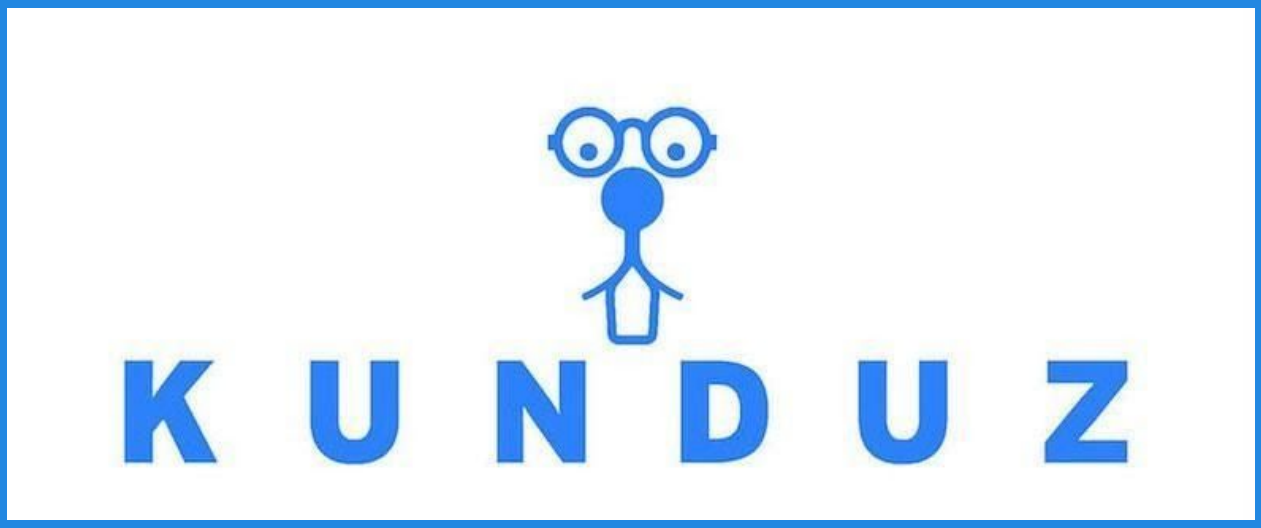


Jan 7 2020 shift 1 Physics prepared by KUNDUZ tutors

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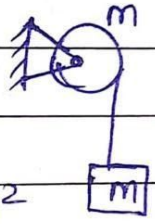
Question no.	Questions and Answers
1	

1. A Block of mass m is suspended from a pulley in form of a circular disc of mass m & Radius R. The system is released from rest, find the angular velocity of disc when block has dropped by height h.

(1) $\frac{1}{R}\sqrt{\frac{4gh}{3}}$ (2) $\frac{1}{R}\sqrt{\frac{2gh}{3}}$

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

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$



$$v = \omega R$$

$$mgh = 1/2\, m\omega^2R^2 + 1/2\, \frac{mR^2}{2}\omega^2$$

$$mgh = 3/4\, m\omega^2R^2$$

$$\omega = \frac{1}{R}\sqrt{\frac{4gh}{3}}$$

2

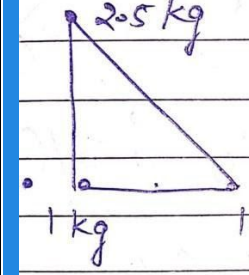
2. Three points masses 1kg, 1.5kg, 2.5kg are placed at the vertices of a triangle with sides 3cm, 4cm and 5cm as shown in figure. The location of centre of mass w.r.t to 1kg mass is

(1) 0.6 cm to the right of 1 kg & 2cm above 1kg mass.

(2) 0.9 cm to the right of 2cm above 1kg mass.

(3) 0.9cm to the left of 1kg & 2 cm above 1kg mass.

(4) 0.9 cm to the right of 1kg & 1.5cm above 1kg mass



$$X\,cm = \frac{1\times0 + 1.5\times3 + 2.5\times0}{5}$$

$$= 0.9\,cm$$

$$Y\,cm = \frac{1\times0 + 1.5\times0 + 2.5\times4}{5}$$

$$= 2\,cm$$

0.9 cm to the right of 1kg & 2 cm above 1kg mass.

