Candidate Marks Report

Series : 6 2018

This candidate's script has been assessed using On-Screen Marking. The marks are therefore not shown on the script itself, but are summarised in the table below.

Centre No :		Assessment Code :	J259
Candidate No :		Component Code :	03
Candidate Name :			

Total Marks :

In the table below ‘Total Mark’ records the mark scored by this candidate.
‘Max Mark’ records the Maximum Mark available for the question.

Answer **all** the questions.

1 Nina is writing a report about the Solar System.

She has written an introduction.

> The planets in our Solar System all move around the Sun.
> They orbit in perfect circles and in the same direction.
> Each planet has at least one moon orbiting it.
> The planets and their moons are all made of rock.

(a) Identify **two** mistakes in Nina's introduction.

1 The planets are not all made of rock

2 Not all planets have a moon orbiting it

[2]

(b) Nina wants to include a section about how the Solar System was formed.

Describe how the Solar System was formed.

Clouds of dust collapsed under pressure to form the features of the solar system, such as stars.

[2]

(c) Nina researches how the Sun releases energy. She finds this information in a textbook.

> The Sun releases energy by nuclear fusion. The Sun emits about 4×10^{26} J of energy every second. As a result, its mass falls by about 4 billion kilograms every second.

Explain why nuclear fusion causes the mass of the Sun to decrease.

~~Particles are ejected from the sun~~ Hydrogen atoms fuse to form helium, which is then fired away from the sun. **[1]**

2 A toothbrush uses a rechargeable battery.

(a) The energy that is stored in the battery comes from a power station.

State how the energy is transferred from the power station to the chemical store in the battery.

Electrically transferred (via the National Grid)

..... **[1]**

(b) The potential difference across the battery is 1.2 V.

During a typical use, 360 C of charge moves through the toothbrush motor over a time of 2 minutes.

(i) Calculate the total energy transferred by the toothbrush in one day if it is used **two** times a day.

Charge = Energy transferred = Charge × potential difference

360 × 1.2 = 432

432 × 2 = 864

Energy transferred = 864 J **[3]**

(ii) Calculate the current in the toothbrush when used for 2 minutes each time.

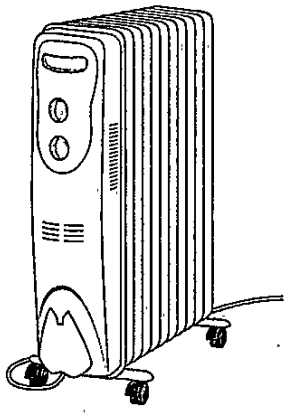
Charge = Current × time 2 mins = 120 secs

360 = C × 120

$\frac{360}{120} = c = 3$

Current = 3 A **[4]**

3 The diagram shows a common type of electric heater. It contains oil which is heated by an electrical element.



The table shows some information about the heater.

Electrical power	1500 W
Voltage rating	230 V
Specific heat capacity of oil	1600 J/kg °C
Mass of oil	4.5 kg

(a) Show that more than 700 000 J of energy is needed to heat the oil from 20 °C to 120 °C.

Use the equation:
change in internal energy = mass × specific heat capacity × change in temperature

4.5 × 1600 × 100 = 7200005

7200005 > 7000005

[2]

(b) (i) Use your answer to (a) to calculate the minimum time for the oil to reach a temperature of 120 °C, starting at 20 °C.

Energy transfered = power x time

~~700000 = 1500W x time~~

~~700000 / 1500 = 466.6 s~~

720000 = 1500 x time

720000 / 1500 = 480

Minimum time = 466.6 480 s [3]

(ii) In practice, it will take longer than this for the heater to reach 120 °C.

State the reason for this.

The temperature does not increase at a constant rate.

..... [1]

4 (a) The maximum speed of a racing car is 320 km/hour.

Calculate this speed in metres per second.

320000 m / hour
88.8 m/s

Maximum speed = 88.8 m/s [2]

(b) (i) A different racing car is moving with a speed of 80 m/s.

Before turning a corner, it slows down to a speed of 20 m/s.

While slowing down, it has a constant acceleration of $-40\ m/s^2$.

Calculate the distance that it travels as it slows down.

