Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

KINEMATICS
MCQ and STRUCTURED QUESTIONS

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.

2. Spend one minute on each mark.

3. Time yourself for every single question.

4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.

5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.

6. Highlight question types that you tend to keep making mistakes and review them nearing exams.

7. Always review the common questions and question type that you tend to make mistakes nearing exams.

8. During exams, classify the question type and recall what you have learnt, how you need to analvse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ **Wishing you all the best for this test!**

You’ve got this!

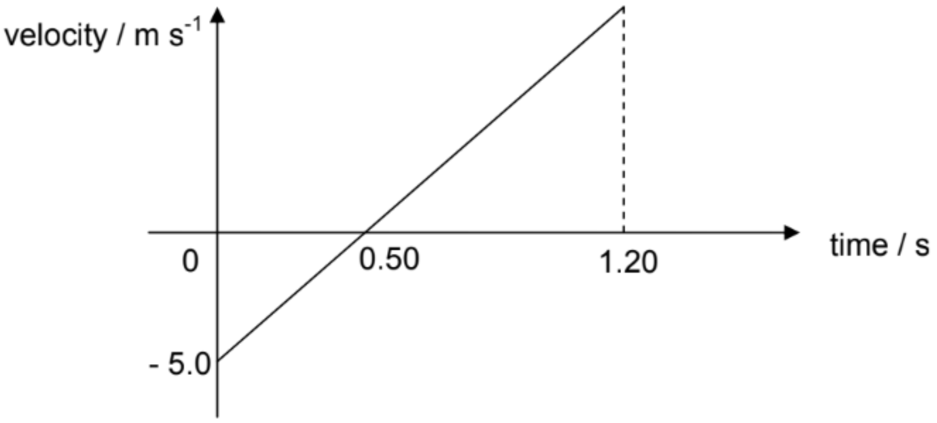
💡 **With lots of love,**
Bright Culture 💛

GOOD LUCK
FOR YOUR EXAM!

MARKS

KINEMATICS MCQ

1 A stone is tossed upwards and undergoes free fall. The diagram below shows its velocity-time graph from the point it was tossed.



What is the stone's final displacement from the point it was tossed?

A 7.2 m upwards **B** 3.7 m downwards

C 2.5 m upwards **D** 3.0 m downwards

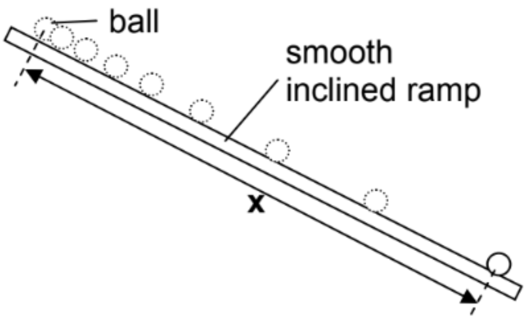
2 An object of mass 2.0 kg is released from a height and accelerates downwards due to gravity. It reaches terminal velocity before it touches the ground.

When the object reaches terminal velocity, what is the magnitude and direction of the net force acting on it?

A 0 N **B** 2.0 N downwards

C 20 N upwards **D** 20 N downwards

3 The diagram shows a sequential photograph of a ball rolling from rest down a smooth inclined ramp with an acceleration of 350 cm s-2. The camera was taking pictures at a constant rate of 20 frames per second.



What is the distance x moved by the ball along the inclined ramp?

A 28.0 cm

B 35.4 cm

C 56.0 cm

D 70.9 cm

4 A hot air balloonist drops a pencil over the side when the balloon is accelerating upwards with a magnitude of 4.0 m s-2.

If the sign convention for downwards direction is positive, what is the acceleration of the pencil once it is released?

A – 4.0 m s^{-2}

B + 6.0 m s^{-2}

C 10.0 m s^{-2}

D 14.0 m s^{-2}

5 An object is accelerating under the influence of a force F1 on a frictionless surface as shown in Fig. 3.1. A while later, an opposing force F2 of equal magnitude acts on the object as shown in Fig. 3.2.

Fig. 3.1

Fig. 3.2

Which of the following statements correctly describes the subsequent motion of the object?

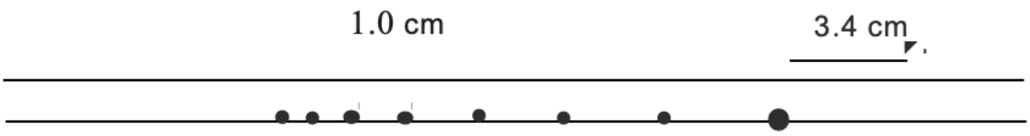
A The object will slow down.

B The object will come to a rest immediately.

C The object will move in the opposite direction.

D The object will continue moving at constant velocity.

6 The diagram below shows a ticker tape that was attached to the back of a trolley moving along a straight track to the left.



If the ticker timer makes 50 dots every second, what is the average acceleration of the trolley?

A 10 m s-2

B 12 m s-2

C 20 m s-2

D 24 m s-2

7 A cyclist moving at a speed of 5.0 m s-1 braked with uniform deceleration and stopped in 6.0 m. How long did she take to stop?

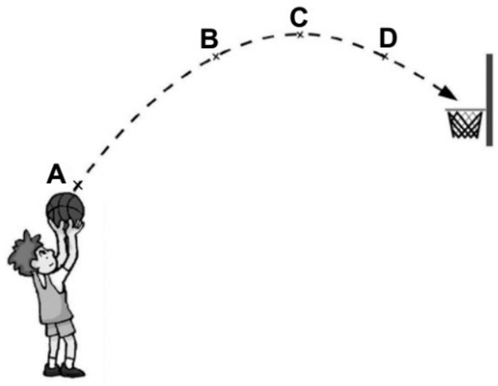
A 0.60 s

B 0.83 s

C 1.2 s

D 2.4 s

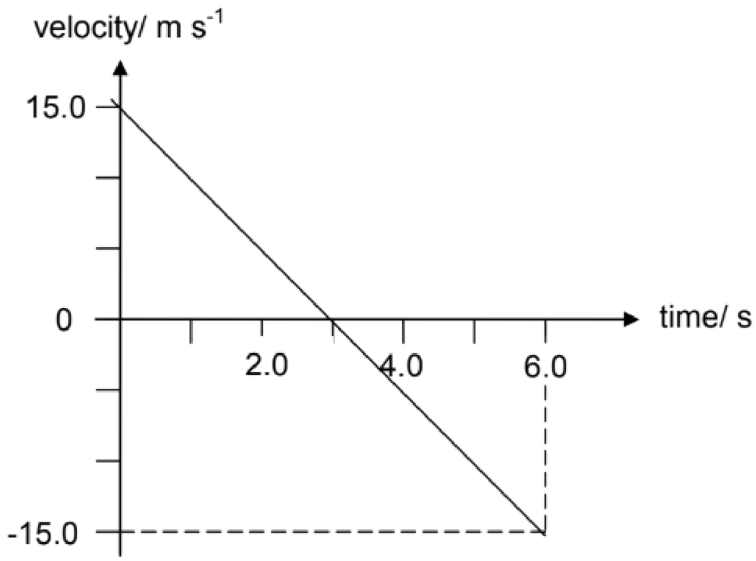
8 In the following figure, a player throws a basketball. **A, B, C** and **D** are points along the path of the ball. **C** is the highest point of the path of the ball, and **B** and **D** are at the same height.



At which point is the kinetic energy of the basketball the greatest?

For questions 9 and 10, please refer to the graph below.

The graph below shows how the velocity of a stone varied from the moment it was thrown vertically into the air.



9 How long did it take the stone to reach its highest point?

A	2.0 s	**B**	3.0 s
C	4.0 s	**D**	6.0 s

10 At the highest point, what is the displacement of the stone from its initial position?

A 15.0 m **B** 22.5 m

C 30.0 m **D** 45.0 m

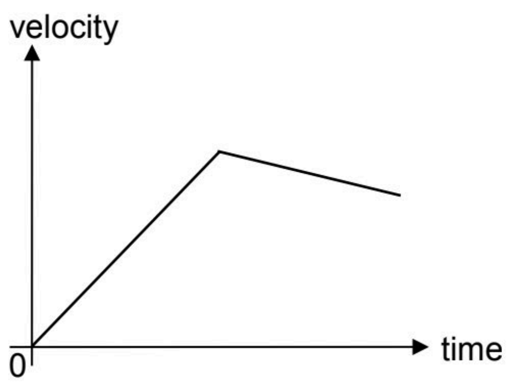
11 A car slows down uniformly to a stop from a speed of 60 km h^{-1} in 9.0 s. What is the braking distance of the car?

A 75 m **B** 150 m

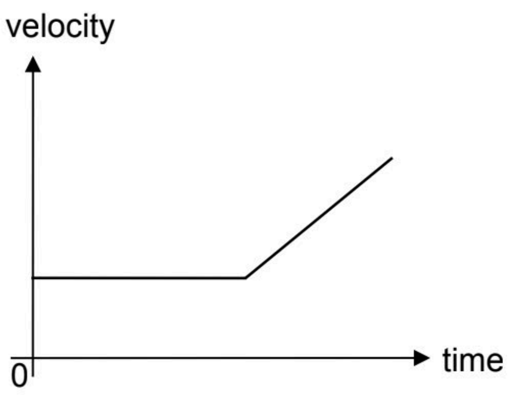
C 225 m **D** 270 m

12 Which of the following graphs shows an object that is travelling at a constant velocity before slowing down?

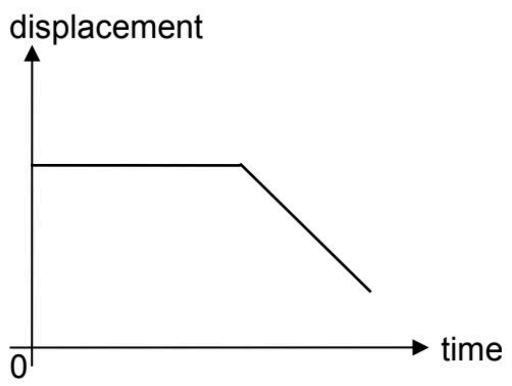
A



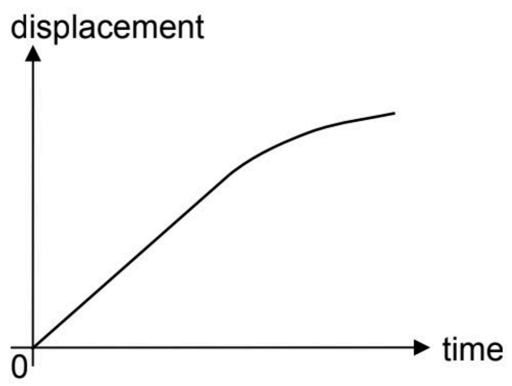
B



C



D

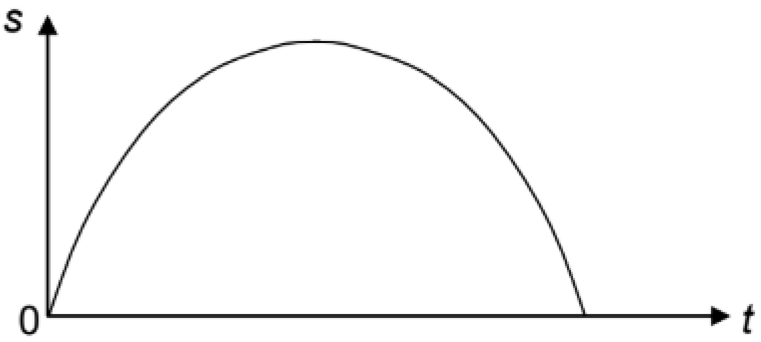


13 A ball is projected vertically upwards at 35 m s-1 from the top of a cliff and lands at the foot of the cliff 7.8 s later. Assume air resistance is negligible.

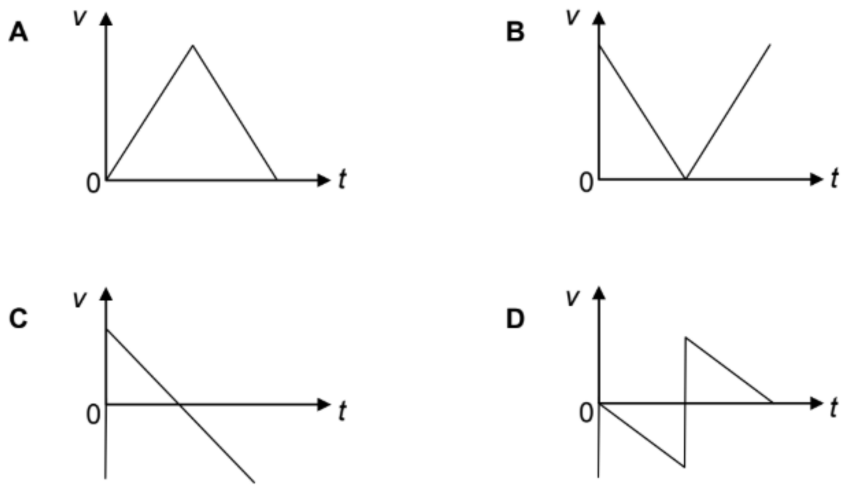
What is the height of the cliff?

A 31 m **B** 61 m **C** 300 m **D** 580 m

14 The diagram below shows a graph of displacement s against time t for a body moving in a straight line.



Which graph shows velocity v against time t for this body?



