text{m}^2\text{s}^{-2}$$

$$v = \sqrt{4\ \text{m}^2\text{s}^{-2}}$$

$$v = 2\ \text{ms}^{-1}$$

71. For the interval $2\ \text{ms}^{-1}$, the function $I_{disc} = \frac{MR^2}{2}$ is continuous.

Thus, the function is also continuous at

$$I_{removed} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right) + \left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

$$= \frac{MR^2 + 18MR^2}{512} \quad \text{and}$$

$$= \frac{19MR^2}{512}$$

$$I_{remaining} = \frac{MR^2}{2} - \frac{19MR^2}{512}$$

$$= \frac{237MR^2}{512}.$$

The limit of the function at $\frac{237MR^2}{512}$ is calculated as,

$$\rho = \frac{m}{v} = \frac{k}{r}$$

The limit of the function at $m = \frac{kv}{r}$ is calculated as,

$$g_{inside} = \frac{Gmr}{R^3}$$
$$= \left(\frac{Gr}{R^3}\right)\left(\frac{kv}{r}\right)$$
$$= \frac{Gkv}{R^3}$$

For $\frac{Gkv}{R^3}$, the value of b from above equation is calculated as,

$$g_{out} = \frac{Gm}{r^2}$$

For $F = Y\alpha_L A\Delta t$, the value of b is calculated as,

$$F = \left(2\times10^{11}\ Nm^{-2}\right)\left(1.2\times10^{-5}\ K^{-1}\right)\left(40\times10^{-4}\ m^2\right)(10)$$
$$= 9.6\times10^{4}\ N$$
$$= 1\times10^{5}\ N$$

The value of b comes out to be an imaginary number which is not possible.

$$\frac{P_1 r_1^4}{l_1} = \frac{P_2 r_2^4}{l_2}$$

$$\frac{P_1 r_1^4}{l_1} = \frac{4P_1 r_2^4}{I_1}$$

Therefore, the ordered pair $Q = \frac{\pi r^4}{8\eta}\frac{\Delta P}{L}$ is $\frac{I_1}{4}$.

$$r_2^4 = \frac{r_1^4}{16}$$

$$r_2 = \frac{r_1}{2}$$

72. The given function is written as follows,

$$u_{initial} = \frac{5}{2}NRT$$

Differentiate the function $u_{final} = \frac{3}{2}(2nRT) + \frac{5}{2}(N\text{-}n)RT$ with

$$= \frac{1}{2}nRT + \frac{5}{2}NRT$$

respect to x.

$$U_{total} = \frac{1}{2}nRT + \frac{5}{2}NRT - \frac{5}{2}NRT$$

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

Determine the interval for which the above function is increasing,

$$a = a_0 e^{\frac{-bt}{m}}$$

73. Let point $\begin{matrix} E \propto a^2 \\ a \propto E \end{matrix}$ be a point that lies on the curve C.

Differentiate the given equation with respect to x.

$$a = \frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$

$$\frac{a_0}{\sqrt{2}} = \frac{bt}{m}$$

$$= \frac{10^{-2}t}{0.1}$$

$$= \frac{t}{10}$$

Thus, the point P is obtained as $\frac{a_0}{\sqrt{2}} = a_0 e^{-\frac{t}{10}}$

$$\frac{1}{\sqrt{2}} = e^{-\frac{t}{10}} .$$

$$\ln\sqrt{2} = \frac{t}{10}$$

$$t = 3.5 \text{ sec}$$

The slope of normal at point P $v = \frac{\omega}{k}$ is equal to $v = \frac{200\pi}{\left(\frac{5\pi}{4}\right)}$.

$$= 160 \text{ m/s}$$

The equation of normal is calculated as follows,

$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$

Among all the given options, it is clear that normal passes through the point $C = \frac{\varepsilon_0 A}{3}$.

74. Integrate the given expression.

$$C = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

$$\frac{\varepsilon_0 A}{3} = \frac{\left(\frac{k\varepsilon_0 A}{3}\right)\left(\frac{\varepsilon_0 A}{2.4}\right)}{\frac{k\varepsilon_0 A}{3} + \frac{\varepsilon_0 A}{2.4}}$$

Substitute $3k = 2.4k + 3$ for $\sigma_1 = \varepsilon_0 \upsilon B, \sigma_2 = -\varepsilon_0 \upsilon B$ and

$k = 5$

then differentiate of this expression.

$$\frac{(A - C)}{D}$$

Substitute these values in the given expression and then integrate.

MnR^2t

Further solve the above expression.

–4500 J ..... (1)

The value of cosine in terms of x is calculated as,

1.37

Substitute this value in equation (1).

$$F_G = \frac{GMm}{(R+h)^2}$$

75. The given integral is as follows,

$(4\pi\mu Bb)\Delta n$ ..... (1)

Rewrite the equation (1) by using the following property,

1.67×10^5 J

Thus, equation (1) becomes,

1.9 Hz ..... (2)

Add equation (1) and equation (2).

