Thinking About Performance Assessments in Your Classroom

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We would like to test several types of KNOWLEDGE:

- Procedural
- Conceptual
- Application of Knowledge

The majority of traditional tests emphasize and test procedural knowledge.

For most traditional tests students memorize a definition without really understanding it.

We would like to test students REASONING

- Traditional testing is poorly suited to assessing reasoning.
- We would like to test analyzing data, formulating and testing hypotheses, and recognizing patterns, but this is not done well through traditional testing.

We would like to assess students use of COMMUNICATION

- We would like to ask students to communicate through writing and/or speaking.
- But this is difficult through traditional testing.
- Alternative forms assessment lend themselves to students using writing and speaking and then evaluating their performance

We would like to assess their various SKILLS (not just procedural skills)

- Traditional tests do lend themselves to assess various types of skills.
- Alternative forms of assessment provide us the opportunity to view
    - Student's social skills.
    - Students skills of using mathematics outside a textbook environment.
    - Student's writing and communication skills
    - Student's reasoning skills

Performance Assessment Tasks usually provide the students a task to complete.

In completing this task students should explain their thinking and reveal their understanding for complex topics.

Performance Assessment Tasks should model how mathematics can be integrated into "out of the classroom experiences."

Characteristics of Good Alternative Assessments

- Should be ENGAGING
  - Interesting to students
  - Students will want to put forth their best effort
  - Assignment has some intrinsic value

- Should be AUTHENTIC
  - Should related to real life
  - Should model authentic application of knowledge and skills

- Should elicit DESIRED KNOWLEDGE AND SKILLS
  - The task should require the students to use their knowledge and skills properly to complete the task.

- Should enable the ASSESSMENT OF INDIVIDUALS
  - The student should be required to produce a summary of what the data shows and what their interpretation of the data reveals

- Assessments should contain CLEAR DIRECTIONS
  - Should be complete and unambiguous
  - Directions should specifically ask students to do everything on which they will be evaluated

Steps in Creating an Alternative Assessment

- Create a draft of the initial design
- Obtain a colleague review
- Pilot the task with some students or other teachers
- Revise the alternative assessment

Course	Topic
Outcomes	
Brief description of the task (what students must do and what product will result	
Directions to the students	
Criteria to be used to evaluate student responses	

Directions: Throughout the history of the American stock exchanges, stock prices have been quoted in multiples of 1/8 of a dollar or 12.5 cents. This tradition dates back to pre-Revolutionary days when dollar coins could be physically cut into "pieces of eight" to make change. However, foreign stock exchanges price their stock in decimal amounts with pennies being the smallest units in which they trade. American stock exchanges are increasingly under pressure to join foreign markets in decimal pricing.

Answer the following questions, showing the procedures that lead to your answers.

1. Suppose that you bough 10,000 shares of a stock when it was selling at its yearly low of 41 ½ and that it is now worth 85 7/8.
2. In dollars and cents, how much did you profit by this increase?
3. By what percent did your investment increase? (Round to the nearest percent.)
4. Could a stock listed on an American stock exchange sell for $20.78? Explain.
5. Some American exchanges are now allowing for prices to be quoted in multiples of 1/16 of a point. Could a stock listed on such an exchange sell for $20.78? Explain
6. Name 5 amounts that can be expressed in dollars and a whole number of cents that can be used in exchanges that allow for pricing in multiples of 1/8.
7. Write a rule for every dollar and cents amount that represents a selling price on a market which prices in multiples of one eighths. (You may state the rule as an equation or you may express it in words.)
8. Representatives of Congress as well as many financial experts believe that American investors would be better served if our pricing were done as it is in foreign stock markets. Why do you think this is the case? (Keep in mind that the price at which investors can buy stock is more than the price at which they can sell that particular stock to a broker and that difference is calculated in eighths.)