3

3. In a single slit diffraction set up, second ~~max~~ minima is observed at an angle of 60°. The expected position of first minima is

(1) 25° (2) 20° (3) 30° (4) 45°

for 2nd maxima

$d \sin\theta = 2\lambda$

$\sin\theta = \sqrt{3}/2$

$\lambda/d = \sqrt{3}/4$

$\theta = 25.65^\circ$

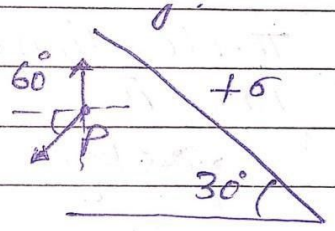
$\theta \simeq \underline{25^\circ}$

4

4. There are two infinite plane sheets each having uniform surface charge density $+\sigma$ C/m². They are inclined to each other at an angle 30° as shown in the figure. Electric field at any arbitrary point P is

(1) $\frac{\sigma}{2\epsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{1}{2}\hat{k}\right]$ (2) $\frac{\sigma}{2\epsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{1}{2}\hat{x}\right]$

(3) $\frac{\sigma}{2\epsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{1}{2}\hat{x}\right]$ (4) $\frac{\sigma}{2\epsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{1}{2}\hat{x}\right]$



$\vec{E} = \frac{\sigma}{2\epsilon_0}\cos 60^\circ(-\hat{x}) + \left[\frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0}\sin 60^\circ\right](\hat{y})$ (+σ)

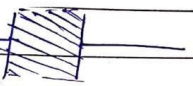
$\vec{E} = \sigma/2\epsilon_0\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y} - \frac{1}{2}\hat{x}\right]$

5

5. A parallel plate capacitor with plate Area A & plate separation d is filled with a dielectric material of dielectric constant given by $k = k_0(1+\alpha x)$. Calculate the capacitance of system

(1) $\frac{k_0\epsilon_0 A}{d}(1+\alpha^2 d^2)$ (2) $\frac{k_0\epsilon_0 A}{d}\left(1+\frac{\alpha d}{2}\right)$ (3) $\frac{k_0\epsilon_0 A}{d}(1+\alpha d)$

Capacitance of element $= \frac{k\epsilon_0 A}{dx}$



Capacitance of element $= \frac{k_0(1+\alpha x)\epsilon_0 A}{dx}$

$$\sum \frac{1}{C} = \int_0^d \frac{dx}{k_0\epsilon_0 A(1+\alpha x)}$$

$$\frac{1}{C} = \frac{1}{k_0\epsilon_0 A\alpha}\ln(1+\alpha d)$$

$$\frac{1}{C} = \frac{1}{k_0\epsilon_0 A\alpha}\left(\alpha d - \frac{\alpha^2 d^2}{2}\right)$$

$$\frac{1}{C} = \frac{d}{k_0\epsilon_0 A}\left(1-\frac{\alpha d}{2}\right)$$

$$C = \frac{k_0\epsilon_0 A}{d}\left(1+\frac{\alpha d}{2}\right)$$

6

6. A long solenoid of Radius R Carries a time dependent current $I = I_0 t(1-t)$. A ring of radius $2R$ is placed coaxially near its centre. During the time interval $0 < t < 1$, the induced current I_R & the induced emf V_R in the ring vary as

(1) current will change its direction & its emf will be zero at $t = 0.25$ sec

(2) current will not change its direction & emf will be maximum at $t = 0.5$ sec

(3) current will not change direction & emf will be zero at 0.25 sec

(4) current will change its direction & its emf will be zero at $t = 0.5$ sec

$I = I_0 t - I_0 t^2$

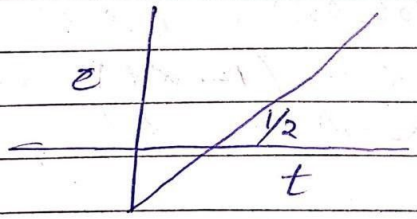
$\phi = BA$

$\phi = \mu_0 n I A$

$V_R = -\frac{d\phi}{dt} = -\mu_0 n A I_0 (1-2t)$

$V_R = 0$ at $t = 1/2$

$I_R = \frac{V_R}{\text{Resistance of loop}}$



current will change its direction & its emf will be zero at $t = 0.5$ sec.

7

7. If 10% of intensity is passed from analyser, then the angle by which analyser should be rotated such that transmitted intensity becomes zero.

(1) 60° (2) 18.4° (3) 45° (4) 71.6°

$I = I_0 \cos^2\theta$

$\frac{I_0}{10} = I_0 \cos^2\theta$

$\cos\theta = 1/\sqrt{10} = 0.31 < 1/\sqrt{2}$.