170 Hz

76. The given integral is written as follows,

$$\rho(r) \propto \frac{1}{r}$$

Differentiate above equation with respect to x.

$\frac{32}{23}\mu F$

Differentiate the above equation.

$\sigma_1 = \varepsilon_0 \upsilon B, \sigma_2 = -\varepsilon_0 \upsilon B$

Further solve the above differential equation.

$400\,\Omega$

77. The given differential equation is written as follows,

$P_2 > P_1 > P_3$ ..... (1)

Substitute $7\,\Omega$ and $45°$ for $\frac{2E_0}{c}\hat{j}\cos kz \cos \omega t$.

Differentiate 27.5 cm with respect to x,

9 mm

Substitute the values in equation (1).

10^{20} ..... (2)

The integrated factor of the above equation is,

$$\frac{h^2}{4\pi m^2 r^3}$$

The solution of differential equation (2) is calculated as follows,

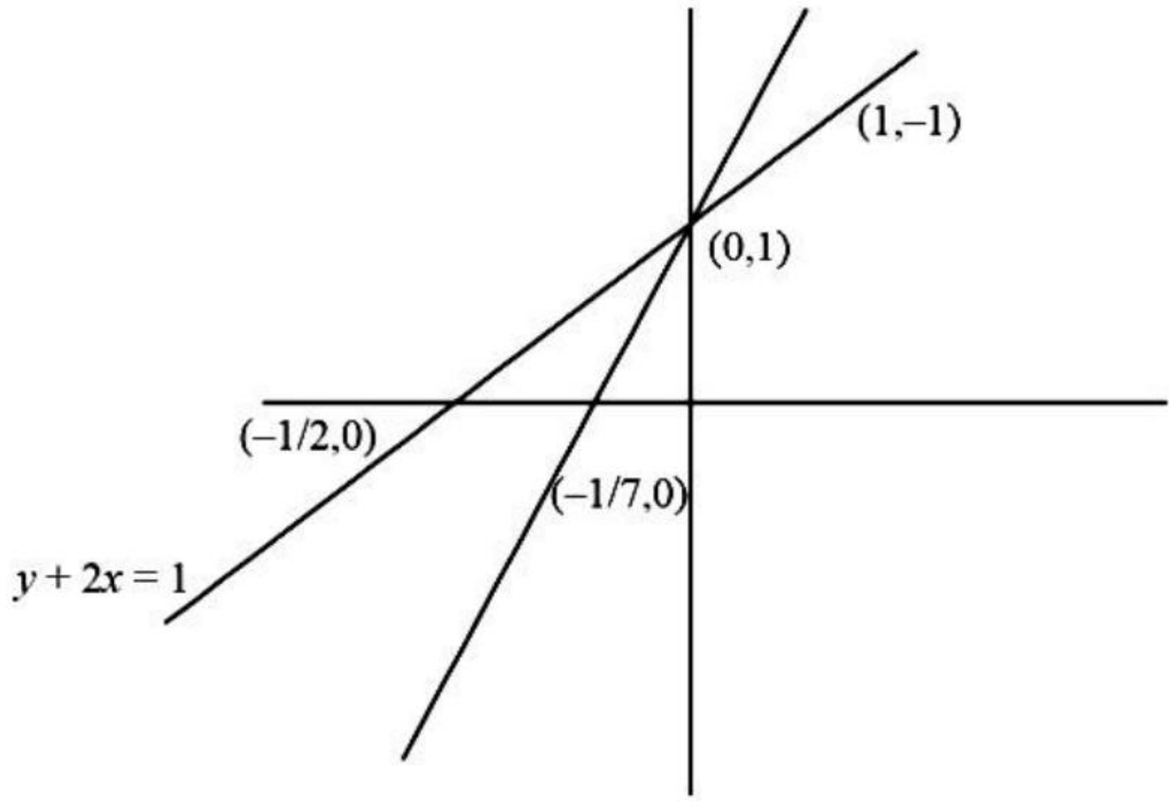
4×10^{-2} gm

78. The equation of incident line is as follows,

6.9 mA ..... (1)

Let a point $\lambda, P_{eff} = K\left(\frac{1}{\lambda}\right)^2$ be on the line $\frac{20}{3}\Omega$ and the image of 0.1 cm lie on the incidence line in $P = a^{1/2}b^2c^3d^{-4}$.

The following figure shows the incident line.



