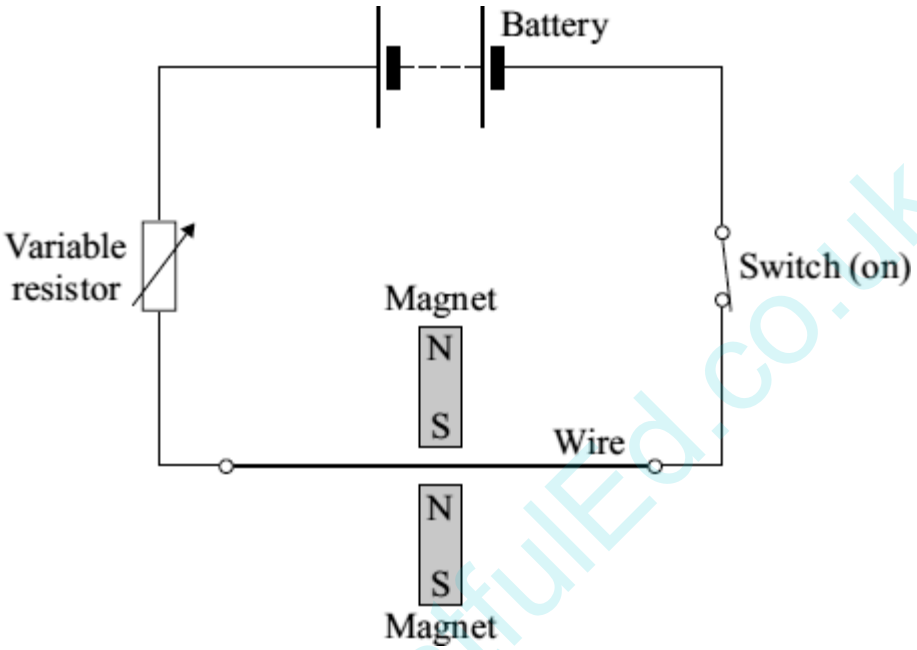
Q1.

A student investigates the electromagnetic force acting on a wire which carries an electric current. The wire is in a magnetic field.

The diagram shows the circuit which the student uses.

(a) Draw an **X** on the diagram, with the centre of the **X** in the most strongest part of the magnetic field.



(1)

(b) Give **one** change that she can make to the magnets to **decrease** the electromagnetic force on the wire.

_____

_____

(1)

(c) The student wants to change the electromagnetic force on the wire without changing the magnets or moving their position.

(i) Give **one** way in which she can **increase** the electromagnetic force.

_____

_____

(1)

(ii) Give **one** way in which she can **reverse** the direction of the electromagnetic force.

_____

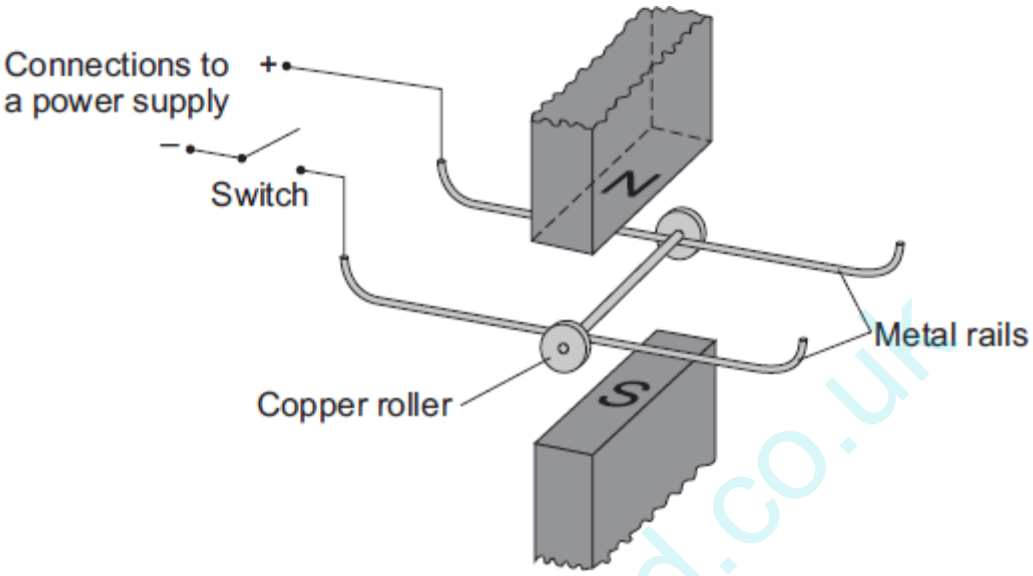
_____

(1)

(Total 4 marks)

Q2.

(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?

