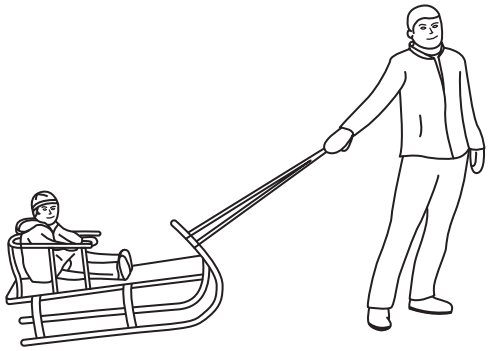
1 The diagram shows a man pulling a child on a sledge.



(a) The acceleration of the sledge is 1.5 m/s^2.

The mass of the child and sledge is 38 kg.

(i) State the equation linking force, mass and acceleration.

(1)

(ii) Calculate the force needed to produce this acceleration.

(2)

force = ... N

(iii) Suggest a reason why the force exerted on the sledge by the man must be greater than the force calculated.

(1)

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(b) The sledge starts from rest and accelerates at 1.5 m/s^2 until its velocity is 2.8 m/s.

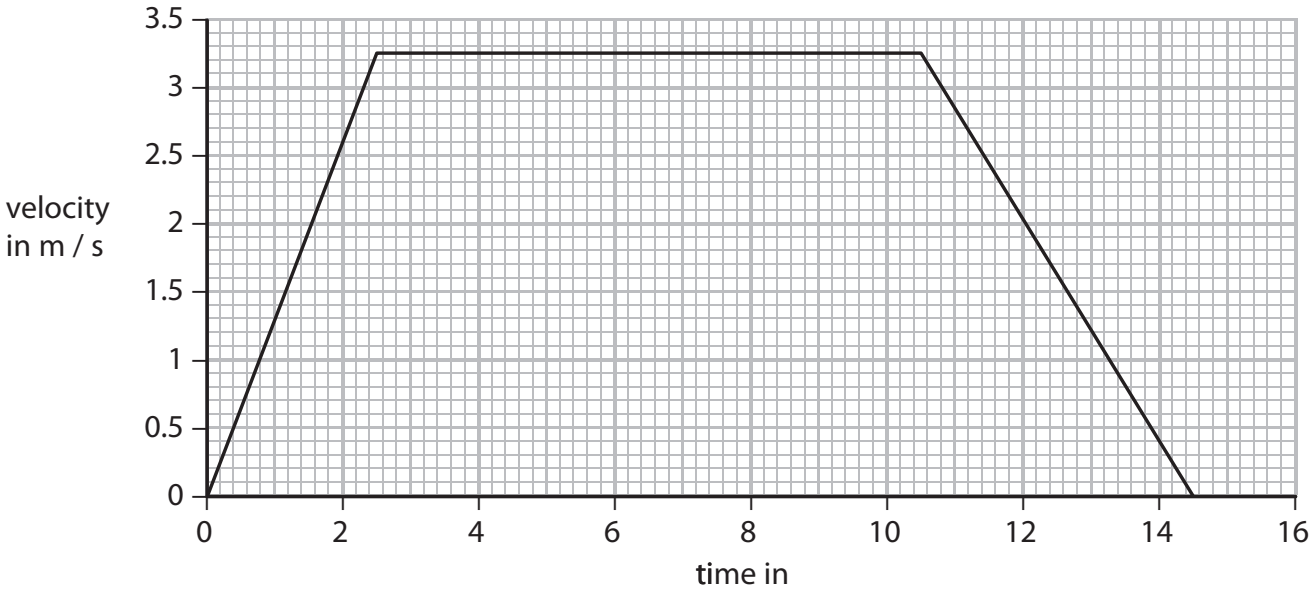
(i) State the relationship between acceleration, velocity and time.

(1)

(ii) Show that the time taken to reach 2.8 m/s is about 2 s.

(2)

(c) This velocity-time graph shows the motion of the sledge as it travels down a hill.



