CH # 4

1. Car A : $\overline{U}_A = 30\hat{i}$ $\frac{Km}{h}$

Car B : $\overline{U}_B = 40\hat{j}$ Km/h

$$\overline{U}_{BA} = \overline{U}_B - \overline{U}_A = 40\hat{j} - 30\hat{i}$$

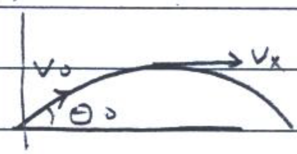
$$\overline{U}_{BA} = -30\hat{i} + 40\hat{j}$$

2. at highest point $v_y = 0$

$V_x = V_0 (x)$

Now: $\theta_0 = 60^\circ$

$U_0 = 50 m/s$



$\therefore$ V at highest point $= V_0 \cos\theta_0 = 50\cos 60$

$$U = 25 \ m/s$$

3. at max hight $V_f = 0$

$\vec{V_0} = 5\hat{i} + 9\hat{j}$ m/s $\Rightarrow |V_0| = \sqrt{25+81} = 10.3 m/s$

Now, to find $\theta_0 = \tan^{-1}\frac{9}{5} = 61^\circ$

$$\Rightarrow \Delta Y_{max} = H = \frac{V_0^2 (\sin\theta_0)^2}{2g}$$

$$\Delta Y_{max} = \frac{(10.3)^2 (\sin 61)^2}{2 \times 9.8} = 4.1 \ m$$

4. $\vec{V_o} = 8\hat{j}\ m/s$ $\qquad X_o = 0,\ Y_o = 0$

$\vec{a} = 4\hat{i} + 2\hat{j}\ m/s^2$

$x = 32\ m,\quad y = ?$

along (x): $V_o(x) = 0 \Rightarrow$

$$\Delta X = V_o^{(x)} t + \frac{1}{2} a_x t^2$$

$$(X - X_o) = 0 + \frac{1}{2}(4)t^2$$

$$32 = 2t^2 \Rightarrow \boxed{t = 4\ s}$$

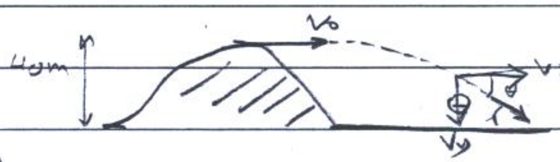
Now along (y): $V_o(y) = 8\ m/s$

$$Y - Y_o = V_o(y)\, t + \frac{1}{2} a_y t^2$$

$$Y = (8 \times 4) + \frac{1}{2} \times 2 \times (16)$$

$$\boxed{Y = 48\ m}$$

5. $\boxed{V_o = V_o(x)}$, $V_o(y) = 0$



$\Theta = 30°$ (at ground)

$\Delta Y = 40\ m$

$V_o(x) = ?\ ,\quad V_o(y) = 0\ ,\quad \Theta_o = 0$

along (y):

$$\Delta Y = V_o(y)\, t - \frac{1}{2} g t^2$$

$$-40 = 0 - \frac{1}{2} \times 9.8\,(t^2)$$

$\Rightarrow t = 2.9\ s \quad \Rightarrow V_y = V_o(y) - gt \Rightarrow V_y = 0 - 9.8(2.9)$

$\Rightarrow V_y = -28.4\ m/s = 28.4\ m/s$ (as speed)

Now when it hits the ground

$$\vec{V} = \vec{V_x}\,\hat{i} + \vec{V_y}\,\hat{j}$$

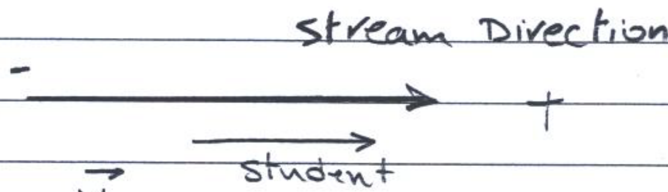
$V_x = V\cos\Theta\ ,\quad V_y = V\sin\Theta$

as speed $\quad 28.4 = V\sin 30 \Rightarrow V = 56.8\ m/s$

$\Rightarrow \left(V_x = 56.8\cos 30 = 49\ m/s = V_o(x) = V_o\right)$

6. it took 20 min to swim 1200 m downstream, so we can find his velocity with respect to ground as follow:

Student : S
River : R
Ground : G



$$\vec{V}_{SG} = \vec{V}_{SR} + \vec{V}_{RG}$$

but:

$$V_{SG} = \frac{1200 \text{ m}}{(20 \times 60)\text{s}} = 1 \text{ m/s}$$

$$\Rightarrow 1 = \vec{V}_{SR} + 0.3$$

$$\Rightarrow \bar{V}_{SR} = 0.7 \text{ m/s}$$

so: we he swims against the stream direction

$$\bar{V}_{SG} = \bar{V}_{SR} + \vec{V}_{RG}$$

$$\bar{V}_{SG} = -0.7 + 0.3 = -0.4 \text{ m/s}$$

as speed $\Rightarrow$ $V_{SG} = 0.4 \text{ m/s}$

$$\Rightarrow \text{time} = \frac{1200}{0.4} = 3000 \text{ s} = 50 \text{ min}$$

$$\Rightarrow \text{total time} = 20 + 50 = 70 \text{ min}$$

Cont. CH 4

7. $r = 0.15 m$

$$v = \frac{1200\,rev \times 2\pi r}{time} = \frac{1200 \times 2 \times 3.14 \times 0.15}{60}\ \frac{m}{s}$$

$$v = 18.84\ m/s$$

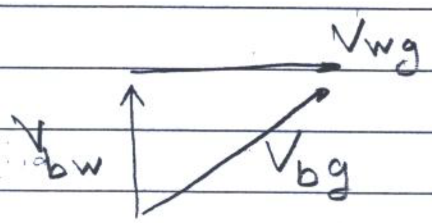
$$a = v^2/r = 355/0.15$$

$$\approx 2370\ m/s^2$$

8. $\vec{V}_{bg} = ?$

$V_{bw} = 1.7\ m/s$, $V_{wg} = 0.75\ m/s$

from the figure:



$$\Rightarrow V_{bg} = \sqrt{(1.7)^2 + (0.75)^2}$$

$$V_{bg} = 1.85\ m/s$$

9. $\Delta Y = -0.5\,Km = -500\,m$ (Down)

$V_0 = V_{0X} = 150\,Km/h = \frac{150\times10^3}{3600}\,m/s$

$V_0(x) = 41.7\,m/s$

$V_0(Y) = 0$

$\Delta Y = V_{0y}t - \frac{1}{2}gt^2$

$-500 = 0 - \frac{1}{2}\times 10\,(t^2)$

$t = 10.\,s$

Now $\Delta X = V_0(x)\,t$

$= 41.7(10)$

$(\Delta X = 417\,m)$

10. $T = \frac{2\pi r}{v} = \frac{2\times\pi\times\pi}{4} = \frac{\pi^2}{2}\,s$