



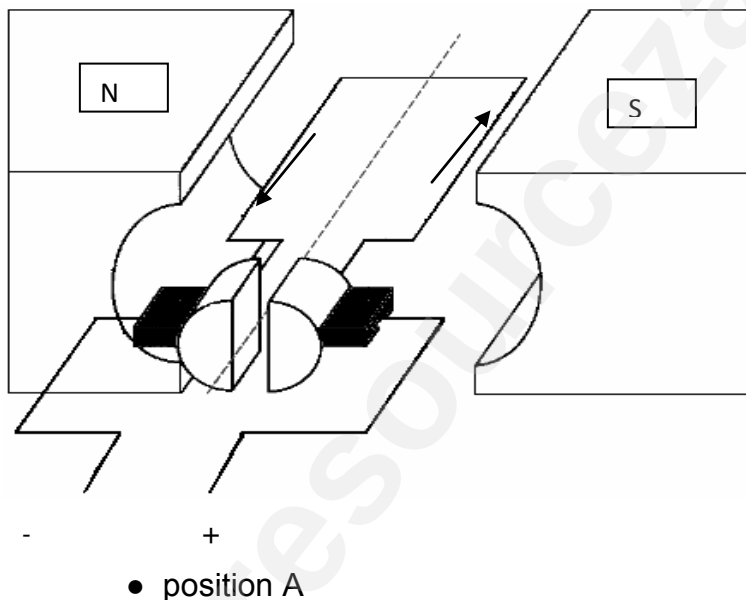
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ELECTRODYNAMICS**SECTION A: TYPICAL EXAM QUESTIONS****Question 1: 12 minutes**

(Taken from the DoE Physical Sciences Preparatory Examination Paper 1 2008)

Electric motors are important components of many modern electrical appliances. AC motors are used in washing machines and vacuum cleaners, and DC motors are used in toys and tools.

- 1.1 What energy conversion takes place in electric motors? (2)
- 1.2 What is the essential difference in the design between DC and AC motors? (2)
- 1.3 List THREE ways in which the efficiency of the motor can be improved. (3)
- 1.4 Consider the diagram below. The conventional current flows in the direction indicated by the arrows.

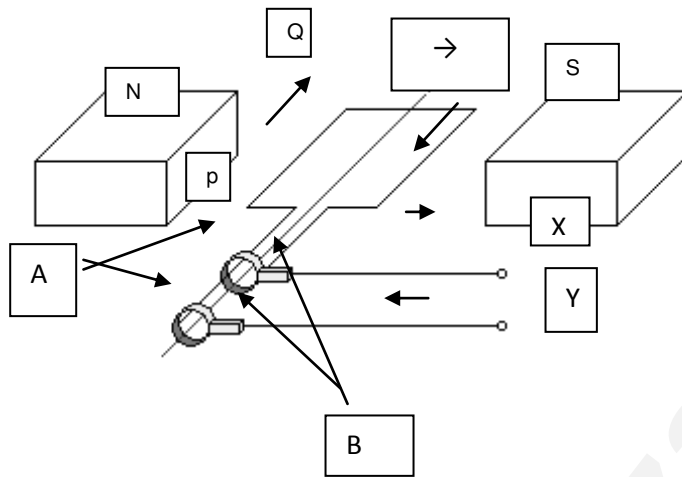


- 1.4.1 In which direction (clockwise or anti-clockwise), as seen from position A, will the coiled armature rotate if the switch is closed? (1)
- 1.4.2 Why does the armature continue moving in the same direction once it has reached the vertical position? (2)

[10]

Question 2: 8 minutes (Taken from the DoE Physical Sciences Exemplar Paper 1 2008)

The simplified sketch below shows the principle of operation of the alternating current (AC) generator.



- 2.1 Name the parts labelled A and B respectively. (2)
- 2.2 In which direction does segment PQ of the coil have to be rotated in order to cause the current direction as shown in the diagram? Write down only clockwise or anticlockwise. (1)
- 2.3 Write down TWO changes that can be brought about to improve the output of the generator. (2)
- 2.4 What changes must be made to the AC generator to make it function as a DC motor? (2)

[7]

SECTION B: ADDITIONAL CONTENT NOTES

The Electric Motor

In order to realise the motor effect the following components are necessary:

A current needs to be flowing in a magnetic field. This combination of force fields causes movement

Electrical energy is converted into kinetic energy.

