5 (a) A car accelerates at a constant rate of 1.83 m/s^2 along a flat straight road.

The force acting on the car is 1.870 kN.

Calculate the mass of the car.

Give your answer to three significant figures.

(3)

mass = ... kg

(b) The car accelerates from rest for 16 s.

Calculate the speed of the car after 16 s.

(3)

speed = ... m/s

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DO NOT WRITE IN THIS AREA

(c) The car starts on another journey.

Figure 6 shows the graph of the car's movement.

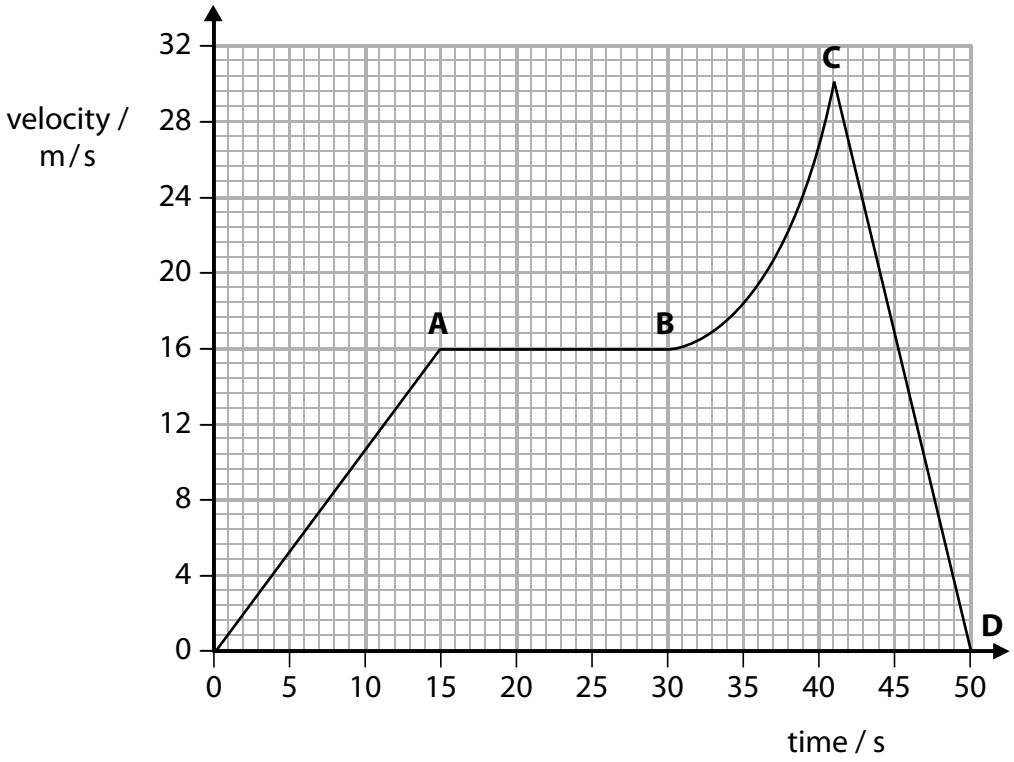


Figure 6

Show that the distance travelled when the car is moving at a constant speed is greater than the distance travelled when the car is slowing down.

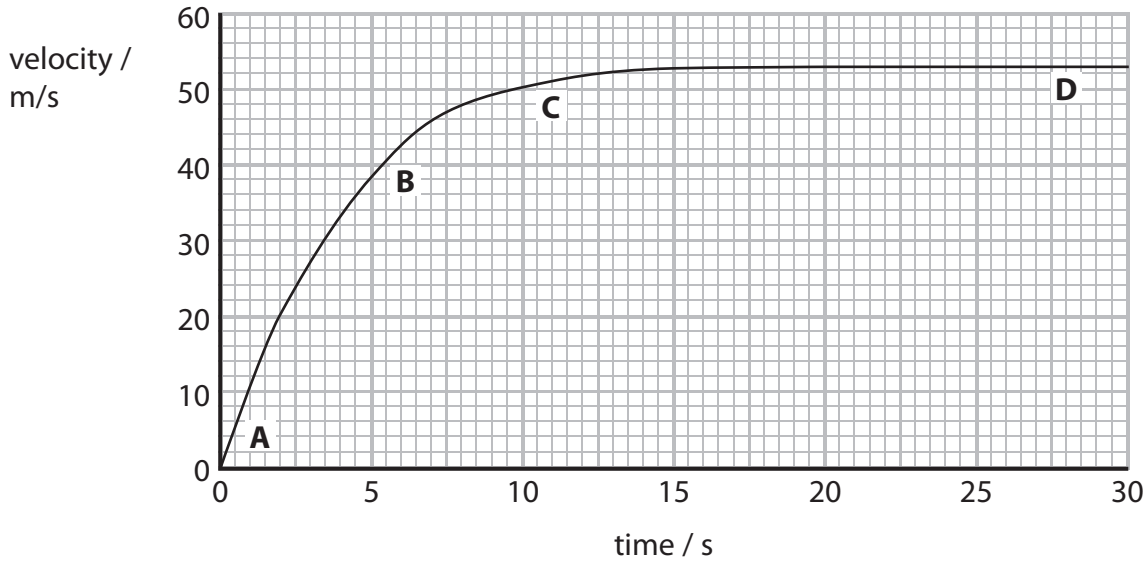
(4)

