PQ + Q + A

# Q1

A racing car starts from rest and accelerates uniformly in a straight line at 12 m s$^{-2}$ for 5 s. Calculate the final velocity of the car.

$u = 0 \text{ ms}^{-1}$

$a = 12 \text{ ms}^{-2}$

$t = 5 \text{ s}$

$v = ?$

$v = u + at$

$v = u + at$

$v = 0 + (12 \times 5)$

$v = 0 + 60$

$v = 60 \text{ ms}^{-1}$ in direction of acceleration

# Q2

A speedboat travels 400 m in a straight line when it accelerates uniformly from 2.5 m s⁻¹ in 10 s. Calculate the acceleration of the speedboat.

$s = 400\,m$

$u = 2.5\,ms^{-1}$

$t = 10\,s$

$a = ?$

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

$400 = (2.5 \times 10) + (0.5 \times a \times 10^2)$

$400 = 25 + 50a$

$50a = 400 - 25 = 375$

$a = \frac{375}{50} = 7.5\,ms^{-2}$ in the direction of original velocity

# Q3

A rocket is travelling through outer space with uniform velocity. It then accelerates at 2.5 m s$^{-2}$ in a straight line in the original direction, reaching 100 m s$^{-1}$ after travelling 1 875 m. Calculate the rocket's initial velocity?

$a = 2.5 ms^{-2}$
$V = 100 ms^{-1}$
$s = 1875 m$
$u = ?$

$$V^2 = u^2 + 2as$$
$$100^2 = u^2 + (2 \times 2.5 \times 1875)$$
$$10\,000 = u^2 + 9375$$
$$u^2 = 10000 - 9375 = 625$$
$u = 25 ms^{-1}$ in direction of acceleration

# Q4

A car, travelling in a straight line, decelerates uniformly at 2 m $s^{-2}$ from 25 m $s^{-1}$ for 3 s. Calculate the car's velocity after the 3 s.

$a = -2\ m\ s^{-2}$

$u = 25\ m\ s^{-1}$

$t = 3\ s$

$v = ?$

$$v = u + at$$

$v = u + at$

$v = 25 + (-2 \times 3)$

$v = 25 + (-6)$

$v = \underline{19\ m\ s^{-1}}$ (in direction of original velocity)

# Q5

A greyhound is running at 6 m $s^{-1}$. It decelerates uniformly in a straight line at 0.5 m $s^{-2}$ for 3 s. Calculate the displacement of the greyhound while it was decelerating.

$u = 6$ m $s^{-1}$

$a = -0.5$ m $s^{-2}$

$t = 3$ s

$s = ?$

$s = ut + 1/2at^2$

$s = (6 \times 3) + (0.5 \times -0.5 \times 3^2)$

$s = 18 + (-2.25)$

$s =$ <u>15.75 m</u> (in direction of original velocity)

| |
|---|
| $s = ut + 1/2at^2$ |

# Q6

A curling stone leaves a player's hand at 5 m $s^{-1}$ and decelerates uniformly at 0.75 m $s^{-2}$ in a straight line for 16.5 m until it strikes another stationary stone. Calculate the velocity of the decelerating curling stone at the instant it strikes the stationary one.

$u = 5$ m $s^{-1}$

$a = -0.75$ m $s^{-2}$

$s = 16.5$ m

$v = ?$

$v^2 = u^2 + 2as$

$v^2 = 5^2 + (2 \times -0.75 \times 16.5)$

$v^2 = 25 + (-24.75)$

$v^2 = 0.25$

$v = \sqrt{0.25} =$ <u>0.5 m $s^{-1}$</u> (in direction of original velocity)

$v^2 = u^2 + 2as$

# Q7

A firework rocket is launched vertically upwards from the ground at 49 m $s^{-1}$.

(a) What will be the velocity of the rocket at its maximum height?

(b) Calculate:

(i) the time taken for the rocket to reach its maximum height;

(ii) the maximum height.

$u = 49$ m $s^{-1}$

$a = -9.8$ m $s^{-2}$

$t = ?$

$s = ?$

(a) At maximum height, $v = 0$ m $s^{-1}$

(b)(i) $v = u + at$

$0 = 49 + (-9.8 \times t)$

$0 = 49 - 9.8\,t$

$9.8\,t = 49$

$t = 49/9.8 =$ 5 s.

(ii) $s = ut + 1/2at^2$

$s = (49 \times 5) + (0.5 \times -9.8 \times 5^2)$

$s = 245 + (-122.5)$

$s =$ 122.5 m

(i.e., 122.5 m upwards, so height = 122.5 m)

$v^2 = u^2 + 2as$

$0^2 = 49^2 + (2 \times -9.8 \times s)$

$0 = 2401 + (-19.6\,s)$

$19.6\,s = 2401$

$s = 2401/19.6 =$ 122.5 m

(i.e., 122.5 m upwards, so height = 122.5 m)

# Q8

A long-range artillery shell is fired from level ground with a velocity of 500 m $s^{-1}$ at an angle of 30° to the horizontal. Determine:

(a) the greatest height the shell reaches;

(b) the time taken to reach that height;

(c) the total time the shell is in the air;

(d) the horizontal distance the shell travels (i.e., its range).

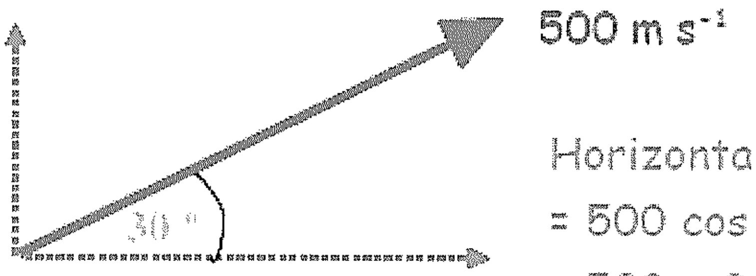
First, resolve the velocity into its horizontal and vertical components:

Vertical component of velocity

= 500 sin 30°

= 500 × 0.5

= 250 m $s^{-1}$.




Horizontal component of velocity

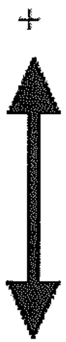
= 500 cos 30°

= 500 × 0.866

= 433 m $s^{-1}$.

# Q8 continued

(a)




v at highest point = 0 — $v^2 = u^2 + 2as$

gravitational acceleration = $-9.8 \text{ m s}^{-2}$

$0^2 = 250^2 + (2 \times -9.8 \times s)$

$0 = 62\,500 - 19.6\,s$

$19.6\,s = 62\,500$

$s = 62\,500/19.6 =$ **3 189 m** (to nearest metre).

# Q8 continued

(b) $v = u + at$

$0 = 250 + (-9.8 \times t)$

$0 = 250 - 9.8\,t$

$9.8\,t = 250$

$t = 250/9.8 =$ **25.5 s**

(c) Total time shell is in air = $2 \times 25.5$ s = **51 s**

(d) $s_h = v_h t$

$= 433 \times 51$

$=$ **22 083 m right**