JEE MAIN 2023

Paper with Solution

PHYSICS | 1st Feb 2023 _ Shift-2

Umeed Rank Ki Ho Ya Selection Ki, JEET NISCHIT HAI!

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Nation's Best SELECTION
Percentage (%) Ratio

Student Qualified in NEET

(2022)
4837/5356 = **90.31%**
(2021)
3276/3411 = **93.12%**

Student Qualified in JEE ADVANCED

(2022)
1756/4818 = **36.45%**
(2021)
1256/2994 = **41.95%**

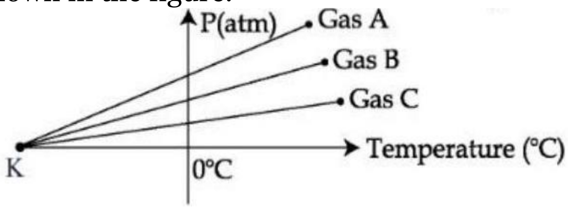
Student Qualified in JEE MAIN

(2022)
4818/6653 = **72.41%**
(2021)
2994/4087 = **73.25%**

NITIN VIJAY (NV Sir)
Founder & CEO

SECTION - A

1. For three low density gases A, B, C pressure versus temperature graphs are plotted while keeping them at constant volume, as shown in the figure.



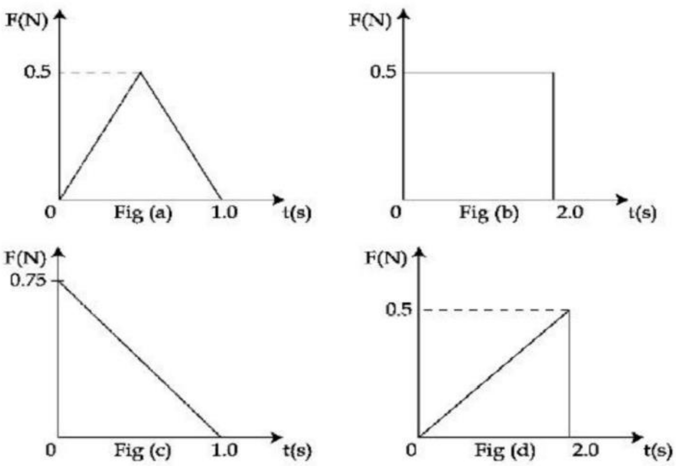
The temperature corresponding to the point ' K ' is :
(1) $-273°C$ (2) $-100°C$ (3) $-40°C$ (4) $-373°C$

Sol. **(1)**
From ideal gas equation
PV = nRT
$\because$ volume is constant
$P \propto T$
It is clear from graph that for all the gases lines of graphs meet at same value.
At x-axis (temperature axis) P is zero but temperature is negative and it will be equal to 0 K or –273°C

2. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : For measuring the potential difference across a resistance of 600Ω, the voltmeter with resistance 1000Ω will be preferred over voltmeter with resistance 4000Ω.
Reason R : Voltmeter with higher resistance will draw smaller current than voltmeter with lower resistance.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both **A** and **R** are correct and **R** is the correct explanation of **A**
(2) Both **A** and **R** are correct but **R** is not the correct explanation of **A**
(3) **A** is not correct but **R** is correct
(4) **A** is correct but **R** is not correct

Sol. **(3)**
To measure the potential difference between two point, voltmeter is used. But this voltmeter should be with higher resistance so that it cannot draw any current.
Now to measure the potential difference across 600 Ω voltmeter of 4000 Ω is much better than 1000 Ω voltmeter.

3. Figures (a), (b), (c) and (d) show variation of force with time.



The impulse is highest in figure.
(1) Fig (c) (2) Fig (b) (3) Fig (d) (4) Fig (a)

Sol. **(2)**

As we know that impulse is given by

$$I = \Delta P = F \times \Delta t$$

or I = Area of f-t graph

For fig (a) $\rightarrow I = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 0.5 \times 1 = 0.25\,N-\text{sec}.$$

For fig (b) I = length × width

= 2 × 0.5 = 1 N-sec

For fig (c) $I = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 1 \times 0.75 = 0.375 \text{ N-sec.}$$

For fig (d) $I = \frac{1}{2} \times \text{base} \times \text{height}$

$$= \frac{1}{2} \times 2 \times 0.5 = 0.5 \text{ N-sec.}$$

Impulse is highest for that figure, whose area under F-t is maximum and i.e. figure(b)

Option (2) is correct.

