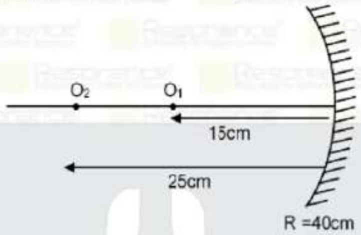
PART : PHYSICS

1. Two objects O_1 & O_2 are placed on principal axis of concave mirror as shown. Find out the separation between images of both objects :



(1) 120 cm (2) 40 cm (3) 160 cm (4) 60 cm

Ans. (3)

Sol. $\frac{1}{V}+\frac{1}{u}=\frac{1}{f}$

From O_1

$u = -15$ cm, $f = -20$ cm

$\frac{1}{V_1}-\frac{1}{15}=-\frac{1}{20} \Rightarrow \frac{1}{V_1}=\frac{1}{15}-\frac{1}{20}=\frac{4-3}{60}=\frac{1}{60}$

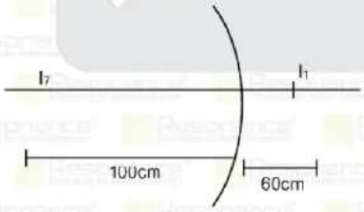
V_1 60 cm (virtual image)

For O_2

$u = -25$ cm, $f = -20$cm

$\frac{1}{V_2}-\frac{1}{25}=\frac{-1}{20} \Rightarrow \frac{1}{V_2}=\frac{1}{25}-\frac{1}{20}=\frac{4-5}{100}=\frac{1}{100}$

$V_2 = -100$ cm (real image)



Separation = 160

2. If F = $(3y^2 + y)$N force acting on a particle along y direction then work done by force from y = 2 to y = 5 :

(1) 200J (2) 300J (3) 127.5J (4) 100J

Ans. (3)

Ans. $\int dw = \int_2^5 F.dy$

$$w = \int_2^5 (3y^2 + y)\ dy$$

$$w = \left[y^3 + \frac{y^2}{2}\right]_2^5$$

$$w = \left[5^3 + \frac{5^2}{2} - 2^3 - \frac{2^2}{2}\right]$$

$$= [125 + \frac{25}{2} - 8 - 2] = 115 + \frac{25}{2} = \frac{255}{2} = 127.5J$$

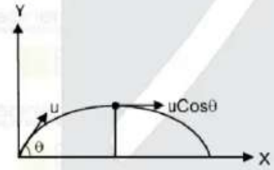
3. A stone is projected from ground at some angle, at highest point of its path -

(1) Vertical component of velocity is maximum (2) Horizontal component of velocity is zero.

(3) Gravitational potential energy is maximum (4) Kinetic energy is half of maximum possible value.

Ans. (3)

Sol.



At maximum height

$V_y = 0$

$V_x = u\cos\theta$

potential energy = mgH_{max}

$$K.E. = \frac{1}{2}m\,(u\cos\theta)^2$$

$$K.E. = \frac{1}{2}mu^2\cos^2\theta$$

4. Find $\frac{I_1 + I_3}{I_2}$ from given electrical circuit :

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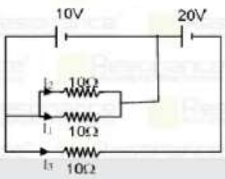
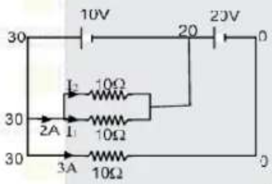


(1) 2 (2) 4 (3) 6 (4) 1

Ans. (2)

Sol.



$I_2 = 1A$

$I_1 = 1A$

$I_3 = 3A$

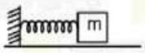
$$\frac{I_1 + I_3}{I_2} = \frac{1+3}{1} = 4$$

5. 0.25J energy is stored in a spring when it is stretched by 10 cm then find spring constant (N/m)

(1) 50 (2) 70 (3) 75 (4) 100

Ans. (1)

Sol.



$$\Rightarrow \frac{1}{2}Kx^2 = 0.25$$

$$\Rightarrow \frac{1}{2} \times k \times (0.1)^2 = 0.25$$

$$k = \frac{0.5}{0.1 \times 0.1} = 50 N/m$$

6. A train moving with speed 20m/s applies brakes to stop at a station when train is 500m away from the station. Another train moving with same speed applies brakes with same retardation as previous train. If

6. A train moving with speed 20m/s applies brakes to stop at a station when train is 500m away from the station. Another train moving with same speed applies brakes with same retardation as previous train. If the train is at a distance of 250 m from station when breaks are applied then velocity of train with which it crosses station will be ?

