



ALL SAINTS' COLLEGE

Ewing Avenue, Bull Creek, Western Australia

Year 12 Physics ATAR

Electromagnetism

2016

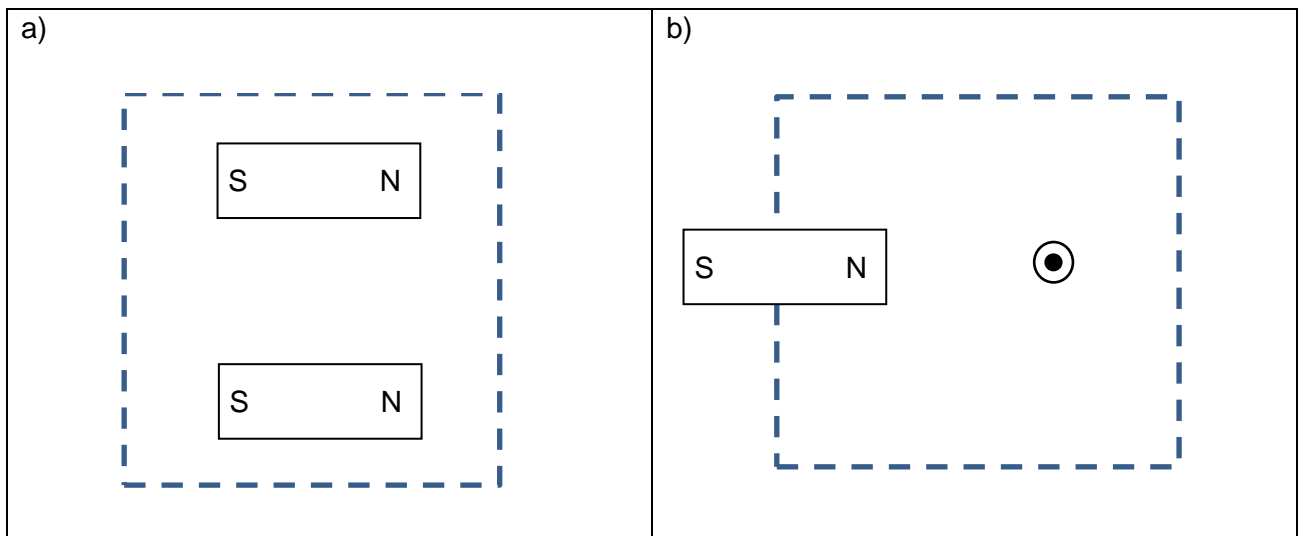
Student Name: _____

Time allowed: 50 minutes
Total marks available: 50
Show calculation answers to 3 significant figures

Question 1

(4 marks)

Consider the areas identified by the hatched boxes in the diagrams below. Within each box sketch the **overall** magnetic field with at least 5 magnetic field lines. You can assume that the magnets and wires are fixed in position and the Earth's magnetic field is negligible.



Question 2

(2 marks)

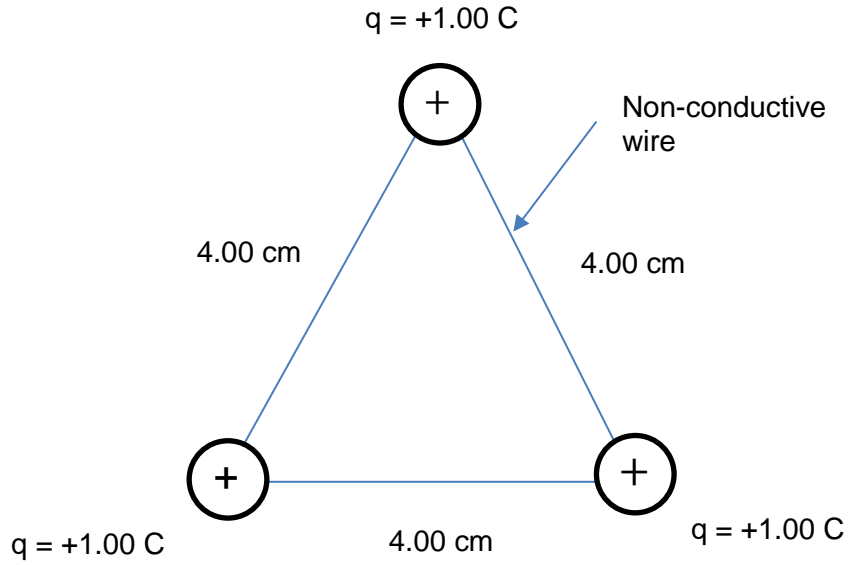
Draw the electric field between the two positively charged spheres shown below. You must use at least 10 electric field lines.