4. An electron of a hydrogen like atom, having $Z = 4$, jumps from 4^{th} energy state to 2^{nd} energy state. The energy released in this process, will be :

(Given Rch = 13.6eV)

Where R = Rydberg constant

c = Speed of light in vacuum

h = Planck's constant

(1) 40.8eV (2) 3.4eV

(3) 10.5eV (4) 13.6eV

Sol. **(1)**

$$\Delta E = 13.6 Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Z = 4 (hydrogen like atom)

$n_1 = 2$, $n_2 = 4$

$$\Delta E = 13.6(4)^2 \left(\frac{1}{4} - \frac{1}{16}\right)$$

$$= 13.6 \times \left(\frac{16-4}{64}\right) \times 16$$

$$\Delta E = 13.6 \times \frac{12}{64} \times 16$$

$$\boxed{\Delta E = 40.8\text{eV}}$$

5. The ratio of average electric energy density and total average energy density of electromagnetic wave is :

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

Sol. **(2)**

Ratio of average electric energy density and total Avg energy density.

Avg electric energy density = $\frac{1}{4}\varepsilon_0 E_0^2$

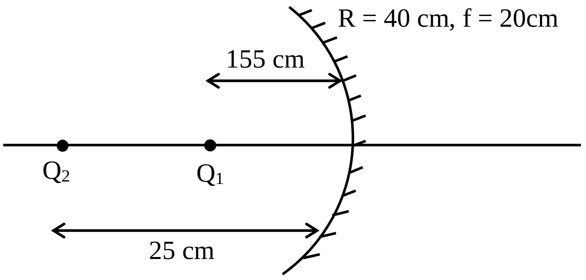
Total Avg energy density = $\frac{1}{2}\varepsilon_0 E_0^2$

$$\Rightarrow \frac{\frac{1}{4}\varepsilon_0 E_0^2}{\frac{1}{2}\varepsilon_0 E_0^2} = \frac{2}{4} = \frac{1}{2}$$

6. Two objects A and B are placed at 15 cm and 25 cm from the pole in front of a concave mirror having radius of curvature 40 cm. The distance between images formed by the mirror is ________.

(1) 100 cm (2) 60 cm (3) 160 cm (4) 40 cm

Sol. **(3)**



Using Mirror formula

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

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{f}$$

$$\boxed{v = \frac{4f}{u - f}}$$

For object A(O_1) $u_i = -15$ cm, f = –20 cm, V_1 = ?

$$v_1 = \frac{u_1 f}{u_1 - f} = \frac{(-15)(-20)}{(-15)-(20)} = \frac{+300}{5}$$

$$\boxed{v_1 = +60\text{cm}}$$

For object B(O_2) $u_2 = -25$ cm, f = –20cm v_2 = ?

$$v_2 = \frac{u_2 f}{u_2 - f} = \frac{(-25)(-20)}{(-25)-(-20)} = \frac{500}{-5}$$

$$\boxed{v_2 = -100\text{cm}}$$

Hence, the distance between images formed by the mirror is

$$\boxed{d = 160\text{cm}}$$

7. Equivalent resistance between the adjacent corners of a regular n-sided polygon of uniform wire of resistance R would be:

(1) $\frac{n^2R}{n-1}$ (2) $\frac{(n-1)R}{n}$ (3) $\frac{(n-1)R}{n^2}$ (4) $\frac{(n-1)R}{(2n-1)}$

Sol. (3)

When, a uniform wire of resistance R is shaped into a regular n-sided polygon, the resistance of each side will be

$$\frac{R}{n} = R_1$$

Let R_1 & R_2 be the resistance between adjacent corners of a regular polygon

$\therefore$ The resistance of (n–1) side, $R_2 = \frac{(n-1)R}{n}$

Since two parts are parallel, therefore R_{eq}

$$R_{eq} = \frac{R_1R_2}{R_1 + R_2} = \frac{\left(\frac{R}{n}\right)\left(\frac{n-1}{n}\right)R}{\left(\frac{R}{n}\right) + \left(\frac{n-1}{n}\right)R}$$

$$R_{eq} = \frac{(n-1)R^2}{n^2} \times \frac{n}{R + nR - R}$$

$$\boxed{R_{eq} = \frac{(n-1)R}{n^2}}$$

8. A Carnot engine operating between two reservoirs has efficiency $\frac{1}{3}$. When the temperature of cold reservoir raised by x, its efficiency decreases to $\frac{1}{6}$. The value of x, if the temperature of hot reservoir is 99°C, will be :

(1) 66 K (2) 62 K (3) 33 K (4) 16.5 K

Sol. (2)

