Kinematic in One Dimension

Questions?

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P2.1g Solve problems involving average speed and constant acceleration in one dimension.

P2.2B Use the change of speed and elapsed time to calculate the average acceleration for linear motion.

Equations of Kinematics for Constant Acceleration

There are five kinematic variables and 4 equations of kinematics:

1. displacement, x
2. acceleration (constant), a
3. final velocity (at time t), v
4. initial velocity, v_o
5. elapsed time, t

$$v = v_o + at$$

$$x = \frac{1}{2}(v_o + v)t$$

$$v^2 = v_o^2 + 2ax$$

$$x = v_o t + \frac{1}{2}at^2$$

Steps to solve kinematic problems:

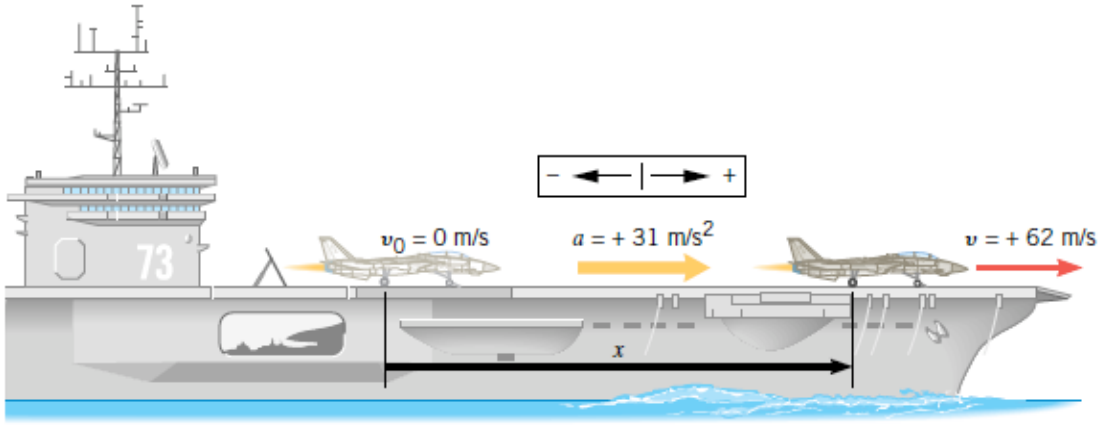
1. Make a drawing.

2. Decide which directions are to be called positive (+) and negative (-).

3. Write down the values that are given for any of the five kinematic variables.

4. Verify that the information contains values for at least three of the five kinematic variables. Select the appropriate equation.

A jet is taking off from the deck of an aircraft carrier as shown in the figure below. Starting from rest, the jet is catapulted with a constant acceleration of +31 m/s^2 along a straight line and reaches a velocity of +62 m/s. Find the displacement of the jet.



Jet Data				
x	a	v	v_0	t
?	+31 m/s^2	+62 m/s	0 m/s	

$$x = \frac{v^2 - v_o^2}{2a} = \frac{(62\,\text{m/s})^2 - (0\,\text{m/s})^2}{2(31\,\text{m/s}^2)} = +62\,\text{m}$$

Free Falling Body

In the absence of air resistance, all bodies at the same location above the Earth fall vertically with the same acceleration due to gravity.

This idealized motion is called free-fall.

The acceleration of a freely falling body is called the acceleration due to gravity.

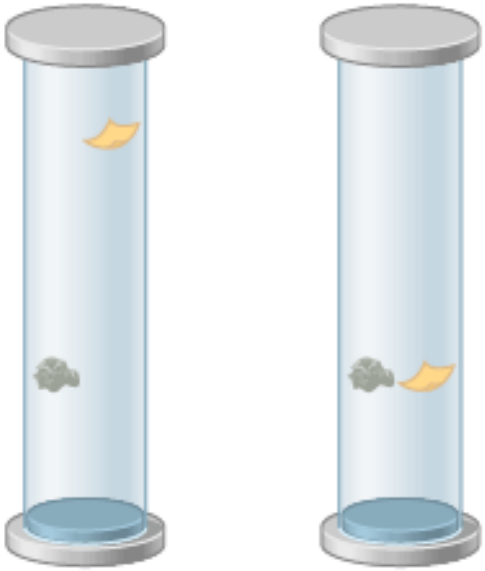
The acceleration due to gravity is directed toward the center of the Earth, has the symbol g and the constant value of $9.80 m/s^2$.

$g = 9.80 m/s^2$ or $32.2 ft/s^2$

The figure show the effect of air resistance on the speed of falling objects.

