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About O Level

(PURE) PHYSICS

(TOPICAL)

About Thinking Process

When solving problems, we first analyse the questions and then gather relevant information until we are able to determine the answers. But for presentation reason, we need to organise, rearrange and then present ONLY the required workings and solutions.

Thinking process reveals the extra but relevant information which is not required as part of the solutions.

About MCQ with HELPs

Explanations are given so that students know exactly why the answer is the right one.

period	2012 to 2022
contents	June & November, Paper 1 & 2, Worked Solutions
form	Topic By Topic
compiled for	O Levels
special features	Thinking Process, MCQ with HELPs

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'O' Level (Pure) Physics 5054 (Topical)

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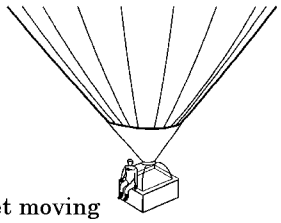
Topic 2 *Kinematics*

MCQ Section

1. The diagrams show a parachutist in four positions after she jumps from a high balloon.

At which position does she have terminal velocity?

A not yet moving 

B accelerating 

C not accelerating 

D not moving 

[N11/P1/Q1]

2. A student drops a table-tennis ball in air.

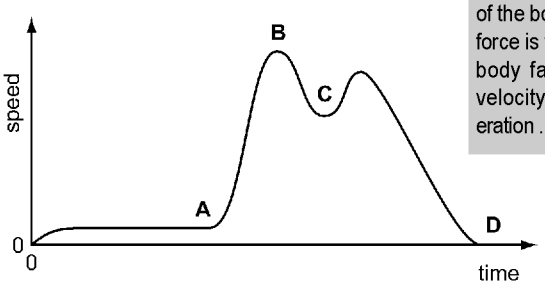
What happens to the velocity and to the acceleration of the ball during the first few seconds after release?

	velocity	acceleration
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

[J12/P1/Q4]

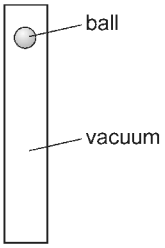
3. A cyclist travels along a hilly road without using the pedals or brakes. Air resistance and friction are negligible. The speed/time graph of the cyclist is shown.

At which point did he reach the bottom of the first hill?



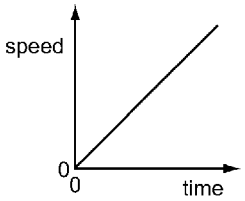
[J12/P1/Q3]

4. A table-tennis ball is released from the top of an evacuated tube.

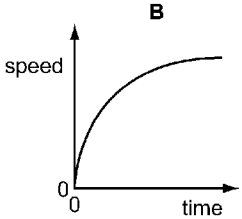


Which graph shows how the speed of the ball changes with time as it falls to the bottom of the tube?

A



B

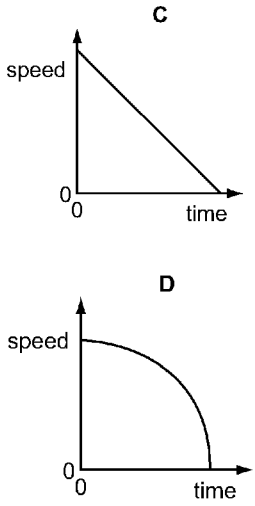


1. **C** When the parachute is opened, the air resistance gradually becomes equal to the weight of the body. The resultant force is then zero and the body falls with terminal velocity and zero acceleration.

2. **C** As the ball just starts falling, it accelerates due to the pull of gravity so its velocity increases but this increase in velocity (i.e. acceleration) decreases with time due to increase in air resistance.

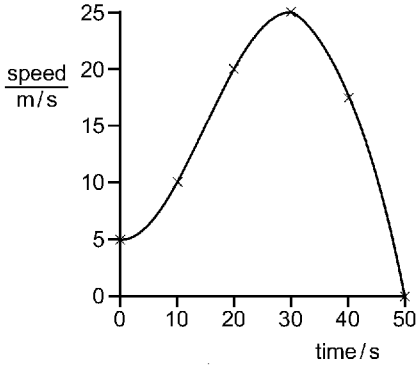
3. **B** A cyclist moving down a hill accelerates and his speed becomes maximum at the bottom. The point **B** represents the maximum speed of the cyclist during his downward motion.

