# P7 MAGNETISM AND ELECTROMAGNETISM

Question Practice

Name: _____

Class: _____

Date: _____

Time: **101 minutes**

Marks: **98 marks**

Comments: **HIGHER TIER**

**1** An electric current is a flow of electrical charge through a circuit.

(a) Complete the sentence.

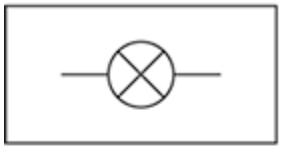
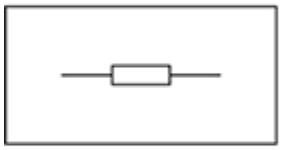
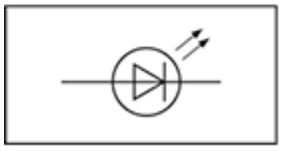
Use a word from the box.

| | | | |
|---|---|---|---|
| **atoms** | **electrons** | **ions** | **molecules** |

Metals are good conductors of electricity because electrical charge is transferred by delocalised _____

**(1)**

(b) Draw **one** line from each symbol to the name of the component.

| **Standard symbol** | **Name of component** |
|---|---|
|  | Battery |
| | Lamp |
|  | LED |
| | Resistor |
|  | Switch |

**(3)**

(c) The table below shows information about some electrical appliances.

| Electrical appliance | Power in watts |
|---|---|
|  Hairdryer | 1500 |
|  Kettle | 2500 |
|  Electric hob | 3000 |
|  Television | 360 |

A student plugs all four of the appliances into one multi-way socket.

The mains electricity is 230 V.

The highest safe current in the socket is 30 A.

Explain why it is not safe to use all four appliances at the same time.

In your answer you should:

- calculate the total power needed
- use the equation

current = power ÷ potential difference

to calculate the total current needed.

_____

_____

_____

_____

_____

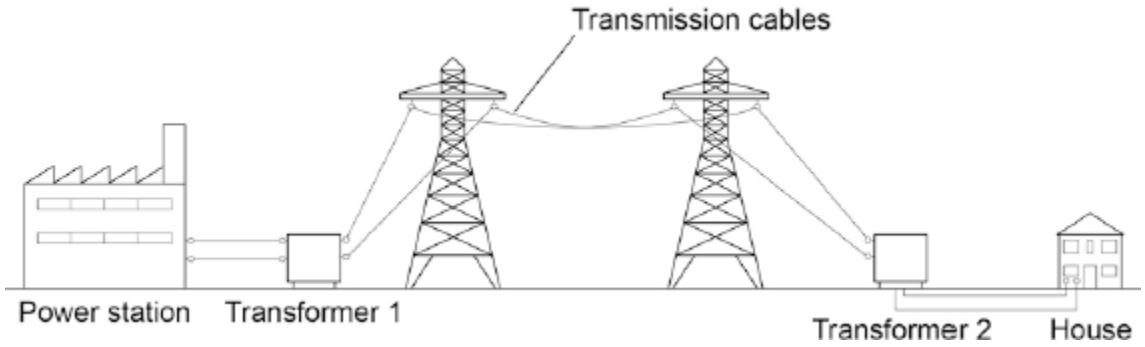
_____

_____

_____

**(4)**

(d) The figure below shows how electrical power is transferred from power stations to consumers using the National Grid.




Transformer 1 is a step-up transformer.

Explain why step-up transformers are used in the National Grid.

_____

_____

_____

_____

_____

_____

**(3)**

(e) What is the purpose of Transformer 2?

_____

_____

**(1)**

(f) In a power station 900 MJ of thermal energy were released by burning natural gas.

Write down the equation that links efficiency, useful input energy transfer and useful output energy transfer.

_____

**(1)**

(g) In a power station 900 MJ of thermal energy were released by burning natural gas.

Only 405 MJ was generated.

Calculate the efficiency of this energy transfer.

_____

_____

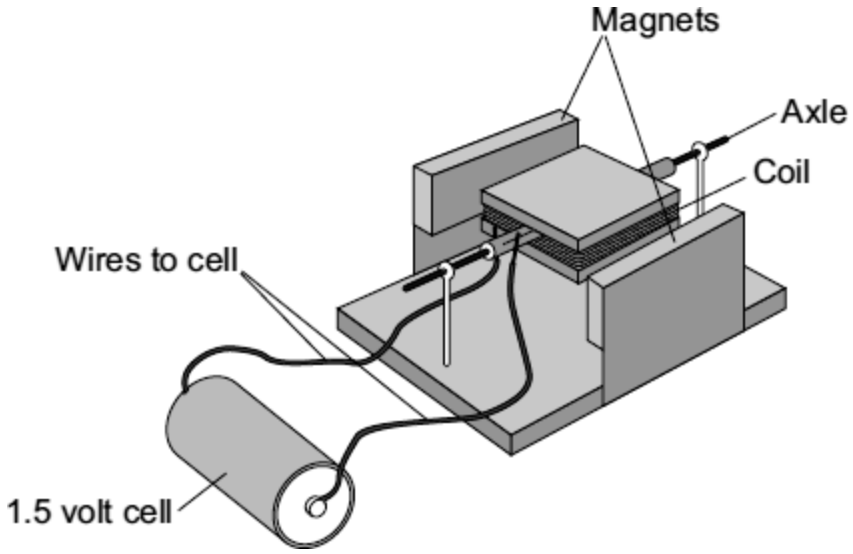
_____

Efficiency = _____

**(2)**

**(Total 15 marks)**

**2** (a) Complete the description of the device shown below by drawing a ring around the correct line in each box.




(i) The device is being used as

| |
|---|
| an electric motor. |
| a generator. |
| a transformer. |

**(1)**

(ii) The coil needs a flick to get started. Then one side of the coil is pushed by the

| |
|---|
| cell |
| coil |
| force |

and the other side is pulled, so that the coil spins.

**(1)**

(b) Suggest **two** changes to the device, each one of which would make the coil spin faster.

