2021 DHS H2 Physics Prelim Paper 2 Suggested Solutions

1 **(a)** time **B2**

(electric) current

allow amount of substance

allow luminous intensity

any two of the above quantities, 1 mark each

(b) **(i)** $T = 2\pi \times \sqrt{\dfrac{200 \times 10^{-3}}{25}}$

= 0.562 s **A1**

percentage uncertainty = (2% + 8%) / 2 (= 5%) **C1**

or

fractional uncertainty = (0.02+0.08) / 2 (= 0.05)

ΔT = 0.562 x 0.05

= 0.028 s **C1**

T = (0.56 ± 0.03) s **A1**

(ii) **1.** total energy = max kinetic energy

$= \frac{1}{2}(200 \times 10^{-3})(2\pi/T)^2(5.00 \times 10^{-2})^2$ **M1**

$= \dfrac{9.87 \times 10^{-3}}{T^2}$ **A1**

2. total energy = $\dfrac{9.87 \times 10^{-3}}{0.56^2}$

= 3.15×10^{-2} J **A1**

2 (a) sum / total momentum of bodies is constant **B1**

or

sum / total momentum of bodies before = sum / total momentum of bodies after

for an isolated / closed system / no (resultant) external force **B1**

(b) (i) $4.0\ v_A = 6.0\ v_B$ **C1**

$E_K = \frac{1}{2}mv^2$ **C1**

ratio = $\dfrac{(0.5)(4.0)(6.0)^2}{(0.5)(6.0)(4.0)^2}$ **M1**

= 1.5 **A0**

(ii) $0.48 = E_K$ of A + E_K of B

= E_K of A + (E_K of A / 1.5) = 5/3 × E_K of A **C1**

E_K of A = 0.29 (0.288) J **A1**

(iii) curve starts from origin and has decreasing gradient **M1**

final gradient of graph line is zero **A1**

3 (a) (i) $E_K = \frac{1}{2}mv^2$

$= 0.5 \times 0.40 \times 0.30^2$

$= 1.8 \times 10^{-2}$ J **A1**

(ii) (change in) kinetic energy = work done on spring / (change in)

elastic potential energy **C1**

$1.8 \times 10^{-2} = \frac{1}{2} \times F \times 0.080$ **C1**

$F_{MAX} = 0.45$ N **A1**

(iii) a = F / m = 0.45 / 0.40

= 1.1 m s^{-2} **A1**

(iv) 1. constant velocity / resultant force is zero, so in equilibrium **B1**

2. decelerating / resultant force is not zero, so not in equilibrium **B1**

(b) curved line from the origin **M1**

with decreasing gradient **A1**

4	**(a)**	two sine waves in antiphase (one dotted, one solid line)	**B1**
		4 antinodes and 5 nodes shown	**B1**
	(b)	a second sine wave of same wavelength on same axis	**B1**
		separated by a quarter of the wavelength	**B1**
	(c)	plane parallel wavefronts before the opening	**B1**
		circular wavefronts showing diffraction after the opening with	
		same wavelength and	**B1**
		greater than the gap width	**B1**

5 **(a)**

$$R=\rho\frac{L}{A}=\rho\frac{L}{\left(\pi d^2/4\right)}=\frac{4\rho}{\pi}\frac{L}{d^2}$$ **M1**

$$\frac{R_{AB}}{R_{BC}}=\frac{L_{AB}}{d_{AB}^2}\times\frac{d_{BC}^2}{L_{BC}} \quad \text{OR} \quad \frac{L_{AB}}{L_{BC}}\times\frac{d_{BC}^2}{d_{AB}^2}$$

$$=\frac{50.0}{d^2}\times\frac{(0.3d)^2}{30.0}$$ **M1**

$$=0.15$$

A0

(b) From **(a)**

(i)

$$\frac{R_{AB}+R_{BC}}{R_{BC}}=\frac{R_{AB}}{R_{BC}}+1$$

➔ $$\frac{R_{AC}}{R_{BC}}=\frac{R_{AB}}{R_{BC}}+1=0.15+1=1.15$$ **C1**

➔ $$\frac{V_{AC}}{V_{BC}}=1.15$$

$$V_{AC}=1.15(2.00)=2.30\text{ V}$$ **A1**

(ii)

$$E=V_{AC}+Ir$$

$$2.50=(2.30)+(0.400)r$$ **C1**

$$r=0.500\ \Omega$$ **A1**

(iii) $\text{Efficiency} = \dfrac{IV_{AC}}{IE} \times 100\%$ **C1**

$= \dfrac{2.30}{2.50} \times 100\% = 92.0\%$ **A1**

(c) Over-estimate. 0.20 V is actually the p.d. across the internal resistance cell *r* as well as that of the ammeter. **B1**