4. **A** In vacuum, the only force acting on the ball is the constant force of gravity (i.e. weight). So, it falls with a constant acceleration due to gravity (i.e. $g = 10\ m/s^2$).



[N12/P1/Q3]

5. The speed-time graph for a car is shown.



What is the acceleration of the car at 30 s?

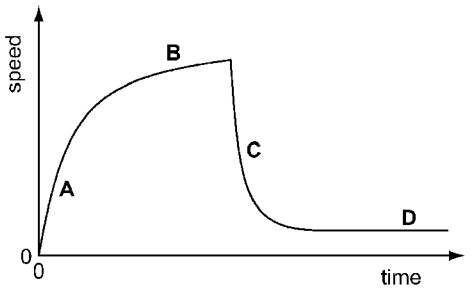
A 0 **B** $\frac{25-5}{30}$ m/s^2

C $\frac{25}{30}$ m/s^2 **D** $\frac{25}{50}$ m/s^2

[N12/P1/Q4]

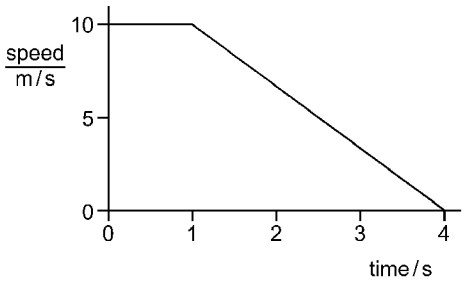
6. The speed-time graph for a falling skydiver is shown below. As he falls, the skydiver spreads out his arms and legs and then opens his parachute.

Which part of the graph shows the skydiver falling with terminal velocity?



[J13/P1/Q3]

7. The diagram shows the speed-time graph of the motion of a car for four seconds.



What is the distance travelled by the car in the four seconds?

A 15 m **B** 25 m

C 30 m **D** 40 m

[J13/P1/Q4]

8. An object moves from P to Q in 10 s with uniform acceleration.

velocity at P = 5 m/s

velocity at Q = 12 m/s

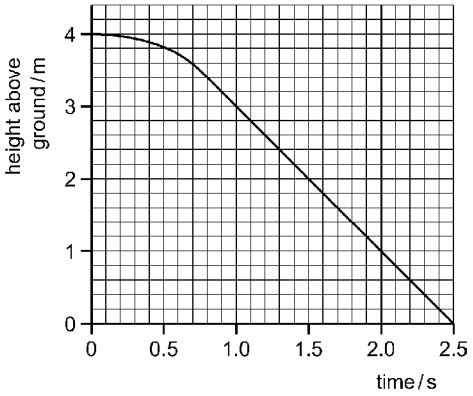
What is the acceleration?

A 0.5 m/s^2 **B** 0.7 m/s^2

C 1.2 m/s^2 **D** 1.7 m/s^2

[N13/P1/Q2]

9. The graph shows how the height of an object above the ground changes with time.



Thinking Process

MCQ Answers

5. **A** The gradient of a *v-t* graph gives the acceleration of a body. And the gradient (slope) of the graph at 30 second is zero. Hence, the acceleration is zero.

6. **D** The gradient (slope) of a speed time graph gives the acceleration. As the horizontal part D gives the zero acceleration. So it represents the skydiver falling with terminal velocity.

7. **B** Distance travelled
= area under the graph (trapezium)
$= \frac{1}{2} \times 10 \times (1+4)$
$= 25\text{m}$

8. **B** $a = \frac{v-u}{t}$
$= \frac{12-5}{10}$
$= 0.7\text{m/s}^2$

9. **D** Using the straight section of the distance-time graph,
the terminal (constant) velocity = gradient of the graph $= \frac{3-0}{2.5-1.0}$
$= \frac{3}{1.5} = 2$ m/s

What is the terminal velocity?

A 1.0 m/s **B** 1.3 m/s
C 1.6 m/s **D** 2.0 m/s

[N13/P1/Q3]

10. An object falls from rest through the air. Its velocity increases until it reaches terminal velocity.

Which quantity **increases** until its terminal velocity is reached?

A acceleration
B air resistance
C resultant force
D weight

[J14/P1/Q4]

11. A car travels along a road at 50 km/h.

The driver applies the same braking force at the same place on a day when the surface is dry and then on a day when the road is wet.

