2015 Question 12 (d) [Ordinary Level]
A solenoid (long coil of wire) is connected to a battery as shown.

(i) Copy the diagram into your answer book and draw the magnetic field in and around the solenoid.

![Correct shape of field](image1)

(ii) Explain the term electromagnetic induction.
- voltage/emf/current induced due to changing magnetic flux/field 6
- partial answer e.g. voltage created (3)

(iii) A magnet and a solenoid can together be used to produce electricity. Describe, with the aid of a diagram, how this can be done.
- apparatus: magnet, (galvano)meter, solenoid any two 2x4
- procedure: magnet moves relative to solenoid 4
- observation/conclusion: the (galvano)meter/needle deflects/emf/voltage/electricity produced 4

2014 Question 9 [Ordinary Level]

(i) What is a magnetic field?
A region in space where the magnetic force is experienced.

(ii) How does a compass indicate the direction of a magnetic field?
It experiences a force in a magnetic field and points in the direction of the field lines

(iii) Describe an experiment to show that there is a magnetic field around a current-carrying conductor and sketch the field lines around the conductor.
- apparatus: power supply/battery/voltage, conductor, compass
- procedure: set up the circuit/turn on the power supply/current
- observation/conclusion: compass deflects circular lines

Continues next page
(iv) Sketch the magnetic field around a bar magnet.
   diagram to show magnet, field lines and correct direction

(v) What is observed when the magnet is moved towards the coil?
   needle / pointer / galvanometer deflects

(vi) What is observed when the magnet is stationary?
   needle / pointer / galvanometer does not deflect

(vii) Explain these observations.
   emf / voltage / current / electromagnetic induction due to changing magnetic field (around the coil)

(viii) How would increasing the speed of movement of the magnet alter the observations?
   greater deflection/ emf // current is greater

2013 Question 11 [Ordinary Level]

(i) What are the key components of the national grid?
   Network of high voltage transmission stations and high voltage power lines

(ii) Why are high voltages used to transmit power over the national grid?
   To avoid energy losses associated with high currents

(iii) Why is the power supplied to domestic customers at lower voltages?
   It is safer

(iv) Name two renewable and two non-renewable energy sources used to generate electricity.
   renewable : wind, solar, wave, hydroelectric, biomass, geothermal etc.
   non-renewable: coal, oil, peat, gas, nuclear etc

(v) The national grid uses alternating current (a.c.) rather than direct current (d.c.).
   What is the difference between them?
   a.c. changes direction; d.c. does not

(vi) Name the device used to convert high voltages to lower voltages.
    Step-down transformer

(vii) Give the principle of operation of the device named in the previous question.
    Electromagnetic induction

(viii) Name the unit of electrical energy that is used in the delivery of electricity to homes and businesses.
    The kilowatt-hour
2011 Question 9 (a) [Ordinary Level]
(i) State Faraday’s law of electromagnetic induction.
    Induced emf is directly proportional to rate of change of magnetic flux

(ii) What is observed on the meter when the magnet is moved towards the coil?
    Needle deflected / moves

(i) What is observed on the meter when the magnet is stationary in the coil?
    No movement of needle

(ii) Explain these observations.
    emf only occurs when the magnetic flux changes.
    When the magnet is stationary there is no change in magnetic flux therefore no induced emf therefore no
    movement of the needle.

(iii) How would changing the speed of the magnet affect the observations?
    More deflection if faster / less deflection if slower

2011 Question 9 (b) [Ordinary Level]
(i) What is meant by a.c.?
    Alternating current / electric current that reverses/changes its direction (at regular intervals)

(ii) Draw a labelled diagram showing the structure of a transformer.

(iii) The input coil of a transformer has 200 turns of wire and is connected to a 230 V a.c. supply.
    What is the voltage across the output coil, when it has 600 turns?

\[
\frac{V_s}{V_p} = \frac{N_s}{N_p}
\]

\[
\frac{600}{230} = \frac{V_s}{200}
\]

\[
V_s = 690 \text{ V}
\]
Read this passage and answer the questions below.

In 1819 the Danish physicist Hans Christian Oersted discovered that an electric current flowing through a wire deflected a compass needle.

A year later the Frenchman François Arago found that a wire carrying an electric current acted as a magnet and could attract iron filings. Soon his compatriot André-Marie Ampère demonstrated that two parallel wires were attracted towards one another if each had a current flowing through it in the same direction. However, the wires repelled each other if the currents flowed in the opposite directions.

Intrigued by the fact that a flow of electricity could create magnetism, the great British experimentalist Michael Faraday decided to see if he could generate electricity using magnetism. He pushed a bar magnet in and out of a coil of wire and found an electric current being generated. The current stopped whenever the magnet was motionless within the coil.

(Adapted from ‘Quantum’ by Manjit Kumar, Icon Books 2008)

(i) Who discovered that an electric current can deflect a compass needle?
   Hans Oersted

(ii) What did Arago discover?
    A wire carrying an electric current acted as a magnet and could attract iron filings.