From A Collection of Performance Tasks and Rubrics High School Mathematics by Charlotte Danielson and Elizabeth Marquez

Score	Description
4	This response offers clear and convincing evidence of a deep knowledge of mathematics related to this task
3	This response offers evidence of substantial knowledge of the mathematics related to this task
2	This response offers limited or inconsistent evidence of knowledge of the mathematics related to this task.
1	This response offers little of no evidence of the knowledge of mathematics related to this task

Score	Description
4	Answers to each part are correct with correct procedures and explanations. In addition the answer to 6 is thoughtful. Or An answer may be incorrect due to a minor error. The remainder of the answers are correct with correct procedures and explanations. Answer to question 6 is thoughtful.
3	Answers are correct with correct procedures and explanations but answer to 6 is weak or missing. Or The answer is incorrect due to a major error in procedures or a missing procedure. The answer to 6 may be weak.
Score	**Description**
2	Answers are correct. However, procedures and explanations are missing for most but not all of the task. Answer to 6 is thoughtful. Or Answers to two or three parts of the task are incorrect but procedures or explanations are shown for the parts that were answered correctly. The answer to 6 may be weak.
1	Answers are incorrect or missing for more than 3 parts of the task.

Performance Assessment Questions on Quadratics

1. Solve the given equation using

   a. A graph.
   b. A table.
   c. A symbolic method

Possible Equations: $4=-2(x-3)^2+4$

$-12=-2.5(x-3)^2-2$

$-36.5=-2(x-1.5)^2+4$

2. Create a graph of $h(t)=-4.9t^2+29.4t$ in an appropriate window. The variable t represents time in seconds, and h(t) represents the height in meters of a projectile.

   a. Create a sketch of your graph and describe the window used.
   b. What is a real-world meaning for the x-intercepts in the graph?
   c. Find the x-intercepts to the nearest 0.01 second.
   d. Use your answer to part c to find the vertex of this parabola.
   e. Describe the real-world meaning for the vertex in the graph.
   f. Explain the meaning of h(2.3).
   g. Describe when the projectile is 11.5 m high. Explain how to find these solutions on a graph.

3. Let $(x+4)^2=8$.

   a. Solve the equation symbolically and show that your answer is a solution to the equation.
   b. Graph $y=(x+4)^2$ and y = 8. Describe the relationship between your solution to part a and these graphs.

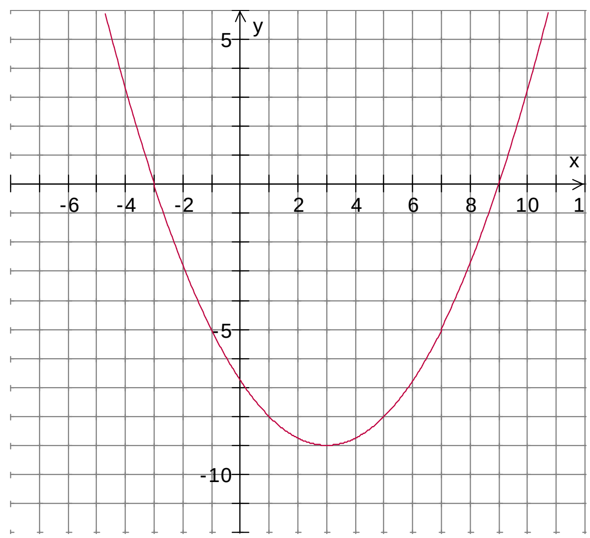
4. The height of a golf ball is given by $h(t)=-16t^2+48t$, where t is in seconds and h is in feet.

   a. Describe the times the golf ball on the ground and how your found the times.
   b. Describe the time and height when the golf ball at its highest point. Show work that leads to your answer.
   c. Describe the domain and range values that make sense in this situation.
   d. If another golf ball had a height that was given by $h=-16t^2+64t$, how would its behavior change from the first golf ball?

5. Juan hits a baseball, and its height in the air at time x is given by the equation $y=-16x^2+55x+3$, where x is in seconds and y is in feet.

a. Create a graph for the 4 seconds after the ball is hit. Make a sketch of your window. Use the graph and tables to help you answer these questions. Give explanations for your answer.
b. Find the initial height of the ball when it is hit by Juan. Label this point on your graph.
c. When does the ball hit the ground? Use your calculator table to find the answer to two decimal places. Label this point on your sketch.
d. Use the graph and table to determine the time, to one decimal place, that the ball the ball at its highest points. Give the time and the height. Label this point on your graph.