On the **wet** surface, how many of these distances are greater than on the dry surface?

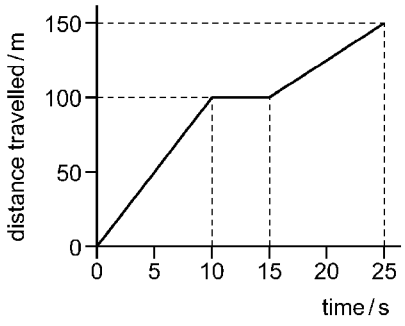
braking distance
stopping distance
thinking distance

A 0 **B** 1
C 2 **D** 3

[N14/P1/Q2]

12. A cyclist takes a ride lasting 25 s.

The diagram shows how her distance travelled from the starting position varies with time.



What is her average speed for the whole ride?

A 6.0 m/s **B** 7.5 m/s
C 10.0 m/s **D** 11.0 m/s

[J15/P1/Q3]

13. A car begins to move. It speeds up until it reaches a constant speed. It continues to travel at this constant speed for the rest of the journey.

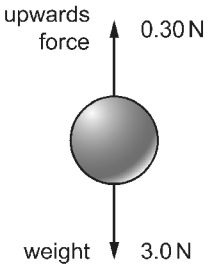
What happens to the acceleration and what happens to the velocity of the car during the journey?

A Both the acceleration and the velocity change.
B Only the acceleration changes.
C Only the velocity changes.
D Neither the acceleration nor the velocity changes.

[J15/P1/Q4]

14. A metal ball of mass 0.30 kg and weight 3.0 N is held so that it is below the surface of oil.

It experiences an upwards force of 0.30 N.



When the ball is released, what is its initial acceleration?

A 1.0 m/s^2
B 9.0 m/s^2
C 10 m/s^2
D 11 m/s^2

[J15/P1/Q5]

15. A student drops, from rest, a table-tennis ball in air.

What happens to the velocity and to the acceleration of the ball during the first few seconds after release?

	velocity	acceleration
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

[J15/P1/Q6]

Thinking Process

MCQ Answers

10. B Weight remains constant. Air resistance increases, which reduces the resultant force, which in turn reduces the acceleration of the object.

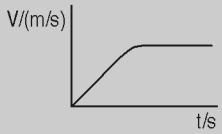
11. C Braking distance and stopping distance are increased by greater speed, icy or wet road conditions. But the thinking distance is independent of the conditions of the road.

12. A Average speed

$$= \frac{\text{total distance}}{\text{total time}}$$

$$= \frac{150}{25} = 6.0 \text{ m/s}.$$

13. A The graph shows the motion of a car.



It shows that the speed increases from zero to maximum value and the acceleration decreases from the maximum value to zero.

14. B Resultant force = mass × acceleration

$3.0 - 0.30 = 0.30 \times a$

$$a = \frac{2.7}{0.30}$$

$$= 9.0 \text{ m/s}^2$$

15. C The velocity of the ball increases with time due to the pull of gravity but this increase in velocity (i.e. acceleration) decreases with time due to the increase in air resistance, since air resistance $\propto$ velocity.

Topic 2 *Kinematics*

THEORY Section

Question 1

A ball rolls down a slope, as shown in Fig. 1.1.

The metre rule shows the position of the ball at times $t = 0$, 1.0 s, 2.0 s and 3.0 s.

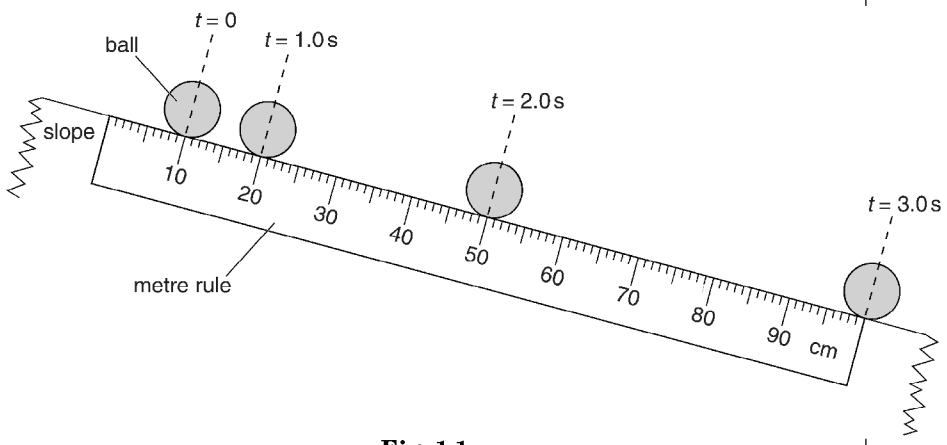


Fig. 1.1

(a) Explain how Fig. 1.1 shows that the ball is accelerating. [1]