15 An object is moving on a smooth surface in a straight line at 12 m s-1 when a constant force in the opposite direction acts on it.

If the force is held constant for a long period of time, which of the following statements describes how the object will move?

A It will stop immediately.

B It will decelerate to a stop.

C It will decelerate to a stop and then move in the opposite direction with a constant speed.

D It will decelerate to a stop and then move in the opposite direction with a constant acceleration.

16 A puck moves with uniform deceleration on a straight air track. It passes two points S and T with speed 8.0 m s^{-1} and 2.0 m s^{-1} respectively.

If the puck passes through the two points within a time of 0.10 s, what is the distance between S and T?

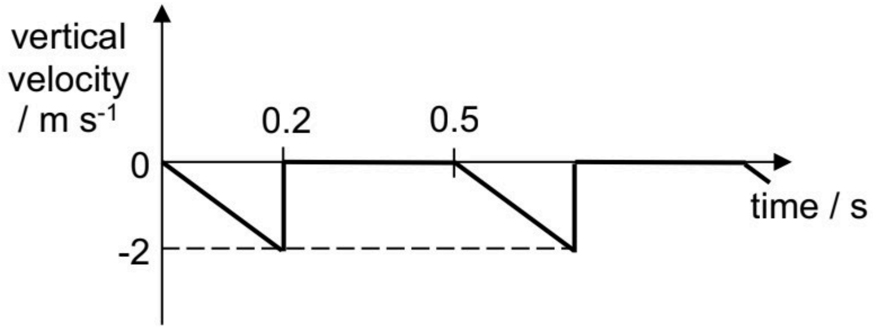
A 20 cm

B 30 cm

C 40 cm

D 50 cm

17 The graph shows the vertical velocity of a ball as it rolls down the steps of a flight of stairs.



What are the heights of each step and the length of each step?

	height of step	length of step
A	0.2 m	0.3 m
B	0.3 m	0.5 m
C	0.2 m	cannot be determined
D	0.3 m	cannot be determined

18 A ball is thrown at an angle of 42.0° from the horizontal with an initial velocity of 37.0 m s^{-1} and reaches a maximum height h. Neglect air resistance.

With what initial speed must the ball be thrown vertically upwards to reach the same maximum height h?

A 23.2 m s^{-1}

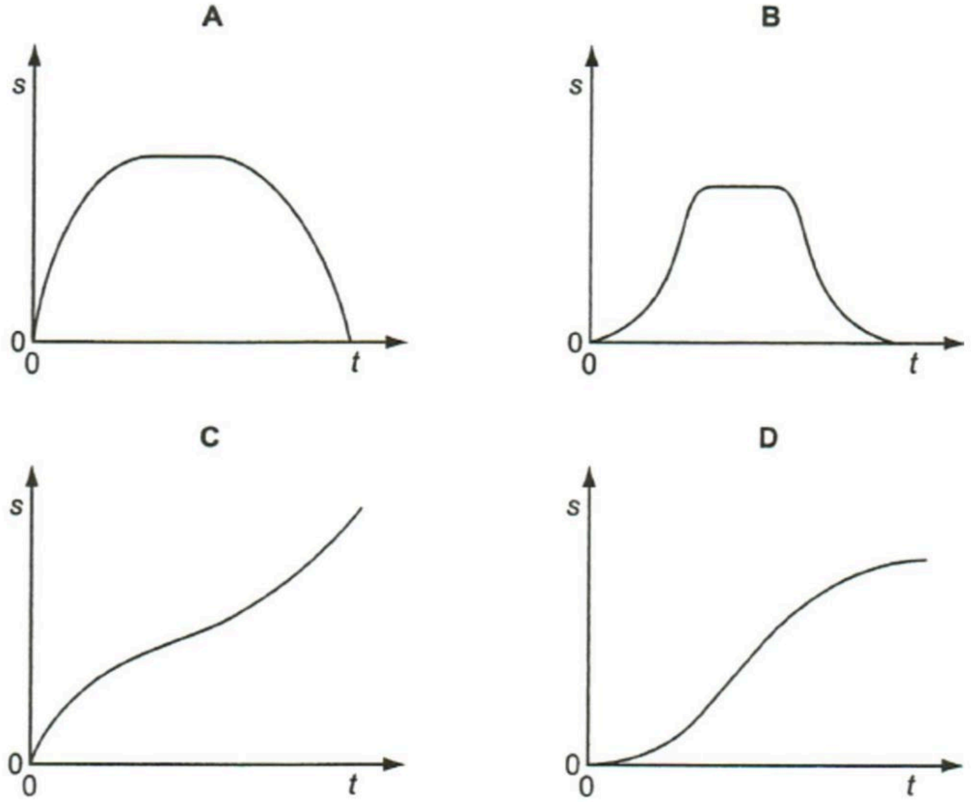
B 24.8 m s^{-1}

C 25.3 m s^{-1}

D 27.5 m s^{-1}

19 A cyclist accelerates down a hill and then travels at constant speed before decelerating as he climbs back up another hill.

Which graph shows how the distance *s* travelled by the cyclist varies with time *t* ?

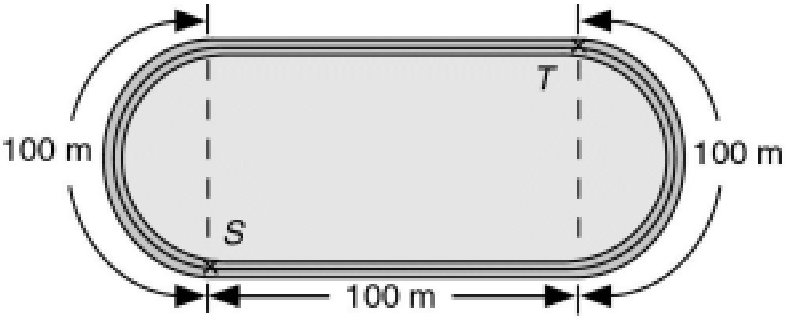


20 A man stands on the edge of a cliff. He throws a stone upwards with a velocity of 20 m s^{-1} at time t = 0 s. The stone reaches the top of its trajectory after 2.0 s and then falls towards the bottom of the cliff. Air resistance is negligible.

Which row shows the correct velocity *v* and acceleration *a* of the stone at different times?

	t / s	v / m s^{-1}	a / m s^{-2}
A	1.0	10	10
B	2.0	0	0
C	3.0	10	-10
D	5.0	- 30	-10

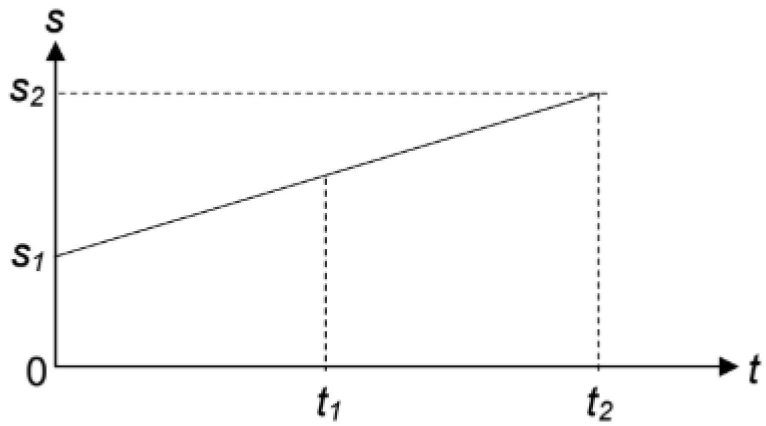
21 In a 1.0 km run, a student starts from *S* and ends at *T* as shown in the diagram below.



What is the magnitude of her displacement?

A 119 m **B** 200 m **C** 400 m **D** 600 m

22 The diagram below shows a graph of displacement s against time t for an object moving in a straight line.



If t_1 is half of t_2, which of the following expressions gives the velocity of the object?

A $s_2\ t_2$

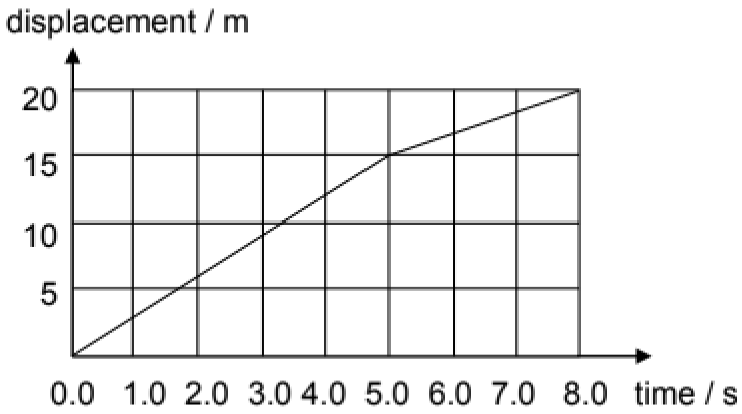
B $s_2 - s_1\ t_2$

C $s_2 - s_1\ t_1$

D $s_2 - s_1\ t_2 - t_1$

23 The graph below shows the displacement of a car over an 8.0 s period.

displacement / m



What is the average velocity of the car?

A 0.40 m s^{-1} **B** 2.5 m s^{-1}

C 5.0 m s^{-1} **D** 11 m s^{-1}

24 Which of the following is **not** possible?

A A car is travelling at a constant velocity along a circular path.

B The speed of a car is constant but its velocity is changing.

C An accelerating car has a constant speed.

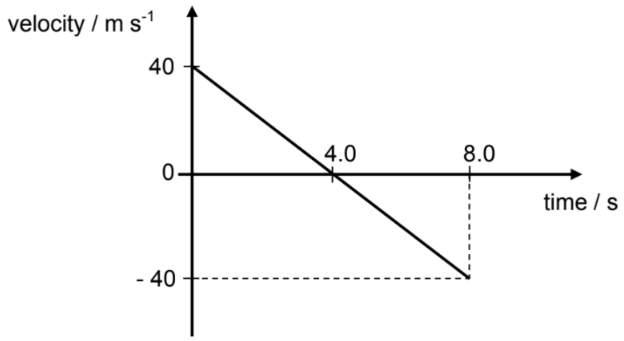
D A car is turning a corner and its speed remains constant.

25 An MRT train, 80.0 m long, stops in a station with its front end in line with the end of the platform. Later it starts off with a constant acceleration of 0.800 m s^{-2}. What is the speed of the train when the tail end of the train passes the end of the platform?

A 10.2 m s^{-1} **B** 102 m s^{-1}

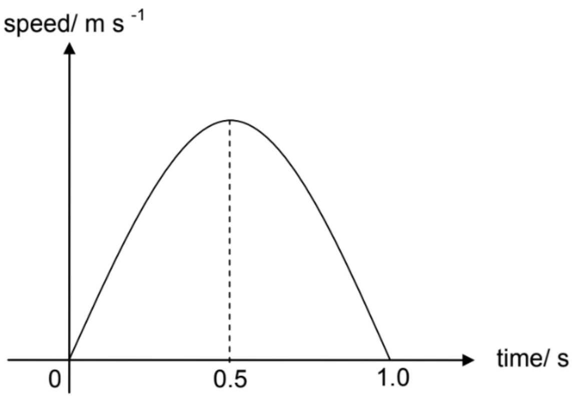
C 11.3 m s^{-1} **D** 128 m s^{-1}

26 The velocity-time graph shows how the velocity of an object varies with time. What are the acceleration and the displacement of the object over the 8.0 s?



	acceleration / m s^{-2}	displacement / m
A	-10	0
B	-10	160
C	10	0
D	10	160

27 The speed-time graph of an oscillating pendulum is shown below.



What is the frequency of the oscillation?

A 0.5 Hz **B** 1.0 Hz **C** 1.5 Hz **D** 2.0 Hz

28 A man standing on the balcony of his house throws a ball vertically upwards. The ball reaches the maximum height after 2.0 s before dropping to the ground below. Take the upward direction as positive and assume air resistance is negligible.

Which of the following statements about the motion of the ball is **incorrect**?

A The acceleration throughout the motion is –10 m s^{-2}.

B The velocity at the maximum height is 0 m s^{-1}.

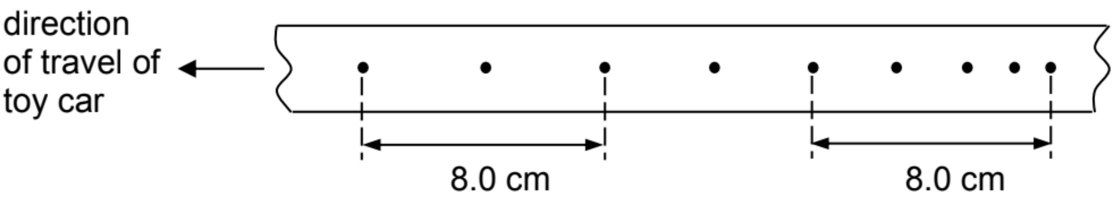
C The ball left the hand at a velocity of 20 m s^{-1}.

D The ball will hit the ground at a velocity of –20 m s^{-1}.

29 In the diagram below, a car is travelling to the left and petrol is leaking from the car at a constant rate of 1 drop every 0.5 s.

A – 6.7 m s^{-2} **B** – 4.4 m s^{-2} **C** 4.4 m s^{-2} **D** 6.7 m s^{-2}

30 A ticker-tape timer is used to investigate the movement of a toy car. The frequency of the timer is 50 Hz and a portion of the tape is shown below.



What is the average deceleration of the toy car?