6. Consider the parabola illustrated at the right.



a. Determine the coordinates for the vertex.
b. Write the equation for the parabola in factored form. Explain how this equation relates to the graph of the parabola.
c. Write the equation for the parabola in vertex form. Explain how this equation relates to the graph of the parabola.
d. Write the equation of the parabola in general form.
e. Select 6 integral values for x. Create a table for these x-values for each equations from part b, c, and d. What does your table illustrate?

7. A professional football team uses computers to describe the projectile motion of a football when punted. After compiling data from several games, the computer models the height of an average punt with the equation $h(t)=-\frac{16}{3}(t-2.2)^2+26.9$, where t is the time in seconds and h(t) is the height in yards. The punter's foot makes contact with the ball when t = 0. Use the graph, table, or equation to answer each question below. Show or explain your reason for each question.

a. When does the punt reach its highest point? How high does the football go?
b. Find the zeros of the height function h(t). Which solution is the hang time—that is, the time it takes until the ball hits the ground?
c. How high is the ball when the punter kicks it?
d. Graph the equation. Label the vertex, y-intercepts, and the x-intercepts. Then describe the real-world meanings of the vertex, the y-intercept, and the x-intercepts.

e. Name the form that the height function was given. Find one additional form for the height function and explain what you can read from this form.

8. The rate at which a bear population **grows** in a park is given by the equation $P(b) = \frac{1}{1000} b(100-b)$. The function value P(b) represents the rate at which the population is growing in bears per year, and b represents the number of bears.

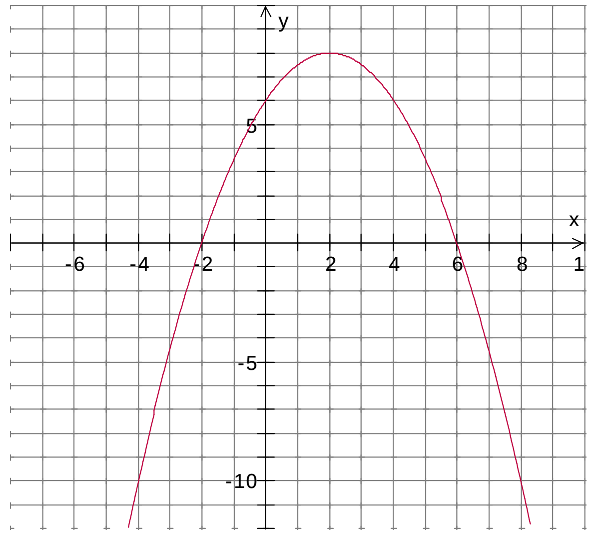
a. Find P(20) and describe the real-world meaning for this value.
b. Find the zero of P(b) and describe the real-world meanings for these solutions.
c. For what size bear population would the population grow fastest? Explain your reasoning.
d. What is the maximum number of bears the park can support?
e. Evaluate P(110). Explain the meaning of this value.

9. A shopkeeper is redesigning the rectangular sign on her store's rooftop. She wants the largest area possible for the sign. When she considers adding an amount to the width, she subtracts that same amount from the length. Her original sign has width 3 m and length 8 m.

Increase (x) (m)	**Length (m)**	**Width (m)**	**Area (m^2)**	**Perimeter (m)**
0	3	8		
.5				
1.0				
1.5				
2.0				
2.5				
3				

a. Complete the table.
b. How do the changes in width and length affect the perimeter?
c. How do the changes in width and length affect the area?
d. Write an equation in factored form for the area A(x) of the rectangle in terms of x, the amount she adds to the width.
e. Explain the meaning of the zeros for the equation you wrote in part d.
f. What are the dimensions of the rectangle with the largest area? Explain how you determined these dimensions.
g. Rewrite the area A(x) in vertex form.
g. Rewrite the equation for A(x) from part d in general form. Explain the meaning of A(0).

10. Demonstrate, using the graph at the right, that you can write the equation of the parabola in three forms: factored form, vertex form, and general form. Explain how various points from the parabola corresponding values in each equation. Use the calculator to demonstrate that all three forms are equivalent.