The equation of line is given by,

$$\frac{\Delta P}{P}=\left[\left(\frac{1}{2}\frac{\Delta a}{a}\right)+\left(2\frac{\Delta b}{b}\right)+\left(3\frac{\Delta c}{c}\right)+\left(4\frac{\Delta d}{d}\right)\right]\times 100\,\%$$

From the above equation, the value of x is calculated as,

$$\frac{\Delta P}{P}=\left[\left(\frac{1}{2}\times 2\right)+(2\times 1)+(3\times 3)+(4\times 5)\right]\%$$

$$=[1+2+9+20]\,\%$$

$$=32\,\%$$

The value of y is calculated as,

$32\,\%$

Substitute the values of x and y in equation (1).

$$s = ut + \frac{1}{2}at^2$$

$$s = (0)t + \frac{1}{2}at^2$$

Substitute $s = \frac{1}{2}at^2$ for $(d + 200)$ in equation (1).

$$t = \sqrt{\frac{2s}{a}}$$

$$t = \sqrt{\frac{2d}{2}}$$

79. Let the straight line through origin $(d + 200)$ be given by,

$$t = \sqrt{\frac{2(d + 200)}{4}}$$

$$\sqrt{\frac{2d}{2}} = \sqrt{\frac{2(d + 200)}{4}}$$

The above line intersects the line $d = \frac{(d + 200)}{2}$ at point

$$d = 200 \text{ m}$$

A, then,

$$t = \sqrt{\frac{2(200\,\text{m})}{2}} \qquad \ldots\ldots (1)$$

$$= 10\sqrt{2}\ \text{s}$$

Again the line through the origin meets line $10\sqrt{2}$ s at point B thus,

M' ..... (2)

Divide equation (1) by equation (2),

υ'

80. The equation of the first straight line is,

$$2M'\upsilon'\sin\theta = M\upsilon\cos 45° + M\upsilon\cos 30°$$

$$2M'\upsilon'\sin\theta = \frac{M\upsilon}{\sqrt{2}} + \frac{\sqrt{3}M\upsilon}{2}$$

$$2M'\upsilon'\sin\theta = M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)$$

..... (1)

The equation of the second straight line is,

$$2M'\upsilon'\cos\theta = -M\upsilon\sin 45° + M\upsilon\sin 30°$$

$$2M'\upsilon'\cos\theta = -\frac{M\upsilon}{\sqrt{2}} + \frac{M\upsilon}{2}$$

$$2M'\upsilon'\cos\theta = M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)$$

..... (2)

Add both equation (1) and (2) to obtain the value of x as follows.

$$\frac{2M'\upsilon'\sin\theta}{2M'\upsilon'\cos\theta} = \frac{M\upsilon\left(\frac{1}{\sqrt{2}} + \frac{\sqrt{3}}{2}\right)}{M\upsilon\left(-\frac{1}{\sqrt{2}} + \frac{1}{2}\right)}$$

$$\tan\theta = \frac{\left(\frac{\sqrt{2}+\sqrt{3}}{2}\right)}{\left(\frac{1-\sqrt{2}}{2}\right)}$$

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

Substitute θ for x in equation (1).

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

The centre of circle is the point where the straight lines ΔPQR and $h = \sqrt{1^2 - \left(\frac{x}{2}\right)^2}$ intersect. Thus, the centre of circle is at

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

$$v = \frac{dh}{dt}.$$

The equation of the circle is calculated as,

$$\frac{dh}{dt}$$

The equation of tangent to the circle at point

$$\frac{dh}{dt} = \frac{d}{dt}\left(\frac{1}{2}\sqrt{4 - x^2}\right)$$

$$= \frac{1}{2}\frac{d}{dx}\left(\frac{1}{2}\sqrt{4 - x^2}\right)\frac{dx}{dt}$$

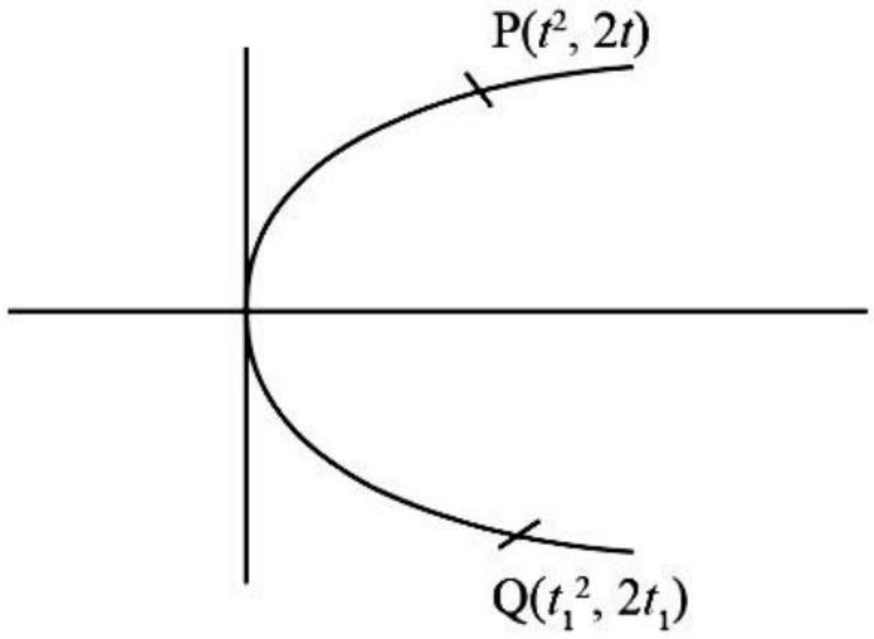
is calculated as,

$$= \frac{1}{4}\left(\frac{1}{\sqrt{4 - x^2}}\right)(-2x)\frac{dx}{dt}$$

$$= -\frac{x}{2\sqrt{4 - x^2}}\frac{dx}{dt}$$

$$\frac{dh}{dt} = -\frac{1}{2\sqrt{\frac{4}{x^2} - 1}} \frac{dx}{dt}$$

81. Consider point P as $\sqrt{\frac{4}{x^2} - 1}$ and consider point Q as $\sqrt{\frac{4}{x^2} - 1}$ on the parabola, $\frac{dh}{dt}$.



