Applications of electromagnetic induction

Q) The diagram below shows a wire AB which is places between two magnets. This wire is connected to a volt meter.

i) suggest what happens to the volt meter when the wire is at rest.

ii) suggest what happens to the volt meter when the wire is moved left or right.

iii) suggest what happens to the volt meter when the wire is moved either upwards or downward.

ans i) when the wire is at rest, it will not cut with the field lines therefore no EMF is induced hence the volt meter gives a zero reading

ans ii) When the wire is moved left or right, it's movement will be parallel to the field lines therefore it will not cut with the field lines, hence no EMF is enduced therefore the voltmeter gives a zero reading.

ans iii) When the wire is moved either upwards or downwards, it will cut with the magnetic field lines because it's movement is *perpendicular* to the field lines. According to faradays law, this will enduce EMF.

When the wire is moved upwards the voltmeter gives a reading in one direction and when the wire moved downwards the voltmeter gives a reading in the opposite direction. This indicates that an alternating current is produced

How can we determin the direction of the induced current

The direction of this induced current can be worked out using flemmings right hand rule. In this rule, we position the first finger in the direction of the magnetic field, that is from north to south, we position the thumb in the direction of the force, the second

finger will now point in the direction of induced current. If the direction of the force is reversed (downwards), the direction of the induced current will also be reversed.

The idea explained above can practically be used in the construction of an **ac generator.**

Fig.2 shows the original diagram and fig.3 is the updated one

Explain how the EMF is induced in the ac generator (fig.3)

As the coil rotates it cuts with the magnetic field lines, based on faradays law this change in cutting effect induced EMF

State how the direction of the induced can be worked out

Direction of induced current can be determined using Flemings right hand rule

What is the purpose of slip rings and carbon brushes

The slip rings will help to maintain a continuous contact between the internal and the external circuit. The carbon brushes behave as lubricants, that is, they help to minimise friction between the moving parts, this reduced the possibility of sparks.

Why is this device termed as ac generator

Initially when the side AB moves *upwards*, the current through it flows in the direction *B to A* , after some time when the coil passes the vertical position, the side AB now starts to moves *downwards* hence the direction of the current through it flows from *A to B*

Which changes if made, can cause the direction of induced current to get reversed

- reversing the poles of the magnet
- Reversing the direction of rotation

Which changes if made, will cause the induced EMF to increase

- Using more powerful magnets
- Increasing the number of turns of the coil
- Wrapping the coil around iron(iron will also get magnetised so cutting effect increases)
- Increasing the speed of the coil, that is, moving the coil faster.

Graphs of an ac generator

The shape of the graph depends upon which position is taken as the reference point, that is if the coil starts from its vertical position, the force acting on the coil and the field lines will be *parallel* to each other, hence induced EMF will be 0, therefore the graph starts from the origin as shown in fig.1.

Similarly if the horizontal position is taken as the reference point, the force will be perpendicular to the field lines, therefore maximum EMF is induced, which allows the graph to start from its highest point as shown in fig.2

Magnetic effects of a current

How to construct magnetic field pattern around a "current carrying wire"

Note: in exams all three of the diagrams in fig.3 and fig.4 are correct and only one needs to be drawn (preferably the third one in each)

- Experiments have shown that a current carrying wire always creates a magnetic field around itself.
- The pattern of this magnetic field is in the form of concentric circles
- As we move further away from the wire, the magnetic field strength decreases, hence the distance between the concentric circles begins to increase
- The magnetic field lines for current going into paper, point in clockwise direction

- For current coming out of the paper, the magnetic field lines point in the anti clockwise direction
- These two are denoted by the symbols

Note: the direction of the magnetic field can either be determined using a plotting compass or is a plotting compass is not available then use the “maxwell rule.” According to this rule, if you point your thumb in the direction of the current, then the fingers of the right hand, would curl in the direction of the magnetic field.