Vertical SUVAT — January 2011

2. A ball is thrown vertically upwards with speed u m s^{-1} from a point P at height h metres above the ground. The ball hits the ground 0.75 s later. The speed of the ball immediately before it hits the ground is 6.45 m s^{-1}. The ball is modelled as a particle.

(a) Show that $u = 0.9$ **(3)**

(b) Find the height above P to which the ball rises before it starts to fall towards the ground again. **(2)**

(c) Find the value of h. **(3)**

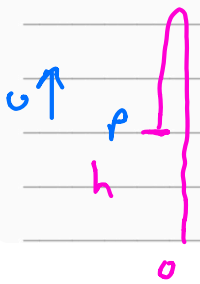
$s - s_0 = ut + \frac{1}{2}at^2$

$s - s_0 = vt - \frac{1}{2}at^2$

$v^2 = u^2 + 2a(s - s_0)$

$v = u + at$

$a = \frac{(v-u)}{t}$



$t = 0.75$

$v = -6.45 \text{ ms}^{-1}$

a) $v = u + at$

$u = v - at$

$u = -6.45 - -9.8 \times 0.75$

$u = -6.45 + 9.8 \times 0.75 = 0.9 \text{ ms}^{-1}$

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b) $v^2 = u^2 + 2a(s - s_0)$

$v^2 = 0.9^2 - 19.6(s - h)$

At highest point $v = 0$

$0 = 0.81 - 19.6(s - h)$

$19.6(s - h) = 0.81$

$s - h = \frac{0.81}{19.6} = 0.041 \text{ m}$

Height above P = $s - h = 0.041\text{ m}$

c) $s - s_0 = ut + \frac{1}{2}at^2$

$0 - h = 0.9 \times 0.75 - 4.9 \times 0.75^2$

$-h = -2.08$

$h = 2.08\text{ m}$

Vertical SUVAT

January 2012

5. A stone is projected vertically upwards from a point A with speed $u\,\text{m s}^{-1}$. After projection the stone moves freely under gravity until it returns to A. The time between the instant that the stone is projected and the instant that it returns to A is $3\frac{4}{7}$ seconds.

Modelling the stone as a particle,

(a) show that $u = 17\frac{1}{2}$,

(3)

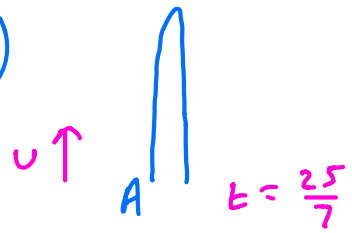
(b) find the greatest height above A reached by the stone,

(2)

(c) find the length of time for which the stone is at least $6\frac{3}{5}$ m above A.

(6)

a)



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

$0 = \frac{25}{7}u - 4.9 \times \left(\frac{25}{7}\right)^2$

$4.9 \times \left(\frac{25}{7}\right)^2 = \frac{25}{7}u$

$u = \frac{4.9 \times \left(\frac{25}{7}\right)^2}{\frac{25}{7}} = 4.9 \times \frac{25}{7}$

$= 17.5\text{ m s}^{-1}$

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

Max height
$v = 0$

$0 = 17.5^2 - 19.6s$

$19.6s = 17.5^2$

$s = \frac{17.5^2}{19.6} = 15.625\text{ m}$

$s = 15.6\text{ m}$

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

$6.6 = 17.5t - 4.9t^2$

$4.9t^2 - 17.5t + 6.6 = 0$

By calc $t = \frac{22}{7}$ or $t = \frac{3}{7}$

Above 6.6 m between these times

$\frac{22}{7} - \frac{3}{7} = \frac{19}{7}$ seconds

or 2.71 s

Horizontal SUVAT

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1. Three posts P, Q and R, are fixed in that order at the side of a straight horizontal road. The distance from P to Q is 45 m and the distance from Q to R is 120 m. A car is moving along the road with constant acceleration a m s^{-2}. The speed of the car, as it passes P, is u m s^{-1}. The car passes Q two seconds after passing P, and the car passes R four seconds after passing Q. Find

(i) the value of u,

(ii) the value of a.

(7)

PQ

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

$$45 = 2u + \tfrac{1}{2}a(2)^2$$

$$45 = 2u + 2a \qquad (1)$$

PR

$$165 = 6u + \tfrac{1}{2}a \times 6^2$$

$$165 = 6u + 18a \qquad (2)$$

Solve (1) and (2) by calc

$u = 20$ ms^{-1} $\quad a = 2.5$ ms^{-2}

2. An athlete runs along a straight road. She starts from rest and moves with constant acceleration for 5 seconds, reaching a speed of $8\,\text{m s}^{-1}$. This speed is then maintained for T seconds. She then decelerates at a constant rate until she stops. She has run a total of 500 m in 75 s.

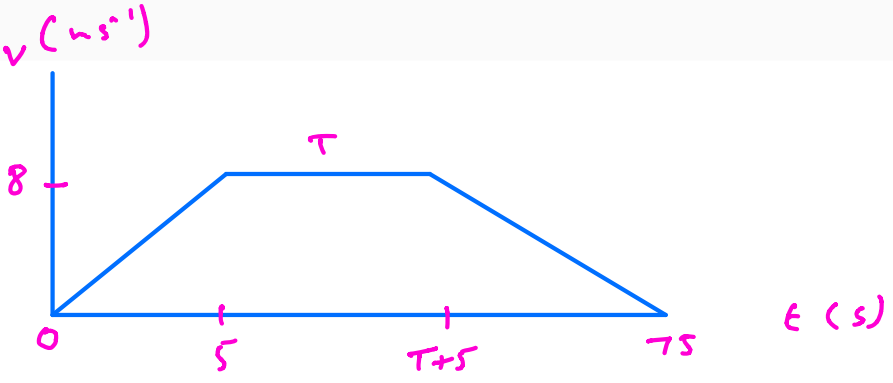
(a) In the space below, sketch a speed-time graph to illustrate the motion of the athlete.

(3)

(b) Calculate the value of T.

(5)

a)



b)

Area = 500 m

$$\frac{1}{2}(75+T)\times 8 = 500$$

$$4(75+T) = 500$$

$$75+T = \frac{500}{4} = 125$$

$$T = 125 - 75$$

$$T = 50\ \text{s}$$