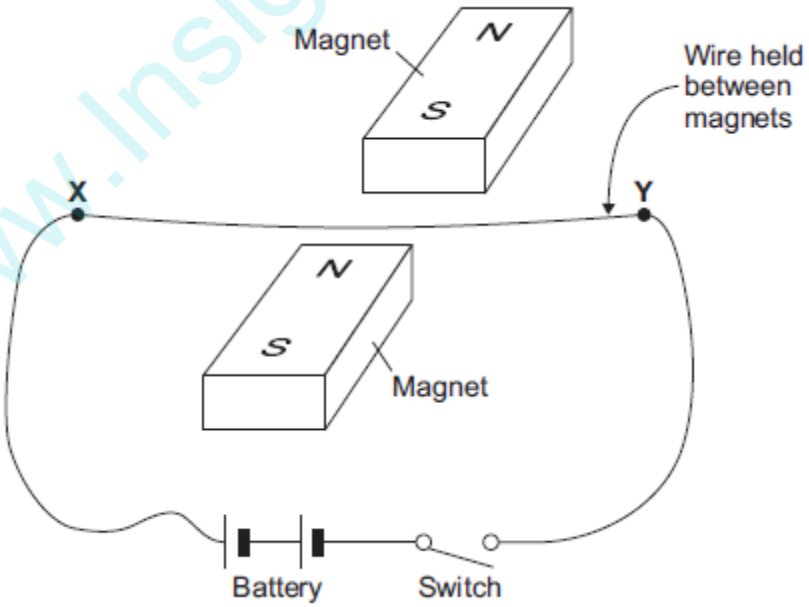
_____

(1)

(Total 6 marks)

Q3.

The diagram shows apparatus set up by a student.



Closing the switch creates a force that acts on the wire **XY**.

(a) (i) Explain why a force acts on the wire **XY** when the switch is closed.

_____

_____

_____

_____

_____

_____

(3)

(ii) The force causes the wire **XY** to move.
Draw an arrow on the diagram above to show the direction in which the wire **XY** will move.

(1)

(iii) State the effect that this experiment demonstrates.

_____

(1)

(b) The student replaced the battery with a low frequency alternating current (a.c.) power supply.

The student closed the switch.

(i) Describe the movement of the wire.

_____

(1)

(ii) Give a reason for your answer to part (i).

_____

_____

_____

(1)

(Total 7 marks)

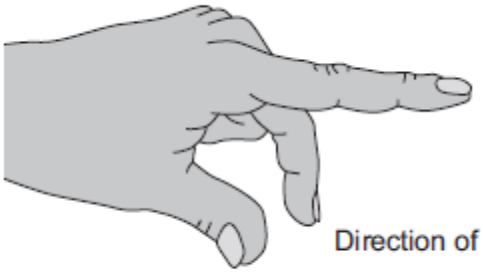
Q4.

The left-hand rule can be used to identify the direction of the force acting on a current-carrying conductor in a magnetic field.

(a) Use words from the box to label **Figure 1**.

current	**field**	**force**	**potential difference**

Figure 1



Direction of _____

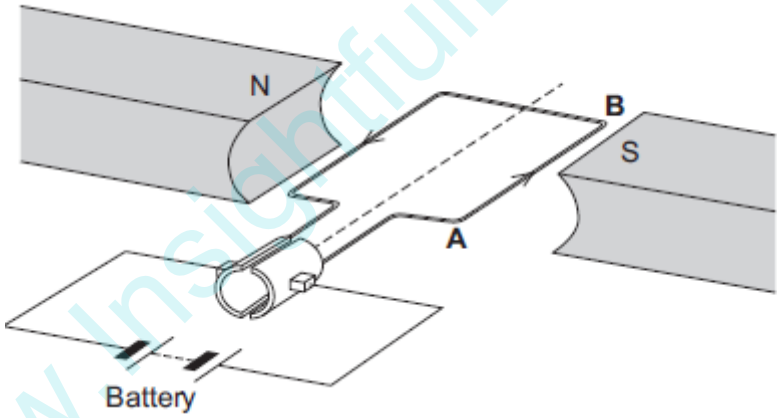
Direction of _____

Direction of _____

(3)

(b) **Figure 2** shows an electric motor.

Figure 2



(i) Draw an arrow on **Figure 2** to show the direction of the force acting on the wire **AB**.

(1)

(ii) Suggest **two** changes that would increase the force acting on the wire **AB**.

1. _____

2. _____

(2)

(iii) Suggest **two** changes that would reverse the direction of the force acting on the wire **AB**.

