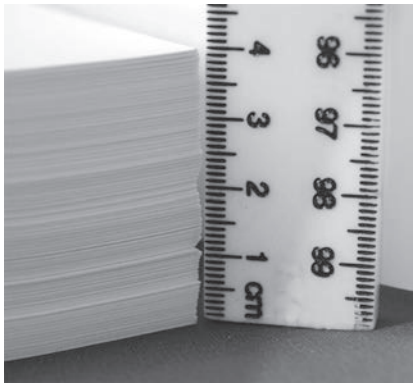
9 A student plans to measure the thickness of a sheet of paper with a ruler.

(a) Explain why it is difficult to measure the thickness of a single piece of paper with a ruler.

(2)

(b) The student puts a pile of 400 sheets of paper on a table.

He uses a ruler to measure the height of the pile.



The student records the thickness of the pile as 4.1 cm.

(i) This means that the thickness of **one** piece of paper is about

(1)

☒ **A** 1 cm

☒ **B** 1 mm

☒ **C** 0.1 mm

☒ **D** 0.01 mm

(ii) Suggest two reasons why the student's value for the thickness of the pile may be inaccurate.

(2)

1 .....

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2 .....

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(c) The student folds the sheet of paper to make a paper aeroplane.

He throws the paper aeroplane into the air and it flies at a constant velocity.

(i) Explain why the forces on the paper aeroplane must be balanced.

(2)

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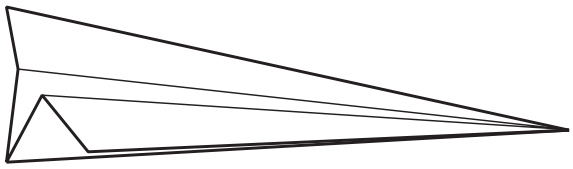
(ii) The diagram shows the paper aeroplane as it moves at a constant velocity towards the right and slightly downwards.



Add labelled arrows to the diagram to show the directions of the forces of

- weight
- lift
- drag

(3)

(iii) As it flies, the paper aeroplane loses gravitational potential energy.

What happens to this energy?

(1)

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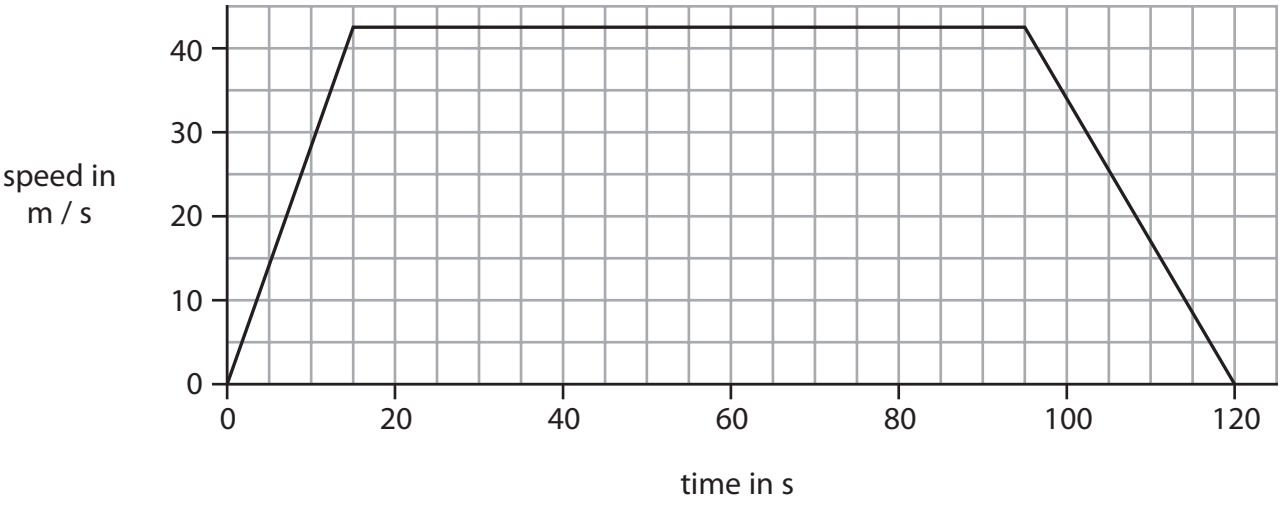
(Total for Question 9 = 11 marks)

10 An aeroplane takes two minutes to travel the short distance between airports on two islands.

The graph shows how the speed of the aeroplane changes as it

- takes off
- flies across the sea
- lands on the other island

When it is flying across the sea, the aeroplane travels at a constant speed.