(final speed)^2 − (initial speed)^2 = 2 × acceleration × distance

$20^2 - 80^2 = 2 \times -40 \times D$

$-6000 = -80 \times D$

$\frac{-6000}{-80} = D = 75$

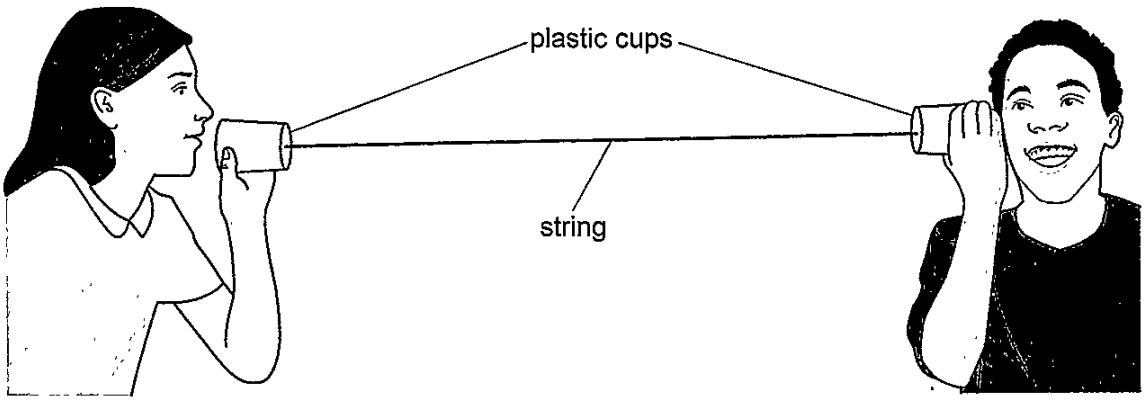
Distance travelled = 75 m [3]

(ii) The car moves at a constant speed around the corner.

Explain why its velocity is changing as it moves around the corner.

Velocity is a vector quantity, and gives the magnitude of the speed as well as the direction of movement. The car is changing direction so the velocity changes. [2]

5 Eve and Amir make a toy telephone out of plastic cups and string.



Sound waves in the air change when they become sound waves in the string.

(a) How do the **speed**, **frequency** and **wavelength** of the sound waves change when they leave the air and enter the string?

Put one tick (✓) in each row. One has been done for you.

	Increase	Decrease	Stay the same
Speed	✓		
Frequency			✓
Wavelength	✓		

[2]

(b) The speed of sound in the string is 600 m/s.

Calculate the frequency of a sound with wavelength 1.2 m in the string.

Speed = frequency x wavelength

$600 = f \times 1.2$

$\frac{600}{1.2} = 500$

Frequency = 500 Hz **[3]**

6 James and Mia investigate their hearing.

James uses an app on his phone to make sounds with different frequencies.

For each frequency, he starts with the volume on his phone set at zero.

Then he turns the volume up step by step until Mia can just hear the sound.

The results show the volume setting needed before Mia can hear the noise for each frequency.

Frequency (Hz)	Volume setting
55	13
110	11
220	7
440	1
880	1
1760	1

(a) Explain why Mia finds it easier to hear some of these frequencies.

The ear can detect frequencies between 1 and 3.6Hz the best. The ossicles transmit these sand waves better ~~more effectively~~ [2]

(b) They repeat the experiment.

This time there is a wall between the phone and Mia. They want to see what effect the wall has on the results.

(i) Suggest **one** variable that should be controlled to make this new experiment a fair comparison with the first experiment.

The distance between James and Mia. [1]

(ii) The volume setting needed for each frequency is higher in the new experiment.

Describe how the sound waves reach Mia and why they sound more faint.

The sand waves reach Mia by particles passing on vibrations in a series of compressions and rarefactions. The wave speed slows down when it reaches a boundary such as a wall. [2]

(c) Mia reads on the internet that the human ear is most sensitive at a frequency about 2000 Hz.

Describe how James and Mia could improve their experiment to test this hypothesis.

They could increase the frequencies they are testing by 200Hz each time, from a range of 600Hz to 3600Hz. They should also ~~decrease~~ increase the distance between the two so that the volume setting has to be higher for her to detect high frequencies.

[3]

7 Ali investigates electromagnetic induction.

He pushes a magnet quickly into a coil of wire. He uses an ammeter to record the biggest current produced in the coil.

He repeats the experiment for coils with different numbers of turns.

Table 7.1 shows his results.