(i) Calculate the distance travelled by the sledge.

(3)

distance travelled = ... m

(ii) State the equation linking average speed, distance moved and time taken.

(1)

(iii) Calculate the average speed of the sledge for the whole journey.

(2)

average speed = ... m/s

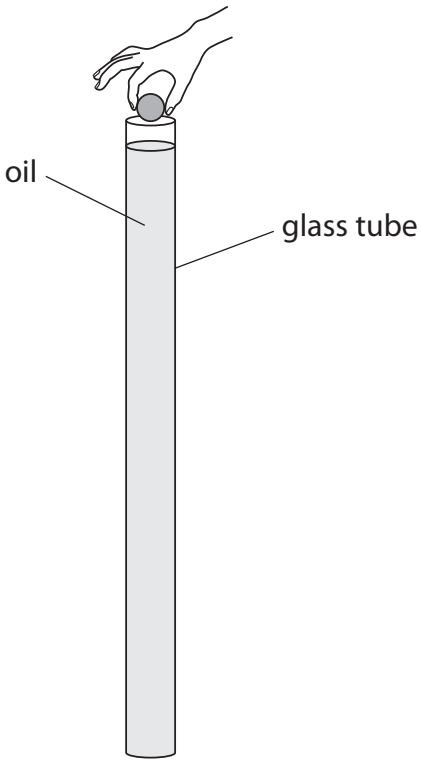
(Total for Question 1 = 13 marks)

2 A student investigates terminal velocity.

She uses a tall glass tube filled with oil.

She drops a metal ball into the tube.

The ball falls through the oil.



(a) Use ideas about forces to explain how a falling object can reach a terminal velocity.

(5)

(b) Describe how the student could find out if the ball reaches terminal velocity as it falls through the oil.

In your answer, you should include

- the measuring instruments that the student will need
- the measurements that she should take
- how she could use her measurements to find out if the ball reached terminal velocity.

You may include a labelled diagram in your answer.

(5)

(Total for Question 2 = 10 marks)

3 A student investigates the motion of different falling masses by measuring the time taken for empty cupcake cases to fall from a window.

(a) The student drops one case from the window.

He repeats the experiment with two cases stuck together, then with three cases and then with four.

Name two measuring instruments that he would need for his investigation.

(2)

1 .....

2 .....

(b) What are the dependent and independent variables in this investigation?

(2)

dependent variable .....

independent variable .....

(c) State one factor that the student should keep constant in order to make this investigation valid (a fair test).

(1)

.....

(d) The student draws this table to record his results.

Add suitable headings to his table.

(2)

..... in	..... in .....

(e) State one way that the student can improve his investigation.

(1)

.....

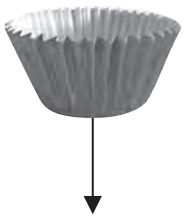
.....

(f) The student notices that the cases accelerate and then fall at constant speed.

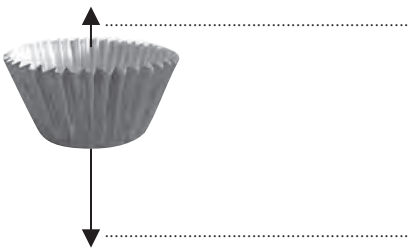
(i) The arrows in the diagrams show the size and direction of the forces acting on a case at different points in its fall.

Label the forces on the middle diagram.

(2)



at the start



part of the way down

near the bottom

(ii) Explain why the case accelerates and then falls at constant speed.