(a) Use the graph to answer the following questions.

(i) State the value of the constant speed.

(1)

speed ..... m/s

(ii) Calculate the acceleration of the aeroplane at the start of the journey and give the unit.

(3)

acceleration = ... unit .....

(iii) Calculate the total distance that the aeroplane travels.

(3)

distance = ... m

(b) Each airport has a runway that is about 500 m long.

When it lands, the speed of the aeroplane is 40 m/s.

Explain why the airline should not use an aeroplane that has more mass and needs a higher speed for landing.

(3)

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(Total for Question 10 = 10 marks)

11 A ray of light enters a glass block and is refracted as shown in Figure 1.

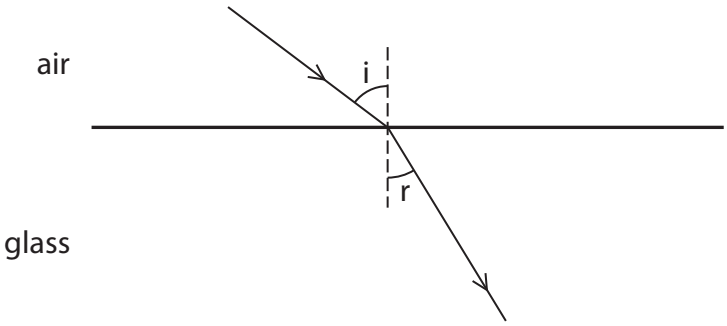

Figure 1

(a) Explain why the ray of light is refracted towards the normal.

(2)

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(b) Opals and diamonds are transparent stones used in jewellery.

Jewellers shape the stones so that light is reflected inside.

Figure 2 shows the path of a ray of light that enters and leaves a shaped piece of opal.

This ray of light is totally internally reflected.

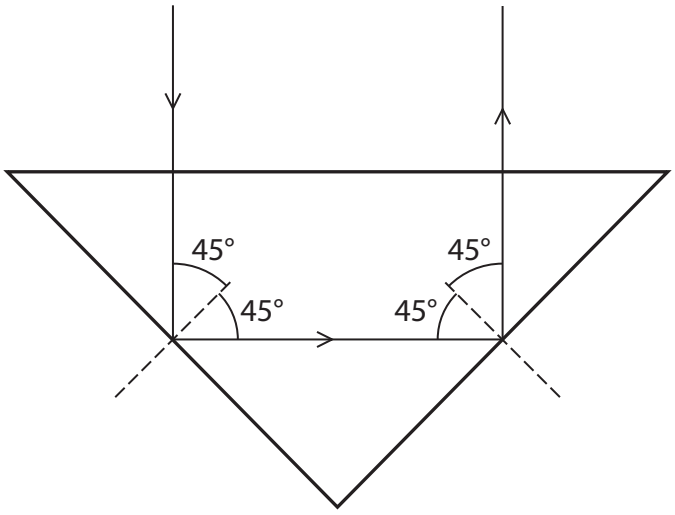

Figure 2

(i) State the equation linking refractive index and critical angle.

(1)

(ii) The critical angle of opal is 43°.

Show that the refractive index of opal is about 1.5.

(2)

(iii) The refractive index of diamond is 2.4.

Explain why rays of light inside a diamond are more likely to be totally internally reflected than those inside an opal.

(3)

(Total for Question 11 = 8 marks)

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12 The table shows information about three isotopes of uranium.

Isotope	Proton number	Neutron number	Half-life	Amount in natural uranium
Uranium-234	92	142	0.0002 billion years	0.005%
Uranium-235		143	0.7 billion years	0.7%
Uranium-238	92		4.5 billion years	99%

(a) (i) Complete the table by filling in the missing numbers.

(2)

(ii) Explain what is meant by the term **half-life**.

(2)

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(iii) Suggest why uranium-238 is the most common isotope of uranium.

(1)

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(b) Nuclear power stations use a uranium isotope as fuel.

What are the products of the fission of uranium nuclei?