1. _____

_____

2. _____

_____

**(2)**

(c) Suggest **two** changes to the device, each one of which would make the coil spin in the opposite direction.

1. _____

_____

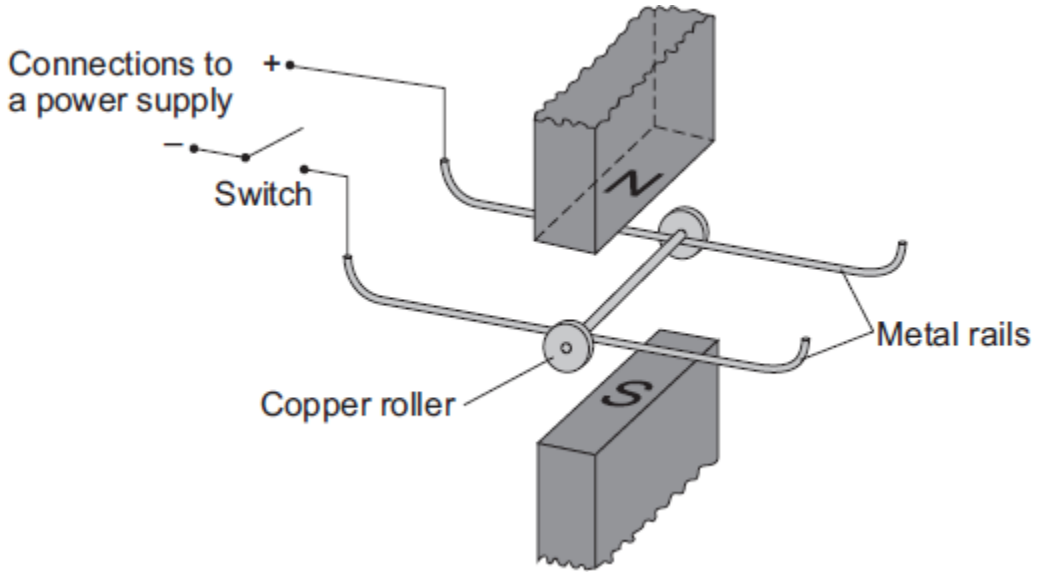
2. _____

_____

**(2)**

**(Total 6 marks)**

**3** (a) A science technician sets up the apparatus shown below to demonstrate the motor effect. He uses a powerful permanent magnet.




The copper roller is placed across the metal rails. When the switch is closed, the copper roller moves to the right.

(i) Complete the sentence by drawing a ring around the correct line in the box.

This happens because copper is

| |
|---|
| an electrical conductor. |
| an electrical insulator. |
| a magnetic material. |

**(1)**

(ii) Suggest **one** change that the technician can make which will cause the copper roller to move faster.

_____

_____

**(1)**

(iii) Suggest **two** changes which the technician can make, each of which will separately cause the copper roller to move to the left.

1. _____

_____

2. _____

_____

**(2)**

(b) Many electrical appliances, such as vacuum cleaners, drills and CD players, contain electric motors. As more electrical appliances are developed, more electricity needs to be generated. Generating electricity often produces pollutant gases.

(i) Complete the sentence by drawing a ring around the correct line in the box.

Generating more electricity to power the increasing number of electrical appliances used raises

| |
|---|
| an ethical |
| an environmental |
| a political |

issue.

**(1)**

(ii) The number of electrical appliances used in the world's richest countries is increasing yet many people in the world's poorest countries have no access to electricity.

What type of issue does this inequality between people in different countries raise?

_____

**(1)**

**(Total 6 marks)**

**4** Many electrical appliances use the circular motion produced by their electric motor.

(a) Put ticks (✓) in the boxes next to **all** the appliances in the list which have an electric motor.

electric drill ☐

electric fan ☐

electric food mixer ☐

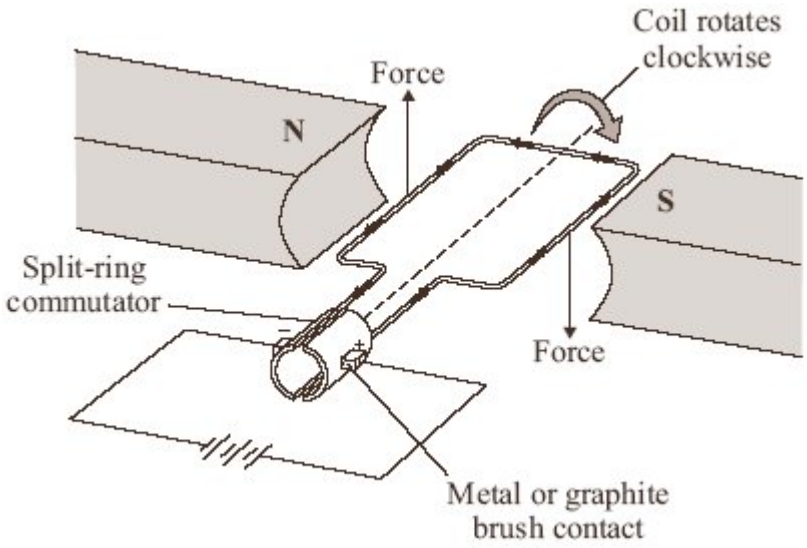
electric iron ☐

electric kettle ☐

electric screwdriver ☐

**(2)**

(b) One simple design of an electric motor is shown in the diagram. It has a coil which spins between the ends of a magnet.




(i) Give **two** ways of reversing the direction of the forces on the coil in the electric motor.

1. _____

_____

2. _____

_____

**(2)**

(ii) Give **two** ways of increasing the forces on the coil in the electric motor.

