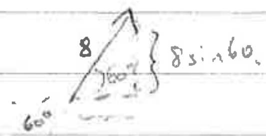
MC Bloch D.

1 A	6 C	11 D	16 C	21 C
2 C	7 B	12 C	17 D	22 A
3 A	8 B	13 A	18 A	23 B
4 B	9 C	14 D	19 C	24 D
5 B	10 A	15 D	20 A	25 B
				26 C



$8 \sin 60 \times 0.3 m \times 2$

MC Bloch C

1 A	6 B	11 A	16 C	21 C
2 D	7 C	12 C	17 A	22 B
3 D	8 C	13 A	18 B	23 C
4 C	9 A	14 B	19 D	24 D
5 B	10 A	15 B	20 D	25 A
				26 C.

$d \sin 45° = 3\lambda$

$\frac{\lambda}{d} = \frac{\sin 45°}{3}$ $\quad \frac{d}{\lambda} = \frac{3}{\sin 45°}$

$d = 3\lambda / \sin 45°.$ $\quad = 4.24.$

$d \sin \theta = n\lambda$

$P = \frac{V^2}{R}$ $\quad R = \frac{V^2}{P}$

V doubles

~~R~~ 4. for same P.

Bloch D

Block D.

(allow 10 N/kg)

B1 a) i) $\Delta E_{grav} = mg\Delta h$ ✓①

$\Delta E_{grav} = \cancel{2.0 \times 10^{-3}}\,kg \times 9.8\,N/kg \times 8.6 \times 10^{-2}\,m$

0.602

$\Delta E_{grav} = \cancel{1.7 \times 10^{-3}}\,J$ ✓①

0.51

ii) $\cancel{M_{bullet}V_{bullet} = M_{tot}V_{tot}}$ $\frac{1}{2}mv^2 = mg\Delta h$

$\cancel{\Rightarrow V_{tot} = V_{bullet} \times \frac{M_{bullet}}{M_{tot}}}$ $\Rightarrow v = \sqrt{2g\Delta h}$ (or other valid method)

$\cancel{\Rightarrow V_{tot} =}$

$\Rightarrow v = \sqrt{2 \times 9.8\,N/kg \times 0.086\,m}$ ✓①

$\Rightarrow v = \sqrt{1.686}\ M/s$

$v = 1.298\,m/s$ or $1.3\,m/s$ to 2sf

iii) $V_{bullet} = V_{tot} \times \frac{M_{tot}}{\cancel{V_{tot}}\ M_{bullet}}$ ✓①

$V_{bullet} = 1.3\,m/s \times \frac{602\,g}{2.0\,g} = 390\,m/s$ to 2sf ✓①

iv) $E_k = \frac{1}{2}mv^2$ ✓①

$E_k = \frac{1}{2} \times 0.002\,g \times (39 \times 10^2\,m/s)^2 = 153\,J$ or 150 J to 2sf ✓①

v) Since kinetic energy has been converted into other forms, ✓①
this is an inelastic collision ✓①.

9

B2a) i) When $R = 1.5\Omega$, $I = 3.0A$

Hence $V = IR = 4.5V$ ✓①

Lost volts $= \mathcal{E} - V = 6.0V - 4.5V = 1.5V$ ✓①

ii) Ir = Lost Volts ✓①

$$r = \frac{\text{Lost Volts}}{I} = \frac{1.5V}{3.0A} = 0.5\Omega$$ ✓① (or other valid method)

b) If R is increased the "lost volts" will <u>decrease</u> ✓①

since I will drop but r is constant so Ir drops ✓①
(or other clear explanation)

6

B3 a i) $\lambda = 0.60\,m$ ✓ 1

ii) $v = f\lambda \therefore f = \frac{v}{\lambda} \therefore f = \frac{330\,m/s}{0.60\,m} = 55\,Hz$ ✓ 1.

b) Exactly out of phase (with same λ) ✓ 1

Amplitude is $\sqrt{2}$ greater ✓ 1

B4 i) ~~Superposition of the waves from S_1 and S_2~~

As S_1 ~~increases~~ is moved, the path difference between waves from S_1 and S_2 increases.

This changes the phase difference between the waves

- When the path difference is $\frac{1}{2}\lambda$, there is destructive interference whereas when it is λ there is constructive interference.