Given $\eta = \frac{1}{3}$

When $T_2 \rightarrow (T_2 + x)$ i.e., temp. of cold reservior

$$\eta' = \frac{1}{6}$$

Temp. of hot reservior (T_1) = 99°C

= 99 + 273 = 372°K

As we know,

$$\eta = 1 - \frac{T_2}{T_1} = \frac{1}{3} \quad \ldots(1)$$

$$\eta' = 1 - \frac{(T_2 - x)}{T_1} = \frac{1}{6} \quad \ldots(2)$$

$$\eta' = \frac{T_1 - (T_2 + x)}{T_1} = \frac{1}{6}$$

From equqation (1)

$$\frac{1}{3} = 1 - \frac{T_2}{372}$$

$$\frac{1}{3} = \frac{372 - T_2}{372}$$

$$372 - \frac{372}{3} = T_2$$

$$T_2 = 248K$$

By putting the value of T_2 in equation (2)

$$\frac{T_1 - (T_2 - x)}{T_1} = \frac{1}{6}$$

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

$$372 - 24 - x = \frac{372}{6}$$

$$124 - x = 62$$

$$124 - 62 = x$$

$$\boxed{x = 62K}$$

9. Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: Two metallic spheres are charged to the same potential. One of them is hollow and another is solid, and both have the same radii. Solid sphere will have lower charge than the hollow one.
Reason R: Capacitance of metallic spheres depend on the radii of spheres.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both **A** and **R** are true and **R** is the correct explanation of **A**
(2) **A** is true but **R** is false
(3) **A** is false but **R** is true 4.
(4) Both **A** and **R** are true but **R** is not the correct explanation of **A**

Sol. **(3)**
As we know, capacitance of spherical conductor

$$C = 4\pi\varepsilon_0 R$$

So, capacitance does not depend on its charge, it depends only on the radius of the conductor (R).
Therefore, assertion is false, R is true.

10. If the velocity of light c, universal gravitational constant G and Planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is :
(1) $[h^{1/2}c^{-1/2}G^{1}]$ (2) $[h^{-1/2}c^{1/2}G^{1/2}]$ (3) $[n^{1/2}c^{1/2}G^{-1/2}]$ (4) $[h^{1}c^{1}G^{-1}]$

Sol. **(3)**

$$[M] = [G]^x [h]^y [c]^z$$

$$[M] = \left[M^{-1}L^3T^{-2}\right]^x \left[ML^2T^{-1}\right]^4 \left[LT^{-1}\right]^z$$

$$\left[M^2L^0T^o\right] = \left[M^{-x+y}\right]\left[L^{3x+2y+z}\right]\left[T^{-2x-y-z}\right]$$

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

On solving, $x = -\frac{1}{2}$, $y = \frac{1}{2}$, $z = \frac{1}{2}$

So $m = \sqrt{\frac{hc}{G}}$

11. Choose the correct statement about Zener diode :
(1) It works as a voltage regulator in forward bias and behaves like simple pn junction diode in reverse bias.
(2) It works as a voltage regulator only in forward bias.
(3) It works as a voltage regulator in both forward and reverse bias.
(4) It works as a voltage regulator in reverse bias and behaves like simple pn junction diode in forward bias.

Sol. **(4)**
Zener diode act as a voltage regulator & it is used in reverse bias.
Similarly it behaves as a pn juction diode in forward bias.

12. The Young's modulus of a steel wire of length 6 m and cross-sectional area 3 mm^2, is 2×10^{11} N/m^2. The wire is suspended from its support on a given planet. A block of mass 4 kg is attached to the free end of the wire. The acceleration due to gravity on the planet is $\frac{1}{4}$ of its value on the earth. The elongation of wire is (Take g on the earth = 10 m/s^2) :
(1) 0.1 cm (2) 0.1 mm (3) 1 cm (4) 1 mm

Sol. **(2)**
As we know,

$$Y = \frac{\text{stress}}{\text{strain}}$$

$$Y = \frac{FL}{A\Delta L}$$

Given : $Y = 2 \times 10^{11}$ N/m^2

$L = 6$ m $\qquad g_p = \frac{g}{4}$

$A = 3mm^2$
$M = 4$ kg
$F = mg_p$

$$F = 4 \times \frac{10}{4} = 10 \text{ N}$$

Hence $2 \times 10^{11} = \frac{10 \times 6}{3 \times 10^{-6} \times \Delta L}$

$$\boxed{\Delta L = 0.1mm}$$

13. In an amplitude modulation, a modulating signal having amplitude of X V is superimposed with a carrier signal of amplitude Y V in first case. Then, in second case, the same modulating signal is superimposed with different carrier signal of amplitude 2Y V. The ratio of modulation index in the two cases respectively will be :
(1) 2: 1 (2) 1: 2 (3) 4: 1 (4) 1: 1