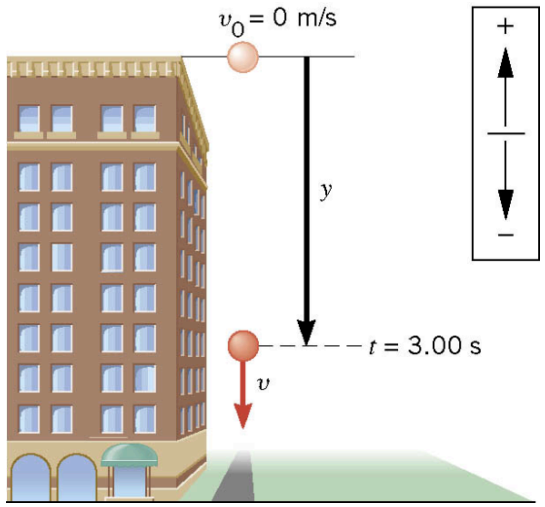
a) In the presence of air resistance, the acceleration of the rock is greater than that of the paper. The effect of air resistance is responsible for the slower fall of the paper.

b) In the absence of air resistance, both the rock and the paper have the same acceleration due to gravity ($g = 9.80 m/s^2$ or $32.2 ft/s^2$).



Example 1: A Falling Stone

A stone is dropped from the top of a tall building. After 3.00s of free fall, what is the displacement y of the stone?



y	a	v	v_o	t
?	-9.80 m/s^2		0 m/s	3.00 s

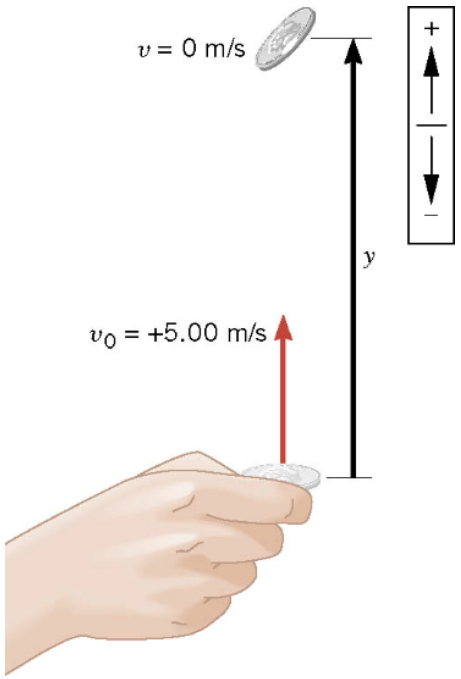
$$y = v_o t + \tfrac{1}{2} a t^2$$

$$= (0\,\text{m/s})(3.00\,\text{s}) + \tfrac{1}{2}(-9.80\,\text{m/s}^2)(3.00\,\text{s})^2$$

$$= -44.1\,\text{m}$$

Practice Problem: Answer questions 1, 2 and 3.

1. The referee tosses the coin up with an initial speed of 5.00m/s. In the absence if air resistance, how high does the coin go above its point of release?