Angle rotated should be $= 90° - 71.6°$

$= 18.4°$

8

8. Three moles of ideal gas A with $C_P/C_V = 4/3$ is mixed with two moles of another ideal gas B with $C_P/C_V = 5/3$. The C_P/C_V of mixture is

(1) 1.5 (2) 1.42 (3) 1.7 (4) 1.3

$$\gamma_{mixture} = \frac{n_1 C_{P_1} + n_2 C_{P_2}}{n_1 C_{V_1} + n_2 C_{V_2}} = \frac{n_1 \gamma_1 R/\gamma_1 - 1 + n_2 \gamma_2 R/\gamma_2 - 1}{\frac{n_1 R}{\gamma_1 - 1} + \frac{n_2 R}{\gamma_2 - 1}}$$

$$\frac{n_1 + n_2}{\gamma_{mix} - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1} \Rightarrow \frac{5}{\gamma_{mix} - 1} = \frac{3}{1/3} + \frac{2}{2/3}$$

$$\frac{5}{\gamma_{mix} - 1} = 9 + 3 = 12$$

$$\gamma_{mix} = \frac{17}{12} = 1 + \frac{5}{12}$$

$$\gamma_{mix} = 1.42$$

9

9. Given magnetic field equation is $B = 3 \times 10^{-8} \sin(\omega t + kx + \phi)\hat{j}$, then appropriate equation for electric field (E) will be

(1) $20 \times 10^{-9} \sin(\omega t + kx + \phi)\hat{k}$ (2) $9 \sin(\omega t + kx + \phi)\hat{k}$

(3) $16 \times 10^{-9} \sin(\omega t + kx + \phi)\hat{k}$ (4) $3 \times 10^{-9} \sin(\omega t + kx + \phi)\hat{k}$

$$\frac{E_0}{B_0} = C$$

$$E_0 = B_0 C = 3 \times 10^{-8} \times 3 \times 10^8$$

$$= 9 \text{ N/C}$$

$$E = 9 \sin(\omega t + kx + \phi)$$

10

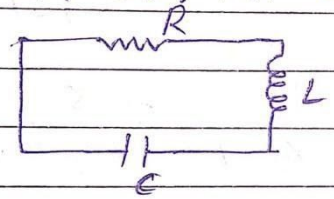
10. There is a LCR circuit. If it is compared with a damped oscillation of mass m oscillating with force constant k & damping coefficient 'b'. Compare the terms of damped oscillation with the devices in LCR circuit.

(1) $L \to m, C \to \frac{1}{k}, R \to b$ (2) $L \to m, C \to k, R \to b$

(3) $L \to k, C \to b, R \to m$ (4) $L \to 1/m, C \to 1/k, R \to 1/b$

In damped oscillation

$ma + bv + kx = 0$



$$\frac{m d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0$$

$$-iR - L\frac{di}{dt} - \frac{q}{C} = 0.$$

$$\Rightarrow L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}\cdot q = 0.$$

$$m = L, \; b = R, \; K = \frac{1}{C}$$

11

11. A Lift can hold 2000 kg, friction is 4000 N and power provided is 60 H.P. (1 HP = 746 W). find the maxm speed with which lift can move up.

(1) 1.9 m/s (2) 1.7 m/s (3) 2 m/s (4) 1.5 m/s

$4000 \times V + mg \times V = P$

$\frac{60 \times 746}{4000 + 20000} = V$

$V = 1.86 \text{ m/s}$

$= 1.9 \text{ m/s}$

12

12. A H-atom in ground state has time period $T = 1.6 \times 10^{-16}$ sec, find the frequency of electron in first excited state

(1) 7.8×10^{14} (2) 7.8×10^{16}

(3) 3.7×10^{14} (4) 3.7×10^{16}

$T \propto \frac{r}{v} \propto \frac{n^2}{z} \times \frac{n}{z} \propto \frac{n^3}{z^3}$

$\frac{T_1}{T_2} = \frac{n_1^3}{n_2^3} = \frac{1}{8}$

$T_2 = 8T_1$

$= 8 \times 1.6 \times 10^{-16} = 12.8 \times 10^{-16}$

$f_2 = \frac{1}{T_2} = 7.8 \times 10^{14}$.

