MATH TEST

25 Minutes—20 Questions

NO-CALCULATOR SECTION

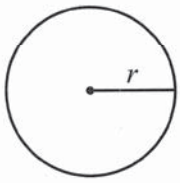
Turn to Section 3 of your answer sheet to answer the questions in this section.

Directions: For this section, solve each problem and decide which is the best of the choices given. Fill in the corresponding oval on the answer sheet. You may use any available space for scratch work.

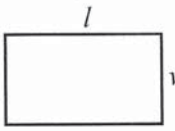
Notes:

1. Calculator use is NOT permitted.
2. All numbers used are real numbers.
3. All figures used are necessary to solving the problems that they accompany. All figures are drawn to scale EXCEPT when it is stated that a specific figure is not drawn to scale.
4. Unless stated otherwise, the domain of any function f is assumed to be the set of all real numbers x, for which $f(x)$ is a real number.

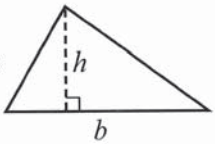
Information:



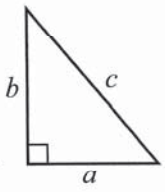
$A = \pi r^2$
$C = 2\pi r$



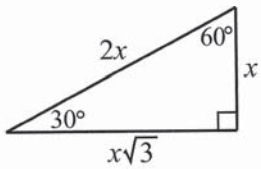
$A = lw$

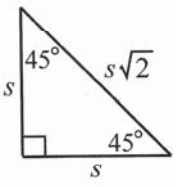


$A = \frac{1}{2}bh$

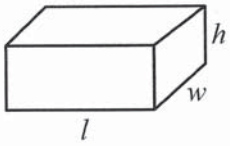


$c^2 = a^2 + b^2$

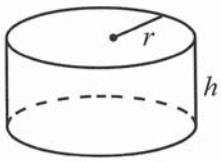




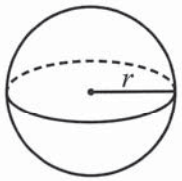
Special Right Triangles



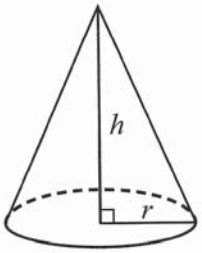
$V = lwh$



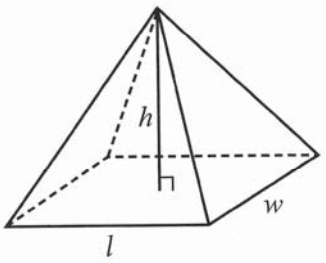
$V = \pi r^2 h$



$V = \frac{4}{3}\pi r^3$



$V = \frac{1}{3}\pi r^2 h$



$V = \frac{1}{3}lwh$

The sum of the degree measures of the angles in a triangle is 180.

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π.

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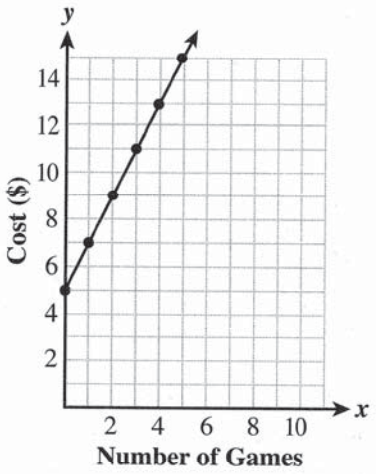


1. The graph above shows the amount that a new, high-tech video arcade charges its customers. What could the y-intercept of this graph represent?

   A) The cost of playing 5 games

   B) The cost per game, which is $5

   C) The entrance fee to enter the arcade

   D) The number of games that are played

$$\frac{3x}{x+5} \div \frac{6}{4x+20}$$

2. Which of the following is equivalent to the expression above, given that $x \neq -5$?

   A) $2x$

   B) $\frac{x}{2}$

   C) $\frac{9x}{2}$

   D) $2x + 4$

$$(x+3)^2 + (y+1)^2 = 25$$

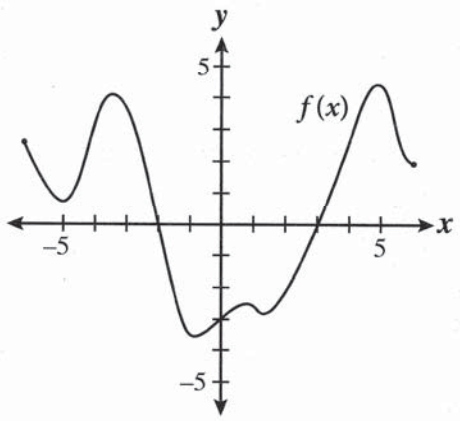
3. The graph of the equation above is a circle. What is the area, in square units, of the circle?

   A) 4π

   B) 5π

   C) 16π

   D) 25π



4. The figure above shows the graph of $f(x)$. For which value(s) of x does $f(x)$ equal 0?

   A) 3 only

   B) -3 only

   C) -2 and 3

   D) -3, -2, and 3

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$$\frac{4(d+3)-9}{8} = \frac{10-(2-d)}{6}$$

5. In the equation above, what is the value of d?

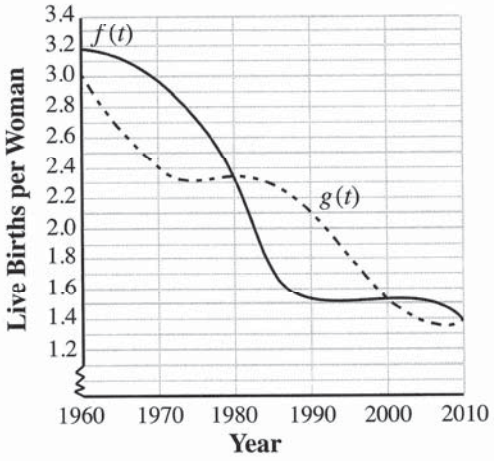
A) $\frac{23}{16}$

B) $\frac{23}{8}$

C) $\frac{25}{8}$

D) $\frac{25}{4}$

Total Fertility Rate, 1960-2010



Source: Data from Eurostat.

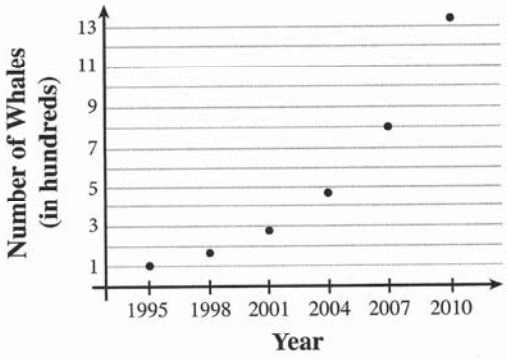
6. One indicator of a declining economy is a continued decline in birth rates. In 2010, birth rates in Europe were at an all-time low, with the average number of children that a woman has in her lifetime at well below two. In the figure above, $f(t)$ represents birth rates for Portugal between 1960 and 2010, and $g(t)$ represents birth rates in Slovakia for the same time period. For which value(s) of t is $f(t) > g(t)$?

A) $1960 < t < 1980$ only

B) $1980 < t < 2000$ only

C) $1960 < t < 1980$ and $1990 < t < 2000$

D) $1960 < t < 1980$ and $2000 < t < 2010$



7. The blue whale is the largest creature in the world and has been found in every ocean in the world. A marine biologist surveyed the blue whale population in Monterey Bay, off the coast of California, every three years between 1995 and 2010. The figure above shows her results. If w is the number of blue whales present in Monterey Bay and t is the number of years since the study began in 1995, which of the following equations best represents the blue whale population of Monterey Bay?

A) $w = 100 + 2t$

B) $w = 100 + \frac{t^2}{4}$

C) $w = 100 \times 2^t$

D) $w = 100 \times 2^{\frac{t}{4}}$

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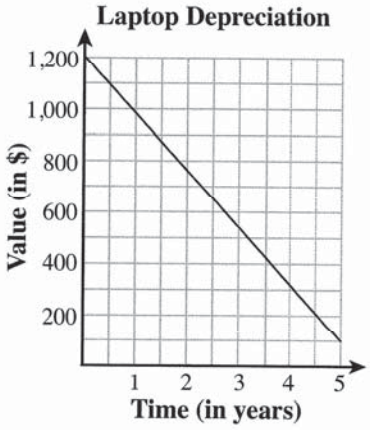
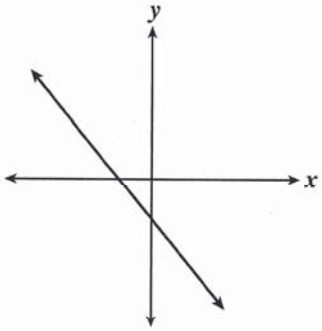


8. The figure above shows the straight-line depreciation of a laptop computer over the first five years of its use. According to the figure, what is the average rate of change in dollars per year of the value of the computer over the five-year period?

A) −1,100
B) −220
C) −100
D) 100

9. What is the coefficient of x^2 when $6x^2 - \frac{2}{5}x + 1$ is multiplied by $10x + \frac{1}{3}$?

A) −4
B) −2
C) 2
D) 4



10. The graph above could represent which of the following equations?

A) $-6x - 4y = 5$
B) $-6x - 4y = -5$
C) $-6x + 4y = 5$
D) $-6x + 4y = -5$

$$\begin{cases} \frac{3}{4}x - \frac{1}{2}y = 12 \\ kx - 2y = 22 \end{cases}$$

11. If the system of linear equations above has no solution, and k is a constant, what is the value of k?

A) $-\frac{4}{3}$
B) $-\frac{3}{4}$
C) 3
D) 4

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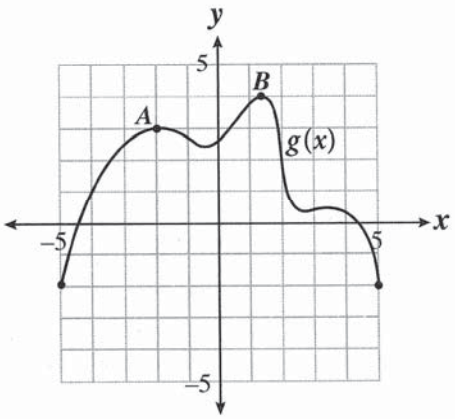
12. In Delray Beach, Florida, you can take a luxury golf cart ride around downtown. The driver charges \$4 for the first $\frac{1}{4}$ mile, plus \$1.50 for each additional $\frac{1}{2}$ mile. Which inequality represents the number of miles, m, that you could ride and pay no more than \$10 ?

A) $3.25 + 1.5m \leq 10$

B) $3.25 + 3m \leq 10$

C) $4 + 1.5m \leq 10$

D) $4 + 3m \leq 10$



13. The graph of $g(x)$ is shown in the figure above. If $h(x) = -g(x) + 1$, which of the following statements is true?

A) The range of $h(x)$ is $-3 \leq y \leq 3$.

B) The minimum value of $h(x)$ is -4.

C) The coordinates of point A on the function $h(x)$ are (2, 4).

D) The graph of $h(x)$ is increasing between $x = -5$ and $x = -2$.

14. If $a + bi$ represents the complex number that results from multiplying $3 + 2i$ times $5 - i$, what is the value of a ?

A) 2

B) 13

C) 15

D) 17

$$\frac{1}{x} + \frac{4}{x} = \frac{1}{72}$$

15. In order to create safe drinking water, cities and towns use water treatment facilities to remove contaminants from surface water and groundwater. Suppose a town has a treatment plant but decides to build a second, more efficient facility. The new treatment plant can filter the water in the reservoir four times as quickly as the older facility. Working together, the two facilities can filter all the water in the reservoir in 72 hours. The equation above represents the scenario. Which of the following describes what the term $\frac{1}{x}$ represents?

A) The portion of the water the older treatment plant can filter in 1 hour

B) The time it takes the older treatment plant to filter the water in the reservoir

C) The time it takes the older treatment plant to filter $\frac{1}{72}$ of the water in the reservoir

D) The portion of the water the new treatment plant can filter in 4 hours

GO ON TO THE NEXT PAGE

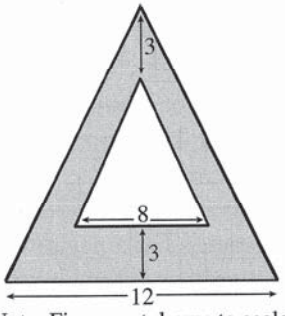
16. If $\frac{1}{4}x = 5 - \frac{1}{2}y$, what is the value of $x + 2y$?

$$\begin{cases} x + 3y \leq 18 \\ 2x - 3y \leq 9 \end{cases}$$

17. If (a, b) is a point in the solution region for the system of inequalities shown above and $a = 6$, what is the minimum possible value for b?

$$\frac{\sqrt{x} \cdot x^{\frac{5}{6}} \cdot x}{\sqrt[3]{x}}$$

18. If x^n is the simplified form of the expression above, what is the value of n?



Note: Figure not drawn to scale.

