Example 1.1

12 inc = 1 foot

1 inc = 2.54 cm

$$6 \text{ Feet} \times \frac{12 \text{ inc}}{1 \text{ Foot}}$$

72 inc

$$72 \text{ inc} \times \frac{2.54 \text{ cm}}{1 \text{ inc}}$$

182.88 cm

100cm = 1m

$$182.88 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}}$$

1.8288 m

1.83 m

Example 1.2

Convert 60 km/h to ms^{-1}

1 km = 1000 m

1 h = 3600 s

Convert units seperately in two steps

$$60 \frac{km}{h} \times \frac{1000\ m}{1\ km}$$

$$60\,000 \frac{m}{h} \times \frac{1\ h}{3600\ s}$$

$$16.7\ m\,s^{-1}$$

Or

$$60 \frac{km}{h} \times \frac{1000\ m}{1\ km} \times \frac{1\ h}{3600\ s}$$

In one step

$$16.7\ m/s$$

Example 1.1

6 feet → m

1 foot = 2.54 cm

$$\therefore 6\ feet \times \frac{2.54\ cm}{1\ foot}$$

Example 1.3

a) $42\,000\ km \rightarrow m$

$1\ km = 1000\ m$

$\therefore\ 42\,000\ km \times \frac{1000\ m}{1\ km}$

$42\,000\,000\ m$

$4.2 \times 10^{7}\ m$

b) $3.2 \times 10^{-8}\ kg \longrightarrow \mu g$

$1\ kg = 1000\ g$

$3.2 \times 10^{-8}\ kg \times \frac{1000\ g}{1\ kg}$

$3.2 \times 10^{-5}\ g$

$1\ g = 10^{6}\ \mu g$ or $1\ \mu g = 10^{-6}\ g$

$\therefore\ 3.2 \times 10^{-5}\ g \times \frac{10^{6}\ \mu g}{1\ g}$

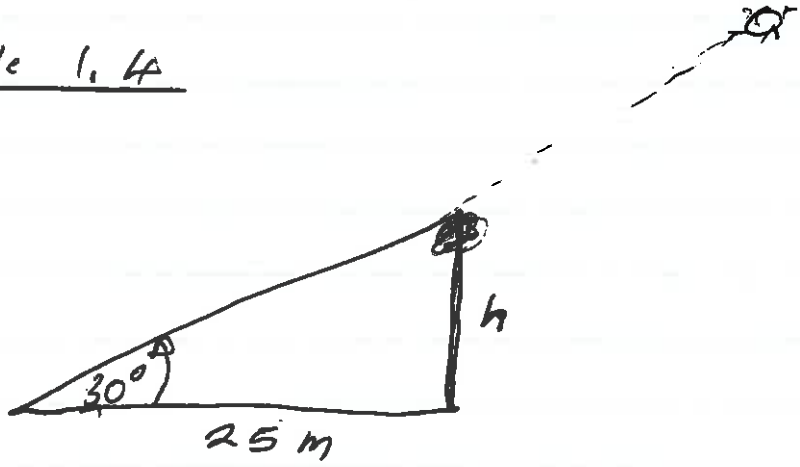
$32\ \mu g$

or

$3.2 \times 10^{-5}\ g \times \frac{1\ \mu g}{10^{-6}\ g}$

$32\ \mu g$

Example 1.4



$$\tan 30^\circ = \frac{h}{25}$$

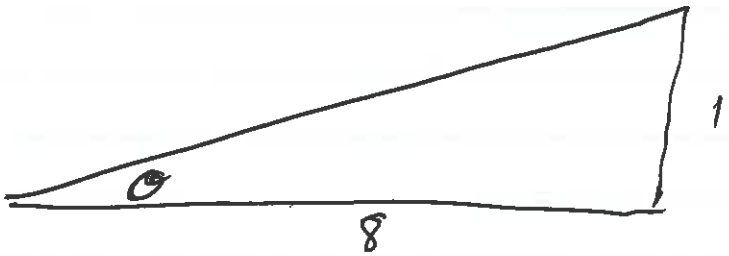
$$h = 25 \tan 30^\circ$$

$$= 14.4 \text{ m}$$

Example 1.5

The ration 1:8 can be written as $\frac{1}{8}$. The gradient $= \Delta y / \Delta x \Rightarrow$

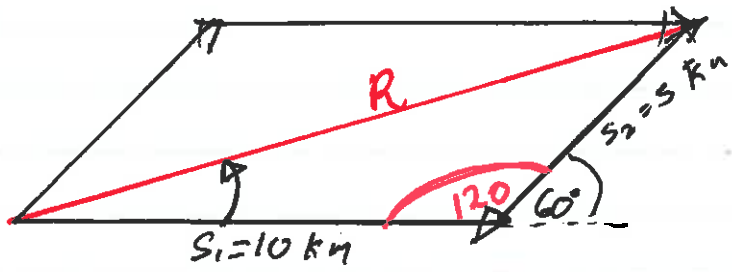
$$\frac{dy}{dx} = \frac{1}{8}$$



$$\tan\theta = \frac{1}{8}$$

$$\theta = \tan^{-1}\left(\frac{1}{8}\right)$$

Example 1.6



$$R^2 = S_1^2 + S_2^2 - 2S_1 S_2 \cos 120$$
$$= 5^2 + 10^2 - 2\times5\times10 \cos 120$$
$$= 125 + 50$$
$$R^2 = 175$$
$$R = 13.2 \quad / \quad 13.3$$