1. _____

_____

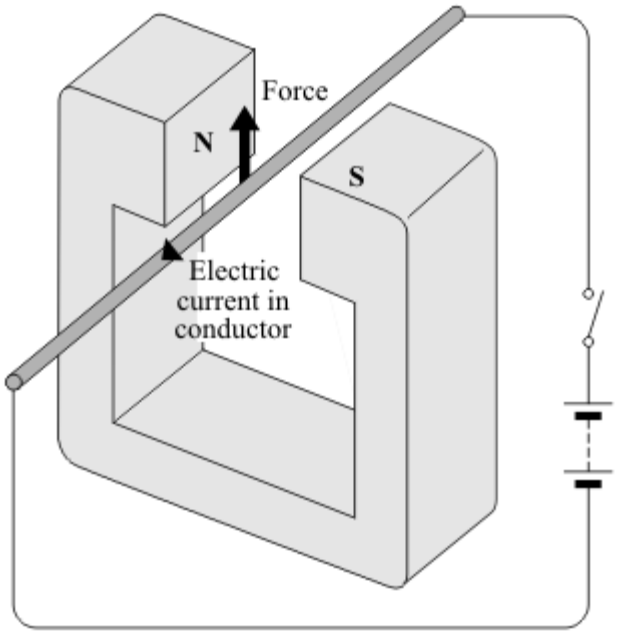
2. _____

_____

**(2)**

**(Total 6 marks)**

**5** When a conductor carrying an electric current is placed in a magnetic field a force may act on it.




(a) State **two** ways in which this force can be increased.

1. _____

2. _____

**(2)**

(b) State **two** ways in which this force can be made to act in the opposite direction.

1. _____

2. _____

**(2)**

(c) In what circumstance will **no** force act on a conductor carrying an electric current and in a magnetic field?

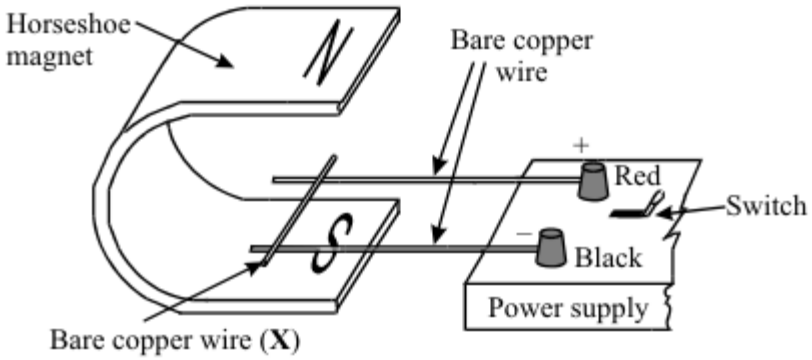
_____

_____

**(1)**

**(Total 5 marks)**

**6** The diagram shows apparatus used to demonstrate the motor effect. **X** is a short length of bare copper wire resting on two other wires.




(a) (i) Describe what happens to wire **X** when the current is switched on.

_____

_____

_____

(ii) What difference do you notice if the following changes are made?

A The magnetic field is reversed.

_____

_____

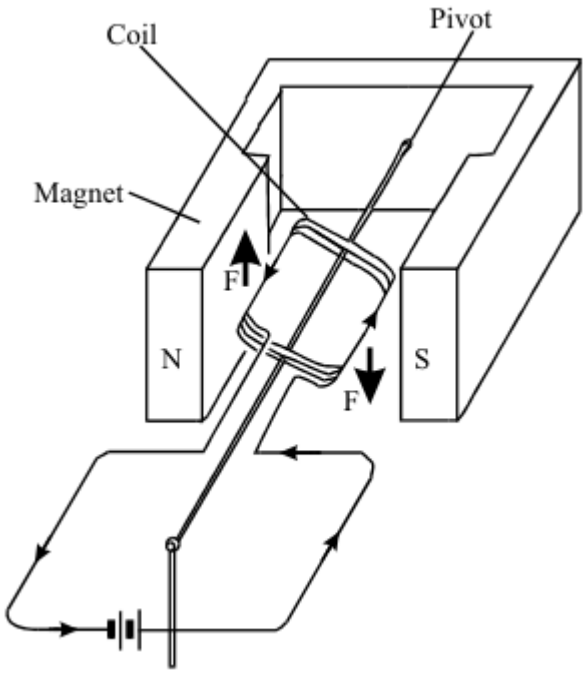
B The current is increased.

_____

_____

**(3)**

(b) The diagram shows a coil placed between the poles of a magnet. The arrows on the sides of the coil itself show the direction of the conventional current.




The arrows labelled **F** show the direction of the forces acting on the sides of the coil. Describe the motion of the coil until it comes to rest.

_____

_____

_____

_____

_____

**(3)**

(c) Most electric motors use electromagnets instead of permanent magnets. State three of the features of an electromagnet which control the strength of the magnetic field obtained.

1. _____

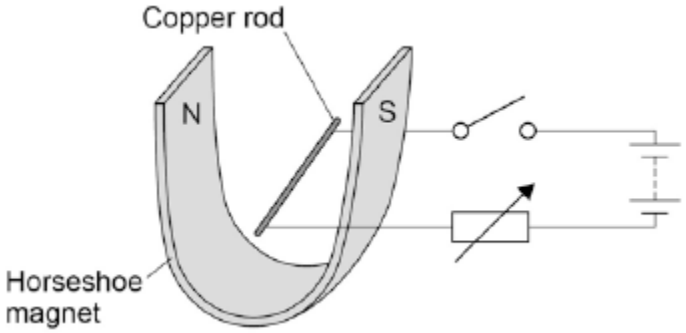
2. _____

3. _____

**(3)**

**(Total 9 marks)**

**7** A teacher used the equipment shown in the figure below to demonstrate the motor effect.




(a) Describe how Fleming's left-hand rule can be used to determine the direction in which the rod will move when the switch is closed, and state the direction.

**(4)**

(b) Increasing the current can increase the force acting on the copper rod.

Give **one** other way in which the size of the force acting on the copper rod could be increased.

**(1)**

(c) The copper rod in the figure above has a length of 7 cm and a mass of $4 \times 10^{-4}$ kg.

When there is a current of 1.12 A the resultant force on the copper rod is 0 N.

Calculate the magnetic flux density.

Gravitational field strength = 9.8 N / kg

Magnetic flux density = _____ T

**(5)**

**(Total 10 marks)**

**8** Iron is a metal that has many uses.

(a) Iron is extracted from iron ore. Part of the process involves reduction of the ore with carbon monoxide.

