AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.1.1

Density of materials

Past-paper questions

Tier	**Higher**
Question groups	**11**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

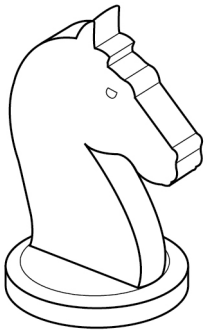
6.3.1.1 Density of materials

Question 01

June 2018 | 8464/P/1H | Original Q2

0 2 A student wanted to determine the density of the irregular shaped object shown in **Figure 3**

Figure 3



0 2 . 1 Plan an experiment that would allow the student to determine the density of the object.

[6 marks]

0 2 . 2 Another student did a similar experiment.

He determined the density of five common plastic materials.

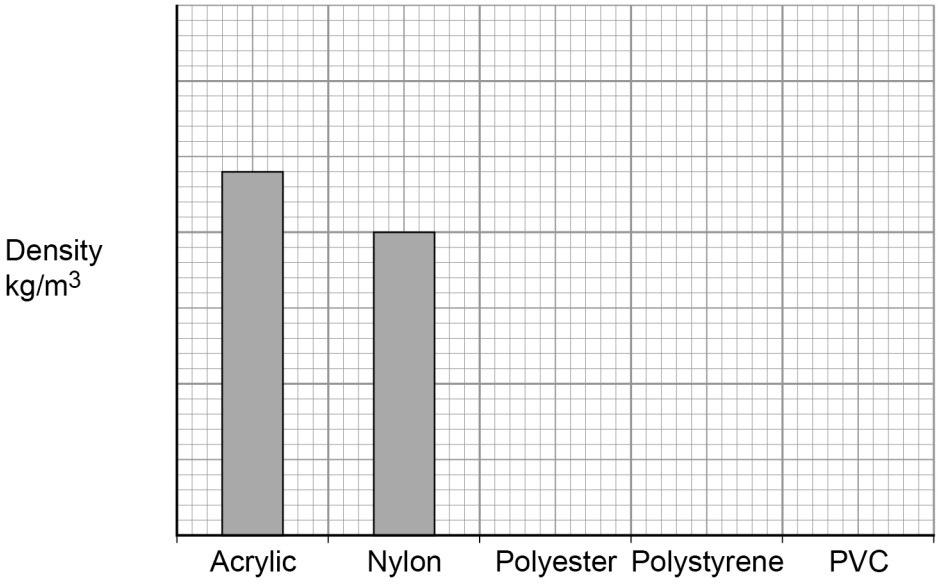
Table 1 shows the results.

Table 1

Plastic material	Density in kg/m^3
Acrylic	1200
Nylon	1000
Polyester	1380
Polystyrene	1040
PVC	1100

Figure 4 shows the results plotted in a bar chart.

Figure 4



Complete **Figure 4**

You should:

- Write the correct scale on the y-axis.
- Draw the bars for polyester, polystyrene and PVC.

[4 marks]

6.3.1.1 Density of materials

Question 01 · continued

0 2 . 3 The student is given a piece of a different plastic material.

The student determined the density of the material three times.

Table 2 shows the results.

Table 2

	Density in kg/m^3
1	960
2	1120
3	1040

Determine the uncertainty in the student's results.

[2 marks]

Uncertainty = _____ kg/m^3

12

6.3.1.1 Density of materials

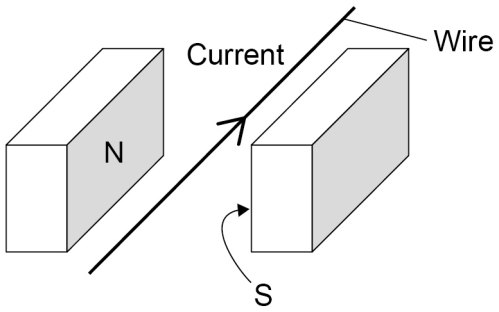
Question 02

June 2019 | 8464/P/2H | Original Q4

0 4 **Figure 6** shows a wire in a magnetic field.

The direction of the current in the wire is shown.

Figure 6

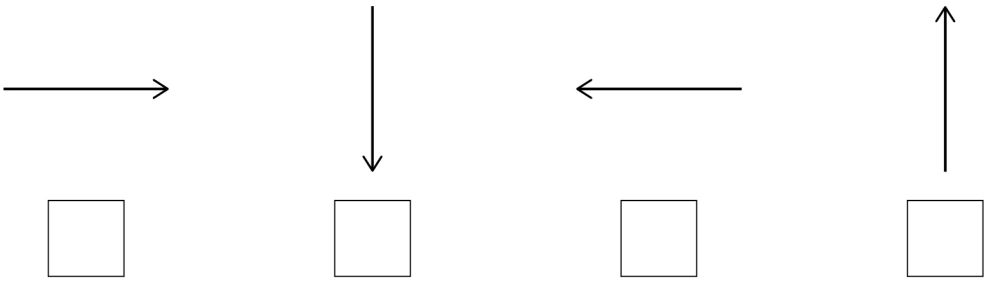


0 4 . 1 There is a force on the wire due to the current in the magnetic field.

In which direction is the force on the wire?

[1 mark]

Tick (✓) **one** box.



0 4 . 2 Give **two** ways that the direction of the force on the wire could be reversed.

[2 marks]

1 _____

2 _____

Question 4 continues on the next page

6.3.1.1 Density of materials

Question 02 · continued

0 4 . 3 The length of the wire in the magnetic field is 0.050 m

The force on the wire is 0.072 N

magnetic flux density = 360 mT

Calculate the current in the wire.

Use the Physics Equations Sheet.