Question 3

(6 marks)

As shown in the diagram below three small, electrically charged spheres are joined by non-conductive wire. The distance between the centre of each sphere is 4.00 cm and the charge of each sphere is +.00 C. You may ignore gravitational force in this question.



(a) Calculate the tension in the non-conductive wire.

(4 marks)

(b) If one the spheres had a charge of +2.00 C instead of +1.00 C would the spheres begin to move? Circle your answer and provide an explanation below. (2 marks)

They will move

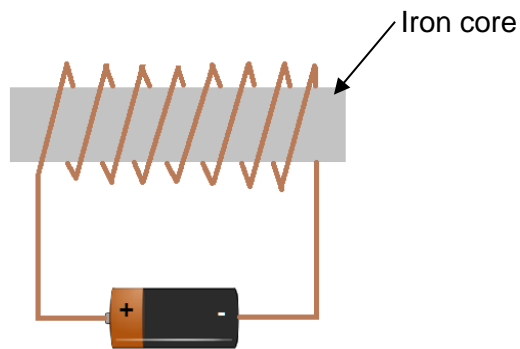
They will not move

Explanation

Question 4

(6 marks)

The diagram below shows an electromagnet powered by a DC battery.



(a) On the diagram

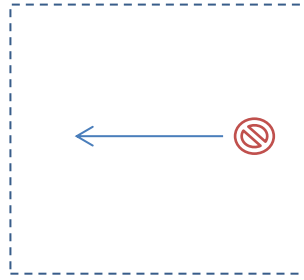
- i. indicate the direction of the conventional current flow through the coil. (1 mark)
- ii. draw the magnetic field produced by the electromagnet. (2 marks)
- iii. indicate the effective north and south poles of the electromagnet. (1 mark)

(b) Explain why adding an iron core increases the strength of an electromagnet. (2 marks)

Question 5

(4 marks)

A beta particle (e^-) enters a magnetic field which is perpendicular to its velocity and experiences a force of 1.08×10^{-13} N upwards. It moves at 2.10×10^6 m s $^{-1}$ to the left as indicated.

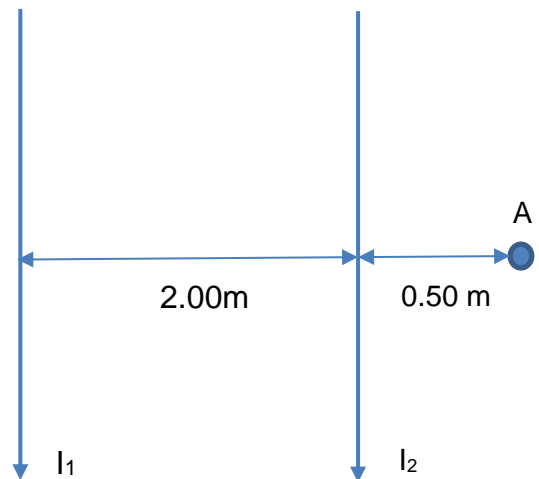


- (a) Indicate the direction of the magnetic field by sketching at least 5 field lines within the hatched box on the diagram. (1 mark)
- (b) Calculate the magnitude of the magnetic flux density perpendicular to the motion of the beta particle. Give your answer in mT. (3 marks)

Question 6

(4 marks)