(1) 16 m/s (2) 10 m/s (3) 14 m/s (4) 12 m/s

Ans. **(3)**

Sol. $V^2 - u^2 = 2as$

$0 - (20)^2 = 2 \times a \times 500$

$-\frac{400}{1000} = a \Rightarrow a = -0.4 \text{m/s}^2$

(–ve sing tells that direction of acceleration is opposite to direction of velocity)

For train -2

$V^2 - u^2 = 2as$

$v^2 - (20)^2 = 2 \times (-0.4) \times 250$

$v^2 = 400 - 200 = 200$

$v = \sqrt{200}\ \text{m/s} = 10\sqrt{2}\ \text{m/s}$

7. Two planets A and B have radius in the ratio 1 : 3 and ratio of their escape speed from surface is 1 : 2, find the ratio of acceleration due to gravity at their surface :

(1) 5/6 (2) 3/4 (3) 2/3 (4) 1/3

Ans. **(2)**

Sol. $v_e = \sqrt{2gR_e}$

$\frac{v_{e_1}}{v_{e_2}} = \sqrt{\frac{g_1R_1}{g_2R_2}}$

$\frac{1}{2} = \sqrt{\frac{g_1}{g_2}\left(\frac{1}{3}\right)}$

$\frac{1}{4} = \frac{g_1}{g_2} \times \frac{1}{3}$

$\frac{g_1}{g_2} = \frac{3}{4}$

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8. Find the minimum value of force so that block of mass 10 kg can move

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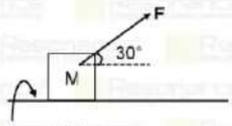
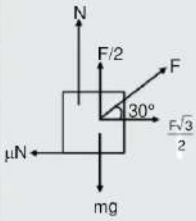


(1) 25 N (2) 25.23 N (3) 35.5 N (4) 20 N

Ans. (1)

Sol. FBD of the block



$N = mg - F/2$

$f = \mu N = 0.25\left[100 - \frac{F}{2}\right]$

Condition so that block can slide

$F \cos 30° \geq f$

$\frac{\sqrt{3}F}{2} \geq 0.25\left[100 - \frac{F}{2}\right]$

$F = \frac{200}{4\sqrt{3}+1}$

$F = 25.23$ N

9. **Statement-1 :** A metallic hollow and a metallic solid sphere of same radius charged to a same potential gains different charge.

Statement-2 : Capacitance of a sphere depends upon the radius.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

Ans. (4)

10. **Statement-1 :** A voltmeter of resistance 400 Ω is much better than the voltmeter of resistance 100Ω.

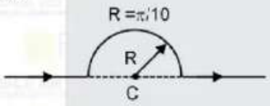
10. **Statement-1 :** A voltmeter of resistance 400 Ω is much better than the voltmeter of resistance 100Ω.
Statement-2 : Current passing through 400Ω voltmeter is lesser as compare to voltmeter of resistance 100Ω.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

Ans. (1)

11. Find the magnetic field at the centre of semi-circular ring of radius $\frac{\pi}{10}$ m when current is 3A :
(1) 30×10^{-7} T (2) 25×10^{-7} T (3) 45×10^{-7} T (4) 77×10^{-7} T

Ans. (1)

Sol.

