1 **(a)** Speed is a scalar quantity and velocity is a vector quantity. State one difference and one similarity between speed and velocity.

difference: ....

....

similarity: ....

.... **[2]**

(b) Fig. 2.1 shows a toy locomotive on a circular track.

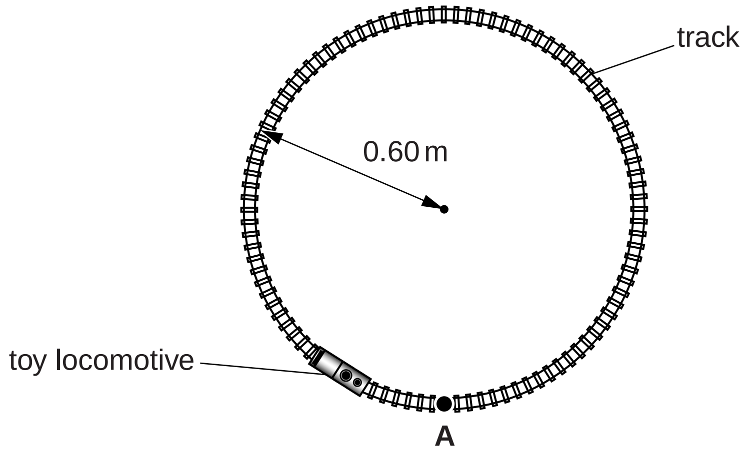

Fig. 2.1

The locomotive travels at constant speed round the track in a clockwise direction. It takes 12 s to travel completely round the track. At time $t = 0$, the locomotive is at point **A**.

(i) Calculate the speed of the locomotive.

speed = ... $m\,s^{-1}$ **[2]**

(ii) Calculate the magnitude of the displacement s of the locomotive from point **A** after it has travelled one quarter of the way round the track.

s = ... m **[2]**

(iii) Explain why the average velocity of the locomotive is zero after a time of 12 s.

....

.... **[1]**

(iv) Explain why the velocity of the locomotive changes even though its speed is constant.

....

.... **[1]**

[Total: 8]

2 A car of mass 1200 kg is travelling at 18 m s^{-1} along a horizontal road. A constant braking force of 3600 N brings it to rest.

(a) Calculate the magnitude of the deceleration of the car.

deceleration = ... m s^{-2} **[1]**

(b) Calculate the distance travelled by the car during the deceleration.

distance = ... m **[3]**

(c) The same car travels **down** a slope at the same speed of 18 m s^{-1}, see Fig. 3.1.

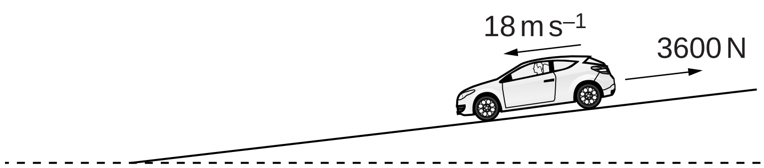

Fig. 3.1

The car is brought to rest by applying the brakes. The same resistive force of 3600 N acts on the car. Explain whether the distance travelled by the car before it stops is greater than, smaller than or the same as your answer to **(b)**.

....

....

....

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....

....

.... **[3]**

(d) Many cars are fitted with Global Positioning System (GPS) devices.

Describe how geostationary satellites are used to track the location of cars on the Earth's surface.

In your answer, you should use appropriate technical terms, spelled correctly.

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.... **[4]**

[Total: 11]

3 **(a)** Define *acceleration*.

....

.... **[1]**

(b) State the **two** factors that affect the acceleration of an object.

....

.... **[1]**

(c) Fig. 4.1 shows the variation of velocity v with time t for a small rocket.

