Physics AH - 2006

Specimen Answers

1. a) i) A.) Total time taken = 50s.

Total no. of revs = 100

Mean T, $\overline{T} = \frac{50}{100} = 0.5$s.

B.) Abs. unc. in measured times = $\frac{10.3 - 9.8}{5}$

$= \frac{0.5}{5}$

$= 0.1$s

Mean measured time = $\frac{50}{5} = 10$s.

$\therefore$ %age unc. in time = $\frac{0.1}{10} \times 100$

$= 1\%$.

$\therefore$ %age unc. in $\overline{T} = 1\%$

$\therefore$ abs. unc. in $T = \frac{0.5}{100} = 0.005$s.

ii.) $F_R = m\omega^2 r$.

$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.5}$

$\therefore F_R = 0.2 \times \frac{4\pi^2}{(0.5)^2} \times 0.5$

$= \frac{0.2 \times 4\pi^2 \times 0.5}{0.25}$

$= 0.4 \times 4\pi^2$

$= 15.78$

$= 15.8$N.

1. a.) iii.) $\omega = \frac{2\pi}{T}$

$\therefore$ % age unc. in ω = % age unc. in T.
= 1%

% age unc. in ω^2 = 2 × 1
= 2%.

$F_R = m\omega^2 r$.

% age unc. in F_R = % age unc in ω^2
= 2%.

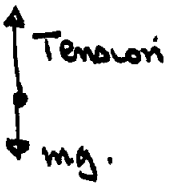
$\therefore$ abs. unc. in F_R = $15.8 \times \frac{2}{100}$

= 0.32

$\therefore$ $F_R = 15.8 \pm 0.32$ N.

iv.) X.

Y.



v.) Min. tension occurs at X.

$F_R = 15.8 = mg + T$

$\therefore T = 15.8 - mg$

$= 15.8 - 1.96$

$= 13.84$ N.

b.) Falls (due to Dopplar Effect)

2 a) i.) $T = Fr$.

$= 10 \times 20 \times 10^{-3}$.

$= 0.2$ Nm.

ii.) $\alpha = \dfrac{\omega - \omega_0}{t}$

$= \dfrac{7.5}{3}$.

$= 2.5 \text{ rad s}^{-2}$.

iii.) $T = I\alpha$.

~~$\alpha = \dfrac{I}{I}$~~ =

$I = \dfrac{T}{\alpha} = \dfrac{0.2}{3.5} = 0.06 \text{ kgm}^2$. (0.057).

b.) i.) $I = \dfrac{mr^2}{2} = \dfrac{3.2 \times 0.12^2}{2} = 0.023 \text{ kgm}^2$.

ii.) $I_0\omega_0 = I\omega$.

$(0.057) \times 7.5 = (0.057 + 0.023) \times \omega$.

$= 0.08\omega$.

$\omega = \dfrac{0.057 \times 7.5}{0.08}$

$= 5.34 \text{ rad s}^{-1}$.

c.) M. of I. for a ring $= mr^2$

" " " disc $= \dfrac{mr^2}{2}$.

I for ring > I for disc.

∴ ω less.

3. a.) i.) Grav. force acting on each kg of a body's mass (Wt. of 1 kg?)

ii.) A.) $Kg = \frac{GmM}{r^2}$

$$\therefore M = \frac{gr^2}{G}$$

b.) $$M = \frac{3.7 \times (3.4 \times 10^6)^2}{6.67 \times 10^{-11}}$$

$$= \frac{3.7 \times 3.4^2 \times 10^{12}}{6.67 \times 10^{-11}}$$

$$= \frac{3.7 \times 3.4^2}{6.67} \times 10^{23}$$

$$= 6.41 \times 10^{23} \text{ kg}$$

b.) i.) $$F_R = \frac{GmM}{r^2}$$

$$= \frac{6.67 \times 10^{-11} \times 10^2 \times 6.41 \times 10^{23}}{(3.7 \times 10^6)^2}$$

$$= \frac{6.67 \times 6.41}{3.7^2} \times 10^2$$

$$= 3.12 \times 10^2 \text{ N}$$

ii.) $F_R = m\omega^2 r$.

$$= m \frac{4\pi^2}{T^2} r.$$

$$T^2 = \frac{m\, 4\pi^2 r}{F_R}$$

$$= \frac{10^2 \times 4\pi^2 \times 3.7 \times 10^6}{3.1 \times 10^2}$$

$$= \frac{4\pi^2 \times 3.7}{3.1} \times 10^6$$

$$T = 2\pi \times 10^3 \times \sqrt{\frac{3.7}{3.1}} = 6.86 \times 10^3 \text{ s.}$$

4. a.) $E_k = \frac{1}{2} m\omega^2(a^2 - y^2)$.

