Past-paper walk-through

2.1.5
Projectile motion

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

9702/12 M24 ▪ Q5 ▪ 1 mark

A projectile is launched at an angle of $25°$ to the horizontal with a horizontal component of velocity of $13\ \text{m s}^{-1}$.

What is the vertical component of the velocity of the projectile when it is launched? **[1]**

A $5.5\ \text{m s}^{-1}$

B $6.1\ \text{m s}^{-1}$

C $12\ \text{m s}^{-1}$

D $14\ \text{m s}^{-1}$

Solution 5

A $5.5\ \mathrm{m\,s^{-1}}$

B $6.1\ \mathrm{m\,s^{-1}}$ ✓

C $12\ \mathrm{m\,s^{-1}}$

D $14\ \mathrm{m\,s^{-1}}$

Answer: **B**

Question 4

9702/13 N24 ▪ Q4 ▪ 1 mark

A boy throws a stone with a horizontal velocity of 10 m s^{-1} from the top of a building. The height of the building is 8.0 m. The stone travels along a curved path until it hits the horizontal ground, as shown.

Air resistance is negligible.

How long does it take the stone to reach the ground? **[1]**

A 0.61 s

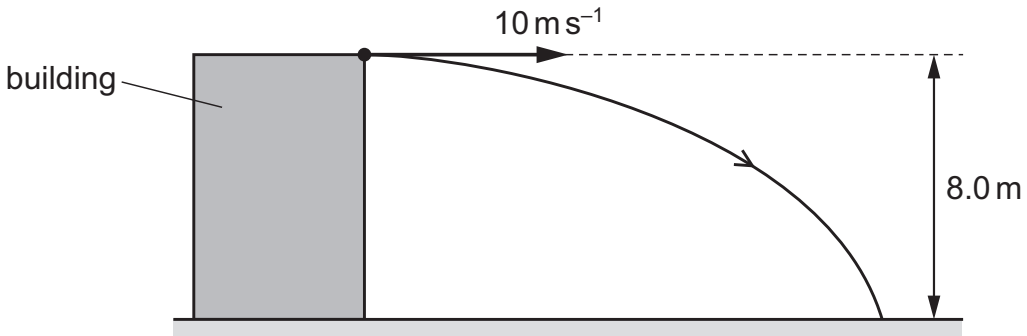
B 0.80 s

C 1.3 s

D 1.6 s

Question 4

The stone travels along a curved path until it hits the horizontal ground, as shown.



Solution 4

A 0.61 s

B 0.80 s

C 1.3 s ✓

D 1.6 s

Answer: **C**

Question 6

9702/11 J22 ▪ Q6 ▪ 1 mark

6 A ball is thrown horizontally with a speed of $10.0\,m\,s^{-1}$ above horizontal ground. The ball hits the ground after a time of 3.0 s.

Air resistance is negligible.

What is the speed of the ball just before it hits the ground?

A $10\,m\,s^{-1}$ **B** $29\,m\,s^{-1}$ **C** $31\,m\,s^{-1}$ **D** $39\,m\,s^{-1}$

Solution 6

Answer: **C**

Question 6

9702/11 J23 ▪ Q6 ▪ 1 mark

A ball is kicked so that it has an initial velocity of 12 m s^{-1} at an angle of $50°$ to horizontal ground.

Assume that air resistance is negligible.

What is the maximum height above the ground that is reached by the ball? **[1]**

A 0.47 m

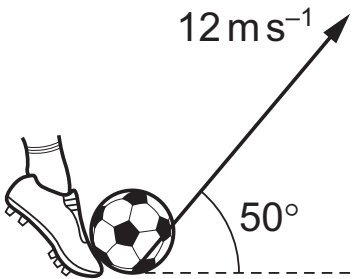
B 3.0 m

C 4.3 m

D 7.3 m

Question 6

A ball is kicked so that it has an initial velocity of ... at an angle of ... to horizontal ground.



Solution 6

A 0.47 m

B 3.0 m

C 4.3 m ✓

D 7.3 m

Answer: **C**

Question 7

9702/11 J24 ▪ Q7 ▪ 1 mark

The diagram shows the path of a golf ball.

