PRACTICE Word Problems with Quadratics

Name: ______________________________

1.A rocket is shot vertically up in the air from ground level. Its distance *d*, in metres, after *t* seconds is given by $d = 96t - 16t^2$.

a) What is the initial height of the rocket?

b) Find the value(s) of *t* when *d* is 128 m.

2. An architect has designed a modern building that is to be supported by a steel arch shaped like a parabola. This parabola can be modelled by the relation $y = -0.025x^2 + 2x$, where *y* represents the height of the arch and *x* represents the distance along the base, both in metres.
   a) What is the width of the base of the arch?
   b) What is the highest point on the parabolic arch?

3. Hiroshi is trying out for the position of kicker on the football team. He wants to know at what angle he should kick the ball for maximum distance. He has used a machine that kicks footballs with constant velocity but at varying angles. Hiroshi has collected some data and used quadratic regression on his graphing calculator to determine that the relation between angle and distance is given by the equation $d = -0.1a^2 + 8.5a - 40$ where *a* is the angle in degrees, and *d* is the distance in metres.
   a) Use factoring to determine the zeros of this graph.
   b) Determine the vertex of the parabola.
   c) Which angle gives the maximum distance, and what is the maximum distance?
   d) Sketch this relation.
   e) For what values of *a* is the graph valid?

4. A flare is launched from a life raft with an initial upward velocity of 192 m/s.
   a) How many seconds will it take for the flare to return to the sea? Use the formula $h = 192t - 16t^2$, where *h* is the height in metres and *t* is the time in seconds.
   b) If a passing boat can only see a flare that is at least 100 m above the life raft, for how long will the flare be visible, rounded to the nearest second?

5. Parabolic arches are often used in the design of bridges for both functional and aesthetic reasons. Examples of parabolas can be found extensively in structures built by the Romans. A modern example of a parabolic arch used to support a structure is the Hulme Arch Bridge in Manchester, England. This arch can be modelled by the relation $h = -0.037x^2 + 25$, where *h* represents the height of the arch in metres at any point *x* metres left or right of the centre.
   a) Use the quadratic formula to determine the zeros of the quadratic relation, rounded to the nearest metre. What do these numbers represent on the Arch?
   b) Find the width of the Arch to the nearest metre.
   c) What is the height of the Hulme Arch?
   d) What fraction of the Arch is above 3 m high?

6. Kim is drafting the windows for a new building. Their shape can be modelled by the relation $h = -w^2 + 4$, where *h* is the height and *w* is the width of points on the window frame, measured in metres.
   a) Graph the relation.
   b) Find the maximum height of each window.
   c) Find the width of each window at its base.

7. A football quarterback passes the ball to a receiver 40 m down-field. The path of the ball can be described by the relation $h = -0.01(d - 20)^2 + 6$, where *h* is the height of the ball, in metres, and *d* is the horizontal distance of the ball from the quarterback, in metres.
   a) What is the maximum height of the ball?
   b) What is the horizontal distance of the ball from the quarterback at its maximum height?
   c) What was the height of the ball when it was thrown?
   d) What was the height of the ball when it was caught?
   e) If a defensive back is 2 m in front of the receiver, how far is he from the quarterback?
   f) How high would the defensive back have to reach to knock down the pass?

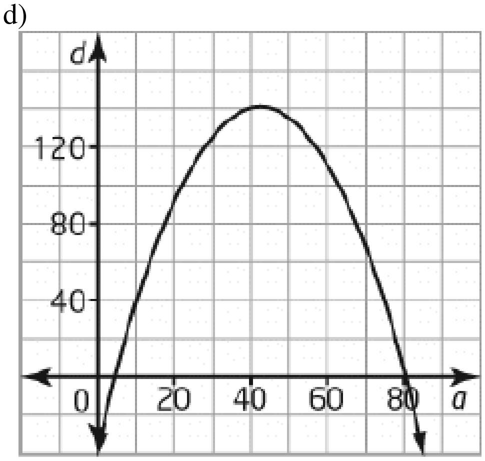
ANSWERS

1. a) 0m b) $t = 2$ or $t = 4$.
2.

a) The roots of the equation are 0 and 80, so the width of the base is 80 m.
b) Find the vertex. The x-coordinate for the vertex is halfway between the ends of the base, at $x = 40$. Substituting $x = 40$ into the equation gives a vertex of $(40, 40)$, so the arch is 40 m tall.

3.

a) The zeros are at 5 and 80.
b) the a-coordinate of the vertex is halfway between the zeros, at $a = 42.5$. Substituting $a = 42.5$ into the equation gives the d-coordinate of 140.625.
c) The angle of $42.5°$ gives the maximum distance of 140.625 m.
d)



e) The relation can only be valid when $5 < a < 80$ because d must be positive.

4.

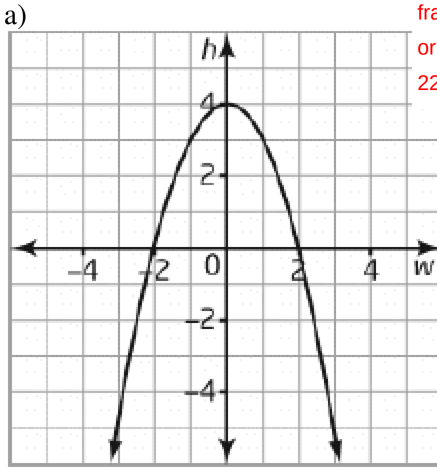
a) $192t - 16t^2 = 0$
The flare will hit the water after 12 s have passed.
b) $192t - 16t^2 = 100$
The roots of this equation are $t = 0.55$ and $t = 11.45$. The flare will be visible for approximately 11 s.

5.

a) $-0.037x^2 + 25 = 0$
The zeros are at approximately –26 and 26. The two zeros represent the points where the Arch touches the ground.
b) The width of the Arch is 52 m.
c) The curve is symmetric about the y-axis. The highest point, the vertex, is at the y-intercept, which is 25 m.
d) $-0.037x^2 + 25 = 3$
The x-values at approximately –24.4 and 24.4. The width of the Arch at a height of 3 m is approximately 48.8 m. The fraction of the Arch above 3 m is approximately $\frac{48.8}{52}$. bad form to leave decimal in fraction 49/52 is the width fraction or 22/25 is the height fraction

6.

a)



b) The maximum height of each window is 4 m.
c) The base of the window is the distance from the points $(-2, 0)$ and $(2, 0)$. The width of each window at its base is 4 m.

7.

a) 6 m
b) 20 m
c) 2 m
d) 2 m
e) 38 m
f) 2.76 m