(3)

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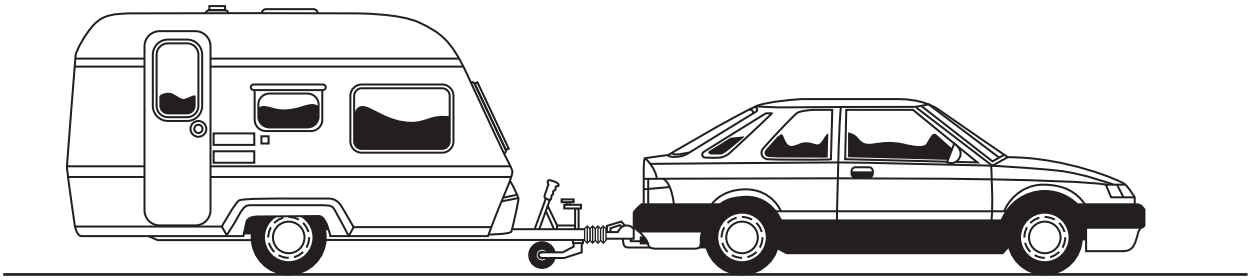
(Total for Question 3 = 13 marks)

4 A car pulls a caravan along a horizontal road.



(a) The car pulls the caravan with a resultant force of 170 N for a distance of 110 m.

(i) State the equation linking work done, force and distance.

(1)

(ii) Calculate the work done by the car on the caravan.

(2)

work done = ... J

(iii) State how much energy is transferred to the caravan.

(1)

energy transferred = ... J

(b) The mass of the car is 1650 kg.

The mass of the caravan is 950 kg.

(i) State the equation linking kinetic energy, mass and velocity.

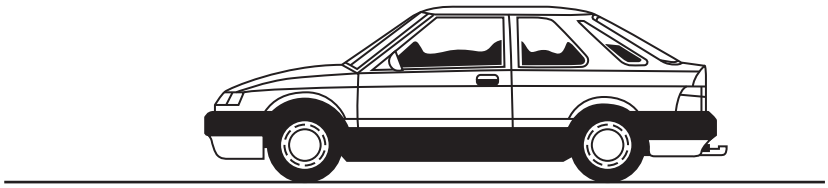
(1)

(ii) Calculate the total kinetic energy when the car and caravan travel together at a constant speed of 23 m/s.

(3)

total kinetic energy = ... J

(c) The caravan is removed and the car makes the return journey without it.



Without the caravan, the car has greater acceleration and uses less fuel.

Explain these changes.

(3)

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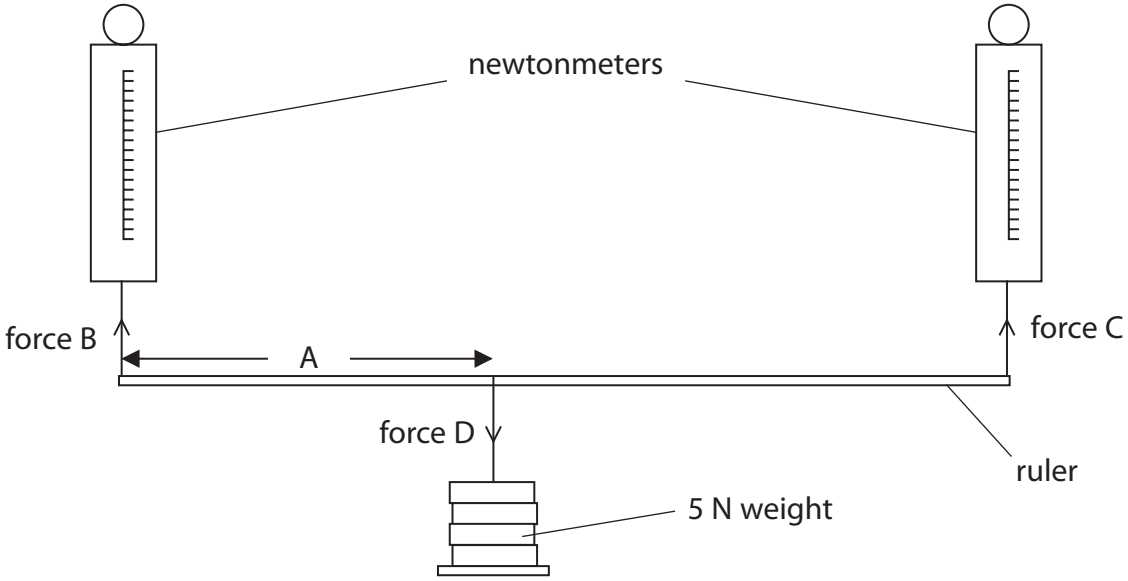
(Total for Question 4 = 11 marks)

