1- A projectile is thrown from the origin with an initial velocity \( V_0 = (20 \ i + 98 \ j) \) m/s. If the projectile hits a target that is at a horizontal distance of 400 m away, what is the time of flight of the projectile?

\[
\Delta X = 400 \ m \\
V_{0x} = 20 \ \text{m/s} \\
\alpha_x = 0 \ (\text{projectile motion}) \\
\text{applying} \quad \Delta X = V_{0x} t \\
\Rightarrow t = \frac{\Delta X}{V_{0x}} = \frac{400 \ m}{20 \ \text{m/s}} = 20 \ \text{s}
\]

2- An airplane is moving due North at a speed of 150 m/s. It faces a wind with speed of 40 m/s due East. Calculate the speed of the airplane with respect to the ground.

\[
\vec{V}_{aw} = 40 \ \hat{e}_x \\
\vec{V}_{aw} = 150 \ \hat{e}_y \\
\vec{V}_{ag} = \vec{V}_{aw} + \vec{V}_{wg} = 40 \ \hat{e}_x + 150 \ \hat{e}_y \\
\text{Speed} = |\vec{V}_{ag}| = \sqrt{40^2 + 150^2} \approx 155 \ \text{m/s}.
\]
Phys 101 - Sec # 2  Quiz # 3 (Ch. 4)

1- A particle leaves the origin with an initial velocity $\vec{v}_0 = (3\hat{i})$ m/s and constant acceleration $\vec{a} = (-\hat{i} - 5\hat{j})$ m/s$^2$.

What is the particle's velocity when it reaches its maximum x-coordinate?

$\vec{v}_{ox} = 3 \text{ m/s}$, $a_x = -1 \text{ m/s}^2$, $v_{oy} = 0$, $a_y = -5 \text{ m/s}^2$.

At max. x-coordinate $v_x = 0$.

Use: $v_x = v_{ox} + a_x t$

$0 = 3 + (-1)t \Rightarrow t = 3 \text{ s}$

Then use $v_y = v_{oy} + a_y t = 0 - 5(3) = -15 \text{ m/s}$

$v_f = v_x \hat{i} + v_y \hat{j} = -15 \hat{j} \text{ m/s}$

2- An astronaut is rotated in a horizontal centrifuge at a radius of 5 m. What is the astronaut's speed if the centripetal acceleration has a magnitude of 7g? (Where $g = 9.8 \text{ m/s}^2$).

Find the period.

$a = \frac{v^2}{r}$

$v = \sqrt{ar} = \sqrt{7(9.8)(5)}$

$= 18.5 \text{ m/s}$

$\text{Period} = \frac{\text{Circumference}}{v} = \frac{2\pi r \text{ (m)}}{v} = \frac{31.4 \text{ m}}{18.5 \text{ m/s}} = 1.7 \text{ s}$
1- A ball is thrown horizontally from the top of a building 100 m high. The ball strikes the ground at a point 65 m horizontally away from the base of the building. What is the speed of the ball just before it strikes the ground?

\[ \Delta y = -100 \text{ m} \]
\[ v_{0y} = 0 \]
\[ a_y = -9.8 \text{ m/s}^2 \]

Apply
\[ \Delta y = v_{0y} t + \frac{1}{2} a_y t^2 \]
\[ -100 = 0 - \frac{1}{2} (9.8) t^2 \]
\[ \Rightarrow t = 4.5 \text{ s} \]

Then
\[ v_y = v_{0y} + a_y t \]
\[ v_y = -9.8 (4.5) = -44 \text{ m/s} \]

we know that
\[ v_{ox} = v_x = \text{const.} \]
and
\[ \Delta x = v_{ox} t \]
\[ \Rightarrow v_{ox} = \frac{\Delta x}{t} \]
\[ = \frac{65}{4.5} = 14.4 \text{ m/s} = v_x \]

The final speed
\[ |v| = \sqrt{v_x^2 + v_y^2} \]
\[ = \sqrt{14.4^2 + (-44)^2} \]
\[ = 46.3 \text{ m/s} \]

2- A train moves due east at 6 m/s, along a straight level track. A boy on the train rolls a ball along the floor with a speed of 3 m/s relative to the train. The ball is rolled directly across the width of the train from South to North. Find the speed of the ball relative to the ground. (Show all steps)

\[ \vec{v}_{tg} = 6 \hat{i} \]
\[ \vec{v}_{bt} = 3 \hat{j} \]
\[ \Rightarrow \vec{v}_{bg} = \vec{v}_{bt} + \vec{v}_{tg} = 6 \hat{i} + 3 \hat{j} \]

Speed
\[ |\vec{v}_{bg}| = \sqrt{6^2 + 3^2} = 6.7 \text{ m/s} \]