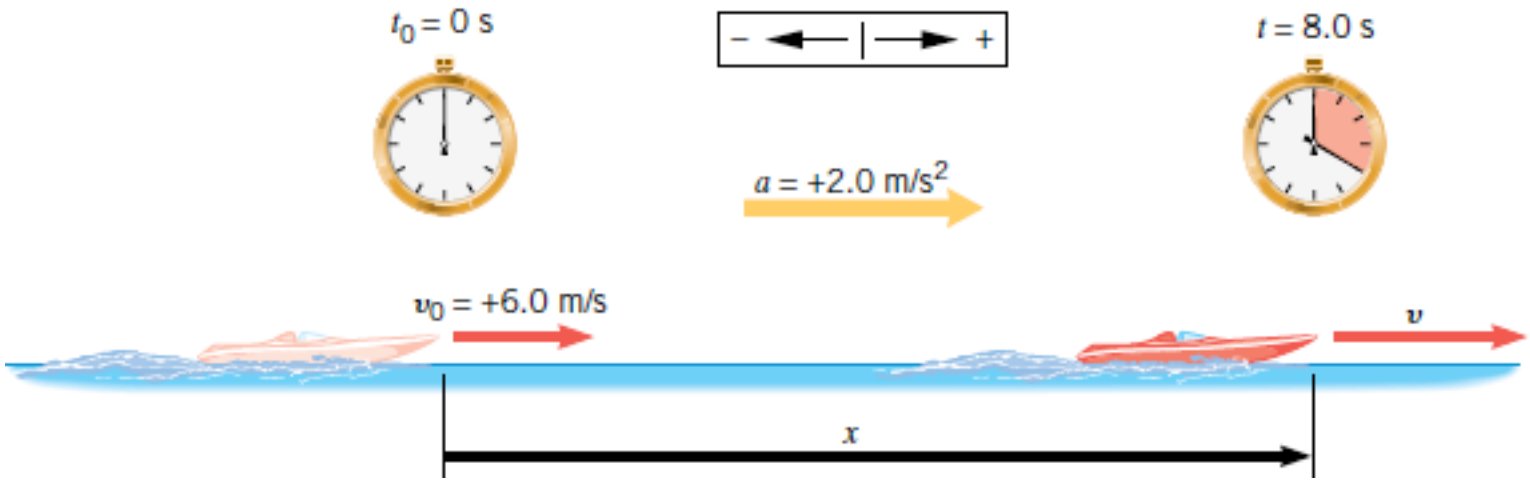


y	a	v	v_o	t
?	-9.80 m/s^2	0 m/s	+5.00 m/s	

You can apply the following kinematic formula:

$$v^2 = v_o^2 + 2ay \quad \Rightarrow \quad y = \frac{v^2 - v_o^2}{2a}$$

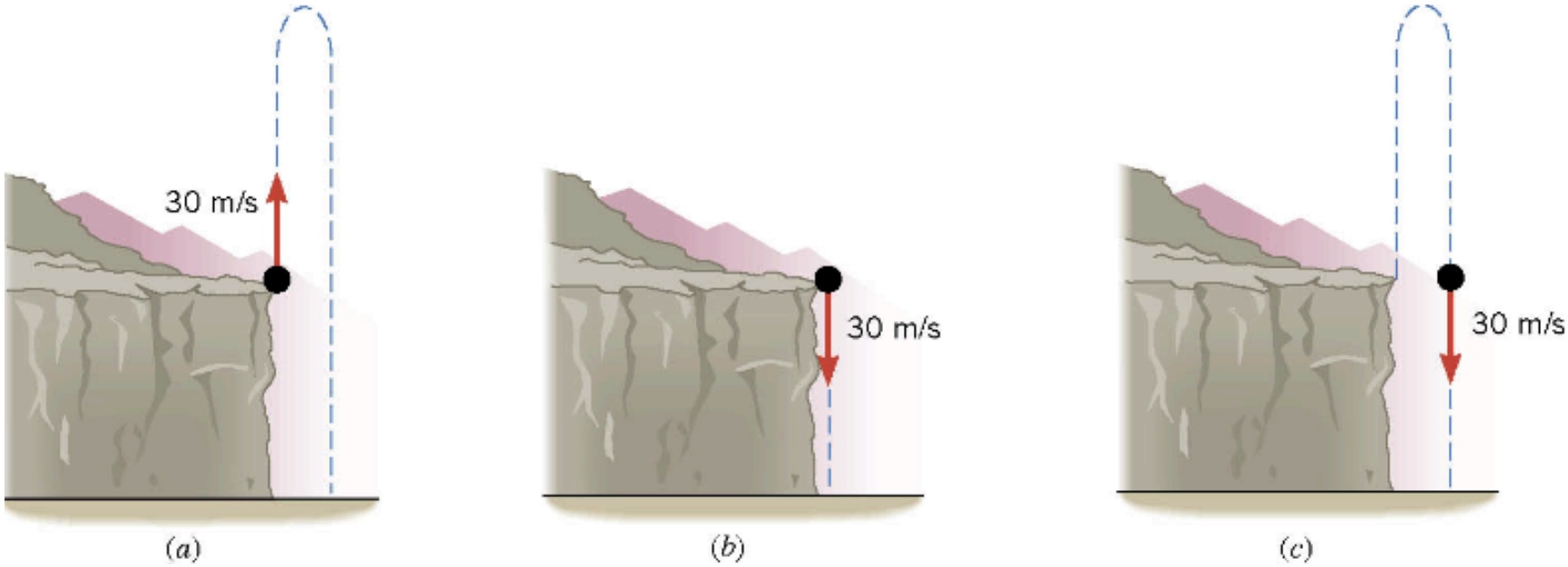
2. The speedboat below has a constant acceleration of +2.0 m/s^2. If the initial velocity of the boat is +6.0 m/s, find the displacement after 8.0 seconds.



We can apply appropriate kinematic equation:

$$x = v_o t + \frac{1}{2} a t^2$$

3. Does the pellet in part b strike the ground beneath the cliff with a smaller, greater, or the same speed as the pellet in part a?



(a) From the edge of a cliff, a pellet is fired straight upward from a gun. The pellet's initial speed is 30 m/s. (b) The pellet is fired straight downward with an initial speed of 30 m/s. (c) Another representation of (a) that is based on symmetry.