19. In the figure above, the area of the shaded region is 52 square units. What is the height of the larger triangle?

20. If $y = ax^2 + bx + c$ passes through the points $(-3, 10)$, $(0, 1)$, and $(2, 15)$, what is the value of $a + b + c$?

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST. STOP

MATH TEST

55 Minutes—38 Questions

CALCULATOR SECTION

Turn to Section 4 of your answer sheet to answer the questions in this section.

Directions: For this section, solve each problem and decide which is the best of the choices given. Fill in the corresponding oval on the answer sheet. You may use any available space for scratch work.

Notes:

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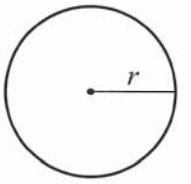
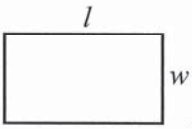
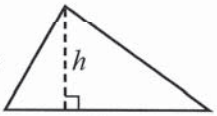


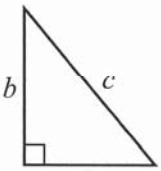
$A = \pi r^2$
$C = 2\pi r$



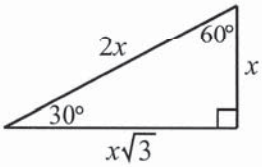
$A = lw$

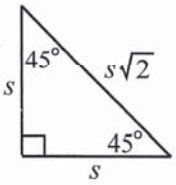


$A = \frac{1}{2}bh$

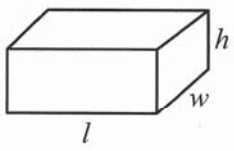


$c^2 = a^2 + b^2$

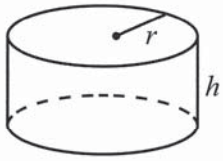




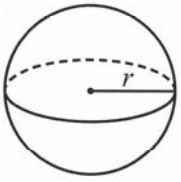
Special Right Triangles



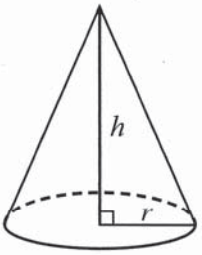
$V = lwh$



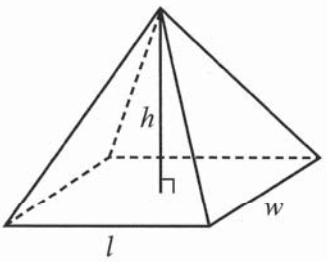
$V = \pi r^2 h$



$V = \frac{4}{3}\pi r^3$



$V = \frac{1}{3}\pi r^2 h$



$V = \frac{1}{3}lwh$

The sum of the degree measures of the angles in a triangle is 180.

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π.

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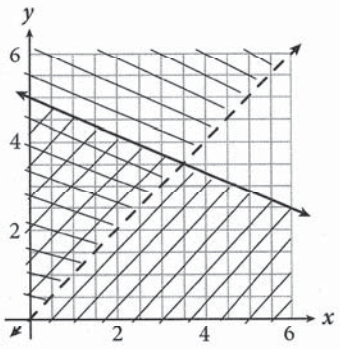
1. Oceans, seas, and bays represent about 96.5% of Earth's water, including the water found in our atmosphere. If the volume of the water contained in oceans, seas, and bays is about 321,000,000 cubic miles, which of the following best represents the approximate volume, in cubic miles, of all the world's water?

   A) 308,160,000
   B) 309,765,000
   C) 332,642,000
   D) 334,375,000

2. An electrician charges a one-time site visit fee to evaluate a potential job. If the electrician accepts the job, he charges an hourly rate plus the cost of any materials needed to complete the job. The electrician also charges for tax, but only on the cost of the materials. If the total cost of completing a job that takes h hours is given by the function $C(h) = 45h + 1.06(82.5) + 75$, then the term $1.06(82.5)$ represents

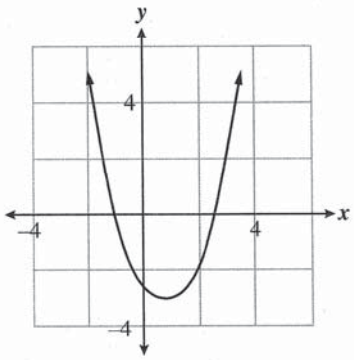
   A) the hourly rate.
   B) the site visit fee.
   C) the cost of the materials, including tax.
   D) the cost of the materials, not including tax.



$$\begin{cases} y > x \\ y \leq -\frac{3}{7}x + 5 \end{cases}$$

3. The figure above shows the solution set for the system of inequalities. Which of the following is not a solution to the system?

   A) (0, 3)
   B) (1, 2)
   C) (2, 4)
   D) (3, 3)



4. Each of the following quadratic equations represents the graph shown above. Which equation reveals the exact values of the x-intercepts of the graph?

   A) $y = \frac{1}{2}(2x - 5)(x + 1)$
   B) $y = x^2 - \frac{3}{2}x - \frac{5}{2}$
   C) $y + \frac{49}{16} = \left(x - \frac{3}{4}\right)^2$
   D) $y = \left(x - \frac{3}{4}\right)^2 - \frac{49}{16}$

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National Government Concerns

5. Margo surveyed all the students in the government classes at her school to see what they thought should be the most important concern of a national government. The results of the survey are shown in the figure above. If the ratio of students who answered "Foreign Policy" to those who answered "Environment" was 5:3, what percentage of the students answered "Environment"?

   A) 16%

   B) 21%

   C) 24%

   D) 35%

6. Which of the following best describes the type of association shown in the scatterplot above?

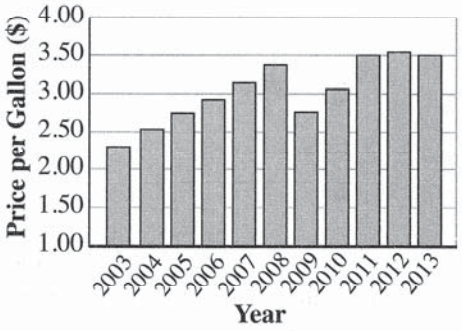
   A) Linear, positive

   B) Linear, negative

   C) Exponential, positive

   D) Exponential, negative

Average Annual Gas Prices



Data from U.S. Energy Information Administration.

7. The figure above shows the average annual gas prices in the United States from 2003 to 2013. Based on the information shown, which of the following conclusions is valid?

   A) A gallon of gas cost more in 2008 than in 2013.

   B) The price more than doubled between 2003 and 2013.

   C) The drop in price from 2008 to 2009 was more than $1.00 per gallon.

   D) The overall change in price was greater between 2003 and 2008 than it was between 2008 and 2013.

$$\begin{cases} -2x + 5y = 1 \\ 7x - 10y = -11 \end{cases}$$

8. If (x, y) is a solution to the system of equations above, what is the sum of x and y?

   A) $-\frac{137}{30}$

   B) -4

   C) $-\frac{10}{3}$

   D) -3

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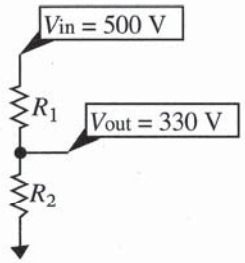

9. A voltage divider is a simple circuit that converts a large voltage into a smaller one. The figure above shows a voltage divider that consists of two resistors that together have a total resistance of 294 ohms. To produce the desired voltage of 330 volts, R_2 must be 6 ohms less than twice R_1. Solving which of the following systems of equations gives the individual resistances for R_1 and R_2?

A) $\begin{cases} R_2 = 2R_1 - 6 \\ R_1 + R_2 = 294 \end{cases}$

B) $\begin{cases} R_1 = 2R_2 + 6 \\ R_1 + R_2 = 294 \end{cases}$

C) $\begin{cases} R_2 = 2R_1 - 6 \\ R_1 + R_2 = \dfrac{294}{330} \end{cases}$

D) $\begin{cases} R_1 = 2R_2 + 6 \\ R_1 + R_2 = 330(294) \end{cases}$

10. If $\frac{2}{5}(5x) + 2(x - 1) = 4(x + 1) - 2$, what is the value of x?

A) $x = -2$

B) $x = 2$

C) There is no value of x for which the equation is true.

D) There are infinitely many values of x for which the equation is true.

11. Crude oil is being transferred from a full rectangular storage container with dimensions 4 meters by 9 meters by 10 meters into a cylindrical transportation container that has a diameter of 6 meters. What is the minimum possible length for a transportation container that will hold all of the oil?

A) 40π

B) $\dfrac{40}{\pi}$

C) 60π

D) $\dfrac{120}{\pi}$

12. The percent increase from 5 to 12 is equal to the percent increase from 12 to what number?

A) 16.8

B) 19.0

C) 26.6

D) 28.8

$$b = \frac{L}{4\pi d^2}$$

13. The brightness of a celestial body, like a star, decreases as you move away from it. In contrast, the luminosity of a celestial body is a constant number that represents its intrinsic brightness. The inverse square law, shown above, is used to find the brightness, b, of a celestial body when you know its luminosity, L, and the distance, d, in meters to the body. Which equation shows the distance to a celestial body, given its brightness and luminosity?

A) $d = \dfrac{1}{2}\sqrt{\dfrac{L}{\pi b}}$

B) $d = \sqrt{\dfrac{L}{2\pi b}}$

C) $d = \dfrac{\sqrt{L}}{2\pi b}$

D) $d = \dfrac{L}{2\sqrt{\pi b}}$

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Questions 14 and 15 refer to the following information.

Each month, the Bureau of Labor Statistics conducts a survey called the Current Population Survey (CPS) to measure unemployment in the United States. Across the country, about 60,000 households are included in the survey sample. These households are grouped by geographic region. A summary of the January 2014 survey results for male respondents in one geographic region is shown in the table below.

Age Group	Employed	Unemployed	Not in the Labor Force	Total
16 to 19	8	5	10	23
20 to 24	26	7	23	56
25 to 34	142	11	28	157
35 to 44	144	8	32	164
45 to 54	66	6	26	98
Over 54	65	7	36	152
Total	451	44	155	650

14. According to the data in the table, for which age group did the smallest percentage of men report that they were unemployed in January 2014?

A) 20 to 24 years
B) 35 to 44 years
C) 45 to 54 years
D) Over 54 years

15. If one unemployed man from this sample is chosen at random for a follow-up survey, what is the probability that he will be between the ages of 45 and 54?

A) 6.0%
B) 13.6%
C) 15.1%
D) 44.9%

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16. Which of the following are solutions to the quadratic equation $(x - 1)^2 = \frac{4}{9}$?

A) $x = -\frac{5}{3}, x = \frac{5}{3}$

B) $x = \frac{1}{3}, x = \frac{5}{3}$

C) $x = \frac{5}{9}, x = \frac{13}{9}$

D) $x = 1 \pm \sqrt{\frac{2}{3}}$

17. Damien is throwing darts. He has a total of 6 darts to throw. He gets 5 points for each dart that lands in a blue ring and 10 points for each dart that lands in a red ring. If x of his darts land in a blue ring and the rest land in a red ring, which expression represents his total score?

A) $10x$

B) $10x + 5$

C) $5x + 30$

D) $60 - 5x$

18. Red tide is a form of harmful algae that releases toxins as it breaks down in the environment. A marine biologist is testing a new spray, composed of clay and water, hoping to kill the red tide that almost completely covers a beach in southern Florida. He applies the spray to a representative sample of 200 square feet of the beach. By the end of the week, 184 square feet of the beach is free of the red tide. Based on these results, and assuming the same general conditions, how many square feet of the 10,000-square-foot beach would still be covered by red tide if the spray had been used on the entire area?

A) 800

B) 920

C) 8,000

D) 9,200

$$\begin{cases} y = \frac{1}{2}x - 2 \\ y = -x^2 + 1 \end{cases}$$

19. If (a, b) is a solution to the system of equations above, which of the following could be the value of b?

A) -3

B) -2

C) 1

D) 2

20. Given the function $g(x) = \frac{2}{3}x + 7$, what domain value corresponds to a range value of 3?

A) -6

B) -2

C) 6

D) 9

21. A landscaper buys a new commercial-grade lawn mower that costs $2,800. Based on past experience, he expects it to last about 8 years, and then he can sell it for scrap metal with a salvage value of about $240. Assuming the value of the lawn mower depreciates at a constant rate, which equation could be used to find its approximate value after x years, given that $x < 8$?

A) $y = -8x + 2{,}560$

B) $y = -240x + 2{,}800$

C) $y = -320x + 2{,}800$

D) $y = 240x - 2{,}560$

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22. A microbiologist is studying the effects of a new antibiotic on a culture of 20,000 bacteria. When the antibiotic is added to the culture, the number of bacteria is reduced by half every hour. What kind of function best models the number of bacteria remaining in the culture after the antibiotic is added?

