STRAIGHT LINE MOTION MECHANICS PAST PAPER QUESTIONS OCR A LEVEL YEAR 1

1.

(a) Define a *vector quantity*.

....

.... **[1]**

(b) Circle all the vector quantities in the list below.

acceleration speed time displacement weight **[1]**

(c) Fig. 1.1 shows graphs of velocity v against time t for two cars **A** and **B** travelling along a straight level road in the same direction.

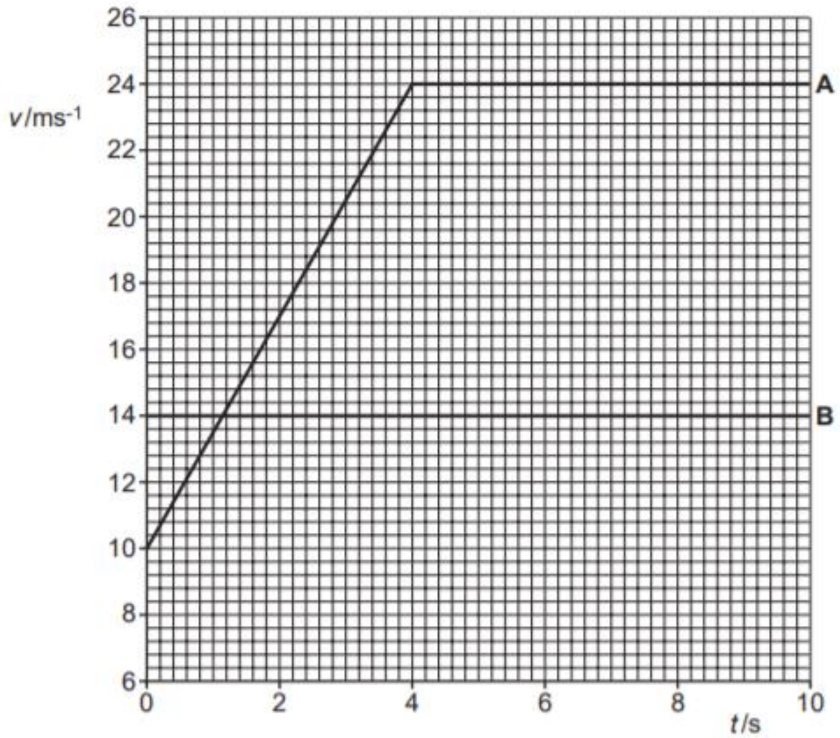

Fig. 1.1

At time t = 0, both cars are side-by-side.

(i) Describe the motion of car **A** from t = 0 to t = 10 s.

....

....

.... **[2]**

(ii) Calculate the distance travelled by car **A** in the first 4.0 s.

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

(iii) Use Fig. 1.1 to find

1 the time at which both cars have the same velocity

time = ... s **[1]**

2 the time *t* at which car **A** overtakes car **B**.

t = ... s **[2]**

[Total: 9]

2.

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 $20\,\text{m}\,\text{s}^{-1}$. The reaction time of the driver is 0.50 s.

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

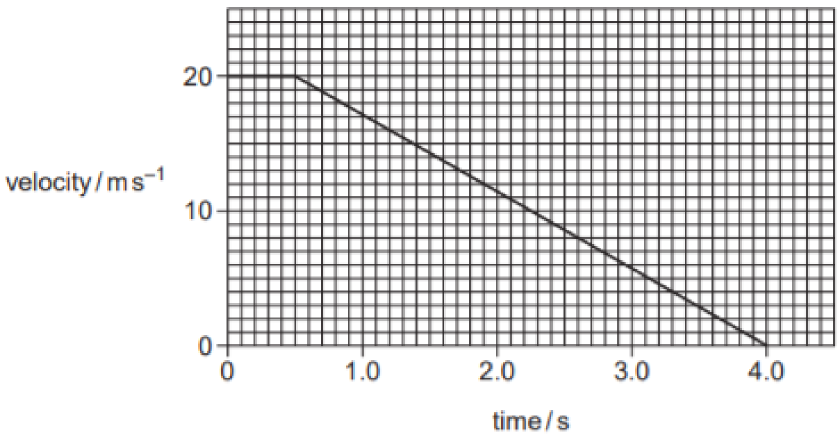

Fig. 2.1

(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]

3.

12

(a) Define *stopping distance* of a car.

....

.... **[1]**

(b) State two factors that affect the braking distance of a car. Describe how each factor affects the braking distance.

....

....

....

....

.... **[4]**

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.

