F6 Physics Mock Exam 2019 to 2020 Paper I Section B Solution

Question 1

(a) (i) By $Q = mc\Delta T$,

specific heat capacity of ice $= \frac{2\times10^5}{0.95(100)} = 2110$ J kg^{-1} °C^{-1}(2105)

(ii) By $Q = ml_v$,

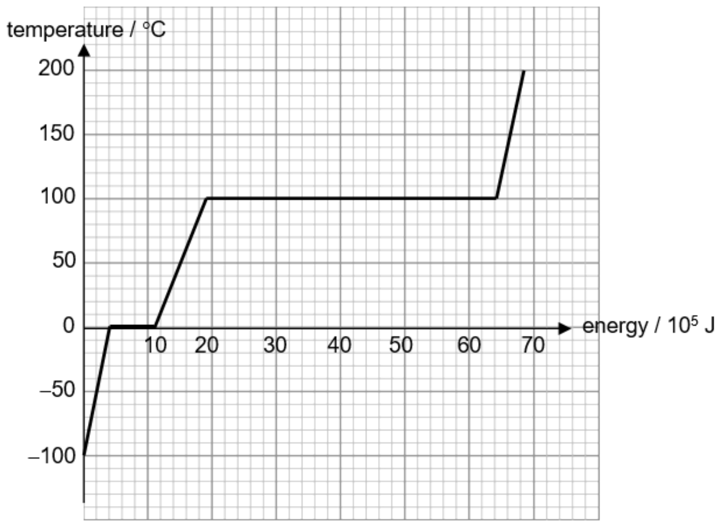
$l_v = \frac{(32-9.5)10^5}{0.95} = 2.37 \times 10^6$ J kg^{-1} (2368421)

(b) $Power = \frac{Energy}{Time}$

$1600t = 32 \times 10^5$

$t = 2000$ s

(c)



Same shape

Energy doubled

Question 2

(a) $PV = nRT$

$n = \frac{1.3\times10^5\times0.4\times0.25}{8.31\times(27+273)}$

$n = 5.21$ mole (5.2146)

(b) $F_{gas} = mg + F_{atm}$

$mg = (P_{gas} - P_{atm})A$

$m = 1220$ kg (1223.24)

(c) isothermal = T constant and

$P_1V_1 = P_2V_2$

$P_2 = P_1(\frac{V_1}{V_1/2}) = 1.3 \times 10^5 \times 2$

$= 2.6 \times 10^5$ Pa

(d) low pressure

Question 3

(a) Consider vertical direction.

$v_y = 0$, $s = 3 - 1.8 = 1.2$ m, $a = -9.81$ ms^{-2}

By $v^2 - u^2 = 2as$

$0^2 - u_y^2 = 2(-9.81)(1.2)$

$u_y = 4.8522$ ms^{-1}

By $v = u + at$

$0 = 4.8522 - 9.81t$

$t = 0.495$ s (0.49462)

(b) $u_x = \frac{4}{0.4946} = 8.087$ ms^{-1} (8.0873)

Speed required $= \sqrt{u_x^2 + u_y^2} = \sqrt{8.087^2 + 4.8522^2}$

$= 9.43$ ms^{-1} (9.43098)

(c) angle of projection $= tan^{-1}\frac{u_y}{u_x}$

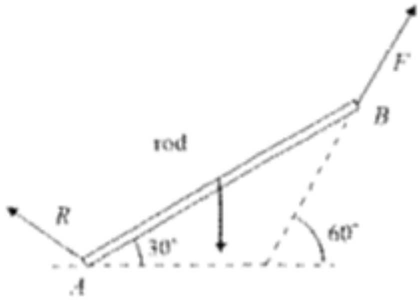
$= tan^{-1}\frac{4.8522}{8.087}$

$= 31.0°$ (30.96)

Question 4

3. (a) Reaction R

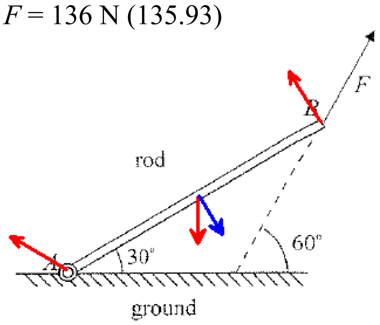
Weight W



(b) (i) Take moment about point A.