Number of turns	Current (mA)
200	1.1
400	3.0
600	5.4
800	6.7
1000	9.1
1200	11.0

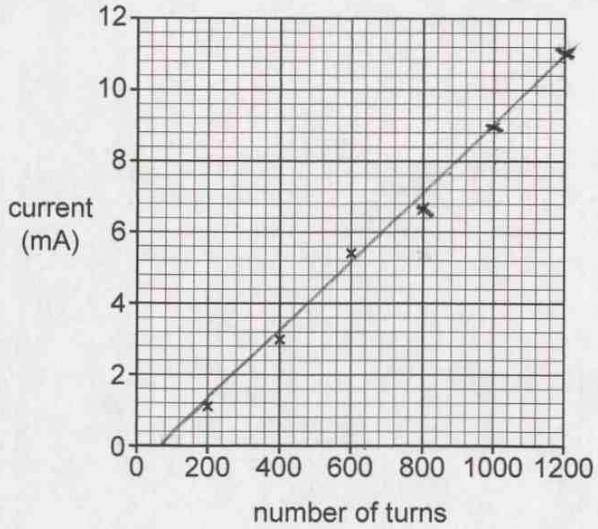
Table 7.1

(a) Explain why a current is produced in the coil.

When a magnet is pushed into a coil of wire, a voltage is induced, which in turn produces a current.

..... **[2]**

(b) **(i)** Complete the graph by plotting the missing results in **Table 7.1** and draw a line of best fit.



[2]

(ii) Use your line of best fit to determine the maximum current that Ali could produce if he used a coil with **700 turns**.

Maximum current = ...6.... mA **[1]**

(iii) Amaya says that this experiment is not valid because the speed of the magnet may be different each time.

Suggest how Ali could control the speed of the magnet.

.....

..... **[1]**

(c) As Ali pushes the magnet towards the coil, he feels a small repulsive force.

Explain why.

The coil g wire has ~~been~~ produced an ~~electric~~ magnetic field.

When two like poles g a magnet near each other, they repel

.....

..... **[2]**

8 **Table 8.1** shows data for four radioactive isotopes.

Isotope	Half life	Type of decay
molybdenum-98	stable	
molybdenum-99	66 hours	beta
technetium-99m	6 hours	gamma
thallium-201	73 hours	gamma

Table 8.1

Technetium-99m is used in hospitals.

Technetium-99m is produced when molybdenum-99 emits beta radiation.

One method of producing molybdenum-99 is by firing neutrons at molybdenum-98.

(a) Complete these nuclear equations to show the production of technetium-99m.

$$^{98}_{42}\text{Mo} + {}^{1}_{0}\text{n} \rightarrow {}^{99}_{42}\text{Mo}$$

$$^{99}_{42}\text{Mo} \rightarrow {}^{99}_{43}\text{Tc} + {}^{0}_{-1}\text{e}$$

[2]

(b) Molybdenum-99 is produced in nuclear reactors and then transported to hospitals. It may take several days for the molybdenum-99 to be transported.

In the hospital molybdenum-99 decays and the technetium-99m is produced as shown in part **(a)**.

Using information from **Table 8.1**, explain why technetium-99m is not transported directly to hospitals.

Technetium-99m has a half life of 6 hours, so the ~~ra~~ activity would have ~~halfed~~ decreased during transportation.

..... **[2]**

(c) Production of technetium-99m is becoming more expensive. An alternative for many medical procedures is thallium-201.

A patient is injected with a compound containing thallium-201. After 24 hours, 80% of the thallium-201 has not decayed.

A second patient is injected with a compound containing technetium-99m.

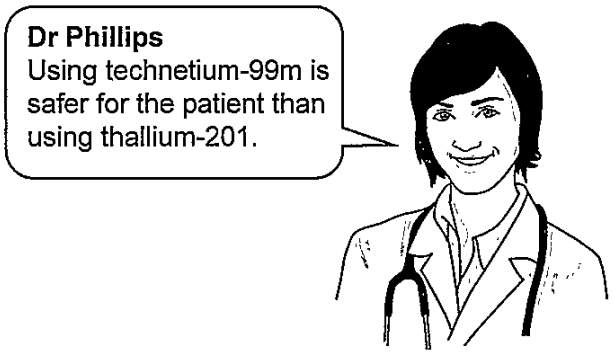
(i) Calculate the percentage of technetium-99m remaining after 24 hours.

24 ÷ 6 = 4

((((100 ÷ 2) ÷ 2) ÷ 2) ÷ 2)

Percentage remaining = 6.25 % **[2]**

(ii) A doctor is deciding which radioactive isotope is best to use.

