

[Bell Ringer]

- Upton Chuck is riding the Giant Drop at Great America. If Upton free falls for 2.6 seconds, what will be his final velocity and how far will he fall?

PHYSICS

Objectives:

- 1) We will apply the kinematic equations to solve motion problems.

[Kinematic Equations]

- A set of 4 equations that relate x , v , a and t for motion where acceleration is constant

$$x = \frac{1}{2}(v_i + v_f) \cdot t \qquad v_f = v_i + a \cdot t$$

$$x_f = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2 \qquad v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

Kinematic Equation #1 and #2

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

- $x \rightarrow$ displacement (m)
- $v_f \rightarrow$ final velocity (m/s)
- $v_i \rightarrow$ initial velocity (m/s)
- $a \rightarrow$ acceleration (m/s²)
- $t \rightarrow$ time (s)

[Kinematic Equation #3 & #4]

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2 \quad v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

- $x \rightarrow$ displacement (m)
- $v_f \rightarrow$ final velocity (m/s)
- $v_i \rightarrow$ initial velocity (m/s)
- $a \rightarrow$ acceleration (m/s²)
- $t \rightarrow$ time (s)

Acceleration and Velocity

- v & a in same direction \rightarrow Object speeding up



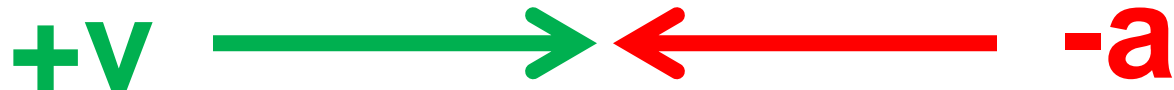
- v & a in opposite directions \rightarrow Object slowing down



[In Your Groups...]

- Draw arrows and indicate signs for v and a :

1) Object moving to right and slowing down



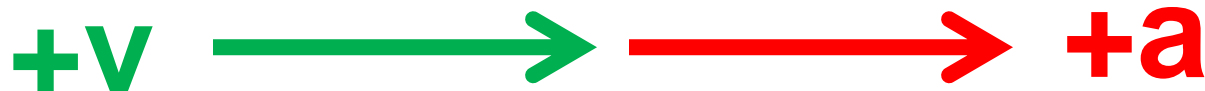
2) Object is speeding up while moving to left



3) Object is moving to left and slowing down



4) Object moving to right while speeding up



[Identify the correct equation:]

- $v_i = 0 \text{ m/s}$
- $a = 15 \text{ m/s}^2$
- $t = 0.2 \text{ s}$
- $v_f = ?$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[Identify the correct equation:]

- $v_i = ?$
- $v_f = 14 \text{ m/s}$
- $a = 5.3 \text{ m/s}^2$
- $t = 2.1 \text{ s}$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[Identify the correct equation:]

- $v_i = 6 \text{ m/s}$
- $v_f = 2.0 \text{ m/s}$
- $t = 4.3 \text{ s}$
- $x = ?$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[Identify the correct equation:]

- $v_i = 19 \text{ m/s}$
- $a = 4.0 \text{ m/s}^2$
- $t = 3.8 \text{ s}$
- $x = ?$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[Identify the correct equation:]

- $v_i = 7 \text{ m/s}$
- $v_f = 19 \text{ m/s}$
- $x = 51 \text{ m}$
- $t = ?$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[Identify the correct equation:]

- $v_i = 8.3 \text{ m/s}$
- $a = 5.1 \text{ m/s}^2$
- $v_f = 1.0 \text{ m/s}$
- $x = ?$

$$x = \frac{1}{2} (v_i + v_f) \cdot t$$

$$v_f = v_i + a \cdot t$$

$$v_f^2 = v_i^2 + 2 \cdot a \cdot \Delta x$$

$$x = x_i + v_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

[In-Class Problem #1]

A plane starting at rest at one end of a runway undergoes a uniform acceleration of 4.8 m/s^2 and takes off 540 m later. Determine the time it took for the plane to take off.

■ $t = 15 \text{ s}$



[In-Class Problem #2]

A soccer player is moving at an unknown speed. He accelerates at 2.5 m/s^2 for 15 m to reach a final velocity of 9 m/s. What was his initial velocity?

- $v_i = 2.45 \text{ m/s}$



[In-Class Problem #3]

A space shuttle traveling at a speed of 95 m/s begins to accelerate negatively using its parachute and braking system and comes to rest in 500 m. Determine the time required to bring the shuttle to rest.

■ $t = 10.5 \text{ s}$

