Free-Fall Motion

By: Robert McGee

What happens ?

- 1) When you drop a rock from a cliff?

Ans: It falls downward.

- 2) When a Skydiver jumps from a plane?

Ans: He/She will fall to the ground.

- 3) To a skydiver's speed as he is falling?

Ans: It will reach a ***terminal velocity*** due to air resistance.

Free-Fall Motion

- An object moving under the influence of gravity only!!

Our Goal For Today

- 1) Perform an experiment to analyze a free-falling object.
- 2) Determine the value of g.
- 3) Enable you to solve problems dealing with free-falling objects.

Properties of Motion

- 1) Displacement
- 2) Velocity
- 3) Acceleration

Displacement

- Displacement: the distance and direction travelled.
- Alex Rodriguez hits a home run. What is his total displacement around the bases?
- Ans: 0!!!

Velocity

- Velocity: $\frac{change-in-displacement}{change-in-time} = \frac{\Delta s}{\Delta t} = \vec{v}$

A Home-Run takes about 3.5 sec to clear Shea's center wall (420 ft.) What is the velocity of the ball?

Ans: $velocity = \frac{420\,ft - 0\,ft}{3.5s - 0s} = 120\,ft/s$

- For every second, the ball travels 120 ft.

Acceleration

- Average Acceleration: $\frac{change-in-velocity}{change-in-time} = \frac{\Delta v}{\Delta t} = \vec{a}$

A car does 0-85 m/s in 6.4 seconds. What the average acceleration for this interval of time?

Ans: $$\vec{a} = \frac{85m/s - 0m/s}{6.4s - 0s} = 13.28m/s^2$$

*For every second, the velocity increases by 13.28

Vector & Scalar Quantities

- A vector quantity has size and direction

EX: Displacement, Velocity, Acceleration

- A scalar quantity has only size and no direction

EX: Distance,Speed

Useful Kinematic Formulas

$$1) v_f^2 = v_i^2 + 2a\Delta s$$

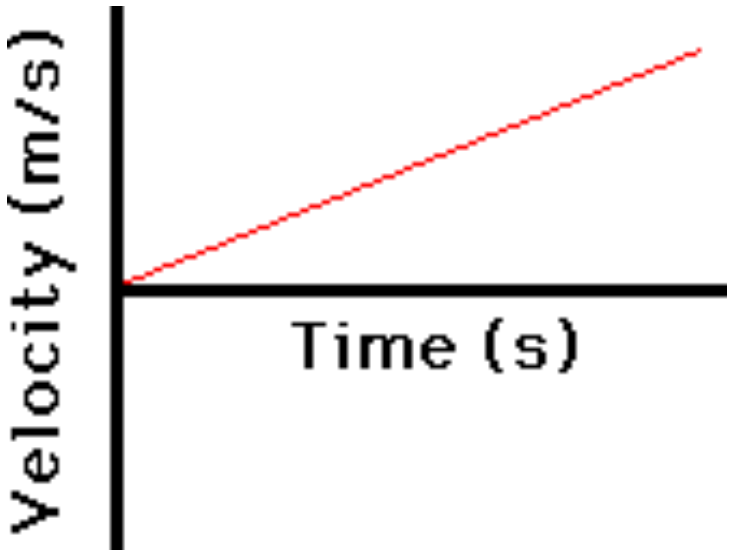
$$2) \Delta s = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$3) v_f = v_i + a\Delta t$$

$$4) \bar{v} = \frac{v_i + v_f}{2}$$

The Velocity vs. Time Graph

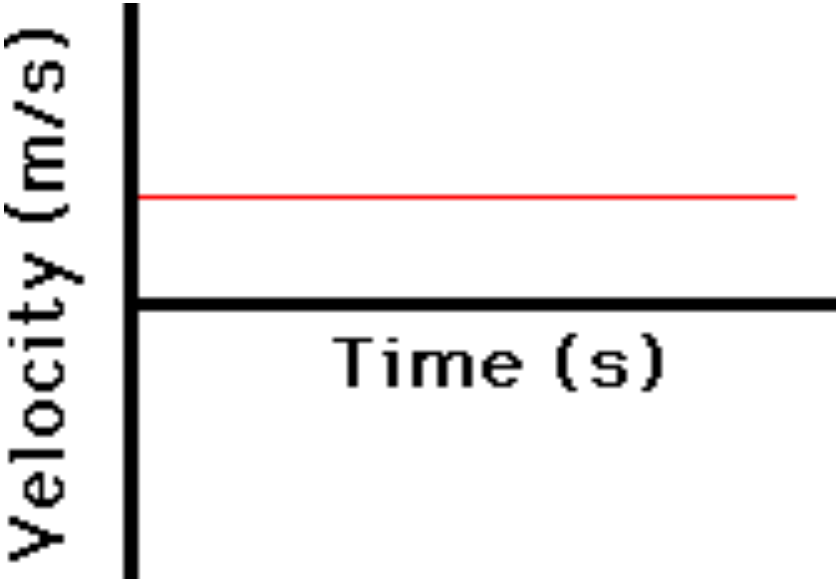
- Pictorial representation of velocity vs. time graph.



As time increases, the velocity increases in this graph.

The Slope of this graph gives us the acceleration of this object.

Do You Understand It?



- Can you Describe the motion of this object? It's Acceleration?
- Ans : Zero Acceleration, Constant Velocity

Experimental Error

$$g = 9.81 m/s^2$$

- What if our values do not match g?
- Remember question regarding ***terminal velocity***

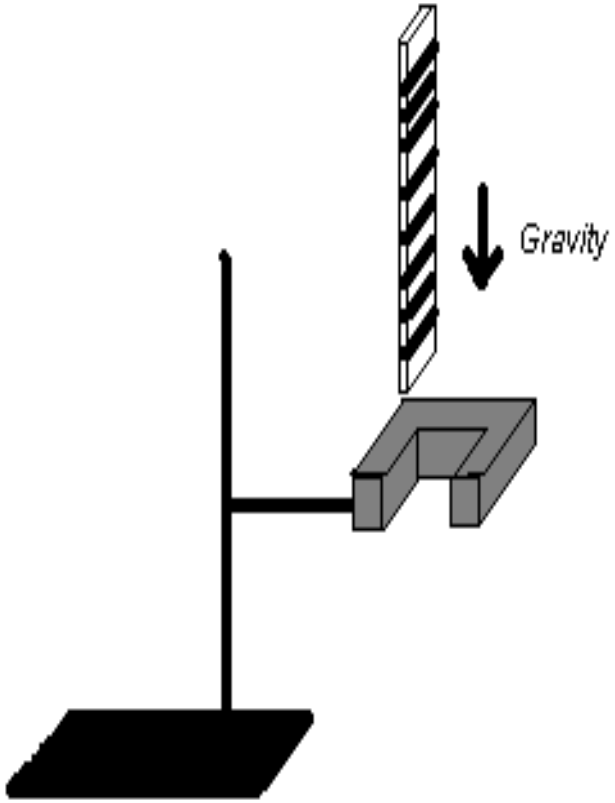
Expermiental Error

- We must calculate the percent error for each of our trials:

$$\%err = \frac{True - Experimental}{True} \times 100$$

Our Experiment

- Drop the picket-fence through the Vernier Photogate
- Collect Data with Vernier Software
- Analyze Velocity vs. Time Graph



Directions

- Drop the picket fence through the photogate 5 times. (5 trials)
- Write down the acceleration values for each trial.
- Write down the experimental error for each trial.