Which row describes changes in the horizontal and vertical components of the golf ball's velocity when air resistance is ignored?

	horizontal	vertical
A	constant deceleration	constant acceleration downwards
B	constant deceleration	acceleration decreases upwards then increases downwards
C	constant velocity	constant acceleration downwards
D	constant velocity	acceleration decreases upwards then increases downwards

Question 7

[1]

A Row A

B Row B

C Row C

D Row D

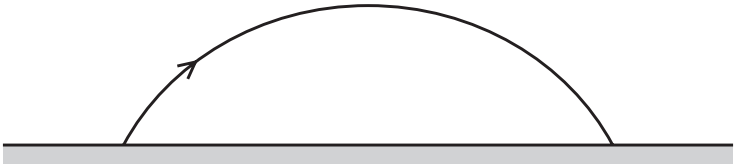
Question 7

The diagram shows the path of a golf ball.

	horizontal	vertical
A	constant deceleration	constant acceleration downwards
B	constant deceleration	acceleration decreases upwards then increases downwards
C	constant velocity	constant acceleration downwards
D	constant velocity	acceleration decreases upwards then increases downwards

Question 7

The diagram shows the path of a golf ball.



Solution 7

A Row A

B Row B

C Row C ✓

D Row D

Answer: **C**

Question 6

9702/12 N24 ▪ Q6 ▪ 1 mark

A ball is thrown horizontally off a tall building. The ground is horizontal. Air resistance is negligible.

Which statement about the motion of the ball is correct? **[1]**

A The acceleration of the ball is always at right angles to the path of the ball.

B The ball follows a circular path until it hits the ground.

C The ball has constant acceleration.

D The ball's time in the air is proportional to the velocity at which the ball is thrown.

Solution 6

A The acceleration of the ball is always at right angles to the path of the ball.

B The ball follows a circular path until it hits the ground.

C The ball has constant acceleration. ✓

D The ball's time in the air is proportional to the velocity at which the ball is thrown.

Answer: **C**

Question 6

9702/11 N23 ▪ Q6 ▪ 1 mark

A projectile is fired from point P with velocity V at an angle θ to the horizontal. It lands at point Q, a horizontal distance R from P, after time T.
The acceleration of free fall is g. Air resistance is negligible.
Which equation is correct? **[1]**

A $R = VT\cos\theta$

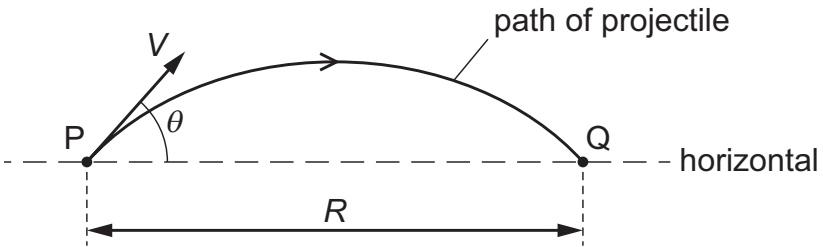
B $R = VT\sin\theta$

C $R = VT\cos\theta - \frac{1}{2}gT^2$

D $R = VT\sin\theta - \frac{1}{2}gT^2$

Question 6

A projectile is fired from point P with velocity ... at an angle ... to the horizontal.



Solution 6

A $R = VT\cos\theta$ ✓

B $R = VT\sin\theta$

C $R = VT\cos\theta - \frac{1}{2}gT^2$

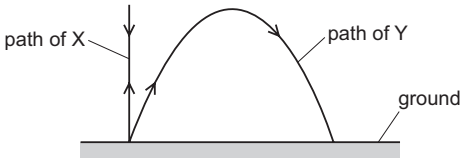
D $R = VT\sin\theta - \frac{1}{2}gT^2$

Answer: **A**

Question 6

9702/13 J22 ▪ Q6 ▪ 1 mark

6 Two projectiles, X and Y, are fired into the air from the same place on level ground and reach the same maximum height, as shown.



Projectile X is fired vertically upwards and projectile Y is fired at an angle to the horizontal.

Air resistance is negligible.

Which statement is correct?

Question 6

9702/13 J22 ▪ Q6 ▪ 1 mark

A X and Y are at rest at their maximum heights.

B X and Y are fired with the same speed.

C X and Y take the same time to return to the ground.

D X and Y travel the same distance.

Solution 6

Answer: **C**

Question 6

9702/12 N23 ▪ Q6 ▪ 1 mark

An astronaut on the Moon, where there is no air resistance, throws a ball. The ball's initial velocity has a vertical component of 8.00 m s^{-1} and a horizontal component of 4.00 m s^{-1}, as shown.