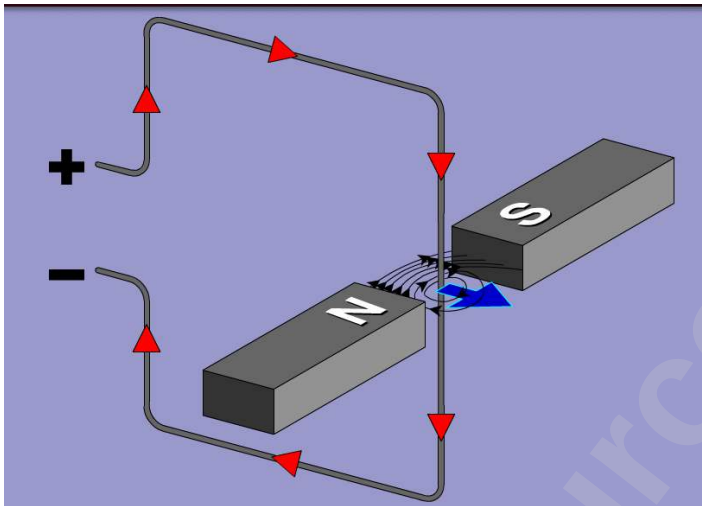


Image taken from Plato Multimedia Science School Simulations 11-16 – Physics – Electric Motor

The direction of the magnetic field is from North to South (N to S)

The current direction is the direction of flow of the conventional current (+'ve to -'ve)



Flemings Left Hand rule can be used to predict the direction of the force acting on the conductor in a magnetic field.

Using the LEFT HAND -

The first (pointer) finger points in the direction of the field, from North to South.

The second (middle) finger points in the direction of conventional current, from positive to negative.

The thumb will then point in the direction of the resultant force.

In an electric motor an electric current passes through the coil in a magnetic field the combination of the two force fields produces a torque which turns the motor.

Electric current supplied through the commutator.

The commutator reverses the current each half turn to keep the torque turning the coil in the same direction.

The brushes on the commutator allow for the free rotation of the coil.

The left hand rule can be applied to each arm of the rotating coil in order to determine the direction of rotation.

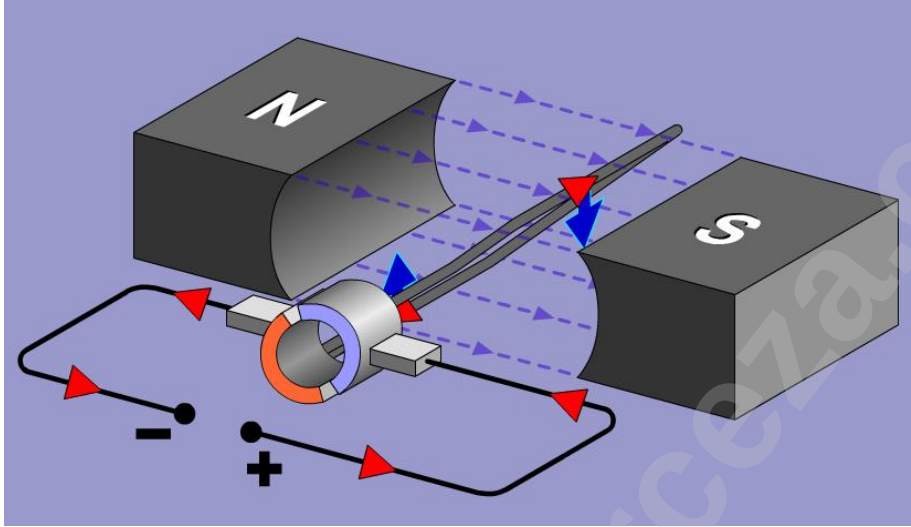


Image taken from Plato Multimedia Science School Simulations 11-16 – Physics – Electric motor

If we want to maximise the force created by the motor effect we can:

- Make the current stronger
- Increase the strength of the magnetic field
- The angle between the magnetic field direction and the direction of the current should be as close to 90° as possible, since the maximum effect is when the current flows at 90° to the magnetic field lines.

