AH Physics

2003

Specimen Answers

1. a.) i.) $s = ut + \frac{1}{2}at^2$

$u = 0$

$\therefore s = \frac{1}{2}at^2$

$\therefore a = \frac{2s}{t^2}$

ii.) $\bar{s} = 3.54m.$

$\bar{t} = 2.45s$

$\therefore \bar{a} = \frac{2 \times 3.54}{(2.45)^2} = 1.18ms^{-2}$

iii.) Unc. in $t = \frac{2.65 - 2.29}{6} = \frac{0.36}{6} = 0.06$

$\therefore$ %age Unc $= \frac{0.06}{2.45} \times 100\% = 2.5\%$

iv.) %age unc. in $s = \frac{0.01}{3.54} \times 100 = 0.3\%$

$\therefore$ Unc. in s can be ignored.

$\therefore$ % age unc. in $a = 2 \times 2.5 = 5\%$

v.) %age unc. $= \frac{\text{Abs. unc.}}{\text{value}} \times 100\%$

$\therefore$ Abs. unc. $= \frac{\text{\%age unc.}}{100} \times$ ~~~~value.

$= \frac{2.5}{100} \times 1.18 = 0.03ms^{-2}$

$\therefore$ Accn. $= 1.18 \pm 0.03ms^{-2}$

b.) i.) $a_R = \frac{v^2}{r} = \frac{6^2}{4} = 9ms^{-2}$

ii.) $F_R = ma_R = 2.5 \times 9 = 22.5N.$

$F_R <$ Friction

$\therefore$ car remains in circular path.

1. c.) Centripetal force = friction + hor. component of Reaction force.
∴ Centripetal force has increased.
∴ v increases.

2. a.) $I = mr^2$
b.) $I = mr^2 = 1.5 \times 0.2^2$
$= 0.06\ kgm^2$.
c.) i.) Torque due to cord $= r \times F = 4 \times 10^{-3} \times 25$
$= 10^{-1}\ Nm$.
∴ Resultant torque $= 10^{-1} - 0.07$
$= 0.1 - 0.07$
$= 0.03\ Nm$.

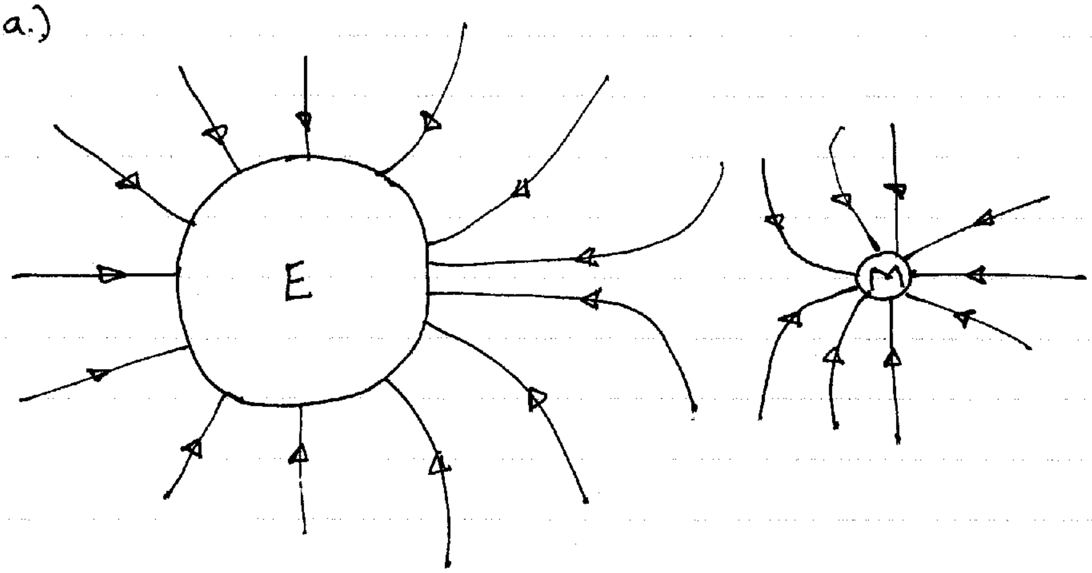
ii.) $G = I\alpha$.
∴ $\alpha = \frac{G}{I} = \frac{0.03}{0.06} = 5\ rad\,s^{-2}$.