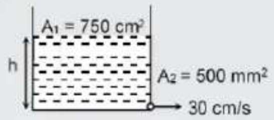


$B = \frac{\mu_0}{4}\frac{i}{R}$

$= \frac{\mu_0}{4} \times \frac{3 \times 10}{\pi}$

$B = 30 \times 10^{-7}$ T

12. A tank has hole at bottom. The area of the hole is 500 mm². The tank is filled with water upto height h. The water comes out through hole with speed 30 cm/s. Area of cross-section of tank is 750 cm² (shown in figure) then the rate of change at height h of water level in tank is $x \times 10^{-3}$ m/s then x will be :



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

Ans. (3)

Sol. Using continuity equation

$A_1V_1 = A_2 V_2$

$750 \text{ cm}^2 \times \frac{dh}{dt} = 500 \times 10^{-2} \text{cm}^2 \times 30\text{cm/s}$

$\frac{dh}{dt} = \frac{150}{750} \text{cm/s} = \frac{1}{5} \text{cm/s} = 0.2 \text{ cm/s}$

$\frac{dh}{dt} = 2 \times 10^{-3}$ m/s

so x = 2

13. Calculate the dimensional formula of mass in terms of G, h and C where G is gravitational constant, h is Plank's constant and C is the speed of light :

13. Calculate the dimensional formula of mass in terms of G, h and C where G is gravitational constant, h is Plank's constant and C is the speed of light :

(1) $[G]^{1/2}[h]^{1/3}[C]^{1/4}$ (2) $[G]^{-1/2}[h]^{1/2}[C]^{1/2}$ (3) $[G]^{1/2}[h]^{1/2}[C]^{1/2}$ (4) [G] [h] [C]

Ans. (2)

Sol. $[M] = [G]^a [h]^b [C]^c$

$[G] = [M^{-1} L^3 T^{-2}]$; $[h] = [ML^2 T^{-1}]$

$[C] = [LT^{-1}]$

$[M] = [M^{-1}L^3 T^{-2}]^a [ML^2T^{-1}]^b [LT^{-1}]^c$

$= M^{-a+b} L^{3a+2b+c} T^{-2a-b-c}$

$-a + b = 1$

$3a + 2b + c = 0$

$-2a - b - c = 0$

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

$b = 1/2$

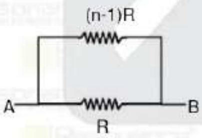
$c = 1/2 \Rightarrow [M] = [G]^{-1/2}[h]^{1/2}[c]^{1/2}$

14. Find equivalent resistance between adjacent edges of n sides polygon if each side is having a resistance R.

(1) $R\left(1-\frac{1}{n}\right)$ (2) R (2n – 1) (3) $R\left(\frac{1}{n}-1\right)$ (4) R (n – 1)

Ans. (1)

Sol.



$$R_{AB} = \frac{R(n-1)R}{R(n-1)+R} = \frac{R(n-1)}{n}$$

$$= R\left(1-\frac{1}{n}\right)\Omega$$

15. In a Carnot engine temperature of source is 99°C & efficiency 1/3. If the temperature of sink increased by x then efficiency becomes 1/6 then x is :

(1) 42k (2) 62k (3) 36k (4) 28k

Ans. (2)

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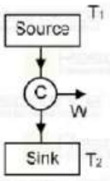
Sol.

Sol.



Let T_2 is the temperature of sink then

$$\eta_1 = 1 - \frac{T_2}{T_1} = 1 - \frac{T_2}{(372)} = 1 - \frac{T_2}{372}$$

given $\eta_1 = \frac{1}{3}$

So $\frac{1}{3} = 1 - \frac{T_2}{372} \Rightarrow \frac{T_2}{372} = 1 - \frac{1}{3} = \frac{2}{3}$

$T_2 = 248$

Now this sink temperature $T_2 = 248$Kn is increased by x & efficiency become $\frac{1}{6}$

$$\eta_2 = 1 - \frac{T_2 + x}{T_1} \Rightarrow \frac{1}{6} = 1 - \frac{248 + x}{372}$$

$$\frac{248 + x}{372} = 1 - \frac{1}{6} = \frac{5}{6}$$

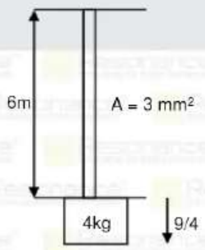
$248 + x = 310 \Rightarrow x = 62K$

16. A block is hanging from a fixed support on a different planet where gravity is 4 times lesser than earth's gravity. The rod by which block is hanging has length of 6m, cross sectional area of 3mm^2 and young modulus is 2×10^{11} N/m^2. Calculate the elongation in the rod if mass of bock is 4 kg. (g on earth = 10 m/s^2)