The normal at point $PT\cos\theta = mg$ passes through point Q

$T\sin\theta = \frac{mv^2}{r}$ and the equation is given as,

$$\tan\theta = \frac{v^2}{rg} \qquad \ldots\ldots (1)$$

Differentiate the above equation with respect to t.

$$\tan 45° = \frac{v^2}{(0.4\,\text{m})(10\,\text{ms}^{-2})}$$

$$v^2 = 4\,\text{m}^2\text{s}^{-2}$$

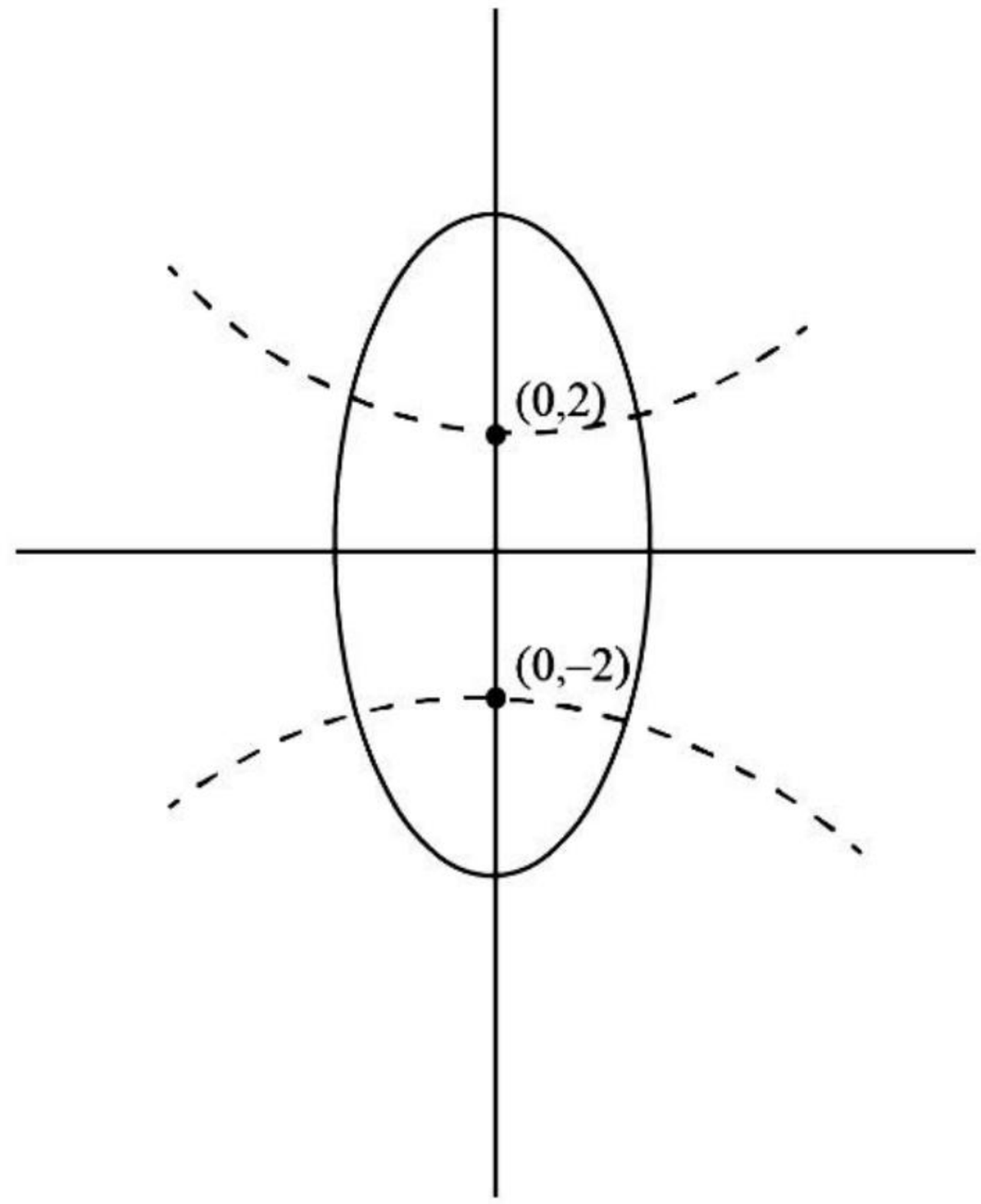
$$v = \sqrt{4\,\text{m}^2\text{s}^{-2}}$$

$$v = 2\,\text{ms}^{-1}$$

Square both sides of equation (1).