Performance Assessment Problems

Constructive Assessment Question 1

Write a quadratic equation for each set of conditions. You may write the equations in any form you wish.

a. The graph of the equation is in Quadrants III and IV only, and has its vertex on the y-axis.

b. The equation has only one real root, and its graph crosses the y-axis at (0, 4).

c. The graph of the equation opens downward, is in all four quadrants, and has its vertex in Quadrant II.

Scoring Rubric for Performance Assessment Question 1

5 Points

All equations meet the given conditions.

a. Sample answer: $y=2x^2 - 3$ (or any equation $y = ax^2 + c$, where $a>0$ and $c<0$)

b. Sample answer: $y = 4(x - 1)(x - 1)$ (or any equation $y = a(x - r)(x - r)$, where $ar^2=4$)

c. Sample answer: $y = 0.25(x + 3)^2 + 4$ (or any equation $y = a(x + h)^2 + k$, where $a < 0$, $h>0$, and $k>0$)

3 Points

Two of the equations meet the given conditions. Or, one equation meets all the conditions, and each of the other equations meets all but one condition.

1 Point

Two of the equations partially meet the conditions.

Performance Assessment Question 2.

You have worked with three different forms of quadratic equations: factored form, vertex form, and general form. Describe the three forms and explain what each tells you about the graph of the equation. You may use examples and graphs in your explanation.

Scoring Rubric for Performance Assessment Question 2

5 Points

The answer correctly describes each form and explains how each form is related to the graph. A correct answer will include the points listed here.

(Note: Students may use specific examples rather than the general equations shown.)

- The factored form is $y=a(x-r_1)(x-r_2)$. From this form you can find the x-intercepts, r_1 and r_2.
- The vertex form is $y=a(x-h)^2+k$. From this form you can find the vertex, (h, k).
- The general form is $y=ax^2+bx+c$. From this form you can find the y-intercept, c.

- In all three forms the value of a tells whether the graph opens upward or downward. If $a>0$, the parabola opens upward. If $a<0$, the parabola opens downward.
- In all three forms the value of a tells whether the graph is a vertical stretch or a vertical shrink of the graph of $y=x^2$. If $|a|>1$, it is a stretch. If $|a|<1$, it is a shrink.

3 Points

One of the major points listed is missing, and there are one or two other minor errors.

1 Point

Only one or two of the points listed are made.

Performance Assessment Question 3.

To raise money for their trips, members of the ski club sell hot dogs at after-school sporting events. Currently they charge $2.00 per hot dog and sell about 40 hot dogs per event. They would like to increase their income. The club treasurer estimates that they will sell five more hot dogs for every 10¢ they lower the price and five fewer hot dogs for every 10¢ they raise the price.

a. Use the given information to complete the table at right.
b. Make a scatter plot with Number of 10¢ increases on the x-axis and Income on the y-axis.
c. Find an equation that fits the data in your scatter plot. (Hint: Start by writing expressions for the Price per hot dog and the Number of hot dogs sold in terms of the Number of 10¢ increases.)
d. How much should the ski club charge per hot dog in order to maximize its income? Explain how you found your answer.

Number of 10¢ increases	Price per hot dog	Number of hot dogs sold	Income
−15	$0.50		
−10			
−5			
0	$2.00	40	$80.00
2			
4			
6			

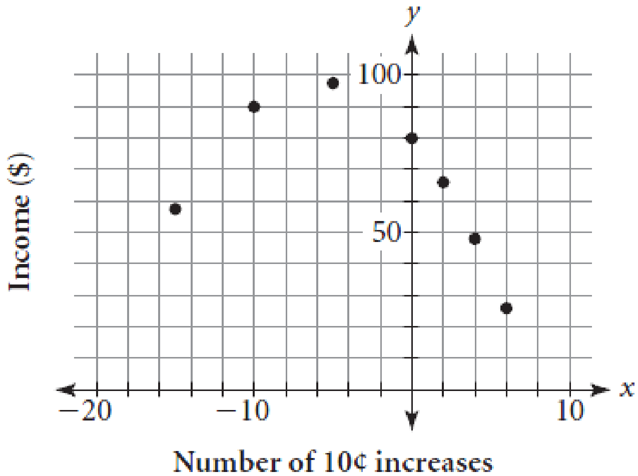
Scoring Rubric for Performance Assessment Question 3.

