Algebra 2: Quadratic Functions Word Problems

1.) The Hulk throws a boulder over his head at a foe standing 8 m away from him. The trajectory of the throw can be defined by the equation \( h = -0.5d^2 + 4d + 2.5 \), where \( h \) is the height in meters, and \( d \) is the horizontal distance in meters.

**Vertex** \((4, 10.5)\)

\[
\begin{align*}
\text{a) What is the maximum height reached by the boulder?} & \quad \frac{-b}{2a} = \frac{-4}{-1} = 4 \\
\text{b) Approximately how tall is the Hulk? (y intercept)} & \quad h = -0.5(4)^2 + 4(4) + 2.5 = 10.5 \\
\text{c) If his foe is not in the path of the trajectory, how far away from the Hulk will the boulder land? (Positive x-intercept) } & \text{Use calculator to find zero} \\
\text{d) If the Hulk’s enemy is 2.2 m tall and standing 8 m away, would the boulder hit him? } & \text{No} \\
\text{e) State the domain and range for this function.} & \text{D: [0, 8.6] R: [0, 10.5]} \\
\end{align*}
\]

2.) A ballerina leaps in the air defined by the equation \( h = -0.25d^2 + d \), where \( h \) is the height in meters above the ground and \( d \) is the distance in meters from the start.

**Vertex** \((2, 1)\)

\[
\begin{align*}
\text{a) How high does the ballerina leap at her highest point?} & \quad \frac{-b}{2a} = \frac{-1}{-0.5} = 2 \\
\text{b) How far away does she land from where she starts?} & \quad y = -0.25(2)^2 + 2 = 1 \\
\text{c) If there is a gym bag lying on the floor 3.5 m away that is 0.4 m high, does she land safely, or does she trip over the bag?} & \quad \text{Since she jumps from 0 height} \quad a(2) = 0 \quad \text{No, she does not land safely.}
\end{align*}
\]

3.) An archer shoots an arrow at a target 20 m away along the arc \( h = -0.02d^2 + 0.44d + 2.8 \) where \( h \) is the height in meters above the ground and \( d \) is the horizontal distance in meters from the start.

**Vertex** \((11, 5.22)\)

\[
\begin{align*}
\text{a) How tall is the archer?} & \quad 2.8 m \\
\text{b) What is the maximum height reached by the arrow?} & \quad 5.22 m \\
\text{c) If there is nothing in its way, how far away will the arrow hit the ground?} & \quad 27.16 m \\
\text{d) If there is a target 25 m away that is 1.5 m tall, will the arrow hit the target?} & \text{(25, 1.3) on curve depends on the size of the target}
\end{align*}
\]
4.) Daniel jumps from a cliff into the water below along the trajectory defined by the equation 
\[ h = 2t^2 - 8t + 6, \] where \( h \) is the height in meters above the water, and \( t \) is the time in seconds since the start of the jump. 

\[ \text{vertex} \ (2, -2) \]

a) Determine the x-intercepts, the y-intercept and the vertex. 
\( (3, 0) \) \( (1, 0) \) \( (0, 6) \)

b) What is the height of the cliff? 
\[ \text{6 m} \]

c) How long does it take Daniel before he touches the water? 
\[ 1 \text{ Second} \]

d) How long is he underwater? 
\[ 2 \text{ seconds} \]

e) How far underwater does he dive? 
\[ 2 \text{ meters} \]

f) State the domain and range for this function. 
\[ [0, 3] \quad [-2, 6] \]

5.) Michelle volleys a volleyball in the arc \( h = -0.2d^2 + 1.2d + 1.8 \) where \( h \) is the height of the ball in meters and \( d \) is the horizontal distance from where Michelle is standing in meters. 

\[ \text{vertex} \ (3, 3.6) \]

\[ \frac{-(1.2)}{2(-1.2)} = -0.5 \]
\[ y = 0.5(3)^2 + 1.2(3) + 1.8 \]

a) What is the maximum height that the ball reaches? 
\[ 3.6 \text{ m} \]

b) Once it has been hit, how far is the ball from Michelle when it reaches its maximum height? 
\[ 3 - 1.8 = 1.2 \text{ m} \]

c) Approximately how tall is Michelle? 
\[ 1.8 \text{ m} \]

d) How far away from Michelle does the ball land? 
\[ 7.2 \text{ m} \]

e) If the court line is 10 m away from Michelle and the other team does not intercept the ball, will the ball land inside or outside the boundary? 
Inside

f) If the net is 1 m away from Michelle and 3 m high, did the ball clear the net? 
\[(1, 2.8) \text{ is on curve - it will not clear} \]

6.) Sammy hits a tennis ball in the arc \( h = -0.8d^2 + 2.4d + 1 \) where \( h \) is the height of the ball in meters and \( d \) is the horizontal distance in meters. 

\[ \text{vertex} \ (1.5, 2.8) \]

\[ \frac{-(2.4)}{2(-0.8)} = -1.5 \]
\[ y = -0.8(1.5)^2 + 2.4(1.5) + 1 \]

a) What is the maximum height that the ball reaches? 
\[ 2.8 \text{ m} \]

b) If the net is 4 m away and 1.2 m tall, does the ball clear the net? 
\[ \text{No, lands at } 3.37 \text{ m.} \]

c) How far away does the ball land? 
\[ 3.37 \text{ m} \]

d) At what height was the ball hit? 
\[ 1 \text{ m} \]
Algebra 2 – Quadratic Function Word Problems (Maximum and Minimum)

1.) A ball is thrown vertically upward with an initial speed of 80 feet per second. Its height after t seconds is given by \( h = -16t^2 + 80t \).

