QUADRATIC WORD PROBLEMS

General quadratic equation:

$y = ax^2 + bx + c$

General quadratic equation of projectile motion:

$h(t) = \frac{1}{2} gt^2 + v_0t + h_0$

h(t): height as a function of time (m or ft)
g: approximate acceleration of gravity is -9.81 m/s^2 or -32.17 ft/s^2
t: time (s)
v_0*:* initial velocity (m/s or ft/s)
h_0*:* initial height (m or ft)

Question 1: "What time does the object reach its maximum height?"

a. Use Vertex Formula: $t = \frac{-b}{2a}$
b. *t* is the time in seconds (s)

Question 2: "What is the object's maximum height?"

a. From Question 1, you determined the time the object reaches its maximum height. Now substitute this time for *t* into the original equation.
b. Solve for *h(t)*

Question 3: "At what times does the object reach a height of ___?"

a. Substitute given height into *h(t)* of the original equation.
b. Rearrange the equation so that is equals zero.
c. Solve for *t* using factoring or the Quadratic Formula.

NOTE: Because the projectile graph is a parabola shape, there are two times when the parabola reaches that height (once on the way up and again on the way down)

Question 4: "What height is the object at ___ seconds after it is launched?"

a. Substitute given time for *t* into the original equation.
b. Solve for *h(t)*.

Question 5: "At what time does the object reach the ground?"

a. Substitute zero for *h(t)* into the original equation (at ground level, height = 0m).
b. Because the parabola opens downward, the *t*-intercepts are when *h* equals zero.
c. To determine the *t*-intercepts, plug in the *a*, *b*, and *c* values from the original equation into the Quadratic Formula and solve for the two *t*-values.

NOTE: The smaller *t*-value is when the object leaves the ground (this may be negative if the object started at a height greater than 0m or 0ft; if so, ignore this value), and the larger *t*-value is when the object lands on the ground.

Question 6: "What is the average speed/velocity of the object ___ seconds after it is launched?

NOTE: The slope of a distance graph is the velocity (m/s or ft/s)

a. Substitute the initial time (0s) for *t* into the original equation and solve for h_0 (this is also the *c*-value).
c. Substitute the given time for *t* into the original equation and solve for *h(t).*
d. Calculate the slope using the slope formula: $m = \frac{y2-y1}{x2-x1} = \frac{h(t)-h0}{t-0}$
e. The slope is the velocity in m/s or ft/s

Question 7: "What is the average speed/velocity of the object between ___ seconds and ___ seconds?"

a. Substitute the first given time (t_1) for *t* into the original equation and solve for *h(t)* (which = h_1)
b. Substitute the second given time (t_2) for *t* into the original equation and solve for *h(t)* (which = h_2)
c. Calculate the slope using the slope formula: $m = \frac{h2-h1}{t2-t1}$

Question 8: "What is the speed/velocity of the object when/right before it hits the ground?"

a. From Question 5, you determined the time that the object hits the ground; call this time t_2 and this height h_2 (NOTE: $h_2 = 0$)
b. Now subtract 0.001 s from that time (t_2) to get t_1, which is the time right before the object hits the ground.
c. Substitute t_1 into the original equation and solve for *h(t)* (which = h_1)
d. Calculate the slope using the slope formula: $m = \frac{h2-h1}{t2-t1}$

Question 9: "What is the instantaneous speed/velocity of the object at ___ seconds?"

a. Substitute the given time (t_1) for *t* into the original equation and solve for *h(t)* (which = h_1)
b. Now subtract 0.001 s from that time (t_1) to get t_2, which is the time right before that instant
c. Substitute t_2 into the original equation and solve for *h(t)* (which = h_2)
d. Calculate the slope using the slope formula: $m = \frac{h2-h1}{t2-t1}$