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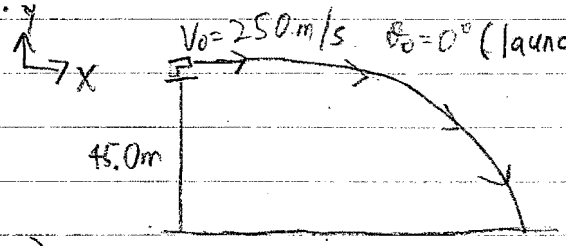
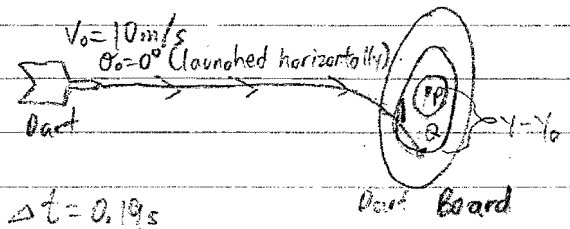
2D Kinematics Lecture Solutions

1. 

a)
$$Y - Y_0 = V_0 \sin\theta_0\, t - \tfrac{1}{2}gt^2 \quad (\sin 0° \to 0)$$
$$-45.0\,m = 250\,m/s \cdot \sin 0°\, t - \tfrac{1}{2}(9.8\,m/s^2)t^2$$
$$t = \sqrt{\frac{45.0\,m}{\frac{1}{2}(9.8\,m/s^2)}} = \boxed{3.03\,s}$$

b) $X - X_0 = V_0 \cos\theta_0\, t$
$$X - X_0 = 250\,m/s \cdot \cos 0° \cdot 3.03\,s = \boxed{758\,m}$$

c) $V_{fy} = V_{0y} - gt$
$$V_{fy} = V_0 \sin\theta_0 - gt$$
$$V_{fy} = 250\,m/s \cdot \sin 0° - (9.8\,m/s^2)(3.03\,s) = -29.7\,m/s$$
The problem asks for magnitude, so $|V_{fy}| = \boxed{29.7\,m/s}$

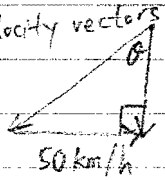
2. 

$\Delta t = 0.19\,s$

a)
$$Y - Y_0 = V_0 \sin\theta_0\, t - \tfrac{1}{2}gt^2$$
$$\overline{PQ} = |Y - Y_0| = |10\,m/s \cdot \sin 0° \cdot 0.19\,s - \tfrac{1}{2}(9.8\,m/s^2)(0.19\,s)^2| = |-0.18\,m| = \boxed{0.18\,m}$$

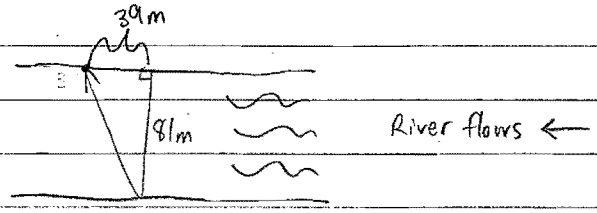
b) $X - X_0 = V_0 \cos\theta_0\, t$
$$X - X_0 = 10\,m/s \cdot \cos 0° \cdot 0.19\,s = \boxed{1.9\,m}$$

3. Velocity vectors:



$$\frac{50\,km}{h}\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,h}{3600\,s}\right) = 14\,m/s$$
$$\theta = \tan^{-1}\left(\frac{14\,m/s}{8.0\,m/s}\right) \approx \boxed{60°}$$

4.



a) Swimmer: $v = 1\,m/s$

$d = 81\,m$

$d = vt$, $t = \frac{d}{v} = \frac{81\,m}{1\,m/s} = 81\,s$ (the time it takes the swimmer to reach the other side)

River: $t = 81\,s$, $d = 39\,m$

$v = \frac{d}{t} = \frac{39\,m}{81\,s} = \boxed{0.48\,m/s}$

b) total distance traveled by swimmer: $\sqrt{(39\,m)^2 + (81\,m)^2} = 89.9\,m$

$v = \frac{d}{t} = \frac{89.9\,m}{81\,s} = \boxed{1.10\,m/s}$

5. $r = 4 \times 10^6\,m$

$T = 100{,}000\,s$

$v = \frac{2\pi r}{T} = \frac{2\pi (4 \times 10^6\,m)}{100{,}000\,s} = 80\pi\,m/s$

$a_c = \frac{v^2}{r} = \frac{(80\pi\,m/s)^2}{4 \times 10^6\,m} = \boxed{0.016\,m/s^2}$