3055 BA SANGAM COLLEGE

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WORKSHEET 17

SCHOOL:BA SANGAM COLLEGE YEAR 12

SUBJECT: PHYSICS NAME OF STUDENT: _____________

STRAND	*ELECTRICITY*
SUB-STRAND	*ELECTROSTATICS*
Content Learning Outcome	Explore electric forces by using Coulomb's law **and** effects on charged objects

ELECTROMAGNETISM

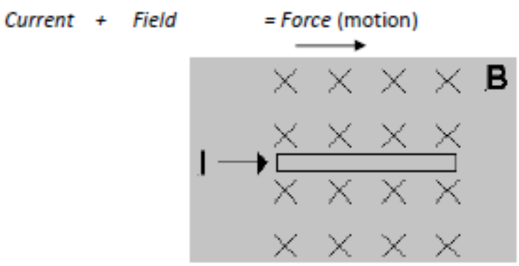
Electromagnetism is the science of the properties and relationship between electric currents and magnetism. An electric current creates a magnetic field and a moving magnetic field will create a flow of charge. This relationship between electricity and magnetism has resulted in the invention of many devices which are useful to humans.

6.1 MOTOR EFFECT

When two magnets are close together, they affect each other and produce a force. The same happens when any two magnetic fields are close together. If a wire carrying a current is placed in a magnetic field a force is produced. This is called the **motor effect.** The direction of the force will depend on the direction of the magnetic field and the direction of the current in the field.

The direction of movement of a current carrying wire in a magnetic field can be determined using Fleming's Left Hand Rule. The current, magnetic field and force will always be at right angles to each other, so the wire will not move towards the poles.

When a current carrying conductor is placed in a magnetic field, a **FORCE** is produced except when it is placed parallel to the magnetic field



The magnitude of the force is given by:

$$F = BIL\sin\theta$$

Where:

F = force

B = magnetic field strength (T)

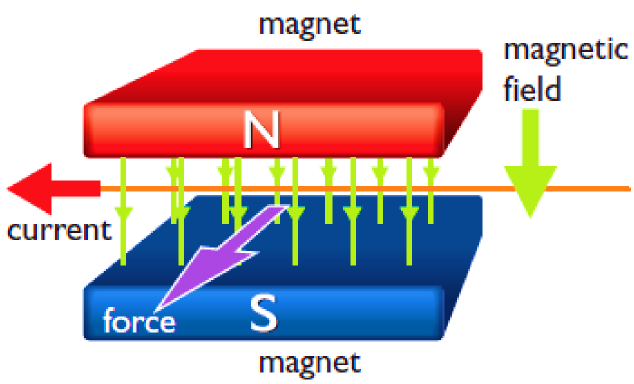
I = current flowing (A)

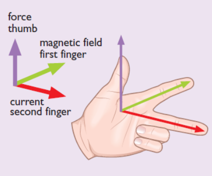
L = Length of conductor (wire) in the field (m).

θ = angle the conductor makes with the magnetic field

LENGTH OF CONDUCTOR IN THE FIELD

When a current is passed through a wire placed in a magnetic field a force is produced which acts on the wire





You need to be able to use **Fleming's Left Hand Rule** to work out the direction of the force that acts on the wire.

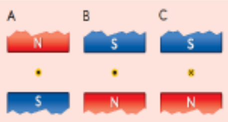
This is also called the **Motor Rule**.

The force acting upon the wire will make the wire move. The thumb of your left hand may be used to determine the direction of movement caused by the force on the wire. In order to remember what component the direction of the thumb shows remember: thu**m**b shows the direction of **m**ovement caused by the force on the wire.

(Alternatively, **f**umb → **f**orce!!)

Example

Use Fleming's Left Hand Rule to work out the direction of the force that will act on the conductors shown in the magnetic fields, below.



a) Field lines should be drawn going from N to S

b) A: ⟶ F
B: ⟵ F
C: ⟶ F

● Shows a conductor carrying current flowing **out of** the plane of the paper perpendicularly **towards** you.

✖ Shows a conductor carrying current flowing **into** the plane of the paper perpendicularly **away from** you.