$F \cos 60° \times \ell = W \cos 30° \times (\ell/2)$

$F = 136$ N (135.93)



Alternative Solution : $F \times \ell \sin 30° = W \times \frac{\ell}{2} \cos 30°$

(ii) The vertical component of R: $W - F \sin 60° = 39.24$ N (upwards)

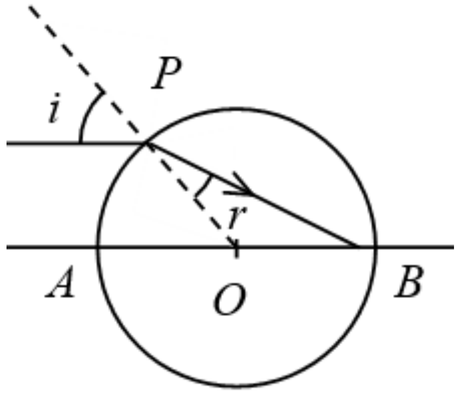
The horizontal component of R: $F \cos 60° = 67.97$ N (leftwards)

The magnitude of R: $\sqrt{39.24^2 + 67.97^2} = 78.5$ N (78.484)

The direction of R: $tan^{-1}\frac{39.24}{67.97} = 30.0°$ from the ground (29.998)

Question 5

(a)



(b) $i = \sin^{-1}(\frac{4.5}{5.0})$

$= 64.2°$

(c) $n = \frac{\sin 64.2°}{\sin 28.6°}$

$= 1.88$

(d) $\lambda_{air} = \frac{c}{f}$

$= \frac{3 \times 10^8}{5.4 \times 10^{14}}$

$= 5.55 \times 10^{-7}$ m

$n = \frac{\lambda_{air}}{\lambda_{glass}}$

$1.88 = \frac{55.5 \times 10^{-7}}{\lambda_{glass}}$

$\lambda_{glass} = 2.95 \times 10^{-7}$ m

Question 6

(a) By lens formula, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

$v = 100$ cm

The distance = 100 + 25 = 125 cm

(b) move the lens away from the ruler / towards the screen

(c) Decrease

Shorter focal length => image distance $v \downarrow$

by magnification $m = \frac{v}{u}$, $m \downarrow$

(d) Only virtual image will be formed.

Question 7

(a) Longitudinal waves: parallel to the direction of wave propagation.

Transverse waves: perpendicular to the direction of wave propagation.

