5.4 Magnetic Effects of Electric Currents
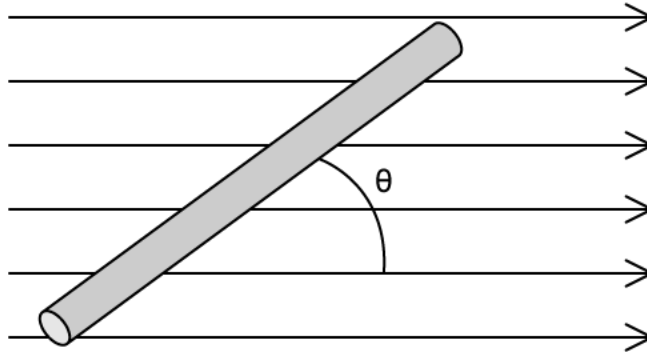
Question Paper

Course	DP IB Physics
Section	5. Electricity & Magnetism
Topic	5.4 Magnetic Effects of Electric Currents
Difficulty	Easy

Time allowed: 60

Score: /50

Percentage: /100

Question 1a

The diagram shows a current-carrying conductor at an angle θ to an external B field.

The force acting on the current-carrying conductor when it lies at different angles to the field can be calculated using the equation

$$F = BIL \sin \theta$$

(a)
State what the symbols *B*, *I* and *L* represent.

[3]

[3 marks]

Question 1b

(b)
State the angle, θ, between the conductor and the B field which would result in the largest force being exerted on the conductor.

[1]

[1 mark]

Question 1c

(c)
State the angle, θ, between the conductor and the B field which would result in there being no force exerted on the conductor from the B field.

[1]

[1 mark]

Question 1d

The conductor in the diagram in part (a) has a length of 1.2 m and a current of 0.85 A flowing through it. The conductor is placed at 30° to the B field, which has a magnetic flux density of 70 mT.
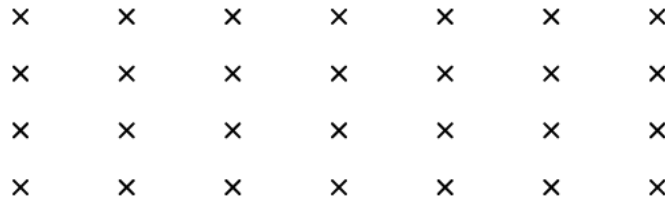
(d)
Calculate the force acting on the conductor.

[3]

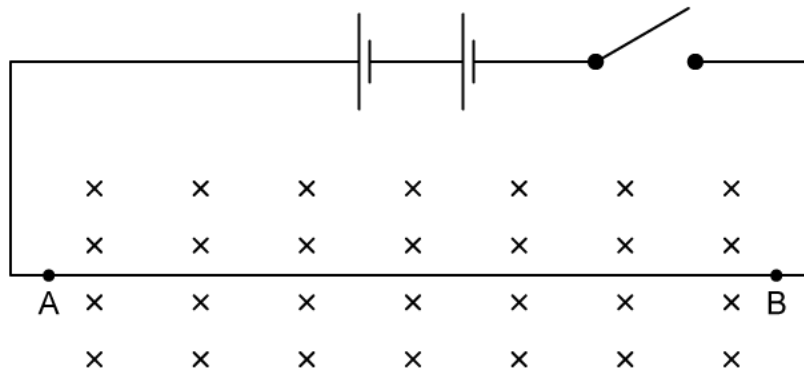**[3 marks]**

Question 2a

The diagram shows a magnetic B field.

(a)
State whether the magnetic field is acting into or out of the page.

[1]

[1 mark]

Question 2b

A circuit is built with a section of wire, between the points A and B, running perpendicular to a magnetic field.

(b)
When the switch is closed, state the direction of:

(i)
The current through wire AB.

[1]

(ii)
The force acting on wire AB.

[1]

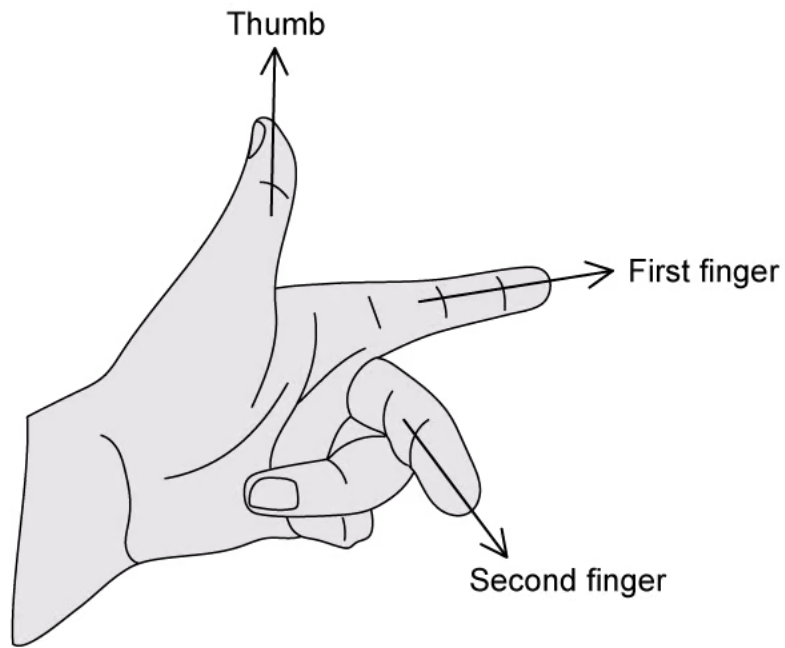**[2 marks]**

Question 2c

(c)

State two ways of increasing the size of the force acting on the current carrying conductor.