(Total for Question 5 = 10 marks)

Parachuting

5 Christine is a free-fall parachutist.

This is a velocity–time graph for her jump.



(a) Complete the sentence by putting a cross (☒) in a box next to your answer.

On the graph, the greatest acceleration is at

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Estimate how far Christine falls in the first 2 s.

(3)

Christine falls = ... m

(c) Explain the difference between velocity and speed.

(2)

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*(d) The graph shows how Christine's velocity changes from the time she leaves the plane until she reaches terminal velocity.

Explain, in terms of forces, why her velocity changes as shown in the graph.

(6)

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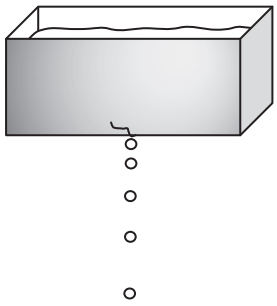
(Total for Question 5 = 12 marks)

6 A water tank drips water.



(a) Scientists could use four quantities to describe the movement of the water drops.
Three of these quantities are vectors.
The other quantity is a scalar.

acceleration	force	mass	velocity

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The scalar quantity is

(1)

☒ **A** acceleration

☒ **B** force

☒ **C** mass

☒ **D** velocity

(ii) Complete the following sentence using one of the quantities from the word box above.

(1)

In a vacuum, all bodies falling towards the Earth's surface

have the same ..... .

(b) The mass of one water drop is 0.000 08 kg.

Calculate its weight.

(gravitational field strength is 10 N/kg)

(2)

weight = ... N

(c) The water drop falls to the ground, 13 m below, in 1.7 s.

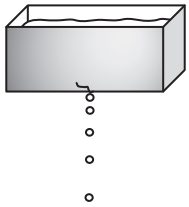
Calculate the average speed of the drop while it is falling.

(2)

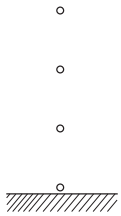
average speed = ... m/s

*(d) The tank is a long way above the ground.
It drips at a steady rate.

The first drawing shows water drops which have just left the tank.
The second drawing shows water drops which are near to the ground.



drops leaving the tank



drops near to the ground

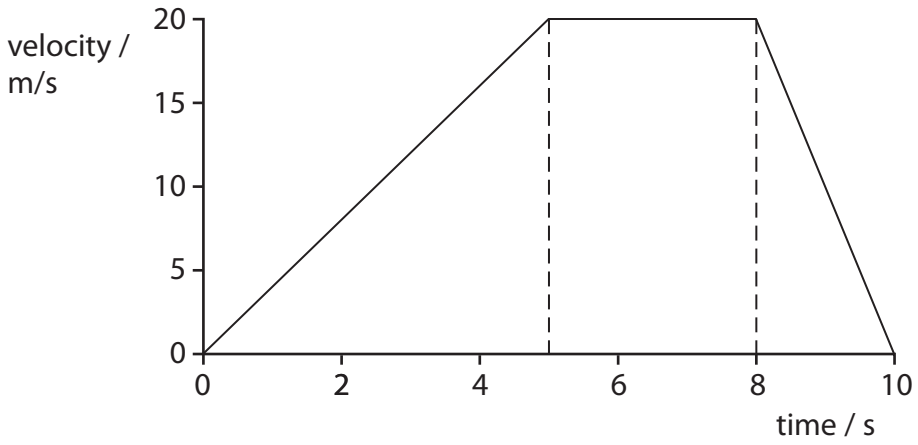
Explain why the drops which are near to the ground are an equal distance apart but the drops which have just started to fall are not.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

3 The graph shows how the velocity of a small car changes with time.



(a) Complete the sentence by putting a cross (☒) in the box next to your answer.

