2011 Higher Physics.

Section A.

1. C

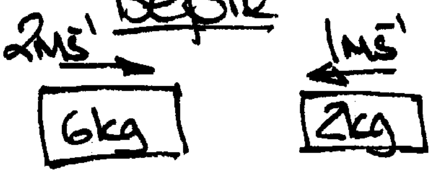
2. E

3. unbalanced force acting on horsebox = tension

$$U.f. = ma \quad (= T)$$
$$= 700 \times 2$$
$$= \underline{1400N} \qquad \underline{C}.$$

4. total momentum before = total momentum after.

Before



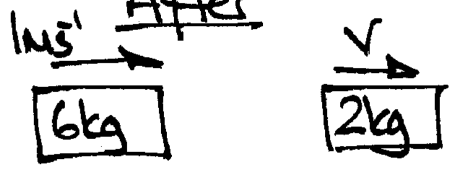
$p = m_1v_1 + m_2v_2$

$p = (6\times2) + (2\times(-1))$

$p = 12 - 2$

$p = \underline{10\,kgms^{-1}}$

After



$p = m_1v_3 + m_2v$

$p = (6\times1) + (2\times v)$

$p = 6 + 2v$

$$10 = 6 + 2v$$
$$10 - 6 = 2v$$
$$4 = 2v$$
$$v = 2ms^{-1}$$

$\underline{A}.$

$$E_{k_{after}} = \tfrac{1}{2}m_1v_3^2 + \tfrac{1}{2}m_2v^2$$
$$= (\tfrac{1}{2}\times6\times1^2) + (\tfrac{1}{2}\times2\times2^2)$$
$$= 3 + 4$$
$$= \underline{7J}$$

5. $P = \frac{F}{A} \rightarrow F = PA$

$F_{external} \longrightarrow | \longleftarrow F_{cabin}$

$$F_{cabin} - F_{external} = (P_{cabin} \times A) - (P_{external} \times A)$$
$$= (1 \times 10^5 \times 2) - (0.4 \times 10^5 \times 2)$$
$$= 2 \times 10^5 - 0.8 \times 10^5$$
$$= \underline{1.2 \times 10^5 \text{ N}}$$

C

6. $P = \rho g h$

$P = (1 \times 10^3) \times 9.8 \times 1.5$

$P = \underline{14\,700 \text{ Nm}^{-2}}$ D.

7. $P \propto T$

Pressure doubles → T (in Kelvin) must double

A.

8. $E = QV$ ($W = QV$)

$V = \frac{E}{Q}$ ← Joules, ← Coulombs E.

9. $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

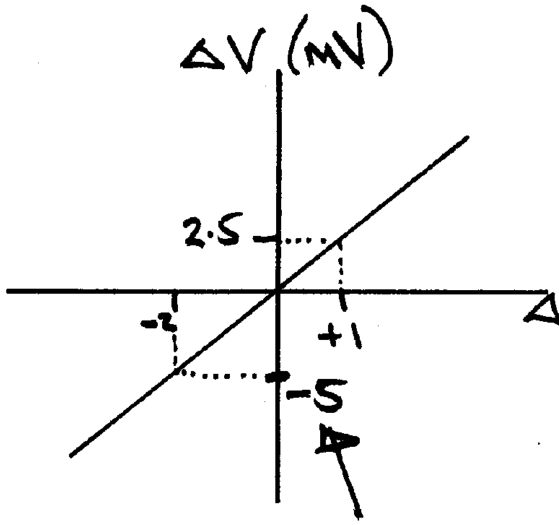
$\frac{7}{5} = \frac{(3+R)}{15}$

$\frac{15 \times 7}{5} = 3 + R$

$21 = 3 + R$

$R = 21 - 3$

$R = \underline{18\ \Omega}$ $\qquad$ <u>C.</u>

10. 

When R is changed by small step away from balance, the change in voltage is proportional to change in resistance.

