HWA CHONG INSTITUTION
JC2 Preliminary Examination
Higher 2

CANDIDATE NAME		**CT GROUP**	22S
CENTRE NUMBER		**INDEX NUMBER**	

PHYSICS **9749/03**

Paper 3 Longer Structured Questions **18 September 2023**

SECTION B BOOKLET **2 hours**

Candidates answer on the Question Paper.

No Additional Materials are required.

INSTRUCTIONS TO CANDIDATES

Write your **Centre number**, **index number, name** and **CT class** clearly on all work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paperclips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Section A
Answer **all** questions.

Section B
Answer **one** question only. **Circle** the question number on the cover page.

You are advised to spend one and a half hours on Section A and half an hour on Section B.

The number of marks is given in brackets [ ] at the end of each question or part question.

You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use		
SECTION B (circle 1 question)		
8		**20**
9		**20**
Deductions		

Data	
speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$ $\approx (1/(36\pi)) \times 10^{-9}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae	
uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on / by a gas	$W = p\,\Delta V$
hydrostatic pressure	$p = \rho g h$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	$T/\mathrm{K} = T/^{\circ}\mathrm{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $= \pm\omega\sqrt{(x_0^{\ 2} - x^2)}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 N I}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 n I$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

Section B

Answer **one** question from this Section in the space provided.

8 **(a)** State the conditions required for a body to be in equilibrium.

....

.... [2]

(b) A uniform beam AB of mass 1.5 kg is placed on a horizontal bench and held in equilibrium by a support cable. The beam is at an angle of 42° to the horizontal bench and the support cable is at an angle of 25° to the horizontal platform, as shown in Fig. 8.1.

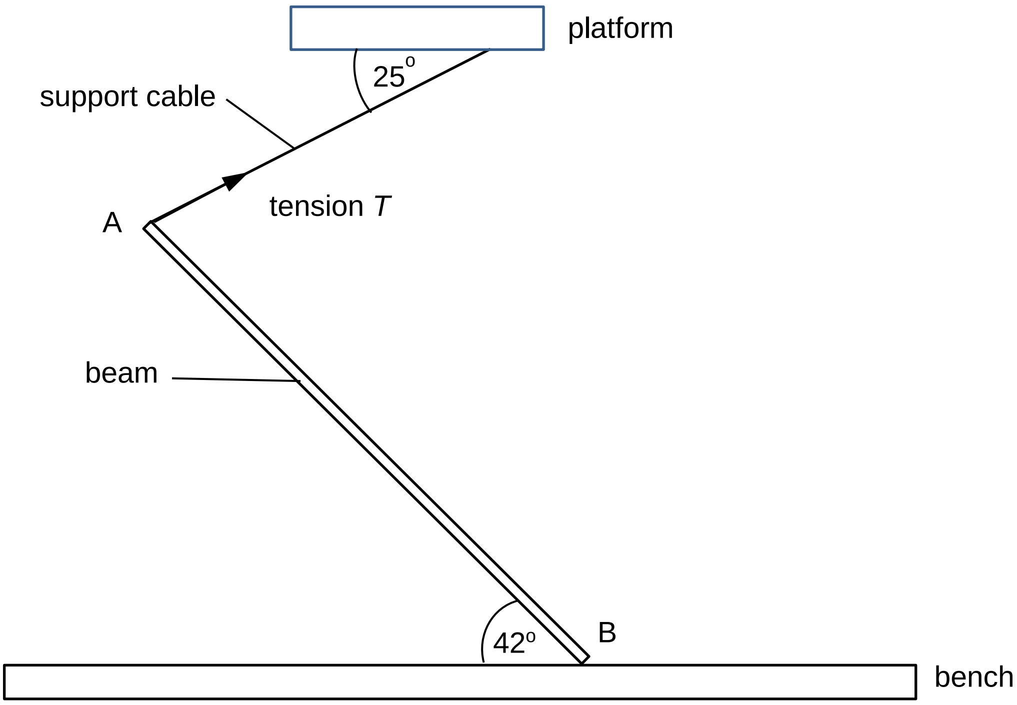

Fig. 8.1 (not drawn to scale)

(i) On Fig. 8.1, draw the forces acting on the beam. [2]

(ii) Show that the magnitude of tension T exerted on the beam by the cable is 5.94 N.

