MeTEOR Performance Task
Algebra I

Mathematics
Quadratics in Volleyball

Performance Task Item: Quadratics and Volleyball

Grade Level: Algebra 1

Focus Area: Solving Quadratic Equations in One Variable
Essential Question: How can we use quadratic equations in real life situations?
Core Ideas:

- Understands the Quadratic Formula.
- Understands the process of completing the square.
- Understands various methods to solving a quadratic equation.
- Understands square rooting both sides of an equation yields two solutions.
- Understands that the quadratic formula can be used to find complex solutions.

Learning Targets:

- Students will solve simple quadratic equations by inspection or by taking square roots.
- Students will use the vertex from of a quadratic equation to complete steps in the derivation of the quadratic formula.
- Students will solve a quadratic equation by choosing an appropriate method (i.e., completing the square, the quadratic formula of factoring).
- Students will explain their reasoning.

STANDARDS

Domain: Algebra: Reasoning with Equations & Inequalities
Content Standards:

- Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.
- Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
- Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

Supporting Standard:

- Know precise definitions of quadratic terminology.

Math Practice Standards:

MP 1: Make sense of problems and persevere in solving them.
MP 2: Reason abstractly and quantitatively.
MP 3: Construct viable arguments and critique the reasoning of others.
MP 4: Model with mathematics.
MP 6: Attend to precision.
MP 7: Look for and make use of structure.

Materials:

- Performance Task
- Pencil
- Paper
- Calculator

Task/Question 1:

DOK Level 1: Recall & Reproduction

Math Practice Standard:

- MP 6: Attend to precision.

A. Write a quadratic equation in standard form:

B. Name four ways to solve quadratic equations:

C. You can derive the Quadratic Formula by _____ the _____.

D. List the three steps in completing the square if the x^2-coefficient equals 1.

First Step: _____

Second Step: _____

Third Step: _____

Add a constant to complete each square:

E. $x^2 + 10x +$ _____ $x^2 - 12x +$ _____ $x^2 + 5x +$ _____ $x^2 - 3x +$ _____

Task/Question 2:

DOK Level 1: Recall & Reproduction

Math Practice Standards:

- MP 1: Make sense of problems and persevere in solving them.
- MP 6: Attend to precision.

A. Write the Quadratic Formula:

B. What do we call the quantity $b^2 - 4ac$ when found under the radical sign?

C. When $b^2 - 4ac$ is negative, you get two _____solutions.

D. Use the Quadratic Formula to solve the following equations:

$x^2 + x - 30 = 0$ _____ $x^2 + 12x + 36 = 0$ _____

$5x^2 - 35x + 50 = 0$ _____ $5x^2 - 13x - 6 = 0$ _____ (nearest tenth)

E. Use $\boldsymbol{d = rt - 5t^2}$ for the following vertical motion problem where ***d = distance***, ***r = rate*** and ***t = time.***

The engineers at the practice range are launching a new missile to check its altitude, times at various heights and when it will return to the ground. The missile is launched with an initial upward velocity of 100m/sec.

Calculate the altitude after 3 seconds:

At what time(s) will it be 480 meters high?

When does the missile return to the ground?

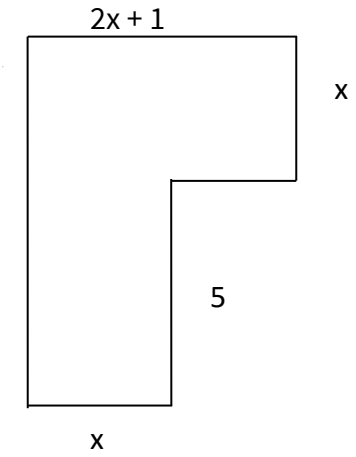
Task/Question 3:

DOK Level 2: Basic Application of Skills and Concepts

Math Practice Standards:

- MP 1: Make sense of problems and persevere in solving them.
- MP 4: Model with mathematics.
- MP 6: Attend to precision.

