

## T25 - Quadratic Functions

IB Math SL1 - Santowski

10/13/2009

1

## Lesson Objectives

- (1) Establish a context for Quadratic Relations
- (2) Features of graphs of Quadratic relations → D,R,intercepts, vertex (extrema/max/min), axis of symmetry, direction of opening, increase/decrease
- (3) Introduce Forms of Quad. Eqns → Standard, Vertex (transformational), intercept

10/13/2009

2

## (A) Context for Quadratic Relations

- The formula for the height,  $h$  in meters, of an object launched into the air as a function of its time in flight,  $t$  in seconds, is given by is  $h(t) = -\frac{1}{2}gt^2 + v_0t + h_0$
- $g$  represents the acceleration due to gravity which is about  $9.8 \text{ m/s}^2$ ,  $v_0$  refers to the launch velocity in  $\text{m/s}$  and  $h_0$  represents the initial launch height in  $\text{m}$ .

10/13/2009

3

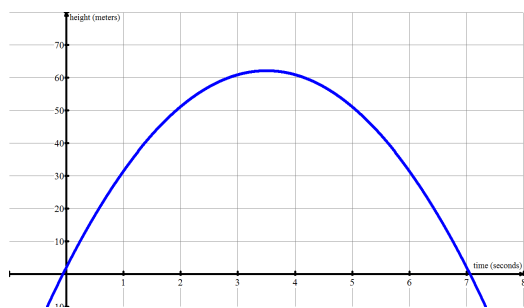
## (A) Context for Quadratic Relations

- If a projectile has an initial velocity of  $34.3 \text{ m/s}$  and is launched  $2.1 \text{ m}$  above the ground, graphically determine:
  - (1) the equation that you will enter into the TI-84
  - (2) the time at which the projectile reaches the maximum height
  - (3) the maximum height reached by the projectile
  - (4)  $h(2)$
  - (5)  $h^{-1}(12)$
  - (6) state the domain and range of the relation and explain WHY
  - (7) the x-intercepts and their significance
  - (8) the total time of flight of the projectile

10/13/2009

4

## (A) Context for Quadratic Relations



10/13/2009

5

## (B) Graphic Analysis of Parabolas

- For our investigation of quadratic functions, you will need to familiar with the following terms:
  - Domain
  - Range
  - Y-intercepts
  - X-intercepts, roots, zeroes
  - Vertex, maximum, minimum, extrema
  - Direction of opening
  - Axis of symmetry
  - Intervals of increase/decrease
  - Concavity
  - Continuity

10/13/2009

6

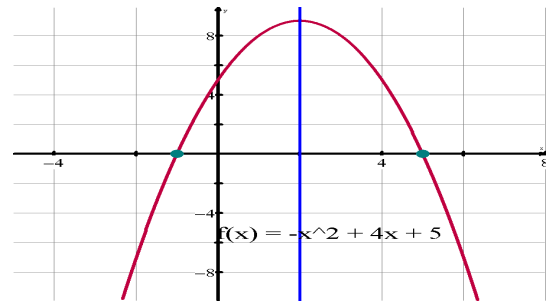
### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Graph the parabola  $f(x) = -x^2 + 4x + 5$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

7

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations



10/13/2009

8

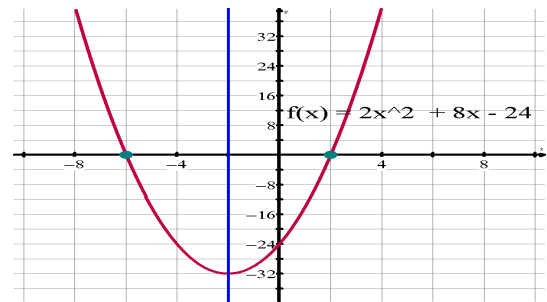
### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Graph the parabola  $f(x) = 2x^2 + 8x - 24$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

9

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations



10/13/2009

10

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = ax^2 + bx + c$  and:
  - The equation and the y-intercept
  - The equation and the axis of symmetry
  - The eqn and intervals of inc/dec
  - The equation and the vertex
  - The equation and the range
  - The equation and the direction of opening
  - The equation and the concavity

