Introduction to Physical Science

Falling Objects

Presented by Robert Wagner

Gravity

- All objects fall at the same rate in a gravitational field
  - Mass does not matter
- If we can eliminate air resistance, a hammer and a feather will fall at the same rate
  - Free fall
- Acceleration due to gravity
  -
  - Can be positive or negative depending on coordinate system used.
  - If up is positive,
  - If down is positive,

Kinematic Equations - Free Fall

- Using upward direction as positive,
  - Equation 1:
  - Equation 2:
  - Equation 3:

Example

- A person at the edge of a cliff throws a rock straight upward with an initial velocity of 13.0 m/s. Find the position and velocity as it falls to earth at 1.00s, 2.00s and 3.00s (neglect air resistance)
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

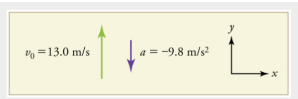

Figure 2.39

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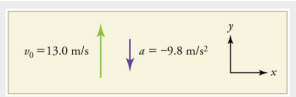
Example



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$y_o = 0\ ;\ v_o = 13.0\ m/s\ ; a = -g = -9.80\ m/s^2$

$For\ t = 1.0\ s$, find position

$$y = y_o + v_o t - \frac{1}{2} g t^2$$

$$y_1 = 0 + (13.0\ m/s)(1.00\ s) + \frac{1}{2}(-9.80 m/s^2)(1.00\ s)^2$$

$$y_1 = +8.10\ m$$

+ sign means it is above its starting position

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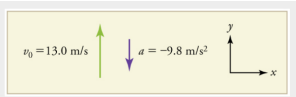
Example



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$y_o = 0\ ;\ v_o = 13.0\ m/s\ ; a = -g = -9.80\ m/s^2$

$For\ t = 1.0\ s$, find velocity

$$v_1 = v_o - gt$$

$$v_1 = 13.0\ m/s - (9.80\ m/s^2)(1.00\ s)^2$$

$$v_1 = +3.20\ m/s$$

+ sign means it is moving upward

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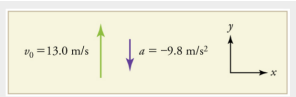
Example



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Determine values for 2.00 s and 3.00 s

Match the table below

Time, t	Position, y	Velocity, v
1.00 s	8.10 m	3.20 m/s
2.00 s	6.40 m	−6.60 m/s
3.00 s	−5.10 m	−16.4 m/s

Table 2.1 Results

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Example

- A rock thrown downward with an initial velocity of 13.0 m/s, What is the velocity of the rock when it is 5.10 m below the starting point?
  - Draw a sketch
  - List known values ; identify unknown
  - Determine equation to use
  - Plug in known values and solve

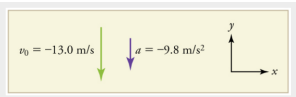

Figure 2.41

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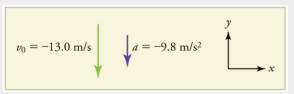
Example



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  - List known values ; identify unknown
  - Determine equation to use
  - Plug in known values and solve

$y_o = 0\ ;\ v_o = -13.0\ m/s\ ;\ a = -g = -9.80\ m/s^2$

Unknown: v_f

$$v^2 = v_o^2 - 2g(y - y_o)$$

$$v^2 = (-13.0\ m/s)^2 + 2(-9.80\ m/s^2)(-5.10\ m - 0\ m)$$

$$v^2 = 268.96\ m^2/s^2$$

$$v = \pm 16.4\ m/s$$

Since the rock is heading down,

$$v = -16.4\ m/s$$

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Summary

- In the absence of air resistance, all objects will fall at the same rate
- The acceleration in free fall problems is given by
- The kinematic equations remain the same otherwise