A 0.0 m s^{-2} **B** 6.3 m s^{-2}

C 10.0 m s^{-2} **D** 25.0 m s^{-2}

31 A car is initially moving with negative velocity and maintains a constant negative acceleration. Which statement must be true?

A The car will change direction during its motion.

B The car is slowing down.

C The displacement of the car is increasing.

D The speed of the car is increasing.

32 A ball is thrown vertically upwards at time t = 0 s. It passes a window, on its way up, at time t = 1.2 s. It passes the same window, on the way back down, at time t = 2.0 s.

What was the initial speed of the thrown ball?

A 8.0 m s^{-1} **B** 12 m s^{-1}

C 16 m s^{-1} **D** 20 m s^{-1}

33 A 120 m long MRT train stops at a station with its front end in line with a signal- post. Later it starts off with a constant acceleration of 0.80 m s-2.

What is the speed of the train when the rear end of the MRT train passes the same signal-post?

A 12 m s-1 **B** 14 m s-1

C 48 m s-1 **D** 96 m s-1

34 The following table shows the distance of a marble from a fixed point at intervals of two seconds as it moves along a straight path.

time / s	0.0	2.0	4.0	6.0
distance / m	2.0	3.0	6.0	11.0

Which of the following statements about the motion of the marble is correct?

A The speed of the marble is constant.

B The acceleration of the marble is constant.

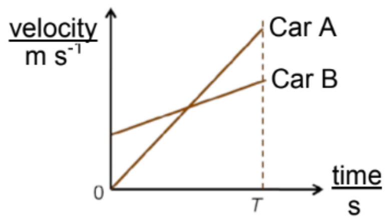
C The acceleration of the marble is increasing.

D None of the above statements is true.

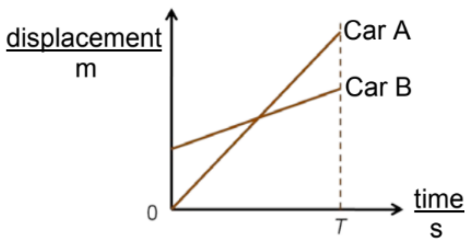
35 Car A is at rest in front of a traffic light. As the light turns green, Car A accelerates forward. At the exact same instant, Car B overtakes Car A at the traffic light. Both cars continue to accelerate uniformly. After T seconds, Car A catches up with Car B.

Which of the following graphs best describes the motion of the two cars after passing the traffic light?

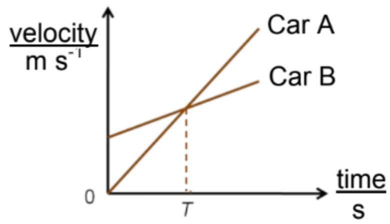
A



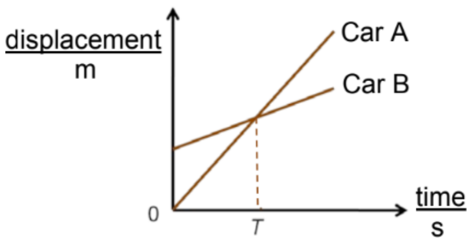
B



C



D



36 A ball is thrown vertically upwards at a velocity of 12 m s-1. The ball rises to the highest point. Which of the following statements is false for the marble at this point?

A The magnitude of the acceleration of the ball is 10 m s-2.

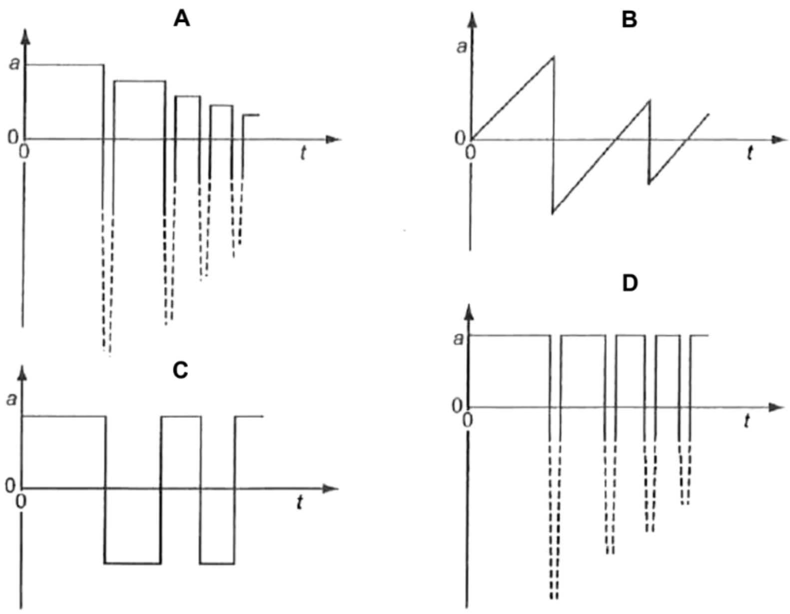
B The velocity of the ball is 0 m s-1.

C The time taken to rise to this point is 1.2 s.

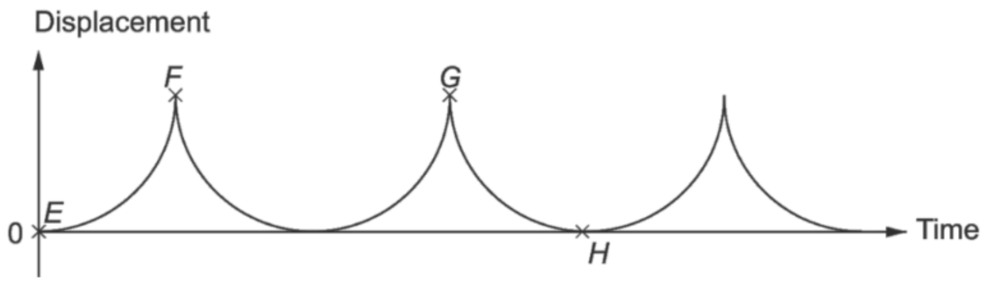
D The ball has travelled a distance of 14.4 m.

37 A steel ball is released from rest at a distance above a rigid horizontal surface and is allowed to bounce.

Which graph best represents the variation with time t of acceleration a?



38 The following is a displacement-time graph of a ping-pong ball that is released from a height of 1 m above a table with zero initial speed. The ping-pong ball bounces several times.



Neglecting the air resistance, which point in the graph represents the second bounce?

A E

B F

C G

D H

39 A ball is thrown at an angle of 37.0° from the horizontal with an initial velocity of 23.0 m s-1 and reaches a maximum height h. Neglect air resistance.

With what initial speed must the ball be thrown vertically upwards to reach the same maximum height h?

A 13.8 m s-1 **B** 17.3 m s-1

C 18.4 m s-1 **D** 23.0 m s-1

40 A puck moves with uniform acceleration on a straight air track (frictionless). It passes two points A and B with speed 2.0 m s-1 and 8.0 m s-1 respectively.

If the puck passes through the two points within a time of 0.1 s, what is the distance between A and B?

A 20 cm

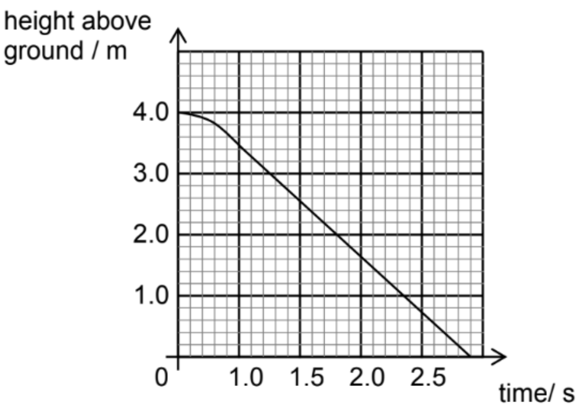
B 30 cm

C 40 cm

D 50 cm

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

What is the magnitude of the terminal speed of the object?



A 3.5 m s-1

B 1.8 m s-1

C 1.4 m s-1

D 1.2 m s-1

KINEMATICS STRUCTURED QUESTIONS

1 An object moves along a straight path. The table below shows the variation of time t and the displacement ***s*** of the object.

t /s	0	5	10	15
s / m	10	35	110	235

(a) Explain how the data in the table above show that the object is accelerating.

....

.... [1]

(b) Calculate the average speed of the object.

average speed = ... [2]

2 Fig. 1.1 shows the velocity-time graph of an object travelling in a straight line.

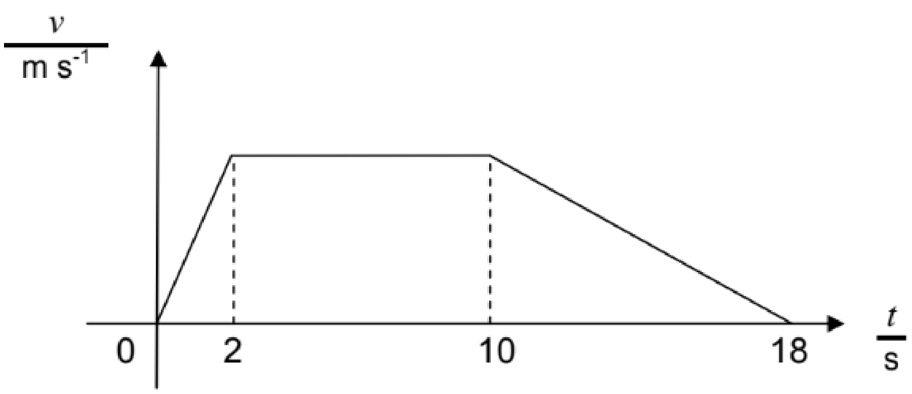
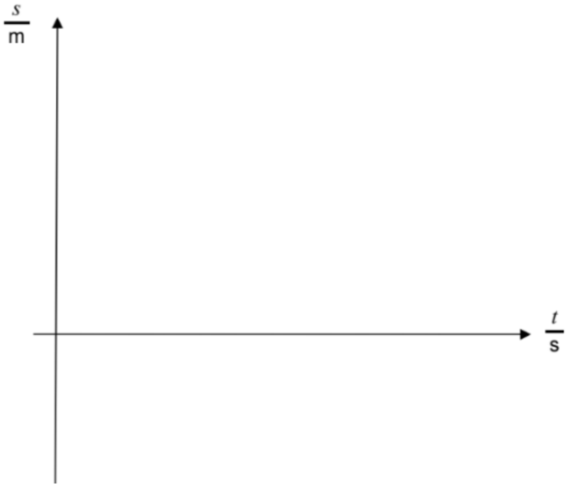


Fig. 1.1

(a) Describe the object's state of motion for the first 2 s.

.... [1]

(b) On the axes given below, sketch the shape of the displacement-time graph of the object for its first 10 s of motion, labelling the time clearly. You are not required to calculate the exact value of the displacement. [2]



3 A man stands at the edge of a cliff and throws a stone vertically upwards. The stone takes 2.4 s to reach the highest point and another 3.8 s to hit the water surface below.

(a) Calculate the velocity of the stone when it leaves the man's hand.

initial velocity = ...[1]

(b) Calculate the height of the cliff above the water surface.

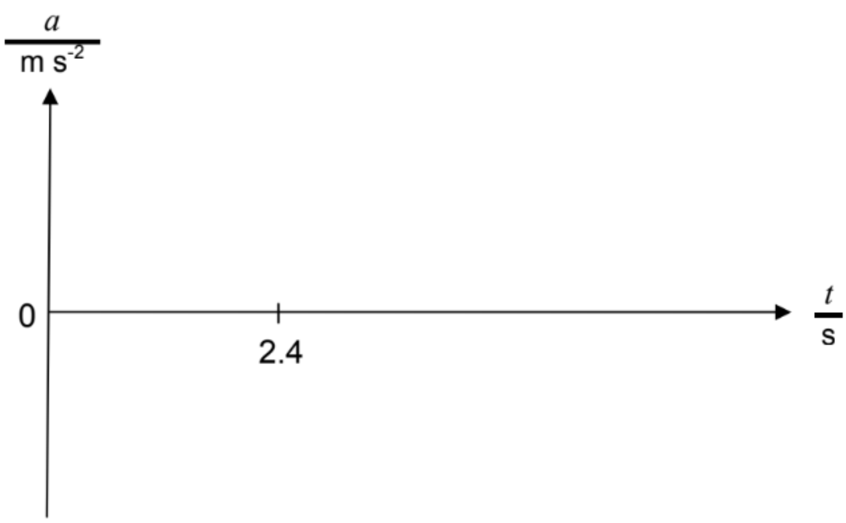
height of the cliff = ...[2]

(c) State an assumption made in calculating (a) and (b) above.

....

....[1]

(d) Sketch the acceleration-time graph of the stone throughout its motion. [2]



4 The graph Fig. 16.1 shows the variation of velocity v with time t of a rubber ball that is dropped from a certain height on planet X.