(b) Calculate the average speed of the ball between t = 1.0 s and 3.0 s. [2]

(c) Two of the forces that act on the ball are air resistance and weight.
State what, if anything, happens to these forces as the ball accelerates. [2]

(d) Explain why, if the slope is long enough, the ball eventually reaches a constant speed. [1]

[J13/P2/Q1]

Solution

(a) A greater distance is covered by the ball in each second. Which means that the velocity of the ball is increasing every second.

(b) Average speed $= \dfrac{\text{total distance}}{\text{total time}}$

$= \dfrac{80}{2.0}$

$= 40$ cm/s or 0.40 m/s

(c) **air resistance:** It increases due to the increase in the speed of the ball.
weight: It remains constant.

(d) The backward and forward forces become equal. The resultant force becomes zero, so the speed becomes constant.

COMMENT on **ANSWER**

❝ **(a)** *Alternative Answer:*
The ball travels further in each second.

(d) As the ball accelerates, its speed increases. As a result the air resistance acting on the ball also increases and becomes equal to the forward force .
The resultant force then becomes zero and the ball then reaches a constant speed. ❞

Question 2

A children's ride consists of a steel cable that runs between two posts of different heights, as shown in Fig. 9.1.

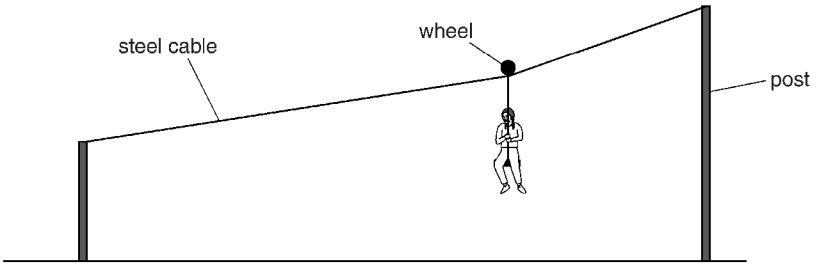
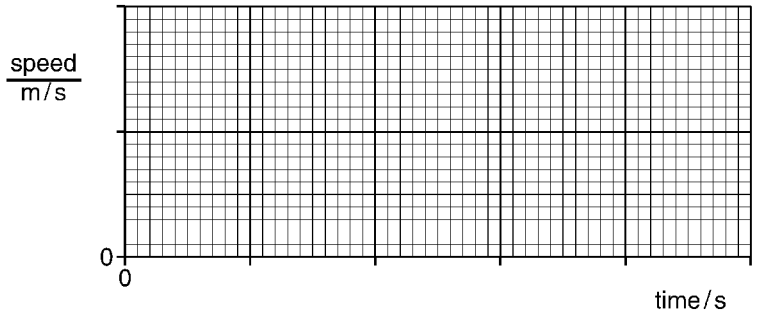


Fig. 9.1

A girl starts and finishes the ride at rest. Her horizontal motion can be taken as

- an initial uniform acceleration for 3.0 s, followed by
- a constant speed of 2.4 m/s for a further 5.0 s and
- a final uniform deceleration that lasts for 1.0 s.

(a) On Fig. 9.2, draw a speed-time graph of the horizontal motion.