Sol. **(1)**
μ = ratio of modulation index
$A_m = X$, $A_c = y$
$A_m = X$, $A_c = 2y$

$$\mu_1 = \frac{A_m}{A_c} = \frac{x}{y} \qquad \ldots(1)$$

$$\mu_2 = \frac{A_m}{A_c} = \frac{x}{2y} \qquad \ldots(2)$$

Hence $\frac{eq^n(1)}{eq^n(2)} = \frac{\mu_1}{\mu_2} = \frac{x/y}{x/2y} = \frac{2y}{y}$

$$\boxed{\frac{\mu_1}{\mu_2} = \frac{2}{1}}$$

14. The threshold frequency of a metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectrons is v_1. When the frequency of incident radiation is increased to $5f_0$, the maximum velocity of photoelectrons emitted is v_2. The ratio of v_1 to v_2 is:

(1) $\frac{v_1}{v_2} = \frac{1}{8}$ (2) $\frac{v_1}{v_2} = \frac{1}{4}$ (3) $\frac{v_1}{v_2} = \frac{1}{16}$ (4) $\frac{v_1}{v_2} = \frac{1}{2}$

Sol. **(4)**

Using photoelectric equation

$hf - hf_0 = eV_0$

As per question

$h(2f_0) - h(f_0) = eV_1$

$h(2f_0 - f_0) = eV_1$

$hf_0 = eV_1$ ...(1)

$h(5f_0) - hf_0 = eV_2$

$h(5f_0 - f_0) = eV_2$

$4hf_0 = eV_2$ ...(2)

Equation $\frac{2}{1} \Rightarrow \frac{4hf_0}{hf_0} = \frac{eV_2}{eV_1}$

$$\boxed{\frac{V_2}{V_1} = 4}$$

As we know

$KE_{max} = eV = \frac{1}{2}mv_{max}^2$

$v_{max} \propto \sqrt{V}$

$\therefore \frac{v_2}{v_1} = \sqrt{\frac{V_2}{V_1}} = \sqrt{4} = 2$

$$\boxed{\frac{v_1}{v_2} = \frac{1}{2}}$$

15. A coil is placed in magnetic field such that plane of coil is perpendicular to the direction of magnetic field. The magnetic flux through a coil can be changed:

A. By changing the magnitude of the magnetic field within the coil.

B. By changing the area of coil within the magnetic field.

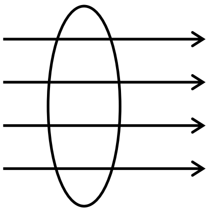
C. By changing the angle between the direction of magnetic field and the plane of the coil.

D. By reversing the magnetic field direction abruptly without changing its magnitude.

Choose the most appropriate answer from the options given below :

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

Sol. **(3)**



$\boxed{\phi = BA\cos\theta}$

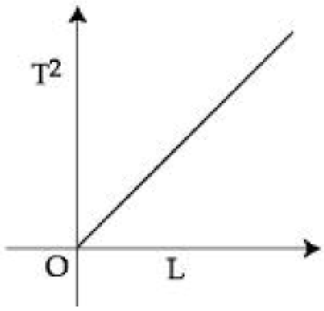
This show

(1) by changing B

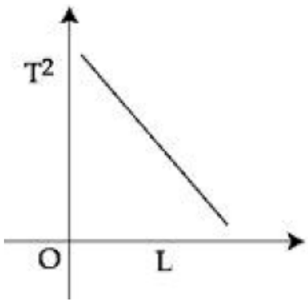
(2) by changing A

(3) Angle (θ) between B and plane of coil.

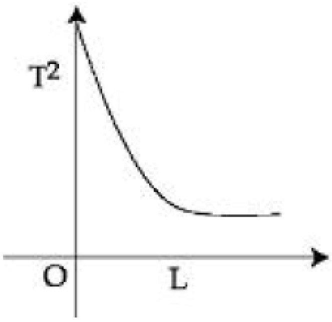
16. Choose the correct length (L) versus square of time period (T^2) graph for a simple pendulum executing simple harmonic motion.



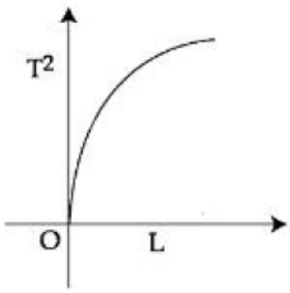
(1)



(2)



(3)



(4)

