CATHOLIC TRIAL HSC 2004

Section I
Total marks – 75

Part A
15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

Please note that this paper, has been modified slightly, it it does not represent the actual CSSA paper. However most questions are CSSA questions, but a few are IND.

Use the Multiple Choice Answer Sheet provided

1 What is the weight of an 80 kg astronaut when placed in a gravitational field of 0.5g, where g is the Earth's gravitational acceleration? Take $g = 10ms^{-2}$.

(A) 40kg
(B) 80kg
(C) 400N
(D) 800N

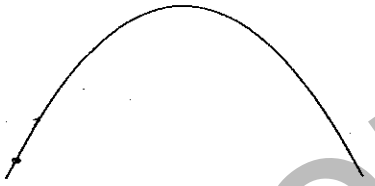
2 Which statement correctly describes the period of a satellite in low Earth orbit?

(A) A satellite in low Earth orbit has a period less than that of a geostationary orbit
(B) A satellite in low Earth orbit has a period equal to that of a geostationary orbit
(C) A satellite in low Earth orbit has a period greater than that of a geostationary orbit
(D) A satellite in low Earth orbit has a period greater than or equal to that of a geostationary orbit

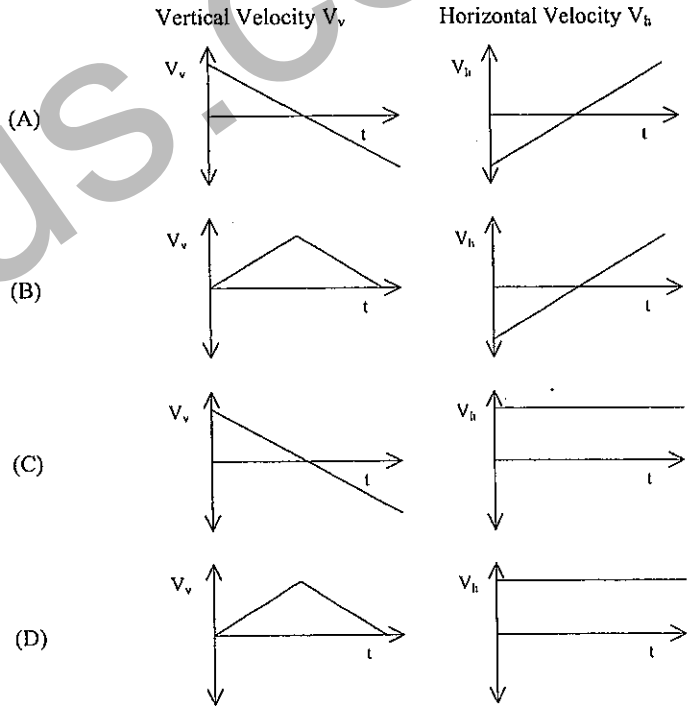
3 A muon at rest has an average lifetime of 10^{-6} s. A muon traveling at high speed in a particle accelerator is found to have a lifetime of 2×10^{-6} s. What is the approximate speed of the muon?

(A) 0.5c
(B) 0.75c
(C) 0.87c
(D) 1.15c

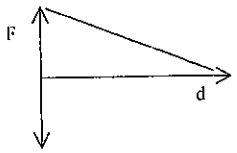
4 The diagram below shows the path of a projectile under the influence of the Earth's gravitational field.

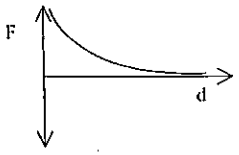


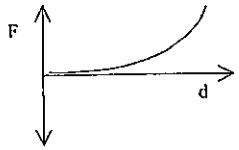
Which combination of graphs best depicts the projectiles vertical and horizontal velocity for the motion with respect to time?

