M^2=Math Mediator   Lesson 27: Graph Quadratics

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<td>Total Recall (Warm-up) (5 minutes approx.)</td>
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Total Recall: Exercise from yesterday's lesson on Quadratic Functions.

1. Graph the following parabola: $y = x^2 + 5x - 6$. Does it have a maximum or minimum? What is the axis of symmetry? Hint: try a table with x values of -1, -2, -3, -4 and -5 to see the pattern.
   a. Answer: Since the coefficient on the x^2 term is positive, the parabola opens upward and there will be a minimum. The axis of symmetry is $x = -2.5$
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<td>Direct Instruction (8 minutes approx.)</td>
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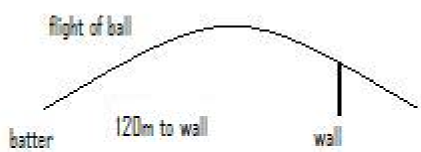
In baseball, the height of a hit ball can be described by the equation $h = -4.9t^2 + v_0t + h_0$ with t being time in seconds, -4.9 is gravity forces, v_0 being the initial velocity at time zero (how hard the batter swings the bat), and h_0 is the initial height (about knee to chest height). For an example of a typical hit ball, we will use v_0 of 30 m/s (we are using meters), and in the ballpark there is a 26 meter high wall that needs to be cleared for a homerun, and since the batter hits the ball about 1 meter off the ground, we will use -25 meters as the height to see if the ball will clear the wall. The quadratic function is $h = -5t^2 + 30t - 25$ (rounding off



the -4.9 to -5).

* The picture shows a parabola of a theoretical flight of a baseball clearing the wall. Our quadratic equation only describes the height with respect to time. It does not give us any information about the distance. Later in this course we will study trigonometry and angles. The distance of the ball is determined by the

angle the ball comes off the bat.
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<td>Review (10 minutes approx.)</td>
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U-DO: Using the graphing calculator to view graph. Press the 'Y=' button on your graphing calculator and enter the equation $y = -5x^2 + 30x - 25$. Press the 'GRAPH' button to view the parabola. If it is not on the screen or it is displayed only partially, press the "WINDOW" button to adjust the viewing size to:

Xmin = 0; Xmax = 6; Xscl = 0.5; Ymin = 0; Ymax = 30; Yscl = 2; Xres=1.

Since the height was set negative with respect to a 26 meter tall wall, all numbers that are positive on the y axis indicate that the baseball is higher than the wall. At y = 0, the baseball is just at the height of the wall. What values of t does this occur? Answer: at 1 second and at 5 seconds. This is the time interval that the ball has enough height to clear the wall and be a homerun.

Q. Does this function have a maximum or minimum and where? A. It has a maximum of 20m at 3 seconds. Press "TABLE" on your calculator and see the tabulated data from your quadratic function. What is the axis of symmetry?
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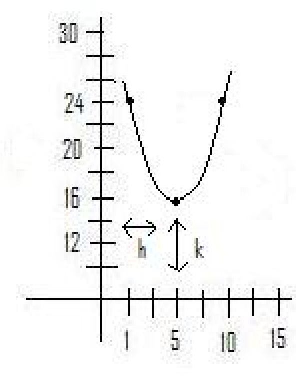
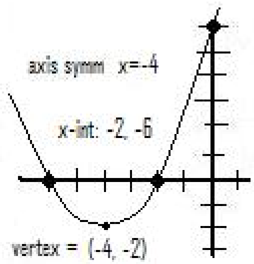
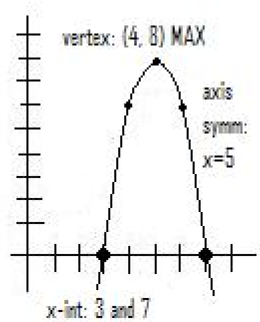
	Answer: at x = 3, where the maximum and vertex is.
Direct Instruction (5 minutes approx.)	If we did not have a graphing calculator, we can try factoring the quadratic function to help us to graph it. In our example: $y = -5x^2 + 30x - 25$, you first can see that all the coefficients are divisible by -5: $y = -5(x^2 - 6x + 5)$. The next step in factoring involves taking the ($x^2 - 6x + 5$) and getting $(x - r_1)$ and $(x - r_2)$ where r_1 and r_2 are roots, or zeros, where the y value is zero. Some may remember the 'foil' method of multiplying the root expressions to get back to the squared expression: foil = first, outer, inner, and last. In our example: $x^2 - 6x + 5$; we can see that the x terms in the factors will have coefficients of 1: $(x - r_1)\cdot(x - r_2)$, because when we multiply the first elements, x time x, we will get x^2 for the first term. To find the roots, we know that they must multiply together to equal the last term, 5. Factors of 5 are only 5 and 1. Therefore, we just need to figure out in which place and with what sign they will have to get the middle term of -6x. The 'outer, inner' of the FOIL determine where the factors are placed. Sometimes trial and error is the only way. Try $(x - 1)\cdot(x - 5) = x^2 - 5x - 1x + 5 = x^2 - 6x + 5$ and that is the answer! Definitions: Standard Form: $y = ax^2 + bx + c$; x-intercept Form: $y = a(x - r_1)\cdot(x - r_2)$
Practice and assessment: (10 minutes approx.)	U-DO: Graph the following functions #1 and #2, label the vertex, axis of symmetry and x-intercepts. 1. $y = 2x(x-4)$ Answer: Vertex = (2, -4); Axis of symmetry is x=2; the x intercepts (where y = 0) are 0, 4. The graph opens up, vertex is minimum. 2. $y = 3(x-4)(x+1)$ Answer: Vertex = (1.5, -18.75); Axis of symmetry is x=1.5; the x intercepts are -1, 4. The graph opens up, vertex is minimum. 3. Change the following to standard form: $y = 2(x+3)(x+2)$ Answer: $2x^2 + 10x + 12$
Exercise: (5 minutes approx.)	Another useful form of quadratics is the "vertex form" or: $y = a(x - h)^2 + k$  Question: for $y = (x - 1)^2 - 4$; what does 'a', 'h' and 'k' equal from the vertex form? Answer: a = 1, k = -4 and h = 1. Plot the function for extra credit.
Exercise:	U-DO; Graph and label the functions with vertex, axis of symmetry, maximum

(10 minutes approx.)	or minimum, and x-intercepts. 1. $y = 0.5(x + 4)^2 – 2$ Answer:  Minimum at vertex.  2. $y = 8 – 2(x - 5)^2$ Answer:
Wrap-up and homework assignment (2 minutes approx.)	Wrap up closing comments and housekeeping. 1. Identify the following forms of quadratic functions: a. $y = 3x(x + 5)$ Answer: Factored form or x-intercept form. b. $y = 2x^2 + 3x – 6$ Answer: Standard form. c. $y = f(x) = -0.25(x – 4)^2 + 6$ Answer: Vertex Form. 2. Change each of these to standard form: a. $y = (x – 1)(x + 2)$ Answer: $y = x^2 + x – 3$ b. $y = 2(x + 4)^2 – 5$ Answer: $y = 2x^2 + 16x + 27$ c. $y = -2(x – 3)(x – 5)$ Answer: $y = -2x^2 + 16x – 30$