iii.) $s = r\theta$.
$0.5 = 4 \times 10^{-3} \times \theta$.
∴ $\theta = \frac{5 \times 10^{-1}}{4 \times 10^{-3}} = 125\ rad$.

iv.) $\omega^2 = \omega_0^2 + 2\alpha\theta$.
∴ $\omega^2 = 0 + 2 \times 5 \times 125$
$= 625$
∴ $\omega = 25\ rad\,s^{-1}$.

v.) $G = I\alpha$
∴ $\alpha = \frac{G}{I} = \frac{0.07}{0.06} = 0.12\ rad\,s^{-2}$
$\omega = \omega_0 + \alpha t$.
∴ $4.2 = 25 - 0.12t$
∴ $t = \frac{25 - 4.2}{0.12} = 17.3s$.

3. a.)



b.) i.) $U = -\frac{GM_1M_2}{r}$

A.) $U = -\frac{6.67\times10^{-11}\times 7.3\times10^{22}\times15}{1.7\times10^{6}}$

$= -4.296\times10^{7}\,J.$

B.) $U = -\frac{6.67\times10^{-11}\times7.3\times10^{22}\times15}{2.2\times10^{6}}$

$= -3.32\times10^{7}\,J.$

ii.) $\Delta U = -\Delta K$

$\Delta K = -3.32\times10^{7} - (-4.296\times10^{7})$

$= 0.98\times10^{7}\,J$

$=$ Initial E_K.

iii.) $\frac{1}{2}mv^2 = 0.98\times10^{8}$

$\therefore v^2 = \frac{2\times0.98\times10^{8}}{15}$.

$= \frac{1.96}{15}\times10^{8}$.

$\therefore v = 0.36\times10^{4}\,ms^{-1}$.

4. a.) $W = mg$

$= 1.5 \times 9.8$

$= 14.7\,N$ = Spring force.

b.) i.) $F = -kx$

$k = \frac{-F}{x} = -\frac{14.7}{4\times10^{-2}} = 367.5\,Nm^{-1}$

Spring force $= -kx = -\left(\frac{-14.7}{4\times10^{-2}}\right)\times 8\times10^{-2}$

$= 25.4\,N.$

U.F. $= 25.4 - 14.7\,N$

$= 10.7\,N.$

ii.) $T = 2\pi\sqrt{\frac{k}{m}} = 2\pi\sqrt{\frac{367.5}{1.5}} = 15.65\times2\pi = 1475\,s.$

5. a.) Force acting on 1C of +ve charge.

b.) i.) $F = QE$

$a = \frac{F}{m} = \frac{QE}{m} = \frac{1.6\times10^{-19}\times750}{9.11\times10^{-31}} = 1.32\times10^{14}\,ms^{-2}$

ii.) $W = Fd = QEd = 1.6\times10^{-19}\times7.5\times10^{2}\times2.5\times10^{-2}$

$= 30\times10^{-19}\,J.$

$\therefore \frac{1}{2}mv^2 = 3\times10^{-18}$

$v^2 = \frac{3\times10^{-18}\times2}{9.11\times10^{-31}}$

$v = 8.1\times10^{6}\,ms^{-1}$

c.) i.) $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{9.11\times10^{-31}}{\sqrt{1-\left(\frac{1.5\times10^{8}}{3\times10^{8}}\right)^2}} = \frac{9.11\times10^{-31}}{\sqrt{0.75}}$

$= \frac{9.11\times10^{-31}}{0.87} = 11.4\times10^{-31}\,kg.$

ii.) $E = mc^2 = 11.4\times10^{-31}\times9\times10^{16}$

$= 1.02\times10^{-13}\,J.$

5. d.) $\Delta U = -\Delta K$.

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

$$r = \frac{Q_1 Q_2}{4\pi\varepsilon_0 \times \frac{1}{2}mv^2} = \frac{74\times1.6\times10^{-19}\times2\times1.6\times10^{-19}}{4\pi\times8.85\times10^{-12}\times1.17\times10^{-12}}$$

$$= \frac{74\times1.6^2\times2\times10^{-38}}{4\pi\times8.85\times1.17\times10^{-24}} = \frac{74\times1.6^2\times2}{4\pi\times8.85\times1.17}\times10^{-14}$$

$$= \frac{378.9}{130}\times10^{-14}$$

$$= 0.3\times10^{-14}\,m.$$

6. a.) $F = I\ell B = 0.4\times0.25\times0.6 = 0.06N.$

b.) $G = Fr = 0.06\times0.055 = 3.3\times10^{-3}\,Nm.$

c.) $G = Fr\sin\alpha = 3.3\times10^{-3}\times\sin 30 = 1.65\times10^{-3}\,Nm.$

d.) Sides of coil always lie at right L's to B.

