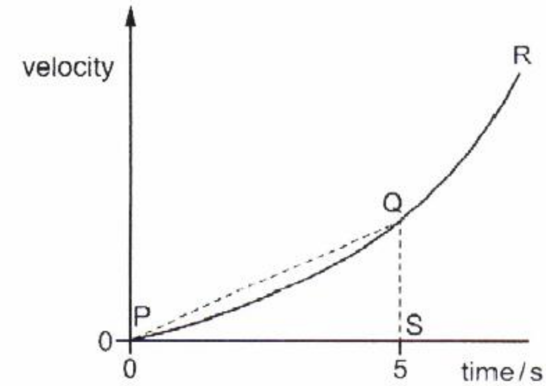
1. June/2022/Paper_11/No.5

The curved line PQR is the velocity–time graph for a car starting from rest.



What is the average acceleration of the car over the first 5 s?

A the area below the curve PQ

B the area of the triangle PQS

C the gradient of the straight line PQ

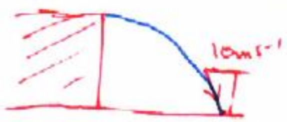
D the gradient of the tangent at Q

– In v-t graph, acc is given by gradient.
– For average acc, this is given by PQ part gradient.
– If it required acc at 5 s, then the correct answer will be gradient of tangent at Q.

2. June/2022/Paper_11/No.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?

vertically: $u_v = 0$, $g = 9.81$, $t = 3$, $v = ?$

$v = 9.81 \times 3 = 29.43\ \text{m s}^{-1}$

$v = \sqrt{29.43^2 + 10^2} = 31.08 \approx 31\ \text{m s}^{-1}$

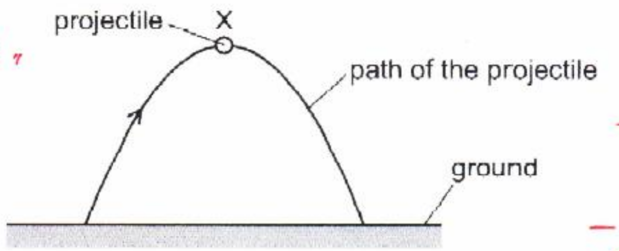
A 10 m s^{-1} **B** 29 m s^{-1} **C** 31 m s^{-1} **D** 39 m s^{-1}

As it strikes the ground, it has both horizontal and vertical motion. So find the hypotenuse using pythagorous method.

3. June/2022/Paper_11/No.9

A projectile is launched at an angle above horizontal ground and travels through the air.

At X, it is vertically at rest, momentarily.

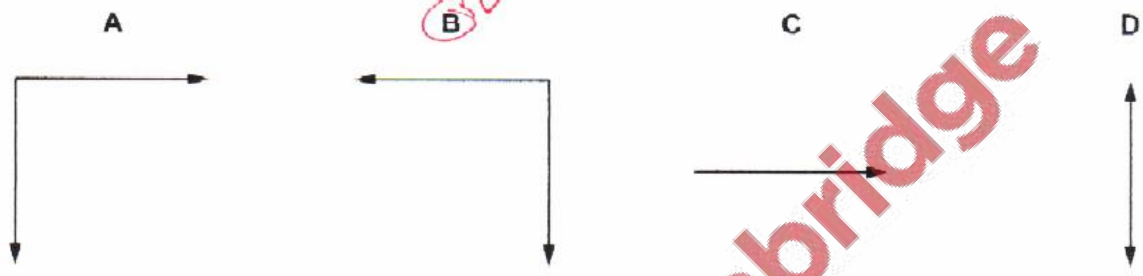


- air resistance is present.
- At X, the projectile is moving horizontally only
- So acted by gravity and air resistance only.

The projectile reaches its maximum height at position X. Assume that no upthrust acts on the projectile.

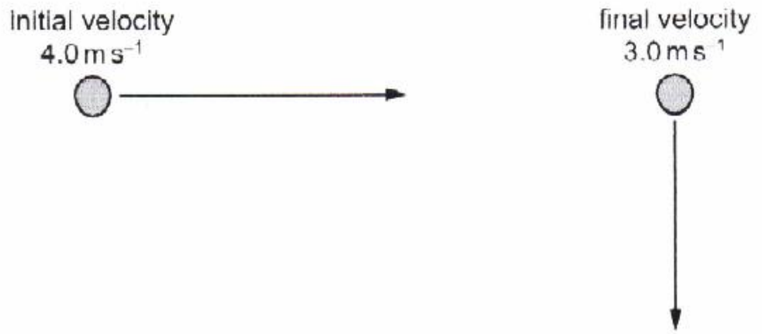
- air resistance is opposite to the motion (horizontally).