<u>B</u>

11. $f = \frac{1}{T}$

$50 = \frac{1}{T}$

$T = \frac{1}{50}$

$T = 0.02\text{s}$
$(= 20\text{ms})$

2 divisions = 20 ms

∴ 1 division = <u>10 ms</u>

<u>B.</u>

12. $V_p = \sqrt{2}\, V_{RMS}$

$= \sqrt{2} \times 6$

$V_p = \underline{6\sqrt{2}}\ V$

$\underline{A.}$

$V_p = I_p R$

$I_p = \frac{V_p}{R}$

$I_p = \frac{6\sqrt{2}}{3}$

$I_p = \underline{2\sqrt{2}}\ A$

13. $Q = CV$

$C = \frac{Q}{V}$

$C = \frac{500 \times 10^{-6}}{10}$

$C = 50 \times 10^{-6}\ F$
($50 \mu F$)

$\frac{0.1}{10} \times 100 = \pm 1\%$ (voltage)

$\frac{25}{500} \times 100 = \underline{\pm 5\%}$ (charge)

$\underline{D.}$

14. E.

15. destructive interference
$\rightarrow$ path difference $= (n + \frac{1}{2})\lambda$

$n = 0 \rightarrow$ p.d. $= (0 + \frac{1}{2})\lambda = \frac{1}{2} \times 40 = 20$ mm.

$n = 1 \rightarrow$ p.d. $= (1 + \frac{1}{2})\lambda = 1.5 \times 40 = 60$ mm.
(too big)

$500 - 20 = \underline{480}$ mm

$\underline{D.}$

16. $I_1 d_1^2 = I_2 d_2^2$

$20 \times 5^2 = I_2 \times 25^2$

$I_2 = \dfrac{20 \times 5^2}{25^2}$

$I_2 = \underline{0.8}\ Wm^{-2}$ $\underline{B}$.

17. D.

18. A.

19. B.

20. A.

2011 Higher Physics

Section B.

21\. (a) (i) $v^2 = u^2 + 2as$

$0 = 7^2 + (2 \times (-9.8) \times s)$

$0 = 49 - 19.6s$

$19.6s = 49$

$s = \frac{49}{19.6} = \underline{2.5\,m}$.

(ii) $v = u + at$

$0 = 7 + (-9.8) \times t$

$+9.8t = 7$

$t = \frac{7}{9.8}$

$t = \underline{0.71\,s}$

(b) (i) At $t = 0.71\,s$, vertical velocity $= 0$
horizontal velocity is constant
$\therefore$ velocity $= 1.5\,ms^{-1}$ to the right.

(ii) Statement Z.
Horizontal velocity of ball is constant and equal to velocity of the trolley.

22\. (a) (i) Impulse = area under force-time graph

$= \frac{1}{2} \times 0.25 \times 6.4$

$= \underline{0.8}\ kgms^{-1}$

(ii) change in momentum = impulse

$= 0.8\ kgms^{-1}$ to the left.