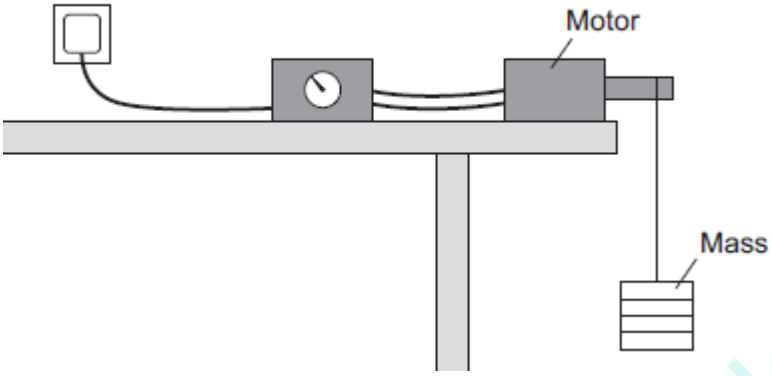
1. _____

2. _____

(2)

(c) A student used an electric motor to lift a mass. This is shown in **Figure 3**.

Figure 3



The student varied the electrical input power to the motor. For each different electrical input power, he recorded the time taken to lift the mass and calculated the output power of the motor.

The results are shown in the table.

Test	Electrical input power in watts	Work done lifting the mass in joules	Time taken to lift the mass in seconds	Output power in watts
A	20	24	2.4	10
B	40	24	1.2	20
C	60	24	0.8	30
D	80	24	0.2	120

The result for **Test D** is anomalous.

(i) Calculate the efficiency of the motor in **Test D**.

_____

_____

Efficiency = _____

(2)

(ii) Comment on your answer to part (c)(i).

_____

_____

(1)

(iii) Suggest a reason for this anomalous result.

_____

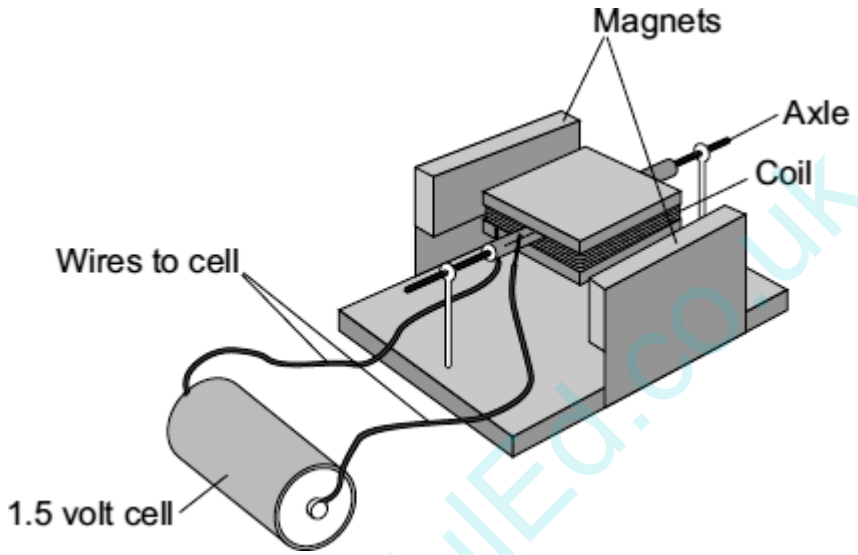
_____

(1)

(Total 12 marks)

Q5.

(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. _____

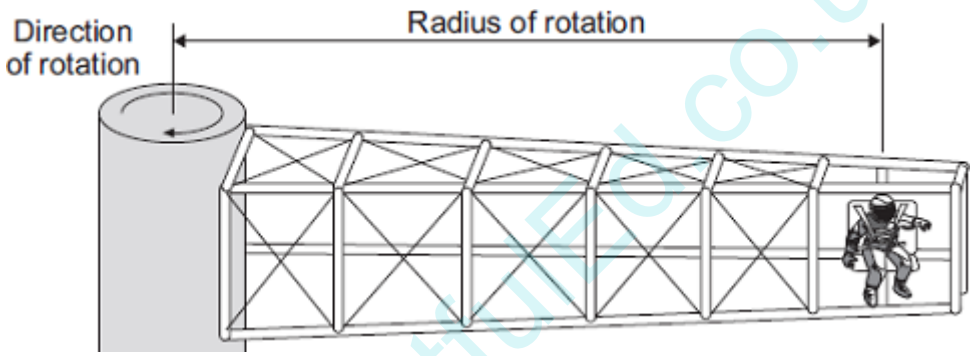
_____

(2)

(Total 6 marks)

Q6.