A) A linear function
B) A quadratic function
C) A polynomial function
D) An exponential function

23. An airline company purchased two new airplanes. One can travel at speeds of up to 600 miles per hour and the other at speeds of up to 720 miles per hour. How many more miles can the faster airplane travel in 12 seconds than the slower airplane?

A) $\frac{1}{30}$
B) $\frac{2}{5}$
C) 2
D) 30

State	Minimum Wage per Hour
Idaho	$7.25
Montana	$7.90
Oregon	$9.10
Washington	$9.32

24. The table above shows the 2014 minimum wages for several states that share a border. Assuming an average workweek of between 35 and 40 hours, which inequality represents how much more a worker who earns minimum wage can earn per week in Oregon than in Idaho?

A) $x \geq 1.85$
B) $7.25 \leq x \leq 9.10$
C) $64.75 \leq x \leq 74$
D) $253.75 \leq x \leq 364$

25. In the United States, the maintenance and construction of airports, transit systems, and major roads is largely funded through a federal excise tax on gasoline. Based on the 2011 statistics given below, how much did the average household pay per year in federal gasoline taxes?

- The federal gasoline tax rate was 18.4 cents per gallon.
- The average motor vehicle was driven approximately 11,340 miles per year.
- The national average fuel economy for noncommercial vehicles was 21.4 miles per gallon.
- The average American household owned 1.75 vehicles.

A) $55.73
B) $68.91
C) $97.52
D) $170.63

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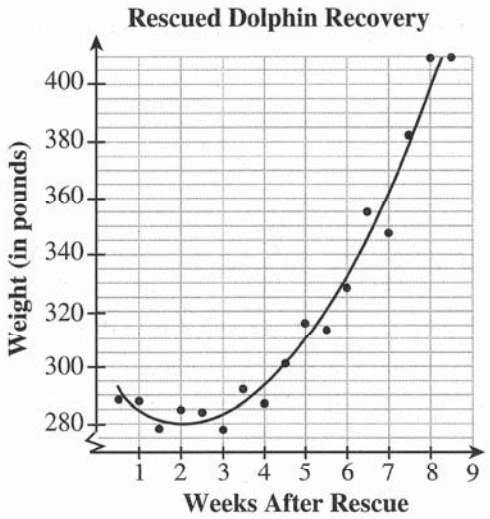
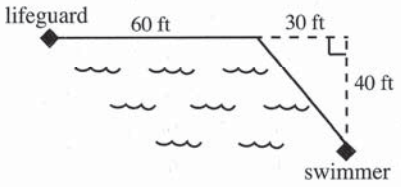


26. Following the catastrophic oil spill in the Gulf of Mexico in April of 2010, more than 900 bottlenose dolphins were found dead or stranded in the oil spill area. The figure above shows the weight of a rescued dolphin during its recovery. Based on the quadratic model fit to the data shown, which of the following is the closest to the average rate of change in the dolphin's weight between week 2 and week 8 of its recovery?

A) 4 pounds per week
B) 16 pounds per week
C) 20 pounds per week
D) 40 pounds per week



27. As shown in the figure above, a lifeguard sees a struggling swimmer who is 40 feet from the beach. The lifeguard runs 60 feet along the edge of the water at a speed of 12 feet per second. He pauses for 1 second to locate the swimmer again, and then dives into the water and swims along a diagonal path to the swimmer at a speed of 5 feet per second. How many seconds go by between the time the lifeguard sees the struggling swimmer and the time he reaches the swimmer?

A) 16
B) 22
C) 50
D) 56

28. What was the initial amount of gasoline in a fuel trailer, in gallons, if there are now x gallons, y gallons were pumped into a storage tank, and then 50 gallons were added to the trailer?

A) $x + y + 50$
B) $x + y - 50$
C) $y - x + 50$
D) $x - y - 50$

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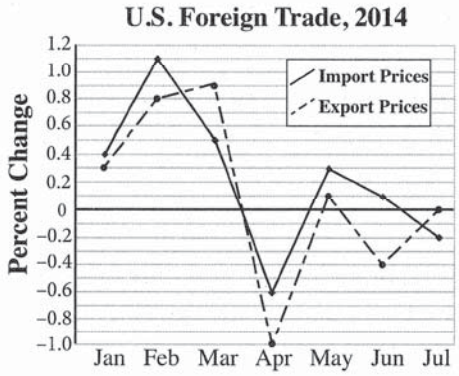

29. The figure above shows the net change, as a percentage, for U.S. import and export prices from January to July 2014 as reported by the Bureau of Labor Statistics. For example, U.S. import prices declined 0.2 percent in July while export prices remained unchanged for that month. Based on this information, which of the following statements is true for the time period shown in the figure?

A) On average, export prices increased more than import prices.

B) Import prices showed an increase more often than export prices.

C) Import prices showed the greatest change between two consecutive months.

D) From January to July, import prices showed a greater overall decrease than export prices.

$$\frac{3.86}{x} + \frac{180.2}{10x} + \frac{42.2}{5x}$$

30. The Ironman Triathlon originated in Hawaii in 1978. The format of the Ironman has not changed since then: It consists of a 3.86-km swim, a 180.2-km bicycle ride, and a 42.2-km run, all raced in that order and without a break. Suppose an athlete bikes 10 times as fast as he swims and runs 5 times as fast as he swims. The variable x in the expression above represents the rate at which the athlete swims, and the whole expression represents the number of hours that it takes him to complete the race. If it takes him 16.2 hours to complete the race, how many kilometers did he swim in 1 hour?

A) 0.85

B) 1.01

C) 1.17

D) 1.87

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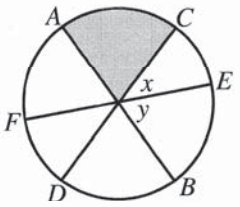
31. What value of x satisfies the equation $\frac{2}{3}(5x + 7) = 8x$?

32. Some doctors base the dosage of a drug to be given to a patient on the patient's body surface area (BSA). The most commonly used formula for calculating BSA is $BSA = \sqrt{\frac{wh}{3{,}600}}$, where w is the patient's weight (in kg), h is the patient's height (in cm), and BSA is measured in square meters. How tall (in cm) is a patient who weighs 150 kg and has a BSA of $2\sqrt{2}$ m^2?

33. A college math professor informs her students that rather than curving final grades, she will replace each student's lowest test score with the next to lowest test score, and then re-average the test grades. If Leeza has test scores of 86, 92, 81, 64, and 83, by how many points does her final test average change based on the professor's policy?



34. In the figure above, $\overline{AB}$, $\overline{CD}$, and $\overline{EF}$ are diameters of the circle. If $y = 2x - 12$, and the shaded area is $\frac{1}{5}$ of the circle, what is the value of x?

35. If the slope of a line is $-\frac{7}{4}$ and a point on the line is (4, 7), what is the y-intercept of the line?

36. Rory left home and drove straight to the airport at an average speed of 45 miles per hour. He returned home along the same route, but traffic slowed him down and he only averaged 30 miles per hour on the return trip. If his total travel time was 2 hours and 30 minutes, how far is it, in miles, from Rory's house to the airport?

Questions 37 and 38 refer to the following information.

Chemical Makeup of One Mole of Chloroform

Element	Number of Moles	Mass per Mole (grams)
Carbon	1	12.011
Hydrogen	1	1.008
Chlorine	3	35.453

A chemical solvent is a substance that dissolves another to form a solution. For example, water is a solvent for sugar. Unfortunately, many chemical solvents are hazardous to the environment. One eco-friendly chemical solvent is chloroform, also known as trichloromethane ($CHCl_3$). The table above shows the chemical makeup of one mole of chloroform.

37. Carbon makes up what percent of the mass of one mole of chloroform? Round your answer to the nearest whole percent and ignore the percent sign when entering your answer.

38. If a chemist starts with 1,000 grams of chloroform and uses 522.5 grams, how many moles of chlorine are left?

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST. STOP

ESSAY TEST

50 Minutes

The essay gives you an opportunity to show how effectively you can read and comprehend a passage and write an essay analyzing the passage. In your essay, you should demonstrate that you have read the passage carefully, present a clear and logical analysis, and use language precisely.

Your essay must be written on the lines provided in your answer booklet; except for the planning page of the answer booklet, you will receive no other paper on which to write. You will have enough space if you write on every line, avoid wide margins, and keep your handwriting to a reasonable size. Remember that people who are not familiar with your handwriting will read what you write. Try to write or print so that what you are writing is legible to those readers.

You have 50 minutes to read the passage and write an essay in response to the prompt provided inside this booklet.

1. Do not write your essay in this booklet. Only what you write on the lined pages of your answer booklet will be evaluated.
2. An off-topic essay will not be evaluated.

As you read the passage below, consider how Morris uses

- evidence, such as facts or examples, to support claims.
- reasoning to develop ideas and to connect claims and evidence.
- stylistic or persuasive elements, such as word choice or appeals to emotion, to add power to the ideas expressed.

Adapted from Elisabeth Woodbridge Morris's essay "The Tyranny of Things." In this portion, Morris paints a portrait of American consumerism in 1917 and offers a distinct perspective on the joy of freedom from "things, things, things."

1 Two fifteen-year-old girls stood eyeing one another on first acquaintance. Finally one little girl said, "Which do you like best, people or things?" The other little girl said, "Things." They were friends at once.

2 I suppose we all go through a phase when we like things best; and not only like them, but want to possess them under our hand. The passion for accumulation is upon us. We make "collections," we fill our rooms, our walls, our tables, our desks, with things, things, things.

3 Many people never pass out of this phase. They never see a flower without wanting to pick it and put it in a vase, they never enjoy a book without wanting to own it, nor a picture without wanting to hang it on their walls. They keep photographs of all their friends and Kodak albums of all the places they visit, they save all their theater programmes and dinner cards, they bring home all their alpenstocks.* Their houses are filled with an undigested mass of things, like the terminal moraine where a glacier dumps at length everything it has picked up during its progress through the lands.

4 But to some of us a day comes when we begin to grow weary of things. We realize that we do not possess them; they possess us. Our books are a burden to us, our pictures have destroyed every restful wall-space, our china

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MATH—NO CALCULATOR TEST

1. C	6. D	11. C	16. 20
2. A	7. D	12. B	17. 1
3. D	8. B	13. A	18. 2
4. C	9. B	14. D	19. 14
5. B	10. A	15. A	20. 6

MATH—CALCULATOR TEST

1. C	11. B	21. C	31. 1
2. C	12. D	22. D	32. 192
3. D	13. A	23. B	33. 3.4
4. A	14. D	24. C	34. 40
5. B	15. B	25. D	35. 14
6. C	16. B	26. C	36. 45
7. D	17. D	27. A	37. 10
8. B	18. A	28. B	38. 12
9. A	19. A	29. B	
10. C	20. A	30. D	

the context of the paragraph. Choice (C), "measured," has a connotation that corresponds to "gauge" in the following sentence.

40. B **Difficulty:** Easy

Category: Usage

Getting to the Answer: Remember that the possessive form must agree with its antecedent. The correct answer will reflect the gender and number of its antecedent; in this case, the word "treaty." Therefore, (B) is correct.

41. A **Difficulty:** Hard

Category: Development

Getting to the Answer: To find the central idea of a paragraph, identify important details and then summarize them in a sentence or two. Then find the choice that is the closest to your summary. Choice (A) most clearly states the paragraph's central idea, that the ozone layer is beginning to return to normal.

42. D **Difficulty:** Medium

Category: Development

Getting to the Answer: To find the correct answer, first determine the central idea of the paragraph. Choice (D) is the least essential sentence in the paragraph, so it is the correct answer.

43. D **Difficulty:** Medium

Category: Effective Language Use

Getting to the Answer: Context clues indicate which word is appropriate in the sentence. Check to see which word fits best in the sentence. The word "reverse," (D), fits with the context of the sentence and connotes a more precise action than does "change."

44. C **Difficulty:** Hard

Category: Organization

Getting to the Answer: Examine the entire paragraph. Decide whether the sentence provides more information about a topic mentioned in one of the other sentences. This sentence provides more information related to sentence 1, "The Montreal Protocol is a living document"; it describes how the document is "living." Choice (C) is the correct answer.

MATH—NO CALCULATOR TEST

1. C **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: To determine what the *y*-intercept could mean in the context of a word problem, examine the labels on the graph and note what each axis represents. According to the labels, the *y*-axis represents cost, and the *x*-axis represents the number of games played. The *y*-intercept, (0, 5), has an *x*-value of 0, which means 0 games were played, yet there is still a cost of $5. The cost must represent a flat fee that is charged before any games are played, such as an entrance fee to enter the arcade, (C).

