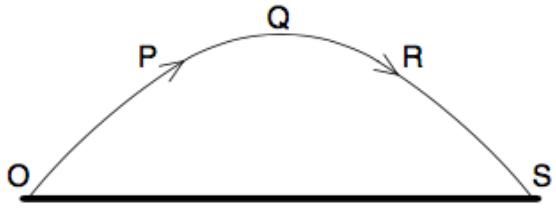
1)

A projectile is launched at point O and follows the path OPQRS, as shown. Air resistance may be neglected.




Which statement is true for the projectile when it is at the highest point Q of its path?

**A** The horizontal component of the projectile's acceleration is zero.

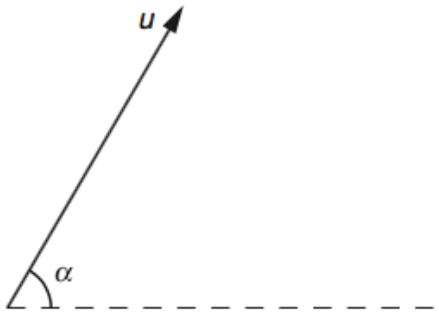
**B** The horizontal component of the projectile's velocity is zero.

**C** The kinetic energy of the projectile is zero.

**D** The momentum of the projectile is zero.

2)

A projectile is fired at an angle $\alpha$ to the horizontal at a speed $u$, as shown.

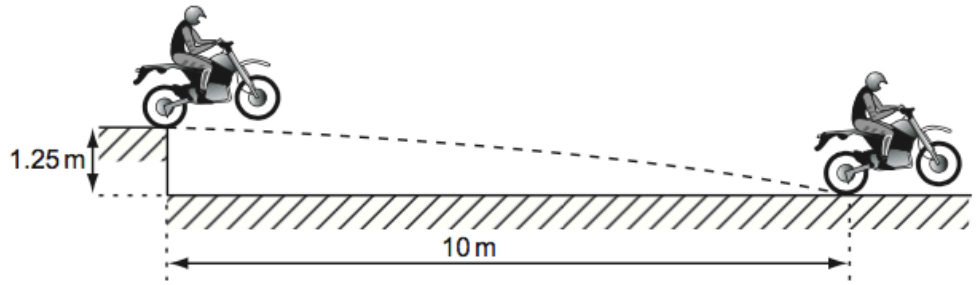



What will be the vertical and horizontal components of its velocity after a time $t$?
Assume that air resistance is negligible. The acceleration of free fall is $g$.

| | vertical component | horizontal component |
|---|---|---|
| **A** | $u \sin \alpha$ | $u \cos \alpha$ |
| **B** | $u \sin \alpha - gt$ | $u \cos \alpha - gt$ |
| **C** | $u \sin \alpha - gt$ | $u \cos \alpha$ |
| **D** | $u \cos \alpha$ | $u \sin \alpha - gt$ |

3)

A motorcycle stunt-rider moving horizontally takes off from a point 1.25 m above the ground, landing 10 m away as shown.

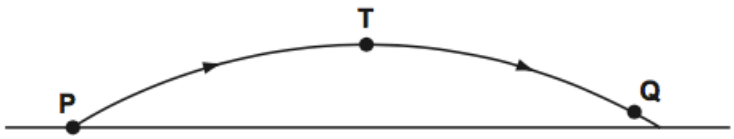



What was the speed at take-off?

**A** $5\,m\,s^{-1}$ **B** $10\,m\,s^{-1}$ **C** $15\,m\,s^{-1}$ **D** $20\,m\,s^{-1}$

4)

In the absence of air resistance, a stone is thrown from **P** and follows a parabolic path in which the highest point reached is **T**. The stone reaches point **Q** just before landing.




The vertical component of acceleration of the stone is

**A** zero at **T**.

**B** greatest at **T**.

**C** greatest at **Q**.

**D** the same at **Q** as at **T**.

5)

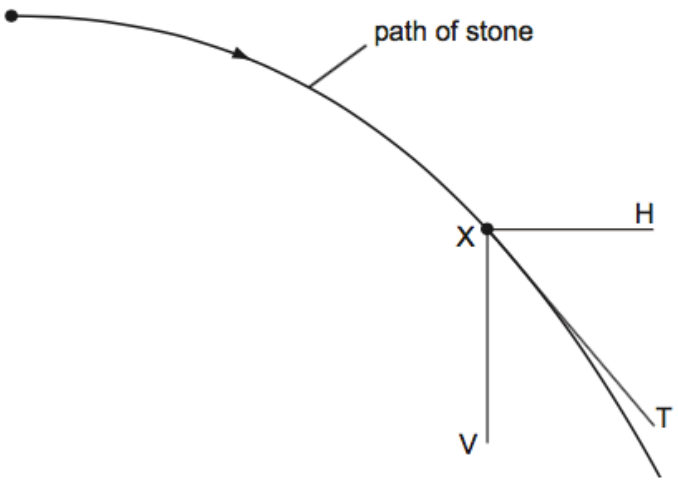
A boy throws a ball vertically upwards. It rises to a maximum height, where it is momentarily at rest, and falls back to his hands.