Phoebe had an area of her property enclosed for her two goats to graze and play upon. To avoid cutting down the trees, they put her fence up to look like the diagram shown below. The total area enclosed is 80 square meters.



A. Find the value of x using the quadratic formula:

B. Explain how you found your answer to Part A:

C. Phoebe decided to cut down the trees in Part A to make the fenced in area larger. This would give the goats a lot more room to graze upon and play. The new shape would make a rectangle for the goats.

What will the new total area be in square meters?

D. Explain how you got your answer to Part C:

Task/Question 4:

DOK Level 3: Strategic Thinking and Complex Reasoning.

Math Practice Standards:

- MP 1: Make sense of problems and persevere in solving them.
- MP 2: Reason abstractly and quantitatively.
- MP 3: Construct viable arguments and critique the reasoning of others.
- MP 4: Model with mathematics.
- MP 7: Look for and make use of structure.

Brittany, a volleyball player for the Yellow Jackets, served an underhanded volleyball in a final attempt to score a point against the Knights. The ball leaves her hand 1 meter above the floor and travels at an upward velocity of 7m/sec. She is successful. No one is able to stop the ball and it hits the ground on the Knight's side and she scores the winning point.

(Use $d = rt - 5t^2$, where ***d = distance***, ***r = rate*** and ***t = time*** to aid in solving this problem.)

A. How high above the floor was the ball after 0.3 seconds?

B. When was the ball back to the level where it was served before hitting the ground?

C. How long did it take to hit the floor?

D. The ball reached its highest level halfway between the time it was served and the time it was back at the level it was served from. How high is that above the floor?

E. Explain how you determined the answer to Part D. Justify and defend how your approach to solving this is the **most efficient**.

Complete Performance Task Scoring Rubric
Quadratics and Volleyball

19-21 Proficient 17-18 Good 15-16 Satisfactory 13-14 Poor 0-12 Unsatisfactory

	Depth of Knowledge Level	Points	Total Possible Points for Task	Total Points Earned by Student
Task 1: A. $ax^2 + bx + c = 0$ B. Factoring, Completing the square, Using the Quadratic Formula and Graphing C. Completing the square D. 1st Step: Take half the coefficient of x 2nd Step: Square it 3rd Step: Add the result E. 25, 36, 6.25, 2.25	**1**	**1** **1** **1** **1** **1**	**5**	
Task 2: A. $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ B. discriminant C. complex D. {5,-6}, {-6} {5, 2}, {3,-0.4} E. 255 meters 8 seconds and 12 seconds 20 seconds	**1**	**1** **1** **1** **1** **1**	**5**	

Task 3: A. x = 5 B. Answers will vary. Possible Explanation: "First, I subdivided the irregular shape into two smaller rectangles. Then, I found the area of each rectangle by multiplying the polynomials together and adding their products. Next, I set it equal to 80 and solved. Since there is no negative distance, I used the solution of 5." C. 110 squared meters D. Answers will vary. Possible Explanation: "Removing the trees in the bottom right corner of the property would allow the pen to become a rectangle as stated in the problem. Since opposite sides of a rectangle are congruent, I used segment addition to find the right side to equal (x + 5). The top and bottom would both be (2x + 1). I multiplied these lengths and widths together to find the area of the new pen and got $2x^2 + 11x + 5$. I substituted *5 from Part A* into the problem to get 110 square meters for the new area."	**2**	 **1** **2** **1** **2**	**6**	
Task 4: A. 2.65 meters B. 1.4 seconds C. 1.53 seconds D. 3.45 meters Answers will vary. Possible Explanation: "I went back to Part B where the time was 1.4 seconds. Since that was the total time from leaving her hand to being one meter	**3**	 **1** **1** **1** **2**	**5**	

above the ground on the way back down, I cut it in half and got .7 for half the time. This is the number I substituted back into the equation for the time. Once I worked out the equation, I had to add 1 back into my answer because she served the ball one meter off the ground."				
			TOTAL POINTS:	

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