Physics 3  Homework Due 2Jul03  YSB

(North)

1. \( \gamma \)

\( \text{Border Intercept} \)

\( \vec{x} \) (East)

\( x_B = 100 \) m

\( \vec{u} := |\vec{u}| = 141 \, \text{m/s} \)

\( \vec{v} = u_x \hat{i} + u_y \hat{j} \)

\( = u \frac{\sqrt{2}}{2} \hat{i} + u \frac{\sqrt{2}}{2} \hat{j} \)

Time to cross border is time for \( \chi \) to increase to \( \chi = \chi_B \)

\( \chi_B = \chi = \chi_0 + u_x \, t \quad \chi_0 = 0 \)

\( u_x = 100 \, \text{m/s} \)

\( t = \frac{\chi_B}{u_x} = \frac{100 \, \text{m}}{100 \, \text{m/s}} = 1 \, \text{hr} \)
\[ \Delta x = \sqrt{2} \Delta v \]

\[ \Delta t = \frac{\Delta x}{\nu} = \frac{\sqrt{2} \times 100 \text{ mi}}{141 \text{ mi/hr}} = \frac{1}{2} \text{ hr} \]
2. \[ \vec{v} = v_2 \hat{k} \]
\[ v_2 = at \]

The given expression for the velocity $v_2$ indicates that the velocity increases steadily with time. The unit of $a$ is:

\[ [a] = \frac{[v_2]}{[t]} = \frac{m/s}{s} = m/s^2 \]

The velocity increases by a m/s each second.

The position $z(t)$ increases at a constantly increasing rate. By definition:

\[ v_2 = \frac{dz(t)}{dt} \]

\[ dz(t) = v_2 \, dt \]

\[ z(t) = \int v_2(t) \, dt \]

\[ z(t) = \int at \, dt \]

\[ = a\int t \, dt \]

\[ = \frac{at^2}{2} + c \]
To find the constant of integration $C$, use the fact that at $t=0$, $z=0$

$$z(0) = 0$$

$$z(t) = \frac{a+2}{t} + C$$

set $t=0$\[ \rightarrow 0$

$$0 = z(0) = \frac{a+2}{0} + C$$

$$C = 0.$$  

Suppose we choose a different origin one where the object is released from a starting position $z(0) = z_0$.

![Diagram of position Z vs. time t]

In this case

$$z_0 = z(0) = C$$

so the general solution is

$$z(t) = z_0 + \frac{1}{2} at^2$$