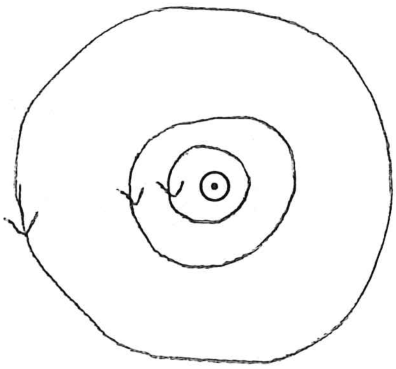
TEST 3 SOLUTIONS.

1. A copper wire carries a current of 5.50 Amps in a direction out of the page.

(a) Draw a diagram showing the shape of the magnetic field around the wire. (2 marks)



1 Shape - increasing diameter or second circle a lot larger

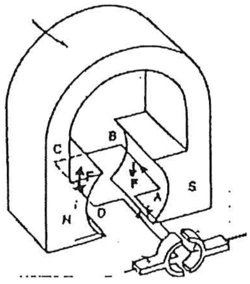
1 Direction

(b) Calculate the magnetic field strength at a distance of 5.50 cm from the wire. (2 marks)

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{1.26\times10^{-6} \times 5.5}{2\times 3.14 \times 5.5\times10^{-2}} \quad (1) \qquad = 2.00\times10^{-5}\,T \quad (1)$$

2. A DC electric motor armature with 500 turns of wire has a length of 100mm and a width of 100mm. If it has an applied current of 2.00A and a magnetic field of 0.200T, calculate the magnitude of the maximum torque supplied by the motor. (4 marks)



$F = nIlB$

$= 500 \times 2.0 \times 0.1 \times 0.2 \quad (2)$

$= 20.0\,N$

$n = 500$

$l = 0.1m$

$w = 0.1m \quad (1)$

$r = 0.05m$

$I = 2.00A$

$B = 0.200T$

$\tau = 2rF$

$= 2 \times 0.05 \times 20 \quad (1)$

$= 2.00\,Nm$

$\tau = nIAB$

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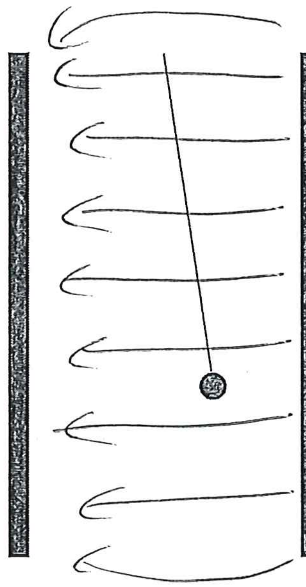
3. A small charged sphere with a mass of 81.0 milligrams is placed in an electric field as shown in the diagram below. The charged sphere is held by a thread of negligible mass. The charge on the sphere is -3.50 x 10^{-17} C and the electric field strength between the charged plates is1.00 x 10^{2} NC^{-1}

a. Draw lines between the plates showing the electric field (2 marks)

b. Calculate the angle that the thread makes with the vertical. (3 marks)



direction 1

evenly spaced 1

+ curved.

$F_{WT} = mg$

$= 81 \times 10^{-6} \times 9.8$

$= 7.938 \times 10^{-4} N$ 1

$F_E = Eq$

$= 1.0 \times 10^{2} \times -3.5 \times 10^{-}$

$= -3.5 \times 10^{-5} N$ 1

$\tan\theta = \frac{-3.5 \times 10^{-5}}{7.938 \times 10^{-4}}$

$\theta = 2.52°$ 1

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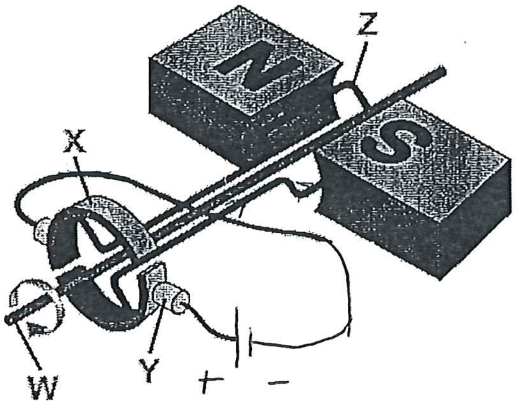
4. A simple DC motor is shown in the diagram below

a. On the diagram below, label the components X, Y and Z. Briefly explain the purpose of these components on an electric motor.