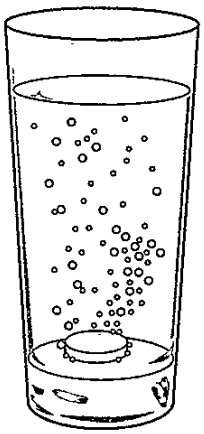


Evaluate this statement.

Use the data in **Table 8.1** and the information above in your answer.

Although both isotopes use gamma radiation, technetium-99m has a much shorter half life (6 hours compared to 73 hours) so takes less time for the activity to half. This quick reduction in radioactivity means cells are exposed to gamma radiation for less time. **[2]**

9 The picture shows a glass of water with a vitamin tablet at the bottom.



The tablet reacts with the water to produce bubbles of carbon dioxide.

The tablet stays at the bottom of the glass. The bubbles rise to the top of the glass.

(a) Which **two** of the statements below, taken together, explain why the bubbles rise but the tablet sinks?

Tick (✓) **two** boxes.

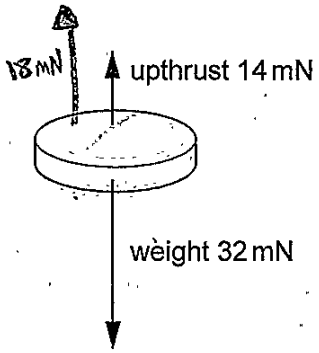
The bubbles are made of gas, but the tablet is solid.	☐
The material in the tablet is denser than water.	✓
The tablet is heavier than the bubbles.	☐
The water pressure at the bottom of the glass is greater than the water pressure at the top.	☐
Water is denser than the gas in the bubbles.	✓

[1]

(b) The diagram below is a free-body diagram for the tablet resting on the bottom of the glass.

Two of the forces acting on the tablet have already been drawn.

Draw **one** further force for the tablet and label it with its name and magnitude.



[2]

(c) **(i)** Explain what causes the force of upthrust that acts on the tablet.

Bubbles of air that are less dense than the water rise up

[2]

(ii) The upthrust on the tablet is bigger than the upthrust on any one bubble.

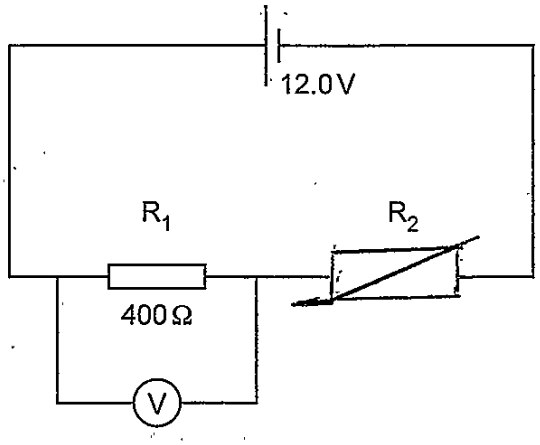
Give a reason for this.

The mass of the tablet is bigger than the mass of the bubbles

[1]

10 Alex wants to use a thermistor as a temperature sensor.

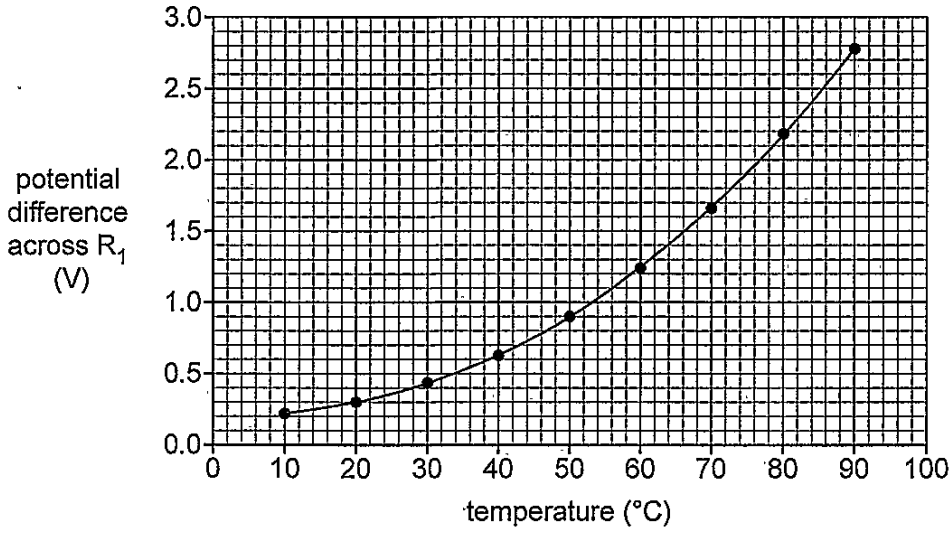
He sets up the circuit shown below.