Iron ore contains iron oxide ($Fe_2O_3$).

Write a balanced equation for the reaction of iron oxide with carbon monoxide.

**(3)**

(b) Explain why this reaction is a redox reaction.

**(2)**

Steel is an alloy of iron. Steel is used to make cars.

After its useful life a car is taken to a scrapyard for recycling.

(c) Suggest **four** benefits of recycling a car body.

_____

_____

_____

_____

_____

_____

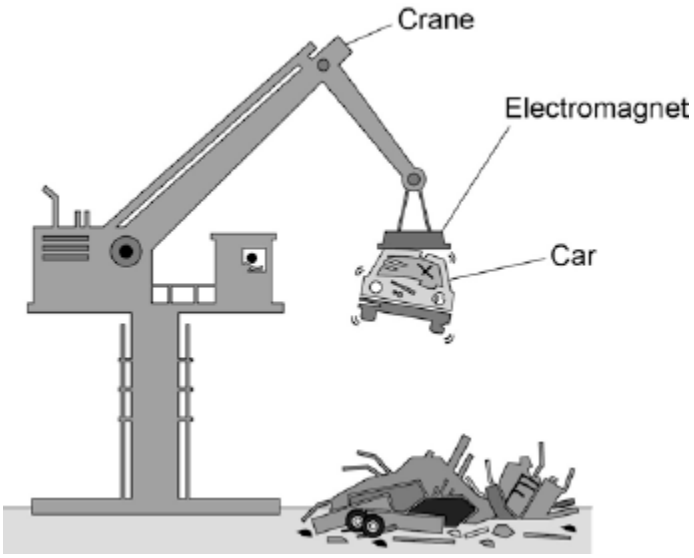
_____

_____

**(4)**

(d) **Figure 1** shows an electromagnet being used to lift a car in a scrapyard.

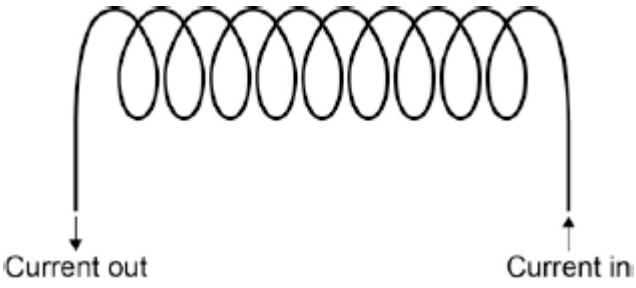
**Figure 1**




An electromagnet is made up of a solenoid.

**Figure 2** shows a solenoid.

**Figure 2**




Draw the magnetic field of the solenoid on **Figure 2**.

**(2)**

(e) In a scrapyard, an electromagnet is used to lift and release cars so they can be moved around.

Suggest **two** ways a solenoid could be made to lift and release cars in a scrapyard.

Explain why each suggestion would be useful in the scrapyard.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

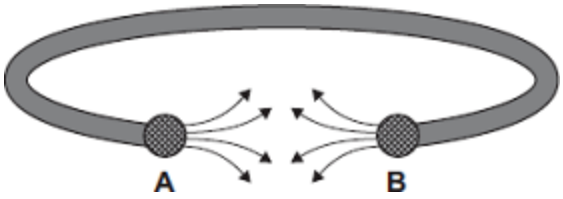
**(Total 15 marks)**

**9** (a) Some people wear magnetic bracelets to relieve pain.

**Figure 1** shows a magnetic bracelet.

There are magnetic poles at both **A** and **B**.
Part of the magnetic field pattern between **A** and **B** is shown.

**Figure 1**



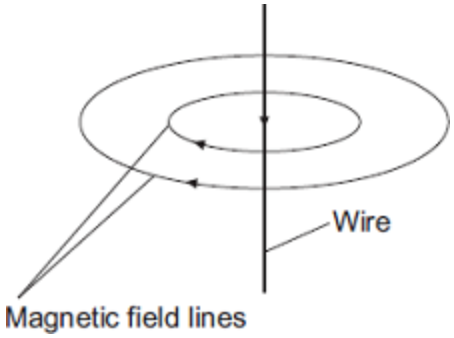

What is the pole at **A**? _____

What is the pole at **B**? _____

**(1)**

(b) **Figure 2** shows two of the lines of the magnetic field pattern of a current-carrying wire.

**Figure 2**




The direction of the current is reversed.

What happens to the direction of the lines in the magnetic field pattern?

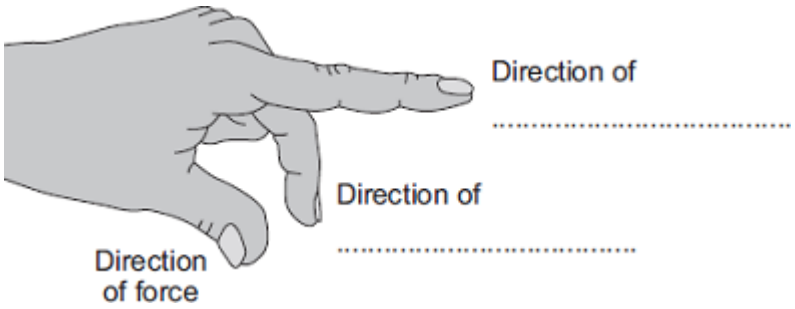
_____

**(1)**

(c) Fleming's left-hand rule can be used to identify the direction of a force acting on a current-carrying wire in a magnetic field.

(i) Complete the labels in **Figure 3**.