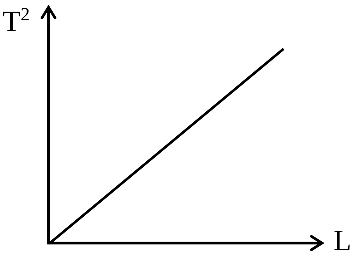
Sol. **(1)**

As we know, time period of simple pendulum is

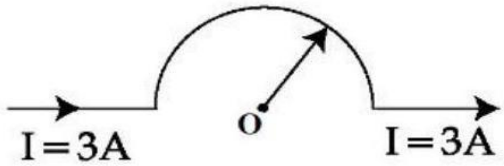
$$T = 2\pi\sqrt{\frac{L}{g}}$$

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

Thus the graph between T^2 & L is a straight line

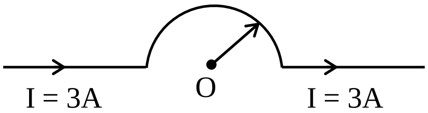


17. As shown in the figure, a long straight conductor with semicircular arc of radius $\frac{\pi}{10}$ m is carrying current I = 3 A. The magnitude of the magnetic field. at the center O of the arc is : (The permeability of the vacuum = $4\pi \times 10^{-7} NA^{-2}$)



(1) 1 μT (2) 3μT (3) 4μT (4) 6μT

Sol. **(2)**



Given: $R = \frac{\pi}{10} m, \quad I = 3A, \quad \mu_0 = 4\pi\times10^{-7} N/A^2$

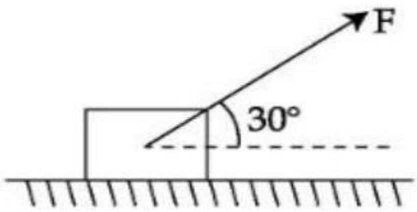
Magnetic field due to semi-circular arc is

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

$$B = \frac{\mu_0 \times 3}{4\times\left(\frac{\pi}{10}\right)} = \frac{4\pi\times10^{-7}\times3}{4\times\frac{\pi}{10}}$$

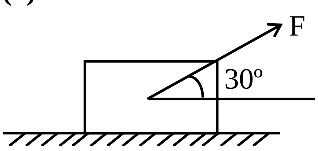
$$\boxed{B = 3\mu T}$$

18. As shown in the figure a block of mass 10 kg lying on a horizontal surface is pulled by a force F acting at an angle 30°, with horizontal. For $\mu_s = 0.25$, the block will just start to move for the value of F : [Given g = 10 ms^{-2}]



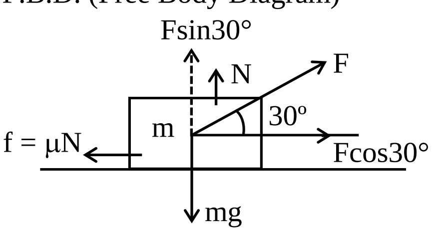
(1) 20 N (2) 33.3 N (3) 25.2 N (4) 35.7 N

Sol. **(3)**



Givne m = 10 kg, μ_s = 0.25, θ = 30°, g = 10m/sec.

F.B.D. (Free Body Diagram)



Fcos30° = f ...(1)

Fsin30° + N = mg ⇒ N = Mg –Fsin30° ...(2)
From equation (1)
Fsin30° = μ_sN
Fcos30° = μ_s(mg – Fsin30°)
Fcos30° = $\mu_s$mg – μ_sF sin30°
F(cos30° + $\mu_s$sin30°) = $\mu_s$mg

$$F = \frac{\mu_s mg}{\cos 30^o + \mu_s \sin 30^o} = \frac{0.25\times 10\times 10}{\sqrt{3}/2\times 0.25\times 1/2}$$

$$F = \frac{25}{\sqrt{3}/2 + \frac{0.25}{2}} = \frac{50}{1.73+0.25} = \frac{50}{1.98} = 25.2\text{N}$$

19. The escape velocities of two planets A and B are in the ratio 1: 2. If the ratio of their radii respectively is 1: 3, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet *B* will be :

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

Sol. **(3)**

Given :

$$\frac{v_A}{v_B} = \frac{1}{2}$$

$$\frac{r_A}{r_B} = \frac{1}{3}$$

$$\frac{g_A}{g_B} = ?$$

As we know,

$$v = \sqrt{\frac{2GM}{R}}$$

Hence,

$$\frac{v_A}{v_B} = \frac{\sqrt{\frac{2GM_A}{R_A}}}{\sqrt{\frac{2GM_B}{R_B}}} = \sqrt{\frac{M_A R_B}{M_B R_A}} = \frac{1}{2} \quad \text{...(1)}$$

Given : $\frac{R_A}{R_B} = \frac{1}{3}$ ...(2)

Therefore,

$$\frac{g_A}{g_B} = \frac{M_A R_A^2}{M_B R_B^2}$$

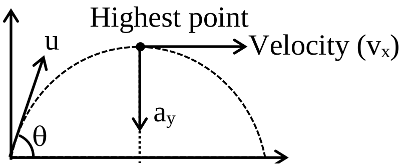
$$= \frac{1}{4}\times\frac{1}{3}\times 9$$

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

20. For a body projected at an angle with the horizontal from the ground, choose the correct statement.
(1) The vertical component of momentum is maximum at the highest point.
(2) The Kinetic Energy (K.E.) is zero at the highest point of projectile motion.
(3) The horizontal component of velocity is zero at the highest point.
(4) Gravitational potential energy is maximum at the highest point.