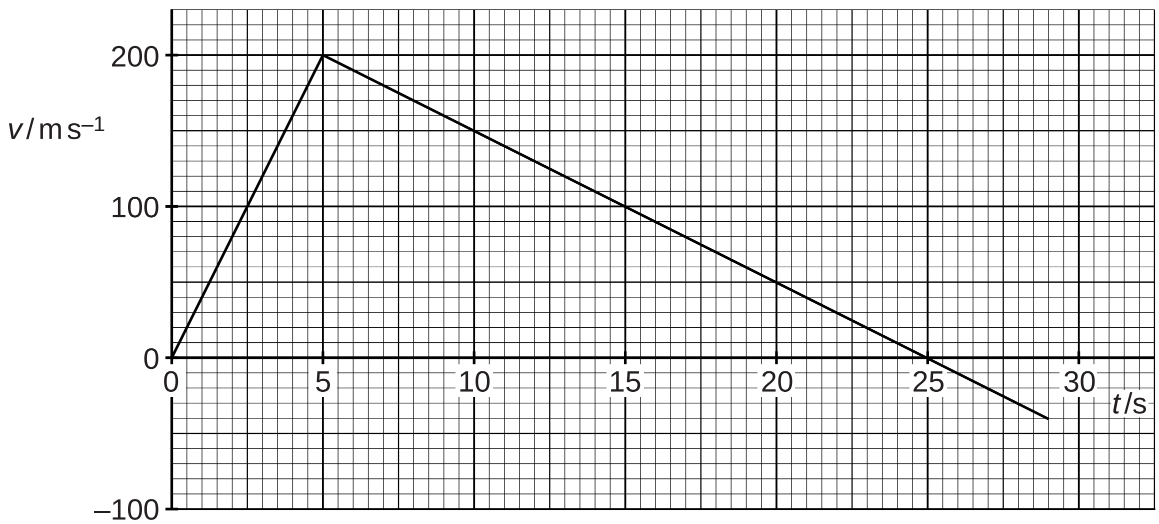

Fig. 4.1

The rocket is initially at rest and is fired vertically upwards from the ground. All the rocket fuel is burnt after a time of 5.0 s when the rocket has a vertical velocity of 200 m s^{-1}. Assume that air resistance has a negligible effect on the motion of the rocket.

(i) Without doing any calculations, describe the motion of the rocket

1 from $t = 0$ to $t = 5.0\,s$

....

....

2 from $t = 5.0\,s$ to $t = 25\,s$.

....

....

.... **[3]**

(ii) Calculate the maximum height reached by the rocket.

height = ... m **[3]**

(iii) Explain why the rocket has a speed greater than $200\,m\,s^{-1}$ as it hits the ground.

....

....

....

.... **[1]**

[Total: 9]

4 **(a)** Define *acceleration*.

....

.... **[1]**

(b) A super-tanker cruising at an initial velocity of 6.0 m s^{-1} takes 40 minutes (2400 s) to come to a stop. The super-tanker has a constant deceleration.

(i) Calculate the magnitude of the deceleration.

deceleration = ... m s^{-2} **[3]**

(ii) Calculate the distance travelled in the 40 minutes it takes the tanker to stop.

distance = ... m **[2]**

(iii) On Fig. 1.1, sketch a graph to show the variation of distance x travelled by the super-tanker with time t as it decelerates to a stop.

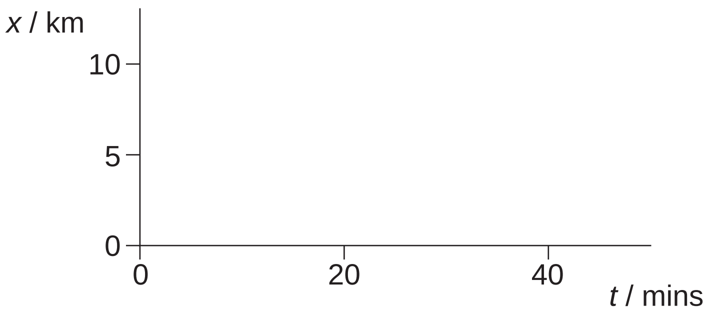

Fig. 1.1 **[2]**

(c) A student repeats one of Galileo's classic experiments from the sixteenth century. Fig. 1.2 shows the arrangement of this experiment.