[4 marks]

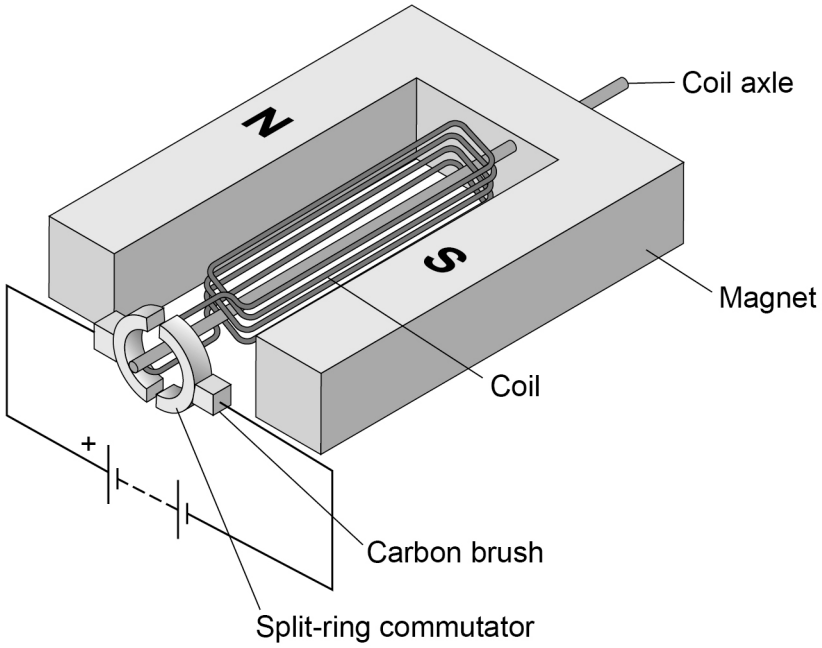
Current = _____ A

6.3.1.1 Density of materials

Question 02 · continued

0 4 . 4 **Figure 7** shows a simple motor.

Figure 7



Explain why the coil rotates when there is a current in the coil.

[4 marks]

11

6.3.1.1 Density of materials

Question 03

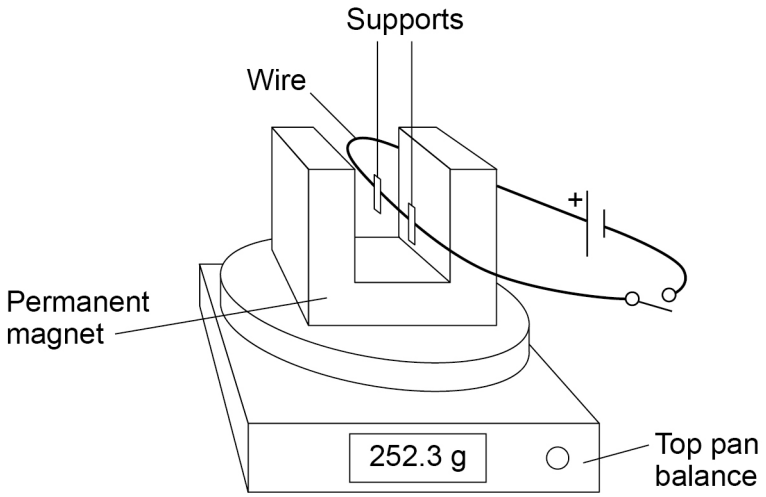
November 2020 | 8464/P/2H | Original Q7

0 7 A student clamped a wire between the poles of a permanent magnet.

The student investigated how the force on the wire varied with the current in the wire.

Figure 13 shows the equipment used.

Figure 13



The top pan balance was used to determine the force on the wire.

0 7 . 1 When the switch was closed the reading on the top pan balance increased.

Explain why the increased reading showed that there was an upward force on the wire.

[2 marks]

6.3.1.1 Density of materials

Question 03 · continued

0 7 . 2 **Table 3** shows the readings on the top pan balance with the switch open and with the switch closed.

Table 3

Switch	Mass in grams
Open	252.3
Closed	254.8

Explain how the values in **Table 3** can be used to determine the size of the force on the wire.

[2 marks]

Question 7 continues on the next page

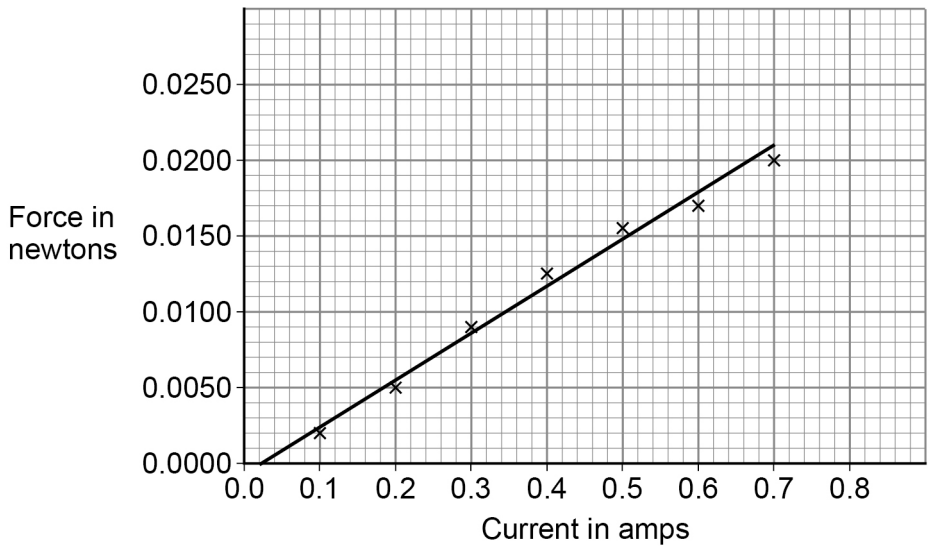
6.3.1.1 Density of materials

Question 03 · continued

0 7 . 3 The student varied the current in the wire and calculated the force acting on the wire.