$\omega = 6$

$a = 0.05$

$\therefore E_k = \frac{1}{2} \times 0.25 \times 6^2 (0.05^2 - y^2)$

$= 4.5(2.5\times10^{-3} - y^2)$.

b.) Max E_k when $y = 0$

$= 4.5 \times 2.5\times10^{-3}$

$= 1.125\times10^{-2}$ J

c.) $E_k = 4.5(2.5\times10^{-3} - (4\times10^{-2})^2)$

$= 4.5(2.5\times10^{-3} - 1.6\times10^{-3})$

$= 4.5(0.9\times10^{-3})$

$= 4.05\times10^{-3}$

$\therefore E_p = 4.5\times10^{-3} - 4.05\times10^{-3}$

$= 0.45\times10^{-3}$ J.

5 a.) i.) $V = \frac{Q}{4\pi\varepsilon_0 r}$

$Q = V \times 4\pi\varepsilon_0 r$.

$= 2.8\times10^5 \times 4\pi \times 8.85\times10^{-12} \times 0.36 \div 2$

$= 2.8 \times 4\pi \times 8.85 \times 0.36 \times 10^{-7} \div 2$

$= 112\times10^{-7}$ C. $\div 2$

$= 56\times10^{-7}$

$= 5.6\times10^{-6}$ C.

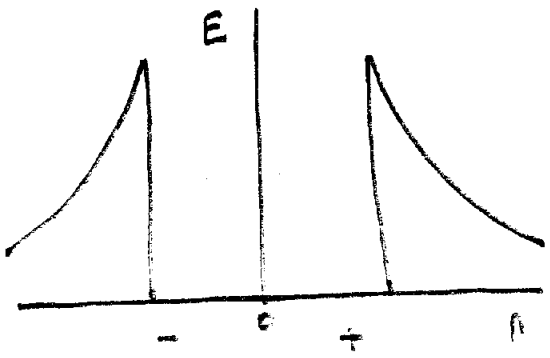
ii.) $0\ V\ C^{-1}$

iii.) A.) $E = \frac{Q}{4\pi\varepsilon_0 r^2} = \frac{5.6\times10^{-6}}{4\pi \times 8.85\times10^{-12} \times (0.18)^2}$

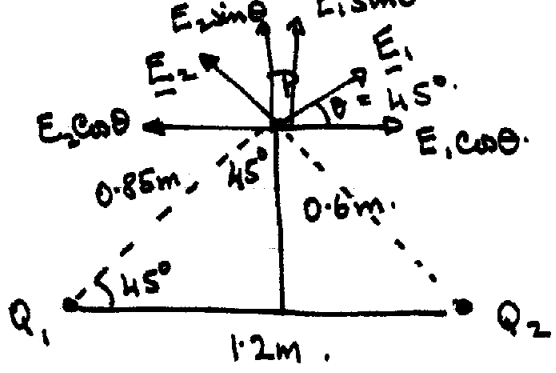
$= \frac{5.6}{4\pi \times 8.85 \times 0.18^2} \times 10^6$

$= 1.55\times10^6\ MC^{-1}$

B.)



5. b.)



$E_1\cos\theta$ and $E_2\cos\theta$ cancel.

magnitude of $E = E_1\sin\theta + E_2\sin\theta$.

$= 2E_1\sin\theta$.

Direction of E is ⊥n to line joining Q_1 and Q_2

$$E_1 = \frac{Q}{4\pi\varepsilon_0 r} = \frac{5.6\times10^{-6}}{4\pi\times885\times10^{-12}\times 0.85}$$

$$= \frac{5.6}{4\pi\times8.85\times0.85}\times10^{6}$$

$$= 5.9\times10^{4}$$

$$2E_1\sin\theta = 2\times5.9\times10^{4}\times\sin 45^\circ$$

$$= 8.34\times10^{4}\ NC^{-1}.$$

6 a.) $F_E = QE$

$= 1.6\times10^{-12}\times 2.5\times10^{4}$

$= 4\times10^{-8}\ N.$

b.) $W = mg$

$= 1.2\times10^{-12}\times 9.8$

$= 11.76\times10^{-12}\ N.$

$\therefore W \ll F_E$

c.) $a = \frac{F}{m} = \frac{4\times10^{-8}}{1.2\times10^{-12}}$

$= 3.33\times10^{4}\ ms^{-2}.$

$t = \frac{s}{v} = \frac{7.5\times10^{-3}}{20} = 3.75\times10^{-4}\ s.$

$s = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}\times3.33\times10^{4}\times(3.75\times10^{-4})^2$

$= \frac{1}{2}\times3.33\times3.75\times10^{-4}$

$= 6.24\times10^{-4}\ m.$

6. d.) No. of electrons $= \frac{1.6\times10^{-12}}{1.6\times10^{-19}}$

$= 10^{7}$

7. a.) i.) $QV = \frac{1}{2}mv^2$.