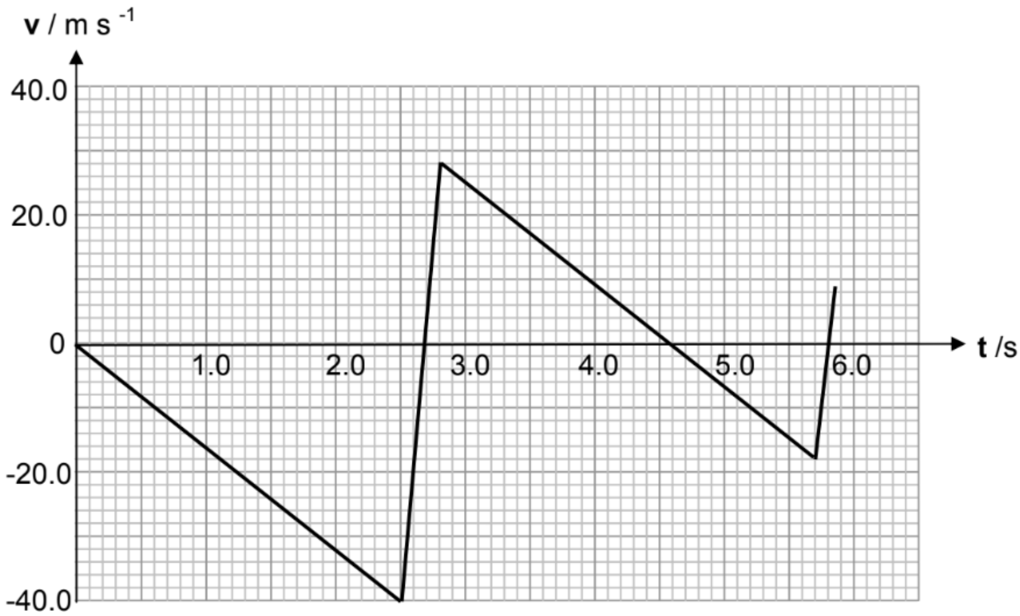


Fig. 16.1

(a) State the sign convention chosen for the graph.

....[1]

(b) Mark on the time axis the point M at which the ball is at maximum height after the first bounce. [1]

(c) Calculate the magnitude of the gravitational acceleration on planet X.

Gravitational acceleration = ... [2]

(d) Calculate the displacement of the ball when it is at time M.

Displacement = ... [2]

(e) State one change to the graph if instead of the rubber ball, a steel ball is dropped from the same height on planet X.

....

....

....

.... [1]

5 Fig. 1.1 shows the velocity-time graph of a ball being thrown vertically downwards at a certain height above the ground. You may assume that there is no air resistance as the ball travels.

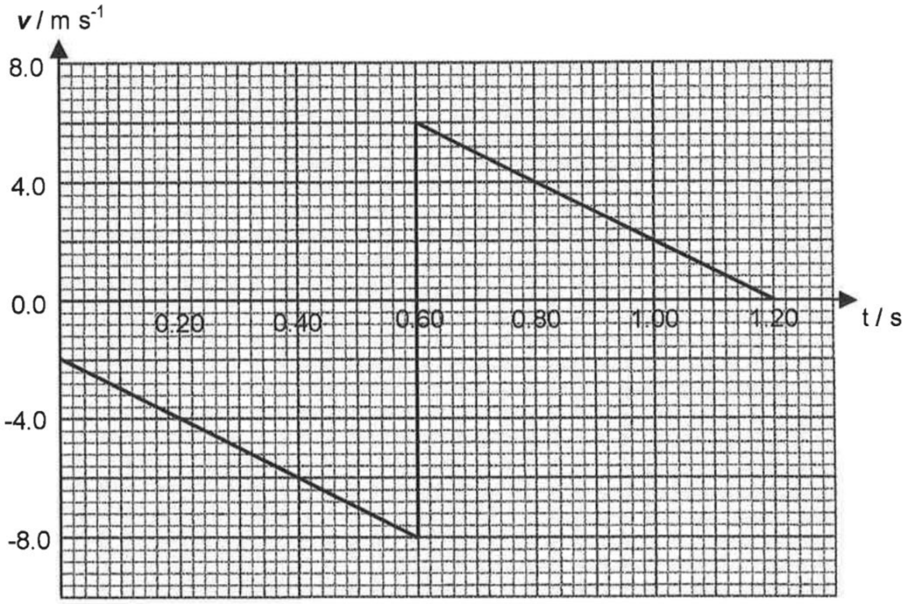


Fig. 1.1

a State the sign convention of the graph in Fig. 1.1. [1]

b Describe the motion of the ball from t=O s to 1.2 s. [2]

c Calculate the height above the ground at which the ball was thrown. [2]

d Calculate the displacement of the ball from t=O s to 1.2 s. [2]

6 A car's engine was leaking oil. As the car moved, the oil drops dripped onto the road at regular time intervals, once every 2 s.

Fig. 1.1 shows the pattern of oil drops left on the road and the distance of subsequent drops from the first drop.

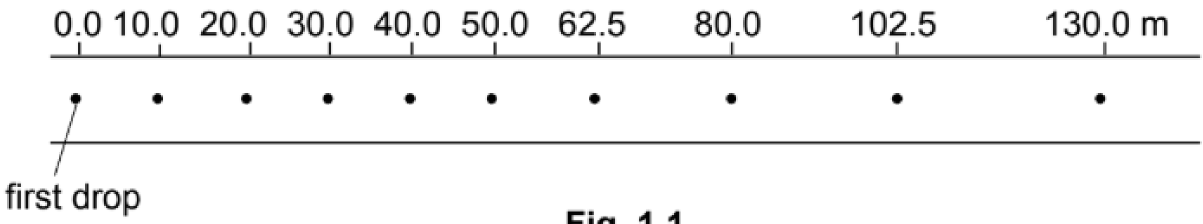


Fig. 1.1

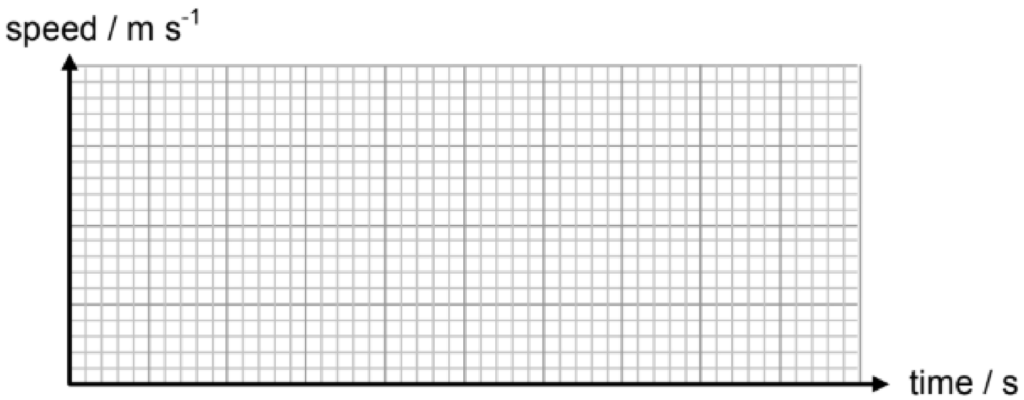
(a) Describe the motion of the car for the first 50.0 m of the journey.

....[1]

(b) Calculate the acceleration of the car after it passed the 50.0 m mark.

acceleration = ... [3]

(c) On Fig. 1.2, draw a graph of speed against time as the car travelled from the 0.0 m mark to the 130.0 m mark. [2]



7 An object is projected up a rough inclined plane with an initial velocity of 27 m s-1 and returns to its starting point 20.0 s later with a final velocity of -18 m s-1.

Fig. 1.1 below shows the velocity-time graph for the motion of the object.

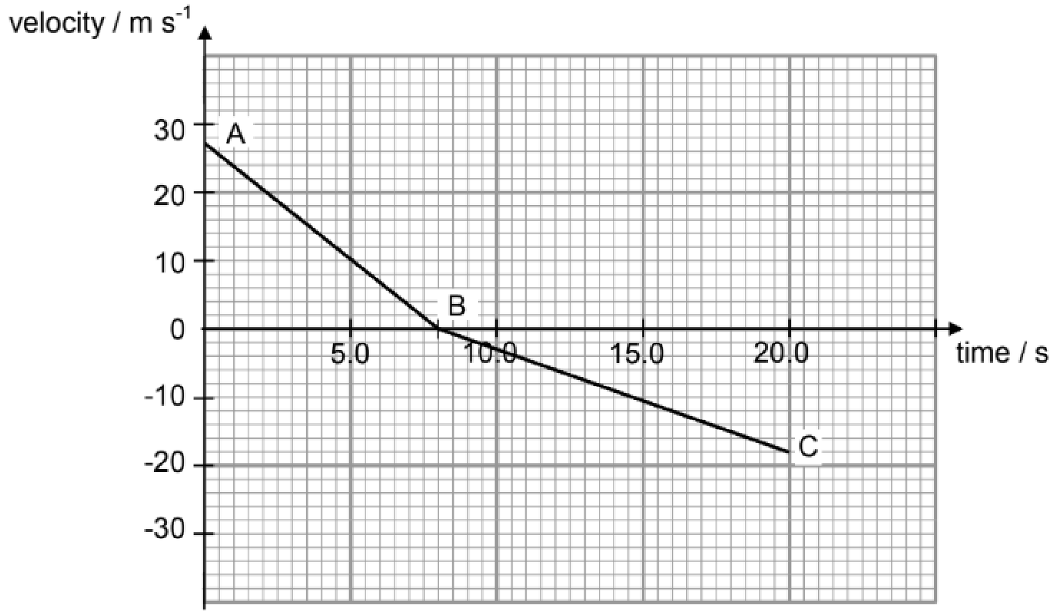


Fig. 1.1

(a) Compare the motion of the object in section AB with its motion in section BC of the graph.

....

....

....

....

.... [2]

(b) Calculate the acceleration for

(i) section AB, and acceleration for section AB = ...[1]

(ii) section BC, acceleration for section BC = ...[1]

(c) On Fig. 1.2 below plot the acceleration-time graph for the object over 20 s. [1]

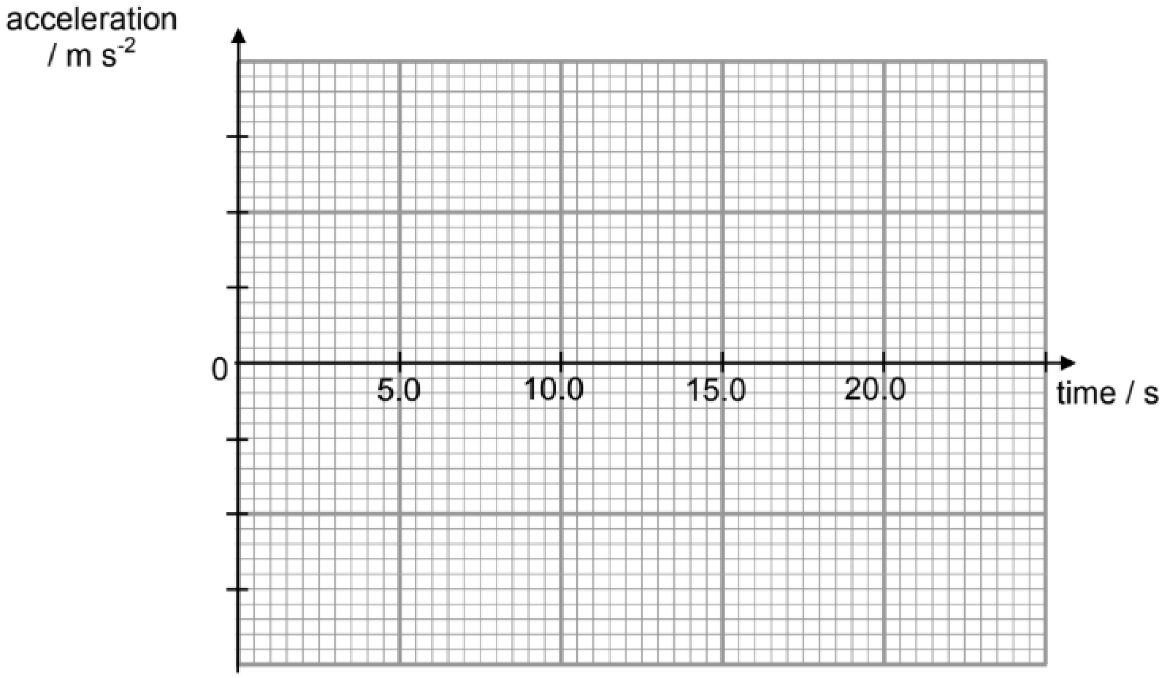


Fig. 1.2

(d) Explain the cause of any change in the acceleration of the object over 20 s.

....

....

.... [1]

8 A ball is dropped from a very tall building.

(a) Using the axes below, sketch a speed-time graph to show the motion of the ball falling without the effect of air resistance (before hitting the ground).

Label this graph A. [1]

(b) On the same axes above, sketch a speed-time graph to show the motion of the same ball falling under the effect of air resistance (before hitting the ground).

Assume that it attains terminal velocity before hitting the ground.

Label this graph B. [1]

9 Fig. 4.1 shows the speed-time graph of car J travelling along a straight road.

(a) Calculate the initial acceleration of car J in S.I. units.

