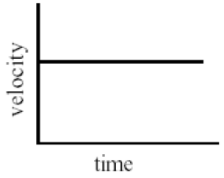
1. Projectile Motion

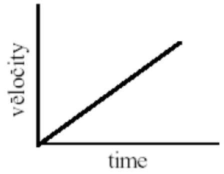
A projectile is an object which has been given a forward motion through the air, but which is also being pulled downward by the force of gravity. This results in the path of the projectile being curved.

A projectile has two separate motions at right angles to each other. In calculations each motion must be treated independent of the other.

Horizontal
- constant speed
- for calculations use $d = v_h \times t$
- velocity graph

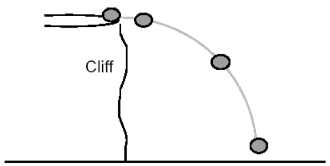


Vertical
- constant acceleration
- for calculations use $v = u + at$, where $u = 0ms^{-1}$ and $a = 9.8ms^{-2}$
- velocity graph



Example 1

A ball is kicked horizontally at 5ms-1 from the top of a cliff as shown below. It takes 2seconds to reach the ground.



a) What horizontal distance did it travel in the 2seconds?

$v_h = 5ms^{-1}$
$d = ?$
$t = 2s$

$d = v_h \times t$
$d = 5 \times 2$
$d = 10m$

b) What was its vertical velocity just before it hit the ground?

$u = 0ms^{-1}$
$v = ?$
$a = 9.8ms^{-2}$
$s = ?$
$t = 2s$

$v = u + at$
$v = 0 + 9.8 \times 2$
$v = 19.6ms^{-1}$

Example 2

In the experimental set-up shown below, the arrow is lined up towards the target. As the arrow is fired, the circuit supplying the electromagnet is broken, and the target falls downwards from A to B.

Explain why the arrow will hit the target.

- **The arrow and the target have the same initial velocity ($u = 0ms^{-1}$), and they both have the same vertical acceleration ($9.8ms^{-2}$).**
- **As they both start to fall from their high points at the same time they will meet directly under the electromagnet. So the arrow will hit the target.**

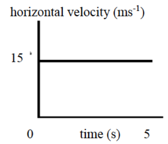
6. PROJECTILES

N5 Past Paper HW
2015 – Sec 2 Q9
2016 – MC Q18

Example 3

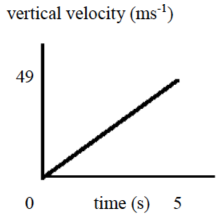
A ball is projected horizontally at 15ms-1 from the top of a vertical building. The ball reaches the ground 5s later. For the period between projection until it hits the ground, draw graphs, with numerical values on the scales of the ball's:

a) horizontal velocity against time



b) vertical velocity against time

$v = u + at$
$v = 0 + 9.8 \times 5$
$v = 49ms^{-1}$



c) From the graphs calculate the horizontal and vertical distances travelled.

horizontal distance = area under graph
horizontal distance = l x b
horizontal distance = 5 x 15
horizontal distance = 75m OR
$d = v \times t$
$d = 5 \times 15$
$d = 75m$

vertical distance = area under graph
vertical distance = ½ x b x h
vertical distance = 0.5 x 5 x 49
vertical distance = 122.5m
vertical distance = 123m