Figure 14 shows the results.

Figure 14



The length of the wire in the magnetic field was 0.125 m

Determine the magnetic flux density.

[4 marks]

Magnetic flux density = _____ T

8

6.3.1.1 Density of materials

Question 04

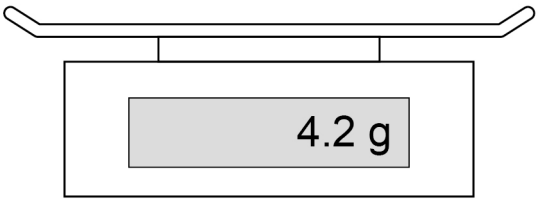
November 2021 | 8464/P/1H | Original Q4

0 4 A student determined the density of a cube made of bronze.

The student used a balance to measure the mass of the bronze cube.

Figure 5 shows the balance before the cube was added.

Figure 5



0 4 . 1 What type of error is shown on the balance?

[1 mark]

0 4 . 2 How could the student get a correct value for the mass of the cube from the balance?

[1 mark]

6.3.1.1 Density of materials

Question 04 · continued

0 4 . 3 The student measured the length of the bronze cube using Vernier callipers and then using a micrometer.

Table 1 shows the results.

Table 1

Equipment	Length in mm
Vernier callipers	20.1
Micrometer	20.14

Complete the sentence.

[1 mark]

The results in **Table 1** show that the Vernier callipers and the micrometer have a different _____ .

Question 4 continues on the next page

Question 04 · continued

The student wanted to determine the density of a bronze coin.

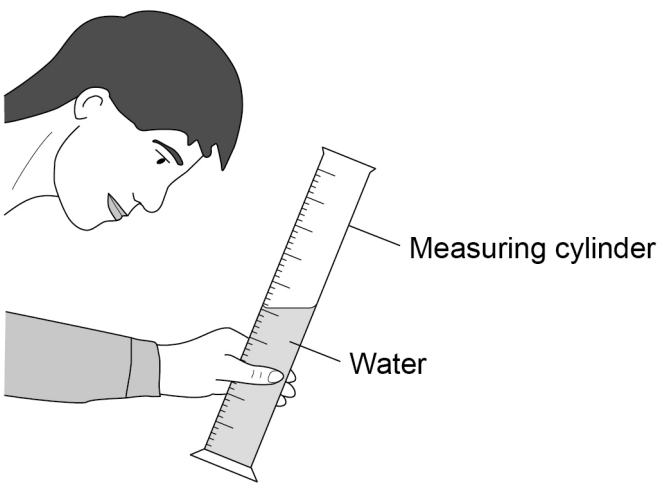
The student had several identical coins.

The volume of each coin was very small.

0 4 . 4 The student added water to a measuring cylinder.

Figure 6 shows the student reading the volume of water in the measuring cylinder.

Figure 6



Give **two** changes the student should make to increase the accuracy of the volume measurement.

[2 marks]

1 _____

_____

2 _____

_____

6.3.1.1 Density of materials

Question 04 · continued

0 4 . 5 Describe how the student could use a displacement method to determine an accurate value for the volume of a single coin.

[3 marks]

Question 4 continues on the next page

0 4 . 6 Old penny coins were made from a disc of bronze.

New penny coins are made from a disc of a different metal.

Figure 7 shows a disc of metal.

Figure 7

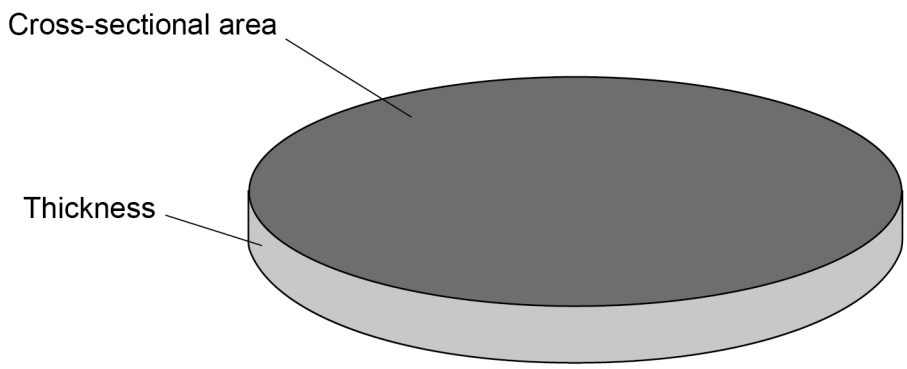


Table 2 shows information about the discs used to make each coin.

Table 2

Disc	Mass in g	Density in g/cm^3	Thickness in cm
Old penny	3.6	8.9	0.16
New penny	3.6	**X**	0.17

6.3.1.1 Density of materials

Question 04 · continued

The discs used to make the old and the new coins have the **same** cross-sectional area.

Calculate value **X** in **Table 2**.

Give your answer to 2 significant figures.

The volume of a disc can be calculated using the equation:

volume of a disc = cross-sectional area × thickness

[5 marks]

Density (2 significant figures) = _____ g/cm^3

13

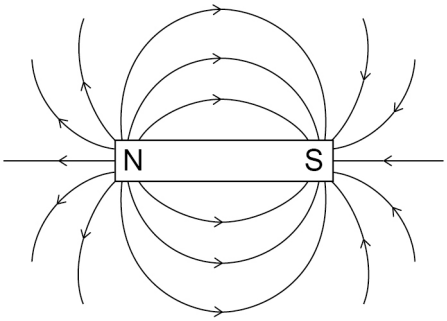
6.3.1.1 Density of materials

Question 05

November 2021 | 8464/P/2H | Original Q4

0 4 **Figure 4** shows the magnetic field pattern around a permanent magnet.

