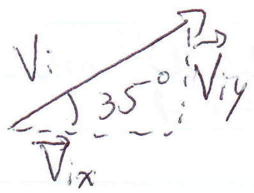
Challenge Problems

1.



$\vec{a}_y = -9.81\ m/s^2$
$\vec{a}_x = 0.0\ m/s^2$
$V_i = 1500.\ m/s$

Find time: $\Delta d = 0\ m$

$d_y = V_{iy}t + \frac{1}{2}at^2$

$V_{ix} = 1500\ m/s(\cos 35°)$
$V_{ix} = 1228.73\ m/s$

$0\ m = (860.4\ m/s)t + \frac{1}{2}(-9.81\ m/s^2)t^2$

$V_{iy} = 1500 \sin 35$
$V_{iy} = 860.4\ m/s$

$0 = 860.4 - 4.905t$
$t = 175.413\ s$

$d_x = V_x t$
$d_x = 1228.73\ m/s(175.413\ s)$
ⓐ $d_x = 215535.2155\ m = 215.5\ km$

ⓑ At max height, $V_{yf} = 0\ m/s$

height ⇒ $V_f^2 = V_i^2 + 2ad$
$0 = (860.4)^2 + 2(-9.81)d$
$-740288.16 = -4.905\vec{d}$
$\vec{d} = 150925\ m = 15.09\ km$ high.

2. $V_i = -2.0\times10^5$ m/s , $a = 4.2\times10^{14}$ m/s²

ⓐ $V_f^2 = V_i^2 + 2ad$

$0 = (-2.0\times10^5 \text{ m/s})^2 + 2(4.2\times10^{14} \text{ m/s}^2)d$

$-4\times10^{10} \text{ m}^2/\text{s}^2 = 8.4\times10^{14} \text{ m/s}^2 \cdot d$

$d = 4.762\times10^{-5}$ m

$d = V_i t + \frac{1}{2}at^2$

$0.05 = (-2.0\times10^5 \text{ m/s})t + \frac{1}{2}(4.2\times10^{14})t^2$

$0 = 2.1\times10^{14}t^2 - 2.0\times10^5 t - 0.05$

$$t = \frac{2.0\times10^5 \pm \sqrt{4\times10^{10} - 4(2.1\times10^{14})(-0.05)}}{4.2\times10^{14}}$$

$$t = \frac{2.0\times10^5 \pm \sqrt{4.204\times10^{13}}}{4.2\times10^{14}}$$

Part ⓑ required quadratic equation, which some people won't know. So I removed it.

Challenge Problems.

3. ⓐ  $V_i = 0\ m/s$ $\qquad t = ?$

$\vec{a} = -9.81\ m/s^2$

$d = 3.0\ m$

$$d = V_i t + \tfrac{1}{2}at^2 \quad (V_i t \to 0)$$

$$-3 = \tfrac{1}{2}(-9.81)t^2$$

$$t^2 = \frac{-3}{-4.905} \Rightarrow t = 0.612\ s$$

$V_x = 10.0\ m/s$

$$d_x = V_x t \Rightarrow d_x = (10.0\ m/s)(0.612\ s)$$

$$d_x = 6.12\ m \text{ away.}$$

4. $V_i = 25\ m/s$, $\vec{a} = -2.5\ m/s^2$, $V_f = 0\ m/s$ $\Big\}$ $d = ?$, $t = ?$

This question needs to be analyzed in several parts.

slowing down:

$$V_f^2 = V_i^2 + 2ad$$
$$0 = (25)^2 + 2(-2.5)(d)$$
$$0 = 625 - 5d$$
$$d = 125\ m$$

$$V_f = V_i + at$$
$$0 = 25 + (-2.5)t$$
$$0 = 25 - 2.5t$$
$$t = 10\ s$$

Stopped: $t = 45\ s$, $d = 0$

speeding up:

$V_i = 0\ m/s$ $\qquad t = 10\ s$

$V_f = 25\ m/s$ $\qquad d = 125\ m$

$\vec{a} = 2.5\ m/s$

Total time $= 65\ s$, total $d = 250\ m$

Train: $d = Vt \Rightarrow d = (25\ m/s)(65\ s)$

$$d = 1625\ m$$

difference $= 1375\ m$