5 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

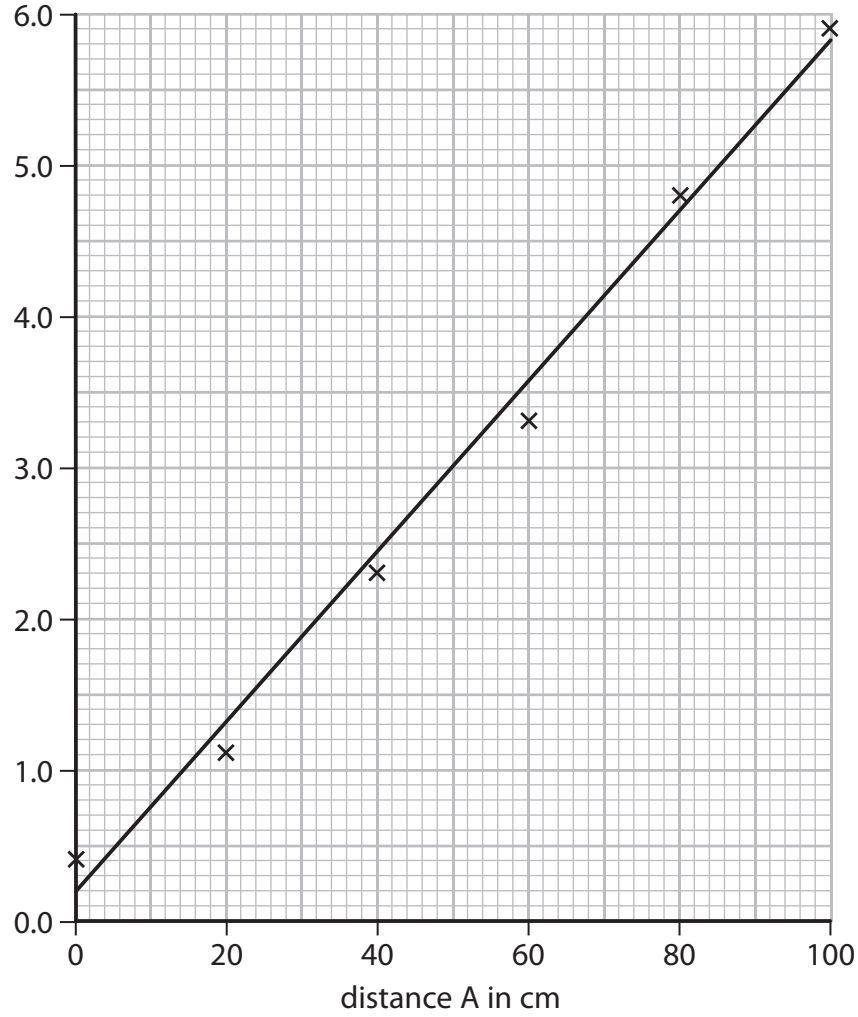
(b) The student records these readings.

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.

.....

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 5 = 8 marks)

6 A student investigates the extension of a rubber band when masses are added.

(a) Tick the boxes to select the correct items of apparatus that the student would need in order to complete this investigation.

Two items have already been selected.

(2)

Item	Tick (✓) if item needed
ammeter	
steel spring	
retort stand and clamp	
rubber band	✓
ruler	
thermometer	
mass hanger	
masses	✓

(b) The table below shows the student's results.