Figure 4



0 4 . 1 Where is the magnetic field of the magnet the strongest?

[1 mark]

0 4 . 2 How does **Figure 4** show that the strength of the magnetic field is not the same at all places?

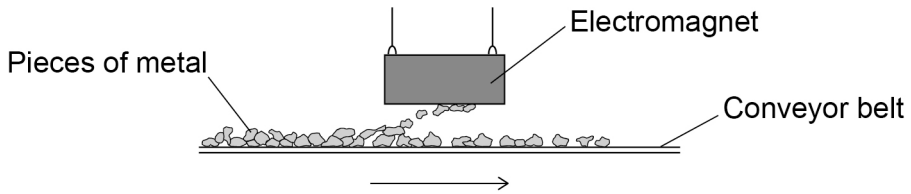
[1 mark]

6.3.1.1 Density of materials

Question 05 · continued

Figure 5 shows an electromagnet being used to separate iron and steel from non-magnetic metals.

Figure 5



0 4 . 3 Explain **one** reason why an electromagnet is used instead of a permanent magnet.

[2 marks]

0 4 . 4 Pieces of iron and steel are attracted to the electromagnet.

Name **two** other metals that would be attracted to the electromagnet.

[2 marks]

1 _____

2 _____

0 4 . 5 The design of the electromagnet **cannot** be changed.

Give **two** ways the force exerted by the electromagnet on a piece of iron or steel could be increased.

[2 marks]

1 _____

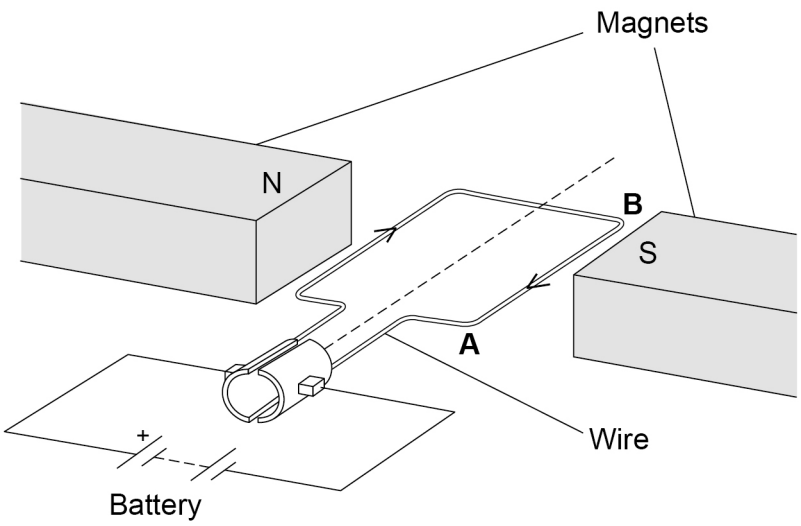
2 _____

Question 05 · continued

The conveyor belt that moves the pieces of metal is driven by an electric motor.

Figure 6 shows a simple electric motor.

Figure 6



6.3.1.1 Density of materials

Question 05 · continued

0 4 . 6 The length of the wire **AB** in the magnetic field is 120 mm.

There is a current of 4.0 A in the wire. The length of wire **AB** experiences a force of 0.36 N.

Calculate the magnetic flux density between the magnets.

Give the unit.

[5 marks]

Magnetic flux density = _____ Unit _____

Question 4 continues on the next page

6.3.1.1 Density of materials

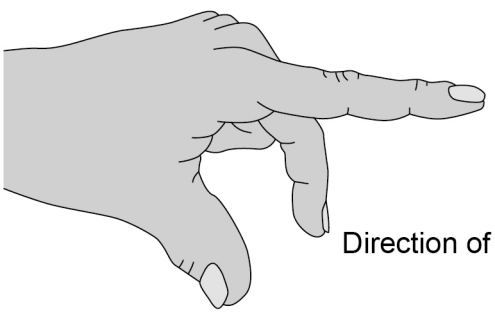
Question 05 · continued

0 4 . 7 Fleming's left-hand rule can be used to determine the direction of the force on wire **AB**.

Complete the labels on **Figure 7** to show Fleming's left-hand rule.

[2 marks]

Figure 7



15

6.3.1.1 Density of materials

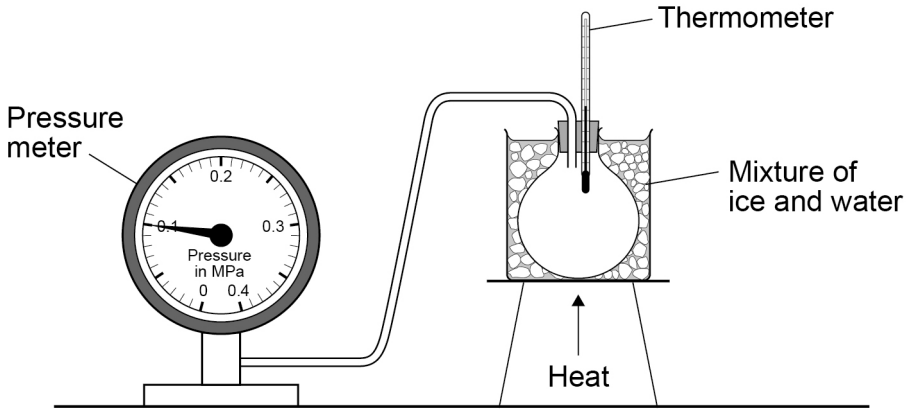
Question 06

0 4 A student investigated how the pressure of a gas depends on its temperature.