[3]

(b) Explain what is meant by *uniform acceleration*. [2]

(c) The final deceleration is larger in size than the initial acceleration.
Explain how the data shows this. [1]

(d) Calculate the horizontal distance travelled by the girl in the first 8.0 s. [3]

(e) (i) The girl has a mass of 30 kg and falls a vertical distance of 1.6 m during the ride.
The gravitational field strength g is 10 N/kg.
Calculate the decrease in gravitational potential energy of the girl. [2]

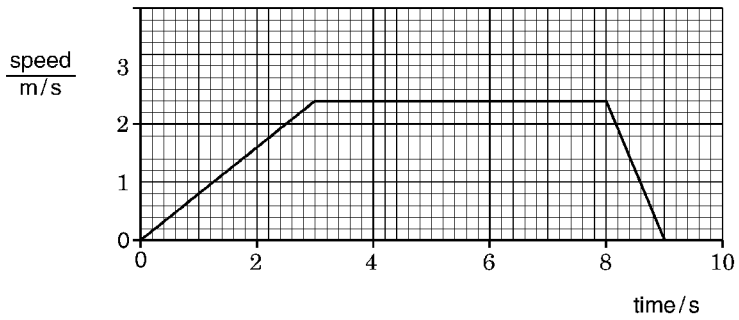
(ii) The gain in kinetic energy of the girl is less than the decrease in her potential energy.
Suggest one reason for this. [1]

(f) A group of pupils make measurements to show that the girl's speed is constant during the middle section of the ride.
Suggest what measurements are made and how they show that the speed is constant. [3]

[J14/P2/Q9]

Solution

(a)



(b) Uniform acceleration refers to a constant increase in velocity per unit time.

(c) Accelerating upto 2.4 m/s took three seconds whereas decelerating from 2.4 m/s to 0 m/s took just one second.

(d) Distance travelled = aea of trapezium

$$= \frac{1}{2} \times 2.4 \times (5 + 8) = 15.6 \text{ m}.$$

(e) (i) Decrease in potential energy = mgh

$$= 30 \times 10 \times 1.6 = 480 \text{ J}$$

(ii) Some energy may have been lost as thermal energy due to work done against air resistance.

(f) The middle section of the ride is marked, on the ground, at equal distances of 1 meter each. Using a stopwatch, time is recorded as the girl passes each of these marks. A distance-time graph is then plotted. A constant slope of the distance-time graph would indicate that the speed of the girl is constant during the middle section of the ride.

Question 3

A bungee jumper falls from a bridge above a river, as shown in Fig. 11.1.

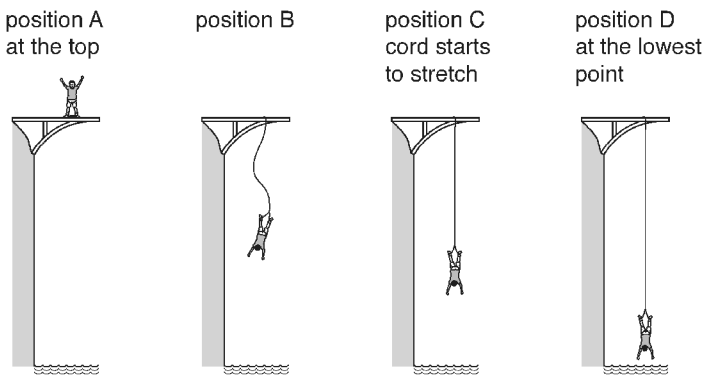


Fig. 11.1 (not to scale)

The man starts from position A in Fig. 11.1. The elastic cord starts to stretch at position C and he stops for the first time at position D. He continues to rise and fall.

Fig. 11.2 shows how the velocity of the man varies with time t.

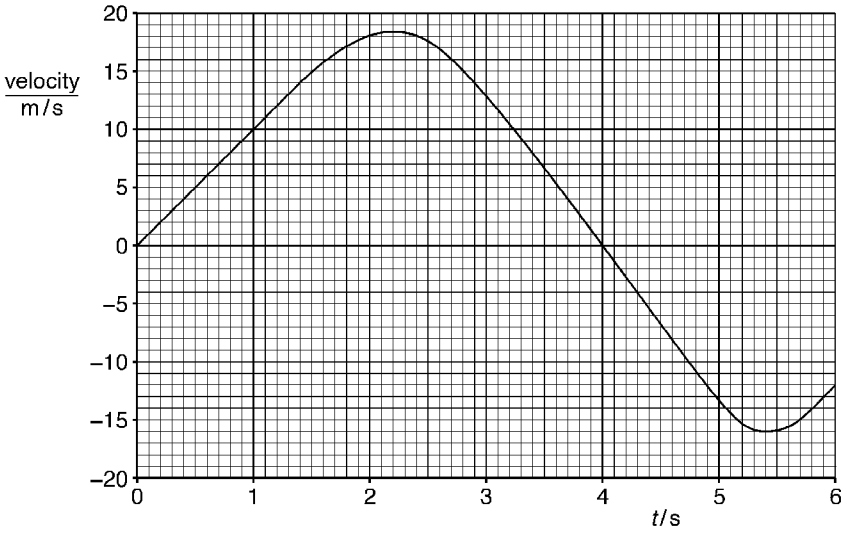


Fig. 11.2

(a) (i) State what is meant by *velocity*. [2]

(ii) State the difference between a positive velocity and a negative velocity. [1]

(iii) In the first 1.4 s the acceleration is uniform.