(a) Draw the symbol for a thermistor in the space labelled R_2. **[1]**

(b) To investigate the sensitivity of the thermistor, Alex places it in a water bath with a temperature control.

He records the potential difference across R_1 for different temperatures set by the water bath. His results are shown in the graph.



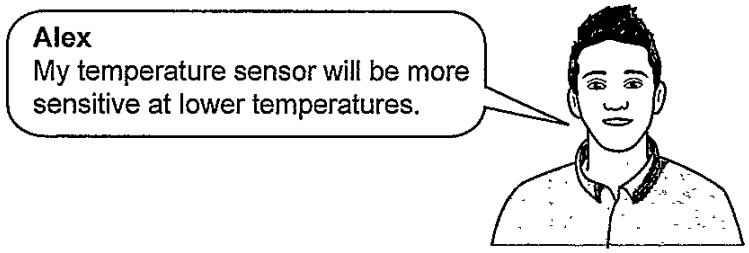
(i) Describe and explain the relationship shown in the graph.

As temperature increases, potential difference increases. This is because as temperature increases, the (thermistor's) resistance decreases. Voltage = current x resistance. Current stays the same, so if resistance increases, voltage must increase too.

[3]

(ii) Alex plans to use the sensor to monitor temperature in a greenhouse. To find the temperature, Alex will measure the potential difference across R_1.

He will then read the temperature off the graph.



Evaluate Alex's statement using evidence from the graph.

At lower temperatures, the change in potential difference is smaller, so the sensor will be more sensitive to any change. At higher temperatures, the change in potential difference is larger as it increases, meaning the sensor will be less sensitive to change and Alex is right. [2]

(c) Mr Orton, Alex's teacher, says that his temperature sensor will not work properly.

Mr Orton
Your temperature sensor will always be slightly hotter than the surroundings, so it will always give a measurement that is slightly too high.

(i) What is the name of this type of error?

Systematic error ..... **[1]**

(ii) Explain why Mr Orton is correct, and suggest how this problem could be reduced.

The resistance in the sensor causes it to heat up, making it hotter than the surroundings. Estimate the diference in temperature and take that away from the readings.

..... **[2]**

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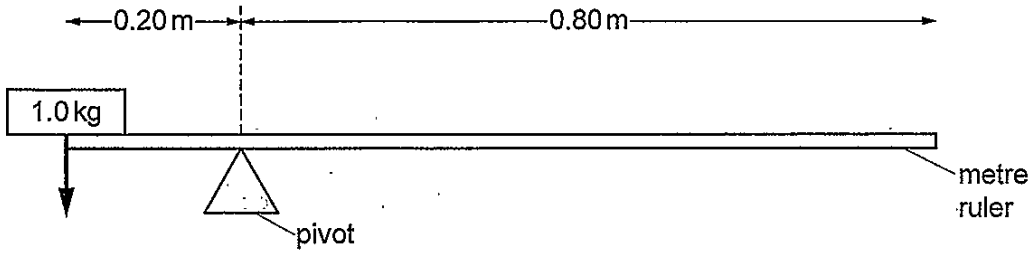
11 Jack investigates using weights to balance a seesaw. He makes the seesaw out of a metre ruler with a pivot placed at the 20 cm mark, as shown in the diagram.

He places a 1.0 kg mass with its centre exactly at one end of the metre ruler.



(a) Calculate the moment of the 1.0 kg mass about the pivot, in units of Nm.

Use the equation: moment of a force = force × distance (normal to the direction of the force)

gravitational field strength = 10 N/kg

$10 \times 1kg = 10kg\,N$

$10 \times 0.2 = 2$

Moment = ... 2 ..... Nm **[3]**

(b) Jack predicts where he should put masses on the right-hand side of the seesaw to make it balance.

He then carefully places those masses at points which make the seesaw balance and measures the actual distances to the pivot.