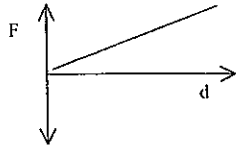


5 Which graph best depicts the variation of gravitational force F, with distance d, from the centre of the Earth?

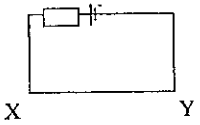
(A) 

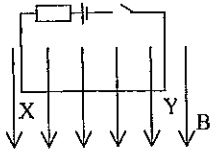
(B) 

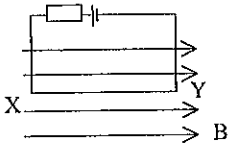
(C) 

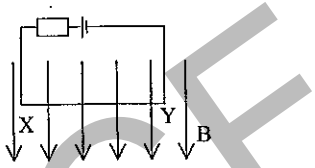
(D) 

6 In which situation will the wire marked XY experience a force?

(A) 

(B) 

(C) 

(D) 

7 The current flowing in a DC motor reduces while the motor's speed increases. How can this change in current be accounted for?

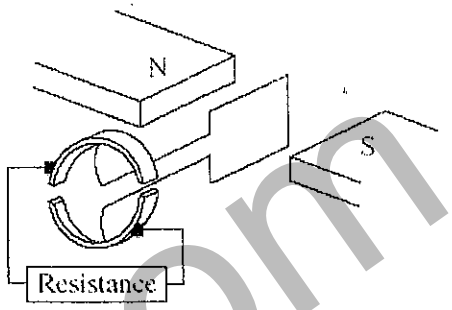
(A) The wires increase in resistance as the coil spins, leading to a reduction in current

(B) The back emf reduces the resistance leading to a reduction in the current in the circuit

(C) The increase in kinetic energy of the motor must be matched by a decrease in electrical energy in the circuit

(D) A governor is used to reduce the current in the circuit as the motor spins more rapidly to reduce the chance of the motor burning out

8 The diagram below represents an electrical generator.



What type of current would be produced by the generator ?

(A) DC of constant magnitude

(B) DC of varying magnitude

(C) AC

(D) None

9 What is the ratio of the number of coils in the primary to the number of coils in the secondary for a step up transformer?

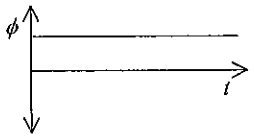
(A) Less than one

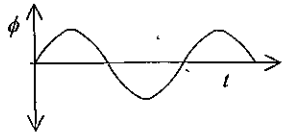
(B) Less than or equal to one

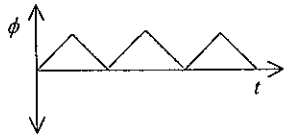
(C) Equal to one

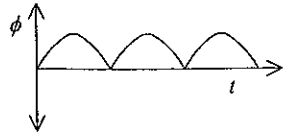
(D) Greater than one

10 A coil is rotated in an area of constant magnetic flux density. Which graph represents the variation of magnetic flux as the coil rotates?

(A) 

(B) 

(C) 

(D) 

11 The wavelength of the radio waves being broadcast from radio station 2MMM in Sydney is 2.86 m.

What is the energy of a photon of that wave?

(A) 6.95×10^{-26} J
(B) 1.895×10^{-33} J
(C) 1.988×10^{-25} J
(D) 2.32×10^{-34} J

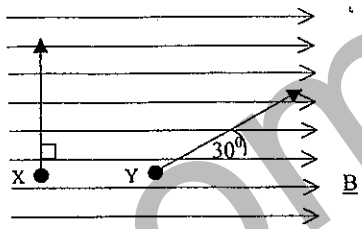
12 A student observes the different striation patterns in a set of discharge tubes. The pressures in the tubes are different but are not in any particular order. He records the following observations:

Tube 1: There is no glow, only the glass at the anode end of the tube glows green.
Tube 2: The column is broken up into striations, separated from the glow at the cathode by a dark space.
Tube 3: The tube is filled with a purple glow.
Tube 4: The glow at the cathode is slightly separated from the cathode leaving a dark space next to the cathode.

What is the order of the discharge tubes from greatest to least pressure?