For 3 marks must get across these three points:

- path difference increase OWTTE.
- therefore waves move out of / into phase OWTTE
- yielding constructive / destructive interference OWTTE

ii) This is half a wavelength ✓①

So $\lambda = 0.164m$ ✓①.

iii) Now, S_1X is a whole wavelength ✓①

So $\lambda = 0.082m$

MUST SHOW WORKING / EXPLANATION.

$v = f\lambda$ ✓①

$v = 4100Hz \times 0.082m = 336.2\ m/s$ ✓①

(Block C B4)(Block D B5) ✓①

B5a) With heater OFF : rate is 0·33 g/s (gradient of graph)

With heater ON : rate is 0·35 g/s. ✓① (Fine just to read numbers off from equation for line)

b) i) Energy delivered in 1s = 3·9V × 1·2A × 1s = 4·68 J ✓①.

N_2 boiled off by this much energy = 0·02 g ✓①

Therefore energy per gram = $\frac{4 \cdot 68\ J}{0 \cdot 02\ g}$ = 234 J. ✓①

ii) ~~We cannot prevent heat entering from the enviroment, so instead we measure how much has the rate what effect it has and adjust our results to compensate for this.~~

We want to know how much N_2 is boiled off by a known energy input - our electrical heater.
But there is a large unknown input - the heat entering from the enviroment. ✓✓② for a clear
Since it's difficult to prevent this, we instead measure its effect and calculate how much additional N_2 is boiled off by the heater. ✓① if vague / flawed but along the right lines.

c) Mass of N_2 boiled away = $25 \times 10^{-3} m^3 \times 810\ kg\,m^{-3}$ = 20·25 kg ✓①

Energy required to boil it = $2 \cdot 34 \times 10^5\ J/kg \times 20 \cdot 25\ kg = 4 \cdot 74 \times 10^6\ J$ ✓

Power = $\frac{4 \cdot 74 \times 10^6\ J}{100 \times 24 \times 3600\ s}$ = **0·55 W** ✓①

(Block C B5) (Block D B6).

B6 a.) $n_1 \sin C = n_2 \sin 90°$ where $n_1 = 1.7$, $n_2 = 1.6$

$\therefore \sin C = \frac{n_2}{n_1}$ $\therefore \sin C = \frac{1.6}{1.7}$

$\therefore C = \sin^{-1}\left(\frac{1.6}{1.7}\right) = \sin^{-1}(0.941) = \underline{70.3°}$

// show at least ~~1~~ ~~step~~ of working for 2 marks.
~~1~~ 2 steps

b) Ratio of hypotenense to ~~adjacent~~ opposite is same as ratio of length of B to length of A. ✓①

Therefore length of B is $\frac{1.0\,km}{\sin C}$

which is 1.0625 km ✓①

B is thus 62.5 m longer than A ✓①

Speed of light is $\frac{3.0\times10^8\,m/s}{1.7} = 1.765\times10^8\,m/s$ ✓①

thus difference in time $= \frac{62.5\,m}{1.765\times10^8\,m/s}$ ✓① $= \underline{\underline{3.54\times10^{-7}\,s}}$

c) ✓① This would make the critical angle (and hence sin C) lower.

Hence the path difference and thus the time
✓① difference would be greater.

d) The greater the time difference, the fewer bits per second could be sent OWTTE ✓①
because each bit would be stretched by the time delay leading to overlap/interference OWTTE ✓①.

B7 a) Einstein says that light of frequency f consists of photons with energy hf. ✓①
The work function $\emptyset$ is the energy required to liberate an electron ✓①
~~If the energy of one photon is sufficient~~
~~If the frequency is belo~~
~~The threshold~~ ~~The threshold frequency~~
~~Below the~~
At the threshold frequency, the photon energy $hf = \emptyset$; i.e. the photon has just enough energy to liberate the electron. If f is any lower, it won't have enough - hence no electrons ✓①

b) i) 1.10×10^{15} Hz ✓①

ii) Gradient of line ✓①

calculation e.g. $\dfrac{3.\cancel{4}^{2}\,\text{eV}}{(1.85 - 1.10)\times 10^{15}\,\text{Hz}} = 4.\cancel{4}^{3} \times 10^{-15}$ eVs ✓①

convert to J 6.8×10^{-34} Js ✓①

iii) $\emptyset$ is y-intercept or hf_0 ✓①

4.7eV or 7.5×10^{-19} J (allow either unit) ✓①