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PHYSICS

1. Two disc made of same material and same thickness having radius R and αR. Their moment of inertia about their own axis are in ration 1 : 16. Calculate the value of α

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

Ans: 1

Sol: Moment of inertia of disc is given by $= \frac{MR^2}{2} = \frac{\left[\rho\left(\pi R^2\right)t\right]R^2}{2}$

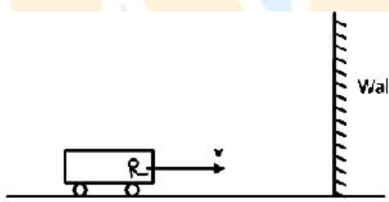
$I \propto R^4$

$\frac{I_2}{I_1} = \left(\frac{R_2}{R_1}\right)^4$

$\frac{16}{1} = \alpha^4$

$\alpha = 2$

2. Bus moving with speed v towards a stationary wall. It produces sound of frequency f = 420 Hz, The heard frequency of reflected sound from wall by driver is 490 Hz. Calculate the speed v of bus. The velocity of sound in air is 300 m/s



1) 61 K m/s 2) 71 Km/s 3) 81 Km/s 4) 91 Km/s

Ans: 4

Sol: Frequency appeared at wall

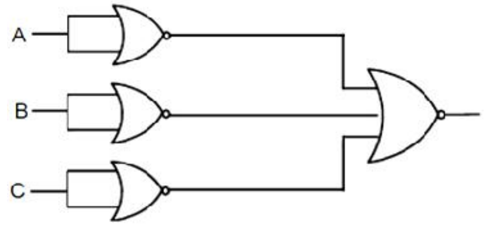
$f_w = \frac{330}{300 - v}.f$ ....(1)

$f' = \frac{300 + v}{300}.f_w = \frac{300 + v}{300 - v}$

$490 = \frac{330 + v}{330 - v}.420$

$v = \frac{330 \times 7}{91} \approx 25.38\,m/s = 91\,Km/s$

3. The given circuit behaves like a following single gate



1) OR 2) AND 3) NAND 4) NOR

Ans: 2

Sol:

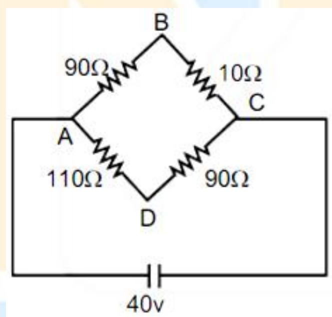
Behaves like a not gate so boolen equation will be

$y=\overline{\overline{A}+\overline{B}+\overline{C}}$

$y = A.\ B.\ C$

Whole arrangement behaves like a AND gate

4.

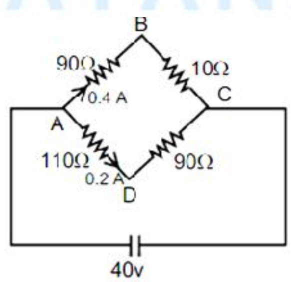


In the given circuit calculate the potential difference between points A and B.

1) 12 V 2) 24 V 3) 36 V 4) 48 V

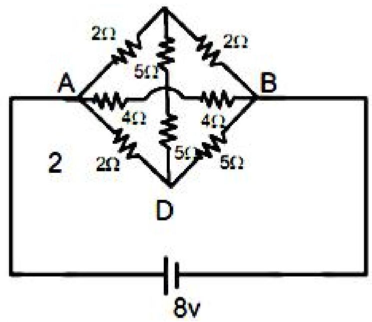
Ans: 3

Sol:



From ohm's law $V_{AB} = 90 \times 0.4 = 36\ V$

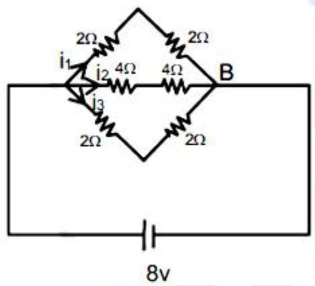
5. Find current through 4Ω resistance



1) 1 Amp 2) 2 Amp 3) 3 Amp 4) 4 Amp

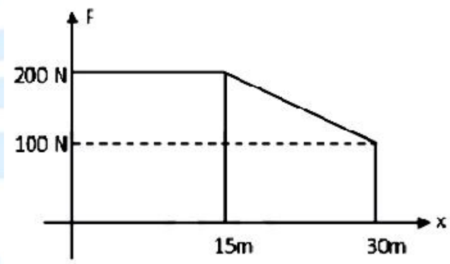
Ans: 1

Sol:



$$i_2 = \frac{8}{4+4} = 1 \text{ Amp}$$

6. Force on a particle varies with position (x) of particle as shown, calculate work done by force from x = 0 to x = 30m



1) 5250 J 2) 4250 J 3) 7500 J 4) 3750

Ans: 1

Sol: W = area = $(200\times15)+\frac{1}{2}(100+200)\times15$

$$= 3000 + 2250$$

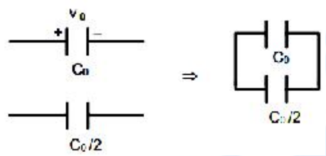
$$W = 5250 \text{ J}$$

7. A capacitor of capacitance C_0 is charged to potentially V_0. Now it is connected to another uncharged capacitor of calculate of capacitance $\frac{C_0}{2}$. Calculate the heat loss in this process.

1) $\frac{1}{2}C_0V_0^2$ 2) $\frac{1}{3}C_0V_0^2$ 3) $\frac{1}{6}C_0V_0^2$ 4) $\frac{1}{8}C_0V_0^2$

Ans: 3

Sol:



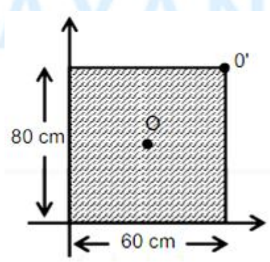
heat loss

$$H = \frac{C_1C_2}{2(C_1+C_2)}(V_1 - V_2)^2$$

$$= \frac{C\times\frac{C}{2}}{2\left(C+\frac{C}{2}\right)}(V_0-0)^2 = \frac{C}{6}V_0^2$$

$$H = \frac{1}{6}C_0V_0^2$$

8. Find the ratio of moment of inertia about axis perpendicular to rectangular plate passing through O' & O



1) $\frac{1}{2}$ 2) $\frac{1}{3}$ 3) $\frac{1}{4}$ 4) $\frac{1}{8}$

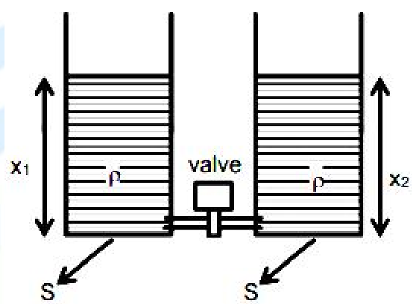
Ans: 3

Sol: $\frac{I_O}{I_{O'}} = \frac{\frac{M}{12}\left(a^2+b^2\right)}{\frac{M}{12}\left(a^2+b^2\right)+m\left(\frac{a^2}{4}+\frac{b^2}{4}\right)}$

$$\frac{\frac{M}{12}\left(a^2+b^2\right)}{\frac{M}{3}\left(a^2+b^2\right)} = 4$$

$$\frac{I_{O'}}{I_O} = \frac{1}{4}$$

9. Find the loss in gravitation potential energy of cylinder when valve is opened and level of liquid in both cylinder become same



1) $\frac{\rho Ag\left(x_1-x_2\right)^2}{4}$ 2) $\frac{\rho Ag\left(x_1+x_2\right)^2}{4}$ 3) $\frac{\rho Ag\left(x_1^2-x_2^2\right)}{4}$ 4) $\frac{\rho Ag\left(x_1^2+x_2^2\right)}{4}$