Which of the following gives the acceleration of the ball at various stages in its motion? Take vertically upwards as positive. Neglect air resistance.

| | rising | at maximum height | falling |
|---|---|---|---|
| **A** | $-9.81\,m\,s^{-2}$ | 0 | $+9.81\,m\,s^{-2}$ |
| **B** | $-9.81\,m\,s^{-2}$ | $-9.81\,m\,s^{-2}$ | $-9.81\,m\,s^{-2}$ |
| **C** | $+9.81\,m\,s^{-2}$ | $+9.81\,m\,s^{-2}$ | $+9.81\,m\,s^{-2}$ |
| **D** | $+9.81\,m\,s^{-2}$ | 0 | $-9.81\,m\,s^{-2}$ |

6)

A stone is projected horizontally in a vacuum and moves along a path as shown. X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.




Along which direction or directions do forces act on the stone at X?

**A** XV **B** XH **C** XV and XH **D** XT

7)

A girl stands at the top of a cliff and throws a ball vertically upwards with a speed of 12 m s$^{-1}$, as illustrated in Fig. 3.1.

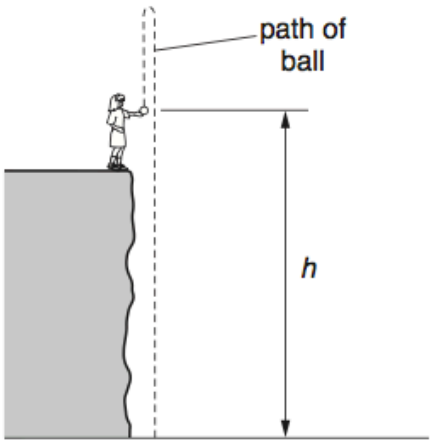



**Fig. 3.1**

At the time that the girl throws the ball, her hand is a height *h* above the horizontal ground at the base of the cliff.
The variation with time *t* of the speed *v* of the ball is shown in Fig. 3.2.