2. A **Difficulty:** Easy

Category: Passport to Advanced Math / Exponents

Getting to the Answer: To divide one rational expression by another, multiply the first expression by the reciprocal (the flip) of the second expression. Rewrite the division as multiplication, factor any factorable expressions, and then simplify if possible.

$$\frac{3x}{x+5} \div \frac{6}{4x+20} = \frac{3x}{x+5} \cdot \frac{4x+20}{6}$$

$$= \frac{3x}{\cancel{x+5}} \cdot \frac{4\cancel{(x+5)}}{6}$$

$$= \frac{12x}{6}$$

$$= 2x$$

Note that the question also states that $x \neq -5$. This doesn't affect your answer—it is simply stated because the denominators of rational expressions cannot equal 0. Choice (A) is correct.

3. D **Difficulty:** Easy

Category: Additional Topics in Math / Geometry

Getting to the Answer: When the equation of a circle is written in the form $(x - h)^2 + (y - k)^2 = r^2$, the point (h, k) represents the center of the circle on a coordinate plane, and r represents the length of the radius. To find the area of a circle, use the formula, $A = \pi r^2$. In the equation given in the question, r^2 is the constant on the right-hand side (25)—you don't even need to solve for r because the area , formula involves r^2, not r. So, the area is $\pi(25)$ or 25π, (D).

4. C **Difficulty:** Easy

Category: Passport to Advanced Math / Functions

Getting to the Answer: When using function notation, $f(x)$ is simply another way of saying y, so this question is asking you to find the values of x for which $y = 0$, or in other words, where the graph crosses the x-axis. The graph crosses the x-axis at the points $(-2, 0)$ and $(3, 0)$, so the values of x for which $f(x) = 0$ are -2 and 3, (C).

5. B **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Choose the best strategy to answer the question. You could start by cross-multiplying to get rid of the denominators, but simplifying the numerators first will make the calculations easier.

$$\frac{4(d+3)-9}{8} = \frac{10-(2-d)}{6}$$
$$\frac{4d+12-9}{8} = \frac{10-2+d}{6}$$
$$\frac{4d+3}{8} = \frac{8+d}{6}$$
$$6(4d+3) = 8(8+d)$$
$$24d+18 = 64+8d$$
$$16d = 46$$
$$d = \frac{46}{16} = \frac{23}{8}$$

Choice (B) is correct.

6. D **Difficulty:** Medium

Category: Passport to Advanced Math / Functions

Getting to the Answer: This is a crossover question, so quickly skim the first couple of sentences. Then look for the relevant information in the last couple of sentences. It may also help to circle the portions of the graph that meet the given requirement.

Because *greater* means *higher* on a graph, the statement $f(t) > g(t)$ translates to "Where is $f(t)$ above $g(t)$?" The solid curve represents f and the dashed curve represents g, so $f > g$ between the years 1960 and 1980 and again between the years 2000 and 2010. Look for these time intervals in the answer choices: $1960 < t < 1980$ and $2000 < t < 2010$. This matches (D).

7. D **Difficulty:** Medium

Category: Passport to Advanced Math / Scatterplots

Getting to the Answer: Use the shape of the data to predict the type of equation that might be used as a model. Then, use specific values from the graph to choose the correct equation. According to the graph, the population of the whales grew slowly at first and then more quickly. This means that an exponential model is probably the best fit, so you can eliminate A (linear) and B (quadratic). The remaining equations are both exponential, so choose a data point and see which equation is the closest fit. Be careful—the vertical axis represents *hundreds* of whales, and the question states that t represents the number of years since the study began, so $t = 0$ for 1995, $t = 3$ for 1998, and so on. If you use the data for 1995, which is the point (0, 100), the results are the same for both equations, so choose a different point. Using the data for 2007, $t = 2007 - 1995 = 12$, and the number of whales was 800. Substitute these values into C and D to see which one is true. Choice C is not true because $800 \neq 100 \times 2^{12}$. Choice (D) is correct because:

$$800 = 100 \times 2^{\frac{12}{4}} = 100 \times 2^3 = 100 \times 8$$

8. B **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: To find the average rate of change over the 5-year period, find the slope between the starting point (0, 1,200) and the ending point (5, 100).

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{100 - 1{,}200}{5 - 0} = \frac{-1{,}100}{5} = -220$$

Choice (B) is correct. (The average rate of change is negative because the laptop decreases in value over time.)

Note: Because the question involves *straight-line* depreciation, you could have used any two points on the graph to find the slope. As a general rule, however, you should use the endpoints of the given time interval.

9. B **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: When multiplying polynomials, carefully multiply each term in the first factor by each term in the second factor. This question doesn't ask for the entire product, so check to make sure you answered the right question (the coefficient of x^2).

$$\left(6x^2 - \frac{2}{5}x + 1\right)\left(10x + \frac{1}{3}\right)$$

$$= 6x^2\left(10x + \frac{1}{3}\right) - \frac{2}{5}x\left(10x + \frac{1}{3}\right) + 1\left(10x + \frac{1}{3}\right)$$

$$= 60x^3 + 2x^2 - 4x^2 - \frac{2}{15}x + 10x + \frac{1}{3}$$

The coefficient of x^2 is $2 + (-4) = -2$, which is (B).

10. A **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: The line is decreasing, so the slope (m) is negative. The line crosses the y-axis below 0, so the y-intercept (b) is also negative. Put each answer choice in slope-intercept form, one at a time, and examine the signs of m and b. Begin with (A):

$$\begin{aligned} -6x - 4y &= 5 \\ -4y &= 6x + 5 \\ y &= \frac{6x}{-4} + \frac{5}{-4} \\ y &= -\frac{3}{2}x - \frac{5}{4} \end{aligned}$$

You don't need to check any of the other equations. Choice (A) has a negative slope and a negative y-intercept, so it is the correct equation.

11. C **Difficulty:** Hard

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Graphically, a system of linear equations that has no solution indicates two parallel lines or, in other words, two lines that have the same slope. So, write each of the equations in slope-intercept form ($y = mx + b$) and set their slopes (m) equal to each other to solve for k. Before finding the slopes, multiply the top equation by 4 to make it easier to manipulate.

$$4\left(\frac{3}{4}x - \frac{1}{2}y = 12\right) \rightarrow 3x - 2y = 48 \rightarrow y = \frac{3}{2}x - 24$$

$$kx - 2y = 22 \rightarrow -2y = -kx + 22 \rightarrow y = \frac{k}{2}x - 11$$

The slope of the first line is $\frac{3}{2}$, and the slope of the second line is $\frac{k}{2}$. Set them equal and solve for k.

$$\begin{aligned} \frac{3}{2} &= \frac{k}{2} \\ 2(3) &= 2(k) \\ 6 &= 2k \\ 3 &= k \end{aligned}$$

Choice (C) is correct.

12. B **Difficulty:** Hard

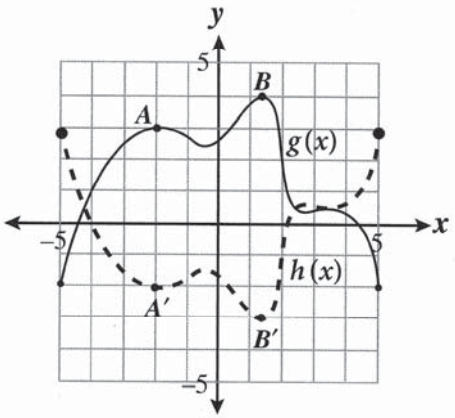
Category: Heart of Algebra / Inequalities

Getting to the Answer: Before you write the inequality, you need to find the per-mile rate for the remaining miles. The driver charges \$4.00 for the first $\frac{1}{4}$ mile, which is a flat fee, so write 4. The additional charge is \$1.50 per $\frac{1}{2}$ mile, or 1.50 times 2 = \$3.00 per mile. The number of miles after the first $\frac{1}{4}$ mile is $m - \frac{1}{4}$, so the cost of the trip, not including the first $\frac{1}{4}$ mile, is $3\left(m - \frac{1}{4}\right)$. This means the cost of the whole trip is $4 + 3\left(m - \frac{1}{4}\right)$. The clue "no more than \$10" means that much or less, so use the symbol ≤. The inequality is $4 + 3\left(m - \frac{1}{4}\right) \leq 10$, which simplifies to $3.25 + 3m \leq 10$. This matches (B).

13. A **Difficulty:** Hard

Category: Passport to Advanced Math / Functions

Getting to the Answer: Based on the equation, the graph of $h(x) = -g(x) + 1$ is a vertical reflection of $g(x)$, over the x-axis, that is then shifted up 1 unit. The graph looks like the dashed line in the following graph:



Now, compare the dashed line to each of the answer choices: The range of $h(x)$ is the set of y-values from lowest to highest (based on the dashed line). The lowest point occurs at point B' and has a y-value of −3; the highest value occurs at both ends of the graph and is 3, so the range is $-3 \leq y \leq 3$. This means (A) is correct and you can move on to the next question. Don't waste valuable time checking the other answer choices unless you are not sure about the range. (Choice B: The minimum value of $h(x)$ is −3, not −4. Choice C: The coordinates of point A on $h(x)$ are (−2, −2), not (2, 4). Choice D: the graph of $h(x)$ is decreasing, not increasing, between $x = -5$ and $x = -2$.)

14. D **Difficulty:** Medium

Category: Additional Topics in Math / Imaginary Numbers

Getting to the Answer: Multiply the two complex numbers just as you would two binomials (using FOIL). Then, combine like terms and use the definition $i^2 = -1$ to simplify the result.

$$\begin{aligned}(3 + 2i)(5 - i) &= 3(5 - i) + 2i(5 - i)\\ &= 15 - 3i + 10i - 2i^2\\ &= 15 + 7i - 2(-1)\\ &= 15 + 7i + 2\\ &= 17 + 7i\end{aligned}$$

The question asks for a in $a + bi$, so the correct answer is 17, (D).

15. A **Difficulty:** Hard

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Think of the rate given in the question in terms of the constant term you see on the right-hand side of the equation. Working together, the two treatment plants can filter the water in 72 hours. This is equivalent to saying that they can filter $\frac{1}{72}$ of the water in 1 hour. If $\frac{1}{72}$ is the portion of the water the two treatment plants can filter *together*, then each term on the left side of the equation represents the portion that each plant can filter *individually* in 1 hour. Because the new facility is 4 times as fast as the older facility, $\frac{4}{x}$ represents the portion of the water the new plant can filter in

1 hour, and $\frac{1}{x}$ represents the portion of the water the older plant can filter in 1 hour. This matches (A).

16. 20 **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

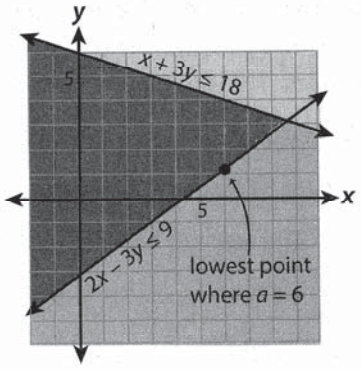
Getting to the Answer: Only one equation is given, and it has two variables. This means that you don't have enough information to solve for either variable. Instead, look for the relationship between the variable terms in the equation and those in the expression that you are trying to find, $x + 2y$. First, move the y-term to the left side of the equation to make it look more like the expression you are trying to find. The expression doesn't have fractions, so clear the fractions in the equation by multiplying both sides by 4. This yields the expression that you are looking for, $x + 2y$, so no further work is required—just read the value on the right-hand side of the equation. The answer is 20.

$$\frac{1}{4}x = 5 - \frac{1}{2}y$$
$$\frac{1}{4}x + y\frac{1}{2} = 5$$
$$4\left(\frac{1}{4}x + \frac{1}{2}y\right) = 4(5)$$
$$x + 2y = 20$$

17. 1 **Difficulty:** Medium

Category: Heart of Algebra / Inequalities

Getting to the Answer: This question is extremely difficult to answer unless you draw a sketch. It doesn't have to be perfect—you just need to get an idea of where the solution region is. Don't forget to flip the inequality symbol when you graph the second equation.



If (a, b) is a solution to the system, then a is the x-coordinate of any point in the darkest shaded region and b is the corresponding y-coordinate. When $a = 6$, the minimum possible value for b lies on the lower boundary line, $2x - 3y \leq 9$. It looks like the y-coordinate is 1, but to be sure, substitute $x = 6$ into the equation and solve for y. You can use $=$ in the equation, instead of the inequality symbol, because you are finding a point on the boundary line.

$$2x - 3y = 9$$
$$2(6) - 3y = 9$$
$$12 - 3y = 9$$
$$-3y = -3$$
$$y = 1$$

18. 2 **Difficulty:** Hard

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Write each factor in the expression in exponential form: $\sqrt{x} = x^{\frac{1}{2}}$ and $\sqrt[3]{x} = x^{\frac{1}{3}}$. Then use the rules of exponents to simplify the expression. Add the exponents of the factors that are being multiplied and subtract the exponent of the factor that is being divided:

$$\frac{\sqrt{x} \cdot x^{\frac{5}{6}} \cdot x}{\sqrt[3]{x}} = \frac{x^{\frac{1}{2}} \cdot x^{\frac{5}{6}} \cdot x^1}{x^{\frac{1}{3}}}$$
$$= x^{\frac{1}{2}+\frac{5}{6}+\frac{1}{1}-\frac{1}{3}}$$
$$= x^{\frac{3}{6}+\frac{5}{6}+\frac{6}{6}-\frac{2}{6}}$$
$$= x^{\frac{12}{6}} = x^2$$

Because n is the power of x, the value of n is 2.