Which diagram shows the **directions** of the force or forces acting on the projectile at position X?

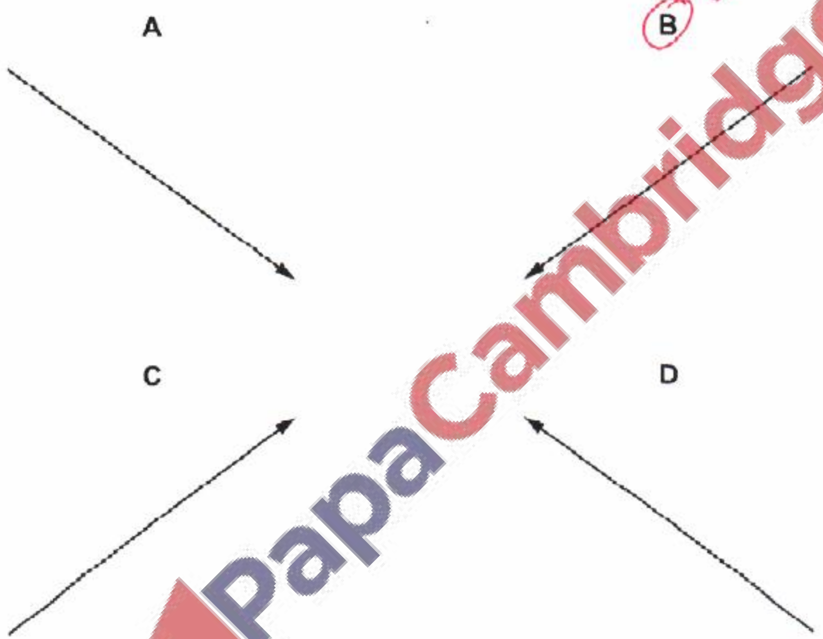


4. June/2022/Paper_12/No.4

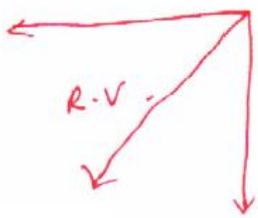
An object is moving with an initial velocity of $4.0\,m\,s^{-1}$ to the right. The velocity of the object changes so that its final velocity is $3.0\,m\,s^{-1}$ downwards, as shown.



Which arrow represents the change in velocity of the object?



- Initial velocity is horizontally to the right.
- Final velocity is downward.
- So it means there is an opposing force acting horizontally to the left and downwards.
- Hence resultant velocity is



5. June/2022/Paper_12/No.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.

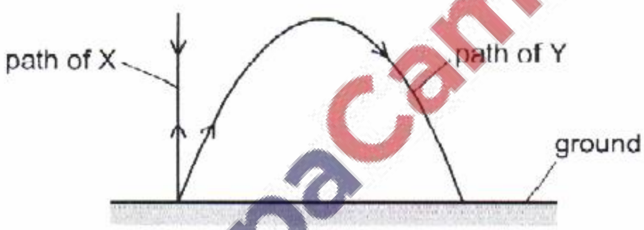
Air resistance is negligible. The speed of sound in the air is $330\,m\,s^{-1}$.

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

6. June/2022/Paper_13/No.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?

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

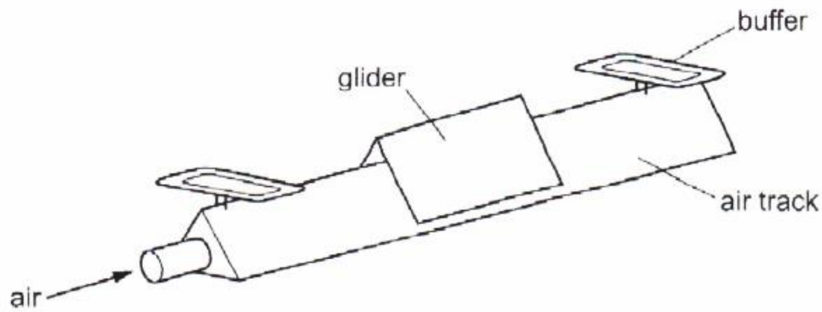
B X and Y are fired with the same speed.

