Past-paper walk-through

2.1.4
Free fall and measuring g

A-Level Physics

Questions in this set

Questions in this set

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 5

9702/1 22 ▪ Q5 ▪ 1 mark

5 A girl throws a ball vertically upwards. It takes a time of 3.20 s to return to her hand.

Assume air resistance is negligible.

What is the initial speed with which the ball is thrown?

A $3.07\,m\,s^{-1}$ **B** $7.85\,m\,s^{-1}$ **C** $15.7\,m\,s^{-1}$ **D** $31.4\,m\,s^{-1}$

Solution 5

Answer: **C**

Question 7

9702/12 N21 ▪ Q7 ▪ 1 mark

7 A stone is projected vertically upwards from the ground at an initial speed of $15\,m\,s^{-1}$. Air resistance is negligible.

What is the maximum height reached by the stone?

A 0.76 m **B** 11 m **C** 23 m **D** 110 m

Solution 7

Answer: **B**

Question 5

9702/12 N24 ▪ Q5 ▪ 1 mark

A stone falls vertically from rest. Air resistance is negligible.

What is the speed of the stone when it has fallen through a distance of 0.40 m? **[1]**

A 2.0 m s^{-1}

B 2.8 m s^{-1}

C 3.9 m s^{-1}

D 7.8 m s^{-1}

Solution 5

A $2.0\ \text{m s}^{-1}$

B $2.8\ \text{m s}^{-1}$ ✓

C $3.9\ \text{m s}^{-1}$

D $7.8\ \text{m s}^{-1}$

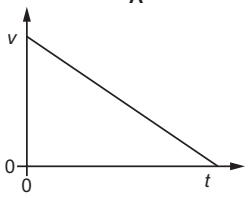
Answer: **B**

Question 6

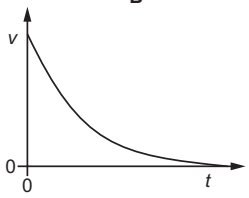
9702/12 J21 ▪ Q6 ▪ 1 mark

6 Which graph shows the variation with time t of the velocity v of an object falling vertically downwards in a vacuum?

A



B

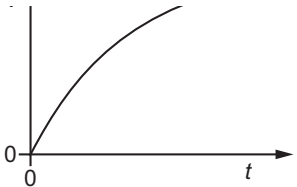


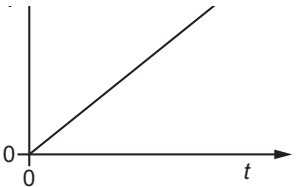
C

D

Question 6

9702/12 J21 ▪ Q6 ▪ 1 mark





Solution 6

Answer: **D**

Question 5

9702/12 J24 ▪ Q5 ▪ 1 mark

The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L.

The feather takes time T to fall from the top to the bottom of the tube.

How far does the feather fall from the top of the tube in time $0.50T$? **[1]**

A $0.13L$

B $0.25L$

C $0.38L$

D $0.50L$

Solution 5

A $0.13L$

B $0.25L$ ✓

C $0.38L$

D $0.50L$

Answer: **B**

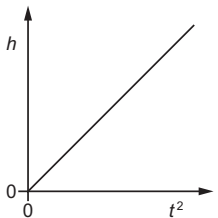
Question 7

9702/13 J21 ▪ Q7 ▪ 1 mark

7 A steel ball is dropped from rest from a height h above the ground. The ball hits the ground after a time t.

This is repeated for a number of different heights.

The graph shows the variation of h with t^2 for the ball.



Question 7

9702/13 J21 ▪ Q7 ▪ 1 mark

The gradient of the graph is G.

Which expression gives the acceleration of the ball?

A $\frac{G}{2}$ **B** G **C** $2G$ **D** G^2

Solution 7

Answer: **C**

Question 6

9702/12 J22 ▪ Q6 ▪ 1 mark

6 The water surface in a deep well is 78.0 m below the top of the well. A person at the top of the well drops a heavy stone down the well.

Air resistance is negligible. The speed of sound in the air is 330 $m\,s^{-1}$.

What is the time interval between the person dropping the stone and hearing it hitting the water?