Sol. **(4)**
At highest point height is maximum and vertical component of velocity is zero.
So momentum is zero.
At highest point horizontal component of velocity will not be zero but vertical component of velocity is equal to zero and because of this K.E. will not be equal to zero.

Gravitational potential energy is maximum at highest point and equal to $mgH = mg\left(\frac{u^2 \sin^2\theta}{2g}\right)$

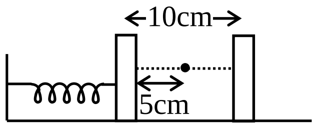


Therefore the correct option is (4).

SECTION - B

21. A block is fastened to a horizontal spring. The block is pulled to a distance $x = 10$ cm from its equilibrium position (at x = 0) on a frictionless surface from rest. The energy of the block at $x = 5$ cm is 0.25 J. The spring constant of the spring is _________ Nm^{-1}

Sol. **(50)**
Given



A= 10cm

At any instant total energy for free oscillation remains constant = $\frac{1}{2}kA^2$

$\Rightarrow \frac{1}{2}kA^2 = 0.25J$

$\Rightarrow \frac{1}{2}kA^2 = 0.25J \quad \Rightarrow K = \frac{0.25 \times 2}{A^2}$

$\Rightarrow k = \frac{0.50}{(10cm)^2} = \frac{0.50}{\left(10 \times 10^{-2}\right)} = \frac{0.50 \times 10^4}{100}$

k = 0.50 × 100 = 50 N/m

22. A square shaped coil of area 70 cm^2 having 600 turns rotates in a magnetic field of 0.4 wbm^{-2}, about an axis which is parallel to one of the side of the coil and perpendicular to the direction of field. If the coil completes 500 revolution in a minute, the instantaneous emf when the plane of the coil is inclined at 60° with the field, will be _________ V. (Take $\pi = \frac{22}{7}$)

Sol. **(44)**
Area (A) = 70 cm^2 = 70 × $10^{-4} m^2$
B = 0.4 T

$f = \frac{500 \text{ revolution}}{60 \text{ minute}} = \frac{500 \text{ rev.}}{60 \text{ sec.}}$

Induced emf in rotating coil is given by

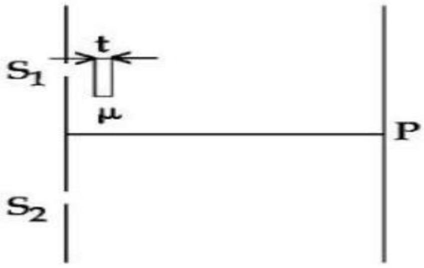
$e = N\omega BA \sin\theta$

$= 600 \times 2 \times \frac{22}{7} \times \frac{500}{60} \times 0.4 \times 70 \times 10^{-4} \sin 30°$

$= 600 \times 2 \times \frac{22}{7} \times \frac{500}{6} \times 0.4 \times 70 \times 10^{-4} \times \frac{1}{2}$

$= 44 \text{Volt}$

23. As shown in the figure, in Young's double slit experiment, a thin plate of thickness $t = 10\mu m$ and refractive index $\mu = 1.2$ is inserted infront of slit S_1. The experiment is conducted in air ($\mu = 1$) and uses a monochromatic light of wavelength $\lambda = 500$ nm. Due to the insertion of the plate, central maxima is shifted by a distance of $x\beta_0$. β_0 is the fringe-width befor the insertion of the plate. The value of the x is __________.



Sol. **(4)**

Given $t = 10 \times 10^{-6}$ m

$\mu = 1.2$

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

When the glass slab inserted infront of one slit then the shift of central fringe is obtained by

$$t = \frac{n\lambda}{(\mu - 1)}$$

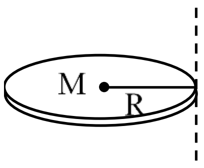
$$\Rightarrow \quad 10 \times 10^{-6} = \frac{n \times 500 \times 10^{-9}}{(1.2 - 1)}$$

$$10 \times 10^{-6} = \frac{n \times 500 \times 10^{-9}}{0.2}$$

$$\boxed{n = 4}$$

24. Moment of inertia of a disc of mass M and radius 'R' about any of its diameter is $\frac{MR^2}{4}$. The moment of inertia of this disc about an axis normal to the disc and passing through a point on its edge will be, $\frac{x}{2}MR^2$. The value of x is __________.