(6 marks)



X Split ring

Reverse the direction of the current every 180°
to maintain torque in a consistent direction

Y Brushes

TO conduct current into the armature

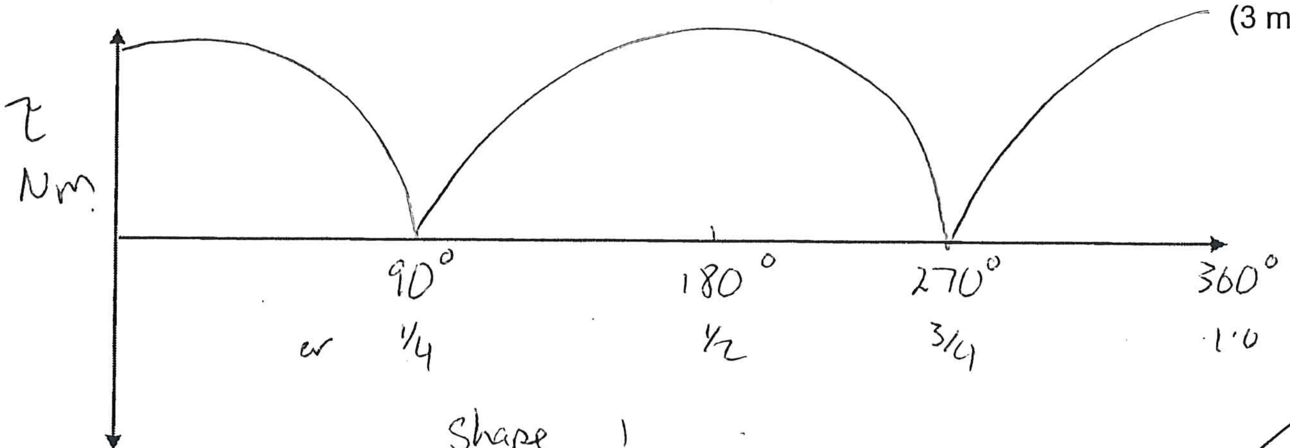
Z Armature or windings a coil

Current passing through the armature interacts with
the magnetic field to produce a force and therefore a torque.

b. Complete the diagram of the two wires going into the motor and draw in the power supply with the correct polarity to spin the motor in the direction shown at **W** (1 marks)

c. On the following axes, draw a graph of the torque generated by this device, starting when the coil is horizontal. Mark a scale on each of the axes.

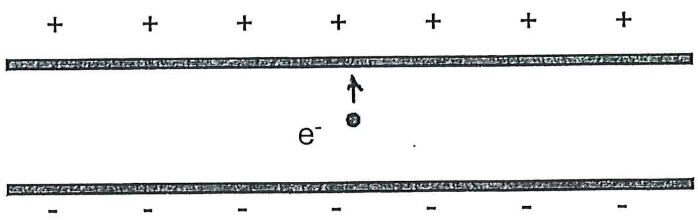
(3 marks)



Shape 1
Start point maximum 1
Scales on axes 1

/10

5.



An electron is placed between two parallel charged plates. The plates are separated by a distance of 1.00 mm.

a. Sketch the path of the electron on the diagram above (1 mark)

b. Given that the potential difference between the plates is 15 kV, calculate the electric field strength between the charged plates. (2 marks)

$E = \frac{V}{d}$ (1)

$= \frac{15000}{0.001} = 1.50 \times 10^{7}\ Vm^{-1}$ (1)

c. Calculate the energy required for the electron to move between the two plates. (2 marks)

$W = Vq$ (1)

$= 1.5 \times 10^{4} \times -1.6 \times 10^{-19}$ ✓

$= \underline{2.4 \times 10^{-15}\ J}$ (1)