5 Points

a. The table is complete and correct.

Number of 10¢ increases	Price per hot dog	Number of hot dogs sold	Income
−15	$0.50	115	$57.50
−10	$1.00	90	$90.00
−5	$1.50	65	$97.50
0	$2.00	40	$80.00
2	$2.20	30	$66.00
4	$2.40	20	$48.00
6	$2.60	10	$26.00

b. The scatter plot is complete and correct.



c. y=(2 +0.1x)(40 -5x), where x is the number of 10¢ increases and y is the income

d. The ski club should charge $1.40. I found this by tracing the graph to find the maximum point, which is (6, 98). This means that six 10¢ decreases would give a maximum income of $98.
After six 10¢ decreases, the price of a hot dog would be $1.40.

3 Points

The table and the scatter plot are correct. Parts c and d are attempted and some of the work is correct, but the answers are incorrect.

1 Point

All answers are attempted and some of the work is correct, but no answer is completely correct.

Performance Assessment Question 4.

The height, y, of a ball x seconds after it is dropped from a height of 100 m can be modeled by the equation $y = -4.9x^2 + 100$. Write and answer three questions about this situation. Show all your work.

Scoring Rubric for Performance Assessment Question 4.

5 Points

Questions are clear, answers are correct, and all work is shown.

Possible answers:

Q1: From what height is the ball dropped?
A1: Substituting x=0 gives the height of the ball before it is released:
$y = 4.9(0)^2 + 100 = 100$ so it is dropped from 100 m.

Q2: What is the height of the ball after 3 s?
A2: $y = -4.9(3)^2 + 100 = 55.9$, so the height of the ball is 55.9 m after 3 s.

Q3: When does the ball hit the ground?
A3: Solve $-4.9x^2 + 100 = 0$.

$$-4.9x^2 + 100 = 0$$

$$-4.9x^2 = -100$$

$$x^2 = 20.41$$

$$x = \pm\ 4.52$$

The solutions are -4.52 and +4.52; because a negative value does not make sense in this situation, the ball hits the ground after about 4.52 s.

3 Points

Three questions are given with correct answers, but no work is shown. Or, three questions are given and work is shown, but the answers are incorrect.

1 Point

Three questions are given, but no answers are given and no work is shown. Or, only one or two questions and answers are given, and no work is shown.

Performance Assessment Question 5.

a. Graph the equations $y = x^2 - 8x + 11$ and $y = 2x + 2$ on the same coordinate axes. How many points of intersection do the graphs have?

b. Algebraically solve the system $y = x^2 - 8x + 11$ and $y = 2x + 2$. Use the quadratic formula in your solution. At what step in your solution can you tell how many times the two graphs will intersect? Explain your thinking.

c. Find the equation of a line parallel to $y = 2x + 2$ that does not intersect the parabola. Algebraically solve the system $y = x^2 - 8x + 11$ and this new linear equation. Use the quadratic formula in your solution. At what step in your solution can you tell that the line and parabola do not intersect? Explain your thinking.

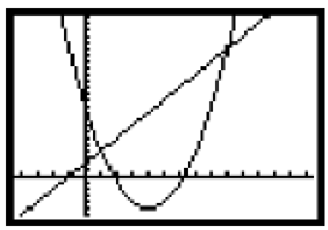
d. Use your work from parts b and c to write the equation of a line parallel to $y = 2x + 2$ that intersects the parabola $y = x^2 - 8x + 11$ in exactly one point. Explain your method.

Scoring Rubric for Performance Assessment Question 5.

5 Points

Work and explanations for all parts are clear and correct. Possible answers:

a. They intersect in two points.



