Sadiq Public School

Do the right, fear no man

Subject: Physics **Class: H2** **Date: Satu6day 15th November 2024**

Topic: Electromagnetic induction

A: Inquiry: As electric current produces magnetic field, magnetic field can also give rise to electric current. Michael Faraday was the first scientist who said that the reverse of electromagnetism should also be possible. He performed different experiments and gave the foundation for electromagnetic induction.

B: Information:

Electromagnetic induction:

Electromagnetic induction refers to the phenomenon where an emf is induced when the magnetic flux linking a conductor changes.

Magnetic flux:

The number of magnetic field lines passing through an area held perpendicular to magnetic field is called magnetic flux. It is the product of magnetic flux density and the area held perpendicular to the magnetic field.

$$\phi = BA$$

The SI units of magnetic flux is weber Wb.

Weber:

Weber is defined as the magnetic flux if a flux density of one tesla passes perpendicular through an area of one square meter.

$$I\ Wb = 1Tm^2$$

Area held at an angle other than 90˚:

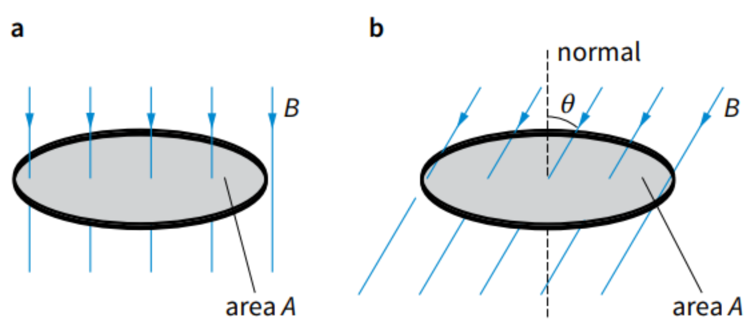
You can easily see that when the field is parallel to the plane of the area, the magnetic flux through A is zero. To find the magnetic flux in general, we need to find the component of the magnetic flux density perpendicular to the area. Figure 'b' shows a magnetic field at an angle θ to the normal.

In this case:

$$\text{magnetic flux} = (B \cos \theta) \times A$$

or simply:

$$\text{magnetic flux} = BA \cos \theta$$



Magnetic flux density:

Magnetic flux density is already defined as the magnetic field strength but we can express magnetic flux density as the magnetic flux per unit area held perpendicular to the magnetic field.

$$B = \phi/A$$
$$Wbm^2 = \text{tesla} = T$$

Magnetic flux linkage:

For a coil with N turns, the magnetic flux linkage is defined as the product of the magnetic flux and the number of turns; that is:

$$\text{magnetic flux linkage} = N\Phi$$

or

$$\text{magnetic flux linkage} = BAN \cos \theta$$

Induced emf:

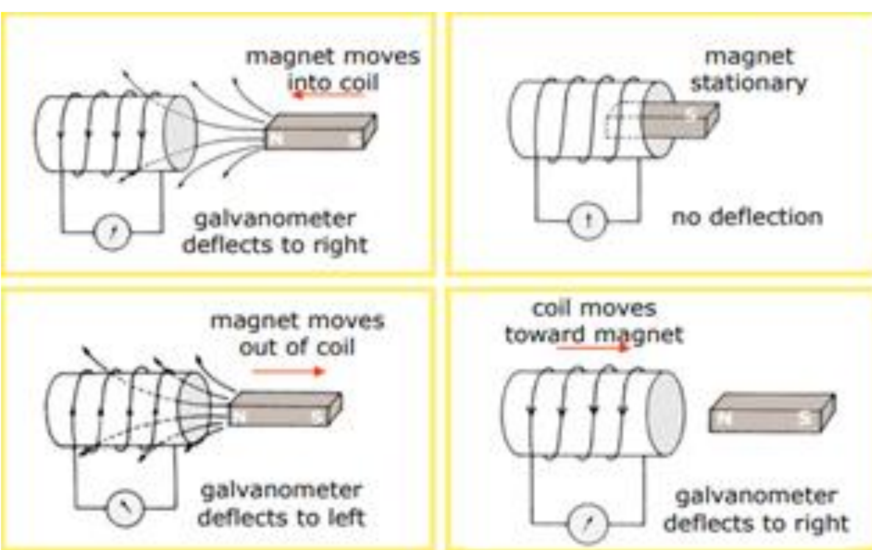
An e.m.f. is induced in a circuit whenever there is a change in the magnetic flux linking the circuit. Electromagnetic induction occurs whenever the magnetic field through a conductor changes. This can be due to a conductor moving through a magnetic field or a conductor being in a fixed position within a changing magnetic field, such as that due to an alternating current. Both of these result in an e.m.f. being induced in the conductor.