1. Using values from Fig. 11.2, determine the acceleration of the man in the first 1.4 s. [3]
2. Comment on your value of acceleration. [1]

(iv) 1. State the value of t when the man is at position D. [1]

2. Explain, in terms of the forces acting, why the man is accelerating upwards at D. [3]

(b) Fig. 11.3 shows the values for the gravitational potential energy of the man, the kinetic energy of the man and the elastic potential energy in the cord at A, C and D.

You may ignore the effect of air resistance in this question.

	gravitational potential energy / J	kinetic energy / J	elastic potential energy / J
position A	20 000	0	0
position C	15 000		0
position D	0	0	

Fig. 11.3

(i) Complete Fig. 11.3 to show the kinetic energy of the man at C and the elastic potential energy in the cord at D. [2]

(ii) The man has a mass of 50 kg.

The gravitational field strength g is 10 N / kg.

Using values from Fig. 11.3, calculate the vertical distance between A and C. [2]

[J15 / P2 / Q11]

Solution

(a) (i) The rate of change of displacement is called velocity.

(ii) The only difference between a positive velocity and a negative velocity is of their opposite direction.

(iii) 1. Acceleration, $a = \dfrac{v-u}{t}$

$$= \frac{14-0}{1.4-0} = 10 \text{ m/s}^2$$

2. This value is the same as the acceleration due to gravity.

(iv) 1. $t = 4.0$ s.

2. At position D, a downward force of gravity (weight) and an upward elastic force in the cord (tension) act on the man. But as this upward tension in the cord is greater than the downward force of gravity on the man, the resultant force is in the upward direction, so he accelerates upwards.

(b) (i)

	gravitational potential energy / J	kinetic energy / J	elastic potential energy / J
position A	20 000	0	0
position C	15 000	**5 000**	0
position D	0	0	**20 000**

(ii) P.E. $= mgh$

$5000 = 50 \times 10 \times h$

$h = 10$ m

COMMENT on **ANSWER**

"**(a)** **(i)** The velocity is also defined as:
— distance travelled per second in a given direction,
— displacement / time
— change in displacement per unit time,

(iii) *Alternatively:*
Acceleration in first 1.4 second = gradient of graph in first 1.4 seconds.

$a = \dfrac{14-0}{1.4-0}$

$= 10 \text{ m/s}^2$ "

Question 4

Fig. 1.1 shows the speed-time graph for a car travelling along a horizontal road.

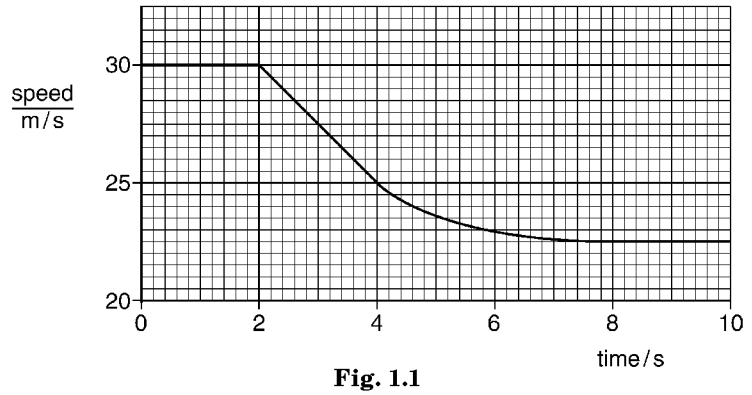


Fig. 1.1

(a) On Fig. 1.1, mark and label a point where the car has a non-uniform deceleration. [1]

(b) Calculate the deceleration of the car at $t = 3.0$ s. [2]

(c) Explain, in terms of the horizontal forces that act on the car, why its speed is constant at $t = 1.0$ s. [2]

[J16/P2/Q1]