The resultant force on the car will be zero when the car is

(1)

☒ **A** accelerating

☒ **B** decelerating

☒ **C** changing velocity

☒ **D** moving at a constant velocity

(b) (i) Use the graph to estimate the velocity of the car at three seconds.

(1)

velocity ..... m/s

(ii) Calculate the acceleration of the car when it is speeding up.

(2)

acceleration = ... m/s^2

(iii) Explain why the units of acceleration are m/s^2.

(2)

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(iv) Show that the car travels further at a constant velocity than it does when it is slowing down.

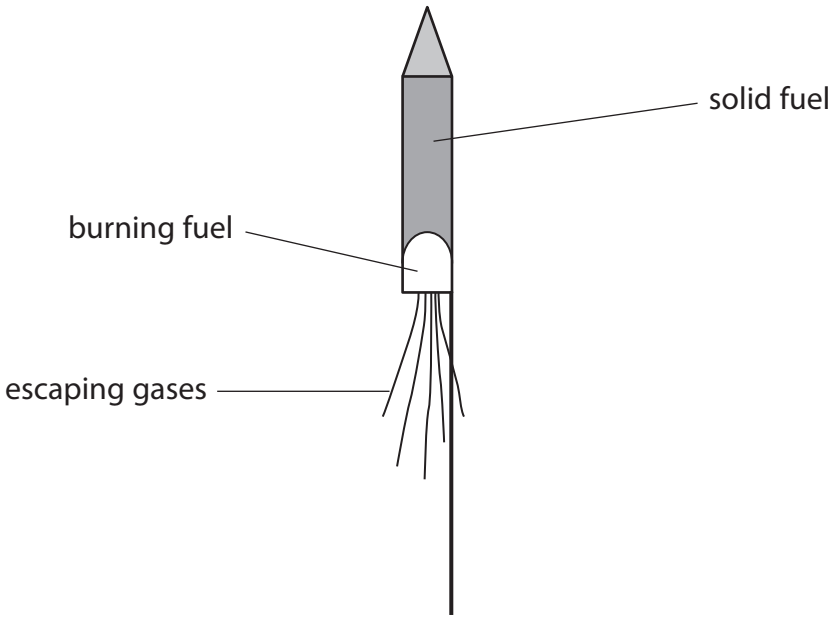
(3)

(Total for Question 3 = 9 marks)

Forces and rockets

5 (a) A firework rocket contains a solid fuel inside a cardboard tube.

The burning of the fuel creates a thrust to propel the rocket upwards.



(i) Scientists can refer to several different quantities when describing the motion of the rocket.

mass	energy	speed	force

Only one of these quantities is a vector.

Complete this sentence using **one** of the words from the box.

(1)

The vector quantity is .....

(ii) Before the fuse is lit, the total weight of a rocket including fuel is 0.7 N.

The gravitational field strength is 10 N/kg.

Complete the sentence by putting a cross (☒) in the box next to your answer.

The total mass of the rocket including fuel is

(1)

☒ **A** 0.007 kg

☒ **B** 0.07 kg

☒ **C** 0.7 kg

☒ **D** 7 kg

(iii) There is a resultant force on the rocket of 0.5 N upwards when it takes off.

The arrow on the diagram shows the size and direction of the force of gravity acting on the rocket when it takes off.

Add another arrow to the diagram to show the thrust produced by the burning fuel at the time the rocket takes off.

You should label the arrow with the size of the thrust.

(2)

(b) Another rocket has a total mass of 90 g when it takes off.
The acceleration of the rocket when it takes off is 3.3 m/s^2.

(i) Calculate the resultant force on the rocket when it takes off.