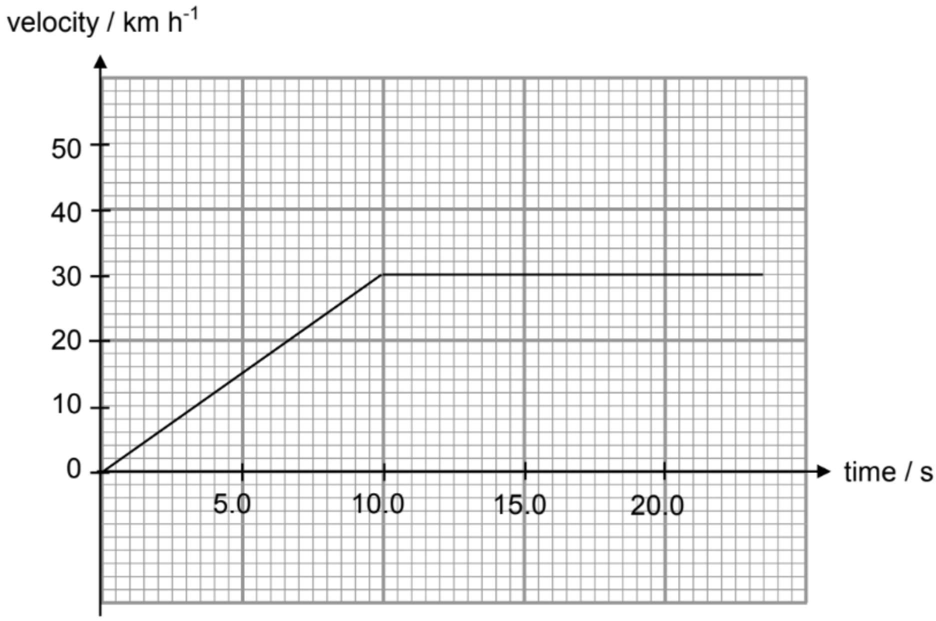


Fig. 4.1

acceleration = ...[2]

(b) Car K accelerates uniformly from rest at t = 0 s and meets car J at 15.0 s.

Calculate the velocity of car K at 15.0 s.

velocity of car K = ...[2]

10 Boy A throws a ball upwards at a velocity of 15 m s-1.Boy B, who stands on a balcony above Boy A, catches the ball 2.0 s later. Neglect air resistance.

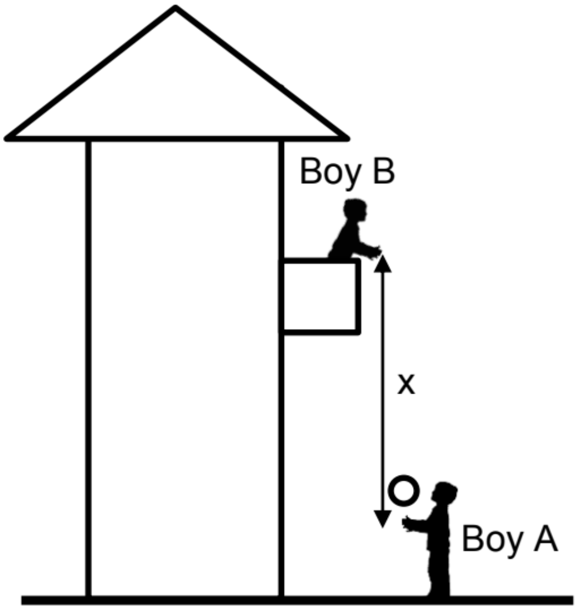
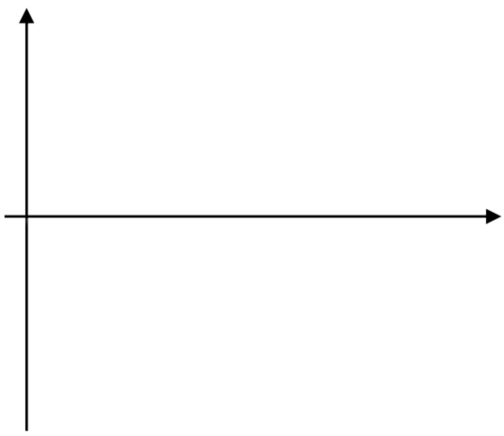


Fig. 1.1

(a) In the space below, sketch a velocity – time graph of the ball from the time it leaves the hands of Boy A until Boy B catches it. State the sign convention adopted and label key values on the axes. Show all necessary working.



sign convention: ....[3]

(b) Using the graph or otherwise, determine the distance x, as shown in Fig. 1.1.

x = ... [2]

11 Fig. 1.1 shows a strip of paper tape that has been pulled under a ticker-tape timer by a toy car moving to the right. The timer vibrates regularly, making 5 dots per second.

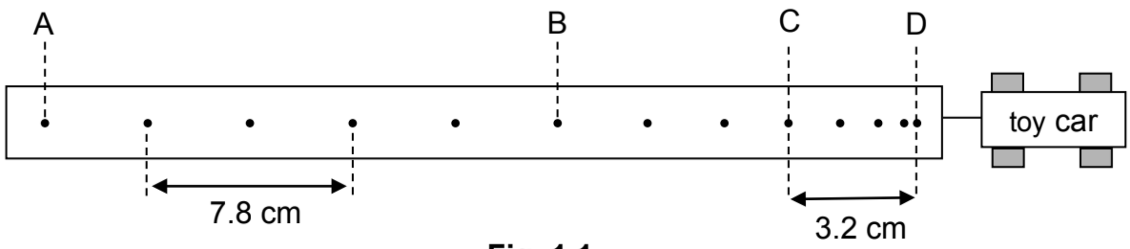


Fig. 1.1

(a) Explain how the dots show that the toy was moving at a constant speed in the region AB.

....

.... [1]

(b) Assuming the toy car accelerates uniformly from B to D, calculate the acceleration of the toy in the region BD.

acceleration = ... [3]

12 Two cars start from rest at the same point along a straight racetrack. Car A starts from rest and accelerates constantly. Car B accelerates rapidly for 3.0 s and then maintains a constant speed.

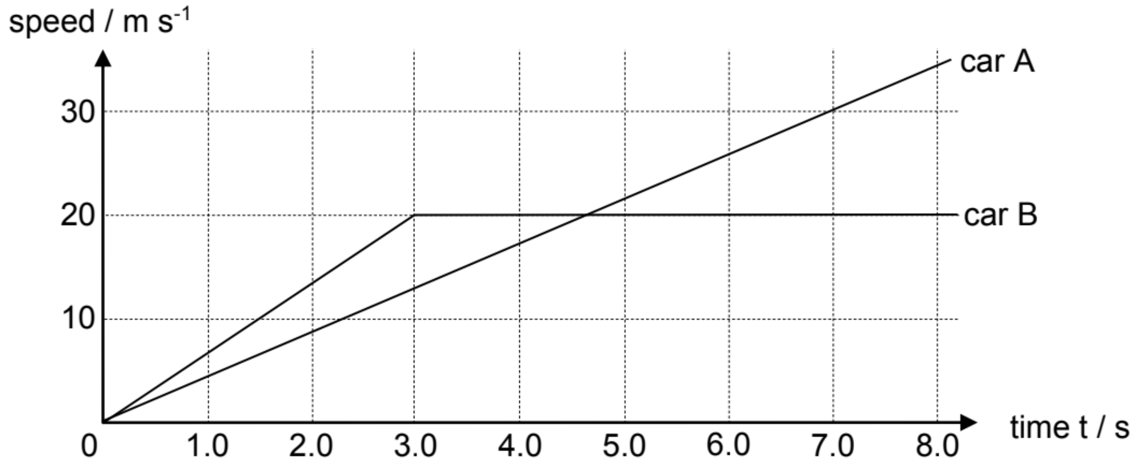


Fig. 1.1

(a) Determine the acceleration of car A.

acceleration of car A = ... [1]

(b) Calculate the time at which the two cars have the same speed.

time = ... [2]

(c) Given that the winning car crosses the finish line at t = 6.5 s, determine which car has won the race. Show all necessary calculations.

Car .... has won the race. [3]

13 Fig 10.1 shows how the vertical velocity of a ball falling through the air varies with time.

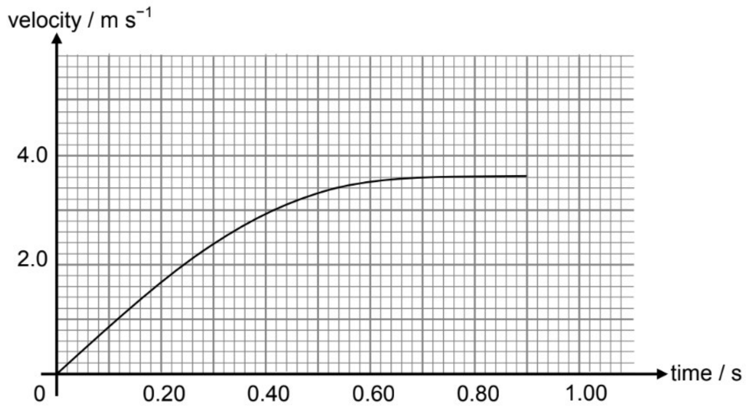


Fig 10.1

The mass of the ball is 25 g and the gravitational field strength can be assumed to be constant at 10 N kg^{-1}.

(a) On Fig. 10.1, draw a line to show the variation of the vertical velocity with time of the ball if it were falling from rest in a vacuum.

[1]

(b) Use Fig 10.1 to determine the acceleration of the ball at 0.50 s. Show all the required construction on Fig. 10.1.

acceleration at 0.50 s = ... [2]

(c) Calculate the magnitude of maximum air resistance that acts on the ball.

magnitude of maximum air resistance = ... [1]

(d) Determine the magnitude of the air resistance that is acting on the ball at 0.50 s.

magnitude of air resistance = ... [2]

(e) The ball hits soft ground and decelerates uniformly at 150 m s^{-2}.

Determine

(i) the time taken for the ball to come to a complete stop, and

time = ... [2]

(ii) the distance moved by the ball into the soft ground.

distance = ... [2]

14 A firework leaves the ground with an intial velocity of 45 m/s, travelling vertically upwards. When it reaches a height of 100 m, it fails to explode and falls back down the same vertical path to the ground.

At any point on its path, the firework has both a speed and a velocity.

(a) Explain the difference between speed and velocity.

....

.... [1]

(b) Fig. 1.1 shows the displacement-time graph for the first 5.0 s of the motion.

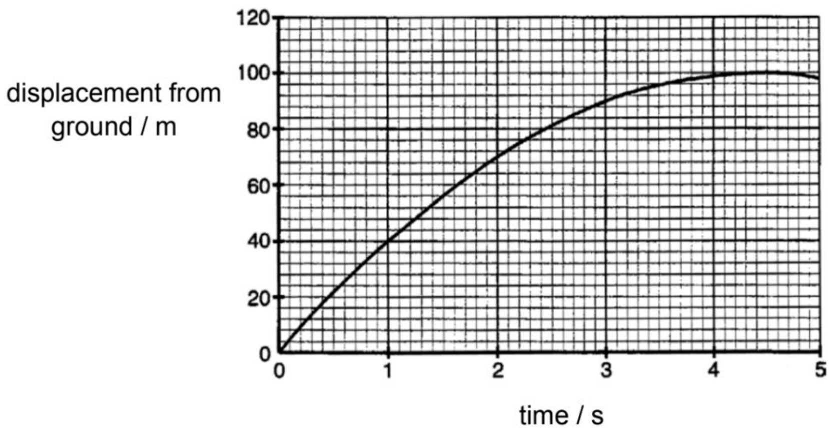


Fig. 1.1

(i) Determine the time taken for the firework to reach the maximum height.

time taken = ... [1]

(ii) Describe the motion of the firework for the first 5.0 s of its journey.

....

....

....

....

[2]

(c) The air resistance acting on the firework is negligible.

The table below is for the magnitude and direction of the acceleration of the firework. Complete the table. Give the unit for the magnitude of any acceleration that you write down.

	magnitude	direction
as the firework moves upwards		
at maximum height		

[2]

(d) In another situation, the firework falls vertically in a horizontal wind.

Fig. 1.2 shows the horizontal and vertical velocity of the firework, drawn to a scale where a length of 1.0 cm represents a speed of 10 m/s.

On Fig 1.2, draw the resultant velocity of the firework. Label it with the letter R and its magnitude. Give your answer to a suitable number of significant figures.

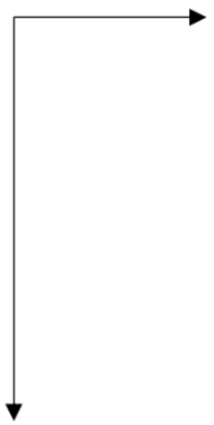


Fig. 1.2 (to scale)

[2]

[Total: 8]

ANSWERS FOR KINEMATICS MCQ

Q1: D	Q11: A	Q21: A	Q31: D	Q41: B
Q2: A	Q12: D	Q22: B	Q32: C	
Q3: A	Q13: A	Q23: B	Q33: B	
Q4: C	Q14: C	Q24: A	Q34: B	
Q5: D	Q15: D	Q25: C	Q35: A	
Q6: B	Q16: D	Q26: A	Q36: D	
Q7: D	Q17: C	Q27: A	Q37: D	
Q8: A	Q18: B	Q28: D	Q38: C	
Q9: B	Q19: D	Q29: B	Q39: A	
Q10: B	Q20: D	Q30: C	Q40: D	

ANSWERS FOR KINEMATICS STRUCTURED QUESTIONS

1 An object moves along a straight path. The table below shows the variation of time t and the displacement ***s*** of the object.

t /s	0	5	10	15
s / m	10	35	110	235

(a) Explain how the data in the table above show that the object is accelerating.

The data shows that change in the displacement is increasing for every consecutive 5 s interval/ rate of change of displacement is increasing. Hence, object must be accelerating. [1]

(b) Calculate the average speed of the object.