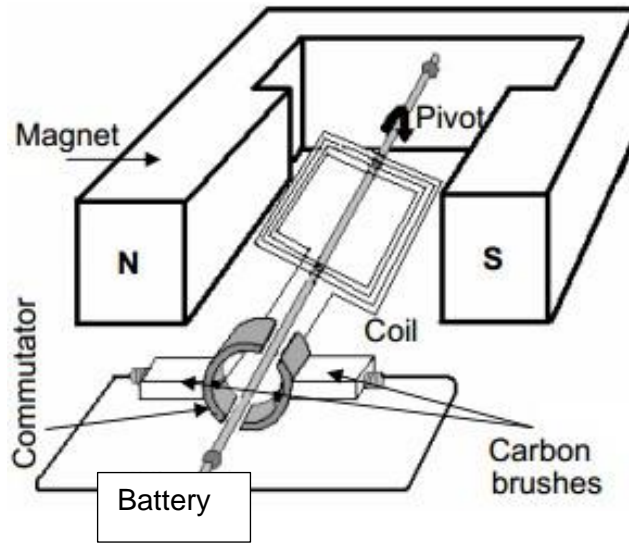
Two long, parallel wires carry current in the direction shown. If the magnetic flux density at A is $3.20 \mu T$, and the current in Wire 1 (I_1) is 7.00 A, calculate the current in Wire 2 (I_2).



Question 7

(13 marks)

The diagram shows a small DC motor connected via a commutator and carbon brushes to a DC battery. The direction of rotation is clockwise as shown. A uniform magnetic field exists between the magnetic poles and the maximum torque produced by the coil is 3.00 N m clockwise. The coil has a length (l) of 8.00 cm and width (w) of 3.50 cm and 150 turns of wire. The coil draws a current of 2.85 A from the battery.



- (a) Indicate the direction of current in the length of the coil next to the north pole by placing an arrow on the diagram. (1 mark)

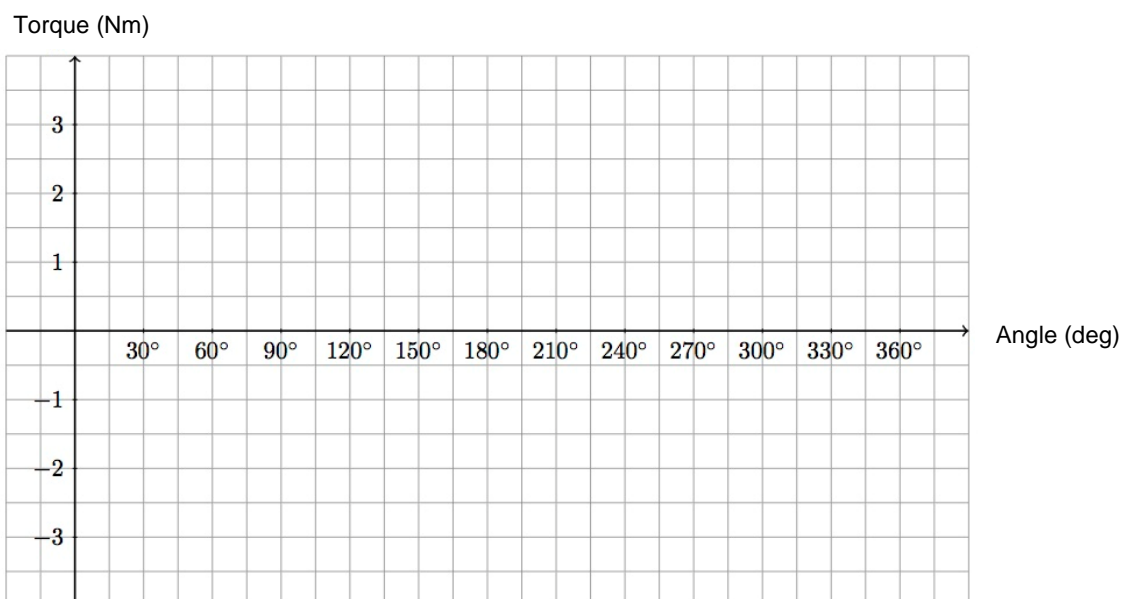
- (b) Explain why DC motors have a commutator and brush arrangement. (3 marks)

(c) Calculate the magnetic flux density of the magnet.