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

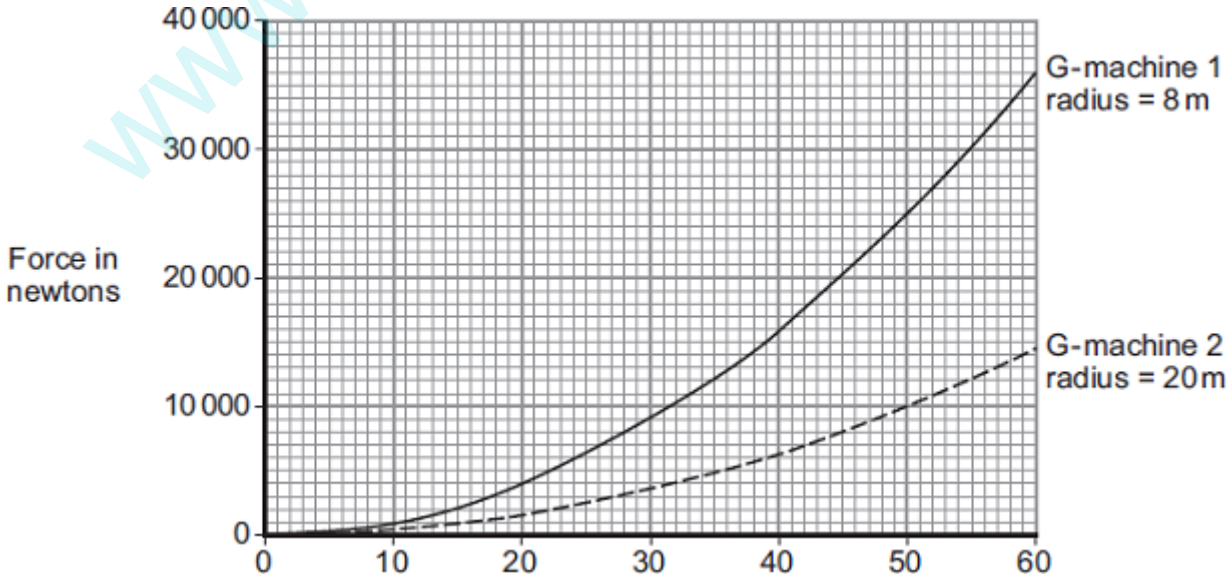


The G-machine moves the astronaut in a horizontal circle.

(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.



Speed in metres per second

(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.

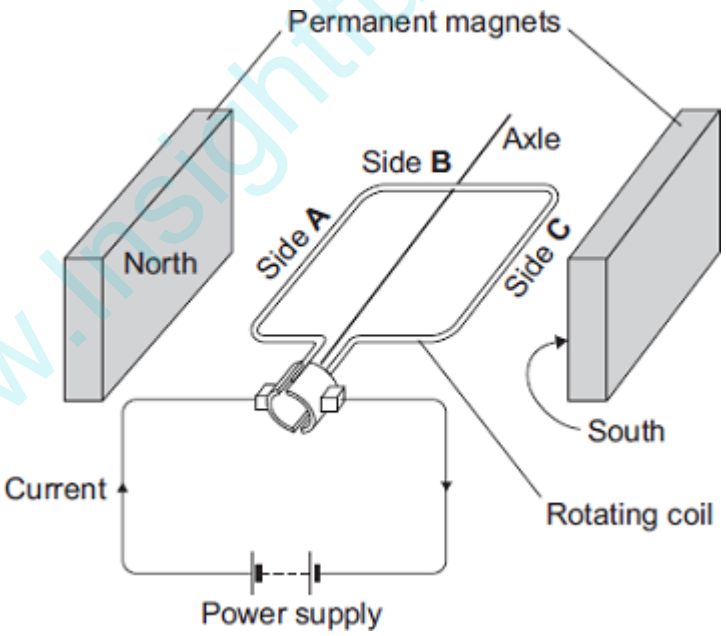
Determine the change in force on the astronaut.

_____

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.

_____

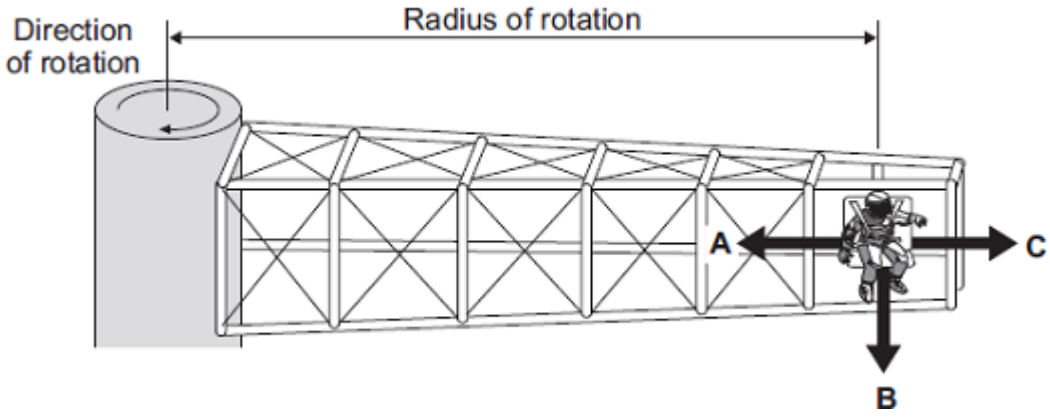
_____

(1)

(Total 10 marks)

Q7.