$2\,\text{ms}^{-1}$

82. The following figure represents the ellipse as per given the point of the hyperbola $I_{disc} = \frac{MR^2}{2}$.



For ellipse,

The equation of ellipse is written as,

$$I_{removed} = \frac{1}{2}\left(\frac{M}{16}\right)\left(\frac{R^2}{16}\right)+\left(\frac{M}{16}\right)\left(\frac{9R^2}{16}\right)$$

$$= \frac{MR^2+18MR^2}{512}$$

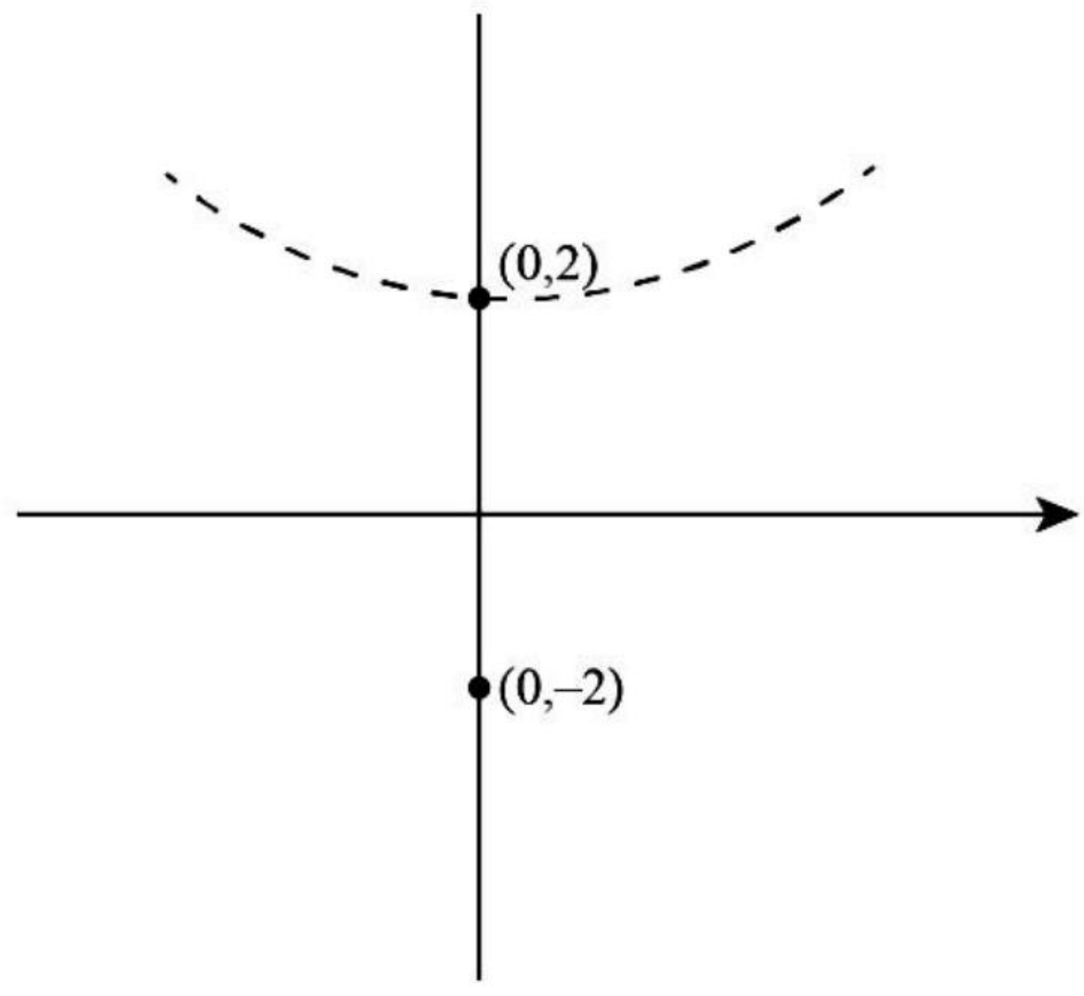
$$= \frac{19MR^2}{512}$$

Let the foci of ellipse be $I_{remaining} = \frac{MR^2}{2} - \frac{19MR^2}{512}$ $= \frac{237MR^2}{512}$. Thus, the eccentricity of ellipse is calculated as,

$\frac{237MR^2}{512}$

Thus, the point $\rho = \frac{m}{v} = \frac{k}{r}$ or $m = \frac{kv}{r}$ does not lie on the parabola.

