O Level Physics Tutorial 19: Electromagnetic Induction

Syllabus :

(a) deduce from Faraday's experiments on electromagnetic induction or other appropriate experiments:

(i) that a changing magnetic field can induce an e.m.f. in a circuit

(ii) that the direction of the induced e.m.f. opposes the change producing it

(iii) the factors affecting the magnitude of the induced e.m.f.

1.

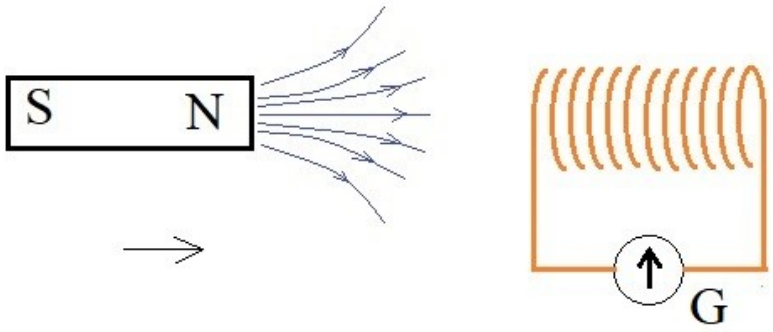

Figure 19-1

(a) A coil of wire is connected to a galvanometer. The north pole of a magnet is moved towards one end of the coil.

(i) What does the galvanometer show?

(ii) It stops just before the coil. What does the galvanometer show?

(iii) The magnet is now moved to the left. What does the galvanometer show?

(b) The following changes are made and the experiment repeated. State how or it the observation would be different.

(i) The magnet is flipped over and the S pole points towards the coil.

(ii) The number of turns of the coil is increased.

(iii) The magnet is moved faster.

(b) describe a simple a.c. generator (rotating coil or rotating magnet) and the use of slip rings (where needed)

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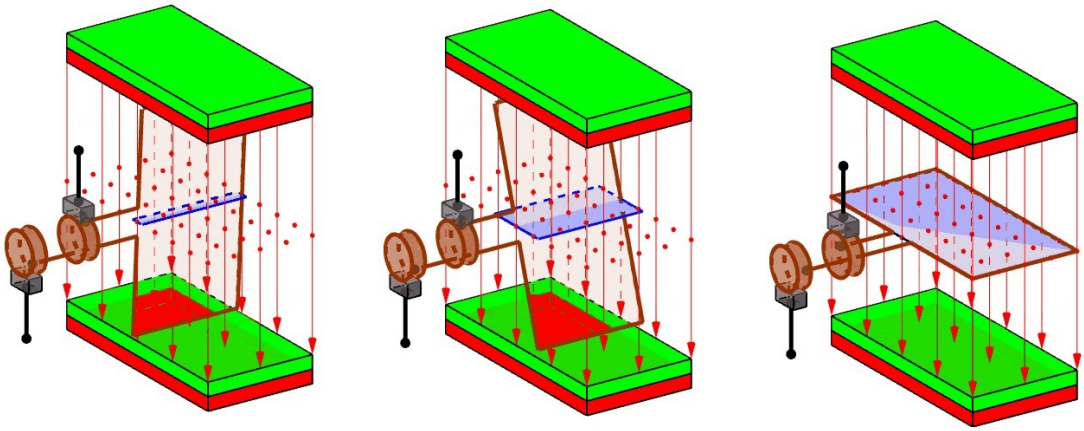
2. The following shows a coil of wire rotating in a roughly uniform magnetic field between the poles of two magnets. From left to right, the figures show the coil positions over roughly a quarter of a cycle.



(a) (b) (c)

Figure 19-2

(i) In which figure is the change in magnetic flux linking the coil (roughly meaning the number of field lines through the coil) fastest?

(ii) In which figure is the change slowest?

(iii) How would the magnitudes of voltage in figures (a) and (c) compare?

(iv) The above figures show roughly a quarter of a cycle where the magnetic flux linking the coil is increasing. Suggests how the voltage magnitude and direction would change in the next quarter of the cycle.

(c) sketch a graph of voltage output against time for a simple a.c. generator

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3. Sketch a graph of voltage output against time for a simple a.c. generator (like the one in the previous question).

(d) describe the structure and principle of operation of a simple iron-cored transformer as used for voltage transformations

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4. This is a figure of a step down transformer.

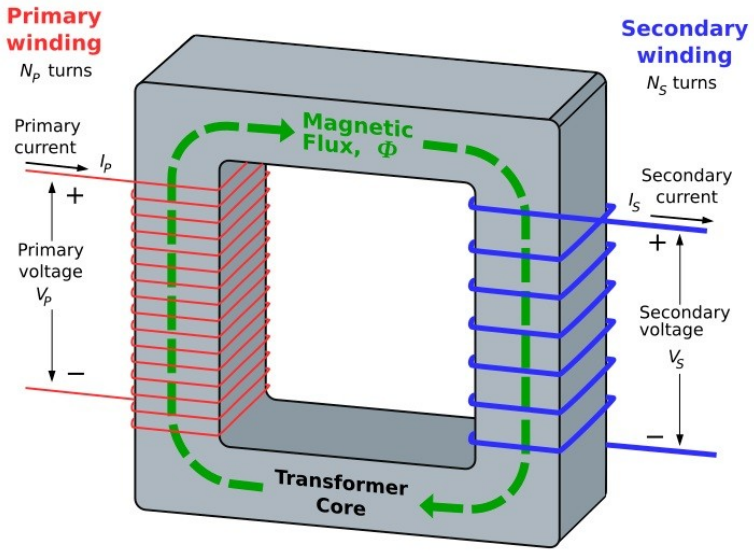

Figure 19-3

(i) Draw a simple sketch of a transformer which has fewer turns in the primary coil and more turns in the secondary coil.

(ii) Explain how this transformer works, and why it produces a higher output voltage in this case?

(e) recall and apply the equations $V_P / V_S = N_P / N_S$ and $V_P I_P = V_S I_S$ to new situations or to solve related problems (for an ideal transformer)

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5. An a.c. voltage is 240 V is connected to the primary coil of a transformer. The transformer has 100 turns at the at the primary coil, and 1000 turns at the secondary coil. Find the voltage output from the secondary coil.

(f) describe the energy loss in cables and deduce the advantages of high voltage transmission. .

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6. (i) Suppose that a power station outputs a voltage of 240 V and sends it directly to people's homes for daily use. A typical electricity transmission line can be about 100 km long, with resistance around 100 Ω. The electrical power produced by the station can as high as 200 MW. Find the current in the cable, and the percentage of power wasted as heat.

(ii) One way to reduce energy loss is to use a transformer. Suppose the voltage is stepped up 1000 times using transformer. Find the current again and the percentage of power wasted as heat.