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

D X and Y travel the same distance.

7. June/2022/Paper_13/No.7

A small glider moves along a horizontal air track as shown.

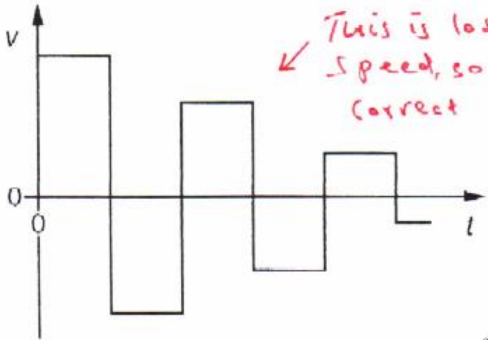


At each end of the air track, the glider has a perfectly elastic collision with a fixed buffer.

The glider moves at a constant speed between collisions.

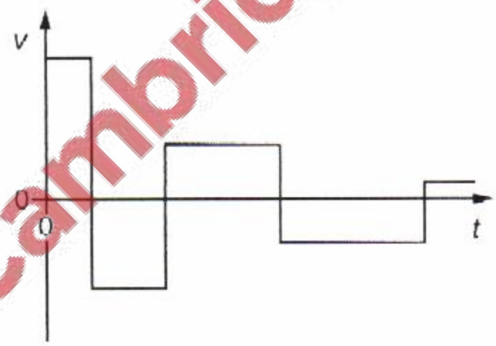
Which graph represents the variation with time t of the velocity v of the glider as it moves between the two buffers?

A

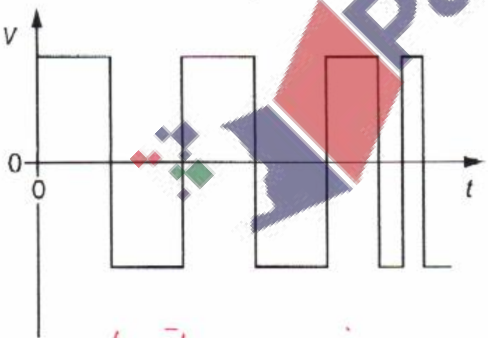


This is losing speed, so not correct

B

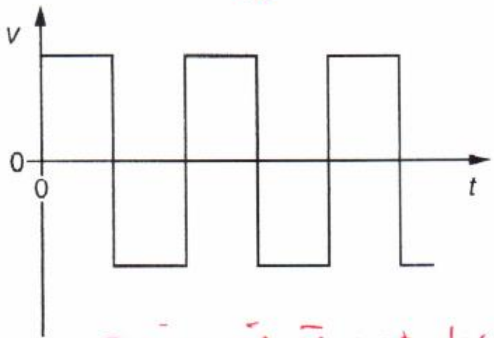


C



velocity remains same but area under the graph is not.

D ✓



Since it is not losing speed, the velocity remains same and distance moved.

8. June/2022/Paper_21/No.1(a),(b)

(a) Define velocity.

Rate of change of displacement (s)

$v = \Delta s / t$. [1]

(b) A rock of mass 7.5 kg is projected vertically upwards from the surface of a planet. The rock leaves the surface of the planet with a speed of $4.0\,\text{m}\,\text{s}^{-1}$ at time $t = 0$. The variation with time t of the velocity v of the rock is shown in Fig. 1.1.