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

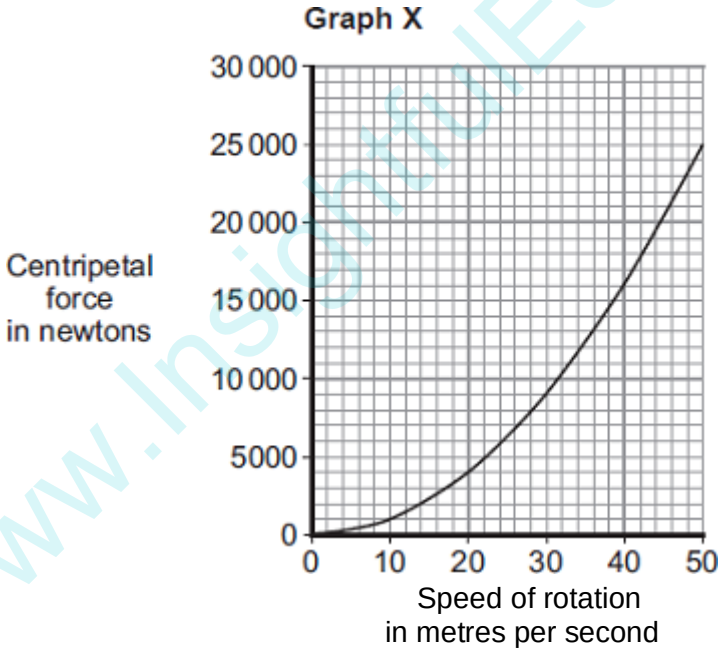


The G-machine moves the astronaut in a horizontal circle.

Force A is known as the **centripetal** force acting on the astronaut

(a) The centripetal force on the astronaut is measured.

Graph X shows how the centripetal force is affected by the speed of rotation. The radius of rotation is kept the same.



(i) Use **Graph X** to determine the centripetal force on the astronaut when rotating at a speed of 30 metres per second.

Centripetal force = _____ newtons

(1)

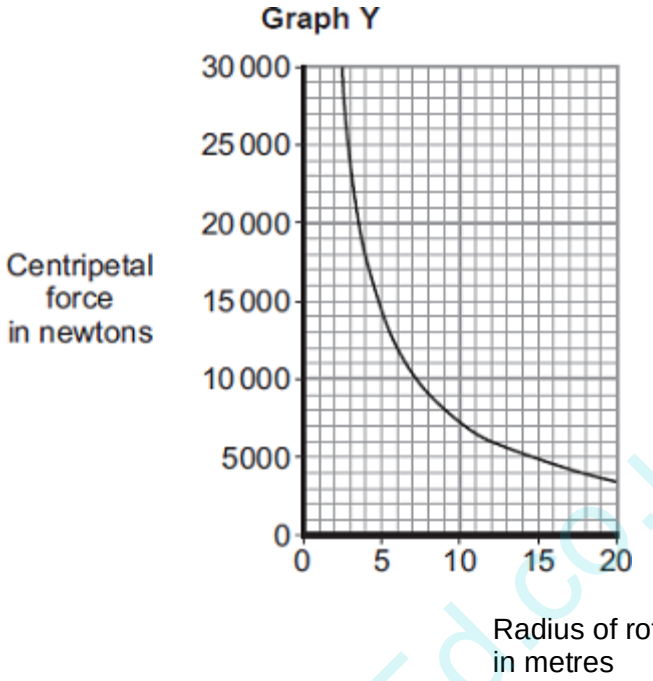
(ii) Complete the following sentence to give the conclusion that can be made from **Graph X**.

Increasing the speed of rotation of a G-machine will _____

the centripetal force on the astronaut.

(1)

(iii) **Graph Y** shows how the centripetal force is affected by the radius of rotation, when the speed of rotation is kept the same.