A 3.75 s **B** 3.99 s **C** 4.19 s **D** 4.22 s

Solution 6

Answer: **D**

Question 6

9702/12 J23 ▪ Q6 ▪ 1 mark

A rock is launched vertically upwards from the surface of the Earth and an identical rock is launched vertically upwards from the surface of Mars. Each rock is launched with an initial velocity of 12 m s^{-1}.

Each rock then reaches its maximum height above the surface before returning back down to the surface. The velocity–time graph for each rock is shown. In both cases, air resistance is negligible.

What is the difference in the maximum heights of the two rocks? **[1]**

A 12 m

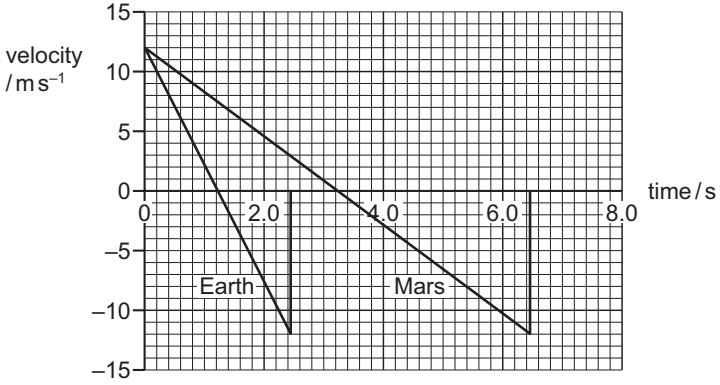
B 15 m

C 19 m

D 24 m

Question 6

The velocity–time graph for each rock is shown.



Solution 6

A 12 m ✓

B 15 m

C 19 m

D 24 m

Answer: **A**

Question 6

9702/13 N22 ▪ Q6 ▪ 1 mark

6 On the Earth, an object takes time T_E to fall from rest through a vertical distance h.

On the Moon, the same object takes time T_M to fall from rest through the same vertical distance h.

The ratio $\frac{\text{acceleration of free fall on the Earth}}{\text{acceleration of free fall on the Moon}}$ is equal to 6.

Air resistance is negligible for the object on the Earth and on the Moon.

What is the ratio $\frac{T_E}{T_M}$?

A $\frac{1}{6}$ **B** $\frac{1}{\sqrt{6}}$ **C** $\sqrt{6}$ **D** 6

Solution 6

Answer: **B**

Question 3

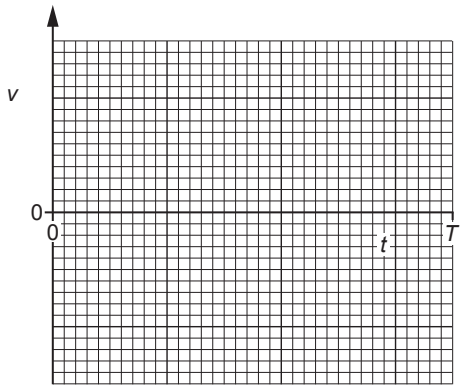
9702/22 J22 ▪ Q3 ▪ 10 marks

A man standing on a wall throws a small ball vertically upwards with a velocity of 5.6 m s–1. The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig. 3.1. 3.1 m velocity 5.6 m s–1 wall man ball ground Fig. 3.1 (not to scale)

Assume that air resistance is negligible.

Question 3

The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig.



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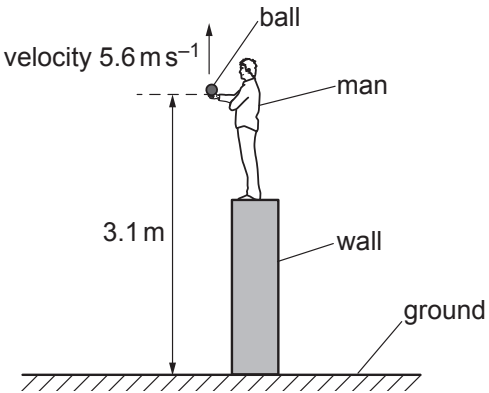


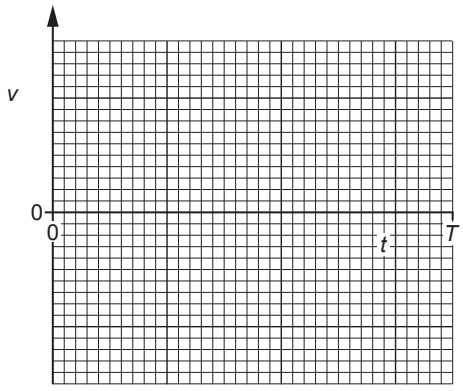
Question 3

The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig.