For hyperbola,



Equation of the hyperbola is given by,

$$g_{inside} = \frac{Gmr}{R^3}$$
$$= \left(\frac{Gr}{R^3}\right)\left(\frac{kv}{r}\right)$$
$$= \frac{Gkv}{R^3}$$

The eccentricity of the hyperbola is calculated as,

$$\frac{Gkv}{R^3}$$

Given that $g_{out} = \frac{Gm}{r^2}$, therefore,

$$F = Y\alpha_L A\Delta t$$

Thus, the equation of the ellipse is,

$$F = \left(2\times10^{11}\ Nm^{-2}\right)\left(1.2\times10^{-5}\ K^{-1}\right)\left(40\times10^{-4}\ m^2\right)(10)$$
$$= 9.6\times10^{4}\ N$$
$$= 1\times10^{5}\ N$$

All the options are checked by substituting the given points on the hyperbola,

Check option (4).

For the point $Q = \frac{\pi r^4}{8\eta}\frac{\Delta P}{L}$,

$$\frac{P_1 r_1^4}{l_1} = \frac{P_2 r_2^4}{l_2}$$

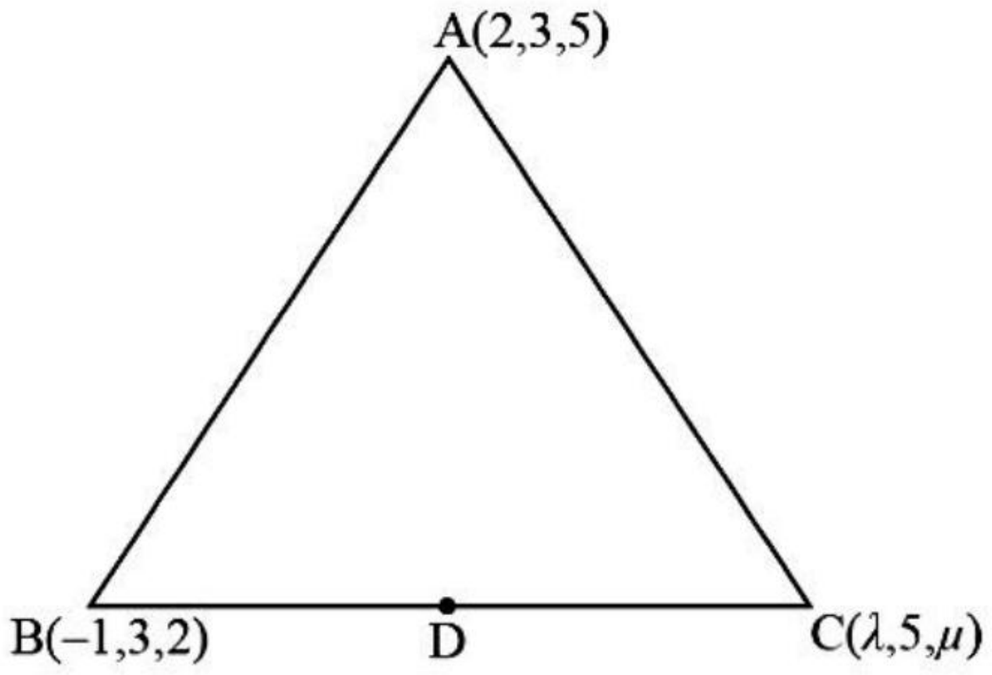
$$\frac{P_1 r_1^4}{l_1} = \frac{4P_1 r_2^4}{\frac{I_1}{4}}$$

$$r_2^4 = \frac{r_1^4}{16}$$

$$r_2 = \frac{r_1}{2}$$

Therefore, option (4) is correct.

83. The following figure shows the triangle ABC with all its vertices.



The coordinates of point D is as follows,

$$u_{initial} = \frac{5}{2}NRT$$

The direction cosine of median AD is given by,

$$u_{final} = \frac{3}{2}(2nRT) + \frac{5}{2}(N\text{-}n)RT$$

$$= \frac{1}{2}nRT + \frac{5}{2}NRT$$

The vector AD is written as follows,

$$U_{total} = \frac{1}{2}nRT + \frac{5}{2}NRT - \frac{5}{2}NRT$$

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

From the above expression,

$$a = a_0 e^{\frac{-bt}{m}}$$

From the above expression, the value of $\frac{E \propto a^2}{a \propto E}$ is found out to be 7 and the value of $\frac{a_0}{\sqrt{2}} = \frac{bt}{m}$ is found out to be 10.