The volume of the gas did **not** change.

Figure 6 shows the equipment used.

Figure 6



0 4 . 1 Pressure is sometimes measured in units called atmospheres.

1 atmosphere is 10^5 pascals (Pa).

What is 1 atmosphere in kilopascals (kPa)?

[1 mark]

1 atmosphere = _____ kPa

0 4 . 2 The student took four pressure readings for each temperature.

Table 1 shows the pressure readings when the temperature was 50.0 °C

Table 1

Temperature in °C	Pressure in MPa			
	1	2	3	4
50.0	0.115	0.120	0.121	0.116

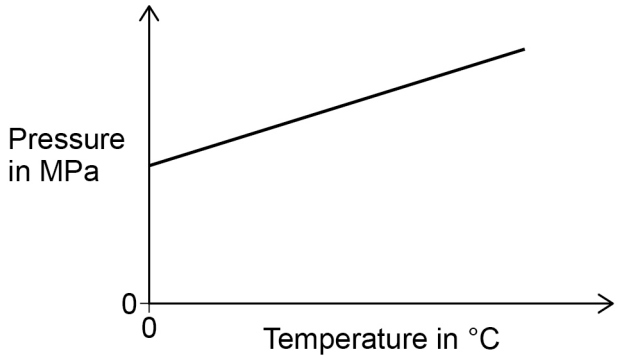
Calculate the uncertainty in the mean pressure.

[2 marks]

Uncertainty = ± _____ MPa

0 4 . 3 **Figure 7** shows a sketch graph of the results.

Figure 7



The student said that as the temperature increases the pressure increases.

Give a better description of the relationship between temperature and pressure.

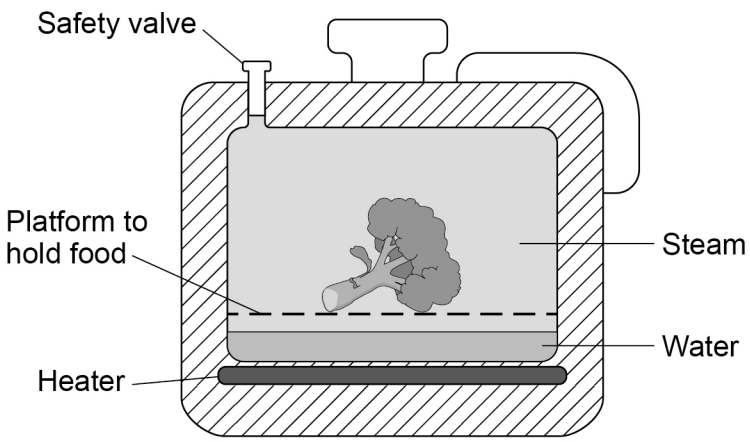
[1 mark]

Question 06 · continued

A pressure cooker is a sealed pot that uses steam to cook food.

Figure 8 shows a pressure cooker.

Figure 8



0 4 . 4 When the water in the pressure cooker starts to boil:

- the amount of steam in the pressure cooker increases
- the temperature of the steam increases above 100 °C

Explain why these changes make the pressure in the cooker increase.

[5 marks]

6.3.1.1 Density of materials

Question 06 · continued

0 4 . 5 If the pressure inside the pressure cooker becomes greater than 200 kPa then some of the steam is released through the safety valve.

The released steam expands as it moves into the atmosphere.

Explain how a change in density of the steam is caused by a change in the arrangement of particles in the steam as it is released.

[3 marks]

12

Turn over for the next question

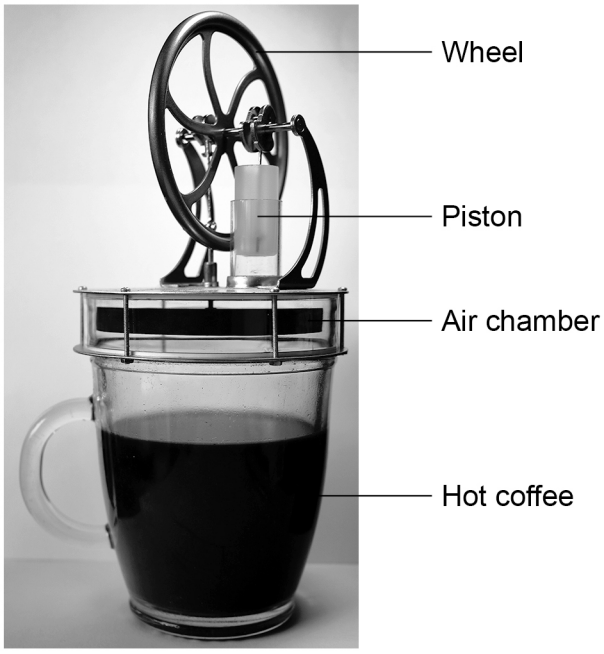
6.3.1.1 Density of materials

Question 07

June 2023 | 8464/P/1H | Original Q6

0 6 **Figure 12** shows a device that uses a mug of hot coffee to turn a wheel.

Figure 12



0 6 . 1 The hot coffee increases the temperature of the air in the chamber.

Explain how the pressure in the chamber changes.

[3 marks]

Question 6 continues on the next page

6.3.1.1 Density of materials

Question 07 · continued

0 6 . 2 For the device to work, the air in the chamber must increase in temperature quickly.

Explain why the bottom of the air chamber is made of metal rather than plastic.

[2 marks]

0 6 . 3 The mass of air in the chamber is constant.