(a) Show that the ball reaches a maximum height above the ground of 4.7 m.
[2] **[2]**

Question 3

The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig.



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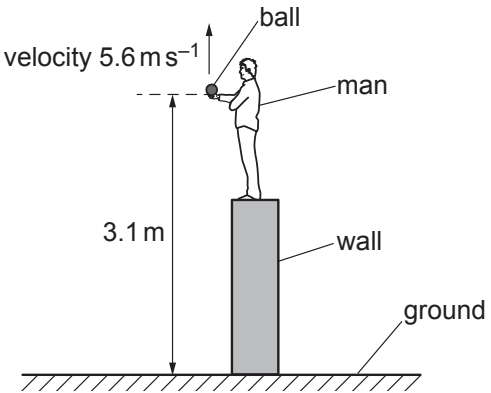

Question 3

The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig.

(b) The man does not catch the ball as it falls.
Calculate the time taken for the ball to fall from its maximum height to the ground.

time taken = ... s [2] **[2]**

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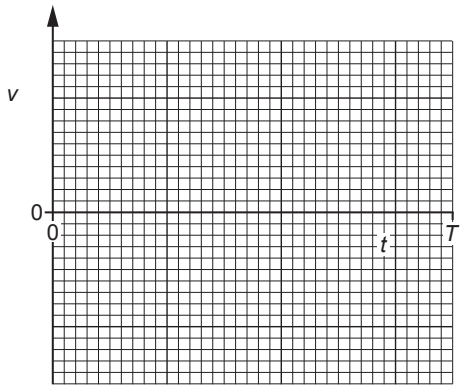

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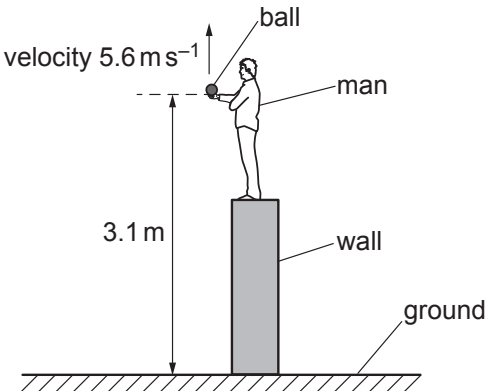

Question 3

The ball leaves his hand when it is at a height of 3.1 m above the ground, as shown in Fig.

(c) The ball leaves the man's hand at time t = 0 and hits the ground at time t = T. On Fig. 3.2, sketch a graph to show the variation of the velocity v of the ball with time t from t = 0 to t = T. Numerical values of v and t are not required. Assume that v is positive in the upward direction. 0 t T v 0 Fig. 3.2

[3] **[3]**

Question 3

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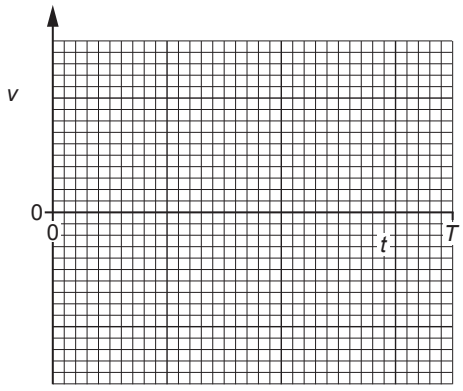