Average speed = total distance ÷ total time = (235 – 10) m ÷ 15 s = $\underline{15\text{ m s}^{-1}}$

average speed = $\underline{15\text{ m s}^{-1}}$ [2]

2 Fig. 1.1 shows the velocity-time graph of an object travelling in a straight line.

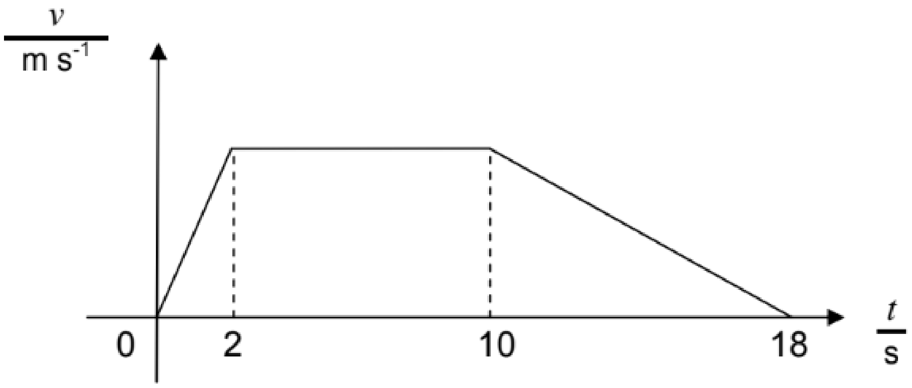


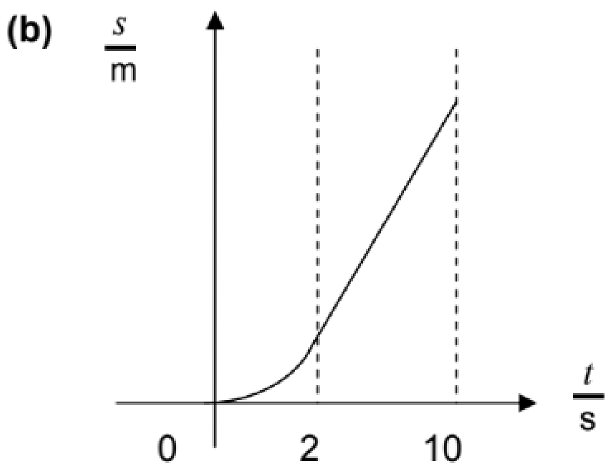
Fig. 1.1

(a) Describe the object's state of motion for the first 2 s.

The object is undergoing uniform/constant acceleration/ speed is increasing at a constant rate. Do not accept: constantly accelerating, or accelerating constantly.

[1]

(b) On the axes given below, sketch the shape of the displacement-time graph of the object for its first 10 s of motion, labelling the time clearly. You are not required to calculate the exact value of the displacement. [2]



Correct curvature of lines for t in (0,2) [1]

Slanted straight line for t in (2,10) [1]

Deduct 1 mark if gradient at t=2 is not smooth.

3 A man stands at the edge of a cliff and throws a stone vertically upwards. The stone takes 2.4 s to reach the highest point and another 3.8 s to hit the water surface below.

(a) Calculate the velocity of the stone when it leaves the man's hand.

u = v – at = 0 – (-10) 2.4 = 24 m s-1 or - 24 m s-1 if the opposite sign used

[1]

(b) Calculate the height of the cliff above the water surface.

s = ut + 1⁄2at2

= 24(6.2) + 0.5(-10)(6.2)2

= 148.8 – 192.2

= - 43.4 m = - 43 m (2sf) (full marks only complete working presented properly)

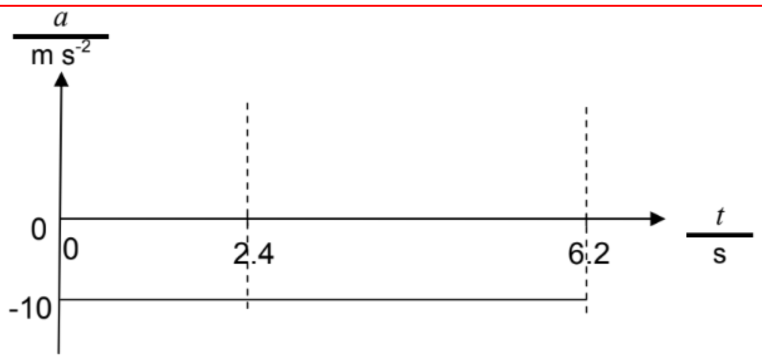
Height of cliff = 43 m [2]

(c) State an assumption made in calculating (a) and (b) above.

Assumed that there is no air resistance to the motion of the stone or the stone is moving at constant acceleration. (No mark for stating gravitational force or acceleration is a constant)

[1]

(d) Sketch the acceleration-time graph of the stone throughout its motion. [2]



Single continuous horizontal line for whole duration from 0 to 6.2s.
Value of acceleration +/-10 m s^{-2} from t = 2.4 s to 6.2 s must be labelled

4 The graph Fig. 16.1 shows the variation of velocity v with time t of a rubber ball that is dropped from a certain height on planet X.

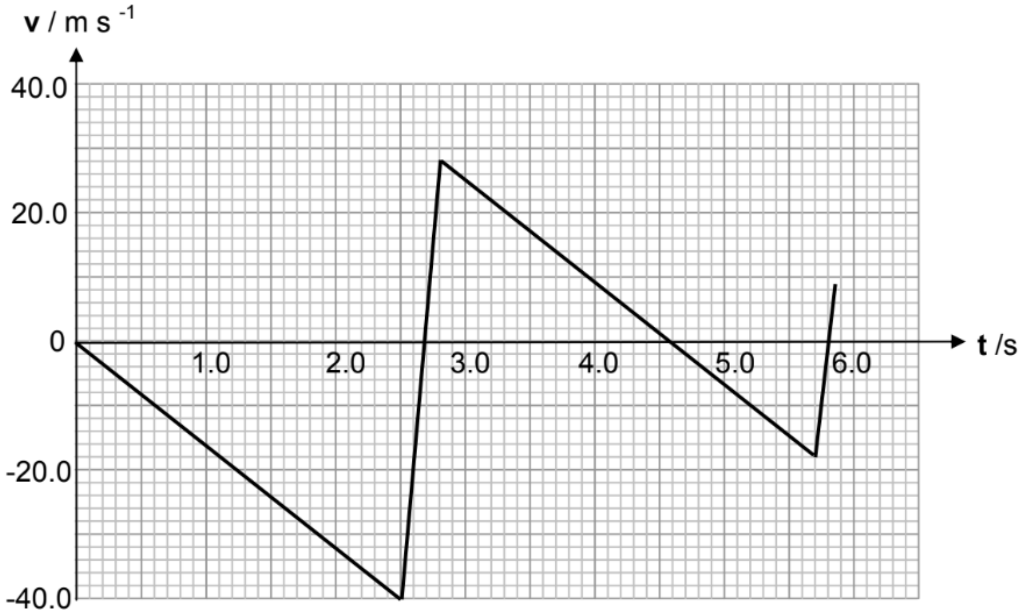


Fig. 16.1

(a) State the sign convention chosen for the graph.

Downwards direction is negative OR Upwards direction is positive. [1]

(b) Mark on the time axis the point M at which the ball is at maximum height after the first bounce. [1]

M is at t = 4.6 s

(c) Calculate the magnitude of the gravitational acceleration on planet X.

a = 40.0 ÷ 2.5 OR 28.0 ÷ 1.8 [1]

= 16 m s^{-2}.(2s.f.). [1]

(Slight variation in the substituted values that are taken from the graph.)

Deduct 1 m *if substituted values are taken across a short time interval. The two points chosen should be across at least half of the slope.*

[2]

(d) Calculate the displacement of the ball when it is at time M.

Displacement = - [dist downwards – dist upwards]

= - [½ x 2.5 x 40 – ½ x (4.6 – 2.8) x 28] [1]

= <u>- 24.8 m</u> [1]

[2]

(e) State one change to the graph if instead of the rubber ball, a steel ball is dropped from the same height on planet X.

The straight line of motion after t =2.5 s will be **shorter** or **nearly vertical.** (Due to its inelasticity, the ball will have a shorter impact time with the ground.)

OR

The steel ball will leave the ground after the first bounce with a **velocity that is lower** than 28.0 m s^{-2}. [1]

5 Fig. 1.1 shows the velocity-time graph of a ball being thrown vertically downwards at a certain height above the ground. You may assume that there is no air resistance as the ball travels.

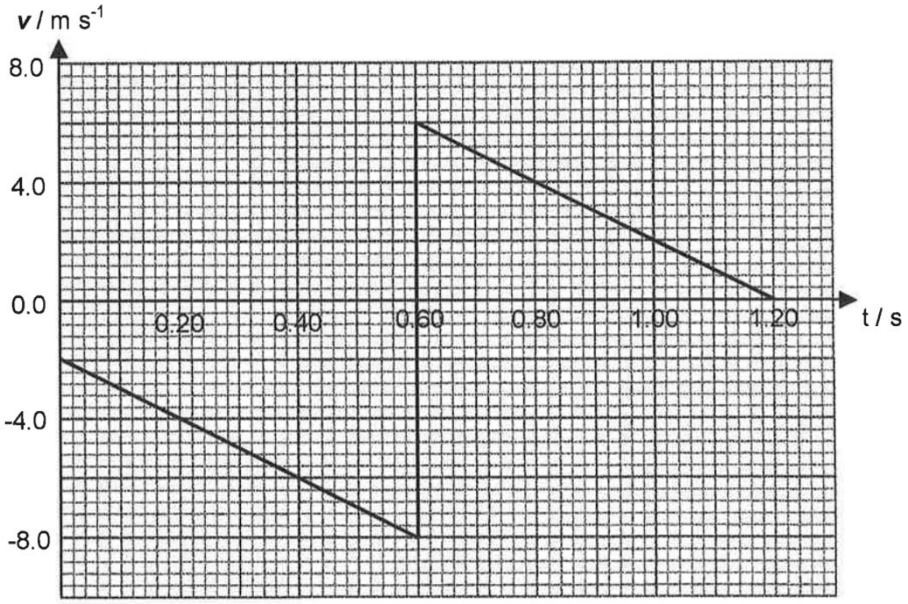


Fig. 1.1

a State the sign convention of the graph in Fig. 1.1. [1]

upward is positive OR downward is negative

b Describe the motion of the ball from t=O s to 1.2 s. [2]

It moves with constant negative acceleration until it hits the ground at 0.60 s it rebounds upward with velocity 6.0 m s-1 and decelerates uniformly to 0.0 m s-1 when it reaches the highest point at 1.20 s

c Calculate the height above the ground at which the ball was thrown. [2]

Total distance travelled = 1⁄2 (2.0 + 8.0) m s-1 × 0.6 s = 3.0 m

d Calculate the displacement of the ball from t=O s to 1.2 s. [2]

Displacement = 1⁄2 × 6.0 m s-1 × 0.6 s - 3.0 m = -1.2 m or 1.2 m downwards

6 A car's engine was leaking oil. As the car moved, the oil drops dripped onto the road at regular time intervals, once every 2 s.

Fig. 1.1 shows the pattern of oil drops left on the road and the distance of subsequent drops from the first drop.

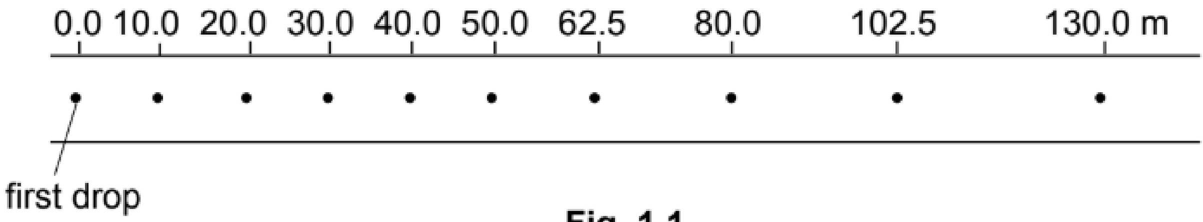


Fig. 1.1

(a) Describe the motion of the car for the first 50.0 m of the journey.

The car is moving at constant velocity (of 5.0 m s-1). [1]

(b) Calculate the acceleration of the car after it passed the 50.0 m mark.

u = (62.5 – 50) / 2 = 6.25 m s-1

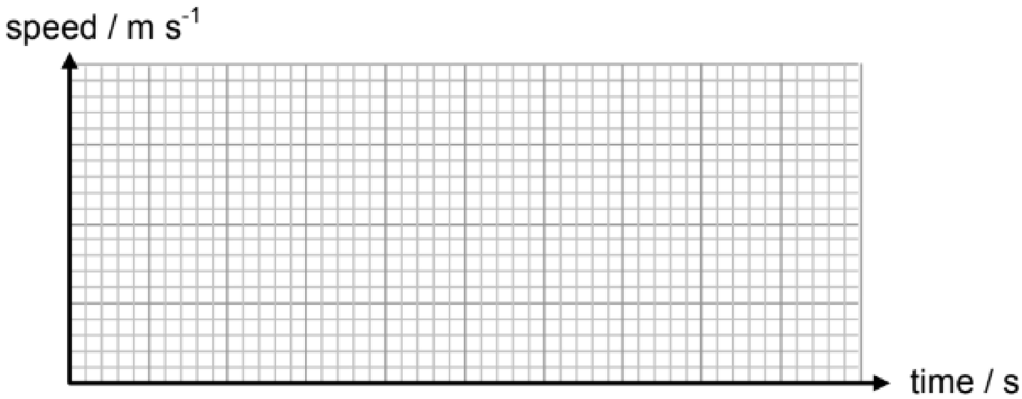
v = (130 – 102.5) / 2 = 13.75 m s-1

a = (v - u) ÷ 3 × 2 = (13.75 – 6.25) ÷ 6 = 1.25 m s-2

(accept calculation based on other sections)

acceleration = ... [3]

(c) On Fig. 1.2, draw a graph of speed against time as the car travelled from the 0.0 m mark to the 130.0 m mark. [2]



Line corresponding to speed = 5.0 m s-1 from t = 0 – 10 s

At 18 s, v = u + at = 5.0 + 1.25 (8) = 15 m s-1

Line corresponding to t = 10 s - 18 s (allow e.c.f.)