(A) Tube 1, Tube 2, Tube 4, Tube 3
(B) Tube 3, Tube 2, Tube 4, Tube 1
(C) Tube 1, Tube 4, Tube 2, Tube 3
(D) Tube 3, Tube 4, Tube 2, Tube 1

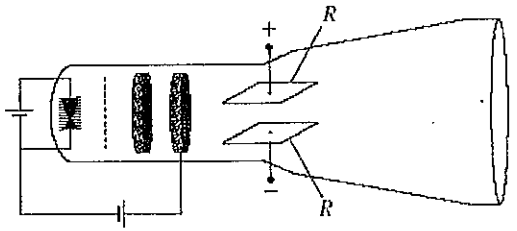
13 Two electrons, X and Y, traveling at the same speed enter a magnetic field as shown in the diagram.



What is the ratio of the force on electron X to the force on electron Y?

(A) 1/2
(B) 1
(C) 3/2
(D) 2

14 The diagram shows the side view of a simple cathode ray tube.

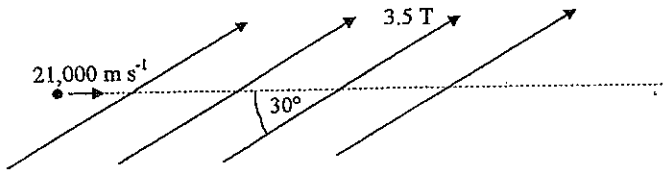


Fluorescent screen

What is the function of the components labelled *R*?

(A) To produce cathode rays
(B) To stop cathode rays striking the screen
(C) To deflect the cathode rays vertically
(D) To deflect the cathode rays horizontally

15 An electron moving at 21 000 ms^{-1} enters a magnetic field of 3.5 tesla at an angle of 30° as shown in the diagram.



What is the force on the electron?

(A) 1.2×10^{-14} newtons into the page
(B) 1.2×10^{-14} newtons out of the page
(C) 5.9×10^{-15} newtons out of the page
(D) 5.9×10^{-15} newtons into the page

Centre Number

Student Number

Physics
Section I (continued)

Part B – 60 marks
Attempt Questions 16-27
Allow about 1 hour and 45 minutes for this part

Show all relevant working in questions involving calculations.

Question 16 (4 marks) **Marks**

(a) Define the term "Gravitational Potential Energy". **1**

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(b) Derive a mathematical expression for the speed of a satellite in a stable circular orbit around the Earth in terms of the Earth's mass (M), Newton's Universal Constant of Gravitation (G) and the satellites distance from the centre of the Earth (r). **3**

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Question 17 (5 marks) **Marks**

(a) Define the Law of Conservation of Momentum. 1

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(b) A rocket of initial mass 2000 tonnes , produces a constant thrust of 8×10^7N during liftoff by expelling 1500 kg of exhaust gases per second. 4

Calculate the net force acting on an 85kg astronaut 30s after liftoff.

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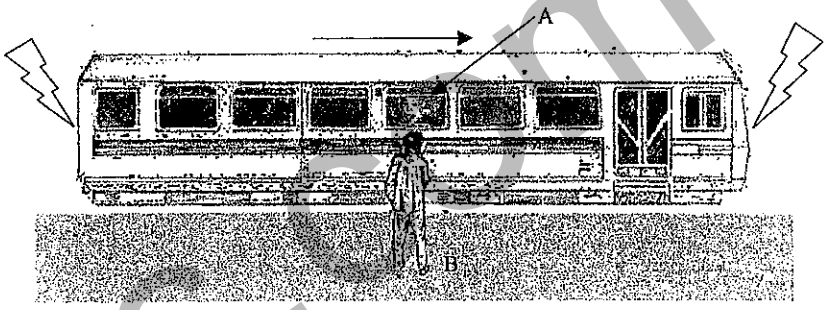
Question 18 (5 marks) **Marks**

Observer A sits in the middle of a train traveling at high speed past a railway station as shown in the picture below. Observer B stands on the station platform. Lightning strikes the front and back of the train at the moment observer A passes observer B. Analyse the statements of both observers regarding the order of the lighting strikes. 5



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Question 19 (6 marks) **Marks**

(a) Describe the important contribution that Galileo's analysis of projectile motion made to our current understanding of this type of motion. **2**

(b) A projectile is fired at an angle of 30^0 to the horizontal from a tower 20m high. The projectile takes 10s to hit the ground. Calculate the initial speed of the projectile. **4**

