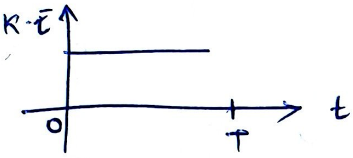
Physics

1. Variation of K.E = $A\sin(\omega t)$ $\quad$ $KE = \frac{1}{2} m v^2$

$v = \frac{dx}{dt} = A\omega\cos(\omega t).$ $\quad$ $= \frac{1}{2} m A^2 \omega^2 \cos^2(\omega t)$

option (3)



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2. Power $= \frac{V^2}{R}$ $\qquad$ $P_2 = \frac{V_2^2}{R}.$

$R = \frac{V^2}{P_1}.$

$$P_2 = \frac{V_2^2}{\frac{V_1^2}{P_1}} = P_1\left(\frac{V_2}{V_1}\right)^2 = 400 \times \left(\frac{200}{220}\right)^2$$

$$= 400 \times \frac{\overset{10}{\cancel{200}}}{\underset{11}{\cancel{220}}} \times \frac{\overset{10}{\cancel{200}}}{\underset{11}{\cancel{220}}}$$

$$= \frac{400}{121} \times 100$$

$$= 330.57 \text{ W}$$

option (3)

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③. $\omega_f = 1200$ rpm $\omega_i = 600$ rpm $\quad$ $t = 10s.$

Avg speed $= \frac{600 + 1200}{2} = 900$ rpm

$= \frac{900}{60} = 15$ rev/s.

Total revolution N = Avg speed × time

$= 15 \text{ rev/s} \times 10$

$= \underline{\underline{150 \text{ revolution.}}}$

option (4)

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④. $T.E = 0.02\,J.$ $\qquad$ $P.E$ = zero at equilibrium

$m = 20g = 0.02\,kg.$

$K.E = \frac{1}{2}mv^2$

$$\cancel{0.02} = \frac{1}{2} \times \cancel{0.02} \times v^2$$

$v^2 = 2 \qquad v = \sqrt{2} = \underline{\underline{1.414\ m/s}}.$

$\boxed{\checkmark \text{ option}(4)}$

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⑤. $N = 100, \quad r = 5cm = 0.05\,m, \quad B = 3.14 \times 10^{-3}\,T.$

$\boxed{\text{option (3) } 2.5A, 2Am^2}$

$$B = \frac{\mu_0 N I}{2r}$$

$$3.14 \times 10^{-3} = \frac{4\pi \times 10^{-7} \times 100 \times I}{2 \times 0.05}$$

$$\frac{3.14 \times 10^{-3} \times 2 \times 0.05}{4 \times 3.14 \times 10^{-7} \times 100} = I = 2.5\,A$$

Magnetic moment, $m = NI\overset{\pi r^2}{A} = 100 \times 2.5 \times 3.14 \times (0.05)^2$

$= 2\,Am^2$

⑥. $P_{Total} = 100 \text{ atm}$

$= 100 \times 10^5 \text{ Pa}$.

$\boxed{\text{option } ② \quad 990 m}$

$\rho = 1000 \text{ kg/m}^3$

$g = 10 \text{ m/s}^2$.

$P_{total} = P_{atm} + \rho g h$

$100 \times 10^5 = 1 \times 10^5 + (1000 \times 10 \times h)$

$99 \times 10^5 = 10^4 \times h$

$h = \frac{99 \times \cancel{10^5}}{\cancel{10^4}} = 990 \text{ m}$

$\boxed{h = 990 m}$

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⑦ Match.

A. $E = h\nu$ ⇒ IV Energy of photon.

B. Diffraction & Interference ⇒ III Wave nature of light

C. $\lambda = h/p$ ⇒ I de-broglie wavelength.

d.) Compton nature ⇒ II particle nature of light.

option ② : A-IV, B-III, C-I, D-II

8. Match.

A. Youngs modulus. – $\underline{II}$ $\frac{FL}{A(\Delta L)}$

B. Compressibility. – $\underline{III}$ $-\frac{1}{\Delta P}\left(\frac{\Delta V}{V}\right)$

C. Bulk modulus – $\underline{IV}$ $-P\left(\frac{V}{\Delta V}\right)$

D. Poisson's ratio. – I $\frac{\Delta d}{\Delta L}\left(\frac{L}{d}\right)$

$$\boxed{\text{option ② .}\quad A-\underline{II},\ B-\underline{III},\ C-\underline{IV},\ D-\underline{I}}$$