$[-4.4, 14.4, 1, -6, 25, 1]$

b.

$$x^2 - 8x + 11 = 2x + 2$$

$$x^2 - 10x + 9 = 0$$

$$x = \frac{10 \pm \sqrt{64}}{2} = \frac{10 \pm 8}{2} = 9 \text{ or } 1$$

$y = 2(9) + 2 = 20$; one intersection point is (9, 20). $y = 2(1) + 2 = 4$; the other intersection point is (1, 4). The discriminant, $b^2 - 4ac$, shows the number of solutions, so you can tell the number of solutions (but not the values of the solutions) by checking whether the discriminant is positive, zero, or negative. Because the discriminant is positive, there are two square roots, leading to two values of x. Each value of x is the x-coordinate of a point of intersection.

c. Answers will vary.

A possible answer is: y=2x-20 is parallel to y=2x+2 and does not intersect the parabola.

$$x^2 - 8x + 11 = 2x - 20$$
$$x^2 - 10x + 31 = 0$$
$$b^2 - 4ac = \ \ 24$$
$$x = \frac{10 \pm \sqrt{-24}}{2}; \text{ No Real Solutions}$$

The system has no real solutions, which means the graphs do not intersect. This can be seen when finding the discriminant, which is negative.
Because there are no real numbers having negative square roots, there are no real solutions for x.

d. y=2x -14 is parallel to y=2x+ 2 and intersects the parabola in exactly one point. Solutions will vary.

Possible solution: The discriminant should equal 0 to give only one real solution, because there is exactly one square root of 0. Because the line is parallel to y=2x+ 2, its equation will have the form y=2x+d.

$$x^2 - 8x + 11 = 2x + d$$
$$x^2 - 10x + 11 - d = 0$$
$$b^2 - 4ac = \ \ 100 - 4(1)(11 - d)$$
$$100 - 4(1)(11 - d) = 0$$
$$-4(1)(11 - d) = -100$$
$$(11 - d) = 25$$
$$d = -14$$

The equation of the line parallel to y=2x+2 that intersects the parabola $y = x^2 - 8x + 11$ exactly once is y=2x-14.

3 Points

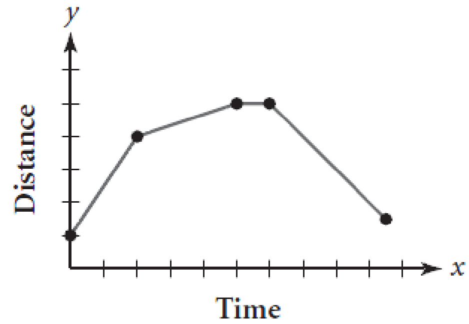
Part a is correct. Two of the parts b, c, or d are done correctly. Or, part a is done correctly and the equations and solutions are found for b, c, and d, but no explanation is given.

1 Point

Part a is correct. One of the parts b, c, or d is done correctly.

Performance Assessment Question 6.

You can think of this graph as a time-distance graph. Choose a scale and unit for each axis, and then write a story that fits the graph. Your story should include specific times, rates, and distances.



Scoring Rubric for Performance Assessment Question 6.

5 Points

The units and scales are clearly defined. The story mentions specific times, rates, and distances, and accounts for each segment of the graph.

Possible answer: The x-axis represents time in hours, with each tick mark representing 1 h. The y-axis represents distance in miles, with each tick mark representing 10 mi. Maya is training for a cross-country bike trip.
She plans to ride to a park 50 mi from her house and then ride home. She begins her ride at a friend's house 10 mi from her home. For the first 2 h of her trip, she rides at 15 mi/h. After 2 h, when she is 40 mi from her home, she gets very tired and slows her pace to about 3.3 mi/h for the next 3 h. She reaches the park at the 5 h mark and stops for 1 h to rest and eat
lunch. Then she starts riding toward home at a speed of 10 mi/h. After 3.5 h at this pace, she decides she is too tired to bike all the way home, so she stops at her aunt's apartment, which is 15 mi from her home.

3 Points

The units and scales are clearly defined. The story accounts for each segment of the graph, but one or two numbers are incorrect.

1 Point

The units and scales are clearly defined. The story accounts for each segment of the graph but uses few specific numbers or uses incorrect numbers.