(b) Station *C*

Smallest *S*-*P* interval

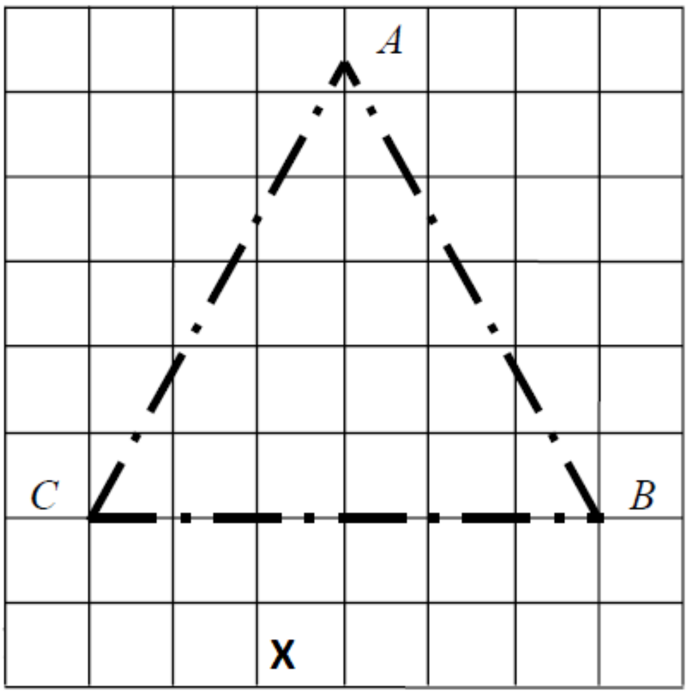
largest amplitude

Earliest registered signal

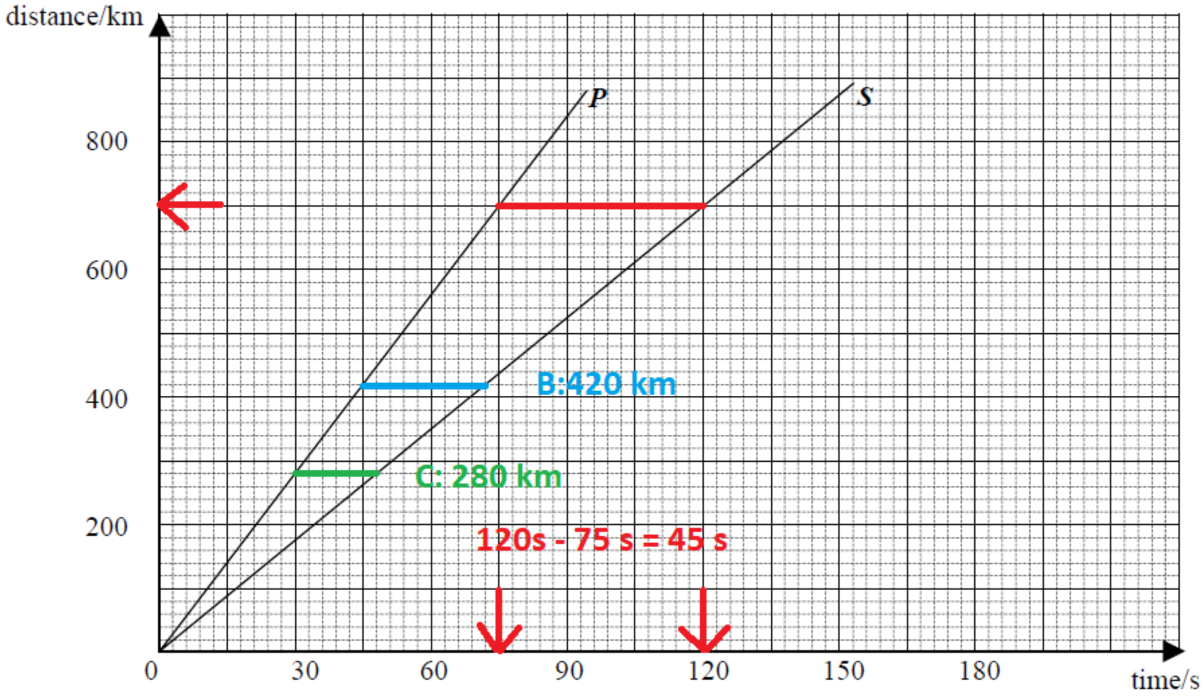
(c) (i) 700 km

indication on the graph

(ii)



Note: from (c)(i) Station A:700 km, Station B:420 km, Station C: 280 km



8. (a) The B field at the centre of the coil

$$B = \frac{N\mu_o I}{2R} = \frac{100 \times 4\pi \times 10^{-7}}{2 \times 150 \times 10^{-3}} I = 4.19 \times 10^{-4} I$$

(b) (i) along *PQRS*

(ii) The torque due to the magnetic force acting on the square loop

= the change in the torque of the rider

$$\tau = 40 \times 10^{-6} \times 10 \times 80 \times 10^{-3} = 3.2 \times 10^{-5} \text{ Nm}$$

(iii) $N'IAB = 100 \times I \times (3 \times 10^{-6}) \times 4.19 \times 10^{-4} I = 1.257 \times 10^{-7} I^2$

$$I = \sqrt{\frac{3.2 \times 10^{-5}}{1.257 \times 10^{-7}}} = 16.0 \text{ A}$$

9. (a) Take the direction out of the paper as positive.

For the loop formed by the moving conducting rod, the parallel rails and the resistor, the magnetic flux linkage is

$$\Phi = BA\cos 180^o = -BA = -B\times l\times s$$

The induced e.m.f. is calculated with the Faraday's law.

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t} = -\frac{\Delta\Phi}{\Delta t} = \frac{\Delta}{\Delta t}(B\times l\times s) = B\times l\times\frac{\Delta s}{\Delta t} = B\times l\times v$$

$$\boxed{\varepsilon = B\,l\,v}$$ and $\varepsilon = 20\times10^{-3}\times0.5\times1 = 0.01\,\text{V}$

(b) $$I = \frac{\varepsilon}{R} = \frac{0.01}{40} = 2.5\times10^{-4}\ \text{A}$$

$$P = I^2R = (2.5\times10^{-4})^2\times40 = 2.5\times10^{-6}\ \text{W}$$

(c) The energy dissipation in the resistor equals to the energy input by the external force.

(d) $$P = Fv$$

$$\Rightarrow\quad F = \frac{P}{v} = \frac{2.5\times10^{-6}}{1} = 2.5\times10^{-6}\ \text{N}$$

10. (a) The energy released in the fusion reaction is

$\Delta E = \Delta mc^2$

$= [(2.014\ 102 + 3.016\ 049) - (4.002\ 603 + 1.008\ 665)] \times (1.661 \times 10^{-27})$

$\times (3.00 \times 10^8)^2$

$= 2.819 \times 10^{-12}$

$\approx 2.82 \times 10^{-12}$ J

(b)(i) Applying $\text{K.E.}_{\text{avg}} = \frac{3R}{2N_A}T$, we have

Divide the P.E. by 2, as the total K.E. include two head-on nuclei.

$$\frac{2.302\times10^{-14}}{2} = \frac{3}{2}\times\left(1.38\times10^{-23}\right)T$$

$$T = 5.560\times10^8 \approx 5.56\times10^8\ \text{K}$$

The temperature required is 5.56×10^8 K.

(ii) The kinetic energy considered in (ii) is the **average** kinetic energy of the hydrogen nuclei in the gas at that temperature . Hence, even at a lower temperature, some hydrogen nucleus will still have the energy required to start fusion .

(c) The temperature required to start fusion is too high that no ordinary container can hold the fuel.

(d) Most of the products of combustion of fossil fuels creates air pollution . On the contrary, the products of nuclear fusion are neither radioactive substances nor air-pollutants .