The acceleration of free fall on the Moon is 1.62 m s^{-2}.

What is the speed of the ball 9.00 s after being thrown? **[1]**

A 6.58 m s^{-1}

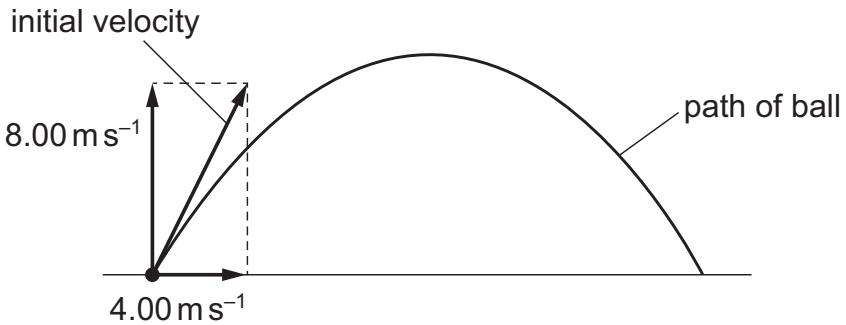
B 7.70 m s^{-1}

C 10.6 m s^{-1}

D 14.6 m s^{-1}

Question 6

The ball's initial velocity has a vertical component of ... and a horizontal component of ... , as shown.



Solution 6

A $6.58\ \text{m s}^{-1}$

B $7.70\ \text{m s}^{-1}$ ✓

C $10.6\ \text{m s}^{-1}$

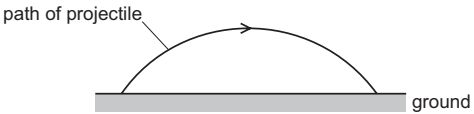
D $14.6\ \text{m s}^{-1}$

Answer: **B**

Question 6

9702/11 J21 ▪ Q6 ▪ 1 mark

6 A projectile is launched at an angle to the horizontal at time $t = 0$. It travels over horizontal ground, as shown.



Air resistance is negligible.

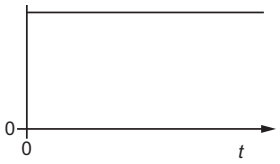
Which graph best shows the variation with t of the speed of the projectile from when it is launched to when it lands on the ground?

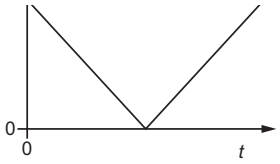
A

B

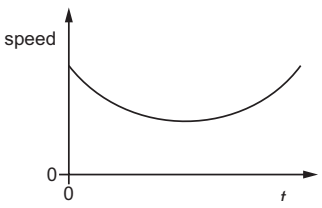
Question 6

9702/11 J21 ▪ Q6 ▪ 1 mark

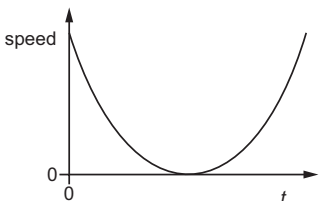




C



D



Question 6

9702/11 J21 ▪ Q6 ▪ 1 mark

Solution 6

Answer: **C**

Question 2

9702/22 M22 ▪ Q2 ▪ 7 marks

Water leaves the end of a hose pipe at point P with a horizontal velocity of 6.6 m s–1, as shown in Fig. 2.1. hose pipe ground 3.5 m h path of water 6.6 m s–1 Q P Fig. 2.1 (not to scale)

Point P is at height h above the ground. The water hits the ground at point Q. The horizontal distance from P to Q is 3.5 m.

Air resistance is negligible. Assume that the water between P and Q consists of non-interacting droplets of water and that the only force acting on each droplet is its weight.