Sample story: A runner starts out going very fast and then slows down. The runner rests for a while and then runs back to where he started.

Performance Question 7.

Consider the line that passes through the points (-3, 7) and (15,-2). Tell whether each statement is true or false and explain how you know.

a. An equation for the line is $y=7-2(x+3)$.
b. An equation for the line is $y=3- 0.5(x-5)$.
c. The line does not pass through Quadrant I.
d. The y-intercept is 11, and the x-intercept is 5.5.

Scoring Rubric for Performance Assessment Questions 7.

5 Points

Answers are correct. Explanations are thorough and demonstrate an understanding of important concepts.

a. False.

Possible explanation: The line with equation y=7-2(x+3) has a slope of 2.

The line through (-3, 7) and (15,-2) has a slope of $\frac{(7-{}^{-}2)}{(-3-15)}=\frac{9}{-18}=-\frac{1}{2}$

b. True.

Possible explanation: The equation for the line though (-3, 7) and (15,-2) is y=7-0.5(x + 3). If you rewrite this in intercept form, you get y=5.5-0.5x. This is the same equation you get when you write y=3-0.5(x-5) in intercept form, so the two original equations represent the same line.

c. False.

Possible explanation: The line has a positive y-intercept and a negative slope (its equation is y= 5.5 - 0.5x), so it passes through every quadrant but Quadrant III.

d. False.

Possible explanation: I found that the equation is y=5.5 -0.5x, so the y-intercept is 5.5, not 11. (And the x-intercept is 11, not 5.5.)

3 Points

At least three answers are correct. Explanations are well written, but a few minor details are missing or incorrect.

1 Point

Answers are correct, but no explanations are given. Or only one answer is correct, but it has a good, clear explanation.

Performance Assessment Question 8.

A door is on one wall of a classroom, and a set of windows is on the opposite wall. Sketch a graph to represent each situation, with the x-axis representing time and the y-axis representing distance from the door. You do not need to show specific scale values. Label each line with the student's name.

a. Emily starts at the windows walking toward the door, and Alison starts at the door walking toward the windows. Each girl walks at a steady pace toward the opposite wall.

b. Emily starts at the windows. Alison starts a few feet in front of the windows. Each girl walks toward the door at a steady pace. Emily gets to the door first.

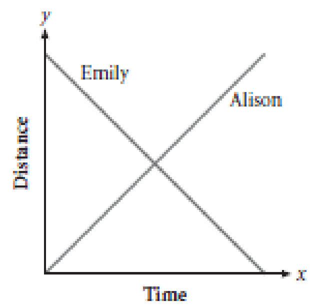
c. Alison starts at the door. Emily starts a few feet in front of the door. Each girl walks toward the windows at a steady pace. Alison gets to the windows first.

d. Emily starts at the windows. Alison starts a few feet in front of the windows. Both girls walk at a steady pace toward the door, keeping the same distance between them the whole way.

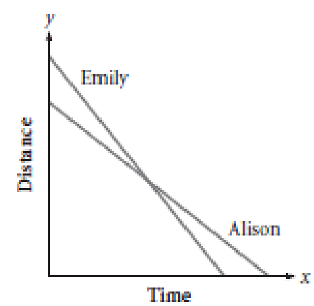
Scoring Rubric for Performance Assessment Question 8.

5 Points

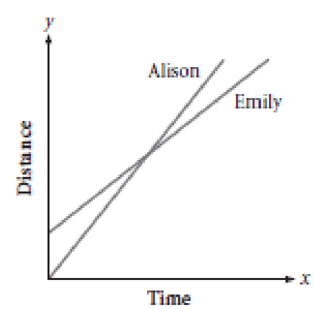
a. Lines have the same relative positions as those shown here.



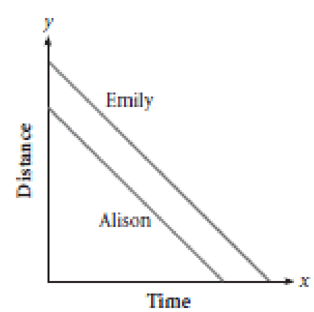
b. Lines have the same relative positions as those shown here.



c. Lines have the same relative positions as those shown here.



d. Lines have the same relative positions as those shown here.



