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## Ex 1: Vertical Motion Models/ Projectile Motion Model (object is thrown/ dropped):

(On Earth Only)
$h(t)=-16 t^{2}+v_{o} t+h_{o}$
$h_{o}=$ initial (starting) height (in feet)
$t=$ number of seconds it has been falling
$h(t)=$ new height of object after falling for $t$ seconds $v=$ the initial vertical velocity ( $\mathrm{ft} / \mathrm{sec}$ )

Note: velocity can be positive or negative depending on whether you throw upward or downward.
How is the equation affected if you don't "throw" at all—if you simply drop an object?
A. A stone is dropped from a height of 32 feet. How long will it take to hit the ground?
C. A golf ball is hit from the ground with an initial vertical velocity of $80 \mathrm{ft} / \mathrm{sec}$. After how many seconds will the ball hit the ground?
B. A coin is dropped from a height of 100 feet. Find its new height after falling for 2 seconds.
D. From the top of a 40 foot cliff, you throw a stone downward at $20 \mathrm{ft} / \mathrm{sec}$ into the water below. How long will it take the stone to hit the water?
E. A ball is dropped from the top of a building. How tall is the building if it takes 5.3 seconds to hit the ground?
F. You jump off a 15 foot diving board with an initial upward speed of $3 \mathrm{ft} / \mathrm{sec}$. How long will it take you to hit the water?

## Ex 2: Geometric word problems

A. The length of a rectangular garden is 4 yards more than its width. The area of the garden is 60 square yards. Find the dimensions of the garden.
B. One side of a rectangle is 3 ft shorter than twice the other side. Find the sides if the area of the rectangle is $209 \mathrm{ft}^{2}$
C. The product of two consecutive even integers is 624 . Find the integers.
D. The owner of a ranch decides to enclose a rectangular region with 140 feet of fencing. To help the fencing cover more land, he plans to use one side of his barn as part of the enclosed region. What is the maximum area the rancher can enclose?

## Ex3: Using a Calculator:

A. Find the zeros of the quadratic function to the nearest hundredth:

$$
y=1.56 x^{2}-5.19 x-2.25
$$

$$
y=-0.82 x^{2}-4 x+12.4
$$

$$
y=5.36 x^{2}+17 x+2.67
$$

B. The height $h(x)$ (in feet) of a soccer ball after it is kicked can be modeled by the graph of the equation $h(x)=-0.04 x^{2}+1.2 x$ where $x$ is the horizontal distance (in feet) that the ball travels. The ball is not touched, and it lands on the ground. Find the distance that the ball was kicked.
C. The opening of a tunnel can be modeled by the graph of the equation $y=-0.18 x^{2}+4.4 x-12$ where $x$ and $y$ are measured in feet. What is the maximum height of the tunnel? How wide is the tunnel?
D. The height $y$ (in feet) of a ball thrown by a child is given by $y=-0.083 x^{2}+2 x+4$ where $x$ is the horizontal distance (in feet) from where the ball is thrown. How high is the ball when it reaches the maximum height? How far from the child does the ball strike the ground?

## Ex4: Using the Discriminant

A. You and a friend are camping in Glacier National Park in Montana. You want to hang a food pack from a high tree branch in order to protect your food from bears. You attach a stick to a rope and your friend is preparing to throw it over a tree branch that is 20 feet from the ground.

1. Your friend can throw the stick upward with an initial velocity of 29 feet per second from an initial height of 6 feet. Will the stick reach the branch when it is thrown? Use the discriminant.
2. You can throw the stick upward with an initial velocity of 32 feet per second from an initial height of 6 feet. Will the stick reach the branch when it is thrown? Use the discriminant.
3. If the discriminant equaled zero, how would you answer/ explain?
B. You kick a football from the ground with an initial velocity of 40 feet per second.
4. Write the vertical motion equation for this situation.
5. Is it possible to reach a height of 16 feet? of 25 feet?
6. If you needed to kick the ball OVER something that was 25 feet, could you? Explain.

## Additional Practice: Practice strategies with and without a calculator.

1. An engineering student is in an "egg dropping contest." The goal is to create a container for an egg so it can be dropped from a height of 32 feet without breaking the egg. To the nearest hundredth of a second, about how long will it take for the egg's container to hit the ground? Assume there is no air resistance.
2. Construction waste falls down a 25 foot chute into a bin. How long will it take the waste to reach the bin? Assume there is no air resistance.
3. How long does it take a free-fall ride at an amusement park to drop 121 feet.
4. You are competing in the Field Target Event at a hot-air balloon festival. You throw a marker down from an altitude of 200 feet toward the target. When the marker leaves your hand, its speed is 30 feet per second. How long will it take the marker to hit the target?
5. From the top of a 40 -foot cliff you throw a stone downward at 20 feet per second into the water below. How long will it take to hit the water?
6. You jump off a 15 foot diving board with an initial velocity of $3 \mathrm{ft} / \mathrm{sec}$. How long will it take you to hit the water?
7. The initial upward velocity of a golf ball is $60 \mathrm{ft} / \mathrm{sec}$. How long will it take the ball to return to the ground?
8. You throw a ball toward a friend in a window, 15 feet off the ground, on the upper floor of your house.
a. You throw the ball with an initial velocity of $35 \mathrm{ft} / \mathrm{sec}$ from a height of 6 feet. Will the ball reach the window?
b. You throw the ball with an initial velocity of $20 \mathrm{ft} / \mathrm{sec}$ from a height of 6 feet. Will the ball reach the window?
9. A basketball is shot from 7 ft with an upward velocity of $24 \mathrm{ft} / \mathrm{sec}$. Write and solve a vertical motion model to see if the ball reaches a height of 16 feet.
10. A bottle-nosed dolphin jumps out of the water. The path the dolphin travels can be modeled by the equation $h=-x^{2}+2 x+3$ (equation is not accurate), where $h$ represents the height of the dolphin and $d$ represents the horizontal distance.
a. What is the maximum height the dolphin reaches? How far horizontally has the dolphin traveled when this happens?
b. How many feet has the dolphin traveled when it hits the water again? Is there one solution, or two? Explain.
11. Natalya Lisovskaya holds the world record for the women's shot put. The path of her record-breaking throw can be modeled by the equation $y=-0.01347 x^{2}+0.9325 x+5.5$, where $x$ is the horizontal distance in feet and $y$ is the height (in feet). What was the distance of the throw to the nearest hundredth of a foot?
12. Raja wants to put a metal works frame around a mirror that is 3 feet by 5 feet. Approximately how wide in inches is the uniform frame if the area of the mirror and frame is $2226.3 \mathrm{in}^{2}$ ?