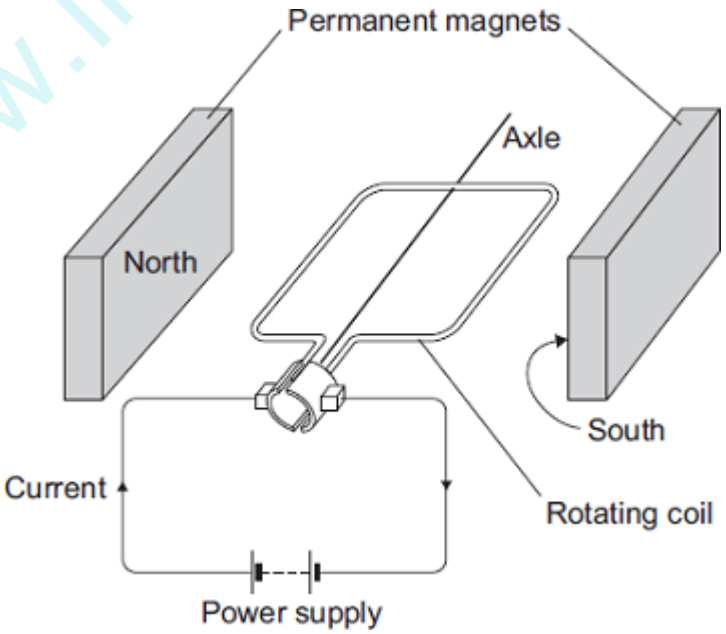
Complete the following sentence to give the conclusion that can be made from **Graph Y**.

The greater the radius of rotation, the _____ the

centripetal force on the astronaut.

(1)

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



The following statements explain how the motor creates a turning force. The

statements are in the wrong order.

M – The magnetic field interacts with the magnetic field of the permanent magnets.

N – A magnetic field is created around the coil.

O – The power supply applies a potential difference across the coil.

P – This creates a force that makes the coil spin.

Q – A current flows through the coil.

Arrange the statements in the correct order. Two of them have been done for you.

(2)

(c) The electric motor produces a turning force.

Give **two** ways of increasing the turning force.

1. _____

_____

2. _____

_____

(2)

(d) Draw a ring around the correct answer to complete the sentence.

It costs a lot of money to send astronauts into space.

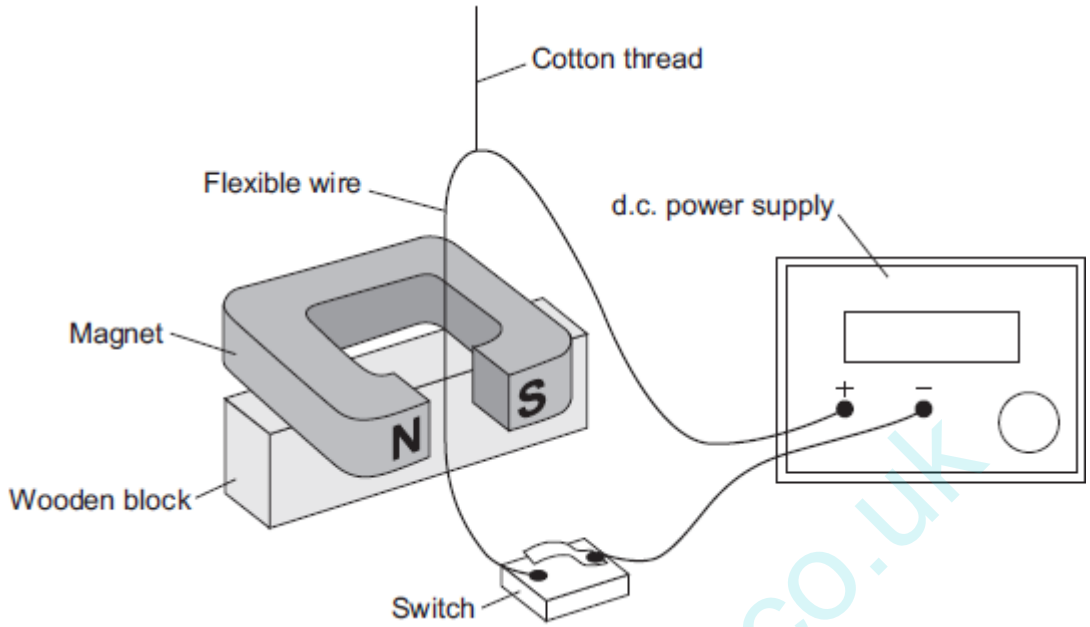
This is [an economic / an environmental / a social] issue.

(1)

(Total 8 marks)

Q8.

The diagram shows a demonstration carried out by a teacher.



When the switch is closed, there is a current of 2 A through the wire. The wire experiences a force and moves.

(a) Use the correct word from the box to complete the sentence.

generator	**motor**	**transformer**

The demonstration shows the _____ effect.

(1)

(b) State **two** changes that the teacher could make to the demonstration, each of which would increase the force on the wire. The teacher does not touch the wire.

1. _____

_____

2. _____

_____

(2)

(c) State **one** change that the teacher could make to the demonstration to change the direction of the force on the wire.