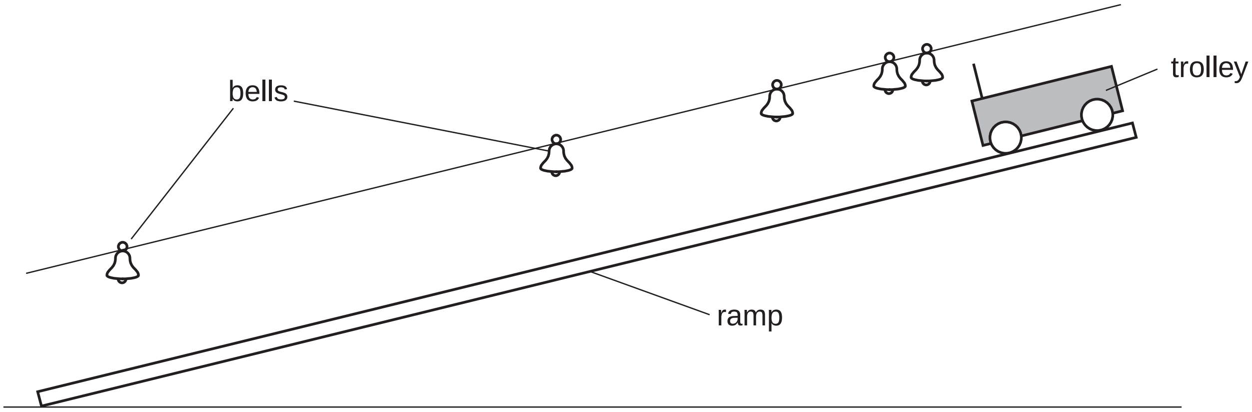

Fig. 1.2

A number of tiny bells are hung above a ramp. A trolley is released from rest from the top of the ramp. It rings each bell on its journey down the ramp. The procedure is repeated several times. The separations between the bells are adjusted until the time taken by the trolley to travel between successive bells is the **same**. This means that the bells ring at regular intervals. The distance between successive bells increases down the ramp.

(i) State what you can deduce about the motion of the trolley as it travels down the ramp.

....

.... **[1]**

(ii) The positions of the bells are unchanged. The mass of the trolley is increased. This heavier trolley is released from rest from the top of the ramp. State and explain the observations made by the student for this trolley.

....

....

....

....

.... **[2]**

[Total: 11]

5 A driver travelling in a car on a straight and level road sees an obstacle in the road ahead and applies the brakes until the car stops. The initial speed of the car is 20 m s^{-1}. The reaction time of the driver is 0.50 s.

Fig. 2.1 shows the velocity against time graph for the car.

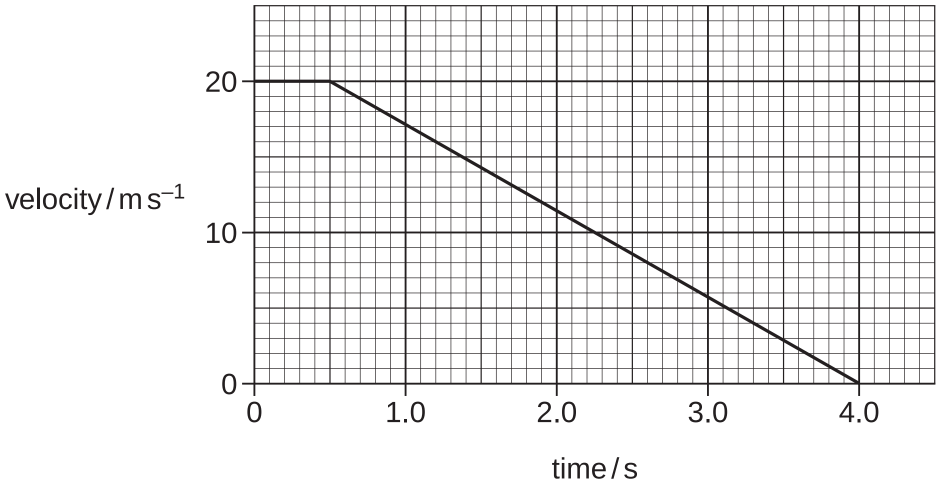

Fig. 2.1

(a) Define *thinking distance*.

....

.... **[1]**

(b) What does the area under a velocity against time graph represent?

.... **[1]**

(c) Use your answer to **(b)** and Fig. 2.1 to determine

(i) the thinking distance

thinking distance = ... m **[1]**

(ii) the braking distance.

braking distance = ... m **[2]**

(d) The total mass of the car is 910 kg. Use Fig. 2.1 to determine

(i) the magnitude of the deceleration of the car

deceleration = ... $m\,s^{-2}$ **[2]**

(ii) the braking force acting on the car as it decelerates.

force = ... N **[2]**

(e) Suppose the initial speed of the car is twice that shown in Fig. 2.1. The braking force remains the same. State and explain by what factor the **braking** distance would increase.

....

....

....

.... **[2]**

(f) One of the safety features in a car is the air bag for the driver. Briefly describe how the air bag is triggered and how it minimises the impact force on the driver.

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.... **[4]**

[Total: 15]