[2]

(iii) Determine the force exerted on the beam by the bench.

magnitude = ………………… N [3]

direction = ………………………………………………… [1]

(c) In a child's toy, a small ball moves along a smooth track. The ball moves down a straight slope and then travels around a vertical circular loop, as shown in Fig. 8.2

The loop has diameter of 34 cm. The slope has a length of 58 cm and is inclined at an angle of 42^o to the horizontal. Initially, the ball is at rest at the top of the slope.

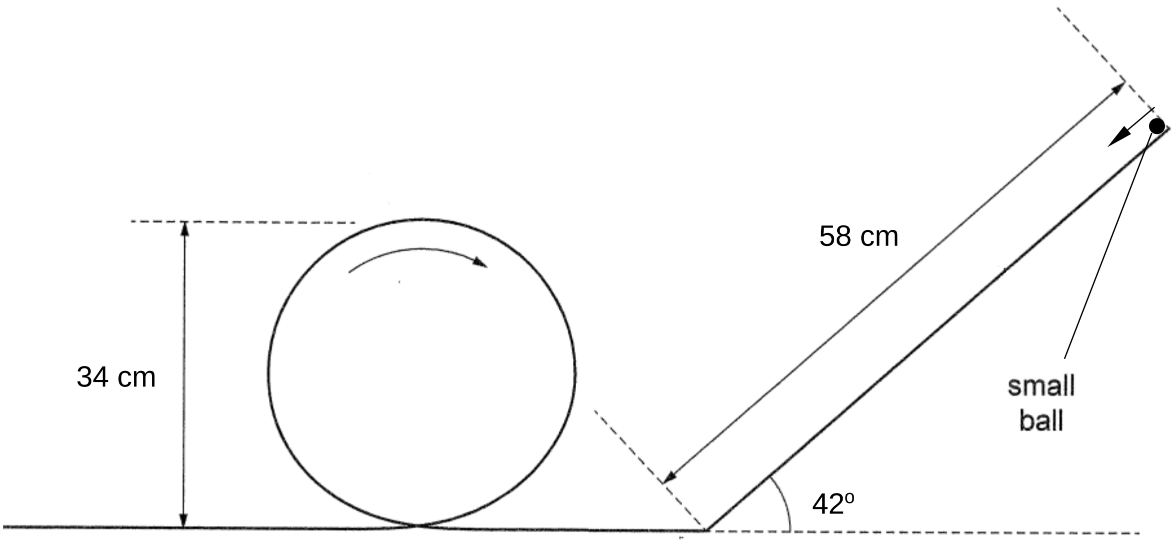

Fig 8.2

(i) Calculate the acceleration of the ball moving down the slope.

acceleration = ………………… m s^{-2} [2]

(ii) State and explain what happens to the acceleration of the ball moving down the slope when it is replaced with another ball of the same size but twice the original weight.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

……………………………………………………………………………………………….... [2]

(iii) Determine whether the ball is able to make a complete loop around the circular track when released at the top of the slope. Show your working clearly.

Assume there is negligible air resistance and friction between the slope, the bench and the circular track with the ball.

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

…………………………………………………………………………………………………. [4]

(iv)