_____

_____

(1)

(d) With the switch closed, the teacher changes the position of the wire so that the force on the wire is zero.

What is the position of the wire?

Tick (✓) **one** box.

The wire is at 90° to the direction of the magnetic field. ☐

The wire is at 45° to the direction of the magnetic field. ☐

The wire is parallel to the direction of the magnetic field. ☐

(1)

(Total 5 marks)

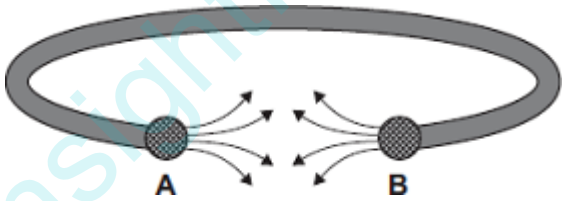
Q9.

(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



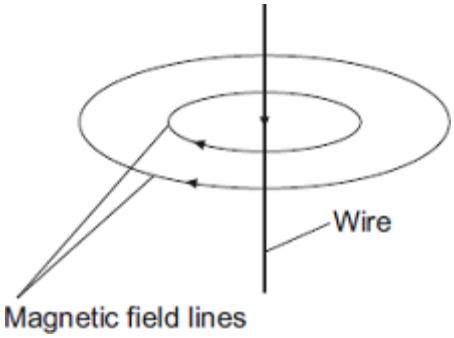
What is the pole at **A**? _____

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?

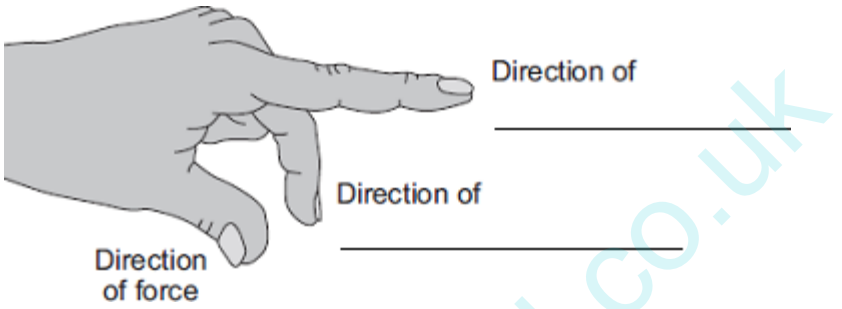
_____

(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

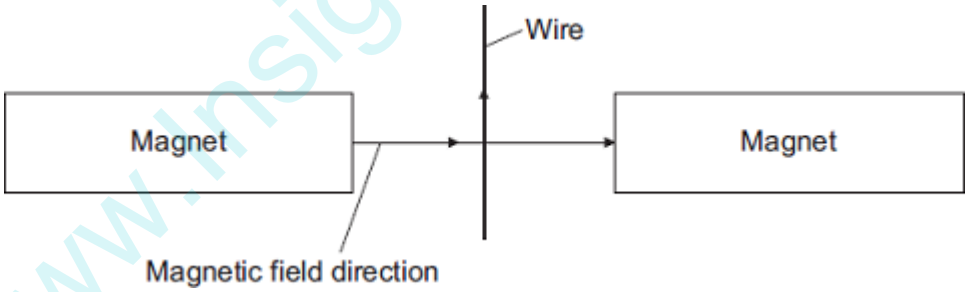


(2)

(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. _____

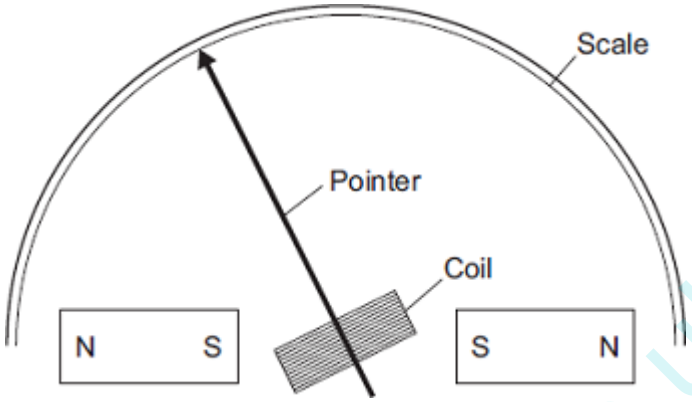
3. _____

(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?