(3)

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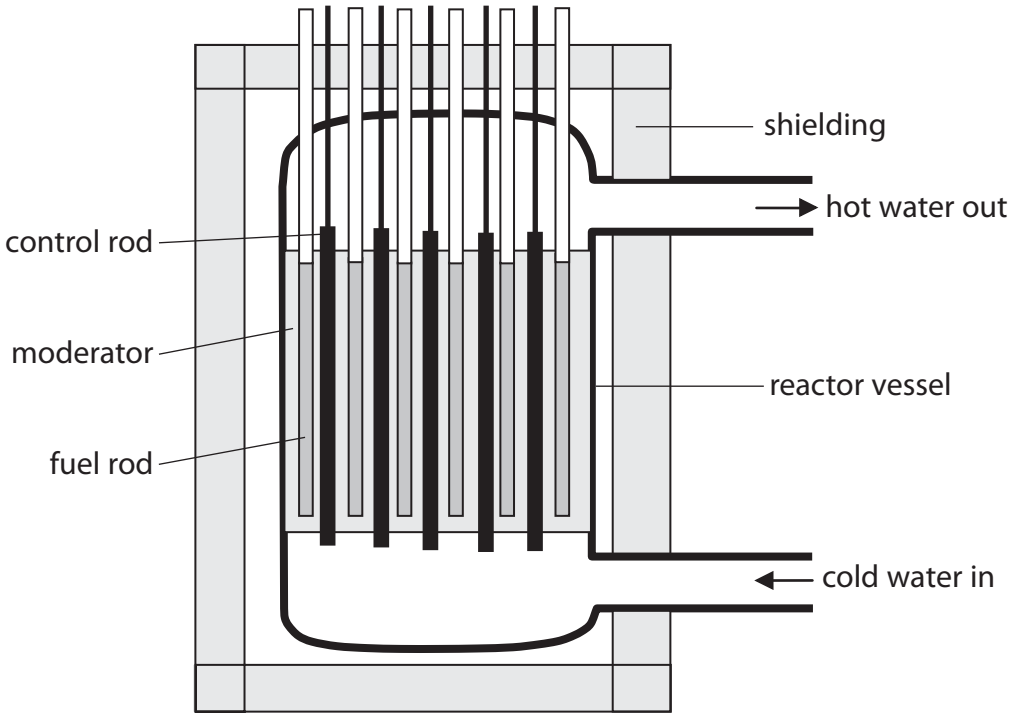
(c) The diagram shows the reactor in a nuclear power station.



(i) What is the purpose of the moderator?

(1)

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(ii) Describe what happens in the reactor when a control rod is removed.

(2)

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(d) There have been several accidents at nuclear power stations.

The most serious accident caused an explosion in the reactor.

This explosion spread material from inside the reactor to the surrounding area.

Explain why it is difficult to make the surrounding area safe again after a serious nuclear accident.

(5)

(Total for Question 12 = 16 marks)

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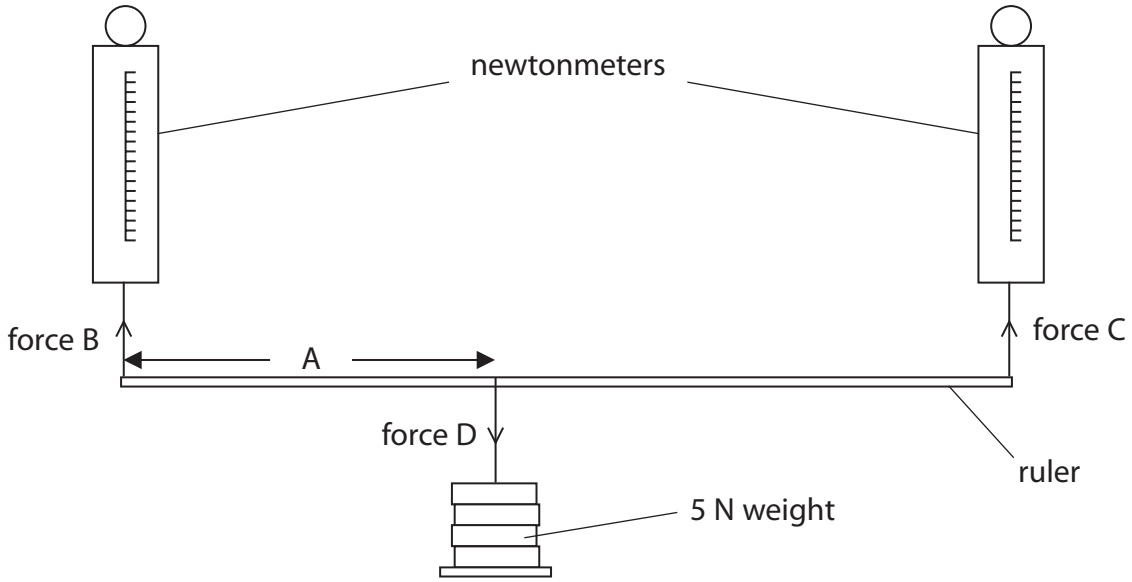
13 A student investigates the vertical forces acting on the ends of a horizontal ruler when it supports a load.