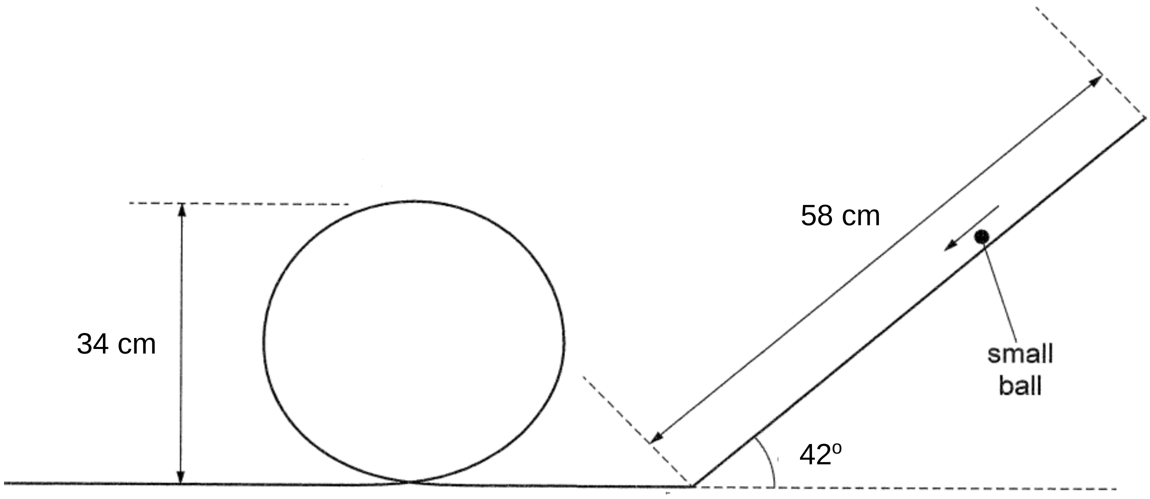

Fig. 8.3

The ball is now released from a new position as shown in Fig. 8.3.

Describe the subsequent path of the ball.

…………………………………………………………………………………………………..

………………………………………………………………………………………………….

………………………………………………………………………………………………… [2]

[Total: 20]

9 **(a)** Define magnetic flux linkage.

....

....

.... [2]

(b) A solenoid of length 30.0 cm is wound evenly with 900 turns of insulated wire. The cross-sectional area of the solenoid is 3.2×10^{-4} m^2.

A flat coil having 250 turns of wire is wound tightly around the centre of the solenoid. A resistor of 35 Ω is connected to the coil as illustrated in Fig. 9.1.

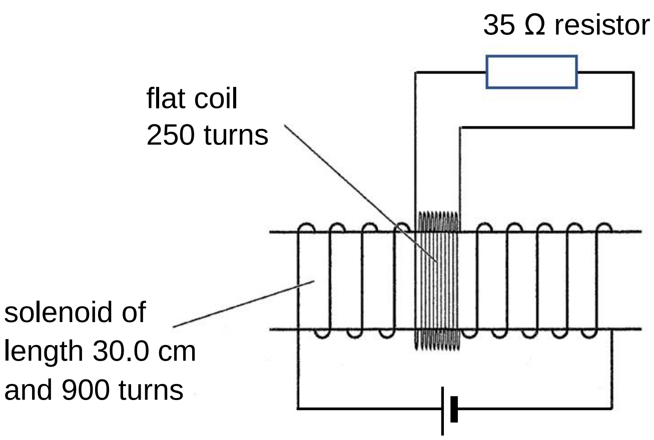

Fig. 9.1

(i) At a particular instant in time, the current through the solenoid is 2.0 A. Show that the magnetic flux through the coil is 2.41×10^{-6} Wb at that instant.

[2]

(ii) The current in the solenoid increases at a uniform rate from 0.0 A to 2.0 A in 0.45 s.

1. Calculate the magnitude of the e.m.f. induced in the flat coil during this period.

e.m.f. = ………………………… V [2]

2. Hence, calculate the amount of charge that flows through the resistor during this period.

charge = ……………………………… C [2]

3. Determine the amount of charge that passes through the solenoid during this period.

charge = ………………………….. C [2]

(c) A potential difference is applied between two horizontal plates, each 15.0 cm long and separated by 4.0 cm.

A uniform magnetic field is directed perpendicularly into the page between the two plates.

A beam of electrons moves in a straight line between the plates along a horizontal path halfway between the two plates as shown in Fig. 9.2.

Each electron has a velocity of 4.50×10^{6} m s^{-1}.