$$S_2 = S_1^2 + R^2 - 2S_1 R \cos\phi$$
$$\frac{25 - 100 - 175}{-(10\times 13.2)\times 2} = \cos\phi$$
$$\frac{249}{264} = \cos\theta = 0.94$$
$$\theta = \cos^{-1}(0.94)$$
$$\theta = 19.4^\circ \qquad 19.1^\circ$$

Example 2.1

- Av. speed = $\frac{\text{distance}}{\text{Time elapsed}}$

$$= \frac{10}{1} = 10\ km\ h^{-1}$$

$$\bar{V} = \frac{s}{t} = \frac{0}{1} = 0$$

Example 2.2

a) Seg. A $\quad \bar{V} = \frac{s}{t} = \frac{20-0}{1-0} = 20\ km\ h^{-1}$

Seg B $\quad V = \frac{s}{t} = \frac{20-20}{2-1} = \frac{0}{1} = 0\ km\ h^{-1}$

Se. C $\quad V = \frac{s}{t} = \frac{0-20}{4-2} = \frac{-20}{2} = -10\ km^{-1}$

b) Total dist $= 20 + 0 + 20 = 40\ km$

c) $S = 20 + 0 - 20 = 0\ km$

d) Av. speed $= \frac{\text{distance}}{\text{Time}} = \frac{40\ km}{4\ h^{-1}} = 10\ km\ h^{-1}$

e) $\bar{V} = \frac{s}{t} = \frac{0}{t} = 0$

Example 2.3

- $V_i = 100$, $V_f = 0$, $t = 10$

$$a = \frac{V_f - V_i}{t} = \frac{0 - 100}{10} = -10\ ms^{-2}$$

-ve implies a deccelerration or retardation.

Example 2.4

Seg A

$$a = \frac{\Delta v}{\Delta t} = \frac{10 - 0}{4 - 0} = \frac{10}{4} = 2.5\ ms^{-2}$$

Seg B $a = \frac{\Delta v}{\Delta t} = \frac{10 - 10}{6 - 4} = \frac{0}{2} = 0\ ms^{-2}$

Seg. C $a = \frac{\Delta v}{\Delta t} = \frac{0 - 10}{8 - 6} = -\frac{10}{2} = -5\ ms^{-2}$

Seg A $S_A = \frac{1}{2} \times 4 \times 10 = 20\ m$

Seg B $S_B = 2 \times 10$

$= 2 \times 10 = 20\ m$

Seg C $= S_C = \frac{1}{2} \times 2 \times 10$

$= 10\ m$

$S = S_A + S_B + S_C$

$= 20 + 20 + 10$

$= 50\ m$

Example 2.5

$u = 0\ ms^{-1}$, $v = 36\ \frac{km}{h} \times \frac{1\ h}{3600\ s} \times \frac{1000\ m}{1\ km}$

$= 10\ ms^{-1}$

$t = 4\ s$

$v = u + at$

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

$a = \frac{10-0}{4}$

$= 2.5\ ms^{-2}$

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

$= \frac{1}{2}(2.5) \cdot 4^2$

$= 20\ m$

or

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

$\frac{v^2-u^2}{2a} = s$

$s = \frac{10^2}{2 \times 2.5} = 20\ m.$

Example 2.6

$u = 3000\ ms^{-1}$, $a = -10\ ms^{-1}$, $v = ?$

$s = 200\ km = 200\ 000\ m.$

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

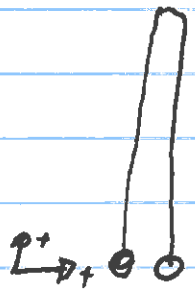
$v^2 = 3000^2 + 2 \times (-10) \times 200\ 000$

$v^2 = 3000^2 - 4\ 000\ 000$

$v^2 = 5\ 000\ 000$

$v = \pm 2236$

Example 2.7



$u = +19.6\ m\,s^{-1}$

$g = -9.8\ m\,s^{-2}$

$s = 0\ m$

$V_{(max)} = 0\ m\,s^{-1}$

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

$0 = 19.6t + \frac{1}{2}(-9.8)t^2$

$\frac{-19.6t \times 2}{-9.8} = t^2$

$t = 4\,s$

Or Upward motion.