Faraday's Law of induction

The induced emf in a conductor is directly proportional to the rate of change of the magnetic flux through the conductor.

Lenz's law

The polarity of the induced emf is such that it produces a current whose magnetic field opposes the change which produces it.

The Dynamo

If a metallic coil is moved in a magnetic field an electric current is induced (created).

An emf is induced across the ends of a coil by a changing magnetic flux, which in turn causes a current to flow.

Kinetic energy is converted into electrical energy

A DC Dynamo with a split ring and brushes

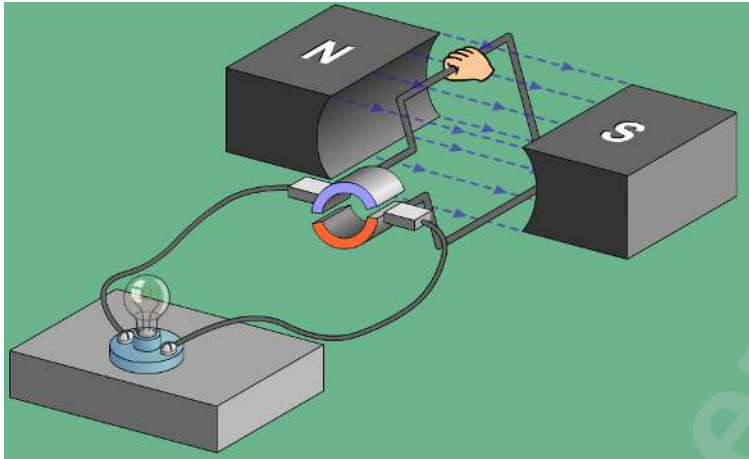


Image taken from Plato Multimedia Science School Simulations 11-16 – Physics – Electric Generator

An AC Dynamo with slip rings

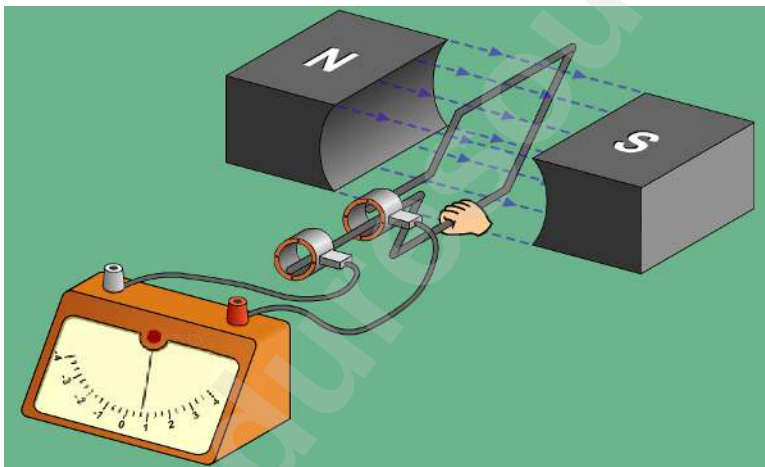
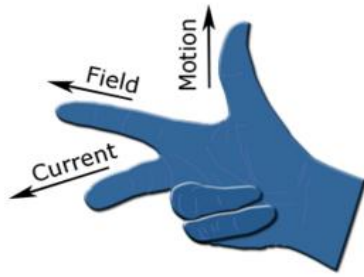


Image taken from Plato Multimedia Science School Simulations 11-16 – Physics – Electric Generator



Flemings Right Hand Dynamo rule can be used to predict the direction of the induced current.

Using the RIGHT HAND -

The first (pointer) finger points in the direction of the field, from North to South.

The thumb points in the direction of the movement.

Then the second (middle) finger points in the direction of the induced conventional current, from positive to negative.