Ans: 1

Sol: Initial height of liquid in container's of same cross section are x_1 and x_2 respectively. Now value is opened find loss in potential energy when water level become same loss in $PE = U_{in} - U_f$

$$=\left[\rho\left(A\right)x_1\frac{x_1}{2}+\rho Ax_2\frac{x_2}{2}\right]g$$

$$-\left[\rho A\left(\frac{x_1+x_2}{2}\right)\times\left(\frac{x_1+x_2}{4}\right)\times 2\right]g$$

$$-\rho Ag\left[\frac{x_1^2}{2}+\frac{x_2^2}{2}-\frac{\left(x_1+x_1\right)^2}{4}\right]=\frac{\rho Ag\left(x_1-x_2\right)^2}{4}$$

10. A coil has moment of inertia $0.8\,kg/m^2$ released in uniform magnetic field 4T when there is 60^0 angle between magnetic field and magnetic moment of coil. Magnetic moment of coil is $20\,A-m^2$. Find the angular speed of coil when it passes through stable equilibrium

1) $20\pi\,rad/s^{-1}$ 2) $20\,rad/s^{-1}$ 3) $10\pi\,rad/s^{-1}$ 4) $10\,rad/s^{-1}$

Ans: 4

Sol: From energy conservation

$$\frac{1}{2}I\omega^2 = U_{in} - U_f$$

$$= -MB\cos 60^0 - (-MB)$$

$$\frac{MB}{2} = \frac{1}{2}I\omega^2$$

$$\frac{20\times 4}{2} = \frac{1}{2}(0.8)\omega^2$$

$$100 = \omega^2$$

$$\omega = 10 \text{ rad}$$

11. A charged particle of charge q released in electric field $E = E_0(1-ax^2)$ from origin. Find position when is kinetic energy again becomes zero.

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

Ans: 3

Sol: $W_{ex} = \Delta K \qquad K_f - K_i = 0$

$$\int_0^x qEdx = 0$$

$$\int_0^x E_0(1-Qx^2)dxx = 0$$

$$qE_0\int_0^x(1-ax^2)dx = 0$$

$$x - \frac{ax^3}{3} = 0$$

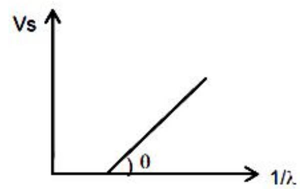
$$1 - \frac{ax^2}{3} = 0$$

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

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

$$x = \pm\sqrt{\frac{3}{a}}$$

12. A light is incident on a metallic surface. Graph between stopping potential Vs and $1/\lambda$ is as shown in figure. When intensity of light is increase at given frequency then



1) Graph does not change
2) Graph steeper
3) Vs intercept change
4) Graph gets narrower

Ans: 1

Sol: $eVs = hv - w$

$$Vs = \frac{hw}{e} - \frac{w}{e}$$

Frequency and work function are constant therefore graph does not change

13. A ball is thrown with velocity v_0 from ground in vertical upward direction. If particle experiences resistance force mkv^2. Where v is the speed of particle, m mass of the particle and k is a positive constant. Find maximum height reached.

1) $\frac{1}{2K} \ln\left(\frac{g+kv_0^2}{g}\right)$ 2) $\frac{1}{3K} \ln\left(\frac{g+kv_0^2}{g}\right)$ 3) $\frac{2}{3K} \ln\left(\frac{g+kv_0^2}{g}\right)$ 4) $\frac{1}{K} \ln\left(\frac{g+kv_0^2}{g}\right)$

