

Analysis in Science – Sample Math Test Questions

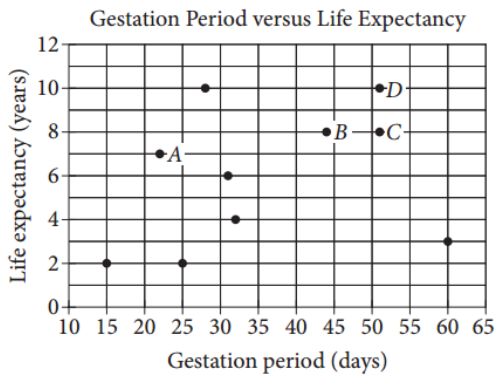
Heart of Algebra – No Calculator  
Student Produced Response Question

1.

The mesosphere is the layer of Earth’s atmosphere between 50 kilometers and 85 kilometers above Earth’s surface. At a distance of 50 kilometers from Earth’s surface, the temperature in the mesosphere is  $-5^{\circ}$  Celsius, and at a distance of 80 kilometers from Earth’s surface, the temperature in the mesosphere is  $-80^{\circ}$  Celsius. For every additional 10 kilometers from Earth’s surface, the temperature in the mesosphere decreases by  $k^{\circ}$  Celsius, where  $k$  is a constant. What is the value of  $k$ ?

Problem Solving and Data Analysis – Calculator

Use the following graph for questions 2 and 3.



A curator at a wildlife society created the scatterplot above to examine the relationship between the gestation period and life expectancy of 10 species of animals.

2.

What is the life expectancy, in years, of the animal that has the longest gestation period?

- A) 3
- B) 4
- C) 8
- D) 10

3.

Of the labeled points, which represents the animal for which the ratio of life expectancy to gestation period is greatest?

- A) A
- B) B
- C) C
- D) D

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4.

Katarina is a botanist studying the production of pears by two types of pear trees. She noticed that Type A trees produced 20 percent more pears than Type B trees did. Based on Katarina's observation, if the Type A trees produced 144 pears, how many pears did the Type B trees produce?

- A) 115
- B) 120
- C) 124
- D) 173

Passport to Advanced Math - No Calculator

5.

$$h = -4.9t^2 + 25t$$

The equation above expresses the approximate height  $h$ , in meters, of a ball  $t$  seconds after it is launched vertically upward from the ground with an initial velocity of 25 meters per second. After approximately how many seconds will the ball hit the ground?

- A) 3.5
- B) 4.0
- C) 4.5
- D) 5.0

## Analysis in Science – Sample Math Test Answer Explanations

- The correct answer is 25. In the mesosphere, an increase of 10 kilometers in the distance above Earth results in a decrease in the temperature by  $k^\circ$  Celsius where  $k$  is a constant. Thus, the temperature in the mesosphere is linearly dependent on the distance above Earth. Using the values provided and the slope formula, one can calculate the unit rate of change for the temperature in the mesosphere to be  $\frac{-80-(-5)}{80-50} = \frac{-75}{30} = \frac{-2.5}{1}$ . The slope indicates that, within the mesosphere, if the distance above Earth increases by 1 kilometer, the temperature decreases by  $2.5^\circ$  Celsius. Therefore, if the distance above Earth increases by  $(1 \times 10) = 10$  kilometers, the temperature will decrease by  $(2.5 \times 10) = 25^\circ$  Celsius. Thus, the value of  $k$  is 25. (Difficulty: Hard)
- Choice A is correct. According to the graph, the animal with the longest gestation period (60 days) has a life expectancy of 3 years. Choices B, C, and D are incorrect. All the animals that have a life expectancy of 4, 8, or 10 years have a gestation period that is shorter than 60 days, which is the longest gestation period. (Difficulty: Easy)
- Choice A is correct. The ratio of life expectancy to gestation period for the animal represented by point A is approximately  $\frac{7 \text{ years}}{23 \text{ days}}$ , or about 0.3 years/day, which is greater than the ratio for the animals represented by the other labeled points (the ratios for points B, C, and D, in units of years of life expectancy per day of gestation, are approximately  $\frac{8}{44}$ ,  $\frac{8}{51}$ , and  $\frac{10}{51}$  respectively, each of which is less than 0.2 years/day). Choices B, C, and D are incorrect and may be the result of errors in calculating the ratio or in reading the graph. (Difficulty: Hard)
- Choice B is correct. Let  $x$  represent the number of pears produced by the Type B trees. Then the Type A trees produce 20 percent more pears than  $x$ , which is  $x + 0.20x = 1.20x$  pears. Since Type A trees produce 144 pears, the equation  $1.20x = 144$  holds. Thus  $x = \frac{144}{1.20} = 120$ . Therefore, the Type B trees produced 120 pears. Choice A is incorrect because while 144 is reduced by approximately 20 percent, increasing 115 by 20 percent gives 138, not 144. Choice C is incorrect; it results from subtracting 20 from the number of pears produced by the Type A trees. Choice D is incorrect; it results from adding 20 percent of the number of pears produced by Type A trees to the number of pears produced by Type A trees. (Difficulty: Hard)
- Choice D is correct. When the ball hits the ground, its height is 0 meters. Substituting 0 for  $h$  in  $h = -4.9t^2 + 25t$  gives  $0 = -4.9t^2 + 25t$ , which can be rewritten as  $0 = t(-4.9t + 25)$ . Thus, the possible values of  $t$  are  $t = 0$  and  $t = \frac{25}{4.9} \approx 5.1$ . The time  $t = 0$  seconds corresponds to the time the ball is launched from the ground, and the time  $t \approx 5.1$  seconds corresponds to the time after launch that the ball hits the ground. Of the given choices, 5.0 seconds is closest to 5.1 seconds, so the ball returns to the ground approximately 5.0 seconds after it is launched. Choice A, B, and C are incorrect and could arise from conceptual or computation errors while solving  $0 = -4.9t^2 + 25t$  for  $t$ . (Difficulty: Hard)