Sol. **(3)**



By using parallel axis theorem

$I' = I_0 + MR^2$

$$I' = \frac{MR^2}{2} + MR^2$$

$I' = \frac{3MR^2}{2}$ sssss

Given $I' = \frac{x}{2}MR^2$

$\therefore \frac{3MR^2}{2} = \frac{x}{2}MR^2$

$x = 3$

25. For a train engine moving with speed of 20 ms^{-1}, the driver must apply brakes at a distance of 500 m before the station for the train to come to rest at the station. If the brakes were applied at half of this distance, the train engine would cross the station with speed $\sqrt{x}$ ms^{-1}. The value of x is __________. (Assuming same retardation is produced by brakes)

Sol. **(200)**

By using 3rd equation of motion

$v^2 = u^2 + 2as$

$(0)^2 = u^2 + 2as$

$u^2 = -2as$

$S = \frac{u^2}{2a} - \frac{(20)^2}{2 \times a} = 500$

acceleration of the train, $a = -\frac{400}{1000} = -0.4 m/sec$

Now, if the brakes are applied at S = 250 m i.e. half of the distance

$v^2 = u^2 + 2as$

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

$v^2 = 400 - 2 \times \frac{4}{10} \times 250$

$v^2 = 200$

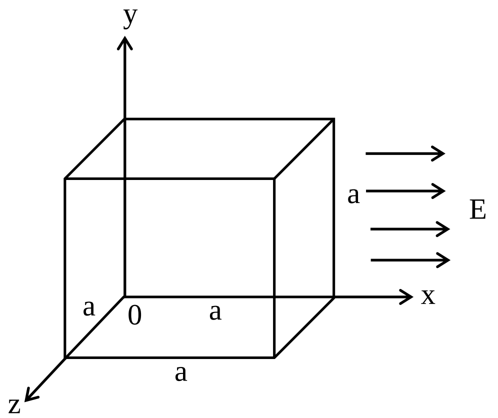
$v = \sqrt{200}$

Given $\Rightarrow v = \sqrt{x}$

$\boxed{x = 200}$

26. A cubical volume is bounded by the surfaces $x = 0, x = a, y = 0, y = a, z = 0, z = a$. The electric field in the region is given by $\vec{E} = E_0 x\hat{i}$. Where $E_0 = 4 \times 10^4 NC^{-1} m^{-1}$. If a = 2 cm, the charge contained in the cubical volume is $Q \times 10^{-14}C$. The value of Q is __________. (Take $\epsilon_0 = 9 \times 10^{-12} C^2/Nm^2$)

Sol. **288**



$\phi = \vec{E} \cdot \vec{A}$

$E = E_0 a i$

$$\phi = E_0 a.a^2 = E_0 a^3$$

$$q_{enc.} = \phi \varepsilon_0$$

$$q_{enc.} = E_0 a^3 \varepsilon_0$$

$$= 4 \times 10^4 \times 8 \times 10^{-6} \times 9 \times 10^{-12}$$

$$q_{enc.} = 288 \times 10^{-14} C$$

Hence the value of Q is 288.

27. A force $F = (5 + 3y^2)$ acts on a particle in the y-direction, where F is in newton and y is in meter. The work done by the force during a displacement from $y = 2$ m to $y = 5$ m is ________ J.

Sol. **132 J**

Given :

F = $(5 + 3y^2)$ in the y direction

Work done is given by

$$W = \int_{y_1}^{y_2} F.dy$$

$$y_1 = 2m, \quad y_2 = 5m$$

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

$$W = \int_2^5 5dy + \int_2^5 3y^2 dy$$

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

$$W = (5 \times 5 - 5 \times 2) + (125 - 8)$$

$$W = (25 - 10) + 117$$

$$\boxed{W = 132 \text{Joule}}$$

28. The surface of water in a water tank of cross section area 750 cm^2 on the top of a house is h m above the tap level. The speed of water coming out through the tap of cross section area 500 mm^2 is 30 cm/s. At that instant, $\frac{dh}{dt}$ is $x \times 10^{-3}$ m/s. The value of x will be ________.