**Figure 3**

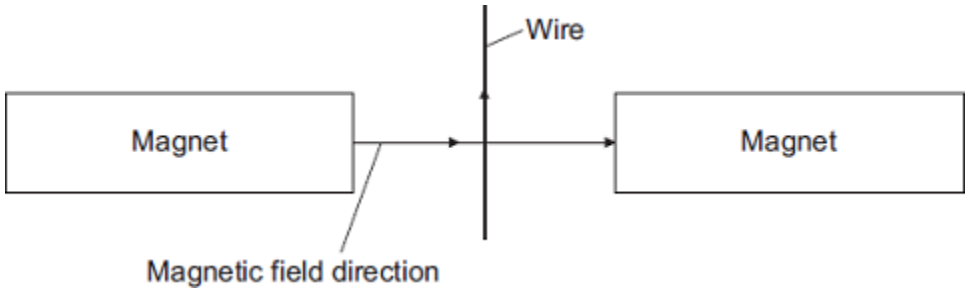



**(2)**

(ii) **Figure 4** shows:

- the direction of the magnetic field between a pair of magnets
- the direction of the current in a wire in the magnetic field.

**Figure 4**




In which direction does the force on the wire act?

_____

**(1)**

(iii) Suggest **three** changes that would **decrease** the force acting on the wire.

1. _____

2. _____

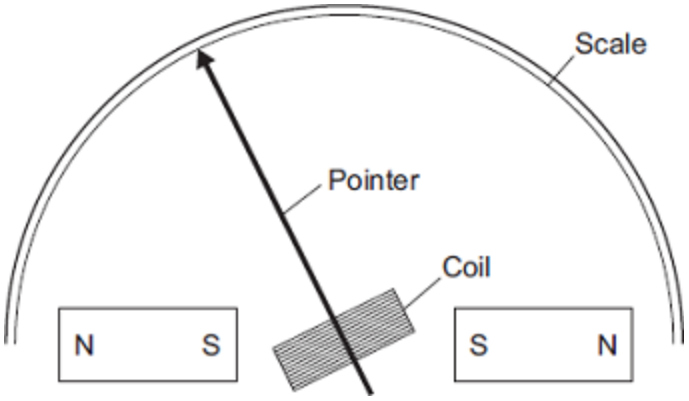
3. _____

**(3)**

(d) **Figure 5** shows part of a moving-coil ammeter as drawn by a student.

The ammeter consists of a coil placed in a uniform magnetic field.
When there is a current in the coil, the force acting on the coil causes the coil to rotate and the pointer moves across the scale.

**Figure 5**




(i) The equipment has **not** been set up correctly.

What change would make it work?

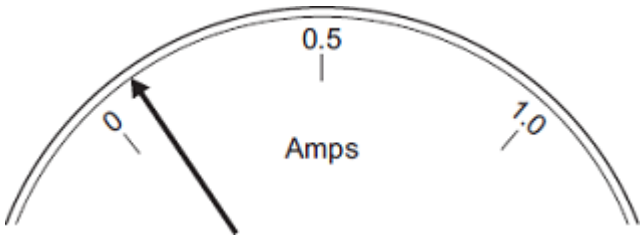
_____

_____

**(1)**

(ii) **Figure 6** shows the pointer in an ammeter when there is no current.

**Figure 6**



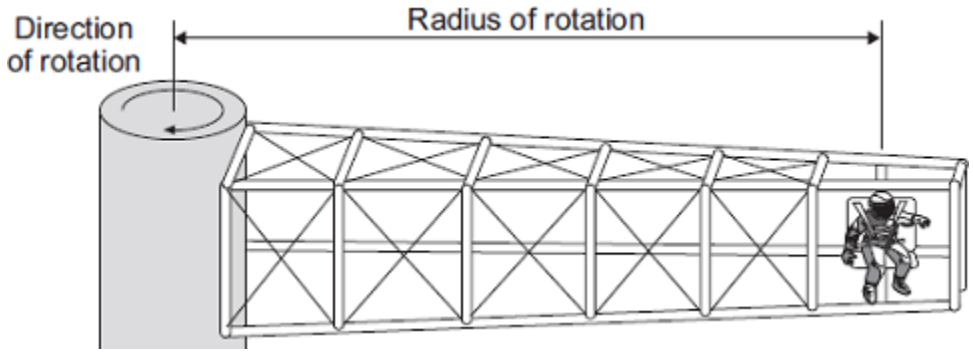

What type of error does the ammeter have?

_____

**(1)**

**(Total 10 marks)**

**10** The diagram shows a 'G-machine'. The G-machine is used in astronaut training.

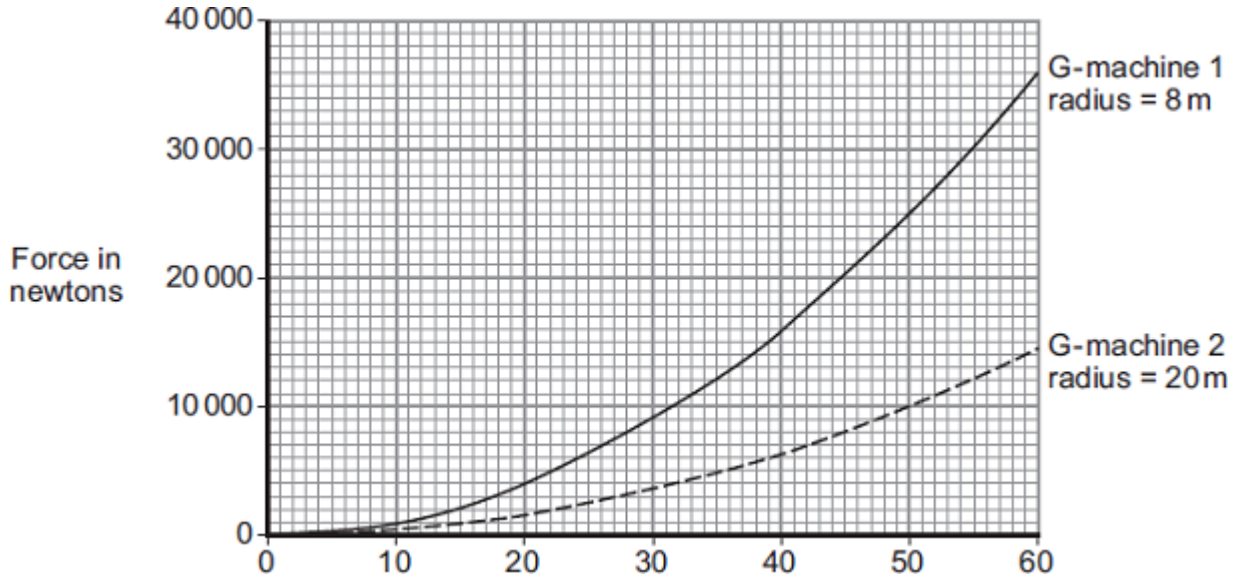



The G-machine moves the astronaut in a horizontal circle.