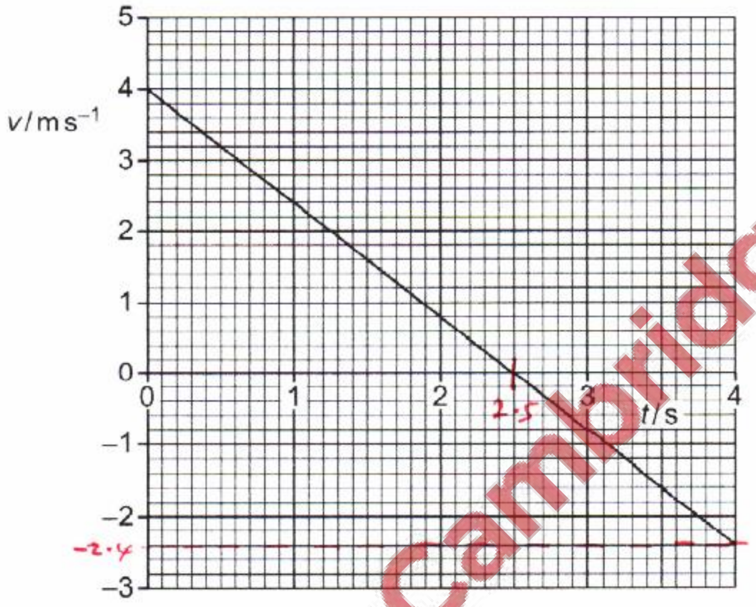


Fig. 1.1

Assume that the planet does not have an atmosphere and that the viscous force acting on the rock is always zero.

(i) Determine the height of the rock above the surface of the planet at time $t = 4.0$ s.

height = displacement

displacement = area under graph.

$$\text{height} = \left(\tfrac{1}{2} \times 2.5 \times 4\right) - \tfrac{1}{2} \times 2.4 \times (4 - 2.5)$$

$$= 5.0 - (1.2 \times 1.5)$$

$$= 5.0 - 1.8$$

$$= 3.2\ \text{m}$$

height = 3.2 m [3]

(ii) Determine the change in the momentum of the rock from time $t = 0$ to time $t = 4.0$ s.

$u = 4.0\ ms^{-1}$
$m = 7.5\ kg$
$v = -2.4\ ms^{-1}$

$\Delta p = mv - mu$
$= m(v - u)$

$\Delta p = 7.5(-2.4 - 4.0)$
$= 7.5 \times 6.4$
$= -48\ Ns$

change in momentum = 48 Ns [2]

(iii) Determine the weight W of the rock on this planet.

$W = mg$
but $Mg = m\left(\frac{v-u}{t}\right)$
$= \frac{mv - mu}{t}$
but $mv - mu = \Delta p$
$\therefore W = \frac{\Delta p}{t}$

$W = \frac{48}{4.0}$
$= 12\ N$

W = 12 N [2]

9. June/2022/Paper_22/No.3

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.

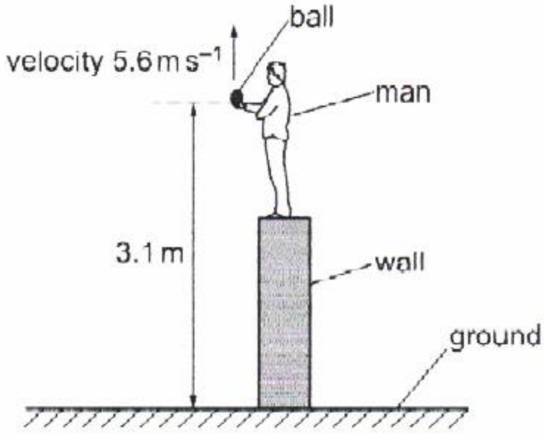


Fig. 3.1 (not to scale)

Assume that air resistance is negligible.

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

At H_{max}

$v = 0$

$g = 9.81$

$s = ?$

$u = 5.6\,m\,s^{-1}$

$v^2 = u^2 - 2gs$

but $v = 0$

$0 = u^2 - 2gs$

$2gs = u^2$

$s = \frac{u^2}{2g}$

$= \frac{5.6^2}{2 \times 9.81}$

$= 1.5983\,m$

max height above ground

$= 3.1 + 1.5983$

$= 4.69$

$\simeq 4.7$

[2]

(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.

$u = 0$

$g = 9.81$

$t = ?$

$s = 4.7\,m$

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

but $u = 0$

$\therefore s = \frac{1}{2}gt^2$

$t^2 = \frac{2s}{g}$

$t = \sqrt{\frac{2s}{g}}$

$= \sqrt{\frac{2 \times 4.7}{9.81}} = 0.9788$

$\simeq 0.985$

time taken = 0.98 s [2]

(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.