What property of air allows a small change in internal energy to cause a large temperature change to the air in the chamber?

[1 mark]

0 6 . 4 The changes in pressure in the air chamber cause the wheel to turn.

Suggest **one** way to increase the speed at which the wheel turns.

[1 mark]

6.3.1.1 Density of materials

Question 07 · continued

0 6 . 5 The temperature of the coffee decreases as the device is used.

The initial temperature of the coffee was 76 °C.

The internal energy of the coffee decreased by 15 kJ.

density of coffee = 1.1×10^{3} kg/m^{3}

volume of coffee = 1.9×10^{-4} m^{3}

specific heat capacity of coffee = 4200 J/kg °C

Calculate the final temperature of the coffee.

Use the Physics Equations Sheet.

[6 marks]

Final temperature of the coffee = _____ °C

13

6.3.1.1 Density of materials

Question 08

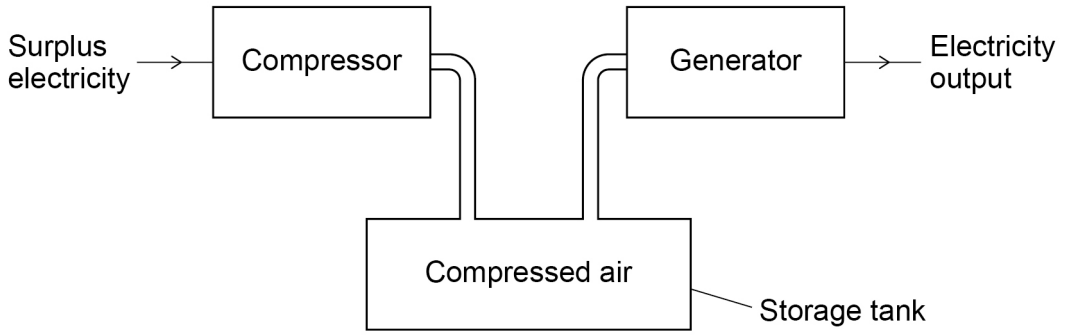
0 6 Energy can be stored using a Compressed Air Energy Storage (CAES) system.

When more electricity is generated than is needed, a CAES system uses the surplus electricity to compress air in a storage tank.

When there is a greater demand for electricity, the CAES system releases the compressed air to generate electricity.

Figure 7 shows a diagram of the CAES system.

Figure 7



0 6 . 1 The CAES system has two processes:

- compressing air to store energy. This process has an efficiency of 0.72
- releasing the air to generate electricity. This process has an efficiency of 0.86

Calculate the efficiency of the CAES system.

Give your answer to 2 significant figures.

[3 marks]

Efficiency of the CAES system (2 significant figures) = _____

6.3.1.1 Density of materials

Question 08 · continued

The generator works when forces from the compressed air cause a turbine to rotate.

When particles of air collide with the turbine they transfer energy to the turbine.

In warm weather the temperature of the compressed air increases, increasing the pressure inside the storage tank.

0 6 . 2 Explain how the motion of the particles in warmer air causes an increase in the power transferred to the turbine.

[4 marks]

Question 6 continues on the next page

6.3.1.1 Density of materials

Question 08 · continued

0 6 . 3 The volume of the storage tank is 5.0×10^5 m^3.

The density of the compressed air is 48 kg/m^3.

specific heat capacity of air = 1100 J/kg °C

The temperature of the compressed air increases from 12 °C to 27 °C.

Calculate the energy transferred to the compressed air in the storage tank.

Use the Physics Equations Sheet.

Give your answer in standard form.

[6 marks]

Energy transferred (in standard form) = _____ J

6.3.1.1 Density of materials

Question 08 · continued

0 6 . 4 The UK government wants the amount of carbon dioxide released into the atmosphere to be reduced.

Explain why efficient energy storage is important in reducing the amount of carbon dioxide released when generating electricity.

[4 marks]

17

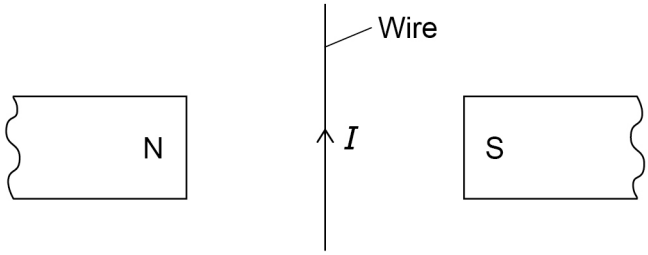
6.3.1.1 Density of materials

Question 09

0 4 **Figure 6** shows two magnets and a wire.

There is a current in the wire.

Figure 6



0 4 . 1 A force acts on the wire in **Figure 6**.

What is the direction of the force on the wire?

[1 mark]

Tick (✓) **one** box.

- Into the page ☐
- Out of the page ☐
- To the left ☐
- To the right ☐

6.3.1.1 Density of materials

Question 09 · continued

0 4 . 2 The length of the wire in the magnetic field between the magnets is 80 mm.

The current in the wire is 4.6 A.

The force on the wire is 0.092 N.

Calculate the magnetic flux density between the magnets.

Use the Physics Equations Sheet.

Give the unit.