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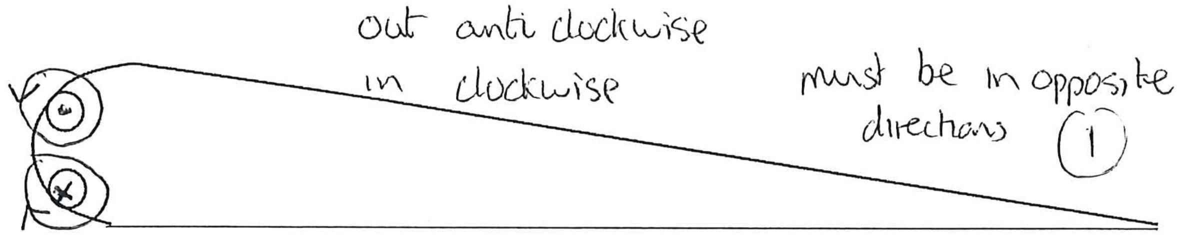
6. Old aeroplanes used to have two parallel wires running through the front of the wings. The pilot could switch on a power supply through these wires, this resulted in a sudden repulsion between the wires which would prevent the formation of ice on the wings by cracking the ice.

The following diagram shows a cross section of the aeroplane wing including two small circles representing a cross section of the wires.



a. Show the direction of the current through the two wires. Use a dot to represent current coming out of the page and/or a cross to represent current going into the page. (1 mark)

b. Show the direction of the magnetic field associated with each wire using a single circle for each wire. (1 mark)

c. Explain how the repulsion is caused. (3 marks)

Each wire is influenced by the magnetic field of the other wire

The top wire has a current coming out of the page. This current interacts with the field associated with the bottom wire resulting in a force up.

The interaction of the bottom wire causes a force down

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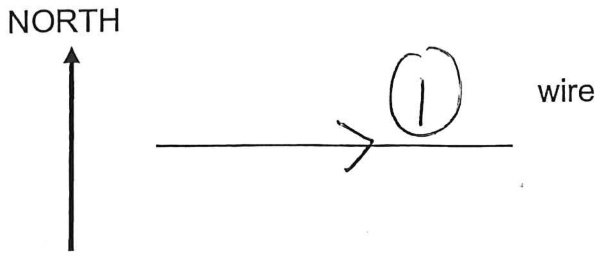
7. A long wire suspended horizontally in a direction perpendicular to North has a mass of 220g/m. Calculate the magnitude and direction of the theoretical current required to make the wire levitate (float) in the Earth's magnetic field where $B_{horizontal} = 4.50 \times 10^{-5}$ T.

(4 marks)



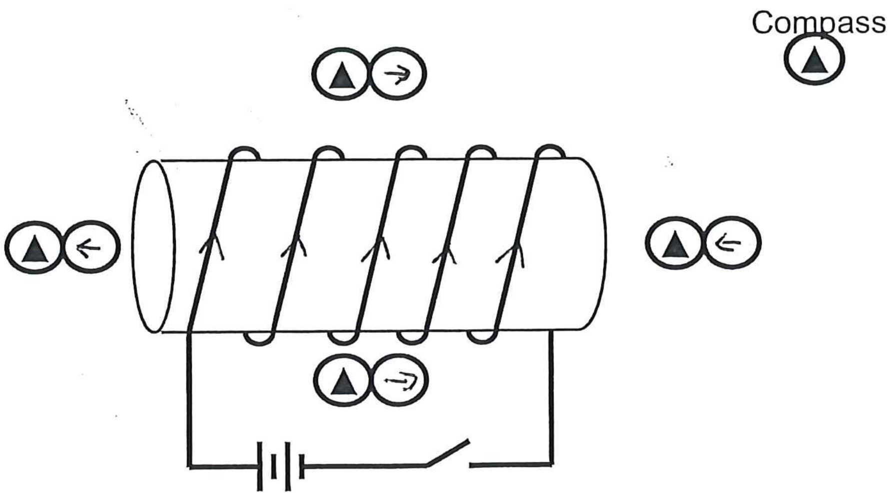
$F_e = IlB$ 1 $\quad F_{grav} = mg$ 1

$IlB = mg$

$I = \frac{mg}{lB}$

$= \frac{0.22 \times 9.8}{1.0 \times 4.5 \times 10^{-5}} = \frac{4.79 \times 10^{4}\,A}{East}$ 1

8. (3 marks)
The diagram below shows a solenoid with magnetic compasses positioned around it. The switch in the circuit is turned off and each compass is pointing North due to the Earth's field.



a) The circuit switch is now closed. Draw the direction of the current through the solenoid. (1 mark)

b) For each magnetic compass, draw the new position of the compass needle in the empty circle alongside the compass when the switch is closed. Assume the arrowhead represents north.

(2 marks)

-1 each mistake / 7