Question 20 (4 marks) **Marks**

(a) Describe the purpose of transformers in electrical circuits. **1**

(b) Discuss the impact of the development of transformers on society. **3**

Question 21 (5 marks) **Marks**

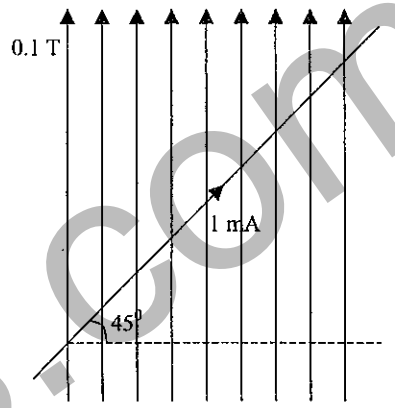
Describe a first-hand investigation to demonstrate the effect on a generated electric current when the relative motion between the magnet and the coil is varied. **5**

In your description, include:

- a labelled sketch of the experimental set-up
- how you varied the relative motion of the magnet and the coil
- how other variables were controlled

Question 22 (5 marks) **Marks**

(a) Calculate the force on a 15cm length of wire carrying 1mA of current placed at 45^0 to a magnetic field of strength 0.1 T as shown in the diagram. **1**



(b) Explain why the torque on a current loop in a magnetic field is zero when the magnetic flux through the coil is at a maximum. **4**

Question 23 (6 marks) **Marks**

(a) Describe ONE differences between AC and DC generators. **1**

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(b) Analyse the competing technologies of Edison and Westinghouse for the supply of domestic electricity. **5**

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Question 24 (5 marks) **Marks**

(a) Outline Thomson's experiment to measure the charge/mass ratio of an electron. **2**

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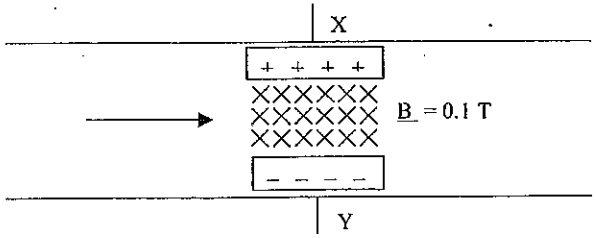
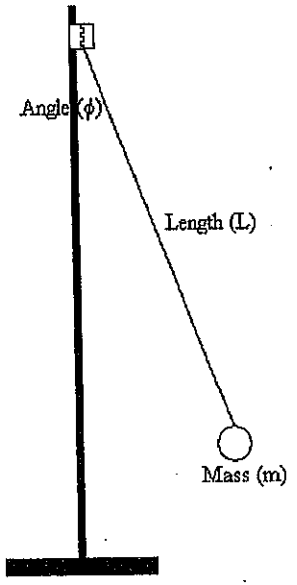
(b) An electron is accelerated to a speed of 1×10^4 ms^{-1} inside a cathode ray tube. The electron enters a region of crossed magnetic field of 0.1 T and electric fields as shown in the diagram below. Calculate the potential difference across the parallel plates, X Y, required to allow the electron to pass undeflected through the electric and magnetic fields. The distance between the plates is 10cm. **3**



Question 25 (6 marks) **Marks**

Two students carried out an investigation to determine the acceleration due to gravity using pendulum motion.

They set up the equipment as shown in the diagram below:



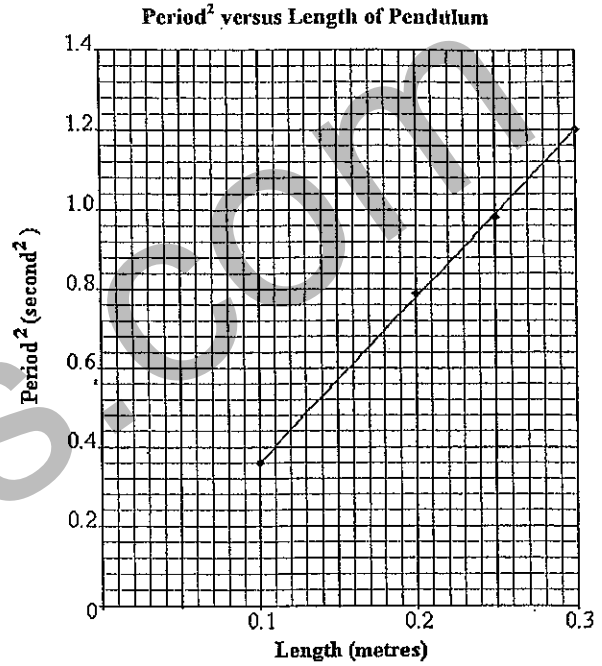
Their results allowed them to construct the following table. One value was omitted.