10/13/2009

11

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = ax^2 + bx + c$  and:
  - The equation and the y-intercept  $\rightarrow (0, c)$
  - The equation and the axis of symmetry  $\rightarrow (x = -b/2a)$
  - The eqn and intervals of inc/dec  $\rightarrow (x > -b/2a \text{ or } x < -b/2a)$
  - The equation and the vertex  $\rightarrow (-b/2a, f(-b/2a))$
  - The equation and the range  $\rightarrow (y > f(-b/2a)) \text{ or } y < f(-b/2a)$
  - The equation and the direction of opening  $\rightarrow (\text{sign of } a)$
  - The equation and the concavity  $\rightarrow (\text{sign of } a)$

10/13/2009

12

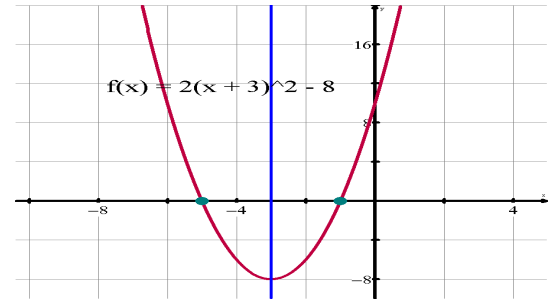
### (C) Graphic Analysis of Parabolas - Vertex Form of Quadratic Equations

- Graph the parabola  $f(x) = 2(x + 3)^2 - 8$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

13

### (C) Graphic Analysis of Parabolas - Vertex Form of Quadratic Equations



10/13/2009

14

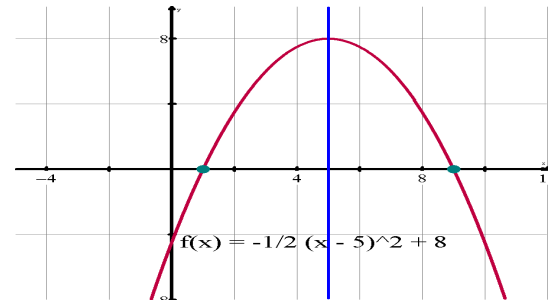
### (C) Graphic Analysis of Parabolas - Vertex Form of Quadratic Equations

- Graph the parabola  $f(x) = -\frac{1}{2}(x - 5)^2 + 8$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

15

### (C) Graphic Analysis of Parabolas - Vertex Form of Quadratic Equations



10/13/2009

16

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = a(x - k)^2 + h$  and:
  - The equation and the y-intercept
  - The equation and the axis of symmetry
  - The eqn and intervals of increase/decrease
  - The equation and the vertex
  - The equation and the range
  - The equation and the direction of opening
  - The equation and the concavity

10/13/2009

17

### (B) Graphic Analysis of Parabolas – Standard form Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = a(x - k)^2 + h$  and
  - The equation and the y-intercept  $\rightarrow (0, f(0)) = ak^2 + h$
  - The equation and the axis of symmetry  $\rightarrow (x = k)$
  - The eqn and intervals of increase/decrease  $\rightarrow (x > k \text{ or } x < k)$
  - The equation and the vertex  $\rightarrow (h, f(k) = h)$
  - The equation and the range  $\rightarrow (y > h) \text{ or } y < h$
  - The equation and the direction of opening  $\rightarrow (\text{sign of } a)$
  - The equation and the concavity  $\rightarrow (\text{sign of } a)$

10/13/2009

18

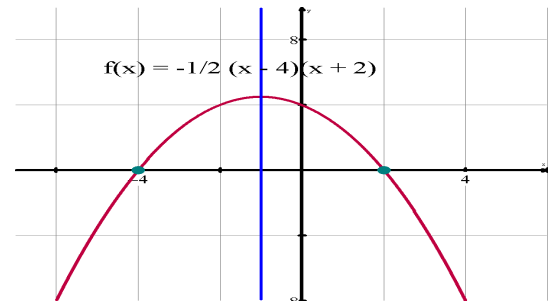
### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations

- Graph the parabola  $f(x) = -\frac{1}{2}(x+4)(x-2)$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

19

### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations



10/13/2009

20

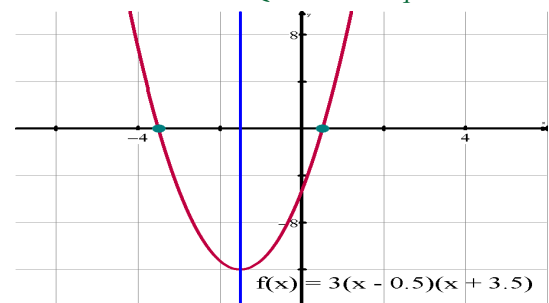
### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations

- Graph the parabola  $f(x) = 3(x-\frac{1}{2})(x+3.5)$  and provide a complete graphical analysis of the parabola. Use your TI-84 to graph and analyze the parabola
- You will eventually NOT have access to a calculator to help with the functional analysis
- You will provide info about Domain, Range, Y-intercept(s), X-intercepts (AKA roots, zeroes), Vertex (AKA maximum, minimum, extrema), Direction of opening, Axis of symmetry, Intervals of increase/decrease, Concavity, Continuity

10/13/2009

21

### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations



10/13/2009

22

### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = a(x-r_1)(x-r_2)$  and:
  - The equation and the y-intercept
  - The equation and the roots/zeroes
  - The equation and the axis of symmetry
  - The eqn and intervals of increase/decrease
  - The equation and the vertex
  - The equation and the range
  - The equation and the direction of opening
  - The equation and the concavity

10/13/2009

23

### (C) Graphic Analysis of Parabolas - Factored Form of Quadratic Equations

- Given the various features that you have seen in the graphs and listed in your analysis, is there an easy/apparent connection between the equation  $f(x) = a(x-r_1)(x-r_2)$  and:
  - The equation and the y-intercept  $\rightarrow (0, f(0)) = ar_1r_2$
  - The equation and the roots/zeroes  $\rightarrow (r_1, 0)$  and  $(r_2, 0)$
  - The equation and the axis of symmetry  $\rightarrow x = \frac{1}{2}(r_1+r_2)$
  - The eqn and intervals of inc/dec  $\rightarrow x < \frac{1}{2}(r_1+r_2)$  or  $x > \frac{1}{2}(r_1+r_2)$
  - The equation and the vertex  $\rightarrow (\frac{1}{2}(r_1+r_2), f(\frac{1}{2}(r_1+r_2)))$
  - The equation and the range  $\rightarrow y >$  or  $y < f(\frac{1}{2}(r_1+r_2))$
  - The equation and the direction of opening  $\rightarrow$  sign of  $a$
  - The equation and the concavity  $\rightarrow$  sign of  $a$

10/13/2009

24

### (D) Switching Forms of the Quadratic Equations

- (1) Write the equation  $f(x) = 2(x + 3)^2 - 8$  in standard form
- (2) Write the equation  $f(x) = -\frac{1}{2}(x - 5)^2 + 8$  in standard form
  
- (3) Write the equation  $f(x) = 2(x + 3)^2 - 8$  in factored form
- (4) Write the equation  $f(x) = -\frac{1}{2}(x - 5)^2 + 8$  in factored form

10/13/2009

25

### (D) Switching Forms of the Quadratic Equations

- (1) Write the equation  $f(x) = -\frac{1}{2}(x + 4)(x - 2)$  in standard form
- (2) Write the equation  $3(x - \frac{1}{2})(x + 3.5)$  in standard form
  
- (3) Write the equation  $f(x) = -\frac{1}{2}(x + 4)(x - 2)$  in vertex form
- (4) Write the equation  $3(x - \frac{1}{2})(x + 3.5)$  in vertex form

10/13/2009

26

### (E) Homework

- HW:
  - Ex8B.1 #2, Ex 8B.2 #2, 3bf, 6;
  - Ex 8J, #1af, 2acgh, 3bc, 4ad;
  - Ex 8H #3cd, 4acei, 5chk, 6gh
  - IB Packet #4, 5

10/13/2009

27