7 An object is projected up a rough inclined plane with an initial velocity of 27 m s-1 and returns to its starting point 20.0 s later with a final velocity of -18 m s-1.

Fig. 1.1 below shows the velocity-time graph for the motion of the object.

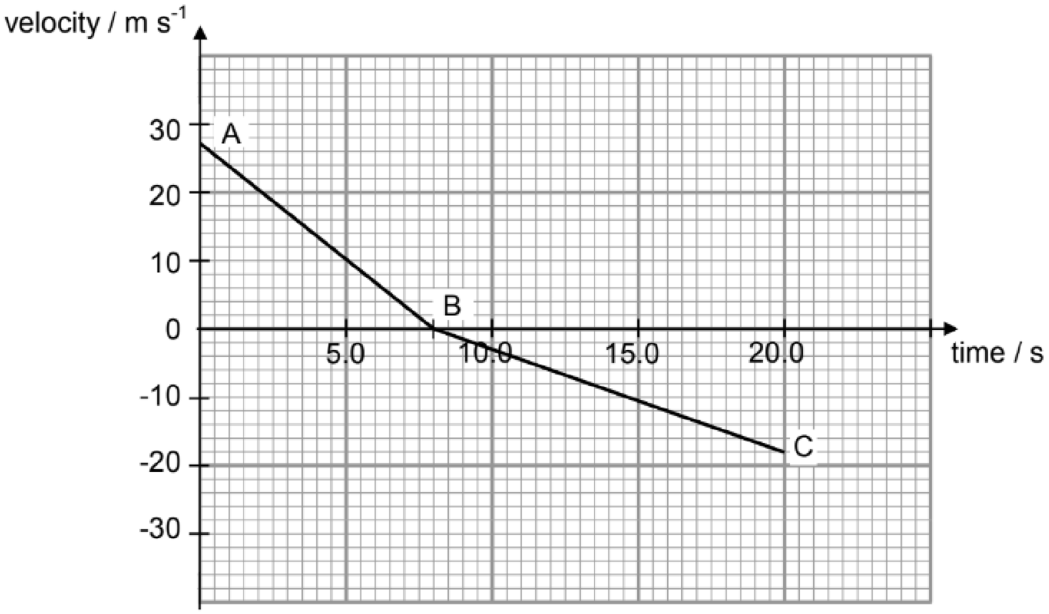


Fig. 1.1

(a) Compare the motion of the object in section AB with its motion in section BC of the graph.

Any two relevant points.

• Both sections AB and BC show (uniform) negative acceleration.

• Section AB shows deceleration while BC shows acceleration.

• The magnitude of deceleration is greater than that of the acceleration.

• The direction of travel in AB is opposite to the direction of travel in BC.

[2]

(b) Calculate the acceleration for

(ii) section AB, and acceleration for section AB = ...[1]

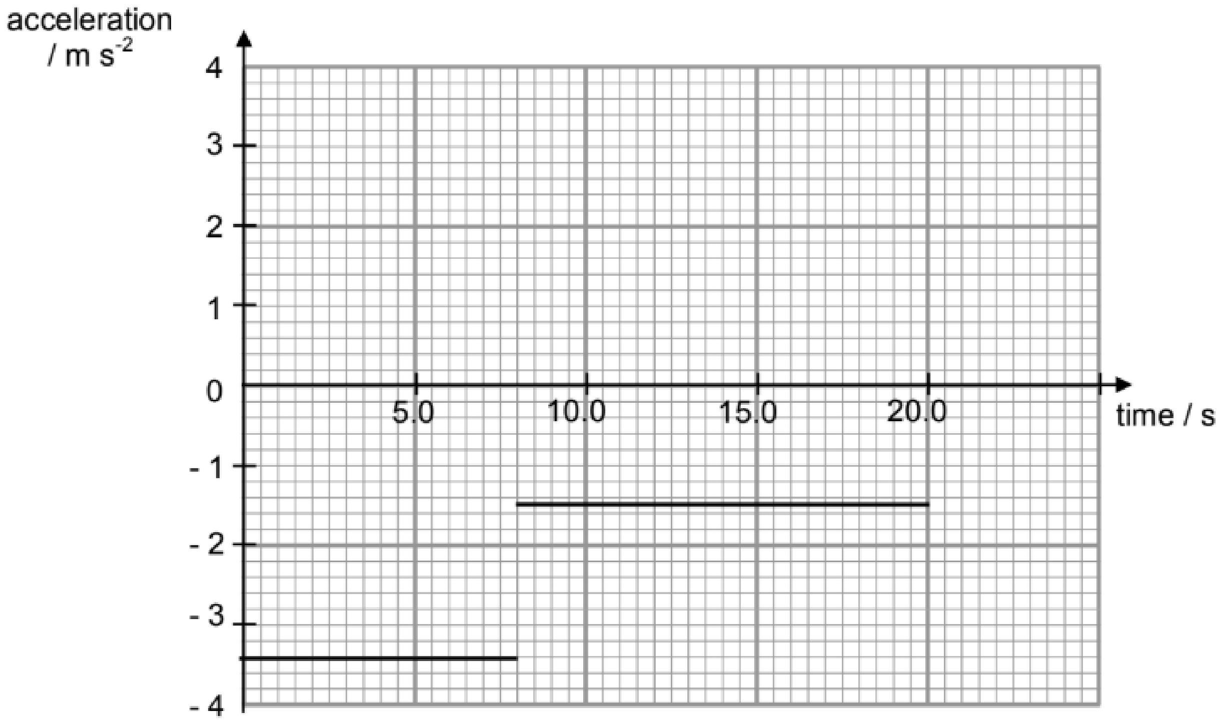
Acceleration for section AB = 0 – 27 / (8.0 – 0.0) = - 3.4 m s-2

(ii) section BC, acceleration for section BC = ...[1]

Acceleration for section BC = -18 – 0 / (20.0 – 8.0) = -1.5 m s-2

(c) On Fig. 1.2 below plot the acceleration-time graph for the object over 20 s. [1]

AB & BC plotted as horizontal lines. (e.c.f. allowed from (b))



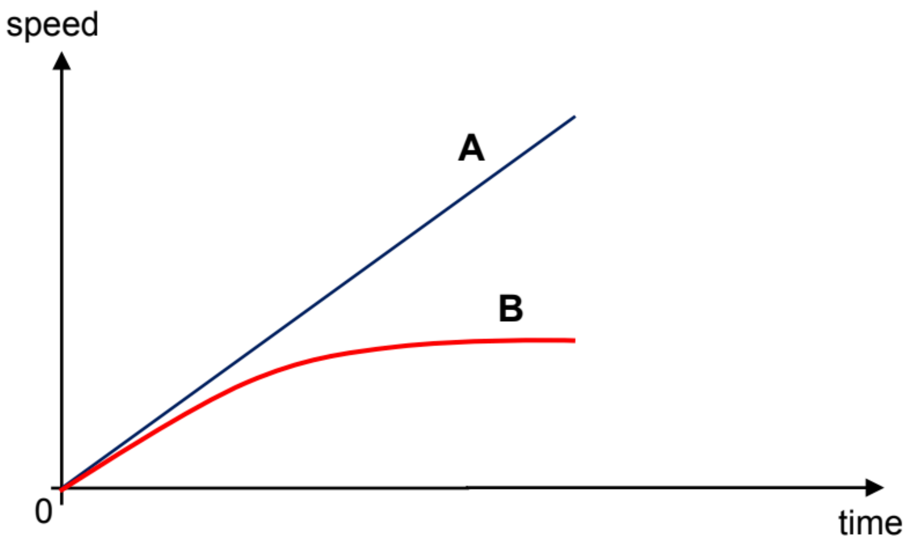
(d) Explain the cause of any change in the acceleration of the object over 20 s.

When the object moves up the plane, friction is acting down along the plane together with a component of the weight. When it moves down the plane, friction is acting up the plane opposite to the component of the weight resulting in a smaller acceleration/net force. [1]

8 A ball is dropped from a very tall building.

(a) Using the axes below, sketch a speed-time graph to show the motion of the ball falling without the effect of air resistance (before hitting the ground).

Label this graph A. [1]



A: Without air resistance: Straight line starting from origin

(b) On the same axes above, sketch a speed-time graph to show the motion of the same ball falling under the effect of air resistance (before hitting the ground).

Assume that it attains terminal velocity before hitting the ground.

Label this graph B. [1]

B: With air resistance: As t increases, the graph curves to show decreasing acceleration as it approaches terminal velocity (constant value/ gradient = 0)

(Graph drawn on separate axis are not accepted) [1]

9 Fig. 4.1 shows the speed-time graph of car J travelling along a straight road.

(a) Calculate the initial acceleration of car J in S.I. units.

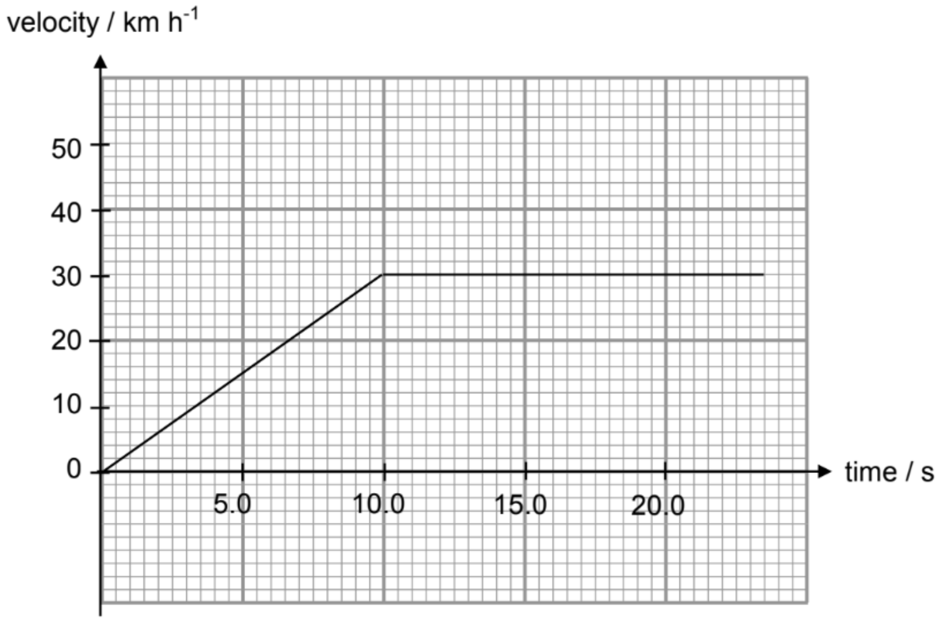


Fig. 4.1

Speed of car J at 10.0 s = (30 km x 1000 m km-1) / (1 h x 60 min h-1 x 60 s min-1)

= 8.33 m s-1

Acceleration of car J = 8.33 m s-1 / 10.0 s = 0.83 m s-2

[2]

(b) Car K accelerates uniformly from rest at t = 0 s and meets car J at 15.0 s.

Calculate the velocity of car K at 15.0 s.

For car K to overtake car J at 15.0 s, it must have travelled the same distance as car J.

Let the speed of car K at 15.0 s be v

Then, area under the graph for J

= area under the graph for K 0.5 ([10.0 - 0.0] s) (30 km h-1) + ([15.0 - 10.0] s × 30 km h-1)

= 0.5 (15.0 s) (v km h-1)

v = 40 km h-1 or 11 m s-1

[2]

10 Boy A throws a ball upwards at a velocity of 15 m s-1.Boy B, who stands on a balcony above Boy A, catches the ball 2.0 s later. Neglect air resistance.

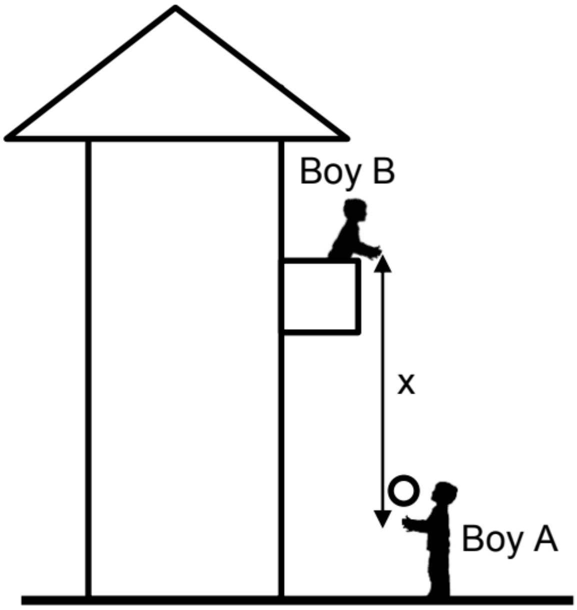
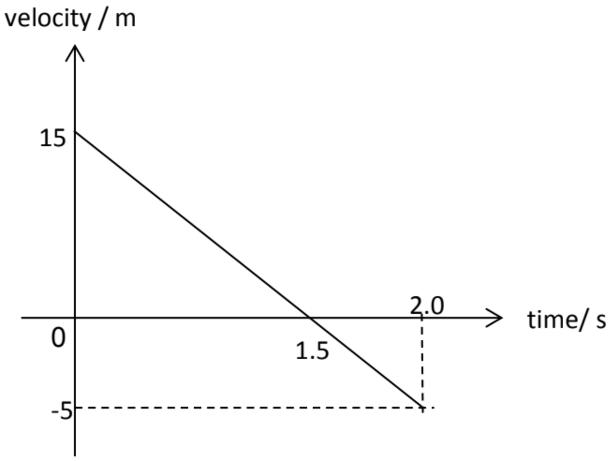


Fig. 1.1

(a) In the space below, sketch a velocity – time graph of the ball from the time it leaves the hands of Boy A until Boy B catches it. State the sign convention adopted and label key values on the axes. Show all necessary working.