SECTION C: SOLUTIONS AND HINTS

Question 1:

- 1.1 Electrical energy √ converted to rotational mechanical energy. √ (2)
- 1.2. A DC motor reverses current direction with the aid of the commutator whenever the coil is in the vertical √ position to ensure continuous rotation.
An AC motor, with alternating current as input, works without commutators since the current alternates.√ (2)
- 1.3 Increase the number of turns on each coil/increased number of coils √
Stronger magnets √
Bigger current √ (3)
- 1.4.1 Clockwise √ (1)
- 1.4.2 Its own momentum ,√ split ring commutator changes direction √ of current, every time the coil reaches the vertical position. (2)

[10]

Question 2:

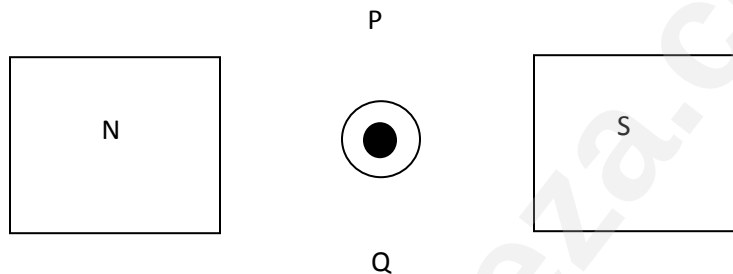
- 2.1 A = slip rings √
B = brushes √ (2)
- 2.2 anti-clockwise √ (1)
- 2.3 Any two:
Increase the number of turns of the coil √
Increase the magnetic field strength (stronger magnets) √
Increase speed of rotation
Use horse-shoe magnet –(**it helps to concentrate the field**) (2)
- 2.5 Use split ring commutators instead of slip rings. √
Add a battery to provide electrical energy to drive motor. √ (2)

[7]

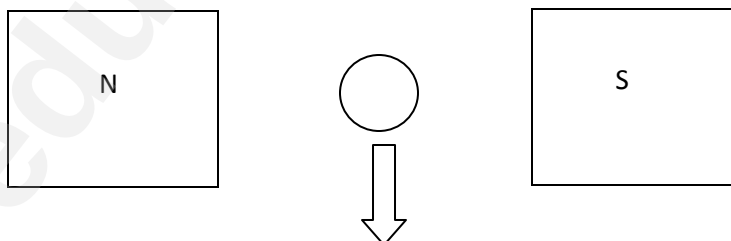
SECTION D: HOMEWORK

Question 1: 7 minutes – (5 x 2 = 10 marks)

- 1.1 Conventional current flows from:
- A. North to South
 - B. South to North
 - C. Positive to negative
 - D. Negative to positive
- 1.2 Referring to the below aerial sketch of a section of a motor, predict the direction of movement of the conducting wire.



- A. Towards P
 - B. Towards Q
 - C. Into the page
 - D. Out of the page
- 1.3 Which of the following is not a function of the commutator?
- A. Supplies electric current
 - B. Reverses the current each half turn.
 - C. Stops the current for a split second to allow the coil to rotate.
 - D. Converts the current into AC
- 1.4 Referring to the below aerial sketch of a section of a dynamo, predict the direction of conventional current in the conducting wire. The arrow represents the applied force.



- A. Towards North
- B. Towards South
- C. Into the page
- D. Out of the page

1.5 Which of the following energy conversion combinations is correct?

	Motor	Dynamo
A	Electrical to kinetic	Electrical to kinetic
B	Kinetic to electrical	Electrical to kinetic
C	Electrical to kinetic	Kinetic to electrical
D	Kinetic to electrical	Kinetic to electrical

Question 2: 13 minutes

- 2.1 What is the advantage of using more than one coil in the rotor of any motor? (2)
- 2.2 In any motor, what is the function of:
- 2.2.1 commutators ? (1)
- 2.2.2 brushes? (1)
- 2.3 Can the speed of a motor be changed without making changes to the motor itself? Explain your answer. (2)
- 2.4 Explain the basic difference between a motor and a generator. (2)
- 2.5 How does Faraday's law apply to a generator? (2)

[10]

SECTION E: SOLUTIONS TO SESSION 29 HOMEWORK

Question 1:

$$1.1 \quad \frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2} \quad \checkmark$$

$$\frac{1}{R_p} = \frac{1}{15} + \frac{1}{5}$$

$$= \frac{1+3}{15}$$

$$= \frac{4}{15}$$

$$R_p = \frac{15}{4}$$

$$R_p = 3,75 \, \Omega \quad \checkmark$$

$$R_{\text{Total}} = 20 + 3,75 = 23,75 \, \Omega \quad \checkmark$$

$$I_{\text{Total}} = V/R_{\text{Total}} \quad \checkmark = 60/23,75 \quad \checkmark = 2,53A \quad \checkmark \quad (6)$$

$$1.2 \quad V_{20\Omega} = IR_{20\Omega}$$

$$= (2,53)(20) \quad \checkmark$$

$$= 50,6V \quad \checkmark$$

$$V_{\parallel} = 60 - 50,6 = 9,4V \quad \checkmark \quad (3)$$

Question 2:

2.1.1 What is the relationship between the electric current and the potential difference?

Or

How does the electric current change when the potential difference changes?