$E - V_{AC} = I(r + R_A)$ **B1**

$r + R_A = 0.500\ \Omega \quad \Rightarrow \quad r < 0.500\ \Omega$

6 **(a)** **(i)** to increase flux linkage (with secondary coil) **B1**

(ii) e.m.f. (induced only) when flux (in core/coil) is changing **B1**

constant / direct voltage gives constant flux / field **B1**

(b) **(i)** $N_S / N_P = V_S / V_P$ **C1**

$N_S = (52 / 150) \times 1200$

$= 416$ turns **A1**

(ii) 0 ms or 7.5 ms or 15.0 ms or 22.5 ms **A1**

(c) **(i)** *either*

mean power = $V^2 / 2R$ and $V = 52$ (V) **C1**

$R = 52^2 / (2 \times 1.2)$

$= 1100\ (1127)\ \Omega$ **A1**

or

mean power = V^2 / R and $V = 52 / \sqrt{2}$ (= 36.8 V) **C1**

$R = 36.8^2 / 1.2$

$= 1100\ \Omega$ **A1**

(ii) sinusoidal shape with troughs at zero power **B1**

only 3 'cycles' **B1**

each 'cycle' is 2.4 W high and zero power at correct times **B1**

7 **(a)** In the magnetic field, the magnetic force acting on the ion provides the centripetal force for the ion to move in uniform circular motion. Thus **B1**

$$Bqv = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{Bq}$$

Since $T = \dfrac{2\pi r}{v}$,

$$\therefore T = \frac{2\pi}{v}\left(\frac{mv}{Bq}\right) \Rightarrow T = \frac{2\pi m}{Bq}$$

B1

which is independent of *r*.

Assume that the time taken by the ion to cross the gaps is negligible compared to the time taken by the ion to travel in the magnetic field. **B1**

(b)(i)

$$\therefore T = \frac{2\pi(6.68 \times 10^{-27})}{0.85 \times 2 \times 1.6 \times 10^{-19}}$$ **C1**

$$= 1.54 \times 10^{-7} \text{ s}$$ **A1**

(b)(ii) In order for the nucleus to accelerate when it crosses the gap, freq. of the alternating voltage = orbital freq. of the nucleus **B1**

$$\therefore f = \frac{1}{1.54 \times 10^{-7}} = 6.49 \times 10^{6} \text{ Hz}$$

A1

(b)(iii) The **work done by the magnetic force on the ion is zero** since the **magnetic force is always perpendicular to the velocity of the ion**. **A1**

Each time the ion crosses the gap, it **gains a kinetic energy of** ***qV*** due to the work done on it by the electric field given by $Fd = qEd = q(V/d)d$ where F is the electric force acting on the ion, d is the separation between the gaps and E is the strength of the uniform electric field between the gaps. In **one revolution**, the ion will cross the gap **two times**. **A1**

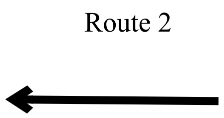
Thus, the total gain in its kinetic energy is $2qV = 4eV$, since the charge of the helium nucleus is $2e$.