$$= \frac{10^{-2} t}{0.1}$$

$$= \frac{t}{10}$$

Thus, the value of given expression is calculated as,

$$\frac{a_0}{\sqrt{2}} = a_0 e^{-\frac{t}{10}}$$

$$\frac{1}{\sqrt{2}} = e^{-\frac{t}{10}}$$

$$\ln\sqrt{2} = \frac{t}{10}$$

$$t = 3.5 \text{ sec}$$

84. The given equation of line is as follows,

$$v = \frac{\omega}{k}$$

$$v = \frac{200\pi}{\left(\frac{5\pi}{4}\right)}$$

$$= 160 \text{ m/s}$$

The given two lines are coplanar. Thus,

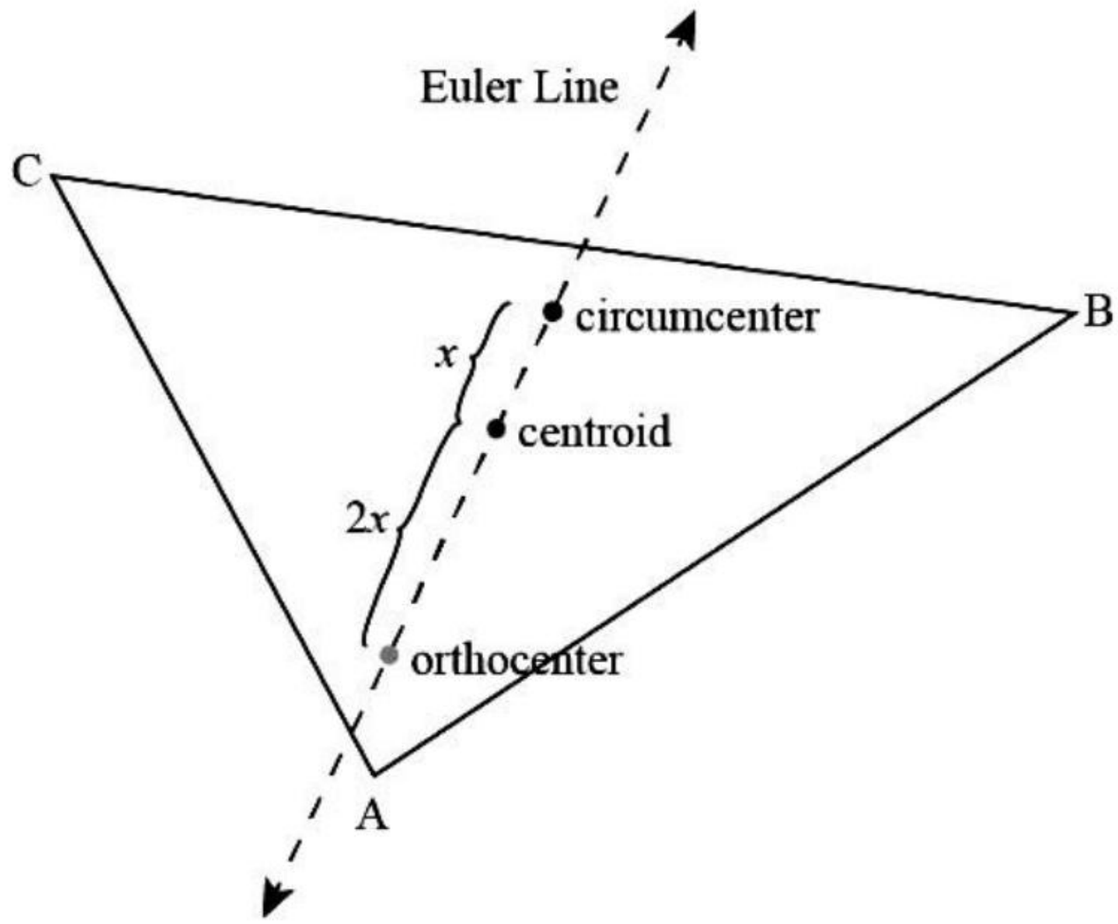
$\Phi_1 = \Phi_2 = \Phi_3 = \Phi_4$

Therefore, there are three possible values of λ.

85. The expression for the centroid of the triangle ABC for the given position vectors $\vec{a}$, b and $\vec{c}$ is as follows,

$$\text{Centroid} \equiv \left(\frac{\vec{a} + \vec{b} + \vec{c}}{3}\right)$$

The relationship between the centroid, circumcenter and orthocenter is shown in the following diagram.



Therefore,

$$\text{Orthocentre} = 3(\text{centroid}) - 2(\text{circumcenter})$$

$$\text{Orthocentre} = 3\left(\frac{\vec{a}+\vec{b}+\vec{c}}{3}\right) - 2\left(\frac{\vec{a}+\vec{b}+\vec{c}}{4}\right)$$

$$= \left(\frac{\vec{a}+\vec{b}+\vec{c}}{2}\right)$$

86. The mean of 5 observations is 5. This can be expressed in the numerical form as,

$$\bar{x} = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}$$

$$5 = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}$$

$$x_1 + x_2 + x_3 + x_4 + x_5 = 25$$

$$\sum_{i=1}^{5} x_i = 25 \qquad \ldots\ldots (1)$$

The variance of the observations is calculated as,

$$\sigma^2 = 124$$

$$\frac{\sum x_1^2}{5} - \left(\bar{x}\right)^2 = 124$$

$$\sum x_1^2 = 745$$

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 + x_5^2 = 745$$

Substitute the given three observations,

Consider as the three observations x_3, x_4 and x_5 are 1, 2 and 6 respectively.