3 Points

Three graphs are correct.

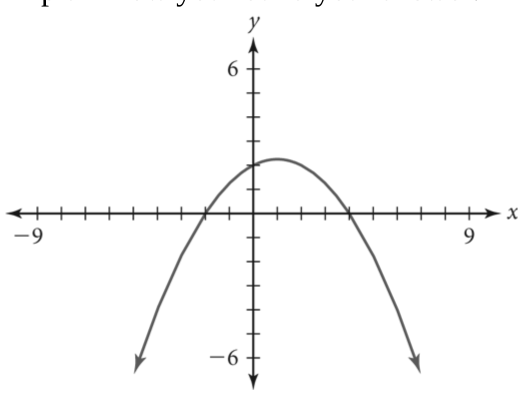
1 Point

One graph is correct.

1. Solve the equation $(x-1)^2-3=13$ symbolically.

2. Use a graph and table to approximate solutions to the equation $-x^2+2x+6=2$ to the nearest hundredth.

3. This parabola has the equation $y=-0.25x^2+0.5x+2$. Find the coordinates of its vertex. Explain how you found your answer.



4. A ball is dropped from the top of a tall building. The ball's height, in meters, t seconds after it is dropped is $h(t)=-4.9t^2+30$.

   a. Find $h(1)$ and give a real-world meaning for this value.

   b. Use a graph to find out when the ball is 10 meters above the ground. Give your answer to the nearest hundredth of a second.
   c. How tall is the building? How do you know?
   d. When does the ball hit the ground? Give your answer to the nearest hundredth of a second.

5. Give an example of each number described in parts a-c.
   a. an integer that is not a whole number
   b. a rational number that is also an integer
   c. a real number that is not rational
   d. What is the name for the type of number in part c?

Answer each question and show all work clearly on a separate piece of paper.

1. A tennis ball is dropped from the top of a tall building. The ball's height, in meters, t seconds after it is released is $h(t) = -4.9t^2 + 200$.

   a. Find $h(3)$ and give a real-world meaning for this value.

   b. When is the ball 30 meters above the ground? Give your answer to the nearest hundredth of a second.

   c. When does the ball hit the ground? Give your answer to the nearest hundredth of a second.

2. Tell whether each statement is true or false. If the statement is false, change the right side to make it true. Give the corrected right side in the same form as the original. For example, if the right side is given in factored form, write the corrected version in factored form.

   a. $x^2 + 5x - 24 = (x+3)(x-8)$

   b. $2(x-1)^2 + 3 = 2x^2 - 4x + 5$

   c. $(x+3)^2 = x^2 + 9$

   d. $(x+2)(x-5) = x^2 - 10$

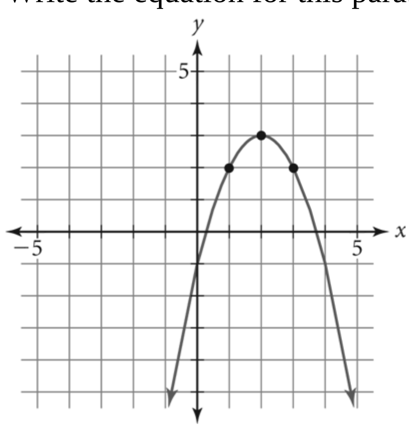
3. Consider the equation $y = (x-6)(x+2)$.

   a. Find the x-intercepts and the vertex of the graph of the equation.

   b. Write the equation in vertex form.

   c. Write the equation in general form.

4. Write the equation for this parabola in vertex form.



Answer each question and show all work clearly on a separate piece of paper.

5. Solve each equation by using the quadratic formula.
   a. $2x^2 - 7x + 5 = 0$
   b. $x^2 - 3x + 4 = 0$

6. Solve the equation $2x^3 - 8x = 0$ by factoring.

7. Solve the equation $x^2 - 4x - 1 = 0$ by completing the square. Leave your answer in radical form.

8. Is it possible for two different quadratic functions to have the same roots? Explain.