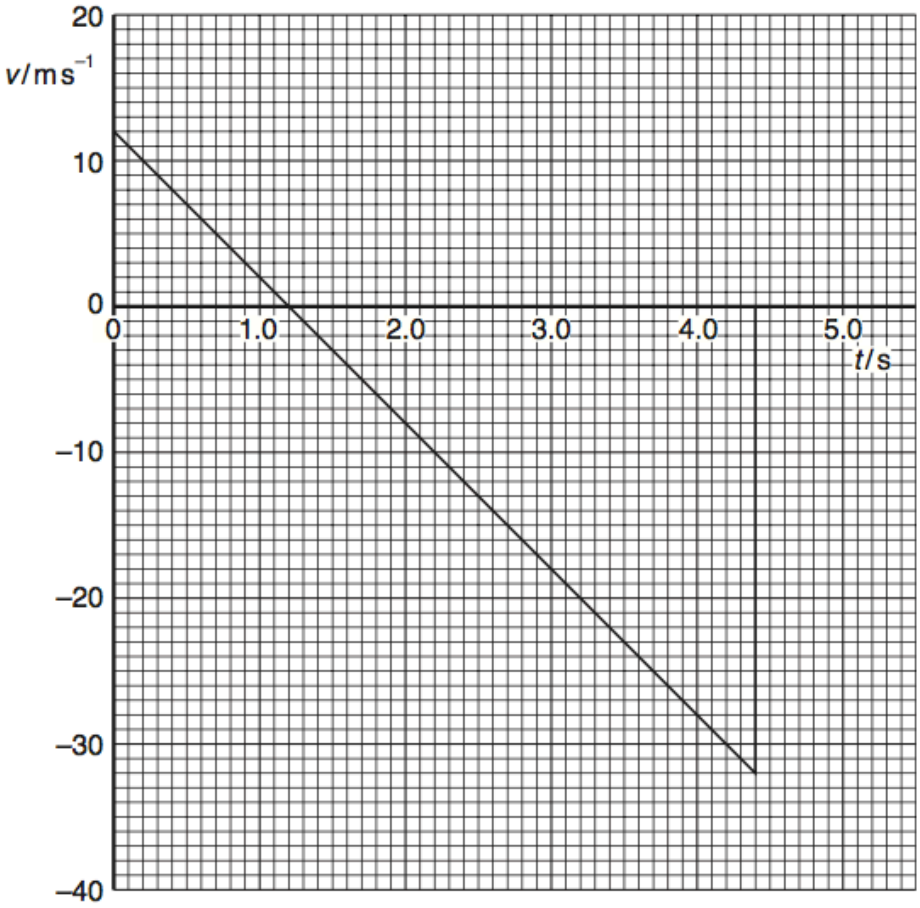



**Fig. 3.2**

Speeds in the upward direction are shown as being positive. Speeds in the downward direction are negative.

**(a)** State the feature of Fig. 3.2 that shows that the acceleration is constant.

..... [1]

**(b)** Use Fig. 3.2 to determine the time at which the ball

**(i)** reaches maximum height,

time = ..... s

**(ii)** hits the ground at the base of the cliff.

time = ..... s
[2]

**(c)** Determine the maximum height above the base of the cliff to which the ball rises.

height = ..... m [3]

8)

**(a)** Derive the SI base unit of force.

SI base unit of force = ..... [1]

**(b)** A spherical ball of radius $r$ experiences a resistive force $F$ due to the air as it moves through the air at speed $v$. The resistive force $F$ is given by the expression

$$F = crv,$$

where $c$ is a constant.

Derive the SI base unit of the constant $c$.

SI base unit of $c$ = ..... [1]

**(c)** The ball is dropped from rest through a height of 4.5 m.

**(i)** Assuming air resistance to be negligible, calculate the final speed of the ball.

speed = ..... $m\,s^{-1}$ [2]

**(ii)** The ball has mass 15 g and radius 1.2 cm.

The numerical value of the constant $c$ in the equation in **(b)** is equal to $3.2 \times 10^{-4}$ when measured using the SI system of units.

Show quantitatively whether the assumption made in **(i)** is justified.

[3]

9)

An experiment is conducted on the surface of the planet Mars.
A sphere of mass 0.78 kg is projected almost vertically upwards from the surface of the planet. The variation with time $t$ of the vertical velocity $v$ in the upward direction is shown in Fig. 2.1.

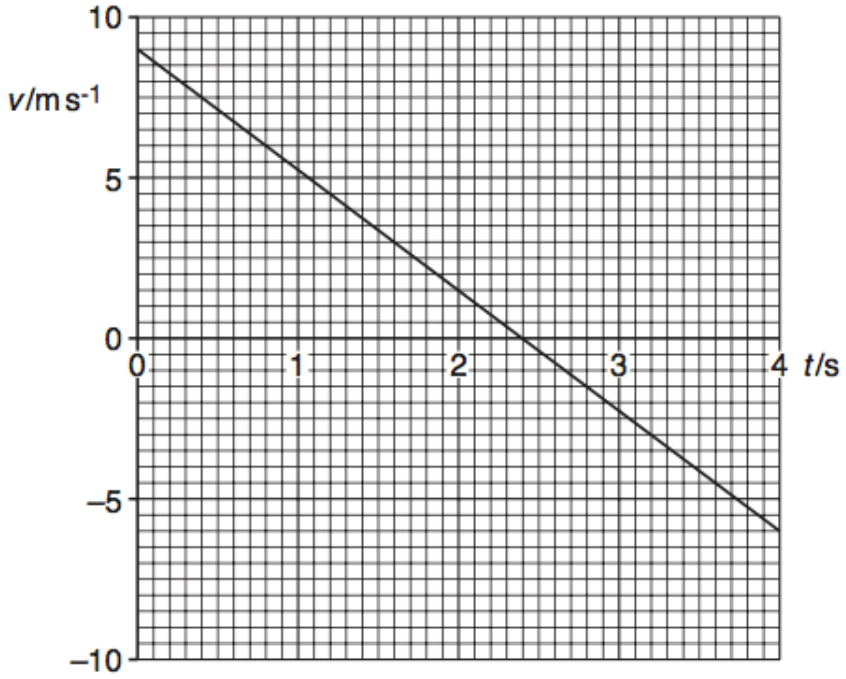



**Fig. 2.1**

The sphere lands on a small hill at time $t = 4.0$ s.

**(a)** State the time $t$ at which the sphere reaches its maximum height above the planet's surface.

$t =$ ..... s [1]

**(b)** Determine the vertical height above the point of projection at which the sphere finally comes to rest on the hill.

height = ..... m [3]