(3 marks)

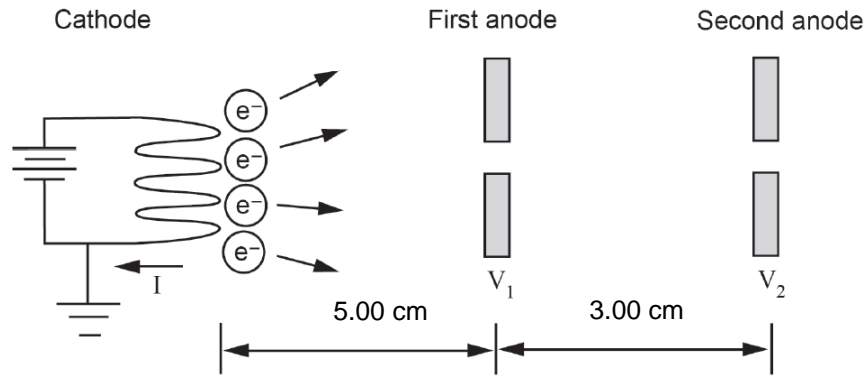
(d) Calculate the rotation angle of the coil from the horizontal if the torque produced by the motor is 85.0 % of the maximum torque. (3 marks)

(e) On the graph paper below sketch the variation of torque produced by the coil when it rotates through one turn (0 to 360°) from being horizontal in the magnetic field. (3 marks)



Question 8**(6 marks)**

An electron gun is a very important component of many devices, including particle accelerators, electron microscopes and cathode-ray tubes. A schematic diagram of an electron gun is shown below. The voltage at the cathode is zero.



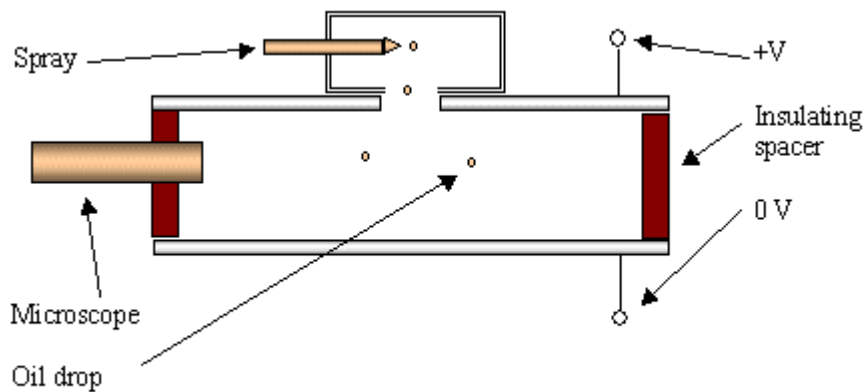
Assume the initial velocity of a thermal electron as it is emitted by the cathode is zero. The anode voltages are $V_1 = 1500 \text{ V}$ and $V_2 = 4500 \text{ V}$ and the distances between the cathode and anodes are as shown above.

- (a) Calculate the velocity in m s^{-1} of the thermal electrons as they pass through the first anode. (3 marks)

- (b) Calculate the electrical work done by the electric field in moving one electron from the first anode to the second anode. (3 marks)

Question 9**(5 marks)**

The Miliken oil drop experiment involved introducing charged oil drops into a space between two charged horizontal plates as shown below. He observed the oil drops using a microscope and noticed that some of the oil drops were held stationary by the electric field working against the force of gravity.



- (a) If the potential difference between the plates is 7.00 kV and the plate separation is 40.0 mm, calculate electric field strength between the plates. (2 marks)

- (b) If the mass of a stationary oil drop is 530 mg, calculate the charge on the oil drop. (3 marks)