13

13. Magnification of compound microscope is 375. Length of tube is 150 mm. Given that focal length of objective lens is 5 mm, then value of focal length of eyepiece is If final image is at least distance of clear vision

(1) 2 mm (2) 22 mm
(3) 12 mm (4) 33 mm

$$M.P = \frac{L}{f_o}\left(1+\frac{D}{f_e}\right) \Rightarrow 375 = \frac{150}{5}\left[1+\frac{25}{f_e}\right]$$

$$\frac{375}{30} = 1+\frac{25}{f_e}$$

$$f_e = 22 \text{ mm}$$

14

14. 1 litre of a gas at STP is expanded adiabatically to 3 litre. find work done by the gas.

$P_1 = 1$ atm, $T_1 = 273$ K

(1) 100.8 J (2) 90.5 J
(3) 45 J (4) 18 J

$P_1 = 1\ atm,\ T_1 = 273\ K$

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$P_2 = P_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 1\ atm\left(\frac{1}{3}\right)^{1/4}$

$\text{Work done} = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = 88.7\ J$

closest is 90.5 J

15

15. A string of length 60 cm, mass 6 gm and area of cross section $1\ mm^2$ & velocity of wave 90 m/s. Given young's modulus is $Y = 1.6 \times 10^{11}\ N/m^2$. find Extension in ~~zinc~~ string.

(1) 0.3 mm (2) 0.2 mm
(3) 0.1 mm (4) 0.4 mm

$V = \sqrt{\frac{T}{\mu}} \quad T = \mu V^2$

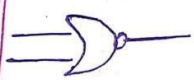
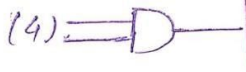
$\frac{\mu V^2}{A} = Y\frac{\Delta l}{l}$

$\Delta l = \frac{\mu V^2 l}{AY}$

$\Delta l = 0.3\ mm$

16

16. which of the following gate is reversible

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

PAGE NO.:
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Ans – A logic gate is reversible if we can recover input data from the output.

e.g. NOT gate



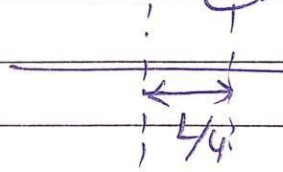
17

17. A thin uniform rod of mass M and length L. find the radius of gyration for rotation about an axis passing through a point at a distance of L/4 from centre & ⊥ to rod.

(1) $\sqrt{\frac{7}{48}}\,L$ (2) $\sqrt{\frac{5}{48}}\,L$

(3) $\sqrt{\frac{7}{24}}\,L$ (4) $\sqrt{\frac{19}{24}}\,L$

$$\frac{ML^2}{12} + M\left(\frac{L}{4}\right)^2 = Mk^2$$



$$\frac{L^2}{12} + \frac{L^2}{16} = k^2$$

$$k = \sqrt{\frac{7}{48}}\,L$$

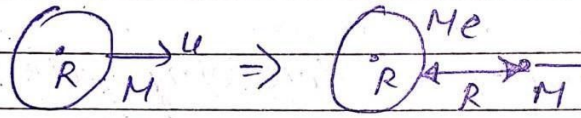
18

18. A satellite of mass M is projected radially from surface of earth with speed u. When it reaches a height equal to radius of earth, it ejects a rocket of mass $\frac{M}{10}$ and itself starts orbiting the earth in circular path of radius $2R$. Find the kinetic energy of the rocket.

(1) $5M\left(u^2 - \frac{119GM_e}{200R}\right)$ (2) $5M\left(u^2 - \frac{113GM_e}{200R}\right)$

(3) $\frac{M}{20}\left(u^2 - \frac{119GM_e}{100R}\right)$ (4) $\frac{M}{20}\left(u^2 - \frac{113GM_e}{200R}\right)$

$$-\frac{GM_eM}{R} + \frac{1}{2}Mu^2 = -\frac{GM_eM}{2R} + \frac{1}{2}MV^2$$



$$V = \sqrt{u^2 - \frac{GM_e}{R}}$$

$$\frac{M}{10}V_T = \frac{9M}{10}\sqrt{\frac{GM_e}{2R}}$$

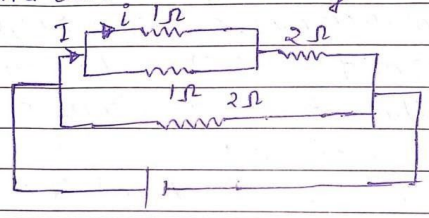
$$\frac{M}{10}V_r = M\sqrt{u^2 - \frac{GM_e}{R}}$$