Sol. **(2)**

By using equation of continuity

$$A_1 v_1 = A_2 v_2$$

$$750 \times 10^{-4} \times v_1 = 500 \times 10^{-6} \times 30 \times 10^{-2}$$

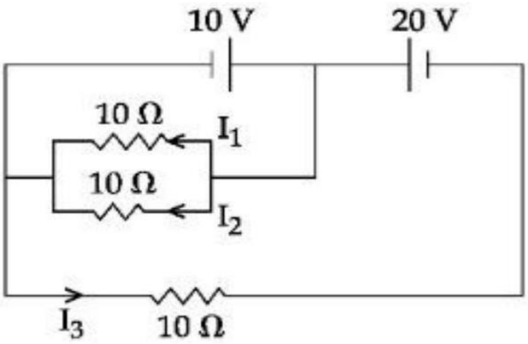
$$v_1 = 20 \times 10^{-4} \text{ m/sec}$$

$$v_1 = 2 \times 10^{-3} \text{ m / sec}$$

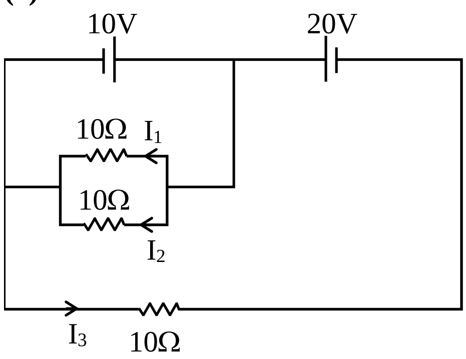
Given : $\frac{dh}{dt} = v = x \times 10^{-3}$ m/sec.

Therefore $\boxed{x = 2}$

29. In the given circuit, the value of $\left|\frac{I_1+I_3}{I_2}\right|$ is ________.



Sol. **(2)**



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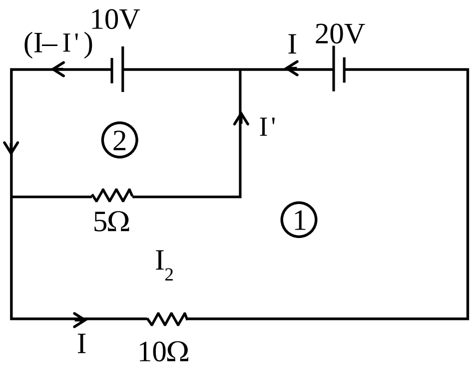

Apply KVL in loop (1)

$20 - 10 - 10\,I = 0$

Or $\boxed{I = 1\text{Amp}}$

Apply KVL in loop (2)

$-10 + 5I' = 0$

Or $\boxed{I' = 2\text{Amp}}$

On comparing $I_3 = 1$ A

$$I_2 = I_1 = \frac{I'}{2} = 1 \text{ Amp}$$

So, the value of $\left|\frac{I_1 + I_3}{I_2}\right| = \left|\frac{1+1}{1}\right| = 2$ Amp.

30. Nucleus A having $Z = 17$ and equal number of protons and neutrons has 1.2MeV binding energy per nucleon. Another nucleus B of $Z = 12$ has total 26 nucleons and 1.8MeV binding energy per nucleons. The difference of binding energy of B and A will be ________ MeV.

Sol. **6 MeV**

<u>For Nucleus A</u>

Z = 17 = Nummber of protons Given (Z = N) ∴ N = 17

A = 34 = Z + N

E_{bn} = 1.2 MeV

$$\frac{(E_B)_1}{A} = 1.2\text{MeV}$$

$$(E_B)_1 = (1.2\text{MeV}) \times A$$

$$(E_B)_1 = (1.2\text{MeV}) \times 34$$

$\boxed{(E_B)_1 = 40.8\text{MeV}}$ → Binding energy of Nucleus A.

For Nucleus B

Z = 12, A = 26

$E_{bn} = 1.8 MeV$

$\frac{(E_b)_2}{A} = 1.8 MeV$

$(E_b)_2 = (1.8 MeV) \times A$

$(E_b)_2 = (1.8 MeV) \times 26$

$\boxed{(E_b)_2 = 46.8 MeV} \rightarrow$ Binding energy of nucleus B

Therefore, difference in binding energy of B and A is

$\Delta E_b = (E_b)_2 - (E_b)_2$

$= 46.8 MeV - 40.8 MeV = 6 MeV$


मोशन है, तो
भरोसा है।
#RankBhiSelectionBhi
ADMISSION ANNOUNCEMENT
Session 2023-24 (English & हिन्दी Medium)
Target: JEE/NEET 2025
Nurture & प्रयास Batch
Class 10th to 11th Moving
Target: JEE/NEET 2024
Enthuse & प्रयास Batch
Class 11th to 12th Moving
Target: JEE/NEET 2024
Dropper & प्रयास Batch
Class 12th to 13th Moving
Target: PRE FOUNDATION
SIP, Evening & Tapasya Batch
Class 6th to 10th Students
MOTION