The table shows his results.

Mass (g)	Predicted distance to pivot (m)	Measured distance to pivot (m)
400	0.50	0.46
600	0.33	0.31
800	0.25	0.23
1000	0.20	0.19

(i) The measured distances to the pivot are all slightly smaller than the predicted distances to the pivot.

Explain why.

The pivot isn't in the centre, so the weight of the metre ruler sticking out at the end will affect the distance needed. **[1]**

(ii) Suggest **one** way to improve his experiment to remove this difference.

Place the pivot in the centre of the bottom of the metre ruler. **[1]**

12 Trolley **A** of mass 5.0 kg moves at a constant speed of 1.6 m/s.

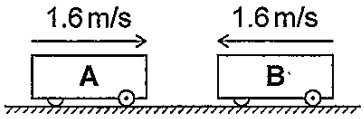
(a) Calculate the momentum of trolley **A**.

Momentum = Mass x velocity

5 x 1.6 = 8

Momentum = ...8..... kg m/s **[2]**

(b) Trolley **B** of mass 2.5 kg heads straight towards the first trolley in the opposite direction at the same speed of 1.6 m/s.



Trolley **A** of mass 5 kg

Trolley **B** of mass 2.5 kg

The two trolleys collide and stick together.

(i) Show that the velocity of the joined-up trolleys after the collision is about 0.5 m/s.

Momentum of Valley B = 2.5 x 1.6 = 4

8 - 4 = 4 kgm/s = Total momentum

5 + 2.5 = 7.5 kg = Total Mass

$\frac{4}{7.5}$ = 0.53 m/s = Velocity

[4]

(ii) The collision takes a total time of 0.20 s.

Calculate the average force acting on trolley **A** during the collision.

Change in momentum = resultant force x time for which it acts

4 kgm/s 0.2 s

Resultant force = $\frac{4}{0.2}$ = 20 N

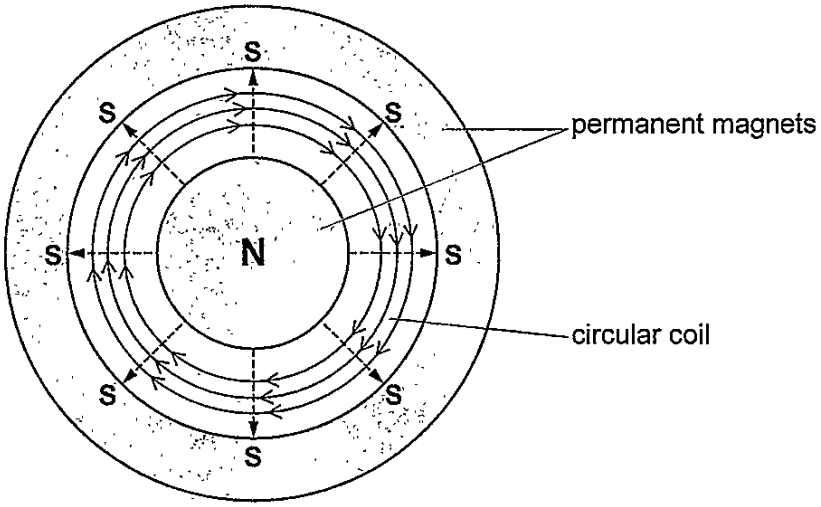
40 N

Force = mass x acceleration

Average force = ...20..... N **[4]**

13 The diagram shows part of a loudspeaker. It contains specially-shaped permanent magnets with south poles, **S**, in a ring around the outside and a circular north pole, **N**, in the centre.

In the gap between the shaped magnets there is a circular coil carrying electrical current.



The direction of the magnetic field between the poles is shown as ------►.

The magnetic field through the coil has strength 0.40 T.

The coil has circumference 25 mm and has 200 turns. The diagram shows only 3 turns of this coil.

A clockwise current of 0.60 A in the coil produces a force on the coil.

(a) What is the direction of the force on the coil?

Tick (✓) **one** box.

Anti-clockwise	☐
Clockwise	✓
Into the page	☐
Out of the page	☐

[1]

(b) Calculate the magnitude of the force acting on the coil.

Force = magnetic flux density x current x length of conductor

0.4 0.6 5000mm 5m

25 x 200 = 5000

or

$0.4 \times 0.6 \times 5 = \frac{6}{5} = 1.2$

Force = ... 1.2 ..... N **[4]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).