1 (a) A car driver sees a rabbit on the road.

The driver makes an emergency stop after he sees the rabbit.

Figure 6 shows the speed of the car from the time the driver sees the rabbit until the car stops.

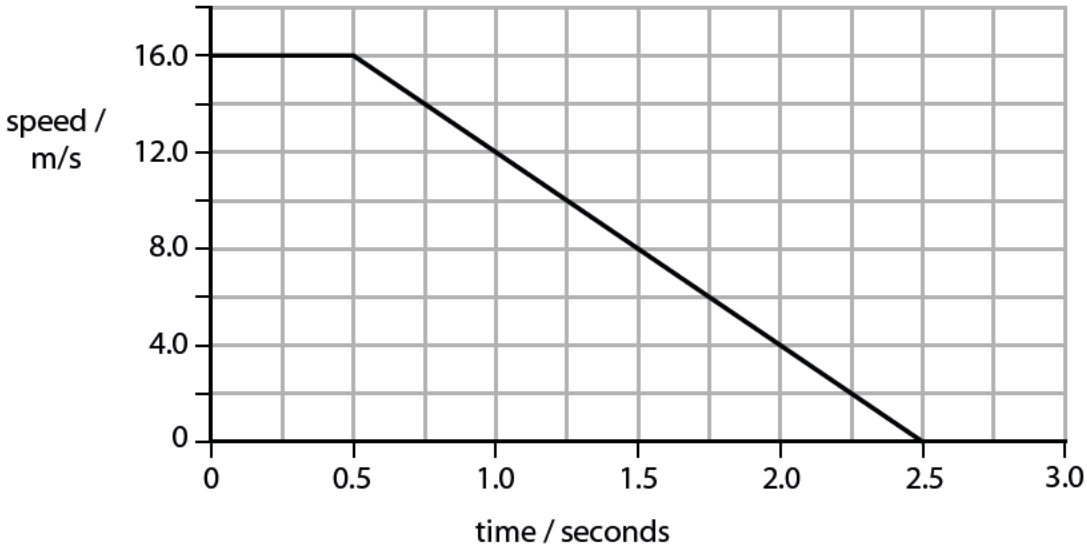


Figure 6

(i) The distance travelled by the car from the time the driver first sees the rabbit to when car starts to slow down is the

(1)

☒ **A** average distance

☒ **B** braking distance

☒ **C** stopping distance

☒ **D** thinking distance

(ii) Calculate the distance that the car travels in the first 0.5 seconds.

(3)

distance = ... m

(iii) Which equation relates acceleration to change in velocity and time?

(1)

☒ **A** $a = \frac{(v - u)}{t}$

☒ **B** $a = \frac{t}{(v - u)}$

☒ **C** $a = t(v - u)$

☒ **D** $a = v - \frac{u}{t}$

(iv) Calculate the deceleration of the car.

(3)

deceleration = ... m/s^2

(b) Two students, Alice and Bob, carry out an experiment to measure the speed of cars.

Alice paces out the distance between two lamp posts.

She records:

'*Distance between lamp posts = 20 paces*'

Bob starts to count when a car passes the first lamp post. He stops counting when he thinks it has passed the second lamp post.

He records:

'My estimate for the time taken for the car to pass between the two lamp posts = 3'

Give **three** ways the students could improve their experimental procedure.

(3)

1 .....

.....

2 .....

.....

3 .....