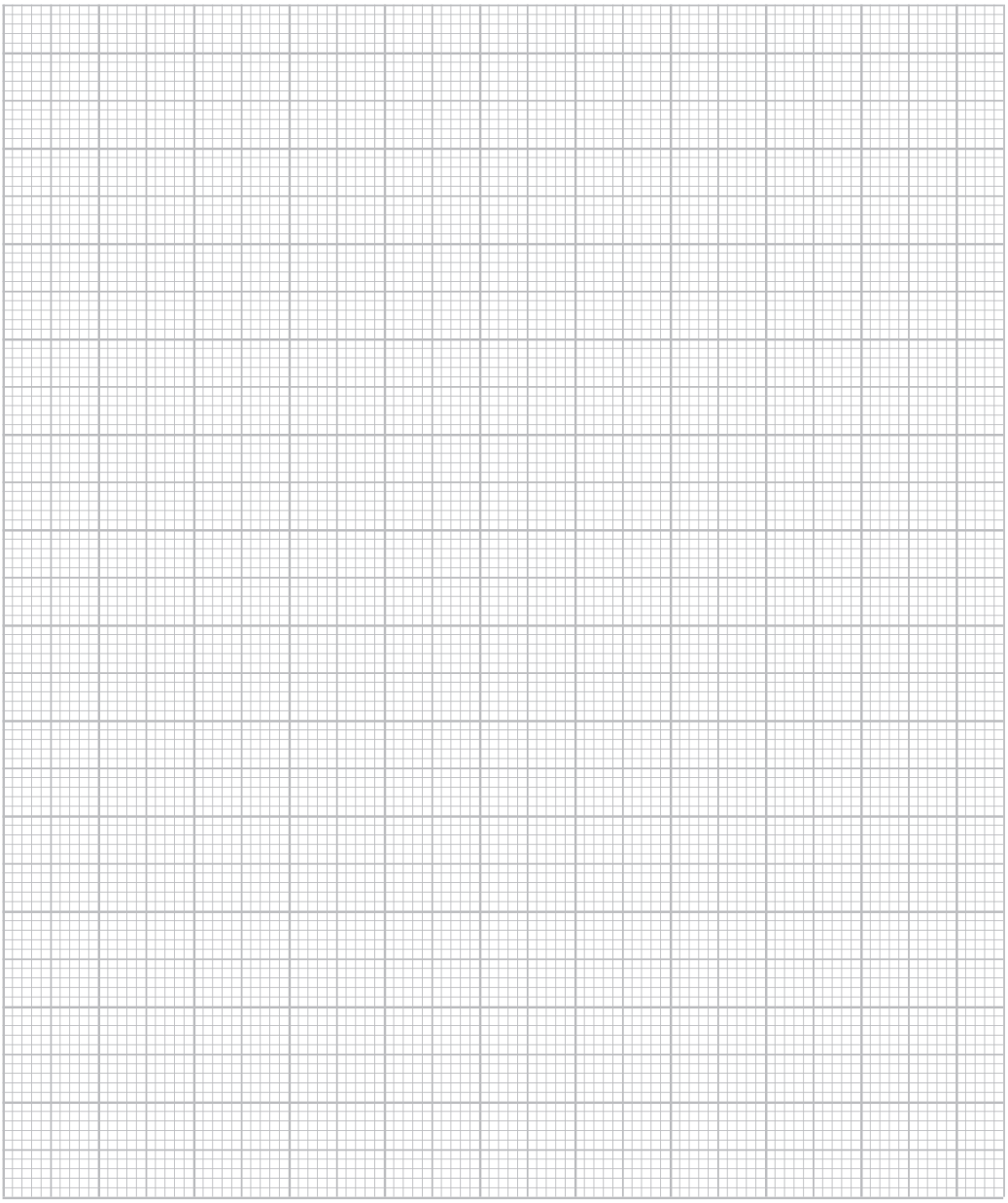
Mass in g	Force in N	Extension in cm
0	0	0.0
150	1.5	2.4
350	3.5	6.3
550		12.8
750	7.5	18.6
1050	10.5	24.0

(i) Complete the table by inserting the missing force.

(1)

(ii) Plot a graph to show how force varies with extension.

(5)



(iii) Use the information from the graph to explain whether the rubber band obeys Hooke's Law.

(2)

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(Total for Question 6 = 10 marks)