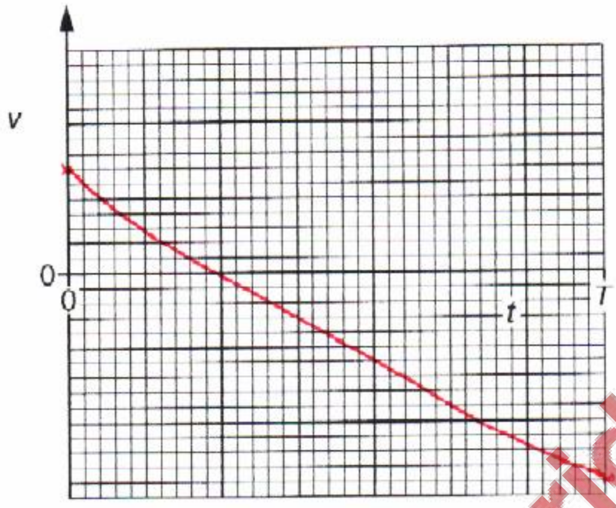


Fig. 3.2

graph is v − t

[3]

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

acceleration of the ball .... [1]

(e) The man now throws a second ball with the same velocity and from the same height as the first ball. The mass of the second ball is greater than that of the first ball. Assume that air resistance is still negligible.

For the first and second balls, compare:

(i) the magnitudes of their accelerations

acceleration is same (acc due to gravity). .... [1]

(ii) the speeds with which they hit the ground.

Speed is the same .... [1]

$v^2 = u^2 + 2gs$

but $u = 0$

$v = \sqrt{2gs}$

The final speed is independent of the mass m of the balls.

[Total: 10]

10. June/2022/Paper_23/No.2

An archer releases an arrow towards a target at a velocity of 65.0 m s^{-1} at an angle of 4.30° above the horizontal, as shown in Fig. 2.1.

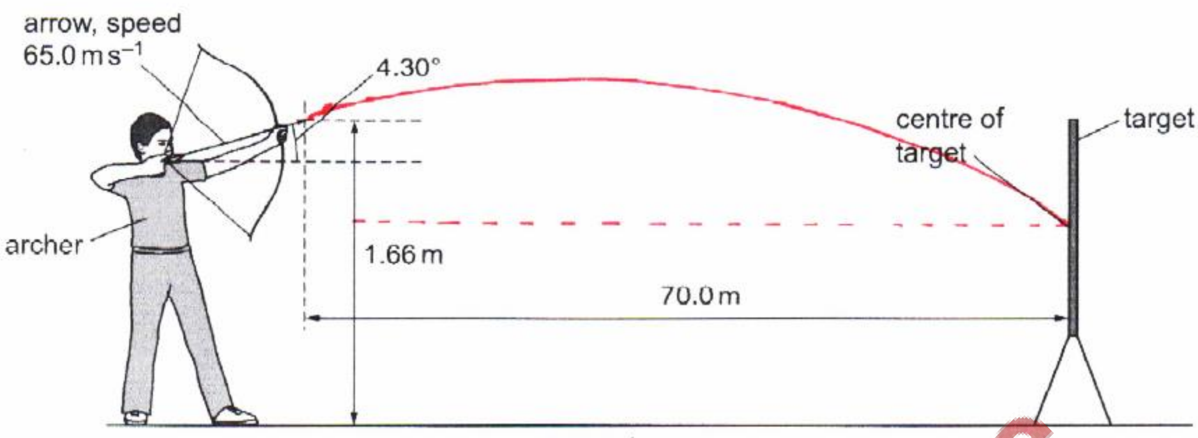


Fig. 2.1 (not to scale)

When released, the tip of the arrow is a horizontal distance of 70.0 m from the target and 1.66 m above the horizontal ground.

The arrow hits the centre of the target.

Assume that air resistance is negligible and that all the mass of the arrow is at its tip.

(a) Show that the time taken for the arrow to reach the target is 1.08 s.

65 m s^{-1}, 4.30°

Horizontal component

$u = 65 \cos 4.30°$

Range = $u \times t$

$t = \frac{R}{u}$

$= \frac{70}{65 \cos 4.30°}$

$t = 1.079$

$\simeq 1.08$ s

[2]

(b) Calculate the height of the centre of the target above the ground.

$u = 65 \sin 4.30°$

$t = 1.08$

$g = 9.81$

Consider vertical motion

65, 4.3, $65 \sin 4.3°$

$s = ut - \frac{1}{2}gt^2$

$= (65 \sin 4.3° \times 1.08) - \frac{1}{2} \times 9.81 \times 1.08^2$

$= 0.46$ m.