The size of the force that acts on a current-carrying conductor placed at right angles to a magnetic field may be increased by either increasing the strength of the magnetic field or by increasing the current in the wire.

When a conductor carrying a current is placed in a magnetic field, the conductor will experience a force. The reason for this is that the current in the conductor creates a surrounding magnetic field which is either repelled or attracted to the field in which it is placed. The force depends on the following

The magnetic field strength (density of the magnetic flux) = B [Tesla]

-The current passing through the wire = A [Amps]

-The length of the conductor in the field = L [meters]

When the conductor is placed to the magnetic field it experiences the maximum force

Example

If a conductor of length 0.4m carrying a current of 10.6A is placed in a magnetic field stength of 0.003T, determine the force experienced by this conductor in Newtons.

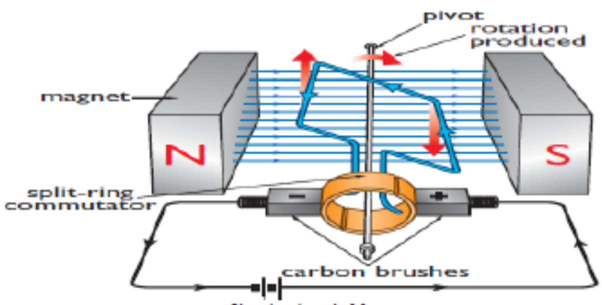
F = BIL

F = (0.03) (10.6) (0.4)

= 0.13N

THE ELECTRIC MOTOR

In its simplest form a DC motor consists of a single turn coil of wire that is free to rotate in a magnetic field about an axle. Carbon brushes make contact with the ends of the coil that are connected to a commutator so that a current can be passed through the coil



Simple electric Motor

The sequence of diagrams below shows the coil from an end-on view, making it easy to see how the forces acting on each side of the coil produce a turning effect about the axle. Diagram *c)* shows that the turning effect is zero when the coil is parallel to the permanent magnets (because the line of action of the forces passes through the axis of rotation). This might suggest that the coil stops in this position, but it will inevitably overshoot, and as soon as it does so, the commutator will reverse the direction of the current in the coil which means the coil will continue to spin.

MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD

When a charged particle moves through a magnetic field it experiences a force. For a particle that is moving at right angles to the magnetic field, the force is given by:

$$F = Bvq$$

Where F is the force

q is the charge on the particle,

v is the velocity of the particle and

B is the magnetic field through which the particle is moving

EXAMPLE

An electron travels at 150 ms^{-1} at right angles to a magnetic field of 80 000 T. What force is exerted on the electron?

Using

$F = qvB$

$= (1.6 \times 10^{-19}\ C)\ (150\ ms^{-1})\ (80\ 000T)$

$= 1.92 \times 10^{-12}$ N

EXERCISE1

A wire of length 2 m is moved perpendicular to a magnetic field of strength 4 T with a velocity of 5 ms^{-1}.

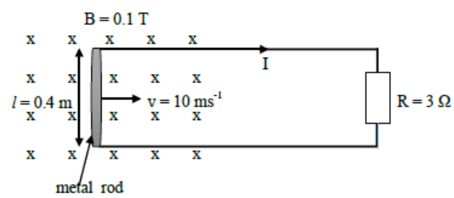
(i) Calculate the induced voltage across the ends of the wire. **(1 mark)**

(ii) The ends of the wire are connected to a circuit with a negligible resistance it is found that a 4 A current flows around it. Calculate the force that must be applied to keep the wire moving and generating this current. **(1 mark)**

(iii) State **two** ways of increasing the current which is generated by the moving wire. **(2 marks)**

EXERCISE 2

A metal rod is pushed in a uniform magnetic field along contacts which are connected to a 3 Ω resistor. The length, *l* of rod in the magnetic field is 0.4 m. The rod moves at 10 ms^{-1}. The strength of the magnetic field, B is 0.1 T.



Calculate the

(i) induced voltage across the rod. **(1 mark)**

(ii) current, I. **(1 mark)**