Ans: 1

Sol: $F_{net} = ma$

$$-mg - mkv^2 = mv\frac{dv}{ds}$$

$$v\frac{dv}{ds} = -g - kv^2$$

$$-\int_{v_0}^{0} \frac{vdv}{g+kv^2} = \int_{0}^{h_{max}} ds = h_{max}$$

$$h_{max} = \frac{1}{2K} \ln\left(\frac{g+kv_0^2}{g}\right)$$

14. $\lambda = 6000\times10^{-10}\,\text{m}$ and width : $0.6\times10^{-4}\,\text{m}$. Find highest order of minima on both side of central maxima

1) 10 2) 20 3) 100 4) 200

Ans: 3

Sol: Light of wavelength $6000\times10^{-10}\,\text{m}$ passes through a single slit of width $0.6\times10^{-4}\,\text{m}$. Find height of highest order of minima on both side central maxima for minima

$$d\sin\theta = n\lambda$$

$$\sin\theta = \frac{n\lambda}{d} < 1$$

$$n \le \frac{d}{\lambda}$$

$$n < \frac{0.6\times10^{-4}}{6000\times10^{-10}}$$

$$n < 100$$

15. Maximum wave length of Lyman series photon for H is then minimum wavelength of Balmer series photon for He^{+} atm

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

Ans: 2

Sol: $$\frac{1}{\lambda_{He^{+}}} = R(4)\left(\frac{1}{4}-\frac{1}{\infty}\right) = R$$

$$\frac{1}{\lambda_{He^{+}}} = \frac{1}{R}$$

$$\frac{1}{\lambda_{He^{+}}} = R\left(1-\frac{1}{4}\right) \text{ given}$$

$$\frac{1}{\lambda} = \frac{3R}{4}$$

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

$$\therefore\ \lambda_{He^{+}} = \frac{3\lambda}{4}$$

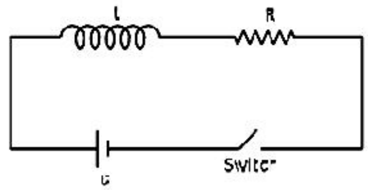
16. Electric field in EM waves is $E = E_0(\hat{i}+\hat{j})\sin(kz-\omega t)$, then equation of magnetic field is

1) $B = B_0(-\hat{i}+\hat{j})\sin(kz-\omega t)$
2) $B = B_C(\hat{i}+\hat{j})\sin(kz-\omega t)$
3) $B = B_C(\hat{j}+\hat{k})\sin(kz-\omega t)$
4) $B = B_0(\hat{i}+\hat{j})\sin(kz-\omega t)$

Ans: 1

Sol: $E \times B \parallel C$

17. The circuit is switched on at t = 0, Find the time when energy stored in inductor becomes $\frac{1}{n}$ times of maximum energy stored in it



1) $\frac{L}{R}\ln\frac{\sqrt{n}}{\sqrt{n}+1}$
2) $\frac{L}{R}\ln\frac{\sqrt{n}}{\sqrt{n}-1}$
3) $\frac{L}{R}\ln\frac{\sqrt{n}+1}{\sqrt{n}}$
4) $\frac{L}{R}\ln\frac{\sqrt{n}-1}{\sqrt{n}}$

Ans: 2

Sol: Potential energy stored in inductor is given by $U = \frac{1}{2}LI^2$

$$\frac{U}{U_0} = \left(\frac{1}{I_0}\right)^2$$

$$\frac{1}{n} = \left(\frac{1}{I_0}\right)^2$$

$$\frac{I}{I_0} = 1 - e^{-RT/L} = \frac{1}{\sqrt{n}}$$

$$t = \frac{L}{R}\ln\frac{\sqrt{n}}{\sqrt{n}-1}$$

18. Intensity of magnetization is 4 (unit) at temperature 6K and B = 0.4 T. What is the intensity of magnetization at temperature 24 K in B = 0.3 T