Height above ground $= 1.66 - 0.46$

$= 1.2$ m

height above ground = ...1.2...... m [3]

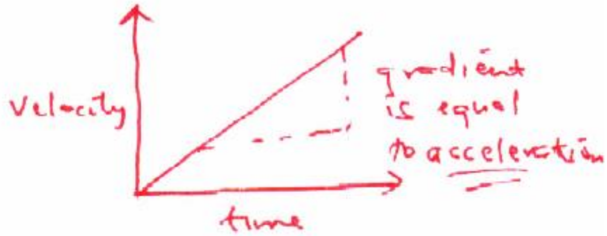
(c) By considering energy changes, state and explain how the final kinetic energy of the arrow as it hits the target compares with its initial kinetic energy immediately after release. A numerical calculation is not required.

- Initial GPE of arrow is higher than final GPE.
- The change in GPE is converted to K·E since air resistance is negligible
- So final K·E is greater than initial K·E. [2]

[Total: 7]

11. March/2022/Paper_12/No.5

How can the acceleration of an object be determined?



A from the area under a displacement–time graph

B from the area under a velocity–time graph

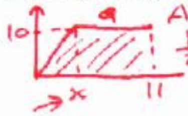
C from the gradient of a displacement–time graph

D from the gradient of a velocity–time graph

12. March/2022/Paper_12/No.6

A sprinter takes a time of 11.0 s to run a 100 m race. She first accelerates uniformly from rest, reaching a speed of $10\,m\,s^{-1}$. She then runs at a constant speed of $10\,m\,s^{-1}$ until the finish line.

What is the uniform acceleration of the sprinter for the first part of the race?



A $0.5\,m\,s^{-2}$ **B** $0.91\,m\,s^{-2}$ **C** $1.7\,m\,s^{-2}$ **D** $5.0\,m\,s^{-2}$

13. March/2022/Paper_22/No.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. 2.1.

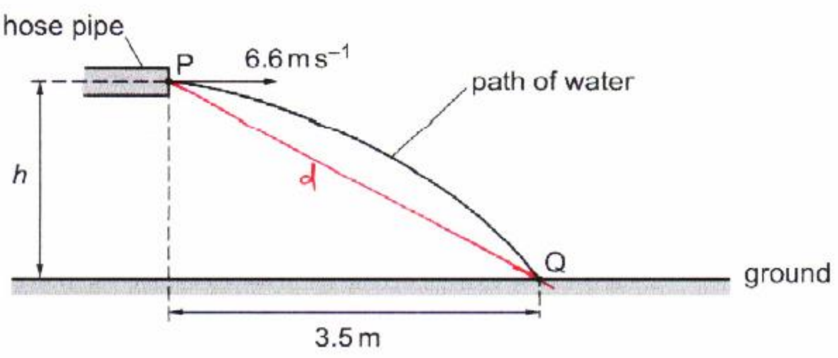


Fig. 2.1 (not to scale)

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.

In the horizontal direction there is no force acting on water droplets [1]

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

Range = time × velocity

$R = t \times v_h$.

$t = \frac{R}{v_h}$

$t = \frac{3.5\,m}{6.6\,m\,s^{-1}}$

$= 0.53\,s$

[1]

(c) Calculate height h.

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

Initial vertical velocity $u = 0$

$\therefore s = \frac{1}{2}gt^2$

$s = \frac{1}{2} \times 9.81 \times 0.53^2$

$= 1.3778$

$= 1.4\,m$

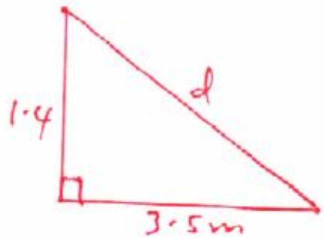
h = 1.4 m [2]

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

- displacement is the distance between P and Q in a straight line. So distance along its path is more than the displacement. [1]

- displacement is less than the distance path

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



Use Pythagoras method

$d^2 = 1.4^2 + 3.5^2$

$d = \sqrt{1.4^2 + 3.5^2}$

$= 3.769$

≈ 3.8 m (2 s.f.)

displacement = 3·8 m [2]

[Total: 7]