(iii) $F\Delta t = m\Delta v$

$-0.8 = m(v-u)$

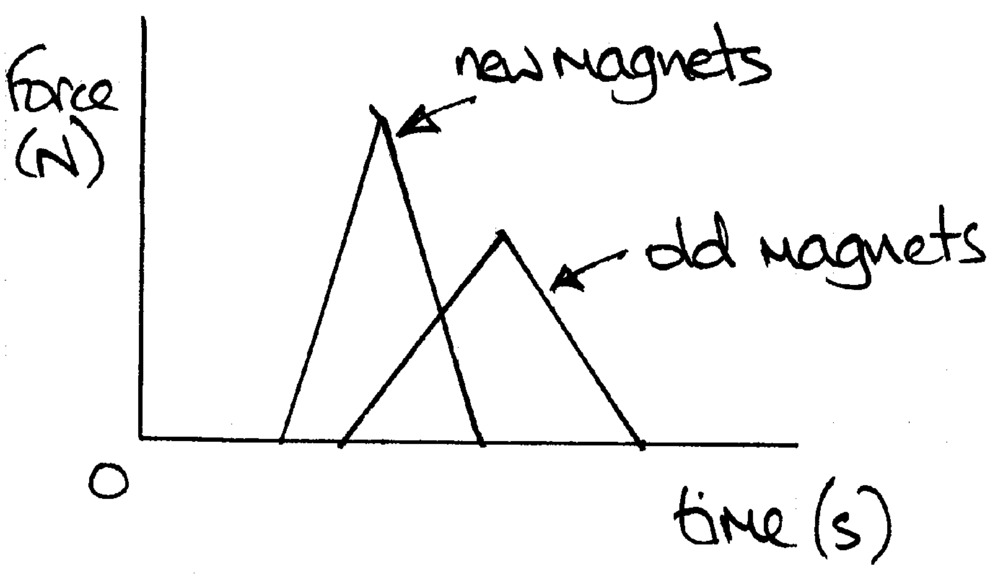
$-0.8 = m(-0.45 - 0.48)$

$-0.8 = m \times (-0.93)$

$m = \frac{-0.8}{-0.93}$

$m = \underline{0.86\ kg}.$

(b)



23.

(a) (i) Mass of air $= 111.49 - 111.26$

$= 0.23g$

$= 2.3 \times 10^{-4}$ kg

$$\rho = \frac{M}{V} = \frac{2.3\times10^{-4}}{2\times10^{-4}}$$

$$\rho = \underline{1.15 \text{ kgm}^{-3}}$$

(ii) Not all of the air has been removed from the bell jar.

(b)

(i) $P_1V_1 = P_2V_2$

$P_1 = 1.01\times10^5$ Pa

$V_1 = 200$ ml

$P_2 = ?$

$V_2 = 250$ ml

$1.01\times10^5 \times 200 = P_2 \times 250$

$$P_2 = \frac{1.01\times10^5 \times 200}{250}$$

$$P_2 = \underline{8.1\times10^4 \text{ Pa}}$$

(ii) Air molecules collide with the walls of the bell jar. When air is removed, these collisions become less frequent. This reduces the average force on the bell jar walls. Pressure on the walls decreases.

24. (a) (i) 10J of energy are given to each coulomb of charge passing through the supply.

(ii) $\varepsilon = V + Ir$

$$10 = 7.5 + (1.25 \times r)$$

$$10 - 7.5 = 1.25r$$

$$1.25r = 2.5$$

$$r = \frac{2.5}{1.25}$$

$$r = \underline{2\,\Omega}$$

(b) (i) Total resistance in the circuit has decreased.

Current has increased due to lower resistance

Lost volts ($= Ir$) has increased, causing a decrease in TPD.

24 (b) (ii) $R_p = \frac{V}{I} = \frac{6}{2} = 3\Omega$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{3} = \frac{1}{6} + \frac{1}{R_2}$$

$$\frac{1}{R_2} = \frac{1}{3} - \frac{1}{6} = \frac{2}{6} - \frac{1}{6} = \frac{1}{6}$$

$$R_2 = \underline{6\Omega}$$

25. (a) When $220\mu C$ of charge is stored on the capacitor plates, a potential difference of 1V exists across the plates.

(b) (i)
$$I = \frac{V}{R}$$

$$= \frac{12}{1400}$$

$$I = \underline{8.6mA}$$

25 (contd).

(b) (ii) initial energy stored.

$$E = \frac{1}{2}CV^2$$

$$= \frac{1}{2} \times (200 \times 10^{-6}) \times 12^2$$

$$= 0.0144\,J$$

final energy stored

$$E = \frac{1}{2}CV^2$$

$$= \frac{1}{2} \times (200 \times 10^{-6}) \times 4^2$$

$$= 0.0016\,J$$

decrease in stored energy

$$= 0.0144 - 0.0016$$

$$= \underline{0.0128\,J}$$

(c) (i) 0.3s

(ii) $S = ut + \frac{1}{2}at^2$

$s = 0.8\,m$
$u = 1.5\,ms^{-1}$
$t = 0.3\,s$

$$0.8 = (1.5 \times 0.3) + (\tfrac{1}{2} \times a \times 0.3^2)$$

$$0.8 = 0.45 + 0.045a$$

$$0.045a = 0.8 - 0.45$$

$$\underline{a = 7.8\,ms^{-2}}$$

25 (c) (iii)

The percentage* uncertainty in the time measurement will decrease and the percentage* uncertainty in the distance measurement will decrease.