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9. Wheatstone's bridge.

$$\frac{1}{10}+\frac{1}{10}+\frac{1}{10}+\frac{1}{10}=\frac{4}{10}.$$

$$=2.5.$$

$$\frac{C1}{C3}=\frac{C2}{C4}=\frac{10}{10}=1.$$

~~[illegible]~~ = ~~[illegible]~~. ~~[illegible]~~ $\frac{1}{C_{series}}=\frac{1}{10}+\frac{1}{10}+\frac{1}{10}+\frac{1}{10}=\frac{4}{10}.$

$C_{series}=\frac{10}{4}=2.5.$

Total C_{eq} = ~~[illegible]~~ $2.5+2.5=5\mu F$

$$Q_{total}=C_{eq}V.$$

$$=\overset{5}{\cancel{1}}\mu F\times 50\ V$$

~~[illegible]~~ . 250 μC

This 500 μC divides equally into two branches.

Thus. each capacitor charge $=\frac{\overset{250}{\cancel{500}}\mu C}{2}=\overset{125}{\cancel{250}}\mu C$

<u>option (4)</u> : 5μF, 125 μC on all capacitors.

⑩. $U = -\frac{GMm}{r}$.

$r_i = R$

$h = R + R = 2R$.

$$W = \left(-\frac{GMm}{2R}\right) - \left(-\frac{GMm}{R}\right) = \frac{GMm}{2R}.$$

$$g = \frac{GM}{R^2}.$$

$$W = \frac{(gR^2)m}{2R} = \frac{1}{2}mgR.$$

option 1 : $\frac{mgR}{2}$.

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⑪. $d = \frac{1}{2}gt^2$ $\quad d \propto t^2$.

order : B > E > A > C > D.

option ①

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⑫. $P = \frac{mgh}{t} = \frac{1000 \times 9.8 \times 20}{10} = 1000 \times 9.8 \times 2$

$= 19{,}600$ W.

$P = 19.6$ kW.

option ① : 19.6 kW

⑬. $$\Delta U = \frac{C_1 C_2}{2(C_1 + C_2)} (V_1 - V_2)^2$$

$C_1 = 200\,pF$

$C_2 = 200\,pF$

$V_1 = 100\,V$

$V_2 = 0V$

$$\Delta U = \frac{(200 \times 10^{-12})^2}{2 \times (400 \times 10^{-12})} (100)^2$$

$$= \frac{\cancel{4}^{1} \times 10^{\cancel{-20}}}{2\cancel{8} \times 10^{\cancel{-10}}} \times 10^4$$

$$\Delta U = 0.5 \times 10^{-10} \times 10^4 = 0.5 \times 10^{-6} J.$$

option ③ : 0.5×10^{-6} J

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⑭. $$f_r = \frac{1}{2\pi\sqrt{LC}}.$$

option ① = 15.9 kHz

$L = 1mH = 10^{-3}\,H.$

$C = 0.1\mu F = 10^{-7}\,F.$

$$f_r = \frac{1}{2 \times 3.14 \sqrt{10^{-3} \times 10^{-7}}} = \frac{1}{6.28 \times 10^{-5}} = \frac{100}{6.28} \times 10^3$$

$= 15.9$ kHz

(15). Ampere's circutal law: $B = \frac{\mu_0 I r}{2\pi a^2} \Rightarrow B \propto r$. (Linear increa

inside. $(r<a)$

Outside $(r>a)$ $B = \frac{\mu_0 I}{2\pi r} \Rightarrow B \propto \frac{1}{r}$. (Hyperbolic) dse.