[4 marks]

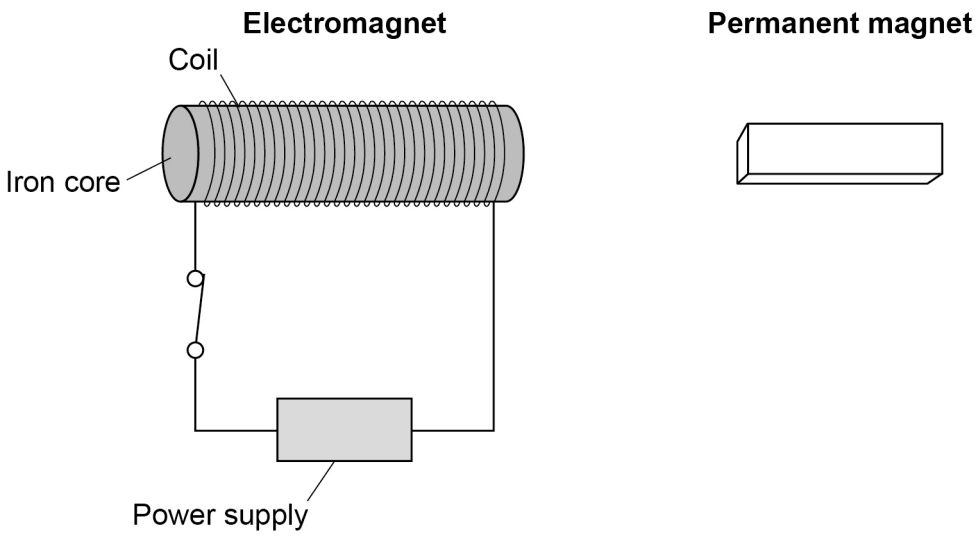
Magnetic flux density = _____ Unit _____

Question 4 continues on the next page

Question 09 · continued

Figure 7 shows an electromagnet close to a permanent magnet.

Figure 7



0 4 . 3 The electromagnet exerts a force on the permanent magnet.

The permanent magnet exerts an equal and opposite force on the electromagnet.

Which law is this an example of?

[1 mark]

Tick (✓) **one** box.

Newton's first law ☐

Newton's second law ☐

Newton's third law ☐

6.3.1.1 Density of materials

Question 09 · continued

0 4 . 4 Give **two** changes to the electromagnet that would increase the force exerted on the permanent magnet**.**

[2 marks]

1 _____

_____

2 _____

_____

0 4 . 5 Give **two** changes to the electromagnet that would reverse the direction of the force exerted on the permanent magnet**.**

[2 marks]

1 _____

_____

2 _____

_____

10

6.3.1.1 Density of materials

Question 10

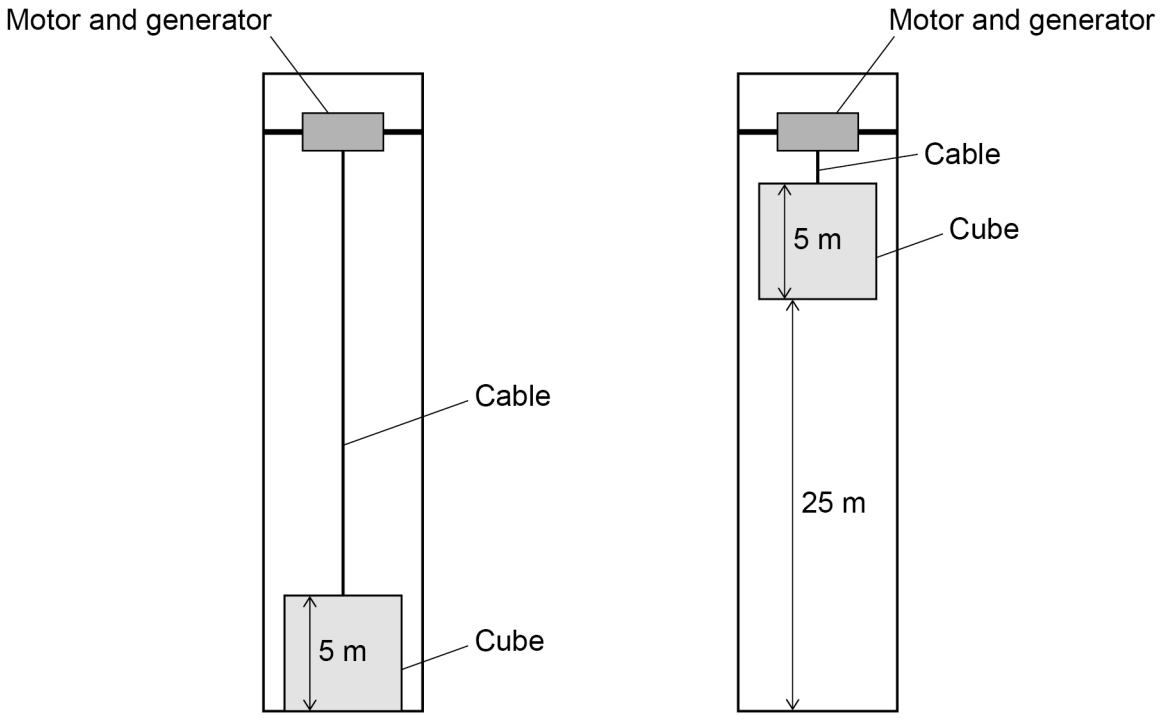
June 2025 | 8464/P/1H | Original Q6

0 6 A system is designed to store excess energy from the National Grid.

- Excess energy from the National Grid powers a motor that lifts a large cube.
- To transfer the energy back to the National Grid, the cube is allowed to fall.
- The falling cube turns a generator which produces electricity.

Figure 6 shows the cube before it is lifted and after it is lifted.

Figure 6



Before cube is lifted **After cube is lifted**

6.3.1.1 Density of materials

Question 10 · continued

0 6 . 1 The cube has a density of 4200 kg/m^3.

Determine the mass of the cube.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

0 6 . 2 Explain why the cube is made from a material with a high density.

[2 marks]

Question 6 continues on the next page

6.3.1.1 Density of materials

Question 10 · continued

0 6 . 3 The system is designed to store excess energy from the National Grid.

