AP Kinematics Review

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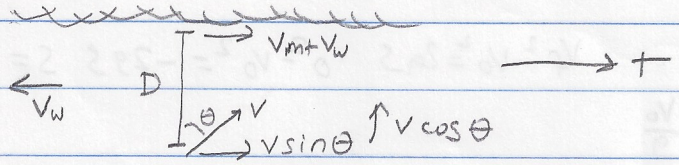
Problem 1



$V_{m,g} - V_{w,g} = V_{m,w}$ $\quad V_{m,g} = V_{m,w} + V_{w,g} = V_m + V_w$

$V\cos\theta \cdot t = D \quad t = \frac{D}{V\cos\theta}$

$(V_m + V_w)t = V\sin\theta\, t \quad \boxed{\theta = \arcsin\left(\frac{V_m + V_w}{V}\right)}$

Problem 2

$a = \frac{dv}{dt} = \alpha t \quad \int_{V_0}^{V_f} dV = \int_0^{t'} \alpha t\, dt \quad V_f - V_0 = \frac{1}{2}\alpha t^2$

$V(t) = V_0 + \frac{1}{2}\alpha t^2 \quad \frac{dx}{dt} = V_0 + \frac{1}{2}\alpha t^2 \quad \int_{x_0}^{x_f} dx = \int_0^{t'} \left(V_0 + \frac{1}{2}\alpha t^2\right) dt$

$x_f - x_0 = V_0 t + \frac{1}{6}\alpha t^3 \quad x_f = x_0 + V_0 t + \frac{1}{6}\alpha t^3$

$0 = V_0 \sin\theta - \frac{1}{2}\alpha t^2 \quad t = \sqrt{\frac{2V_0\sin\theta}{\alpha}} \quad T = 2t = \boxed{2\sqrt{\frac{2V_0\sin\theta}{\alpha}} \text{ seconds}}$

$$\boxed{\text{max height} = 0 + V_0\sin\theta\sqrt{\frac{2V_0\sin\theta}{\alpha}} + \frac{1}{6}\alpha\left(\frac{2V_0\sin\theta}{\alpha}\right)^{3/2}}$$

$$\text{range} = V_0\cos\theta\, T = \boxed{2V_0\cos\theta\sqrt{\frac{2V_0\sin\theta}{\alpha}}}$$

Problem 3

$\omega(s) = \omega + 5\alpha$

$V_f = V_0 + at$ $\qquad V_f^2 - V_0^2 = 2as$ $\qquad 0^2 - V_0^2 = -2gs$ $\qquad s = \frac{V_0^2}{2g}$

$0 = V_0 - gt$ $\qquad t = \frac{V_0}{g}$

$\Delta S_{TOTAL} = \frac{V_0^2}{2g} + \frac{V_0^2}{2g} + 2R = \frac{V_0^2}{g} + 2R = \frac{1}{2}gt^2$ $\qquad t = \sqrt{\frac{2V_0^2}{g^2} + \frac{4R}{g}}$

Total time $= \boxed{\frac{V_0}{g} + \sqrt{\frac{2V_0^2}{g^2} + \frac{4R}{g}}}$

Range $= (\omega + 5\alpha)R \cdot (\text{Total time})$

$= \boxed{R(\omega + 5\alpha)\left[\frac{V_0}{g} + \sqrt{\frac{2V_0^2}{g^2} + \frac{4R}{g}}\right]}$