[2]

[2 marks]

Question 2d

When the force, the magnetic field and the current are all mutually perpendicular to each other, the directions of each can be interpreted using a technique known as Fleming's Left Hand Rule.

(d)
State what is represented by the direction of:

(i)
The thumb

[1]

(ii)
The first finger

[1]

(iii)
The second finger

[1]

[3 marks]

Question 3a

(a)
Define magnetic flux density.

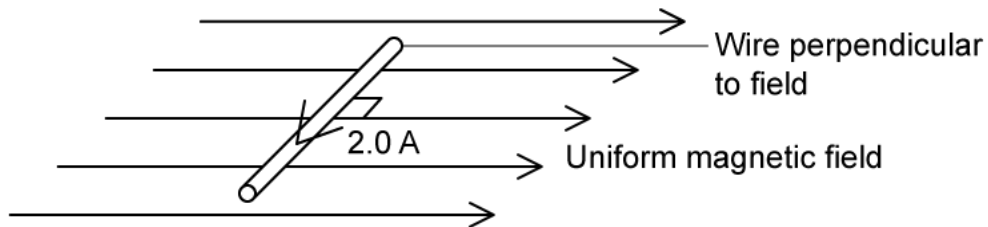[2]

[2 marks]

Question 3b

(b)
State the unit for magnetic flux density.

[1]

[1 mark]

Question 3c

A wire of length 15 cm has a mass of 30 g and current of 2.0 A flowing through it. When the wire is placed inside a uniform magnetic field it 'floats' in equilibrium in the magnetic field.

(c)

(i)
Calculate the weight of the wire

[3]

(ii)
Hence determine the size of the force produced by the magnetic field acting on the wire when it is carrying current

[2]

[5 marks]

Question 3d

(d)
Calculate the magnetic flux density required to keep the wire 'floating' in equilibrium.

[3]

[3 marks]

Question 4a

The equation used to calculate the force acting on a moving charged particle is
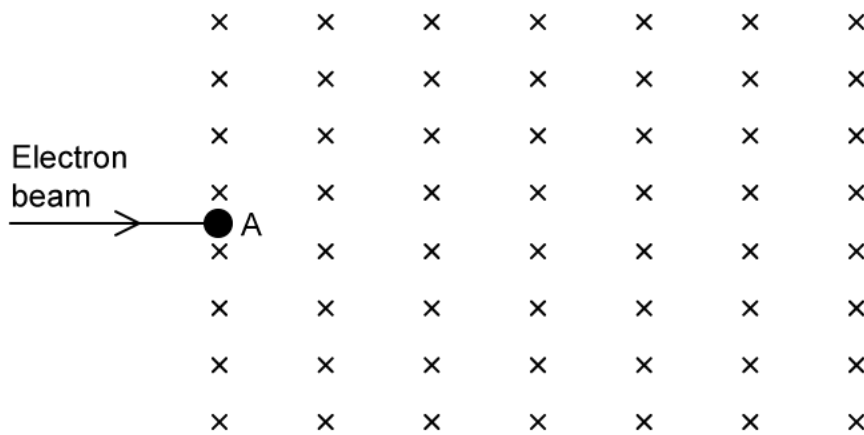
$$F = qvB\sin\theta$$

(a)
State what each symbol in the above equation represents.

[5]

[5 marks]

Question 4b

A beam of electrons is fired into a uniform magnetic field of flux density 0.5 T, as shown. An electron enters the magnetic field at point A.

(b)
Draw an arrow, labelled F, from point A to show the direction of the force acting on the electron.

[2]

[2 marks]

Question 4c

The electron is travelling at a speed of 4.8×10^7 m s^{-1} in the magnetic field where magnetic flux density $B = 0.5$ T

(c)
Calculate the force on the electron when it enters the magnetic field and is travelling perpendicular to it.

[2]

[2 marks]

Question 4d

(d)
On your sketch, continue the path of the electron beam

(i)
Through the magnetic field

[2]

(ii)
After it has emerged from the magnetic field

[2]

[4 marks]

Question 5a

When a moving charge enters a magnetic field the magnetic field produces a force on the charge, which can be calculated using

$$F = qvB\sin\theta$$

where q = charge, v = velocity, B = magnetic flux density, and θ = the angle between the velocity of the charge and the direction of the magnetic field.

The magnetic force provides the centripetal force which causes the charge to move in a circular orbit. The equation to calculate centripetal force acting on an object is

$$F = \frac{mv^2}{r}$$

where m = mass of the object, v = speed of the object and r = radius of the circular orbit.

(a)
Using the equations given above, show that the radius of the circular orbit of the charged object inside the magnetic field can be given as

$$r = \frac{mv}{qB}$$

[3]

[3 marks]

Question 5b

(b)
State three ways of increasing the radius of the circular orbit.

[3]

[3 marks]

Question 5c

An electron is travelling at right angles to a uniform magnetic field which has a magnetic flux density of 5.6 mT. The speed of the electron is $3.0 \times 10^{6}\,\mathrm{m\,s^{-1}}$.

(c)
Use the following information to calculate the radius of the circular orbit of the electron:

Mass of an electron, $m = 9.11 \times 10^{-31}\,\mathrm{kg}$
Charge of an electron, $q = 1.60 \times 10^{-19}\,\mathrm{C}$

[3]

[3 marks]

Question 5d

(d)
Name the particle accelerator which accelerates charged particles along a spiral path.

[1]

[1 mark]