19. 14 **Difficulty:** Hard

Category: Additional Topics in Math / Geometry

Getting to the Answer: The shaded region is the area of the larger triangle minus the area of the smaller triangle. Set up and solve an equation using the information from the figure. You don't know the height of the smaller triangle, so call it h. You do know the area of the shaded region—it's 52 square units.

Larger triangle: base = 12; height = $h + 3 + 3$

Smaller triangle: base = 8; height = h

Shaded area = large area − small area

$$52 = \left[\left(\frac{1}{2}\right)(12)(h+6)\right] - \left[\left(\frac{1}{2}\right)(8)(h)\right]$$
$$52 = 6(h+6) - 4h$$
$$52 = 6h + 36 - 4h$$
$$52 = 2h + 36$$
$$16 = 2h$$
$$8 = h$$

The question asks for the height of the *larger* triangle, so the correct answer is 8 + 3 + 3 = 14.

20. 6 **Difficulty:** Hard

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: The highest power of x in the equation is 2, so the function is quadratic. Writing quadratic equations can be tricky and time-consuming. If you know the roots, you can use factors to write the equation. If you don't know the roots, you need to create a system of equations to find the coefficients of the variable terms. You don't know the roots of this equation, so start with the point that has the easiest values to work with, (0, 1), and substitute them into the equation $y = ax^2 + bx + c$.

$$1 = a(0)^2 + b(0) + c$$
$$1 = c$$

Now your equation looks like $y = ax^2 + bx + 1$. Next, use the other two points to create a system of two equations in two variables.

$$(-3,10) \rightarrow 10 = a(-3)^2 + b(-3) + 1 \rightarrow 9 = 9a - 3b$$
$$(2,15) \rightarrow 15 = a(2)^2 + b(2) + 1 \rightarrow 14 = 4a + 2b$$

You now have a system of equations to solve. None of the variables has a coefficient of 1, so use elimination to solve the system. If you multiply the top equation by 2 and the bottom equation by 3, the b terms will eliminate each other.

$$2[9a - 3b = 9] \rightarrow 18a - 6b = 18$$
$$3[4a + 2b = 14] \rightarrow \underline{12a + 6b = 42}$$
$$30a = 60$$
$$a = 2$$

Now, find b by substituting $a = 2$ into either of the original equations. Using the top equation, you get:

$$9(2) - 3b = 9$$
$$18 - 3b = 9$$
$$-3b = -9$$
$$b = 3$$

The value of $a + b + c$ is 2 + 3 + 1 = 6.

MATH—CALCULATOR TEST

1. C **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: You can use the formula $\text{Percent} = \frac{\text{part}}{\text{whole}} \times 100\%$ whenever you know two out of the three quantities. The clue "all" tells you that the "whole" is what you don't know. The percent is 96.5, and the part is 321,000,000.

$$\begin{aligned} 96.5 &= \frac{321{,}000{,}000}{w} \times 100\% \\ 96.5w &= 32{,}100{,}000{,}000 \\ w &= \frac{32{,}100{,}000{,}000}{96.5} \\ w &= 332{,}642{,}487 \end{aligned}$$

The answer choices are rounded to the nearest thousand, so the answer is 332,642,000, (C).

2. C **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: The total cost consists of the one-time site visit fee (a constant), an hourly cost (which depends on the number of hours), and the cost of the materials (which are taxed). The constant in the equation is 75 and is therefore the site visit fee; 45 is being multiplied by h (the number of hours), so \$45 must be the hourly rate. That leaves the remaining term, 1.06(82.5), which must be the cost of the materials (\$82.50) plus a 6% tax. This matches (C).

3. D **Difficulty:** Easy

Category: Heart of Algebra / Inequalities

Getting to the Answer: The intersection (overlap) of the two shaded regions is the solution to the system of inequalities. Check each point to see whether it lies in the region with the darkest shading. Don't forget to check that you answered the right question—you are looking for the point that is *not* a solution to the system. Each of the first three points clearly lies in the overlap. The point (3, 3) looks like it lies on the dashed line, which means it is *not* included in the solution. To check this, plug (3, 3) into the easier inequality: $3 \not> 3$ (3 is equal to itself, not greater than itself), so (D) is correct.

4. A **Difficulty:** Easy

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: Quadratic equations can be written in several forms, each of which reveals something special about the graph. The factored form of a quadratic equation reveals the solutions to the equation, which graphically represent the x-intercepts. Choice (A) is the only equation written in this form and therefore must be correct. You can set each factor equal to 0 and solve to find that the x-intercepts of the graph are $x = \frac{5}{2}$ and $x = -1$.

5. B **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Break the question into steps. Before you can use the ratio, you need to find the percent of the students who answered either "Foreign Policy" or "Environment." The ratio given in the question is 5:3, so write this as 5 parts "Foreign Policy" and 3 parts "Environment." You don't know how big a *part* is, so call it x. This means that $5x + 3x$ equals the percent of the students who answered either "Foreign Policy" or "Environment," which is 100% minus all the other answers:

$$\begin{aligned} 100 - (16 + 14 + 9 + 5) &= 100 - 44 = 56 \\ 5x + 3x &= 56 \\ 8x &= 56 \\ x &= 7 \end{aligned}$$

Each part has a value of 7, and 3 parts answered "Environment," so the correct percentage is 3(7) = 21%, (B).

6. C **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Scatterplots

Getting to the Answer: A data set that has a linear association follows the path of a straight line; a data set that is exponential follows a path that is similar to linear data, but with a curve to it because the rate of increase (or decrease) changes over time. This data set has a curve to it, so "exponential" describes the association better than "linear." This means you can eliminate A and B. A positive association between two variables is one in which higher values of one variable correspond to higher values of the other

variable, and vice versa. In other words, as the *x*-values of the data points go up, so do the *y*-values. This is indeed the case for this data set, so (C) is correct.

7. D **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: Your only choice for this question is to compare each statement to the figure. Don't waste time trying to figure out the exact value for each bar—an estimate is good enough to determine whether each statement is true. Choice A is incorrect because the price in 2008 was slightly less (not more) than \$3.50, while the price in 2013 was right around \$3.50. Choice B is incorrect because the price in 2003 was more than \$2.00, and the price in 2013 was not more than twice that (\$4.00). Choice C is incorrect because the price in 2008 was about \$3.25 and the price in 2009 was about \$2.75—this is not a difference of more than \$1.00. This means (D) must be correct. You don't have to check it—just move on. (Between 2003 and 2008, the change in price was about \$3.40 – \$2.30 = \$1.10; between 2008 and 2013, the change in price was only about \$3.50 – \$3.40 = \$0.10; the change in price was greater between 2003 and 2008.)

8. B **Difficulty:** Medium

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Because none of the variable terms has a coefficient of 1, solve the system of equations using elimination (combining the equations). Before you choose an answer, check that you answered the right question (the sum of *x* and *y*). Multiply the top equation by 2 to eliminate the terms that have *y*'s in them.

$$\begin{aligned} 2[-2x + 5y = 1] &\rightarrow -4x + 10y = 2 \\ 7x - 10y = -11 &\rightarrow \underline{\quad 7x - 10y = -11} \\ 3x &= -9 \\ x &= -3 \end{aligned}$$

Now, substitute the result into either of the original equations and simplify to find *y*:

$$\begin{aligned} -2x + 5y &= 1 \\ -2(-3) + 5y &= 1 \\ 6 + 5y &= 1 \\ 5y &= -5 \\ y &= -1 \end{aligned}$$

The question asks for the *sum*, so add *x* and *y* to get $-3 + (-1) = -4$, which is (B).

9. A **Difficulty:** Medium

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Take a quick peek at the answers just to see what variables are being used, but don't study the equations. Instead, write your own system using the same variables as given in the answer choices. One of the equations in the system needs to represent the sum of the two resistors ($R_1 + R_2$), which is equal to 294. This means you can eliminate C and D. The second equation needs to satisfy the condition that R_2 is 6 less than twice R_1, or $R_2 = 2R_1 - 6$. This means (A) is correct.

10. C **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Use the distributive property to simplify each of the terms that contains parentheses. Then use inverse operations to solve for *x*.

$$\begin{aligned} \frac{2}{\cancel{5}}\left(\cancel{5}x\right) + 2(x - 1) &= 4(x + 1) - 2 \\ 2x + 2x - 2 &= 4x + 4 - 2 \\ 4x - 2 &= 4x + 2 \\ -2 &\neq 2 \end{aligned}$$

All of the variable terms cancel out, and the resulting numerical statement is false (because negative 2 does not equal positive 2), so there is no solution to the equation. Put another way, there is no value of *x* for which the equation is true, (C).

11. B **Difficulty:** Medium

Category: Additional Topics in Math / Geometry

Getting to the Answer: Think about this question logically before you start writing things down—after it's transferred, the volume of the oil in the cylindrical container will be the same volume as the rectangular container, so you need to set the two volumes equal and solve for h. The volume of the rectangular container is $4 \times 9 \times 10$, or 360 cubic meters. The volume of a cylinder equals the area of its base times its height, or $\pi r^2 h$. Because the diameter is 6 meters, the radius, r, is half that, or 3 meters. Now we're ready to set up an equation and solve for h (which is the height of the cylinder or, in this case, the length of the transportation container):

$$\begin{aligned} \text{Volume of oil} &= \text{Volume of rectangular container} \\ \pi(3)^2 h &= 360 \\ 9\pi h &= 360 \\ h &= \frac{360}{9\pi} = \frac{40}{\pi} \end{aligned}$$

Choice (B) is correct.

12. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Even though this question uses the word *percent*, you are never asked to find the actual percent itself. Set this question up as a proportion to get the answer more quickly. Remember, percent change equals amount of change divided by the original amount.

$$\begin{aligned} \frac{12-5}{5} &= \frac{x-12}{12} \\ \frac{7}{5} &= \frac{x-12}{12} \\ 12(7) &= 5(x-12) \\ 84 &= 5x - 60 \\ 144 &= 5x \\ 28.8 &= x \end{aligned}$$

Choice (D) is correct.

13. A **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Focus on the question at the very end—it's just asking you to solve the equation for d. First, cross-multiply to get rid of the denominator. Then, divide both sides of the equation by $4\pi b$ to isolate d^2. Finally, take the square root of both sides to find d.

$$\begin{aligned} b(4\pi d^2) &= L \\ \frac{b(4\pi d^2)}{4\pi b} &= \frac{L}{4\pi b} \\ d^2 &= \frac{L}{4\pi b} \\ \sqrt{d^2} &= \sqrt{\frac{L}{4\pi b}} \\ d &= \sqrt{\frac{L}{4\pi b}} \end{aligned}$$

Unfortunately, this is not one of the answer choices, so you'll need to simplify further. You can take the square root of 4 (it's 2), but be careful—it's in the denominator of the fraction, so it comes out of the square root as $\frac{1}{2}$. The simplified equation is $d = \frac{1}{2}\sqrt{\frac{L}{\pi b}}$. This matches (A).

14. D **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: To calculate the percentage of men in each age group who reported being unemployed in January 2014, divide the number in *that* age group who were unemployed by the total number in *that* age group. There are six age groups but only four answer choices, so don't waste time on the age groups that aren't represented. Choice (D) is correct because $7 \div 152 \approx 0.046 = 4.6\%$, which is a lower percentage than that for any other age group (20 to 24 = 12.5%; 35 to 44 = 4.9%; 45 to 54 = 6.1%).

15. B **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: The follow-up survey targets only those respondents who said they were unemployed, so focus on that column in the table. There were 6 respondents out of 44 unemployed males who were between the ages of 45 and 54, so the probability is $\frac{6}{44} = 0.13\overline{6}$, or about 13.6%, (B).

16. B **Difficulty:** Medium

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: Taking the square root is the inverse operation of squaring, and both sides of the equation are already perfect squares, so take their square roots. Then solve the resulting equations. Remember, there will be two equations to solve.

$$(x-1)^2 = \frac{4}{9}$$
$$\sqrt{(x-1)^2} = \sqrt{\frac{4}{9}}$$
$$x - 1 = \pm\frac{\sqrt{4}}{\sqrt{9}}$$
$$x = 1 \pm \frac{2}{3}$$

Now, simplify each equation: $x = 1 + \frac{2}{3} = \frac{3}{3} + \frac{2}{3} = \frac{5}{3}$ and $x = 1 - \frac{2}{3} = \frac{3}{3} - \frac{2}{3} = \frac{1}{3}$. Choice (B) is correct.