$$\text{kinetic energy} = \frac{1}{2}\frac{M}{10}\left(V_T^2 + V_r^2\right)$$

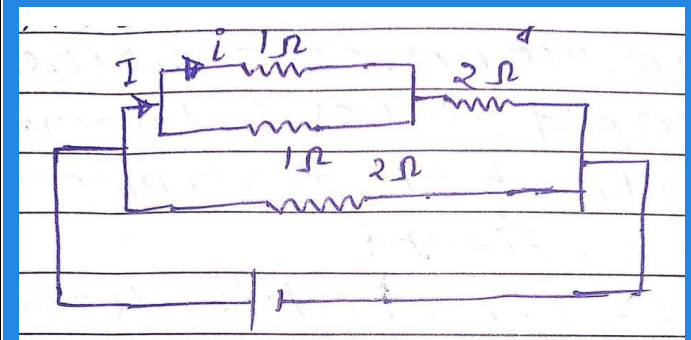
$$= 5M\left(u^2 - \frac{119GM_e}{200R}\right)$$

19

19. The current i in the given circuit is.



(1) 0·2 A (2) 0·3 A (3) 0·5 A (4) 0·25 A



$$I = \frac{1}{2 \cdot 5} = 0 \cdot 4\ A$$

$$i = \frac{I}{2} = 0 \cdot 2\ A$$

20

20. A current carrying circular loop is placed in an infinite plane if ϕ is the magnetic flux through the inner region & ϕ_0 is magnitude of magnetic flux through the outer region, then.

(1) $\phi > \phi_0$ (2) $\phi < \phi_0$

(3) $\phi = -\phi_0$ (4) $\phi = \phi_0$

As magnetic field lines always form a closed loop, hence every magnetic field line creating magnetic flux in the inner region must be passing through the outer region. Since flux in two regions are in opp. direction.

$\therefore \phi_i = -\phi_o$

21

Numerical value type question

21. Consider a loop ABCDEFA with Coordinates A(0,0,0), B(5,0,0), C(5,5,0), D(0,5,0), E(0,5,5) and F(0,0,5). find magnetic flux through loop due to magnetic field $\vec{B} = 3\hat{i} + 4\hat{k}$.

$$\phi = \vec{B} \cdot \vec{A} = (3\hat{i} + 4\hat{k}) \cdot (25\hat{i} + 25\hat{k})$$

$$\phi = 3 \times 25 + 4 \times 25$$

$$= 175 \text{ weber.}$$

22

22. A Carnot's engine operates between two reservoirs of temperature 900K & 300K. The engine performs 1200 J of work per cycle. The heat energy delievered by the engine to the low temp. reservoir in a cycle is:-

$$\eta = \frac{W}{Q_h} = \frac{1 - 300}{900} = \frac{2}{3}$$

$$Q_h = \frac{3}{2} W = 1800 \text{ J}$$

$$Q_L = Q_h - W$$

$$= 600 \text{ J}$$

23

23. A non-isotropic solid metal cube has coefficients of linear expansion as $5 \times 10^{-5}/°C$ along the x-axis & $5 \times 10^{-6}/°C$ along y-axis & z-axis. If coefficient of volume expansion of solid is $C \times 10^{-6}/°C$. Then the value of C is

$V = \alpha\alpha_2 + \alpha_1$

$= 10 \times 10^{-6} + 5 \times 10^{-5}$

$= 60 \times 10^{-6}/°C$

24

24. A particle is released at point A. find its kinetic energy at point P.

$KE = PE_1 - PE_2 = mgh_1 - mgh_2$

$= 1 \times 10 \times 2 - 1 \times 10 \times 1$

$= 10\ J$

25

25. On a photosensitive metal of area $1 cm^2$ & work function 2eV, light of intensity $6.4 \times 10^{-5}\ W/cm^2$ and wavelength 310 nm is incident normally. If 1 out of every 10^3 photons are successful, then no. of photons emitted is 10^X. Find X.

$\text{Energy} = \frac{1240}{310} = 4eV > 2eV$

$= 4 \times 1.6 \times 10^{-19} = 6.4 \times 10^{-19}\ J$

No. of photons falling per second $= 10^{14}$

No. of photoelectron $= \frac{10^{14}}{10^3}$

$= 10^{11}$

$X = 11$

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