How high does the ball go?

\[
\frac{-80}{a(-16)} = 2.5 \\
\begin{align*}
\text{at} (-16) & = 2.5 \\
\text{height} & = -10(2.5)^2 + 80(2.5) \\
\text{height} & = 100 \\
\text{vertex} & = (2.5, 100)
\end{align*}
\]

2.) Suppose that a group of high school students conducted an experiment to determine the number of hours of study that leads to the highest score on a comprehensive year-end exam. The exam score \( y \) for each student who studied for \( x \) hours can be modeled by \( y = -0.853x^2 + 17.48x + 6.923 \).

a.) Which amount of studying produced the highest score on the exam?

\[
\frac{-17.48}{2(-0.853)} = 10.25
\]

\[
y = -0.853(10.25)^2 + 17.48(10.25) + 6.923
\]

\[
y = 96.47
\]

b.) What is the highest score the model predicts?

\[
\text{vertex: (10.25, 96.47)}
\]

3.) The graph at the right shows the height \( h \) in feet of a small rocket \( t \) seconds after it is launched. The path of the rocket is given by the equation: \( h = -16t^2 + 128t \).

a.) How long is the rocket in the air? \( \underline{8 \text{ seconds}} \)

b.) What is the greatest height the rocket reaches? \( \underline{2660 \text{ ft}} \)

c.) About how high is the rocket after 1 second? \( \underline{100 \text{ ft}} \)

d.) After 2 seconds, about how high is the rocket? \( \underline{190 \text{ ft}} \)

e.) After 2 seconds, is the rocket going up or going down? \( \underline{up} \)

f.) After 6 seconds, about how high is the rocket? \( \underline{190 \text{ ft}} \)

g.) After 6 seconds, is the rocket going up or going down? \( \underline{down} \)

h.) Do you think the rocket is traveling faster from 0 to 1 second or from 3 to 4 seconds? Explain your answer.

i.) Using the equation, find the exact value of the height of the rocket at 2 seconds.

\[
h = -16(2)^2 + 128(2)
\]
4.) A rocket carrying fireworks is launched from a hill 80 feet above a lake. The rocket will fall into lake after exploding at its maximum height. The rocket's height above the surface of the lake is given by \( h = -16t^2 + 64t + 80 \).

a.) What is the height of the rocket after 1.5 second?
\[
\begin{align*}
  h &= -16(1.5)^2 + 64(1.5) + 80 \\
  h &= 140 \text{ ft}
\end{align*}
\]

b.) What is the maximum height reached by the rocket?
\[
\begin{align*}
  \frac{-64}{2(-16)} &= 2.5 \\
  y &= -16(2.5)^2 + 64(2.5) + 80 \\
  y &= 144 \text{ ft}
\end{align*}
\]

\begin{align*}
\text{Vertex: } & (2.5, 144) \\
\end{align*}

5.) In a 110 volt circuit having a resistance of 11 ohms, the power, \( W \), in Watts when a current of \( x \) amps is flowing is \( W = 110x - 11x^2 \).\[
\begin{align*}
  W &= -11x^2 + 110x \\
  \frac{-110}{2(-11)} &= 5
\end{align*}
\]

a.) Determine the maximum power that can be delivered to this circuit.
\[
\begin{align*}
  W &= 110(5) - 11(5)^2 \\
  W &= 275 \text{ Watts}
\end{align*}
\]

b.) Determine the current flowing when the power is at a maximum.
\[
\begin{align*}
  \text{5 amps}
\end{align*}
\]

6.) Red aerial mini-flares are used by some boaters in an emergency. The flight of one brand of flare, when fired at a angle of 70° to the horizontal is modelled by the function \( h = -9(t - 3)^2 + 83 \), where \( h \) is the height, in meters and \( t \) is the time, in seconds, since the flare was fired.

a.) State the vertex. \((3, 83)\)

b.) State whether it is a max or a min. \(\text{Max}\)

c.) What is the max/min height reached? \(83 \text{ m}\)

d.) When was the max/min height reached? \(3 \text{ seconds}\)

e.) What is the height reached after 4 seconds?
\[
\begin{align*}
  h &= -9(4 - 3)^2 + 83 \\
  h &= -9(1)^2 + 83 \\
  h &= -9 + 83 = 74
\end{align*}
\]