(iii) What happens when currents flow in the same direction in two parallel wires?
     The wires attract

(iv) How could two parallel wires be made to repel each other?
     Reverse one of the currents / current in opposite directions

(v) Draw a sketch of the apparatus Michael Faraday used to generate electricity.
    Correct diagram to include magnet, coil and meter

(vi) What name is given to the generation of electricity discovered by Michael Faraday?
    Electromagnetic induction

(vii) What energy conversions take place in Faraday’s experiment?
     Kinetic to electric

(viii) How does Faraday’s experiment show that a changing magnetic field is required to generate electricity?
     Current stopped whenever the magnet was motionless // electricity is only generated when the magnet or coil is moving.

What is electromagnetic induction?
Electromagnetic Induction occurs when an emf is induced in a coil due to a changing magnetic flux.

A magnet and a coil can be used to produce electricity.
How would you demonstrate this?
Apparatus: coil, magnet and galvanometer.
Procedure: Set up as shown.
Move the magnet in and out of the coil.
Observation: the needle deflects.

The electricity produced is a.c. What is meant by a.c.?
Alternating current
2007 Question 12c [Ordinary Level]
The circuit diagram shows two resistors connected in series with a 6 V battery.
(i) State Ohm’s law.
   Ohm’s Law states that the current flowing through a conductor is directly proportional to the potential difference across it, assuming constant temperature.
(ii) Calculate the total resistance of the circuit.
   \[ R = 3 + 9 = 12 \, \Omega \]
(iii) Calculate the current in the circuit.
   \[ V = IR \Rightarrow I = \frac{V}{R} = \frac{6}{12} = 0.5 \, A \]
(iv) Calculate the potential difference across the 9 \, \Omega resistor.
   \[ V = IR = 0.5 \times 9 = 4.5 \, V \]
(v) Name an instrument used to measure potential difference.
   A voltmeter

2005 Question 9 [Ordinary Level]
(i) What is a magnetic field?
   A Magnetic Field is any region of space where magnetic forces can be felt.
(ii) Draw a sketch of the magnetic field around a bar magnet.
   See diagram.
(iii) Describe an experiment to show that a current carrying conductor in a magnetic field experiences a force.
   Apparatus: power supply, conductor, magnet
   Procedure: set up the circuit as shown, then turn on the power supply.
   Observation: conductor moves / conductor deflects
(iv) List two factors that affect the size of the force on the conductor.
   Current, strength of magnetic field, length of conductor
(v) A coil of wire is connected to a sensitive galvanometer as shown in the diagram.
   What is observed when the magnet is moved towards the coil?
   The needle in the galvanometer deflects.
(vi) Explain why this occurs.
   An emf is induced in the coil of wire, which in turn produces a current which moves the needle.
(vii) Describe what happens when the speed of the magnet is increased.
   There is a greater deflection of the needle.
(viii) Give one application of this effect.
   Generator, motor, dynamo.

2004 Question 12c [Ordinary Level]
(i) A transformer is a device based on the principle of electromagnetic induction.
   What is electromagnetic induction?
   Electromagnetic Induction occurs when an emf is induced in a coil due to a changing magnetic flux.
(ii) Name another device that is based on electromagnetic induction.
   Dynamo, generator, induction motor.
(iii) Name the parts of the transformer labelled A, B and C in the diagram.
   A = primary / input coil
   B = secondary / output coil
   C = iron core
(iv) Part A has 400 turns of wire and part B has 1200 turns. Part A is connected to a 230 V a.c. supply.
   What is the voltage across part B?
   \[ \frac{V_{\text{in}}}{V_{\text{out}}} = \frac{N_{\text{input}}}{N_{\text{output}}} \]
   \[ 230/V_{\text{out}} = 400/1200 \]
   \[ V_{\text{out}} = 230 \times \frac{400}{1200} = 690 \, \text{Volts} \]
2002 Question 9 [Ordinary Level]

(i) What is electromagnetic induction?
   Electromagnetic Induction occurs when an emf is induced in a coil due to a changing magnetic flux.

(ii) Describe an experiment to demonstrate electromagnetic induction.
   **Apparatus:** coil, magnet and galvanometer.
   **Procedure:** Set up as shown. Move the magnet in and out of the coil.
   **Observation:** the needle deflects.

(iii) The transformer is a device based on the principle of electromagnetic induction.
   Name two devices that use transformers.
   Computer, radio, TV, doorbell, washing machine, mobile phone chargers.

(iv) Name the parts of the transformer labelled A, B and C in the diagram.
   A = primary/input coil, B = (iron) core, C = secondary/output coil

(v) The mains electricity supply (230 V) is connected to A, which has 400 turns. C has 100 turns. What is the reading on the voltmeter?
   \[
   \frac{V_{\text{in}}}{V_{\text{out}}} = \frac{N_{\text{input}}}{N_{\text{output}}}
   \]
   \[
   \frac{230}{V_{\text{out}}} = \frac{400}{100}
   \]
   \[
   V_{\text{out}} = 230 \times \frac{100}{400} = 57.5 \text{ Volts}
   \]

(vi) How is the part labelled B designed to make the transformer more efficient?
   It has a laminated core.

(vii) The efficiency of a transformer is 90%. What does this mean?
   10% of the power in is lost.