Length - L (metres)	Period^2 (T^2) (seconds^2)
0.10	0.36
0.15	Not calculated
0.20	0.79
0.25	0.97
0.30	1.2

Question continues

Question 25 *cont'd* **Marks**

The results from the table were used to plot a graph of period^2 against length as shown below:



(a) State the value and units for the missing data. **1**

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(b) Given that the period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, describe how the value of acceleration due to gravity can be determined from the slope of the graph. **2**

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Question continues

Question 25 (continued) Marks

(c) Calculate the value of acceleration due to gravity in this situation. 2

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(d) The average value for acceleration due to gravity is 9.8 ms^{-2}. Assuming that the results recorded and the measurements taken were accurate, and assuming that the density of the earth is uniform, what does your answer in (c) indicate with reference to the distance from the Earth's centre of mass? 1

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Question 26 (4 marks)

Cathode rays were first investigated over 150 years ago. Experiments, since that time, have indicated that cathode rays have the following properties:

- Cathode rays travel in straight lines.
- Cathode rays are charged particles.
- The charge on the cathode rays is negative.
- Cathode rays are able to transfer energy and do work.

(a) For any TWO of these properties, describe how they can be demonstrated in the laboratory using discharge tubes. 2

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(b) Justify the conclusion of the demonstrations you chose in (a). 2

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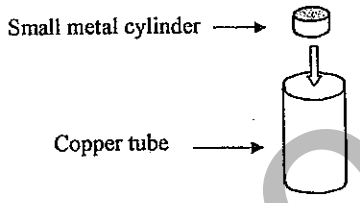
Question 27 (5 marks) Marks

When a small metal cylinder is dropped into one end of the copper tube shown below, it falls freely under the action of gravity.



Yet a small magnet of identical dimensions takes much longer to fall through the tube.

(a) Explain this observation. 3

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(b) Outline how a similar phenomenon is used in certain braking mechanisms. 2

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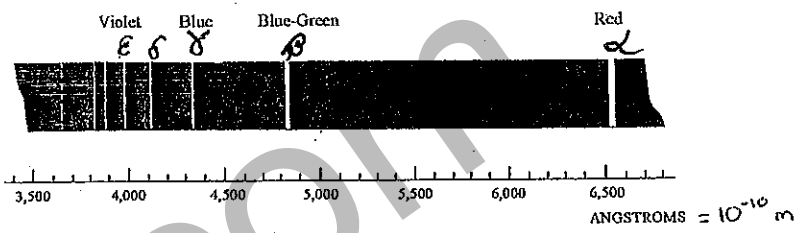
Marks

Question 31 From Quanta to Quarks (25 marks)

(a) (i) Describe a first hand laboratory investigation used to observe the visible spectrum of the hydrogen atom. 2

(ii) The diagram represents the visible spectrum of the hydrogen atom.



Calculate the frequency of the blue/green line. 2

(iii) Describe how Bohr's postulates led to the development of a mathematical model to account for the lines in the spectrum shown above 3

(b) (i) Define diffraction. 1

(ii) Describe the impact of de Broglie's proposal about electrons presented in his doctoral thesis. 3

(c) (i) Explain the importance of moderators in nuclear reactors using a uranium fuel. 2

(ii) Modern accelerators are very expensive to build and run. Assess their usefulness to society. 4

(d) A famous scientist once stated that he was able to make scientific advances because he "stood on the shoulders of giants".

Discuss this statement with reference to the contributions that Bohr, Chadwick and Fermi made to our understanding of the atom. 8

End of Question 31