Accelerated Motion

Part 2

Example

An object is dropped from a height of 3.00 m. How long will it take to hit the ground?

d = 3.00 m down

vi = 0 m/s

a = 9.81 m/s^2 down

$$\Delta \vec{d} = \vec{v}_i\, t + \frac{1}{2}\vec{a}\,\Delta t^2$$

Basic equation, $v_i = 0$

$$\Delta \vec{d} = \frac{1}{2}\vec{a}\,\Delta t^2$$

Multiply by 2 to remove the fraction

Divide by a to get Δt^2 by itself

$$\Delta t^2 = \frac{2\Delta \vec{d}}{\vec{a}}$$

Take square root to get Δt

$$\Delta t = \sqrt{\frac{2\Delta \vec{d}}{\vec{a}}}$$

$$t = \sqrt{\frac{2(3.00)}{9.81}} = \sqrt{\frac{6.00}{9.81}} = \sqrt{0.61162.}$$

t = 0.782 s

- Sub in the data

Example

Space Cadet (4th class) Boyd is on the surface of an alien planet. He drops a large rock from a height of 1.75 m and it lands on the captain's foot 0.340 s later. What is the acceleration of gravity on the planet?

- d = 1.75 m
- t = 0.340 s
- vi = 0 m/s
- a = ?

$$\Delta \vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}(\Delta t)^2$$

$$\Delta \vec{d} = \frac{1}{2}\vec{a}(\Delta t)^2$$

$$2\Delta \vec{d} = \vec{a}(\Delta t)^2$$

$$\vec{a} = \frac{2\Delta \vec{d}}{\Delta t^2}$$

$$\vec{a} = \frac{2(1.75\text{m})}{(0.340\text{s})^2} = \frac{3.50\text{m}}{0.1156\text{s}^2} = 30.3\text{m/s}^2$$

Example

The Batmobile is moving at 14.0 m/s when Robin sees a bank robbery in progress 560 m away. Batman accelerates and they reach the bank in 15.0 s. Determine the final velocity of the Batmobile.

- d = 560 m
- vi = 14.0 m/s
- t = 15.0 s
- vf = ?

$$\Delta \vec{d} = \frac{\vec{v}_f + \vec{v}_i}{2} \Delta t$$

$$\frac{\Delta \vec{d}}{\Delta t} = \frac{\vec{v}_f + \vec{v}_i}{2}$$

$$\frac{2\Delta \vec{d}}{\Delta t} = \vec{v}_f + \vec{v}_i$$

$$\frac{2\Delta \vec{d}}{\Delta t} - \vec{v}_i = \vec{v}_f$$

Do the multiplying 1st, then the dividing, then subtract

$$\frac{2(560m)}{15.0s} - 14.0m/s = \frac{1120m}{15.0s} - 14.0m/s = \vec{v}_f$$

$$\vec{v}_f = 60.7m/s$$