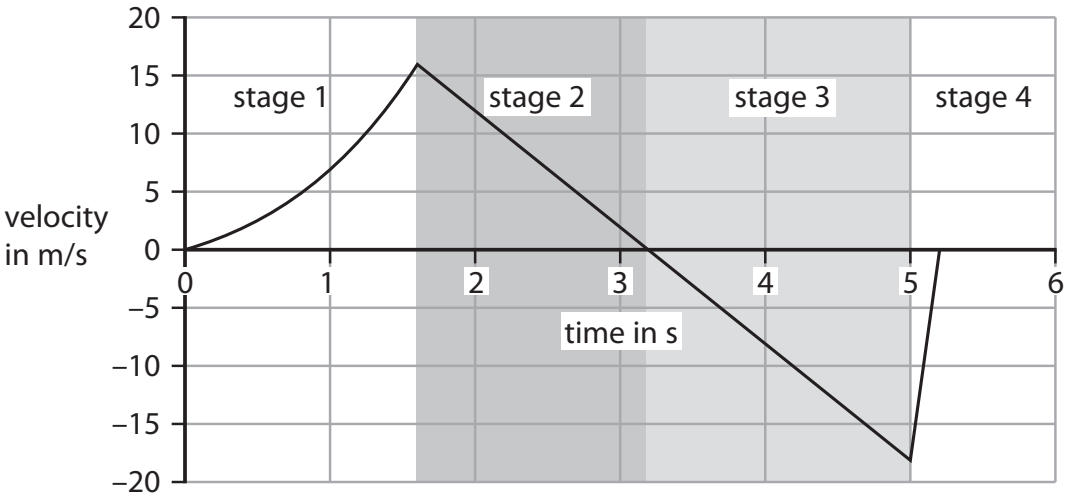
(2)

resultant force = ... N

*(ii) The rocket contains 50 g of fuel when it takes off.
The fuel burns and the rocket rises vertically.
After a while, there is no fuel left.
Eventually the empty rocket falls back to the ground.

The graph is a velocity–time graph for the rocket.

Four stages are labelled on the graph.



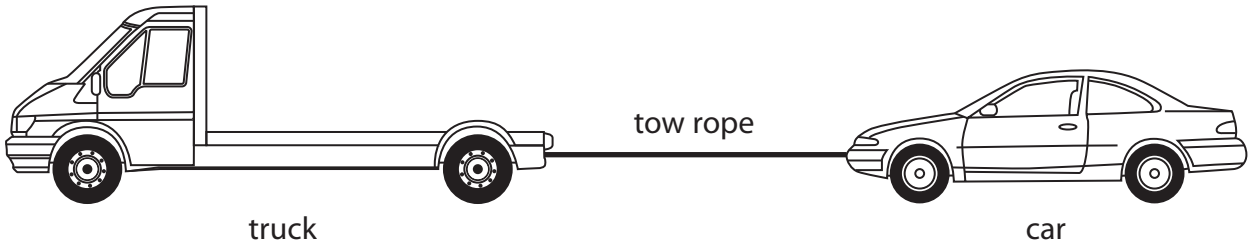
Explain why the velocity of the rocket changes as shown in the graph.

(6)

(Total for Question 5 = 12 marks)

4 A truck is towing a car along a level road at a constant velocity.

A tow rope is attached to the truck and the car.



(a) Which of these shows the directions of the forces between the car and the tow rope?

Put a cross (☒) in the box next to your answer.

(1)

	force exerted by car on tow rope	force exerted by tow rope on car
☒ **A**	←	→
☒ **B**	→	←
☒ **C**	→	→
☒ **D**	←	←

(b) The truck has to provide a force of 4000 N to the left on the car to keep the car at a constant velocity.

Complete the sentence by putting a cross (☒) in the box next to your answer.

The resultant force on the car is

(1)

☒ **A** 0 N

☒ **B** 4000 N to the left

☒ **C** 4000 N to the right

☒ **D** 8000 N to the left

(c) Both vehicles are travelling at 13 m/s.

The driver of the truck then accelerates at 1.2 m/s^2 until both vehicles are travelling at 20 m/s.

(i) Calculate the time taken for this acceleration.

(3)

time = ... s

(ii) The mass of the car is 1400 kg.

Calculate the resultant force on the car needed to produce an acceleration of 1.2 m/s^2.

(2)

force = ... N

(iii) A rope can withstand a tension of 12 000 N before it breaks.
The weight of the car is 14 000 N.

Discuss whether this rope could be strong enough to tow the car with the truck.

(3)

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(Total for Question 4 = 10 marks)