* note that scale reading uncertainty has not changed, so no marks for saying scale reading or absolute uncertainty is smaller. <u>Must</u> be percentage (or fractional) to get this mark.

26. (a) (i) inverting mode

(ii)

$$V_o = -\frac{R_f}{R_1} \times V_i$$

$$6 = -\frac{40}{10} \times V_i$$

$$6 = -4V_i$$

$$V_i = -\frac{6}{4}$$

$$V_i = \underline{-1.5\,V}$$

Choose any pair of values for V_o + R_f from graph (below saturation)

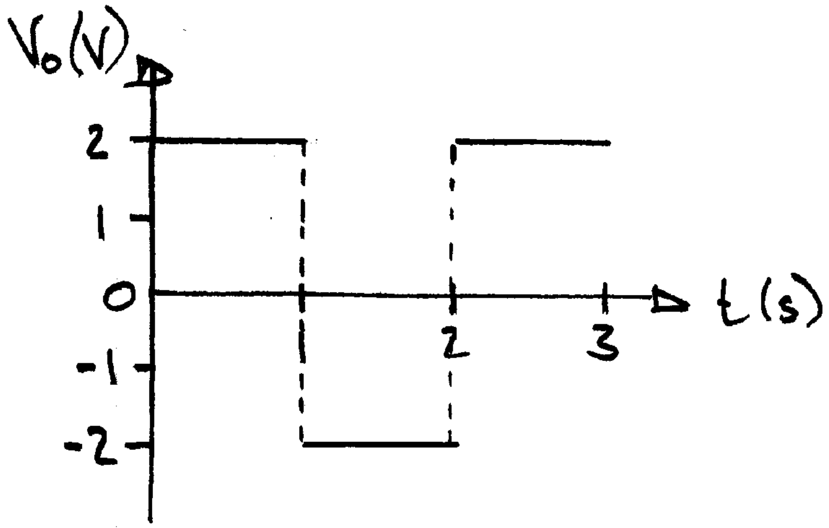
26 (a) (iii) The op amp has reached saturation.

(b) $V_o = \frac{R_f}{R_1}(V_2 - V_1)$

$t = 0 \to 1s$ $\quad V_o = \frac{20}{10}(2-1) = +2V$

$t = 1 \to 2s$ $\quad V_o = \frac{20}{10}(1-2) = -2V$

$t = 2 \to 3s$ $\quad V_o = \frac{20}{10}(-1+2) = +2V$



27. (a) (i)

$$n = \frac{\sin\theta_1}{\sin\theta_2}$$

$$1.66 = \frac{\sin 40}{\sin\theta}$$

$$\sin\theta = \frac{\sin 40}{1.66}$$

$$\theta = \sin^{-1}\left(\frac{\sin 40}{1.66}\right)$$

$$\theta = \underline{22.8^\circ}$$

(ii)

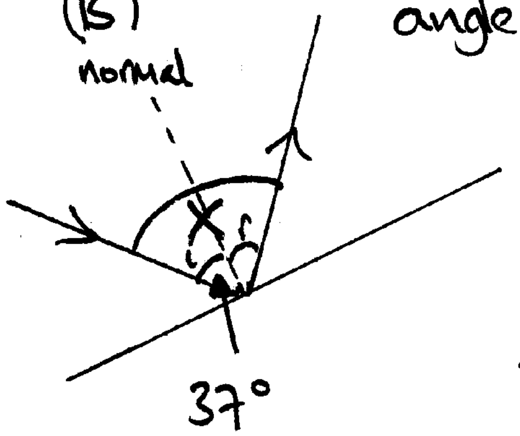
(A) $\sin\theta_c = \frac{1}{n}$

$$\sin\theta_c = \frac{1}{1.66}$$

$$\theta_c = \sin^{-1}\left(\frac{1}{1.66}\right)$$

$$\theta_c = \underline{37^\circ}$$

(B)



angle of incidence = angle of reflection

$\hat{i} + \hat{r} = X$

$i = 37^\circ$, $\hat{i} = \hat{r}$

so $X = 37 + 37$

$X = \underline{74^\circ}$

27 (b) No.