$t_{up} = t_{down}$

$V = u + gt$

$\frac{v-u}{g} = t$

$t = \frac{0 - 19.6}{-9.8}$

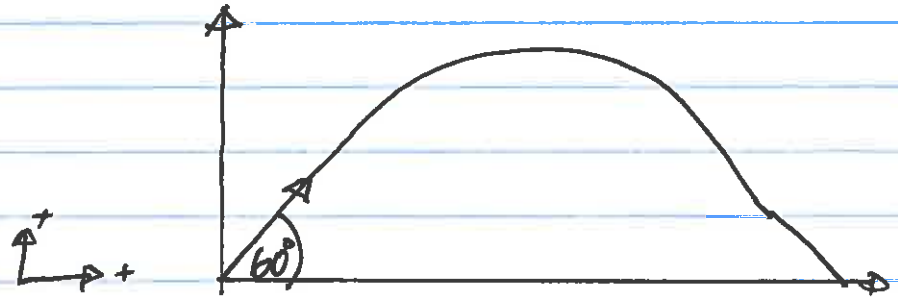
$t_{up} = 2\,s$

$t_{down} = 2\,s$

$t = t_{up} + t_{down}$

$t = 4\,s$

Example



$u = 20 ms^{-1}$, $\theta = 60°$

$u_x = 20 \cos 60° = 10 ms^{-1}$ $\qquad$ $u_y = 20 \sin 60° = 17.3 ms^{-1}$

$a_x = 0$ $\qquad$ $a_y = g = -9.8$

$V_x = u_x = 10 ms^{-1}$ $\qquad$ $V_{(max)} = 0 ms^{-1}$

a) Upward motion

$$V_y^2 = u_y^2 + 2 a_y s_y$$

$$s_y = \frac{V_y^2 - u_y^2}{2g}$$

$$= \frac{0^2 - 17.3^2}{2 \times (-9.8)}$$

$$h = s_y = \underline{15.3 \text{ m}} \rightarrow$$

b) Upward motion $\qquad$ C

$$V_y = u_y + g t$$

$$\frac{V_y - u_y}{g} = t$$

$$t_{up} = \frac{0 - 17.3}{-9.8}$$

$$t_{up} = 1.77 s$$

$$t_{down} = 1.77 s$$

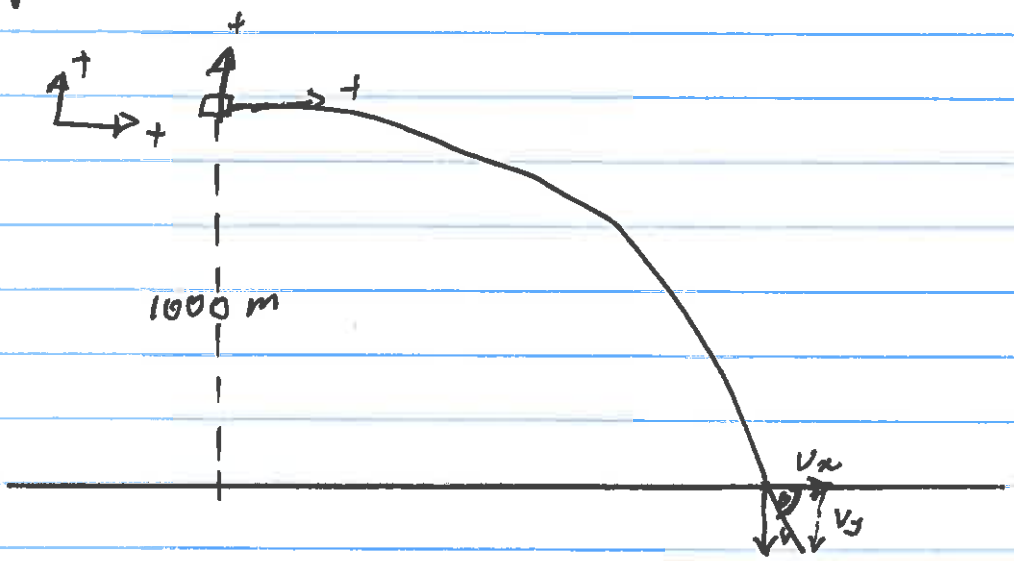
$$t = 1.77 + 1.77 = \underline{3.53 s} \rightarrow$$

c) $R = s_x = u_x t + \frac{1}{2} a_x t^2$

$$= 10 \times 3.53 + 0$$

$$= \underline{35.3 \text{ m}}$$

Example 2.8



$u_y = 0\ ms^{-1}$

$a_y = g = -9.8\ ms^{-2}$

$s_y = -1000\ m$

$u_x = 120\ ms^{-1}$

$a_x = 0$

$v_x = u_x = 120\ ms^{-1}$

a) $s_y = u_y t + \frac{1}{2} g t^2$

$-1000 = 0 + \frac{1}{2}(-9.8)\, t^2$

$\frac{-1000 \times 2}{-9.8} = t^2$

$14.3\ s = t$

b) $v_x = 120\ ms^{-1}$

$v_y^2 = u_y^2 + 2 a_y s_y$

$= 2 \times (-9.8)(-1000)$

$v_y = -140\ ms^{-1}$

$v_y = u_y + g t$

$v_y = -9.8 \times 14.3$

$= -140\ ms^{-1}$

c $v = \sqrt{(-140)^2 + 120^2}$

$= 184\ ms^{-1}$

$\theta = \tan^{-1}\left(\frac{-140}{120}\right)$

$= -49°$