8 **(a)** A longitudinal wave is one in which the <u>oscillation of the molecules</u> of the wave is <u>along the direction of transfer of energy</u> of the wave. **A1**

(b) $A = \rho v^2 = (2700)(3100)^2 = 2.59 \times 10^{10}$ **A1**

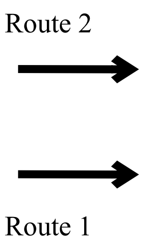
Units of A = $(\text{kg m}^{-3})(\text{m s}^{-1})^2 = \text{kg m}^{-1}\text{ s}^{-2}$ = Pa **A1**

(c)



A1

(d)



A1

(e) The waves should be weaker after traveling longer distances, **B1** hence direct waves should show larger amplitude than reflected waves. **B1**

(f) **(i)** SD_8, t = 0.40 s

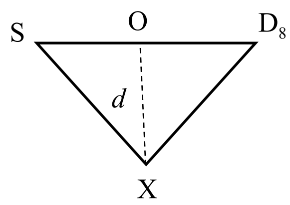
SD_8 = (3.1)(0.40) = 1.24 km **A1**

(ii) SXD_8, t = 0.60 s

SXD_8 = (3.1)(0.60) = 1.86 km **A1**

(g) Assume SX = XD_8

Using Pythagoras Theorem,



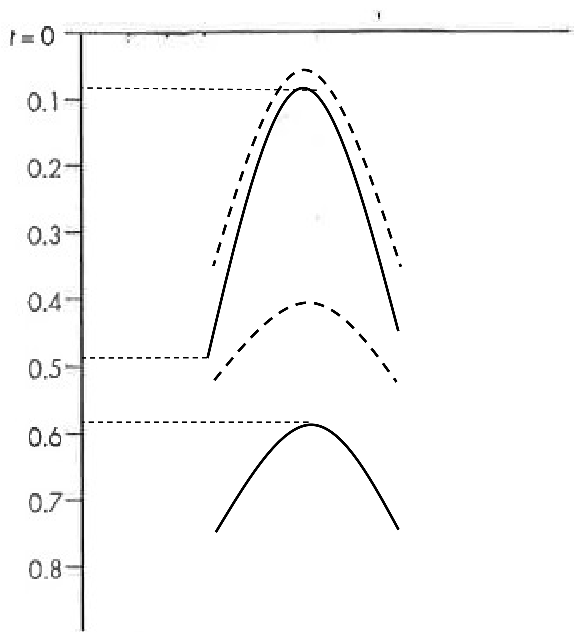
depth d = $\sqrt{(XD_8)^2-(OD_8)^2}$

= $\sqrt{\left(\frac{SXD_8}{2}\right)^2-\left(\frac{SD_8}{2}\right)^2}$ **M1**

= $\sqrt{\left(\frac{1.89}{2}\right)^2 - \left(\frac{1.27}{2}\right)^2}$

= 0.70 km **A1**

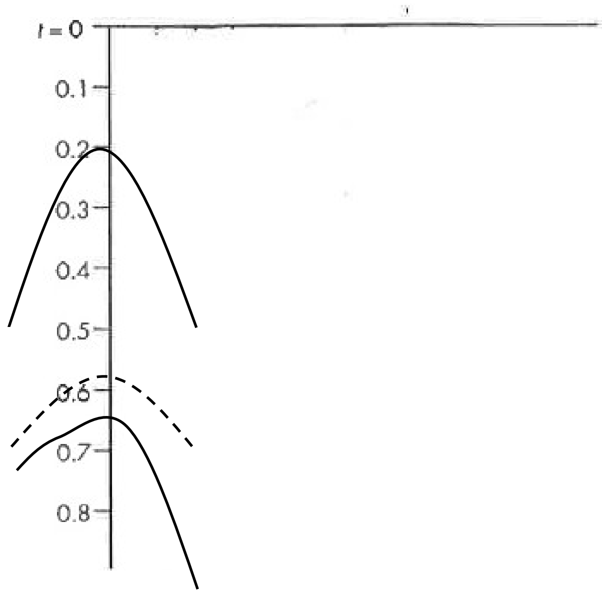
(h) **(i)**



Graph is lower, **B1**

Any peak value at a time factor about (3.1/2.4) = 1.3 times later **B1**

(ii)



Top graph is same, **B1**

Lower graph is lower and asymmetric as shown **B1**

(iii) Any one of the following:

- An extra layer of rock halfway down that can cause partial reflection
- Double reflection before reaching detector
- Some refraction takes place at intermediate level

(as a result of density changes) **B1**

- THE END -