2026 S4 Assignment 20a

Electromagnetic Induction - Answers

General approach to electromagnetic induction phenomenon:

- Identify any relative motion between magnet and conductor
  ➔ Rate of cutting of magnetic field lines by the conductor (e.g. coil or solenoid)
  OR
  Rate of change (increase or decrease) magnetic flux linked to the conductor

  ➔ By Faraday's law, an e.m.f. is induced in the conductor (e.g. coil or solenoid)

  ➔ Observation of change in circuit (e.g. deflection in electrical meter, light bulb lights up, display on C.R.O.)

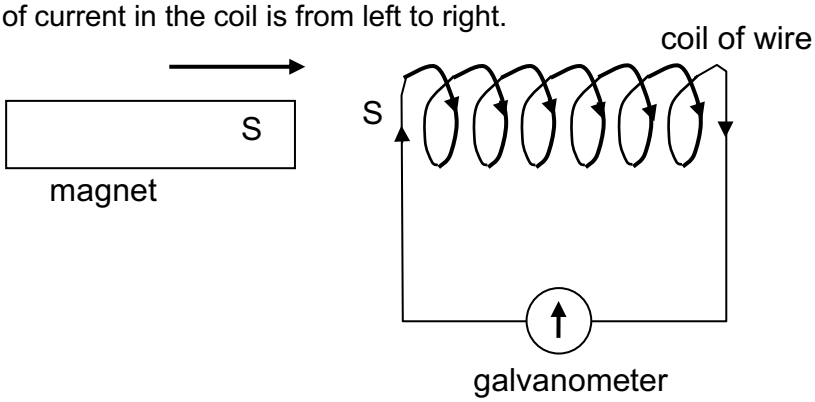
- ***Note:*** *Explain by applying a law means paraphrasing it suitably, not stating it.*

1(a) As the magnet moves towards the coil, there is an increase in the rate of cutting of magnetic field lines by the coil

OR there is an increase in the magnetic flux linked to the coil. *[not momentary change!]*

By Faraday's Law, an e.m.f is induced in the coil.

(b) Direction of current in the coil is from left to right.



(c) According to Lenz's Law, the induced e.m.f. in the coil induces a current in the coil to oppose the strengthening magnetic field experienced by the coil.
To oppose the approaching S-pole, the current in the coil flows to set up a S-pole on the left side of the coil
Using the right hand grip rule, the current direction in the coil is from the left to right.

(d) Any two ways:
(1) Move the magnet faster towards the coil.
(2) Increase the number of turns in the coil.
(3) Use a stronger magnet.
(4) Insert a soft iron core in the coil (or wind the turns of the coil on a soft iron core) – (note that this prevents the magnet from entering the coil).

2(a) When the magnet accelerates towards the solenoid, there is an increasing rate ofcutting of magnetic field lines by the solenoid.
By Faraday's law, there is an increasing e.m.f. induced in the solenoid resulting in an increase in the deflection of the galvanometer in one direction.

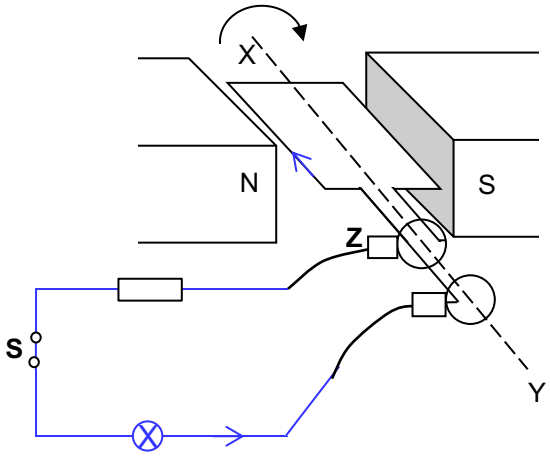
(b) The rate of cutting of magnetic field lines by the solenoid decreases to zero.
By Faraday's law, the e.m.f. induced in the solenoid decreases to zero resulting in the deflection of the galvanometer decreasing to zero.

3(a) As the magnet falls towards the pipe, there is an increasing rate of cutting of magnetic field lines by the copper pipe.
By Faraday's Law, an e.m.f. is induced in the conducting pipe.

(b) The induced e.m.f. causes induced currents (or eddy currents) to flow in the pipe.
By Lenz's Law, the induced currents flow in a direction to set up a magnetic field to oppose the motion of the falling magnet. The net downward force on the magnet decreases.
Therefore, the magnet falls with a decreasing acceleration.
Note: *The magnet does not slow down, it continues to fall but at a lower acceleration.*

(c) Copper is an electrical conductor, so there is induced e.m.f. which causes induced currents that oppose the motion of the falling magnet. Plastic is an electrical insulator that would not cause electromagnetic induction when the magnet falls through it. It has no effect on the motion of the magnet.
Hence the time taken to fall through the copper pipe will be longer than that for the plastic pipe.

4(a) As the coil rotates, there is rate of cutting of the magnetic field lines of the permanent magnets by the coil.
By Faraday's law, an e.m.f. is induced in the coil.
OR
As the coil rotates, there is a rate of change in the magnet flux of the permanent magnets linked to the coil. By Faraday's law, an e.m.f. is induced in the coil.



(b) (i) external circuit with light bulb and switch

(ii) direction of current shown above, polarity of Z is positive

(iii) Using Fleming's right hand rule, the direction of the induced current in the coil is clockwise.
The current flows out of the coil from its right side and flows through the carbon brush at **Z** to the external circuit. The direction of current flow in a circuit is from the positive terminal to the negative terminal. Hence **Z** is positive.

5(a) Point **C**

The coil is moving towards the position where its plane is perpendicular to the magnetic field, where the rate of cutting of magnetic flux is going to be zero. Hence the magnitude of the induced e.m.f. is decreasing to zero.

(b)(i) The amplitude of the induced voltage would be doubled and

the frequency of the induced voltage would be doubled or its period is halved.

Note: *This question does not require an explanation.*

(ii)