7. a.) $$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi\times10^{-7}\times0.5}{2\pi\times1.2\times10^{-1}}$$

$$= \frac{1\times10^{-6}}{1.2} = 0.83\times10^{-6}\,T$$

b.) Unlike currents repel ∴ Force on RS to right

$$F = \frac{\mu_0 I_1 I_2}{2\pi r} = \frac{4\pi\times10^{-7}\times0.5\times0.5}{2\pi\times1.2\times10^{-1}}$$

$$= \frac{0.5}{1.2}\times10^{-6}\,N = 0.42\times10^{-6}\,N.$$

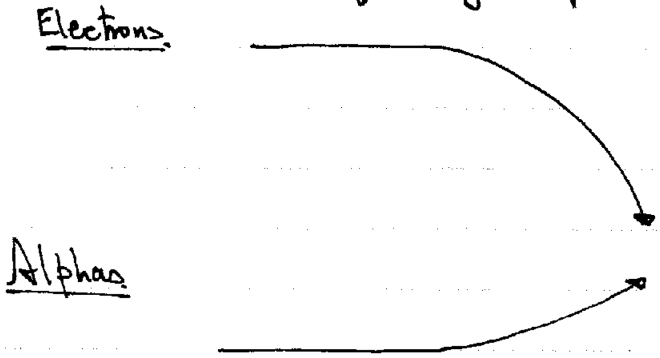
8. a.) i.) Electrical and magnetic forces are equal in size and opposite in direction, i.e. cancel.

ii.) $\not{q}vB = \not{q}E$

$$v = \frac{E}{B} = \frac{4.2\times10^{3}}{2.8\times10^{-3}} = 1.5\times10^{6}\,ms^{-1}.$$

8. b.) $v = \frac{E}{B}$.

∴ v is independent of charge on particle.

c.) 

9. a.) i.) Back EMFs setup in coil oppose supply voltage and reduce current flow.

ii.) $R = \frac{V}{I} = \frac{2}{250 \times 10^{-3}} = 8\Omega$.

iii.) $\mathcal{E} = -L \frac{dI}{dt}$.

$L = \frac{2}{20} = 0.1H$.

iv.) $E = \frac{1}{2}LI^2 = \frac{1}{2} \times 0.1 \times (2.5)^2 \times (10^{-3})^2$

$= 0.3125 \times 10^{-6}$ J.

b.) As $f \uparrow$ current has less time to reach max. value. Current decreases.

∴ voltage across R ↓, i.e. $V_2 \downarrow$. ∴ $V_1 \uparrow$.

10 a.) $y = a \sin 2\pi \left(ft - \frac{x}{\lambda}\right)$

∴ $a = 25$mm.

b.) $f = 55$, $\lambda = 16$

∴ $v = f\lambda = 55 \times 16 = 880 ms^{-1}$

c.) 24mm = 1.5λ

∴ phase difference = $180° = \pi$

10. d.) Sepn. = $\lambda, 2\lambda, 3\lambda$ etc.
= 16, 32, 48 mm etc.

11. a.) i.) Sources are always in phase.
ii.) Optical P.D. = $n \times$ path diffce.
iii.) A.) $2nt = (m + \frac{1}{2})\lambda$.
B.) $2nt = m\lambda$.
iv.) Initially X undergoes phase diffce. π at reflection
" Y " no " " at reflection.
New situation - both rays undergo phase change π.
b.) i.) At reflection from coating light undergoes destructive interference
No light is reflected.
ii.) $t = \dfrac{\lambda}{4n} = \dfrac{550 \times 10^{-9}}{4 \times 1.4} = 98.2 \times 10^{-9}$ m.

12. a.) Unpolarised light - plane in which E lies varies randomly
Polarised " - E always lies in same plane.

Polarised Unpolarised.

b.)

A	5.0
B	2.5
C	0
D	2.5.
E	5.0

c.) $n = \dfrac{\sin i}{\sin r} = \dfrac{\sin i_p}{\sin(90 - i_p)} = \dfrac{\sin i_p}{\cos i_p} = \tan i_p$.