$\boxed{\text{option (1)}}$

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(16). $\Delta Q = \Delta U + \Delta W$

$$\frac{dU}{dt} = \frac{dQ}{dt} - \frac{dW}{dt}.$$

$\frac{dQ}{dt} = 100\ W.$ $\frac{dW}{dt} = 75\ J/W.$

$$\frac{dU}{dt} = 100 - 75 = 25\ W.$$

$\boxed{\text{option (2) : 25W}}$

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(17). $I = I_0 \sin(\omega t)$

peak value at $\omega t = \frac{\pi}{2}$

$$t = \frac{\pi}{2\omega} = \frac{\pi}{2(2\pi f)} = \frac{1}{4f}.$$

$f = 60\ Hz$

$$t = \frac{1}{4 \times 60} = \frac{1}{240}\ s$$

$\boxed{\text{option (2)} : \frac{1}{240}\ s}$

⑱. Intensity in YDSE.

$$I = I_{max} \cos^2\left(\frac{\phi}{2}\right)$$

First case:

$\Delta x = \lambda$

$\phi = 2\pi . I$

$= I_{max} \cos^2 (\pi)$

$\phi = k.$

$I_{max} = k.$

$\boxed{\text{option (4)} : \frac{k}{4}}$

case II.

$\Delta x = \frac{\lambda}{3}.$

$\phi = \frac{2\pi}{\cancel{\lambda}} . \frac{\cancel{\lambda}}{3} = \frac{2\pi}{3}$

$I' = k \cos^2 \left(\frac{\cancel{2}\pi/3}{\cancel{2}}\right)$

$= k \cos^2 \left(\frac{\pi}{3}\right)$

$= k \left(\frac{1}{2}\right)^2 = \frac{k}{4}$

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⑲. option (2)- B and D are true, but A and C are false.

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⑳. option (2) A is true, but B is false.

㉑ $V = E - Ir.$

$E = 12 V.$

$(r) = 2 \Omega.$

$I = 0.6 A.$

$V = 12 - (0.6 \times 2)$

$= 12 - 1.2$

$= 10.8 V.$

$\boxed{\text{option (4)} : 10.8 V}$

㉒. Both right-sided and left sided deflection and at balance point, no deflection.

option ④

㉓. $T = \frac{60}{30} = 2s.$

option ② = 1m

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

$$T^2 = 4\pi^2 \times \frac{L}{g}.$$

$$L = \frac{gT^2}{4\pi^2} = \frac{\cancel{9.8} \times 2^2}{4 \times \cancel{9.8}} = \frac{4}{4} = 1m.$$

㉔. option ① - A, C and D only

㉕. option ③ - Statement A is true; But Statement B is false.

㉖. option ② - appears to diverge from the first principal focus.

㉗. $M = 19.926 \times 10^{-27}$

Average ~~of~~ mass of nucleon $= \frac{\text{Total mass}}{1 \text{ amu}}$

$$= \frac{19.926 \times \cancel{10^{-27}}}{1.66 \times \cancel{10^{-27}}} = 12.$$

$\boxed{\text{option (3) - 12}}$

㉘. $G = 100\,\Omega$

$I_g = 1\text{mA} = 1 \times 10^{-3}\,A.$

$I = 10\,A.$

$$S = \frac{I_g \cdot G}{I - I_g} \Rightarrow I = \frac{I_g \cdot G}{I}$$

$$S = \frac{10^{-\cancel{3}} \times 10\cancel{0}}{1\cancel{0}} = \underline{0.01\,\Omega}$$

$\boxed{\text{option ④ : } 0.01\,\Omega}$

㉙. Parallel axis theorem

$$I = I_{\text{diameter}} + MR^2$$

$$= \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2$$

$$I = \frac{3}{2}(mL)\left(\frac{L}{2\pi}\right)^2 = \frac{3mL^3}{8\pi^2}$$

option (2)

$$\frac{3mL^3}{8\pi^2}$$

㉚. $y = 2.0 \cos\left[2\pi(10t - 0.0080x + 0.35)\right]$

$\Delta x = 0.5\,m = 50\,cm.$

$\Delta\phi = k \cdot \Delta x = 2\pi \times 0.0080 \times 50$

$= 0.8\pi$ rad.

option ③ − 0.8π

$ma \leq \mu_s mg$

31. $a_{max} = \mu_s g = 0.12 \times 10$

$= 1.2\,m/s^2$

option ② − 1.2

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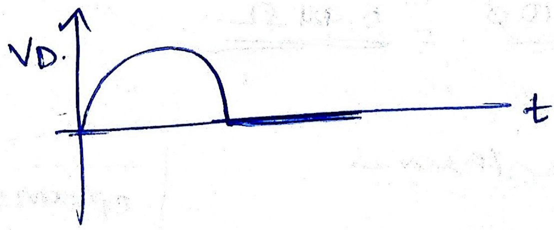
32. option ④