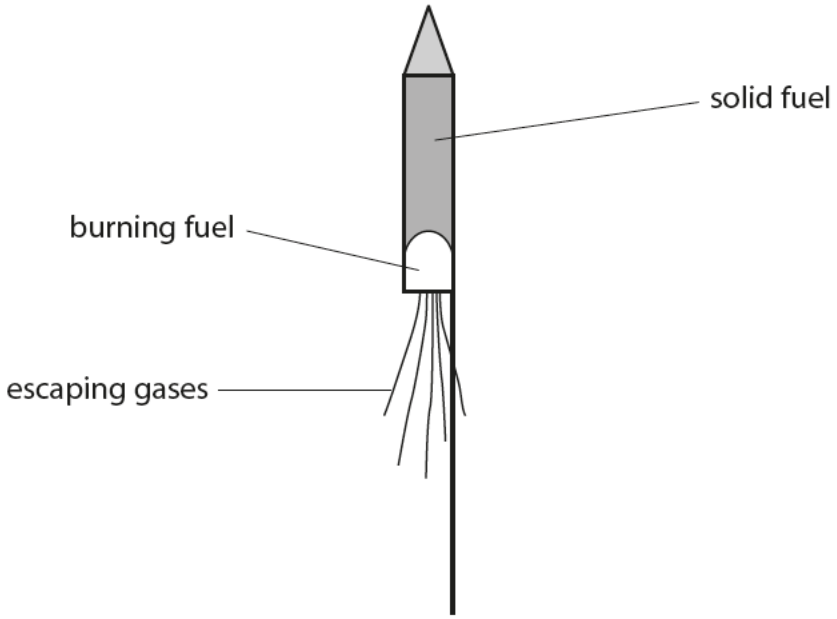
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(Total for Question = 11 marks)

Forces and rockets

2 (a) A firework rocket contains a solid fuel inside a cardboard

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.

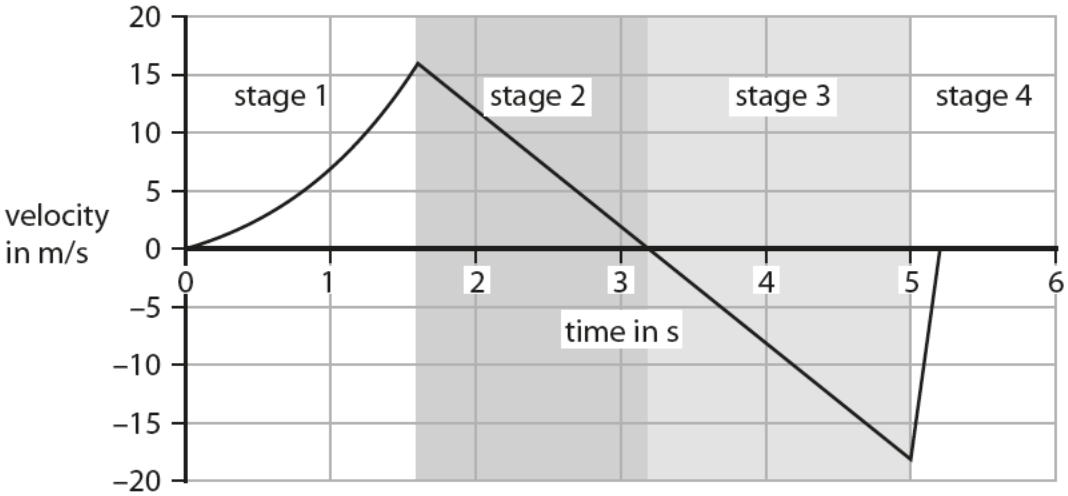
(2)

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)

