Q2

Kinematics !!

First, h does not matter. ① Second, I'll set the horizontal velocity as $(30\ m/s)\cdot\cos\theta + (0.5\ m/s)$

☆ I'll set the origin at (0, h) !!

☆ They are approaching !!

$$\begin{cases} a_x = 0 \\ a_y = -g \quad \text{where } g = 9.8\ m/s^2. \end{cases}$$

$$\begin{cases} v_x = (30\ m/s)\cdot\cos\theta + (0.5\ m/s) \\ v_y = -gt + (30\ m/s)\cdot\sin\theta \end{cases} \qquad \begin{cases} s_x = \{(30\ m/s)\cdot\cos\theta + (0.5\ m/s)\}\,t \\ s_y = -\frac{1}{2}gt^2 + (30\ m/s)\cdot\sin\theta\cdot t \end{cases}$$

Now, we can get θ since we will have two equations when $s_x = 40\ m$ and $s_y = 0\ m$.

$$\begin{cases} t = \dfrac{(40\ m)}{(30\ m/s)\cos\theta + (0.5\ m/s)} \\ 0 = -\frac{1}{2}gt^2 + (30\ m/s)\cdot\sin\theta\cdot t \end{cases} \Rightarrow \frac{1}{2}\theta\left(\frac{40\ m}{(30\ m/s)\cos\theta + (0.5\ m/s)}\right) = (30\ m/s)\sin\theta$$

$$\Leftrightarrow 196\ m^2/s^2 = (900\ m^2/s^2)\sin\theta\cos\theta + (15\ m^2/s^2)\sin\theta$$

Therefore, $(450)\sin 2\theta + (15)\sin\theta = 196$.

$\sin\theta$ negligible. Thus, $\sin 2\theta \approx \frac{196}{450} \Leftrightarrow \theta \approx \sin^{-1}\left(\frac{196}{450}\right)/2 \approx 12.9°$

Double check, $199 \approx 196$ (Good). $\therefore \theta = 12.9°$