1) 0.75
2) 0.25
3) 0.5
4) 1

Ans: 1

Sol: Magnetization = 4 T= 6k, B = 0.4 T

(Paramagnetic substance) T= 24k, B = 0.3 T

$$M = \frac{CB_{ex}}{T}$$

$$\frac{4}{M} = \frac{0.4/6}{0.3/24} = 0.75$$

19. Match the following

I	Adiabatic	A)	$\Delta U = 0$
II	Isothermal	B)	$\Delta W = 0$
III	Isobaric	C)	$\Delta Q = 0$
IV	Isochoric	D)	$\Delta U \neq 0$, $\Delta Q \neq 0$, $\Delta W \neq 0$

1) $I \rightarrow A$ $II \rightarrow C$ $III \rightarrow D$ $IV \rightarrow B$

2) $I \rightarrow D$ $II \rightarrow B$ $III \rightarrow C$ $IV \rightarrow A$

3) $I \rightarrow C$ $II \rightarrow A$ $III \rightarrow D$ $IV \rightarrow B$

4) $I \rightarrow B$ $II \rightarrow D$ $III \rightarrow C$ $IV \rightarrow A$

Ans: 3

20. A satellite is revolving around the earth. Ratio of its orbital speed and escape speed will be

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

Ans: 1

Sol: $$\frac{v_0}{v_0} = \frac{\sqrt{\frac{GM}{r}}}{\sqrt{\frac{2Gm}{r}}} = \frac{1}{\sqrt{2}}$$

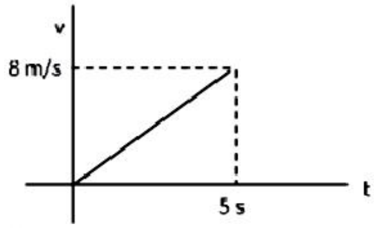
21. If I is moment of inertia, F is force, v is velocity, E is energy and L is length then, dimension of $\frac{I F v^2}{E\ L^4}$ will be

1) Energy density 2) Viscosity 3) Young modulus 4) Torque

Ans: 1 or 3

Sol: $$\frac{I F v^2}{E\ L^4} = \frac{\left(M^1L^2\right)\left(M^1L^1T^{-2}\right)\left(L^1T^{-2}\right)^2}{\left(M^1L^2T^{-2}\right)\left(L^4\right)} = \frac{M^1L^{-2}T^{-2}}{L^3} = M^1L^{-1}T^{-2} = \text{Energy density}$$

22. Speed time graph of a particle is shown in figure. Find distance travelled by particle in 5 second



Ans: 20.00

Sol: Distance = Area of $|v| - t$ graph

$$= \frac{1}{2} \times 8 \times 5 = 20\,m$$

23. In displacement method distance of lens and screen is 100 cm initial image is obtained on screen. Now lens is displaced 40cm image formed on screen again. If power of the lens is (100/N) dioptre, then find the value of N.

Ans: 21.00

Sol: $$f = \frac{D^2 - d^2}{4D} = \frac{100^2 - 40^2}{4(100)} = \frac{(100+40)(100-40)}{4(100)}$$

$$= \frac{140 \times 60}{4 \times 100} = \frac{14 \times 6}{2 \times 2} = 7 \times 3 = 21\text{ cm}$$

$$P = \frac{100}{21} = \frac{100}{21}D$$

24. Binding energy per nucleon of $_{50}Sn^{120}$ approximately will be. [Atomic mass of Sn^{120} is 120.500 u and that of ^1H is 1.007 u. Mass of neutron = 1.008 u, $1u = 931\text{ MeV}$]

Ans: 3.18 MeV

Sol: The number of protons in $_{50}Sn^{120} = 50$ and the number of neutron = 120 – 50 = 70.

The binding energy of $_{50}Sn^{120}$ is

$$= [50 \times 1.007\,u + 70 \times 1.008\,u - 120.500\,u]c^2 = (0.41\,u)c^2$$

$$= (0.41\text{ u})(931\text{MeV}/\text{u}) = 381.71\text{ MeV}$$

Binding energy per nucleon = $\frac{381.71}{120} = 3.18\text{ MeV}$