Therefore, from the above equation,

$$x_1^2 + x_2^2 + \left(1^2\right) + 2^2 + 6^2 = 745$$

$$x_1^2 + x_2^2 = 704 \qquad \ldots\ldots (2)$$

Similarly,

From equation (1),

$$x_1 + x_2 + 1 + 2 + 6 = 25$$

$$x_1 + x_2 = 16 \qquad \ldots\ldots (3)$$

From equation (2) and equation (3),

$$(x_1 + x_2)^2 = (16)^2$$

$$2x_1x_2 + 704 = 256$$

$$x_1x_2 = \frac{256 - 704}{2}$$

$$x_1x_2 = -224$$

The mean deviation is calculated as follows,

$$\frac{\sum|x_1 - 5|}{5} = \frac{|x_1 - 5| + |x_2 - 5| + |1 - 5| + |2 - 5| + |6 - 5|}{5}$$

$$= \frac{8 + |x_1 - 5| + |16 - x_1 - 5|}{5}$$

$$= \frac{8 + 6}{5}$$

$$= 2.8$$

87. The experiment succeeds twice as often as it fails. The condition is mathematically written as,

$$p = 2q$$

The total number of experiments is given by,

$$p + q = 1$$

From above equations, the value of q is $\frac{1}{3}$ and the value of p is $\frac{2}{3}$.

The probability of at least 5 successes in the six trails is given by,

$$^6C_5p^5q + {}^6C_6p^6 = 6\left(\frac{2}{3}\right)^5\left(\frac{1}{3}\right) + 1\left(\frac{2}{3}\right)^6$$
$$= \frac{256}{729}$$

88. Consider the given expression as,

$$y = \tan A + \tan B$$

Differentiate the above equation with respect to A.

$$\frac{dy}{dA} = \sec^2 A - \sec^2 B$$

$$= \sec^2 A - \sec^2\left(\frac{\pi}{6} - A\right) \qquad \left(\because A + B = \frac{\pi}{6}\right)$$

The expression $(\tan A + \tan B)$ increases in the interval $\left[\frac{\pi}{12}, \frac{\pi}{6}\right]$ and decreases in the interval $\left[0, \frac{\pi}{12}\right]$.Thus, it is can be concluded that the expression $(\tan A + \tan B)$ is minimum when A and B is equal to $\frac{\pi}{12}$.

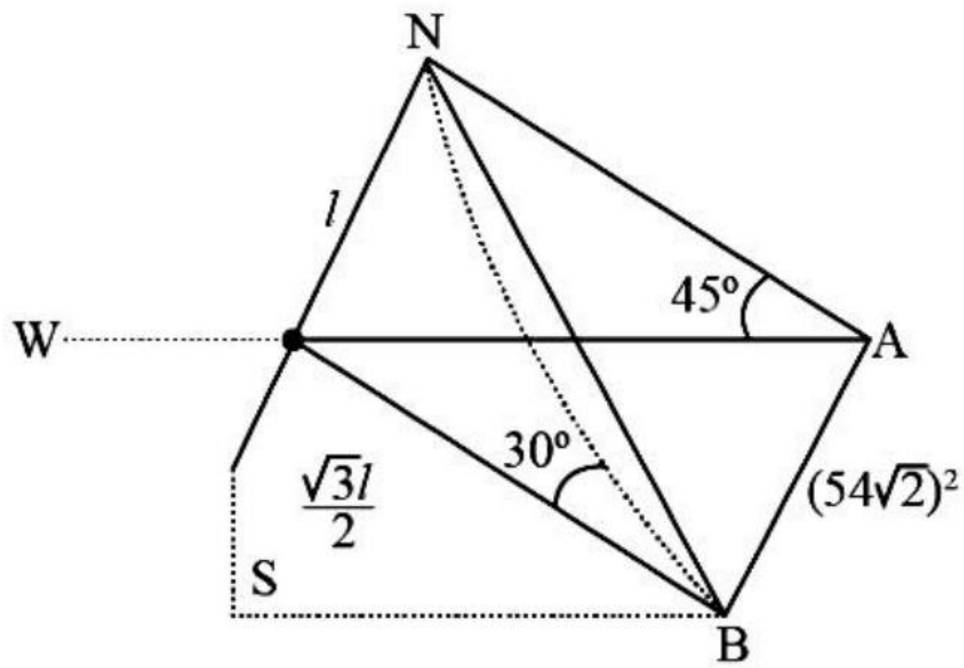
Therefore, the minimum value of the expression is calculated as,

$$y_{min} = 2\tan\frac{\pi}{12}$$

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

$$= 4 - 2\sqrt{3}$$

89. The following figure is a pictorial representation of the given conditions.



From the figure the height of the tower is calculated as,

$$\frac{l^2}{4}+\left(54\sqrt{2}\right)^2=\frac{3l^2}{4}$$

$$(54)^2\times 2\times 2=l^2$$

$$l=54\times 2$$

$$=108\text{ m}$$

90. Assume the side of a square doubles to be represented as p. The area of square increases by four times. Let it be represents by q. Thus, the contra positive of $p\rightarrow q$ is $\sim q\rightarrow\sim p$.

Therefore, the correct option is (4).