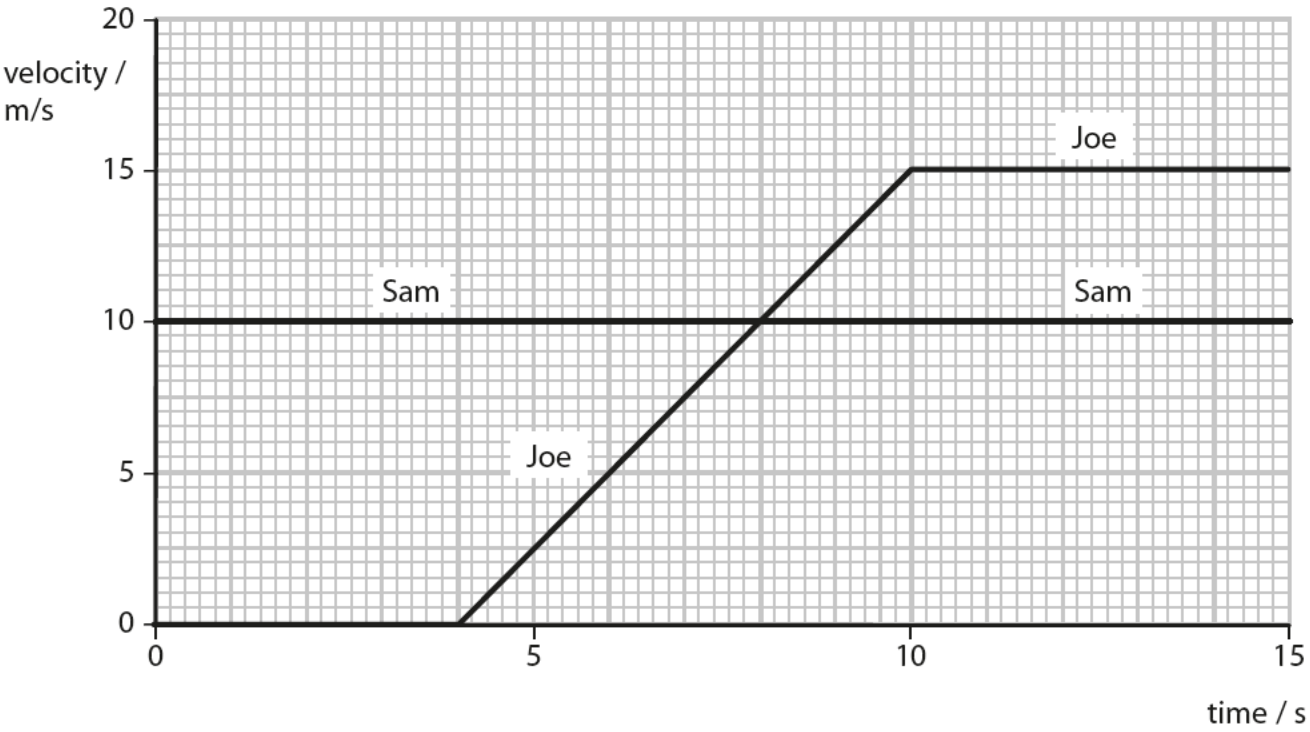
(Total for Question = 12 marks)

3 Sam and Joe are on their bikes. They are on a flat, straight road.

(a) Joe is stationary when Sam rides past at a constant velocity of 10 m/s.

Joe waits for 4 s and then follows Sam.

This is a velocity/time graph of their motion.



(i) How far did Sam travel during these 15 s?

distance = velocity × time

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

(1)

☐ **A** 1.5 m

☐ **B** 10 m

☐ **C** 100 m

☐ **D** 150 m

(ii) At which of these times is the resultant force on Joe bigger than the resultant force on Sam?

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

(1)

☐ **A** at 3 s

☐ **B** at 7 s

☐ **C** at 11 s

☐ **D** at 15 s

(iii) For how many seconds was Joe accelerating?

(1)

number of seconds = ... s

(iv) Calculate Joe's acceleration during this time.

(2)

Joe's acceleration = ... m/s^2

(b) The diagram shows the horizontal forces acting on Joe at one point while he is accelerating.



(i) Calculate the size of the resultant horizontal force acting on Joe and his bike.

(2)

size of resultant force = ... N

(ii) The total mass of Joe, his heavy bag, and his bike is 55 kg.

Calculate the total weight.

Gravitational field strength, g = 10 N/kg

(1)

total weight = ... N

(c) On another day, Joe is riding the same bike on the same piece of road.

This time he does not have the heavy bag on his back.

He finds that it is easier to accelerate.

Explain why Joe finds it easier to accelerate.

(2)

(Total for Question = 10 marks)