(1) 0.2 mm (2) 1 mm (3) 0.1mm (4) 2 mm

Ans. (3)

Sol. Stress $= \frac{F}{A} = \frac{4 \times \frac{10}{4}}{3 \times 10^{-6}} = \frac{10}{3} \times 10^6 \text{ N/m}^2$



$$\frac{\text{Stress}}{\text{strain}} = y$$

$$\frac{\text{stress}}{y} = \frac{\Delta \ell}{\ell} \Rightarrow \Delta \ell = \frac{\ell \times \sigma}{y}$$

$$\Delta \ell = \frac{6 \times \frac{10}{3} \times 10^6}{2 \times 10^{11}} = \frac{10^7}{10^{11}}$$

$\Delta\lambda = 10^{-4}$ m $\Rightarrow \Delta\lambda = 0.1$ mm

17. Pressure temperature graph is plotted for three ideal gases A, B, C with almost same density (least

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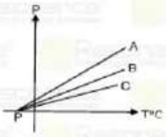
17. Pressure temperature graph is plotted for three ideal gases A, B, C with almost same density (least density varies). Then temperature at point P shown in graph will be :

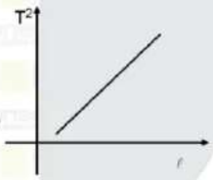


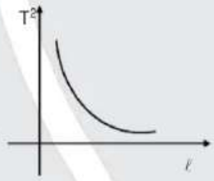
(1) –273°C (2) –100°C (3) –80°C (4) 0°C

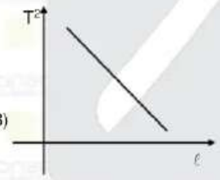
Ans. (1)

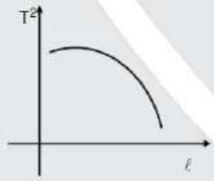
Sol. When temperature goes to –273°C, all constituent particles get freeze and pressure goes to zero irrespective of the density of gas.

18. Which of the following graph is correct between T^2 and ℓ for a simple pendulum :

(1)


(2)


(3)


(4)


Ans. (1)

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

$T^2 = 4\pi^2\frac{\ell}{g} \Rightarrow T^2 \propto \ell$

$\Rightarrow \quad T^2 = k\ell$

19. Which of the graph represent maximum impulse?

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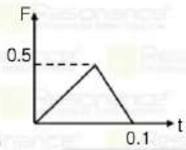
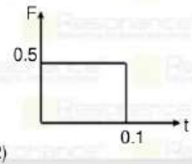
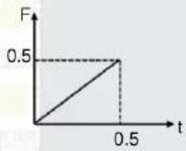
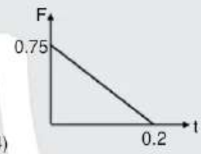
(1) 

(2) 

(3) 

(4) 

Ans. **(3)**

Sol. Impulse (I) = $\int F.dt$

So impulse is area under curve between F & t

For option (1)

Area = $\frac{1}{2} \times 0.1 \times 0.5 = \frac{0.05}{2} = 0.025$ N.s

$I_A = 0.025$ N.s

For option (2)

Area = $0.5 \times 0.1 = 0.05$ N.s

$I_B = 0.05$N.s

For option (3)

Area = $1/2 \times 0.5 \times 0.5 = 0.125$ N.s

$I_C = 0.125$ N.s

For option (4)

Area = $1/2 \times 0.2 \times 0.75 = 0.075$ N.s

$I_D = 0.075$ N.s

20. A coil is placed perpendicular to the magnetic field. Magnetic flux (ϕ_B) through the coil changes when :

(a) Area of coil will change
(b) Direction of magnetic field will change
(c) strength of magnetic field will change
(d) moving the coil along the magnetic field.