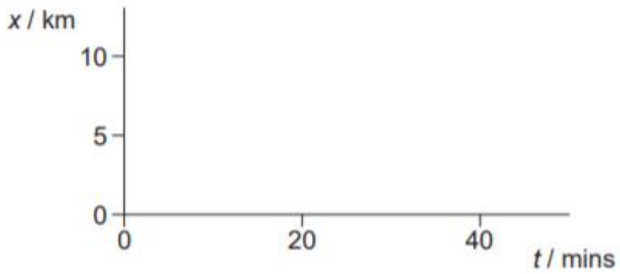

Fig. 1.1 **[2]**

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

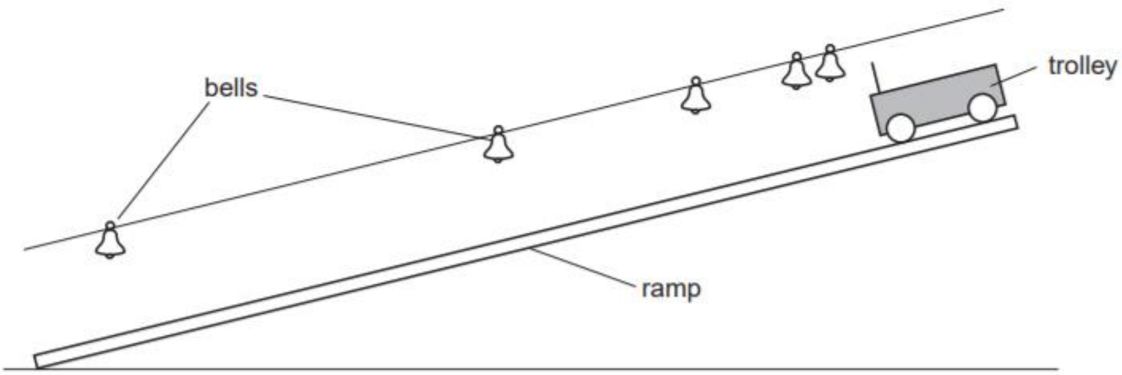

Fig. 1.2

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.

Thinking and braking distances are important quantities when considering road safety.

(a) The driver of a car travelling at constant speed sees a hazard ahead at time $t = 0$. The reaction time of the driver is 0.5 s. On Fig. 3.1, sketch a graph of distance travelled by the car against time t during this interval of 0.5 s.

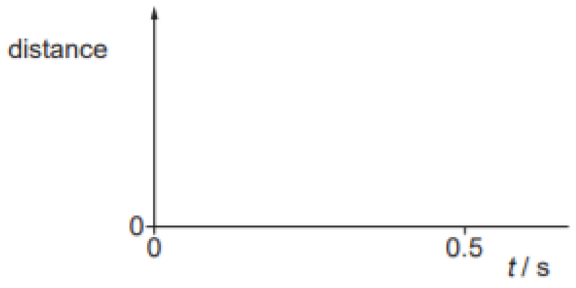

Fig. 3.1 **[1]**

(b) Explain the shape of your graph in Fig. 3.1.

....

.... **[1]**

(c) Define *braking distance*.

....

.... **[1]**

(d) Apart from the conditions of the tyres, brakes, road surface and weather, state two other factors that affect the **braking distance** of a car. For each factor, discuss how it affects the braking distance.

....

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.... **[4]**

(e) Describe and explain how seat belts reduce the forces on a driver during the impact in an accident.

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....

....

.... **[3]**

[Total: 10]

6.

(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.

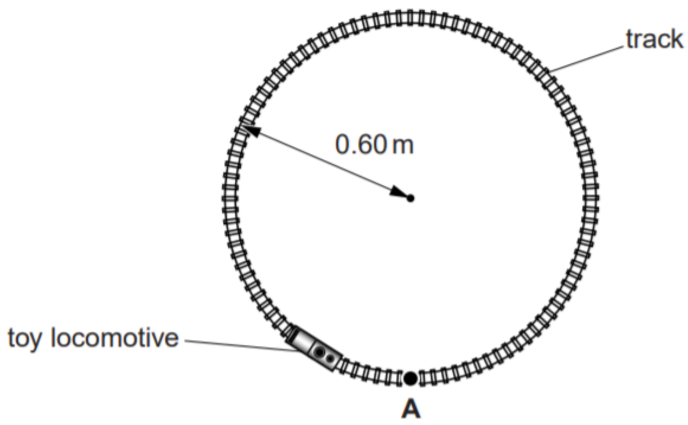

Fig. 2.1

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]

7.

(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.

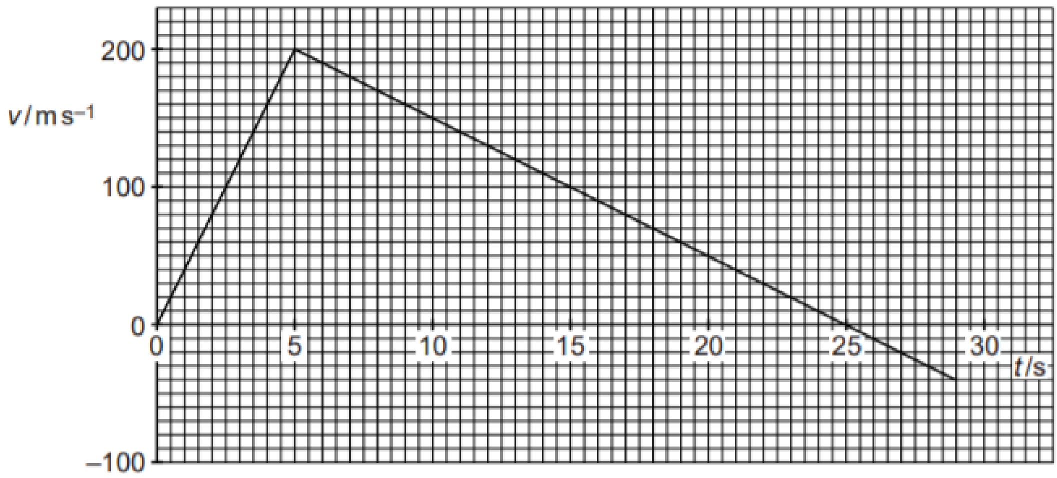

Fig. 4.1

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]