Checklist	Marks
Question refers to dependent variable	✓
Question refers to independent variable	✓

(2)

2.1.2 Electric current is directly proportional to potential difference.

Or

Electric current increases as the potential difference increases.

Checklist	Marks
Statement that can be proved true or false (not aim)	✓
Statement refers to dependent and independent variables	✓

(2)

2.1.3 Temperature ✓

(1)

2.1.1 Method 1:

Torch batteries, ammeter, voltmeter, resistor e.g. nichrome wire (not a bulb),
connecting wires

Or

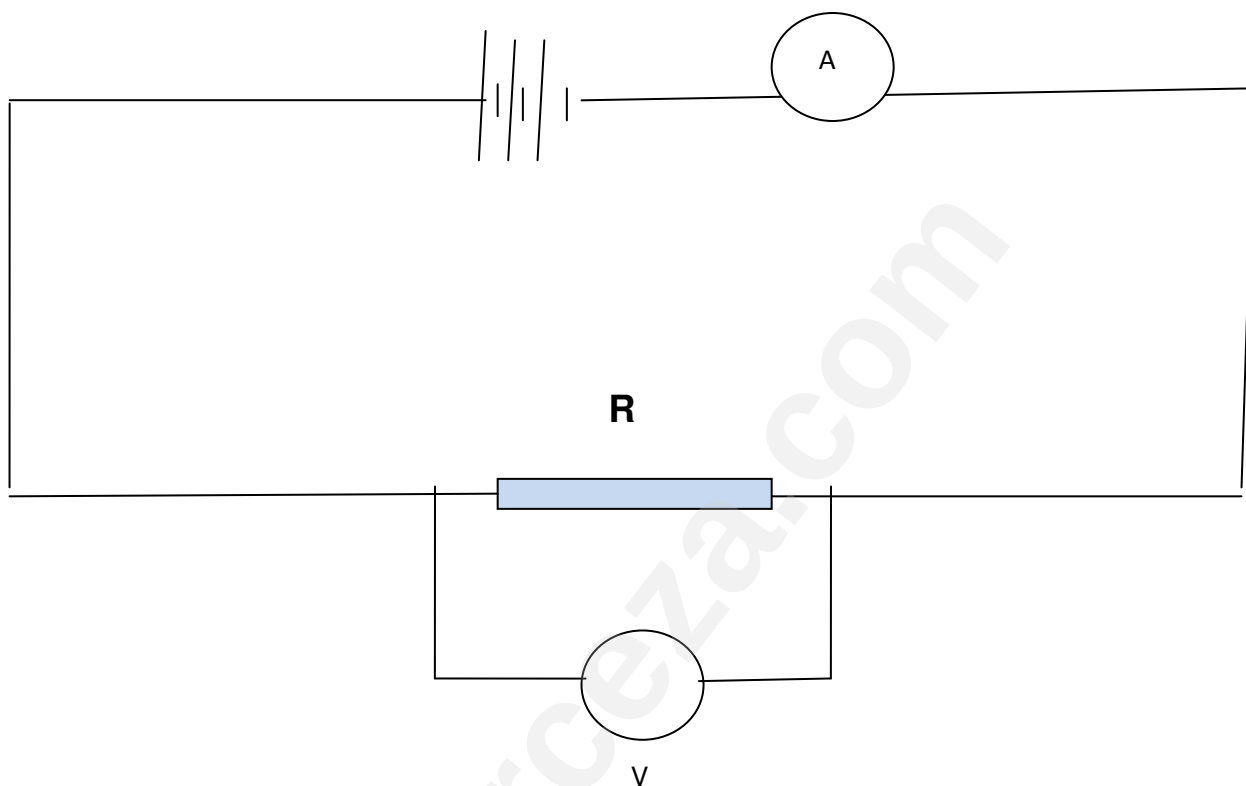
Method 2:

Power source, rheostat, ammeter, voltmeter, resistor e.g. nichrome wire (not a bulb),
connecting wires

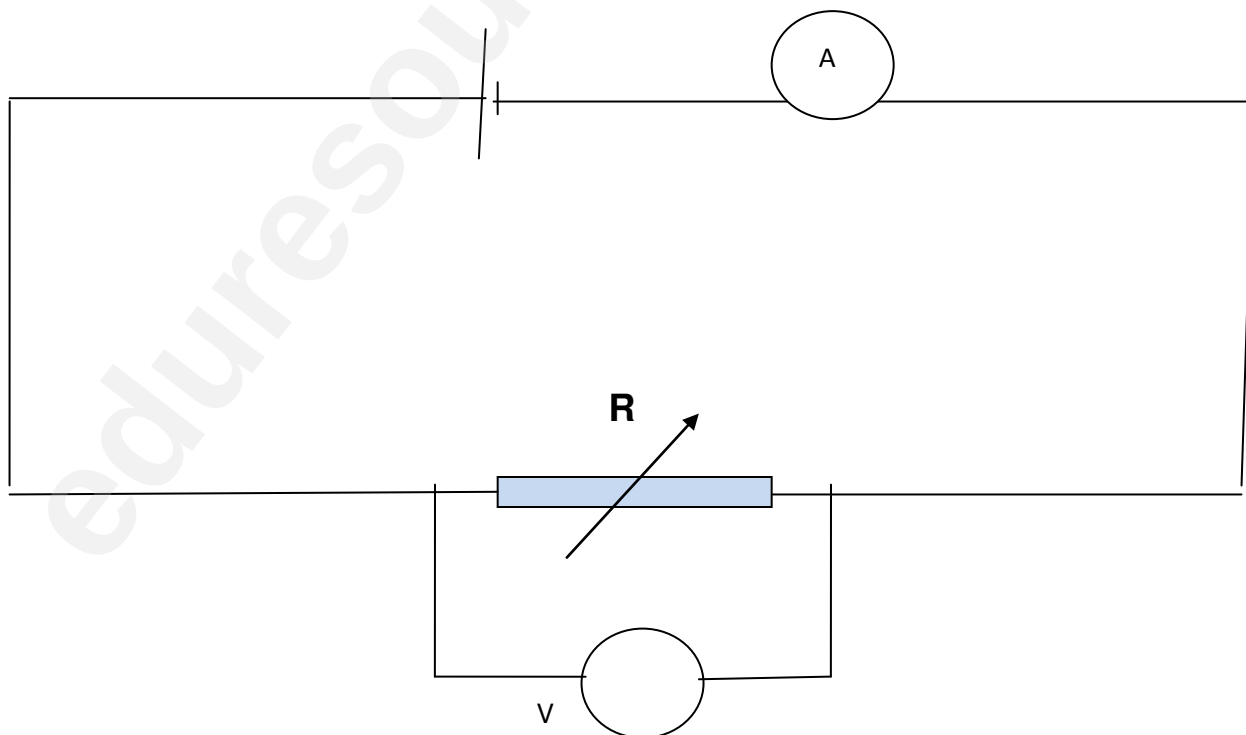
Checklist	Marks
Any source of electricity of which potential difference can be changed	✓
Ammeter and voltmeter	✓
Resistor	✓

(3)

2.2.2 Method 1:



Method 2:



Checklist	Marks
Source of electricity correctly indicated	√
Resistor with voltmeter connected in parallel across resistor correctly	√
Ammeter connected in series to measure current in resistor	√

(3)

- 2.1.2 With one battery, measure the voltmeter reading and the ammeter reading. Add another battery in series with the first and repeat the measurements. Add a third battery in series with the first two and repeat the measurements.

OR

Adjust the rheostat connected in series to the power source and take the readings on the ammeter and voltmeter. Increase/decrease the resistance of the rheostat and take a second set of readings. Increase/decrease the resistance of the rheostat to take a third set of readings.

Checklist	Marks
Indicates that potential difference must be adjusted	√
Indicates that voltmeter reading must be taken	√
Indicates that ammeter reading must be taken	√

(3)