Sign convention: Up is positive (for the graph below)



• for stating the sign convention and sketching graph to reflect the correct convention adopted.

• for constant gradient (negative gradient if up is positive)

• for labeling all 4 correct values, labelling axes & origin

(working should be shown to obtain these values)

$v = u + at = 15 + (-10)(2) = -5$ m s^{-1} [3]

(b) Using the graph or otherwise, determine the distance x, as shown in Fig. 1.1.

Using,

$s = ut + \frac{1}{2}at^2$

$h = (15)(2.0) + \frac{1}{2}(-10)(2.0)^2 = 10$ m

Also accept if answer is derived from area under graph.

Area under graph = $\frac{1}{2}(15 \times 1.5) - \frac{1}{2}(5 \times 0.5) = 10$ m [2]

11 Fig. 1.1 shows a strip of paper tape that has been pulled under a ticker-tape timer by a toy car moving to the right. The timer vibrates regularly, making 5 dots per second.

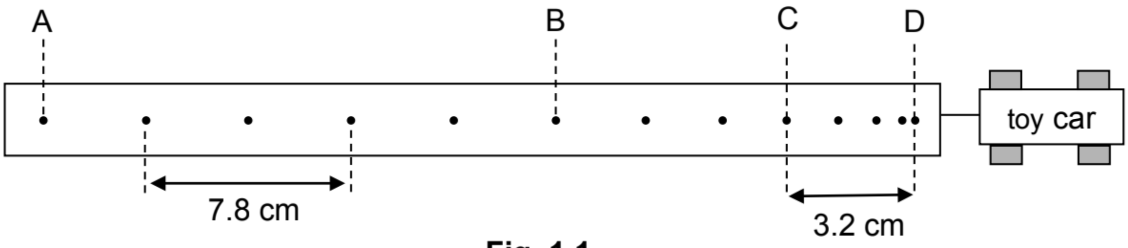


Fig. 1.1

(a) Explain how the dots show that the toy was moving at a constant speed in the region AB.

Equal spacing between successive dots. [1]

(b) Assuming the toy car accelerates uniformly from B to D, calculate the acceleration of the toy in the region BD.

Constant speed in region AB=7.8/(2x0.2) = 19.5 cm/s [1]

Average speed in region C-D = 3.2/(4x0.2) = 4.0 cm/s [1]

Average acceleration in D-B = (19.5 - 4.0)/(5 x 0.2) = 15.5 cm/s^2

[3]

12 Two cars start from rest at the same point along a straight racetrack. Car A starts from rest and accelerates constantly. Car B accelerates rapidly for 3.0 s and then maintains a constant speed.

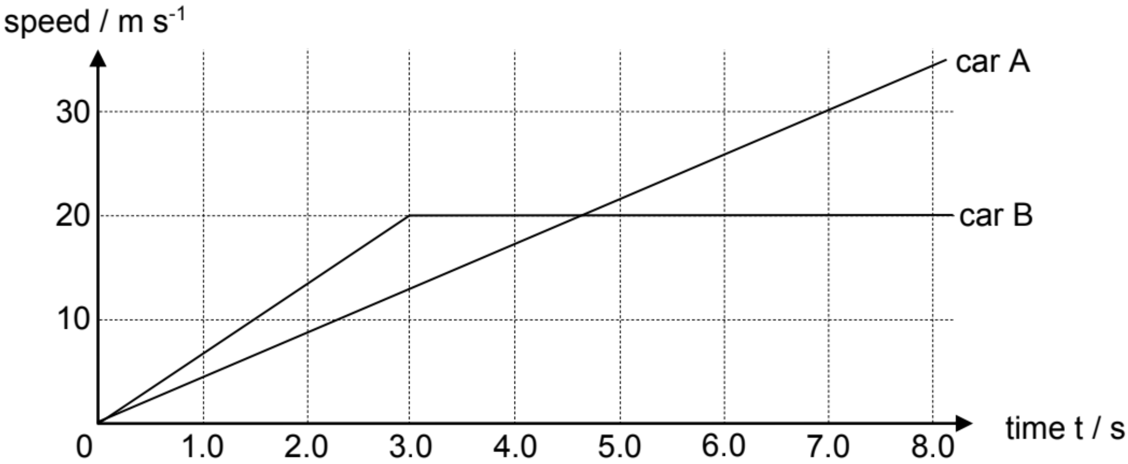


Fig. 1.1

(a) Determine the acceleration of car A.

a = (v-u)/t = (30 - 0)/7 = 4.286 ≈ 4.29 m s-2

OR 4.3 m s-2

[1]

(b) Calculate the time at which the two cars have the same speed.

both cars have the same speed of 20 m s-1.

This happens for car B when 4.286 = (20 - 0)/t [1] t = 4.67 s OR t = 4.7 s [1]

[2]

(c) Given that the winning car crosses the finish line at t = 6.5 s, determine which car has won the race. Show all necessary calculations.

distance travelled by car A = s = ut + 1⁄2 at2 = 0 + 1⁄2 × 4.286 × 6.52 = 90.5 m [1]

distance travelled by car B = area under graph = 1⁄2 × 3 × 20 + 3.5 × 20 = 100 m [1]

therefore, Car B wins the race as it has travelled further during 6.5 s. [1]

[3]

13 Fig 10.1 shows how the vertical velocity of a ball falling through the air varies with time.

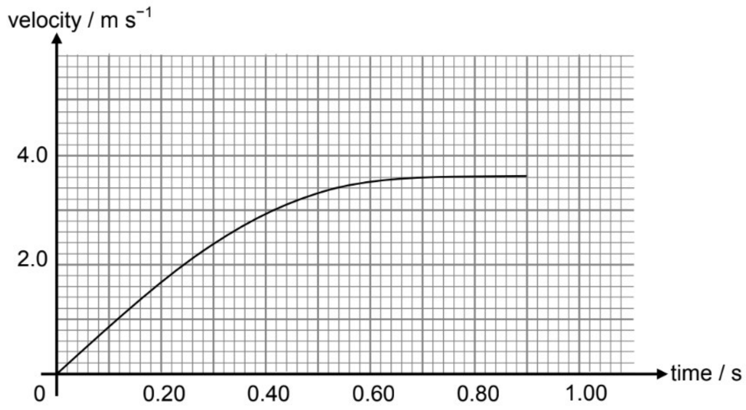
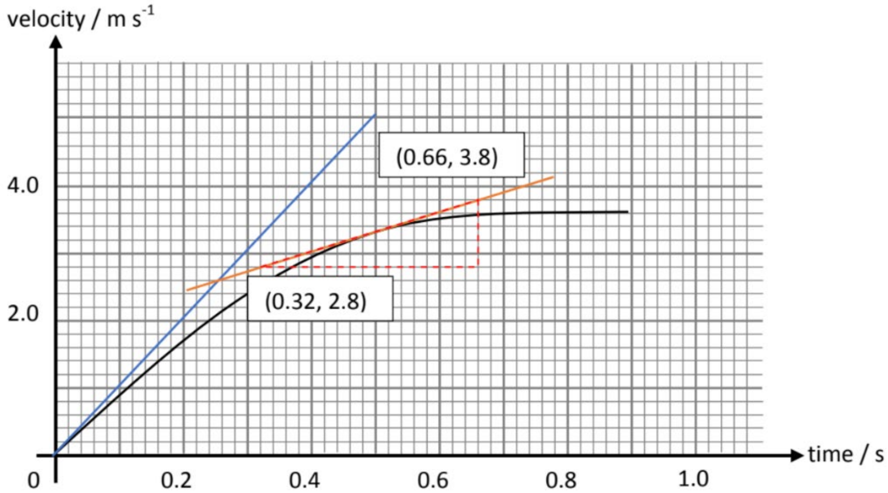


Fig 10.1

The mass of the ball is 25 g and the gravitational field strength can be assumed to be constant at 10 N kg^{-1}.

(a) On Fig. 10.1, draw a line to show the variation of the vertical velocity with time of the ball if it were falling from rest in a vacuum.

Straight line passing through origin with gradient of 10 m s^{-2}



[1]

(b) Use Fig 10.1 to determine the acceleration of the ball at 0.50 s. Show all the required construction on Fig. 10.1.

Construction lines for gradient at 0.5 s.

Gradient = (3.8 m s^{-1} – 2.8 m s^{-1})/(0.66 s – 0.32 s) = 2.9 m s^{-2}

[2]

(c) Calculate the magnitude of maximum air resistance that acts on the ball.

Maximum air resistance = weight of the ball = 0.025 kg × 10 m s^{-2} = 0.25 N

[1]

(d) Determine the magnitude of the air resistance that is acting on the ball at 0.50 s.

W – R = ma

0.25 N – R = (0.025 kg)(2.941 m s^{-2})

R = 0.18 N

[2]

(e) The ball hits soft ground and decelerates uniformly at 150 m s^{-2}.

Determine

(i) the time taken for the ball to come to a complete stop, and

a = *(v-u)/t*
-150m s^{-2}= (0 m s^{-1} -3.6m s^{-1})/*t*
T = 0.024s

[2]

(ii) the distance moved by the ball into the soft ground.

S = ut + ½ at^2

= 3.6 m s^{-1} (0.024 s) + ½ (-150 m s^{-2})(0.024 s)^2

= 0.043 m

[2]

14 A firework leaves the ground with an intial velocity of 45 m/s, travelling vertically upwards. When it reaches a height of 100 m, it fails to explode and falls back down the same vertical path to the ground.

At any point on its path, the firework has both a speed and a velocity.

(a) Explain the difference between speed and velocity.

Speed is a scalar with only magnitude.
Velocity is a vector with both magnitude and direction.

speed is scalar and velocity is a vector.
[not acceptable, require explanation]
define speed and define velocity. [not acceptable] [1]

(b) Fig. 1.1 shows the displacement-time graph for the first 5.0 s of the motion.

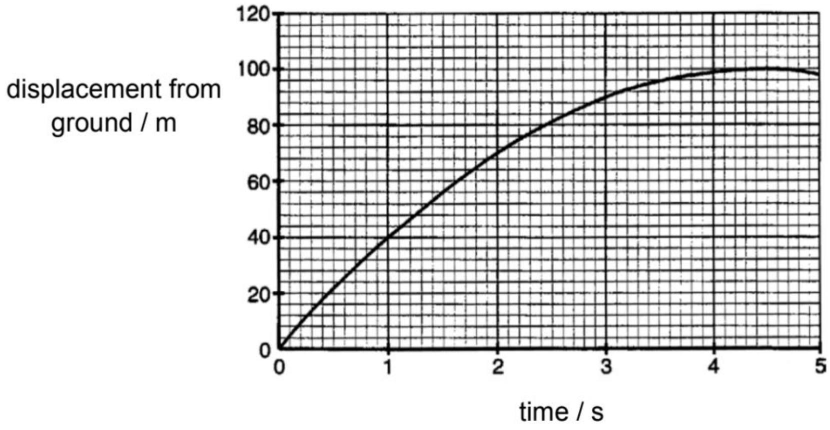


Fig. 1.1

(i) Determine the time taken for the firework to reach the maximum height.

4.5 s (accept 4.3 – 4.6 s)

[1]

(ii) Describe the motion of the firework for the first 5.0 s of its journey.

The firework is moving upwards from 0 to 4.5 s with decreasing velocity. (It reaches the highest point at 4.5 s)

It is moving downwards after 4.5 s.

[note: graph shows only 5.0s of motion]

ecf for timing using b(i) answer

[2]

(c) The air resistance acting on the firework is negligible.

The table below is for the magnitude and direction of the acceleration of the firework. Complete the table. Give the unit for the magnitude of any acceleration that you write down.

	magnitude	direction
as the firework moves upwards		
at maximum height		

[2]

10 m/s^2, downward

10 m/s^2, downward [note: the misconception]

units is a must.

cannot be negative.

(d) In another situation, the firework falls vertically in a horizontal wind.

Fig. 1.2 shows the horizontal and vertical velocity of the firework, drawn to a scale where a length of 1.0 cm represents a speed of 10 m/s.

On Fig 1.2, draw the resultant velocity of the firework. Label it with the letter R and its magnitude. Give your answer to a suitable number of significant figures.

Fig. 1.2 (to scale)

[2]

Draw the *resultant* correctly (with label R)

Resultant = 5.5 x 10 = 55 m/s (to correct sf) (acceptable 54 – 57 m/s) R

maximum 1 mark for part (d) if no double arrow for resultant velocity.

[Total: 8]