BIG PICTURE of this UNIT:	• How do we WORK WITH & EXTEND the concept of "functions" • Why are quadratic equations written in different forms? • How do we EXTEND and APPLY our knowledge of quadratic functions, beyond the basics of IM2?

This lesson will be based upon a STUDENT DIRECTED DISCUSSION model ….. in your groups, you should be having DISCUSSIONS about how to think and work through and then present the solutions to the following questions. So, discuss & prepare solutions to the following questions. Record the key ideas of your discussions/solutions in your notebook. Then, once you have had your discussions, present your solutions on the board. Solutions do NOT necessarily NEED to be correct – they simply form the basis for DISCUSSIONS!!!! If your group has (i) multiple solutions that lead to the same answers OR (ii) same/different solutions that lead to different answers, present them ANYWAY!!

1. (CI) Given the quadratic function $f(x) = x^2 - 3x - 10$, answer the following using ALGEBRAIC methods (no TI-84s) {1,2,3,4,9}

   a. Evaluate $f(-3)$
   b. Factor the equation for $y = f(x)$ (rewrite in factored form)
   c. HENCE, solve $0 = x^2 - 3x - 10$ (i.e. find the zeroes of $y = f(x)$)
   d. HENCE, determine the optimal point of $y = f(x)$
   e. Solve $f(x) = 18$ (i.e. solve $18 = x^2 - 3x - 10$)
   f. HENCE, sketch the parabola defined by $f(x) = x^2 - 3x - 10$, labelling the key points you've worked out.

2. (CI) Given the quadratic function $f(x) = 2(x-6)(x+10)$, answer the following using ALGEBRAIC methods (no TI-84s) {1,2,3,4,9}

   a. Evaluate $f(-3)$
   b. Solve $0 = 2(x-6)(x+10)$ (i.e. find the zeroes of y = f(x))
   c. Expand the equation for $y = f(x)$ (rewrite in standard form)
   d. HENCE, determine the optimal point of $y = f(x)$
   e. Solve $f(x) = -30$ (i.e. solve $-30 = 2(x-6)(x+10)$)
   f. HENCE, sketch the parabola defined by $f(x) = 2(x-6)(x+10)$, labelling the key points you've worked out.

3. (CI) Given the quadratic function $f(x) = -4(x-2)^2 + 16$, answer the following using ALGEBRAIC methods (no TI-84s) {1,2,3,4,5,9}

   a. Evaluate $f(-3)$
   b. Determine the optimal point of $y = f(x)$
   c. Solve $0 = -4(x-2)^2 + 16$ (i.e. find the zeroes of y = f(x) HINT: inversing the operations)
   d. Expand the equation for $y = f(x)$ (rewrite in standard form)
   e. Solve $f(x) = -20$ (i.e. solve for x when $-20 = -4(x-2)^2 + 16$)
   f. HENCE, sketch the parabola defined by $y = -4(x-2)^2 + 16$, labelling the key points you've worked out.
   g. CONNECTIONS: Determine the transformations that were applied to the parent function of $y = x^2$
   h. CONNECTIONS: Write the equation for the inverse of $y = f(x)$

4. (CI – Ideally) A model rocket is shot into the air and its path is approximated by $h(t) = 30t - 5t^2$, where h is the height of the rocket above the ground in meters and t is the elapsed time in seconds. {7,9,15,16}

   a. When will the rocket hit the ground?
   b. What is the maximum height of the rocket?

5. (CI – Ideally) A computer software company models its profits of its latest game using the relation $P(x) = -2x^2 + 28x - 90$, where x is the number of games its produces in hundreds of thousands and P is the profit in millions of dollars. {7,9,15,16}

   a. What is the maximum profit the company can earn?
   b. How many games must the company produce to earn this profit?
   c. What are the break-even points for the company?

6. Use DESMOS to conduct the following investigation ➔ Explain the transformational effect of the parameter a in the equation $f(x) = ax^2$ {5,6}

   a. First, see what happens when $a > 1$. Explain what you see happening to the "parent" function $y = x^2$. How would you describe this change as a transformation?

   b. Secondly, see what happens when $0 < a < 1$. How would you describe this change as a transformation?

   c. Lastly, see what happens when $a < 0$. How would you describe this change as a transformation?

7. Use DESMOS to conduct this investigation ➔ Explain the transformational effect of the parameter h and k in the equation $f(x) = (x - h)^2 + k$ {5,6}

   a. First, see what happens when $h > 0$. Explain what you see happening to the "parent" function $y = x^2$. How would you describe this change as a transformation?

   b. First, see what happens when $h < 0$. Explain what you see happening to the "parent" function $y = x^2$. How would you describe this change as a transformation?

   c. First, see what happens when $k > 0$. Explain what you see happening to the "parent" function $y = x^2$. How would you describe this change as a transformation?

   d. First, see what happens when $k < 0$. Explain what you see happening to the "parent" function $y = x^2$. How would you describe this change as a transformation?

Higher Level Questions for More Complex Concepts OR an EXTENSION of basic concepts involved with Quadratic Functions.

1. The standard form of a quadratic function is $f(x) = ax^2 + bx + c$. Knowing that $f(-2) = -9$ and that $f(2) = 3$ and that $f(4) = 15$, determine the values for a, b and c. {18}

2. A movie theatre can accommodate a maximum of 450 people in one day. The theatre operators have changed admission prices on several occasions to find out how price affects attendance, daily revenue and profit . After reviewing their data and using the formula profit = revenue – expenses, the operators found they could express the relation between profit, $\boldsymbol{P}$, and ticket price, $\boldsymbol{t}$ as $\boldsymbol{P} = \boldsymbol{t}(450 - 30\boldsymbol{t}) - 790$. {7,9,15,16}

   a. What does the expression 450 – 30t represent?
   b. What does the 790 represent?
   c. What is the ticket price that maximizes the daily profit?
   d. How many tickets will be sold at this price?
   e. What is the maximum profit?
   f. Determine the break-even ticket price and required minimum ticket sales

   g. However, the operators forgot to take into account the revenue from concession sales. They expect this to be \$3.50 per ticket. As a result, the new profit equation is $\boldsymbol{P} = (\boldsymbol{t} + 3.50)(450 - 30\boldsymbol{t}) - 790$.

      i. Explain what the expression $\boldsymbol{t} + 3.50$ represents.
      ii. What new ticket price will maximize the profit?
      iii. What will the maximum profit be?
      iv. Determine the new break even ticket price and the required minimum ticket sales.