(a) Explain, briefly, why the horizontal component of the velocity of a droplet of water remains constant as it moves from P to Q. **[1]**

(b) Show that the time taken for a droplet of water to move from P to Q is 0.53 s. [1] **[1]**

Question 2

(c) Calculate height h.

h = ... m [2] **[2]**

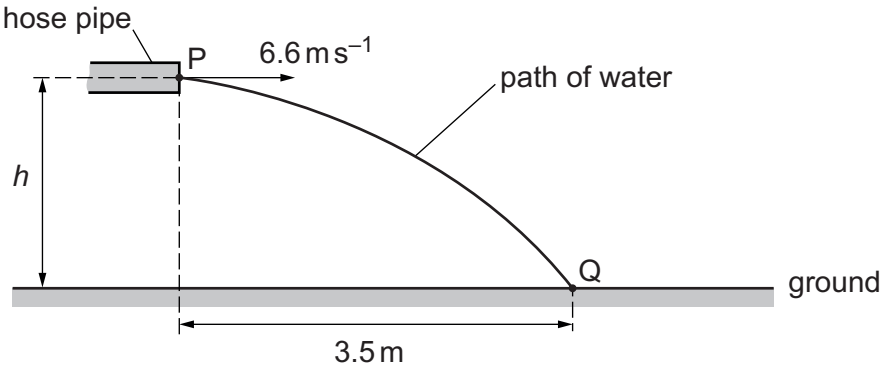
(d) For the movement of a droplet of water from P to Q, state and explain whether the displacement of the droplet is less than, more than or the same as the distance along its path. **[1]**

(e) Calculate the magnitude of the displacement of a droplet of water that moves from P to Q.

displacement = ... m [2] **[2]**

Question 2

Water leaves the end of a hose pipe at point P with a horizontal velocity of 6.6 m s–1, as shown in Fig.



Solution 2

(a)

Mark scheme

- force (on droplet of water) in horizontal direction is zero. B1

Solution 2

(b)

Mark scheme

- (time taken =) 3.5 / 6.6 = 0.53 (s) A1

Solution 2

(c)

Mark scheme

- $s = ut + \frac{1}{2}at^2$ $s = \frac{1}{2} \times 9.81 \times 0.532$ C1
- $h = 1.4$ m A1

Solution 2

(d)

Mark scheme

- displacement is straight-line distance (from P to Q) so less (than distance along path) or displacement is the shortest distance (from P to Q). B1

Solution 2

(e)

Mark scheme

- (displacement)$2 = 3.52 + 1.42$ C1
- displacement $= 3.8$ m A1

Question 2

9702/21 N22 ▪ Q2 ▪ 6 marks

A steel ball is projected horizontally from the top of a table, as shown in Fig. 2.1.

Fig. 2.1 (not to scale)

The ball is projected horizontally at a speed of 4.9 m s–1. The ball lands on the ground a horizontal distance of 180 cm from the edge of the table.

Assume that air resistance is negligible.

(a)(i) Calculate the time taken for the ball to reach the ground.

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

(a)(ii) Calculate the vertical component of the velocity of the ball as it hits the ground.

velocity = ... m s–1 [2] **[2]**

(a)(iii) Determine the magnitude and the angle to the horizontal of the velocity of the ball as it hits the ground.

magnitude of velocity = ... m s–1

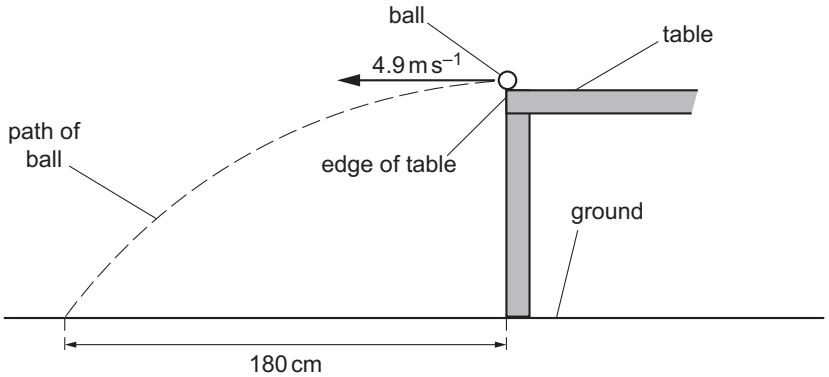
Question 2

angle to the horizontal = ... °

[3] **[3]**

Question 2

A steel ball is projected horizontally from the top of a table, as shown in Fig.



Solution 2

(a)(i)

Mark scheme

- t = 1.8 / 4.9
- = 0.37 s A1

Solution 2

(a)(ii)

Mark scheme

- $v = u + at$
- $= 9.81 \times 0.37$ C1
- $= 3.6$ m s–1 A1

Solution 2

(a)(iii)

Mark scheme

- v 2 = 3.62 + 4.92 C1
- v = 6.1 m s–1 A1
- θ = tan–1 (3.6 / 4.9)
- = 36° A1