17. D **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Write the expression in words first: points per blue ring (5) times number of darts in blue ring (x), plus points per red ring (10) times number of darts in red ring ($6 - x$). Now, translate the words into numbers, variables, and operations: $5x + 10(6 - x)$. This is not one of the answer choices, so simplify the expression by distributing the 10 and then combining like terms: $5x + 10(6 - x) = 5x + 60 - 10x = 60 - 5x$. This matches (D).

18. A **Difficulty:** Medium

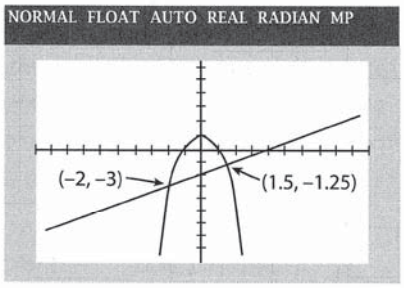
Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: This is a science crossover question. Read the first two sentences quickly—they are simply describing the context of the question. The last two sentences pose the question, so read those more carefully. In the sample, 184 out of 200 square feet were free of red tide after applying the spray. This is $\frac{184}{200} = 0.92 = 92\%$ of the area. For the whole beach, 0.92(10,000) = 9,200 square feet should be free of the red tide. Be careful—this is *not* the answer. The question asks how much of the beach would still be covered by red tide, so subtract to get 10,000 – 9,200 = 800 square feet, (A).

19. A **Difficulty:** Medium

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: The solution to a system of equations is the point(s) where their graphs intersect. You can solve the system algebraically by setting the equations equal to each other, or you can solve it graphically using your calculator. Both equations are given in calculator-friendly format ($y = \ldots$), so graphing them is probably the more efficient approach. The graph looks like:



The solution point in the question is given as (a, b), so b represents the y-coordinate of the solution. The y-coordinates of the points of intersection are –3 and –1.25, so choice (A) is correct.

20. A **Difficulty:** Medium

Category: Passport to Advanced Math / Functions

Getting to the Answer: The given range value is an output value, so substitute 3 for $g(x)$ and use inverse operations to solve for x, which is the corresponding domain value.

$$\begin{aligned} g(x) &= \frac{2}{3}x + 7 \\ 3 &= \frac{2}{3}x + 7 \\ -4 &= \frac{2}{3}x \\ -12 &= 2x \\ -6 &= x \end{aligned}$$

Choice (A) is correct. Note that you could also graph the function and find the value of x (the domain value) for which the value of y (the range value) is 3. The point on the graph is (−6, 3).

21. C **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Write your own equation using the initial cost and the rate of change in the value of the lawn mower. Remember—when something changes at a constant rate, it can be represented by a linear equation. When a linear equation in the form $y = mx + b$ is used to model a real-world scenario, m represents the constant rate of change, and b represents the starting amount. Here, the starting amount is easy—it's the purchase price, $2,800. To find the rate of change, think of the initial cost as the value at 0 years, or the point (0, 2,800), and the salvage amount as the value at 8 years, or the point (8, 240). Substitute these points into the slope formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{240 - 2{,}800}{8 - 0} = \frac{-2{,}560}{8} = -320$$

The correct equation is $y = -320x + 2{,}800$. This matches (C).

22. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Functions

Getting to the Answer: Determine whether the change in the number of bacteria is a common difference (linear function) or a common ratio (exponential function) or if the number of bacteria changes direction (quadratic or polynomial function). The question tells you that the number of bacteria is reduced by half every hour after the antibiotic is applied. The microbiologist started with 20,000, so after one hour, there are 10,000 left, or $20{,}000 \times \frac{1}{2}$. After 2 hours, there are 5,000 left, or $20{,}000 \times \frac{1}{2} \times \frac{1}{2}$, and so on. The change in the number of bacteria is a common ratio $\left(\frac{1}{2}\right)$, so the best model is an exponential function, (D), of the form $y = a\left(\frac{1}{2}\right)^x$. In this scenario, a is 20,000.

23. B **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Let the units in this question guide you to the solution. The speeds of the airplanes are given in miles per hour, but the question asks about the number of miles each airplane can travel in 12 seconds, so convert miles per hour to miles per second and multiply by 12 seconds.

Slower airplane:

$$\frac{600 \text{ mi}}{\cancel{\text{hr}}} \times \frac{1 \cancel{\text{hr}}}{60 \cancel{\text{min}}} \times \frac{1 \cancel{\text{min}}}{60 \cancel{\text{sec}}} \times 12 \cancel{\text{sec}} = 2 \text{ mi}$$

Faster airplane:

$$\frac{720 \text{ mi}}{\cancel{\text{hr}}} \times \frac{1 \cancel{\text{hr}}}{60 \cancel{\text{min}}} \times \frac{1 \cancel{\text{min}}}{60 \cancel{\text{sec}}} \times 12 \cancel{\text{sec}} = 2.4 \text{ mi}$$

The faster plane can travel 2.4 − 2 = 0.4 miles farther, which is the same as $\frac{2}{5}$ miles, (B).

24. C **Difficulty:** Medium

Category: Heart of Algebra / Inequalities

Getting to the Answer: Based on the data in the

table, a worker would earn \$9.10 − \$7.25 = \$1.85 more for one hour of work in Oregon than in Idaho. If he worked 35 hours per week, he would earn 35(1.85) = \$64.75 more. If he worked 40 hours per week, he would earn 40(1.85) = \$74 more. So, the worker would earn somewhere between \$64.75 and \$74 more per week, which can be expressed as the compound inequality $64.75 \leq x \leq 74$. This matches (C).

25. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: This is another question where the units can help you find the answer. Use the number of vehicles owned to find the total number of miles driven to find the total number of gallons of gas used to find the total tax paid. Phew!

$$1.75 \text{ vehicles} \times \frac{11{,}340 \text{ miles}}{\text{vehicle}} = 19{,}845 \text{ miles}$$

$$19{,}845 \text{ miles} \times \frac{1 \text{ gallon of gas}}{21.4 \text{ miles}} = 927.336 \text{ gallons}$$

$$927.336 \text{ gallons} \times \frac{\$0.184}{\text{gallon}} = \$170.63$$

Choice (D) is correct.

26. C **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Scatterplots

Getting to the Answer: The average rate of change of a function over a given interval, from a to b, compares the change in the outputs, $f(b) - f(a)$, to the change in the inputs, $b - a$. In other words, it is the slope of the line that connects the endpoints of the interval, so you can use the slope formula. Look at the quadratic model, not the data points, to find that the endpoints of the given interval, week 2 to week 8, are (2, 280) and (8, 400). The average rate of change is $\frac{400 - 280}{8 - 2} = \frac{120}{6} = 20$, so the dolphin's weight increased by about 20 pounds per week, (C).

27. A **Difficulty:** Hard

Category: Additional Topics in Math / Geometry

Getting to the Answer: In this question, information is given in both the diagram and the text. You need to relate the text to the diagram, one piece of information at a time, to calculate how long the lifeguard ran along the beach and how long he swam. Before you find the swim time, you need to know how *far* he swam. Whenever you see a right triangle symbol in a diagram, you should think Pythagorean theorem or, in this question, special right triangles. All multiples of 3-4-5 triangles are right triangles, so the length of the lifeguard's swim is the hypotenuse of a 30-40-50 triangle, or 50 feet. Add this number to the diagram. Now calculate the times using the distances and the speeds given. Don't forget the 1 second that the lifeguard paused.

$$\text{Run time} = 60 \text{ ft} \times \frac{1 \text{ sec}}{12 \text{ ft}} = \frac{60}{12} = 5 \text{ sec}$$

Pause time = 1 second

$$\text{Swim time} = 50 \text{ ft} \times \frac{1 \text{ sec}}{5 \text{ ft}} = \frac{50}{5} = 10 \text{ sec}$$

Total time = 5 + 1 + 10 = 16 seconds, (A).

28. B **Difficulty:** Hard

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Call the initial amount A. After you've written your equation, solve for A.

Amount now (x) = Initial amount (A) minus y, plus 50

$$x = A - y + 50$$
$$x + y - 50 = A$$

The initial amount was $x + y - 50$ gallons, (B). Note that you could also use Picking Numbers to answer this question.

29. B **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: When a question involves

reading data from a graph, it is sometimes better to skip an answer choice if it involves long calculations. Skim the answer choices for this question—A involves finding two averages, each of which is composed of 7 data values. Skip this choice for now. Start with (B). Be careful—you are not looking for places where the line segments are increasing. The *y*-axis already represents the change in prices, so you are simply counting the number of positive values for the imports (5) and for the exports (4). There are more for the imports, so (B) is correct and you don't need to check any of the other statements. Move on to the next question.

30. D **Difficulty:** Hard

Category: Passport to Advanced Math / Exponents

Getting to the Answer: The key to answering this question is deciding what you're trying to find. The question tells you that x represents the athlete's swim rate, and you are looking for the number of kilometers he swam in one hour—these are the same thing. If you find x (in kilometers per hour), you will know how many kilometers he swam in one hour. Set the equation equal to the total time, 16.2, and solve for x. To do this, write the variable terms over a common denominator, $10x$, and combine them into a single term. Then cross-multiply and go from there.

$$\begin{aligned} 16.2 &= \frac{10}{10}\left(\frac{3.86}{x}\right) + \frac{180.2}{10x} + \frac{2}{2}\left(\frac{42.2}{5x}\right) \\ 16.2 &= \frac{38.6}{10x} + \frac{180.2}{10x} + \frac{84.4}{10x} \\ 16.2 &= \frac{303.2}{10x} \\ 10x(16.2) &= 303.2 \\ 162x &= 303.2 \\ x &= \frac{303.2}{162} \approx 1.87 \end{aligned}$$

Choice (D) is correct.

31. 1 **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Choose the best strategy to answer the question. If you distribute the $\frac{2}{3}$, it creates messy calculations. Instead, clear the fraction by multiplying both sides of the equation by 3. Then use the distributive property and inverse operations to solve for x.

$$\begin{aligned} \frac{2}{3}(5x + 7) &= 8x \\ \cancel{3} \cdot \frac{2}{\cancel{3}}(5x + 7) &= 3 \cdot 8x \\ 2(5x + 7) &= 24x \\ 10x + 14 &= 24x \\ 14 &= 14x \\ 1 &= x \end{aligned}$$

32. 192 **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Before you start substituting values, quickly check that the units given match the units required to use the equation—they do, so proceed. The patient's weight (w) is 150 and the patient's BSA is $2\sqrt{2}$, so the equation becomes $2\sqrt{2} = \sqrt{\frac{150h}{3{,}600}}$. The only variable left in the equation is h, and you are trying to find the patient's height, so you're ready to solve the equation. To do this, square both sides of the equation and then continue using inverse operations. Be careful when you square the left side—you must square both the 2 and the root 2.

$$\begin{aligned} 2\sqrt{2} &= \sqrt{\frac{150h}{3{,}600}} \\ \left(2\sqrt{2}\right)^2 &= \left(\sqrt{\frac{150h}{3{,}600}}\right)^2 \\ 2^2\left(\sqrt{2}\right)^2 &= \frac{150h}{3{,}600} \\ 4(2) &= \frac{150h}{3{,}600} \\ 28{,}800 &= 150h \\ 192 &= h \end{aligned}$$

33. 3.4 **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: The test average is the same as the mean of the data. The *mean* is the sum of all the values divided by the number of values. Break the question into short steps to keep your calculations organized. Before gridding in your answer, make sure you answered the right question (how much the final test average changes).

Step 1: Find the original test average:

$$\frac{86 + 92 + 81 + 64 + 83}{5} = \frac{406}{5} = 81.2$$

Step 2: Find the average of the tests after replacing the lowest score (64) with the next to lowest score (81):

$$\frac{86 + 92 + 81 + 81 + 83}{5} = \frac{423}{5} = 84.6$$

Step 3: Subtract the original average from the new average: 84.6 – 81.2 = 3.4.

34. 40 **Difficulty:** Hard

Category: Additional Topics in Math / Geometry

Getting to the Answer: Because $\overline{AB}$, $\overline{CD}$, and $\overline{EF}$ are diameters, the sum of x, y, and the interior angle of the shaded region is 180 degrees. The question tells you that the shaded region is $\frac{1}{5}$ of the circle, so the interior angle must equal $\frac{1}{5}$ of the degrees in the whole circle, or $\frac{1}{5}$ of 360. Use what you know about y (that it is equal to $2x - 12$) and what you know about the shaded region (that it is $\frac{1}{5}$ of 360 degrees) to write and solve an equation.

$$\begin{aligned} x + y + \frac{1}{5}(360) &= 180 \\ x + (2x - 12) + 72 &= 180 \\ 3x + 60 &= 180 \\ 3x &= 120 \\ x &= 40 \end{aligned}$$

35. 14 **Difficulty:** Hard

Category: Heart of Algebra / Linear Equations

Getting to the Answer: When you know the slope and one point on a line, you can use $y = mx + b$ to write the equation. The slope is given as $-\frac{7}{4}$, so substitute this for m. The point is given as (4, 7), so $x = 4$ and $y = 7$. Now, find b:

$$\begin{aligned} y &= mx + b \\ 7 &= -\frac{7}{\cancel{4}}(\cancel{4}) + b \\ 7 &= -7 + b \\ 14 &= b \end{aligned}$$

The y-intercept of the line is 14.