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33. $V_{rms} = \sqrt{\frac{3RT}{M}}$

option (3) $= \sqrt{7}/2$

$\frac{V_{Ar}}{V_{Cl_2}} = \sqrt{\frac{M_{Cl_2}}{M_{Ar}}} = \sqrt{\frac{71}{40}} \simeq \sqrt{\frac{7}{4}} = \frac{\sqrt{7}}{2}$

㉞. option ④

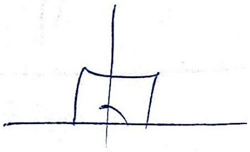
A - IV

B - I

C - II

D - III

㉟. $F_{net} = \sqrt{8^2+6^2} = \sqrt{100} = 10\,N$.



$a = \frac{F_{net}}{m} = \frac{10}{5} = 2\,m/s^2$.

$\tan\theta = \frac{6}{8} = \frac{3}{4}$ $\theta = \tan^{-1}(3/4)$.

$\boxed{\text{option ② } - 2\,m/s^2, \tan^{-1}(3/4)}$

Reverse biased.

㊱- $R = 3\Omega + 2\Omega = 5\Omega$.

$I = \frac{V}{R} = \frac{10\,V}{5\,\Omega} = 2A$.

$\boxed{\text{Option ③ - 2A}}$

㊲ $\lambda_0 = \frac{hc}{\phi} = \frac{1242\,\cancel{eV}.nm}{6.63\,\cancel{eV}} \simeq 187.3\,nm$.

Does not occur ~~before~~ if greater than 187.3 nm

Option ① - 200 nm

(38). $c = 1$, $d = t$,

Light takes 8 min 20s to reach

$t = (8 \times 60) + 20 = 500\ s.$

$d = c \times t = 1 \times 500 = 500$ units,

Option ② - 500 units

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(39). Induced emf $\mathcal{E} = Bdv$

$B = 0.3\ T$

$v = 2\ cm/s = 0.02\ m/s.$

$l = 8\ cm = 0.08\ m$

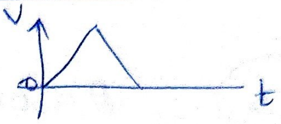
$\mathcal{E} = 0.3 \times 0.08 \times 0.02$

$= 0.00048\ V$

$= 4.8 \times 10^{-4}\ V$

option (4) - 4.8×10^{-4} Volt

40. option ① − B only



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41. 20 VSD = 16 MSD.

1MSD = 1mm = 0.1 cm.

$1\ VSD = \frac{16}{20}\ MSD = 0.8\ MSD.$

LC = 1MSD − 1VSD.

= 1 MSD − 0.8 MSD = 0.2 MSD.

LC = 0.2 × 0.1 = 0.02 cm.

$\boxed{\text{option ③ − 0.02cm}}$

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42. m = 5.50 kg. (3 sig. Fig)

a = 9.0 cm (2 sig. fig.).

$V = a^3 = (0.090)^3 = 0.000729\ m^3$

$(\rho) = \frac{m}{V} = \frac{5.50}{0.000729} \approx 7544.58\ kg/m^3.$

$\rho = 7.5 \times 10^3\ kg/m^3$

$\boxed{\text{correct option ④ } \underline{7.6}}$

㊸ $A = 60°.$

option ④ - 40°

$i = e.$

$i = 50°$

$\delta = i + e - A.$

$= 50° + 50° - 60°$

$= 40°.$

㊹ $n = 2$

$r_n = 0.529\ Å \times n^2$

$r_2 = 0.529 \times 10^{-10} \times (2)^2$

$= 0.529 \times 10^{-10} \times 4$

$= 2.11 \times 10^{-10}\ m$

option ② ⇒ $2.1 \times 10^{-10}\ m$

(45). $\dfrac{R_{AB}}{R_{AD}} = \dfrac{R_{BC}}{R_{CD}} = \dfrac{1}{1}$. (Wheatstone bridge).

$R_{eq} = \dfrac{2 \times 2}{2+2} = 1\Omega$.

$I = \dfrac{V}{R_{eq}} = \dfrac{2V}{1\Omega} = 2A$.

$\boxed{\text{option (4) : } 2A}$