Explain how the efficiency of the system could be determined.

[2 marks]

0 6 . 4 The system in **Figure 6** on page 20 needs to be able to store excess energy as quickly as possible.

Explain **one** change to this system that would allow the same amount of energy to be stored more quickly.

Do **not** refer to efficiency in your answer.

[2 marks]

10

6.3.1.1 Density of materials

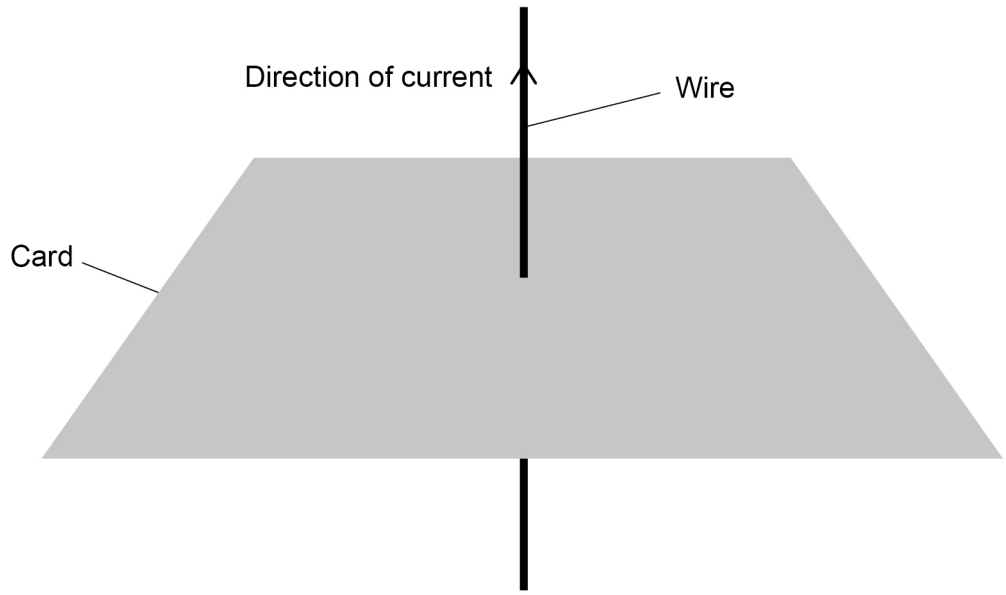
Question 11

0 4 When there is a current in a wire, there is a magnetic field around the wire.

0 4 . 1 **Figure 5** shows a wire passing through a piece of card.

There is a current in the wire.

Figure 5



Draw **two** magnetic field lines on the card in **Figure 5** to show the magnetic field pattern around the wire.

[2 marks]

6.3.1.1 Density of materials

Question 11 · continued

0 4 . 2 A student positioned a straight wire in the magnetic field between two magnets.

The wire was perpendicular to the magnetic field.

There was a current of 0.56 A in the wire.

The magnetic force on the wire was 2.1 mN.

The length of wire in the magnetic field was 0.050 m.

Calculate the magnetic flux density of the magnetic field between the magnets.

Use the Physics Equations Sheet.

Give the unit.

[5 marks]

Magnetic flux density = _____ Unit _____

Question 4 continues on the next page

Question 11 · continued

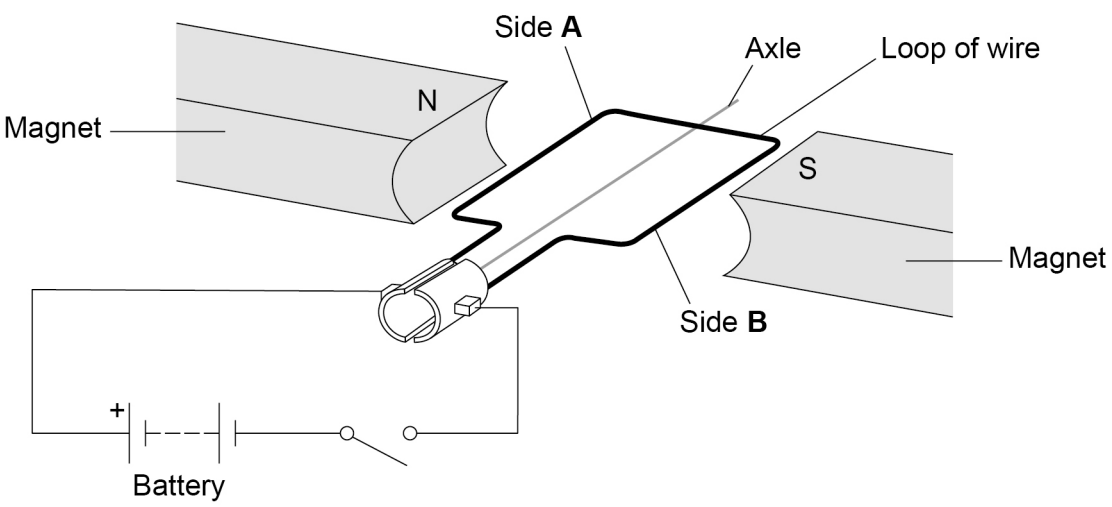
0 4 . 3 The student replaced the straight wire with a loop of wire.

The loop of wire was on an axle so that the loop could rotate.

The student connected the loop of wire to a battery and a switch.

Figure 6 shows the apparatus.

Figure 6



6.3.1.1 Density of materials

Question 11 · continued

When the switch is closed, magnetic forces on the loop make the loop begin to rotate.

Explain how.

You should refer to side **A** and side **B** of the loop of wire in **Figure 6**.

[5 marks]

Extra space

12