Refractive index depends on frequency of light, so $\theta_{c_{blue}} < \theta_{c_{red}}$.

The angle of incidence is now greater than the critical angle for blue light, so total internal reflection will occur.

28. (a) Light is a wave.

(b)(i) $n\lambda = d\sin\theta$

$2 \times \lambda = 5\times10^{-6} \times \sin 11$

$\lambda = \frac{(5\times10^{-6})\times\sin 11}{2}$

$\underline{\lambda = 480\,nm}$

(2nd order → 2nd order $= 22^\circ$ $\therefore \theta = 11^\circ$, $n=2$)

(ii) The maxima will spread further apart.

As R.I decreases, λ will increase

$\sin\theta = \frac{n\lambda}{d}$ *

so θ will increase when λ increases.

* note that 'n' in this equation is <u>order</u> of maxima, not refractive index!!

29. (a) (i) $v = f\lambda$

$$f = \frac{v}{\lambda} = \frac{3\times10^{8}}{525\times10^{-9}} = 5.71\times10^{14}\ \text{Hz}$$

$$E = hf$$
$$= (6.63\times10^{-34})\times(5.71\times10^{14})$$
$$E = \underline{3.79\times10^{-19}\ \text{J}}$$

(ii) $\text{Max } E_K = E - W$
$$= hf - W$$
$$= (3.79\times10^{-19}) - (2.24\times10^{-19})$$
$$\text{Max } E_K = \underline{1.55\times10^{-19}\ \text{J}}$$

(b) (i) Photons with frequency less than f_0 have insufficient energy to free electrons from the metal.

(ii) $W = hf_0$

$$2.24\times10^{-19} = (6.63\times10^{-34})\times f_0$$
$$f_0 = \frac{2.24\times10^{-19}}{6.63\times10^{-34}}$$
$$f_0 = \underline{3.38\times10^{14}\ \text{Hz}}$$

30. (a) (i) nuclear fusion

(ii) total mass before

$= 5.005 \times 10^{-27} + 3.342 \times 10^{-27}$

$= 8.347 \times 10^{-27}$ kg

total mass after

$= 6.642 \times 10^{-27} + 1.675 \times 10^{-27}$

$= 8.317 \times 10^{-27}$ kg

Mass lost $= (8.347 - 8.317) \times 10^{-27}$

$= 0.03 \times 10^{-27}$ kg

$E = mc^2$

$E = (0.03 \times 10^{-27}) \times (3 \times 10^{8})^2$

$= (0.03 \times 10^{-27}) \times (9 \times 10^{16})$

$= \underline{2.7 \times 10^{-12}\ \text{J}}$

(b)(i) energy absorbed

$$= (-1.360 \times 10^{-19}) - (-5.424 \times 10^{-19})$$

$$E = 4.064 \times 10^{-19} \text{ J}$$

$$E = hf$$

$$4.064 \times 10^{-19} = (6.63 \times 10^{-34}) \times f$$

$$f = \frac{4.064 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$f = \underline{6.13 \times 10^{14} \text{ Hz}}$$

$$v = f\lambda$$

$$3 \times 10^{8} = (6.13 \times 10^{14}) \times \lambda$$

$$\lambda = \frac{3 \times 10^{8}}{6.13 \times 10^{14}}$$

$$\lambda = \underline{\underline{489 \text{ nm}}}$$

(ii) $\lambda = 489$ nm so <u>blue</u>