(1) c & d (2) b, c & d (3) a, b, c (4) All of the above

Ans. **(3)**

21. For a hydrogen like atom whose atomic number is 4 an electron jumps from It's 4^{th} excited state to 2^{nd} excited state energy level. Calculate the energy of the photon emitted in the process :

(1) 57. 57 eV (2) 15.5 eV (3) 41. 29 eV (4) 27. 27 eV

Ans. (2)

Sol. $E_1 = -13.6 \times \frac{(4)^2}{(5)^2}$

$E_2 = 13.6 \times \frac{(4)^2}{(3)^2}$

$E_1 - E_2 = -13.6\,(4^2)\left[\frac{1}{25} - \frac{1}{9}\right] = -13.6 \times 16 \times \left(\frac{9-25}{25\times 9}\right)$

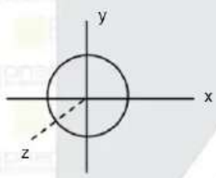
$\Delta E = 15.5$ eV

22. The moment of inertia of a disc about its diameter is $MR^2/4$. Find out moment of inertia of disc about an axis normal to the edge of disc :

(1) $\frac{3MR^2}{4}$ (2) $\frac{5MR^2}{4}$ (3) $\frac{3MR^2}{2}$ (4) MR^2

Ans. (3)

Sol. Using perpendicular axis theorem

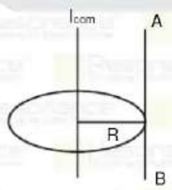


$I_z = I_x + I_y$

by symmetry $I_x = I_y = \frac{MR^2}{4}$

$I_z = I_{com} = \frac{MR^2}{4} + \frac{MR^2}{4} = \frac{MR^2}{2}$

using parallel axis theorem



$I_{AB} = I_{com} + MR^2$

$I_{AB} = \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$

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23. If f_0 is the threshold frequency for a metal. If a light of frequency $2f_0$ is incident on metal plate, the velocity

23. If f_0 is the threshold frequency for a metal. If a light of frequency $2f_0$ is incident on metal plate, the velocity of photoelectron is observed to be V_1 and if a light of frequency $5f_0$ is incident on metal plate the velocity of photoelectron is observed to be V_2 Find the ration of V_1 & V_2

(1) 2/1 (2) 1/2 (3) 1/3 (4) 1/4

Ans. **(2)**

Sol. When h is the plank's constant & f is the incident frequency f_0 threshold frequency of metal & KE is the kinetic energy of photoelectron

For $2f_0$

$$h(2f_0) = hf_0 + KE_1 \Rightarrow KE_1 = hf_0 \quad ......(I)$$

For $5f_0$

$$h(5f_0) = hf_0 + KE_2 \Rightarrow KE_2 = 4hf_0 \quad ....(II)$$

divide (I) by (II)

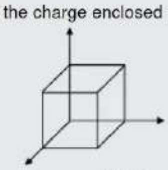
$$\frac{KE_1}{KE_2} = \frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \frac{hf_0}{4hf_0} \Rightarrow \frac{v_1^2}{v_2^2} = \frac{1}{4} \Rightarrow \frac{v_1}{v_2} = \frac{1}{2}$$

24. Which of the following statement is true about Zener diode?

(1) Used in reverse biased mode as voltage regulator.
(2) Used in forward biased mode as voltage regulator.
(3) it is not used as voltage regulator.
(4) Used in forward and reverse biased mode as voltage regulator.

Ans. **(1)**

25. A cube is imagined as shown If $\vec{E} = E_0 x \hat{i}$ N/c exists in the region where $E_0 = 4 \times 10^4$ N/c and $\varepsilon_0 = 9 \times 10^{-12}$ Nm²/c², a = 1 cm, and the charge enclosed in the cube is $x \times 10^{-14}$ C. Find x



(1) 14 (2) 12 (3) 36 (4) 10

Ans. **(3)**

Sol. $E_{at\ x=a} = E_0 a$

$$\Rightarrow \int \vec{E}.d\vec{A} = \frac{Q}{\varepsilon_0}$$

$$\Rightarrow E_0 a \times a^2 = \frac{Q}{\varepsilon_0}$$

$$Q = E_0 a^3 \varepsilon_0$$

$$Q = 4 \times 10^4 \times \left(\frac{1}{100}\right)^3 \times 9 \times 10^{-12}$$

$$Q = 36 \times 10^{-8} \times 10^{-6}$$

$$Q = 36 \times 10^{-14}\ C$$

$$x = 36$$