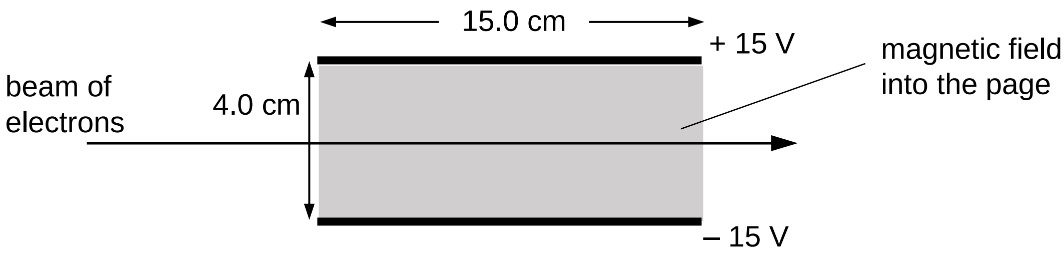

Fig. 9.2 (not drawn to scale)

(i) Determine the magnetic flux density of the magnetic field.

magnetic flux density = …………………….. T [2]

The undeflected beam of electrons enters a second region of uniform magnetic field as shown by the shaded region in Fig. 9.3. A magnetic flux density of 0.50×10^{-3} T is directed perpendicularly into the page.

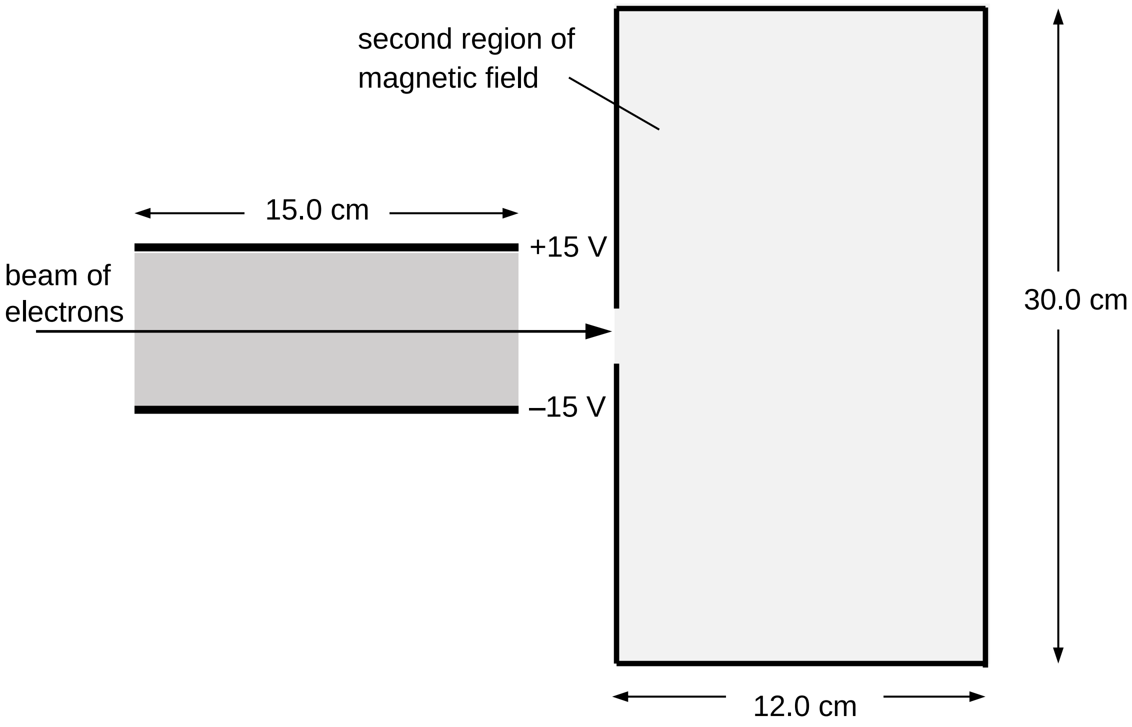

Fig. 9.3

(ii) Explain why the electrons move in a uniform circular motion inside the second region of magnetic field.

....

....

....

.... [2]

(iii) Calculate the radius of the path.

radius = ... m [2]

(iv) The beam of electrons is now replaced by a beam of protons. The velocities of the protons before going between the two parallel plates ranges from of 3.00×10^{6} m s^{-1} to 6.00×10^{6} m s^{-1}.

Determine the speed of the protons that enters the second region of magnetic field.

speed = …………………….. m s^{-1} [1]

(v) Sketch and label the respective paths of the electrons and protons inside the second magnetic field in Fig. 9.3.

[3]

[Total: 20]

End of Paper 3 Section B