The ruler hangs from two newtonmeters with a weight suspended from it as shown.



(a) The student moves the weight along the ruler and records forces B and C by taking readings from the newtonmeters.

(i) Which of these is the independent variable in this investigation?

(1)

- ☒ **A** Distance A
- ☒ **B** Force B
- ☒ **C** Force C
- ☒ **D** Force D

(ii) Which of these is a controlled variable in this investigation?

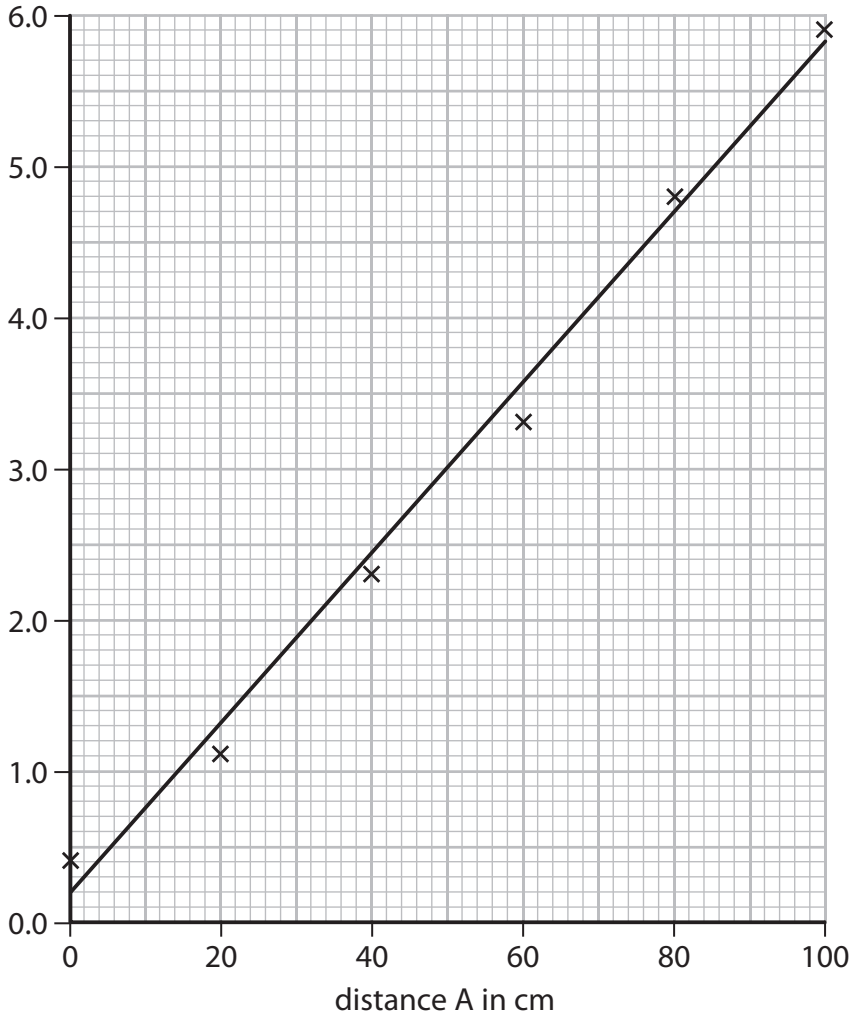
(1)

- ☒ **A** Distance A
- ☒ **B** Force B
- ☒ **C** Force C
- ☒ **D** Force D

(b) The student records these readings.

Distance A in cm	Reading from newtonmeter of force B in N	Reading from newtonmeter of force C in N
0	5.1	0.4
20	4.0	1.1
40	2.9	2.3
60	2.0	3.3
80	1.1	4.8
100	0.2	5.9

She plots this graph to show how force C changes with distance A.



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in .....

(i) Complete the student's graph by labelling the vertical axis.

(1)

(ii) Using the same grid and axes, plot a second line to show how force B varies with distance A.

(3)

(iii) Use the lines on the graph to find distance A for which force B and force C are equal.

(1)

Distance = ... cm

(c) Suggest why neither force B nor force C are ever zero during the investigation.