(a) The force causing the astronaut to move in a circle is measured.

The graph shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

The radius of rotation of the astronaut is different for each G-machine.




(i) State **three** conclusions that can be made from the graph.

1. _____

_____

2. _____

_____

3. _____

_____

**(3)**

(ii) The speed of rotation of G-machine 1 is increased from 20 m/s to 40 m/s.

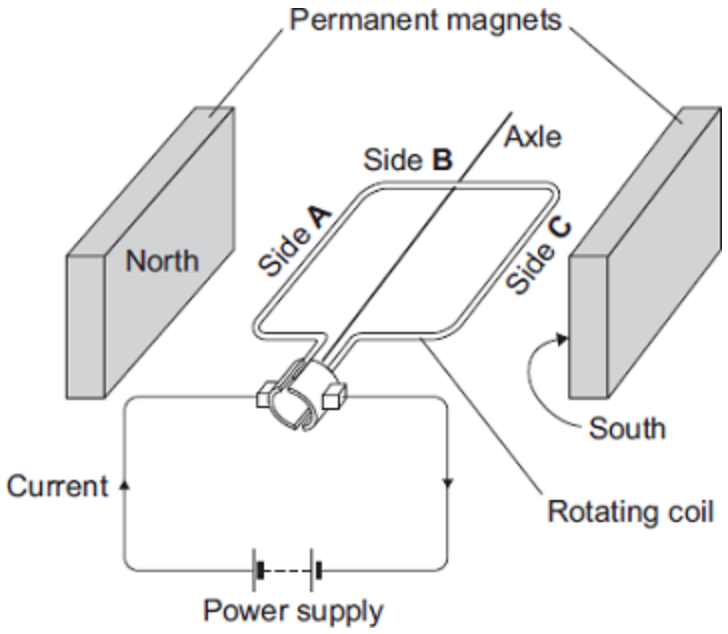
Determine the change in force on the astronaut.

_____

Change in force = _____ N

**(1)**

(b) Each G-machine is rotated by an electric motor. The diagram shows a simple electric motor.




(i) A current flows through the coil of the motor.

Explain why side **A** of the coil experiences a force.

_____

_____

_____

_____

**(2)**

(ii) Draw arrows on the diagram to show the direction of the forces acting on side **A** of the coil and side **C** of the coil.

**(1)**

(iii) When horizontal, side **B** experiences no force.

Give the reason why.

_____

_____

**(1)**

(c) While a G-machine is rotating, the operators want to increase its speed.

What can the operators do to make the G-machine rotate faster?

_____

_____

**(1)**

(d) The exploration of space has cost a lot of money.

Do you think spending lots of money on space exploration has been a good thing?

Draw a ring around your answer.

**Yes** **No**

Give a reason for your answer.

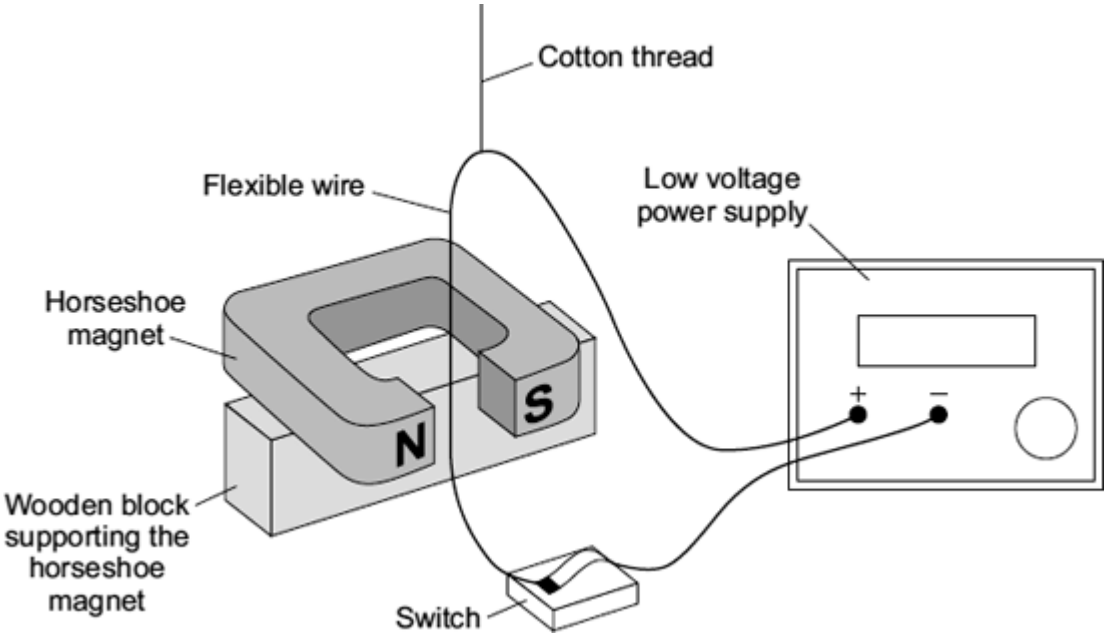
_____

_____

**(1)**

**(Total 10 marks)**

**11** (a) A laboratory technician sets up a demonstration.




A flexible wire is suspended between the ends of a horseshoe magnet. The flexible wire hangs from a cotton thread. When the switch is closed, the wire kicks forward.

Identify the effect which is being demonstrated.

_____

**(1)**

(b) A teacher makes some changes to the set-up of the demonstration.

What effect, if any, will each of the following changes have?

(i) more powerful horseshoe magnet is used.