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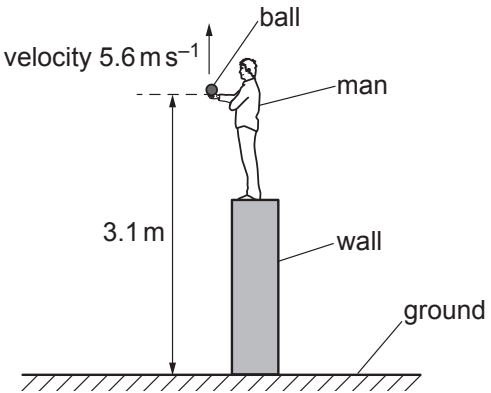

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(d) State what is represented by the gradient of the graph in (c).**[1]**

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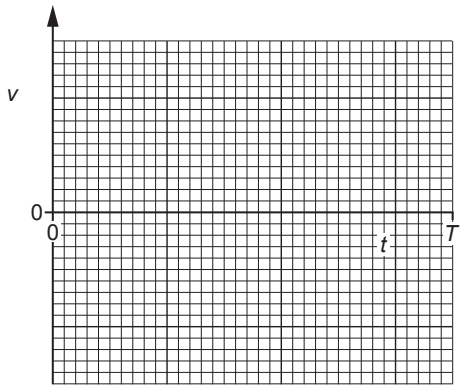

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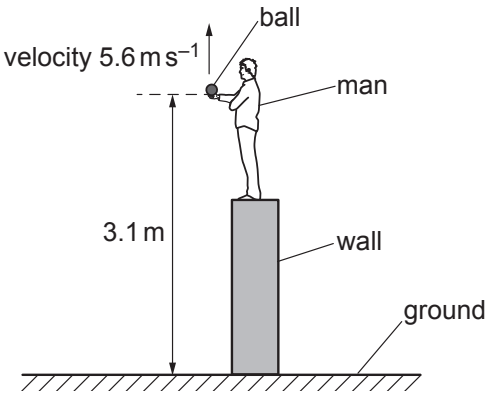

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(e)(i) the magnitudes of their accelerations **[1]**

(e)(ii) the speeds with which they hit the ground. **[1]**

Question 3

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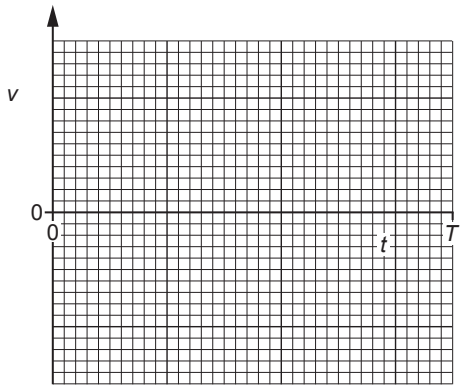

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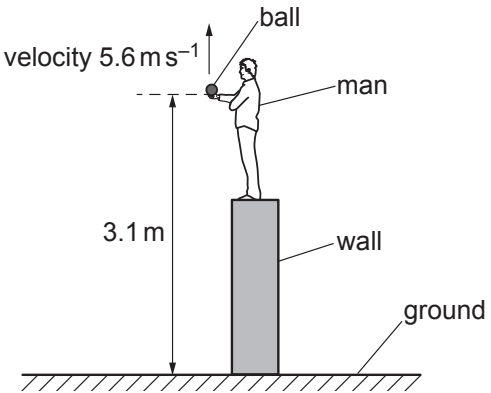

Solution 3

(a)

Mark scheme

- v2 = u2 + 2as s = 5.62 / (2 × 9.81) C1
- (max height =) 3.1 + 5.62 / (2 × 9.81) = 4.7 (m) A1

Solution 3

(b) Mark scheme

- 2
- 1
- 2 s ut at
- ×
- ×
- 2
- 1
- 4.7

Solution 3

- 9.81
- 2 t C1
- $t = 0.98$ s A1

Solution 3

(c)

Mark scheme

- line drawn from a non-zero speed at t = 0 to a greater speed at t = T **B1**
- a single sloping straight line drawn from t = 0 to t = T **B1**
- line starts with a positive non-zero value of v and ends with a negative non-zero value of v **B1**

Solution 3

(d)

Mark scheme

- acceleration (of the ball) B1

Solution 3

(e)(i)

Mark scheme

- (magnitudes of accelerations are) equal / same B1

(e)(ii)

Mark scheme

- (speeds are) equal / same B1