You could also very carefully graph the line using the given point and the slope. Start at (4, 7) and move toward the y-axis by rising 7 and running *to the left* 4 (because the slope is negative). You should land at the point (0, 14).

36. 45 **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Make a chart that represents rate, time, and distance and fill in what you know.

	Rate	Time	Distance
To airport	45 mph	t	d
Back to home	30 mph	$2.5 - t$	d

Now use the formula $d = r \times t$ for both parts of the trip: $d = 45t$ and $d = 30(2.5 - t)$. Because both are

equal to d, you can set them equal to each other and solve for t:

$$\begin{aligned} 45t &= 30(2.5 - t) \\ 45t &= 75 - 30t \\ 75t &= 75 \\ t &= 1 \end{aligned}$$

Now plug the value of t back in to solve for d:

$$\begin{aligned} d &= 45t \\ d &= 45(1) \\ d &= 45 \end{aligned}$$

37. 10 **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: You don't need to know chemistry to answer this question. All the information you need is in the table. Use the formula $\text{Percent} = \frac{\text{part}}{\text{whole}} \times 100\%$. To use the formula, find the part of the mass represented by the carbon; there is 1 mole of carbon, and it has a mass of 12.011 grams. Next, find the whole mass of the mole of chloroform: 1 mole carbon (12.011 g) + 1 mole hydrogen (1.008 g) + 3 moles chlorine ($3 \times 35.453 = 106.359$ g) = $12.011 + 1.008 + 106.359 = 119.378$. Now use the formula:

$$\begin{aligned} \text{Percent} &= \frac{12.011}{119.378} \times 100\% \\ &= 0.10053 \times 100\% \\ &= 10.053\% \end{aligned}$$

Before you grid in your answer, make sure you follow the directions—round to the nearest whole percent, which is 10.

38. 12 **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Think about the units given in the question and how you can use what you know to find what you need. Start with grams of chloroform; the chemist starts with 1,000 and uses 522.5, so there are $1{,}000 - 522.5 = 477.5$ grams left. From the previous question, you know that 1 mole of chloroform has a mass of 119.378 grams, so there are $477.5 \div 119.378 = 3.999$, or about 4 moles of chloroform left. Be careful—you're not finished yet. The question asks for the number of moles of *chlorine*, not chloroform. According to the table, each mole of chloroform contains 3 moles of chlorine, so there are $4 \times 3 = 12$ moles of chlorine left.

MATH TEST

25 Minutes—20 Questions

NO-CALCULATOR SECTION

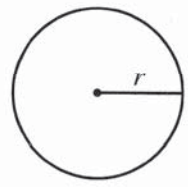
Turn to Section 3 of your answer sheet to answer the questions in this section.

Directions: For this section, solve each problem and decide which is the best of the choices given. Fill in the corresponding oval on the answer sheet. You may use any available space for scratch work.

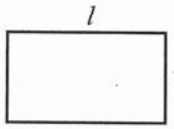
Notes:

1. Calculator use is NOT permitted.
2. All numbers used are real numbers.
3. All figures used are necessary to solving the problems that they accompany. All figures are drawn to scale EXCEPT when it is stated that a specific figure is not drawn to scale.
4. Unless stated otherwise, the domain of any function f is assumed to be the set of all real numbers x, for which $f(x)$ is a real number.

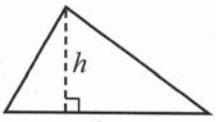
Information:



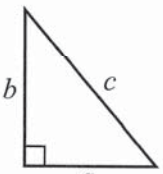
$A = \pi r^2$
$C = 2\pi r$



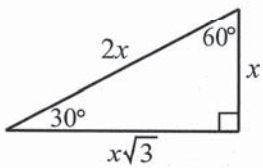
$A = lw$

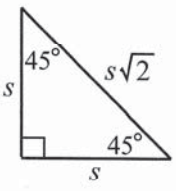


$A = \frac{1}{2}bh$

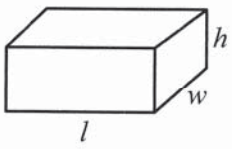


$c^2 = a^2 + b^2$

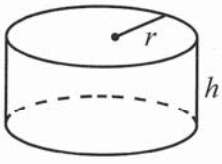




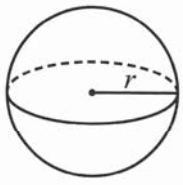
Special Right Triangles



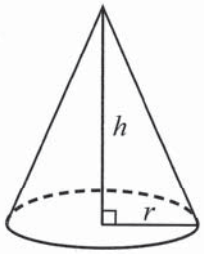
$V = lwh$



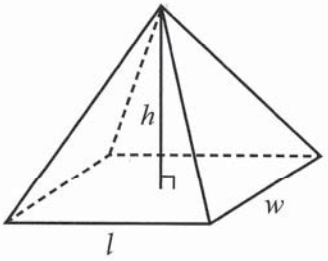
$V = \pi r^2 h$



$V = \frac{4}{3}\pi r^3$



$V = \frac{1}{3}\pi r^2 h$



$V = \frac{1}{3}lwh$

The sum of the degree measures of the angles in a triangle is 180.

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π.

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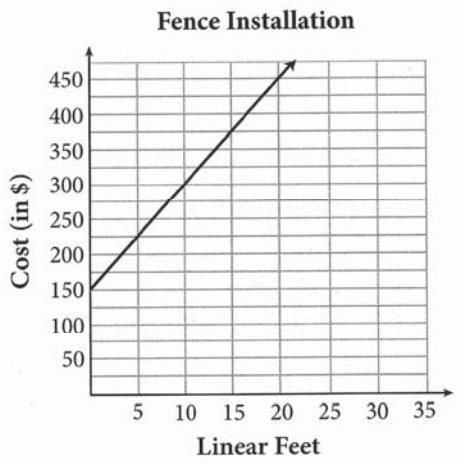


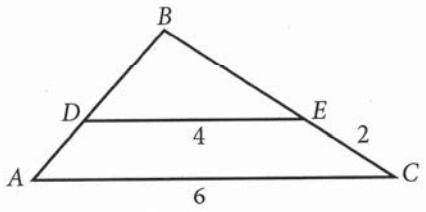
1. The graph shows the cost of installing a vinyl privacy fence. The company charges a flat installation fee plus a cost per linear foot of fencing. Based on the graph, how much does one linear foot of this particular vinyl fence cost?

   A) $5
   B) $15
   C) $75
   D) $150

$$\frac{24x^4 + 36x^3 - 12x^2}{12x^2}$$

2. Which of the following expressions is equivalent to the expression shown above?

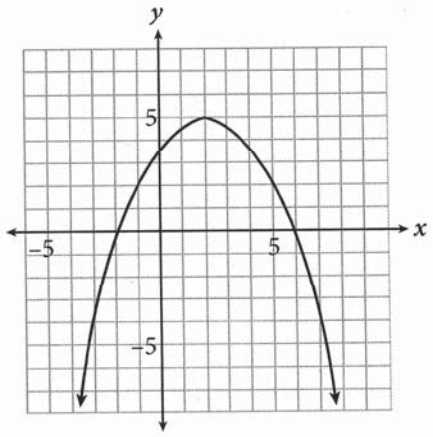
   A) $2x^2 + 3x$
   B) $24x^4 + 36x^3$
   C) $2x^2 + 3x - 1$
   D) $24x^4 + 36x^3 - 1$



Note: Figure not drawn to scale.

3. In the figure shown, $\Delta ABC \sim \Delta DBE$. What is the length of $\overline{BE}$?

   A) 3.5
   B) 3.75
   C) 4
   D) 4.5



4. Which of the following represents the function shown?

   A) $f(x) = -\frac{1}{3}(x-2)^2 + 5$
   B) $f(x) = -\frac{1}{3}(x+2)^2 + 5$
   C) $f(x) = \frac{1}{3}(x+2)^2 + 5$
   D) $f(x) = 3(x-2)^2 + 5$

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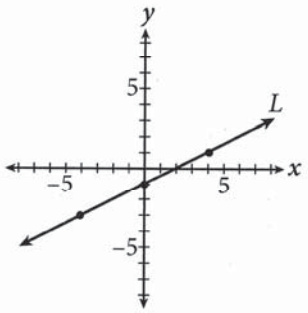


5. If line L shown here is reflected over the x-axis, what is the slope of the new line?

A) -2

B) $-\frac{1}{2}$

C) $\frac{1}{2}$

D) 2

6. If $p = 4x^3 + x - 2$, $q = x^2 - 1$, and $r = 3x - 5$, then what is $2p - (q + r)$?

A) $7x^3 - x + 2$

B) $8x^3 - x^2 - x + 2$

C) $8x^3 - x^2 - x - 10$

D) $8x^3 - x^2 + 5x - 8$

7. Which of the following are the roots of the equation $2x^2 + 4x - 3 = 0$?

A) $\frac{-2 \pm \sqrt{10}}{2}$

B) $-2 \pm \sqrt{5}$

C) $-1 \pm \sqrt{10}$

D) $-1 \pm 2\sqrt{10}$

8. If $g(x) = 3x - 5$ and $h(x) = \frac{7x + 10}{4}$, at what point does the graph of $g(x)$ intersect the graph of $h(x)$?

A) $(-2, -11)$

B) $(-2, 1)$

C) $(3, 4)$

D) $(6, 13)$

9. If $x = k^{-\frac{1}{3}}$, where $x > 0$ and $k > 0$, which of the following equations gives k in terms of x?

A) $k = \frac{1}{x^3}$

B) $k = \frac{1}{\sqrt[3]{x}}$

C) $k = -\sqrt[3]{x}$

D) $k = -x^3$

$$4x - (10 - 2x) = c(3x - 5)$$

10. If the equation shown has infinitely many solutions, and c is a constant, what is the value of c?

A) -2

B) $-\frac{2}{3}$

C) $\frac{2}{3}$

D) 2

11. If $0 < 1 - \frac{a}{3} \leq \frac{1}{2}$, which of the following is not a possible value of a?

A) 1.5

B) 2

C) 2.5

D) 3

GO ON TO THE NEXT PAGE

$$\begin{cases} y - \frac{2}{k}x \leq 0 \\ \frac{1}{k}x - \frac{1}{2}y \leq -1 \end{cases}$$

12. If the system of inequalities shown has no solution, what is the value of k ?

A) 1

B) 2

C) There is no value of k that results in no solution.

D) There are infinitely many values of k that result in no solution.

$$\frac{4x}{x-7} + \frac{2x}{2x-14} = \frac{70}{2(x-7)}$$

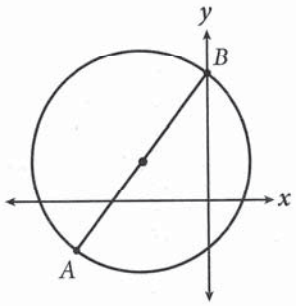
13. What value(s) of x satisfy the equation above?

A) 0

B) 7

C) No solution

D) Any value such that $x \neq 7$



14. The circle shown is given by the equation $x^2 + y^2 + 6x - 4y = 12$. What is the shortest distance from A to B ?

A) 5

B) 10

C) $4\sqrt{3}$

D) 24

15. If g is a function defined over the set of all real numbers and $g(x-1) = 3x^2 + 5x - 7$, then which of the following defines $g(x)$?

A) $g(x) = 3x^2 - x - 9$

B) $g(x) = 3x^2 + 5x + 1$

C) $g(x) = 3x^2 + 11x + 1$

D) $g(x) = 3x^2 + 11x - 6$

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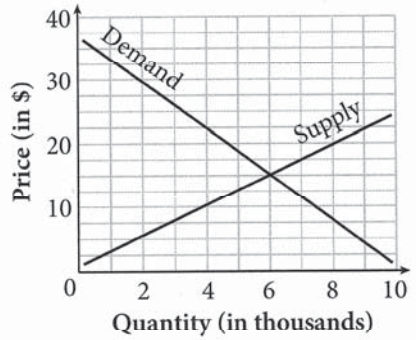


16. Retail businesses strive to price their products so that they sell as many as possible without losing money. Economic equilibrium is the price point at which the supply for a product is equal to the demand for that product. The graph above models this scenario. According to the graph, at what price in dollars will supply equal demand for this particular product?