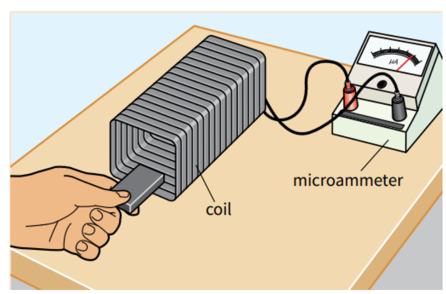
Since magnetic flux is equal to BA cos θ, there are three ways an e.m.f. can be induced:

- ■ changing the magnetic flux density B
- ■ changing the area A of the circuit
- ■ changing the angle θ.

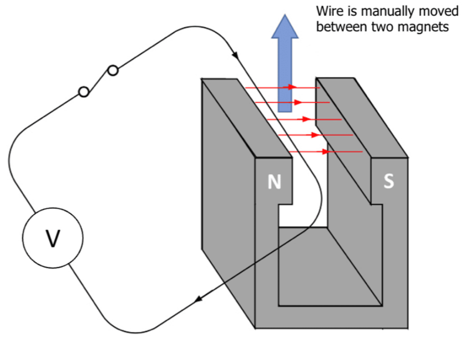
Experiment 1:

Connect a coil to a sensitive microammeter (Figure 28.3). Move a bar magnet in towards the coil. Hold it still, and then remove it. How does the deflection on the meter change? Try different speeds, and the opposite pole of the magnet. Try weak and strong magnets. With the same equipment, move the coil towards the magnet and observe the deflection of the meter.





Experiment 2:
Connect a long wire to a sensitive microammeter. Move the middle section of the wire up and down through the magnetic field between the magnets. What happens to the meter reading?



In both the experiments, emf and current is induced due to the change in the magnetic flux linking through the coil or wire.
When a wire or a magnet is moved through a magnet, field lines are being "cut" by the wire. This generates an induced emf in the wire that produced induced current that flows in the wire causing the deflection in the ammeter.
It does not matter whether you move magnet or wire, emf will be induced as electromagnetic induction is a relative phenomenon.

Factors affecting the induced emf:

From the above experiments, you should see that the size of the induced current or e.m.f. depends on several factors. For a straight wire, the induced current or e.m.f. depends on:
■ the magnitude of the magnetic flux density
■ the length of the wire in the field
■ the speed of movement of the wire.

For a coil of wire, the induced current or e.m.f. depends on:
■ the magnitude of the magnetic flux density
■ the cross-sectional area of the coil
■ the number of turns of wire
■ the rate at which the coil turns in the field.

Faraday's law of electromagnetic induction:
The magnitude of induced emf is directly proportional to the rate of change of magnetic flux linkage through the coil.

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$

The negative sign shows the direction of induced current or voltage.

Rate of change of magnetic flux depend upon:
■ strength of the magnet
■ speed of the magnet or the coil
■ number of turns of the coil

- Read **page # 436- 441** of book.

C: Synthesising/absorbing information:

- Explain the topic with the help of diagram.
- Make notes of the topic.

D: Practising:

1. Solve past paper questions:
   a. F/M 2021 P42 Q9
   b. F/M 2019 P42Q10
   c. M/J 2024 P42 Q7

Feedback: These questions are only meant to check our understanding. You are supposed to write only the answers down in to a separate email and send it to your teachers. You are not required to send the images of your daily work to the teacher. If you have any issues regarding the above topic, ask your teacher through the mentioned email addresses but do not send the images of your homework to your teachers.

Class	Teachers' Names	Teachers' Abbreviations	Teachers' Email addresses	Instructions
H2A	**Usman Malik**	**UM**	**Malikusman_um_sadiq@protonmail.com**	H2A students will send their home assignment to their subject teacher (UM) for checking and getting feedback.
H2G	**Humaira Yasmeen**	**HY**	**Yasmeen_HY_sadiq@protonmail.com**	H2G students will send their home assignment to their subject teacher (HY) for checking and getting feedback.