_____

_____

**(1)**

(ii) The connections to the power supply are reversed.

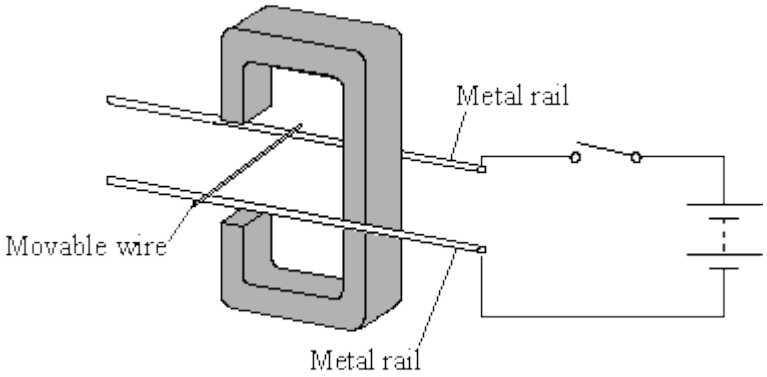
_____

_____

**(1)**

**(Total 3 marks)**

**12** The diagram shows apparatus used to demonstrate the electric motor effect. When he switch is closed the wire moves.




(i) Draw an arrow on the diagram to show the direction the wire moves.

**(1)**

(ii) Explain why the wire moves.

_____

_____

_____

_____

**(2)**

**(Total 3 marks)**

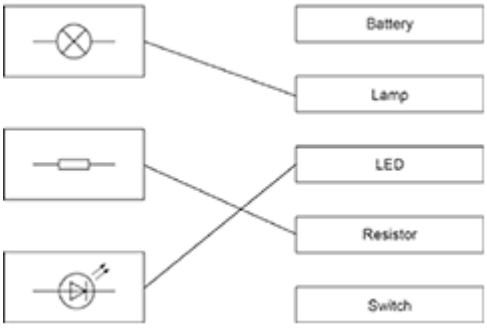
# Mark schemes

**1**

(a) electrons

**1**

(b)




*extra lines from a symbol negate the mark*

**3**

(c) the total power = 7360 watts

**1**

current = 7360 ÷ 230

**1**

= 32 A

*allow 32 with no working shown for **3** marks*

**1**

so the current is greater than 30 A

**1**

(d) to increase the voltage (across the cables) or to decrease the current (through the cables)

**1**

reducing energy losses (in the cables)

*do **not** allow electricity for energy*

*do **not** allow no energy loss*

**1**

increasing the efficiency of transmission

**1**

(e) to decrease the potential difference for domestic use

**1**

(f) $efficiency = \frac{useful\ output\ energy\ transfer}{total\ input\ energy\ transfer}$

1

(g) 405 / 900

1

=0.45

*accept 45%*

1

*allow 0.45* ***or*** *45% with no working shown for* ***2*** *marks*

**[15]**

**2** (a) (i) an electric motor

1

(ii) force

1

(b) any **two** from:

- more powerful magnet

  *do* ***not*** *allow 'bigger magnet'*

- reduce the gap (between magnet and coil)
- increase the area of the coil
- more powerful cell

  *do* ***not*** *allow 'bigger cell'*
  *accept battery for cell*
  *accept add a cell*
  *accept increase current / potential difference*

- more turns (on the coil)

  *allow 'more coils on the coil'*
  *do* ***not*** *allow 'bigger coil'*

2

(c) reverse the (polarity) of the cell

*allow 'turn the cell the other way round'*
*accept battery for cell*

1

reverse the (polarity) of the magnet

*allow 'turn the magnet the other way up'*

1

**[6]**

**3** (a) (i) an electrical conductor

1

(ii) increase current

*accept increase p.d. / voltage*

**or**

use stronger magnets

*accept move magnets closer*

*do **not** accept use larger magnets*

**1**

(iii) reverse the poles / ends (of the magnet)

*either order*

**1**

reverse the connections (to the power supply)

**1**

(b) (i) environmental

**1**

(ii) ethical

*allow political (instability)*

*allow economic (migration)*

**1**

**[6]**

**4** (a) electric drill, electric fan, electric food mixer and electric screwdriver

*all four ticked and no others (2)*

***either** all four of these ticked and only one other (1)*

***or** any three of these ticked and none/one/two of the others (1)*

**2**

(b) (i) reverse (the direction of the) current (1)

***or** reverse the connections (to the battery)*

reverse (the direction of the) magnetic field (1)

***or** reverse the (magnetic) poles /ends*

*do **not** credit 'swap the magnets (around)'*

**2**

(ii) any **two** from:

- increase the strength of the magnet(s)/(magnetic) field

  *do **not** credit 'use a bigger magnet'*

- increase the current

  *allow 'increase the voltage/p.d.'*
  *allow add cells/batteries*
  *allow increase the (electrical) energy*
  *allow increase the power supply*
  *allow 'decrease the resistance'*
  *allow 'increase charge'*
  *allow ' increase the electricity'*

  *do **not** credit 'use a bigger battery'*

- reduce the gap (between coil/armature and poles/magnets)

  *allow increase the (number of) coils*

- increase the turns (on the coil/armature)

  *do **not** credit 'use a bigger coil'*

**2**

**[6]**

**5** (a) increase the current (1)

*credit increase the p.d./voltage*
*credit reduce the resistance*
*credit have thicker wiring*
*credit add extra / more cells*

**1**

increase the magnetic field (strength) (1)

*credit 'have stronger magnet(s)*
*do **not** credit 'bigger magnets' either order*

**1**

(b) **either** reverse polarity

**or** connect the battery the other way round

**1**

**either** reverse direction of the magnetic field

**or** put the magnet the other way round / reverse the magnet

*do **not** give any credit to a response in which both are done at the same time*

*either order*

**1**

(c) **either**

conductor parallel to the magnetic field

**or** lines of magnetic force and path of electricity do not cross

**1**

**[5]**

**6**

(a) (i) it moves or experiences a force horizontally to the right

*for 1 mark*

**1**

(ii) A – moves in opposite direction or force reversed e.c.f.
B – faster movement or larger force
(**not** move further)