(1)

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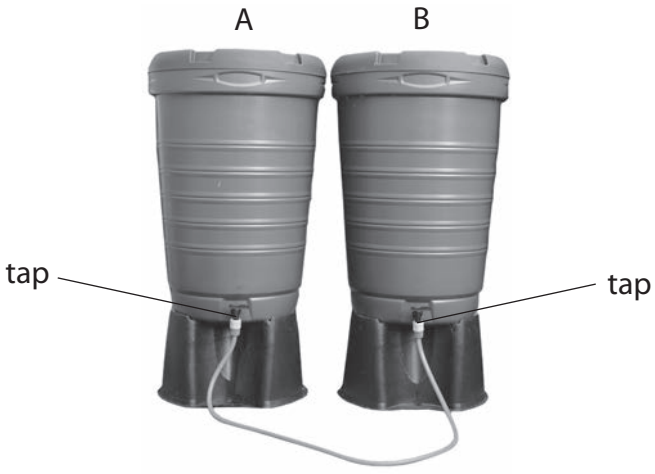
(Total for Question 13 = 8 marks)

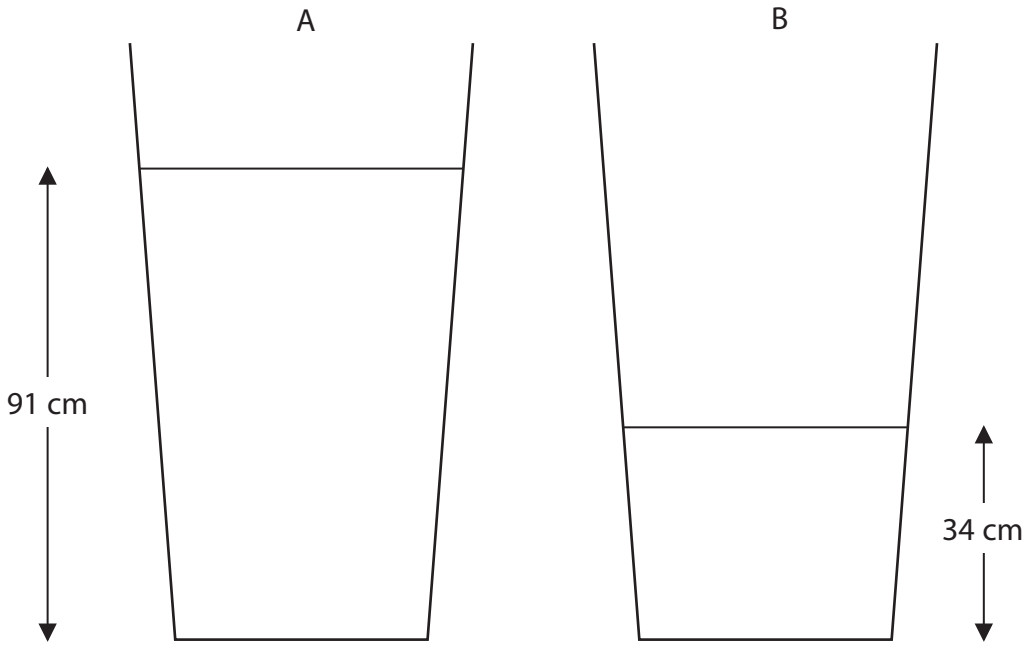
14 The photograph shows two containers that store rainwater.

The containers have taps that are joined by a pipe.

The taps are closed.



The diagram shows the water levels inside the containers.



(a) The density of water is 1000 kg/m^3.

(i) State the equation linking pressure difference, height, density and *g*.

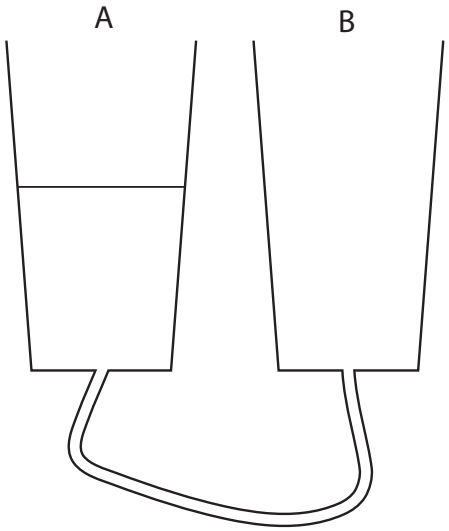
(1)

(ii) Calculate the pressure that the water causes at the base of container A.

(2)

pressure = ... Pa

(b) When the taps are opened, water flows in the pipe for some time. The diagram shows the final water level in container A.



(i) Complete the diagram to show the final water level in container B.

(1)

(ii) Explain why the water starts to flow and then stops.

(3)

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(Total for Question 14 = 7 marks)

TOTAL FOR PAPER = 120 MARKS

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