$v^2 = \frac{2QV}{m}$

$= \frac{2\times1.6\times10^{-19}\times2\times10^{3}}{1.673\times10^{-27}}$

$= \frac{4\times1.6}{1.673}\times10^{11}$

$= 3.82\times10^{11}$

$v = 6.18\times10^{5}\ ms^{-1}$

ii.) $\frac{mv^2}{r} = QvB$

$r = \frac{mv}{QB}$.

$= \frac{1.673\times10^{-27}\times6.18\times10^{5}}{1.6\times10^{-19}\times1.3}$

$= \frac{1.673\times6.18}{1.6\times1.3}\times10^{-3}$

$= 5\times10^{-3}\ m$.

iii) Total E_K gained $= 2QV$

$\therefore \frac{1}{2}mv^2 = 2QV$

$\therefore v^2 = \frac{2QV}{\frac{1}{2}m}$

$\therefore v = \sqrt{\frac{2QV}{\frac{1}{2}m}}$

$= \sqrt{2}\times6.18\times10^{5}$

$= 8.74\times10^{5}\ ms^{-1}$.

7. b.) $\Delta U = -\Delta K$

$$\frac{Q_1 Q_2}{4\pi\varepsilon_0 r} = \tfrac{1}{2}mv^2$$

$$r = \frac{Q_1 Q_2}{4\pi\varepsilon_0 \times \tfrac{1}{2}mv^2}$$

$$= \frac{1.6\times10^{-19} \times 79\times10^{-16}}{4\pi \times 8.85\times10^{-12} \times 1.57\times10^{-13}}$$

$$= 1.25\times10^{-13}\ m.$$

c.) $$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}$$

$$v^2 = \left[1 - \left(\frac{m_0}{m}\right)^2\right] \times c^2$$

$$= \left[1 - \left(\frac{1.673\times10^{-27}}{4.66\times10^{-27}}\right)^2\right] \times 9\times10^{16}$$

$$= \left[1 - 0.13\right] \times 9\times10^{16}$$

$$= \left[0.87\right] \times 9\times10^{16}.$$

$$v = \sqrt{0.87} \times 3\times10^8$$

$$= 0.93 \times 3\times10^8$$

$$= 2.79\times10^8\ ms^{-1}.$$

8. a.) Value of R.

b.) $$\varepsilon = -L\frac{dI}{dt}.$$

$$L = -\frac{\varepsilon}{\frac{dI}{dt}}$$

$$= \frac{9}{12}$$

$$= 0.75\ H.$$

8. c.) $E = \frac{1}{2} LI^2$

$= \frac{1}{2} \times 0.75 \times (0.1)^2$

$= 0.00375$

$= 3.75 \times 10^{-3} J$

d.) When S is opened current falls to zero.
Field lines collapse back in on L.
Self induced e.m.f. is set up.
e.m.f. is >> than applied e.m.f.

9. a.) i.) Strong nuclear.

ii.) A.) Proton charge: $+1e$

$= 2x \pm \frac{2}{3}e - \frac{1}{3}e.$

$= 2$ up $+1$ down.

B.) Neutron charge $= 0$

$= 1x + \frac{2}{3}e - 2x \frac{1}{3}e$

$= 1$ up $+ 2$ down.

b.) Weak nuclear.

c.) $\lambda = \frac{h}{mv}$

$= \frac{6.63 \times 10^{-34}}{1.675 \times 10^{-27} \times 3.5 \times 10^3}$

$= \frac{6.63}{1.675 \times 3.5} \times 10^{-10}$

$= 1.13 \times 10^{-10}$ m.

10. a.) Nodes

b.) i.) Node separation $= 88$mm $= \lambda/2$

$\therefore \lambda = 176$ mm

$= 176 \times 10^{-3}$ m.

$v = f\lambda = 176 \times 10^{-3} \times 2 \times 10^3$

$= 352$ ms^{-1}.

ii.) Measure separation of, say, 10 nodes, and find average separation.
This will reduce unc. in measurement

10. c. The reflected and transmitted waves are interfering less destructively than previously. The difference in amplitude of the 2 waves is greater than previously.

11. a) i.) As Notes.

ii) $\Delta x = \frac{\lambda l}{d} = \frac{589\times10^{-9} \times 7.5\times10^{-4}}{d}$

$d = \frac{589\times10^{-9}\times10^{-4}}{3.4\times10^{-4}} = \frac{589}{3}\times10^{-9} = 196\times10^{-9}$ m.

b) i.) $t = \frac{\lambda}{4n}$

$= \frac{548\times10^{-9}}{4\times1.45}$

$= 97.5\times10^{-9}$ m.

ii) Destructive interference no longer occurs for reflected light.

Γ light undergoes no phase change when travelling from liquid to TgF_2 or when travelling from TgF_2 to glass ⌟

c.) Constructive interference occurs when light is reflected by the oil film. As the film thickness varies constructive interference occurs for different λs at different points on the film.