*for 1 mark each*

**2**

(b) turns clockwise
oscillates/reverses
comes to rest facing field/at 90$^{o}$ to field/vertically

*for 1 mark each*

**3**

(c) number of turns or linear number density of turns current core

*for 1 mark each*

**3**

**[9]**

**7**

(a) thumb, index finger and third finger are held mutually at right angles

**1**

index finger shows the direction of the magnetic field from North to South, third finger shows the direction of the current from positive to negative terminal

**1**

the thumb then shows the direction of the force acting on the copper rod

**1**

so the copper rod will move upwards

**1**

(b) any **one** from:

use a stronger magnet

increase the magnetic flux density

increase the length of the copper rod in the magnetic field

coil the copper rod

**1**

(c) $W = 9.8 \times 4 \times 10^{-4} = 3.92 \times 10^{-3}$

**1**

conversion of the length 7cm to 0.07m

1

$3.92 \times 10^{-3} = B \times 1.12 \times 0.07$

1

$B = 3.92 \times 10^{-3} / 0.0784$

1

B = 0.05 (T)

1

*allow 0.05 (T) without working shown for the **5** calculation marks*

**[10]**

**8** (a) $Fe_2O_3 + 3\,CO \rightarrow 2Fe + 3\,CO_2$

*correct formulae of reactants*

1

*correct formulae of products*

1

*correct balancing*

1

(b) iron loses oxygen – reduction

1

carbon gains oxygen – oxidation

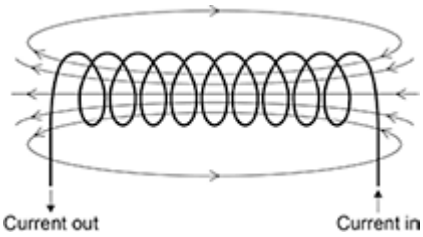
1

(c) any **four** from:

- resources for manufacture are limited
- recycling reduces the use of resources
- reduces energy consumption in extraction / manufacture
- reduces waste from processing and extraction
- reduces environmental impact of extraction

4

(d)




*field lines going through and around coil*

1

*correct directional arrows*

1

(e) any **two** from:

***1*** *mark for suggestion,* ***1*** *mark for correctly linked explanation*

- use many coils **or** tight coils **or** long wire (1)
- to give a strong magnetic field for lifting heavy objects (1)

*explanation must be correctly linked to the suggestion to gain the mark*

**or**

- add an iron core
- to increase field circuit for lifting

**or**

- include a switch in circuit
- so can drop / pick up cars

**max. 4**

**[15]**

**9**

(a) north (pole)

*accept N*

north (pole)

*both needed for mark*

**1**

(b) reverses

*accept changes direction*

**1**

(c) (i) first finger:
(direction of) (magnetic) field

**1**

second finger:
(direction of) (conventional) current

**1**

(ii) into (plane of the) paper

**1**

(iii) less current in wire

*accept less current / voltage / more resistance / thinner wire*

**1**

weaker field

*allow weaker magnets / magnets further apart*

*do* ***not*** *accept smaller magnets*

**1**

rotation of magnets (so) field is no longer perpendicular to wire

**1**

(d) (i) reverse one of the magnets

*do **not** accept there are no numbers on the scale*

**1**

(ii) systematic or zero error

*accept all current values will be too big*

*accept it does not return to zero*
*accept it does not start at zero*

**1**

**[10]**

**10** (a) (i) the greater the speed (of a centrifuge), the greater the force

*answers must be comparative*

*accept velocity for speed*

*accept positive correlation between speed and force*

*speed and force are not proportional – treat as neutral*

**1**

the smaller the radius, the greater the force (at a given speed)

*allow **(G machine) 1** has / produces a greater force (than **G machine 2** ) at the same speed*

*must be comparative, eg a small radius produces a large force = 0 marks on own*

**1**

as the speed increases the rate of change in force increases

*accept force is proportional to the square of the speed*

***or***

*doubling speed, quadruples the force*

*accept any clearly correct conclusion*

**1**

(ii) 12000 (N)

**or**

12 k(N)

**1**

(b) (i) the current (in the coil) creates a magnetic field (around the coil)

*accept the coil is an electromagnet*

**1**

so the magnetic field of the coil interacts with the (permanent) magnetic field of the magnets (producing a force)

*accept the two magnetic fields interact (producing a force)*

*if no marks scored an answer in terms of current is perpendicular to the (permanent) magnetic field is worth max **1** mark*

**1**

(ii) vertically downwards arrow on side A

*one arrow insufficient*

**and**

vertically upwards arrow on side C

**1**

(iii) the current is parallel to the magnetic field

*allow the current and magnetic field are in the same direction*

*allow it / the wire is parallel to the magnetic field*

**1**

(c) increase the current / p.d. (of the coil)

*accept decrease resistance*

*accept voltage for p.d.*

*accept increase strength of magnetic field / electromagnet*

**1**

(d) yes with suitable reason

**or**

no with suitable reason

***eg***

***yes** – it has increased our knowledge*

***yes** – It has led to more (rapid) developments / discoveries (in technology / materials / transport) accept specific examples*

***no** – the money would have been better spent elsewhere on such things as hospitals (must quote where, other things not enough)*

***no** mark for just **yes** / **no***

*reason must match **yes** / **no***

**1**

**[10]**

**11** (a) motor (effect)

**1**

(b) (i) wire kicks further (forward)

*accept moves for kicks*

*accept moves more*

*accept 'force (on the wire) increased'*

**1**

(ii) wire kicks back(wards) / into (the space in) the (horseshoe) magnet

*accept moves for kicks*

*accept 'direction of force reversed'*

**1**

**[3]**

**12** (i) away from magnet

*arrow should be perpendicular to field lines and current as judged by eye*

**1**

(ii) current in wire creates magnetic field around wire

**1**

two fields interact **or** combine giving a resultant force (on the wire)

**1**

**[3]**