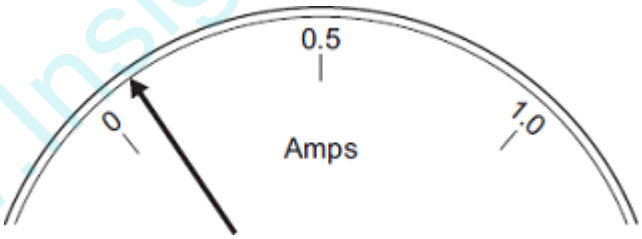
_____

_____

(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)

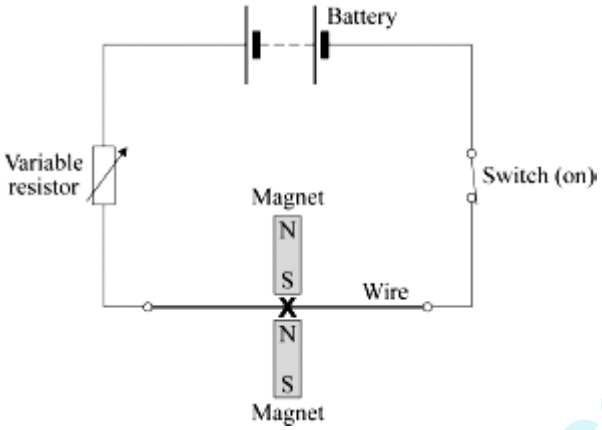
(Total 10 marks)

Q1.

(a) centre of the **X** midway between the poles

intention correct as judged by eye

example



1

(b) move the poles further apart

accept turn for move

accept ends / magnets for poles

accept use weaker magnets

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

1

(c) (i) add more cells (to the battery)

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

accept increase the potential difference / voltage

accept increase the current

or

reduce the resistance (of the variable resistor)

*do **not** accept any changes to the magnets, to the wire or to their relative positions*

1

(ii) reverse (the polarity of) the battery

accept turn the battery / cells round

accept swap the connections to the battery

*do **not** accept any changes to the magnets, to the wire or to their relative positions*

1

[4]

Q2.

(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]

Q3.

(a) (i) (closing the switch makes) a current (through the wire)

1

(the current flowing) creates a magnetic field (around the wire)

1

this field interacts with the permanent magnetic field

accept links / crosses attracts / repels is insufficient

1

(ii) arrow drawn showing upwards force on XY

judge vertical by eye the arrow must be on or close to the wire XY

1

(iii) motor

accept catapult

1

(b) (i) the wire moves up and down

or

the wire vibrates

back and forth or side to side is insufficient for vibrate

1

(ii) the force (continually) changes direction (from upwards to downwards, on the wire)

accept the direction of the magnetic field (of the wire) changes

1

[7]

Q4.

(a) field

correct order only

1

current

1

force

accept motion

accept thrust

1

(b) (i) arrow pointing vertically downwards

1

(ii) increase current / p.d.

accept voltage for p.d.

1

increase strength of magnetic field

accept move poles closer together

1

(iii) reverse (poles of) magnets

1

reverse battery / current

1

(c) (i) 1.5 or 150%

efficiency = 120 / 80 (× 100)

*gains **1** mark*

an answer of 1.5 % or 150

*gains **1** mark*

2

(ii) efficiency greater than 100%

or

output is greater than input

or

output should be 40 (W)

1

(iii) recorded time much shorter than actual time

accept timer started too late

accept timer stopped too soon

1

[12]

Q5.

(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]

Q6.

(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]

Q7.

(a) (i) 9000

*an answer of 9 k(N) gains **1** mark*

1

(ii) increase

accept other comparative terms, eg give a bigger

affect / change is insufficient

1

(iii) smaller

accept other comparative terms, eg less

1

(b) Q N M

all three in correct boxes

*one statement in correct box gains **1** mark*

2

(c) any **two** from:

- increase the current / p.d. (supplied to the coil)

  *accept reduce the resistance of the coil **or** increase cross sectional area of wire*

  *accept more cells / batteries **or** turn up the power supply*

  increase power is insufficient

- increase number of turns (on the coil)

- increase the area (of the coil)

  accept increase the width of the coil

  increase width / size is insufficient

- increase the (strength of the permanent) magnetic field

  accept move the magnets closer to the coil

  accept use stronger magnets

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

2

(d) an economic

1

[8]

Q8.

(a) motor

1

(b) increase the strength of the magnetic field

accept use a stronger magnet

use a larger / bigger magnet is insufficient

*do **not** accept move magnets closer*

1

increase the (size of the) current

accept use a current greater than 2 (A)

accept increase the p.d. / voltage (of the power supply)

increase the power supply is insufficient

1

(c) any **one** from:

- (reverse the) direction of the current

  accept swap the wires at the power supply connections

  swap the wires around is insufficient

- (change the) direction of the magnetic field

  accept turn the magnet around

  *do **not** accept use an a.c. supply*

1

(d) The wire is parallel to the direction of the magnetic field.

1

[5]

Q9.

(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]