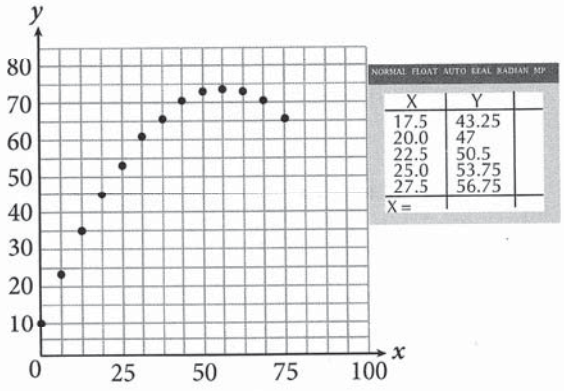
17. Once an insect reaches its larval stage, its mass increases linearly for a short period of time and then slows down as it prepares to enter pupation. Suppose the larva of a certain species has an initial mass of 10 grams and grows linearly from $t = 0$ to $t = 48$ hours of its larval stage. If after 48 hours, the mass of the larva is 14 grams, what was its mass in grams at $t = 6$ hours ?

x	$f(x)$
−1	−2
0	0
1	2
2	4
3	6

x	$g(x)$
−2	3
−1	2
0	1
1	−1
2	−2

18. Several values for the functions $f(x)$ and $g(x)$ are shown in the tables. What is the value of $f(g(-1))$?

19. If $(4 + 3i)(1 - 2i) = a + bi$, then what is the value of a ? (Note that $i = \sqrt{-1}$.)



20. The maximum value of the data shown in the scatterplot occurs at $x = 56.25$. If the data is modeled using a quadratic regression and the model is an exact fit, then what is the y-value when $x = 90$?

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST. **STOP**

MATH TEST

55 Minutes—38 Questions

CALCULATOR SECTION

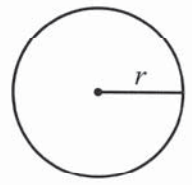
Turn to Section 4 of your answer sheet to answer the questions in this section.

Directions: For this section, solve each problem and decide which is the best of the choices given. Fill in the corresponding oval on the answer sheet. You may use any available space for scratch work.

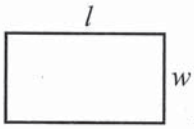
Notes:

1. Calculator use is permitted.
2. All numbers used are real numbers.
3. All figures used are necessary to solving the problems that they accompany. All figures are drawn to scale EXCEPT when it is stated that a specific figure is not drawn to scale.
4. Unless stated otherwise, the domain of any function f is assumed to be the set of all real numbers x, for which $f(x)$ is a real number.

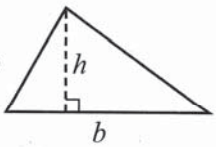
Information:



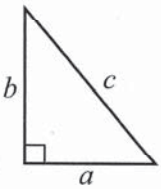
$A = \pi r^2$
$C = 2\pi r$



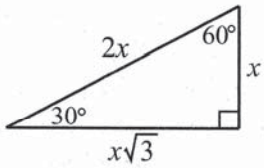
$A = lw$

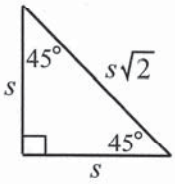


$A = \frac{1}{2}bh$

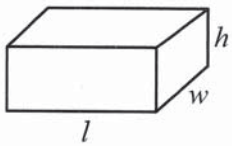


$c^2 = a^2 + b^2$

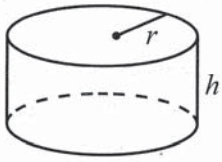




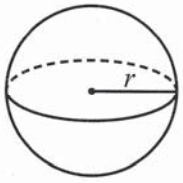
Special Right Triangles



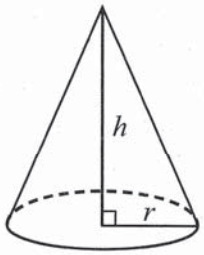
$V = lwh$



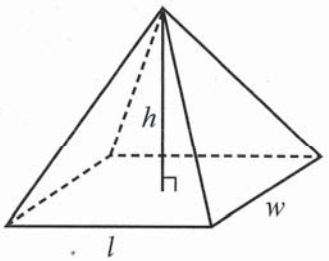
$V = \pi r^2 h$



$V = \frac{4}{3}\pi r^3$



$V = \frac{1}{3}\pi r^2 h$



$V = \frac{1}{3}lwh$

The sum of the degree measures of the angles in a triangle is 180.

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is 2π.

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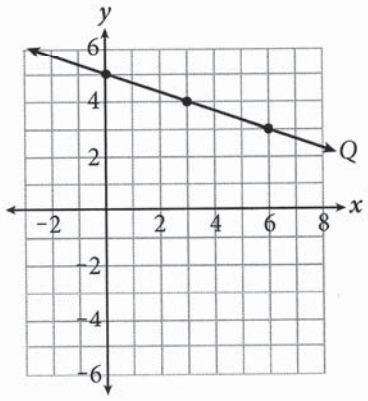
1. The U.S. Centers for Disease Control recommends that adults engage in 2.5 hours per week of vigorous exercise. A local health society conducts a survey to see if people are meeting this goal. They ask 100 people with gym memberships how many minutes of exercise they engage in per week. After analyzing the data, the health society finds that the average respondent exercises 142 minutes per week, but the margin of error was approximately 36 minutes. The society wants to lower this margin of error. Using which of the following samples instead would do so?

   A) 50 people with gym memberships
   B) 50 people randomly selected from the entire adult population
   C) 100 people with gym memberships, but from a variety of gyms
   D) 200 people randomly selected from the entire adult population

2. As a general rule, businesses strive to maximize revenue and minimize expenses. An office supply company decides to try to cut expenses by utilizing the most cost-effective shipping method. The company determines that the cheapest option is to ship boxes of ballpoint pens and mechanical pencils with a total weight of no more than 20 pounds. If each pencil weighs 0.2 ounces and each pen weighs 0.3 ounces, which inequality represents the possible number of ballpoint pens, b, and mechanical pencils, m, the company could ship in a box and be as cost-effective as possible? (There are 16 ounces in 1 pound.)

   A) $0.3b + 0.2m < 20 \times 16$
   B) $0.3b + 0.2m \leq 20 \times 16$
   C) $\frac{b}{0.3} + \frac{m}{0.2} < 20 \times 16$
   D) $\frac{b}{0.3} + \frac{m}{0.2} \leq 20 \times 16$



3. Where will line Q shown in the graph intersect the x-axis?

   A) 13
   B) 14
   C) 15
   D) 16

4. The function $f(x)$ is defined as $f(x) = 2g(x)$, where $g(x) = x + 5$. What is the value of $f(3)$?

   A) -4
   B) 6
   C) 8
   D) 16

5. A printing company uses a color laser printer that can print 18 pages per minute (ppm) when printing on thick cardstock paper. One of the company's best sellers on the Internet is business cards, which are sold in boxes of 225 cards. The cards are printed 10 per page, then cut and boxed. If a real estate company has 12 full-time agents and orders two boxes of cards per agent, how many minutes should it take to print the cards, assuming the printer runs continuously?

   A) 15
   B) 20
   C) 30
   D) 45

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6. If $0.002 \leq x \leq 0.2$ and $5 \leq y \leq 25$, what is the maximum value of $\frac{x}{y}$?

A) 0.04
B) 0.4
C) 4
D) 40

7. Following a study of children in the United States under three years old, the American Academy of Pediatrics stated that there is a positive correlation between the amount of time spent watching television and the likelihood of developing an attention deficit disorder. Which of the following is an appropriate conclusion to draw from this statement?

A) There is an association between television time and attention disorders for American children under three years old.
B) There is an association between television time and attention disorders for all children under three years old.
C) An increase in attention disorders is caused by an increase in television time for American children under three years old.
D) An increase in attention disorders is caused by an increase in television time for all children under three years old.

8. A bicyclist is training for the Liège-Bastogne-Liège, one of Europe's oldest road bicycle races. The line graph above shows the number of miles she biked each week for eight weeks. According to the graph, what was the greatest change (in absolute value) in the weekly number of miles she biked between two consecutive weeks?

A) 7
B) 8
C) 9
D) 10

9. If a line that passes through the coordinates $(a - 1, 2a)$ and $(a, 6)$ has a slope of 5, what is the value of a?

A) -2
B) $-\frac{1}{2}$
C) $\frac{1}{2}$
D) 2

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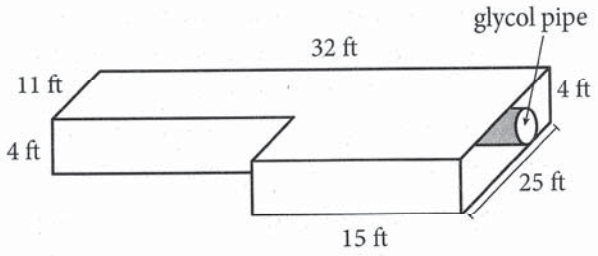
10. An occupational health organization published a study showing an increase in the number of injuries that resulted from elderly people falling in the bathtub. In response to this increase, a medical supply company decided to drop its price on bathtub lifts from $450 to $375, hoping to still break even on the lifts. The company breaks even when its total revenue (income from selling n bathtub lifts) is equal to its total cost of producing the lifts. If the cost C, in dollars, of producing the lifts is $C = 225n + 3{,}150$, how many more of the lifts does the company need to sell at the new price to break even than at the old price?

A) 7
B) 12
C) 14
D) 21

Questions 11 and 12 refer to the following information.

A zoo is building a penguin exhibit. It will consist of an underwater area and a land area. The land area is made of thick sheets of ice. An outline of the total space covered by the ice is shown below. A pipe 2 feet in diameter runs the full length of the exhibit under the ice. A substance known as ice-cold glycol continuously runs through the pipe to keep the ice frozen.



11. About how many cubic feet of water are needed to create the ice portion of the exhibit?

A) 1,850
B) 2,150
C) 2,450
D) 3,100

12. The zoo is planning to hire a company to fill the space with water. The company plans to use two 4-inch hoses that can each pump 60 gallons of water per minute. About how long should it take to fill the space? (There are 7.48 gallons of water in 1 cubic foot of ice.)

A) 1 hour
B) 1 hour, 30 minutes
C) 1 hour, 55 minutes
D) 2 hours, 15 minutes

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13. Which of the following quadratic equations has no solution?

A) $0 = -2(x - 5)^2 + 3$

B) $0 = -2(x - 5)(x + 3)$

C) $0 = 2(x - 5)^2 + 3$

D) $0 = 2(x + 5)(x + 3)$

Questions 14 and 15 refer to the following information.

Three airplanes depart from three different airports at 8:30 AM, all travelling to Chicago O'Hare International Airport (ORD). The distances the planes must travel are recorded in the following table.

From	Distance to Chicago (ORD)
Kansas City (MCI)	402
Boston (BOS)	864
Miami (MIA)	1,200

14. The plane traveling from Boston traveled at an average speed of 360 mph. The plane traveling from Kansas City arrived at 10:34 AM. How many minutes before the plane from Boston arrived did the plane from Kansas City arrive?

A) 20

B) 28

C) 42

D) 144

15. For the first $\frac{1}{4}$ of the trip, the plane from Miami flew through heavy winds and dense cloud cover at an average speed of 200 mph. For the remaining portion of the trip, the weather was ideal, and the plane flew at an average speed of 450 mph. Due to a backlog of planes at ORD, it was forced to circle overhead in a holding pattern for 25 minutes before landing. At what time did the plane from Miami land in Chicago?

A) 12:00 PM

B) 12:25 PM

C) 12:50 PM

D) 1:15 PM

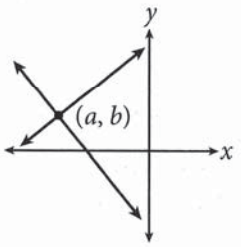
16. If $h(t) = \sqrt{t^2 + 9}$ for all real values of t, which of the following is not in the range of $h(t)$?

A) 1

B) 3

C) 9

D) 10



17. If (a, b) represents the solution to the system of equations shown in the graph and $a = -3b$, then which of the following could be the value of $a + b$?

A) -9

B) 0

C) 3

D) 6

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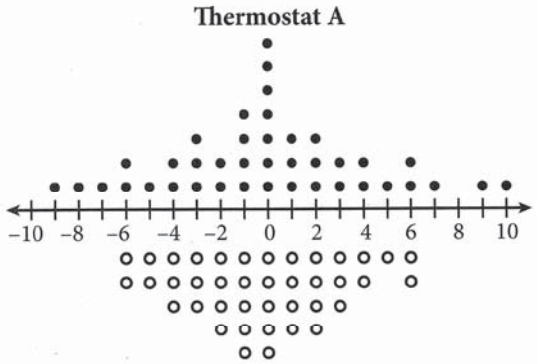


18. A car manufacturer tested two types of thermostats to determine which one it wanted to use in a new model of car. The more consistently the thermostat engages the engine's cooling fan, the better the cooling system performs over the long run. The double dot plot above shows the test results, given the following conditions:

- Zero indicates that the cooling fan engaged at exactly the temperature at which the thermostat was set (the target temperature).
- Negative numbers indicate that the fan engaged below the target temperature.
- Positive numbers indicate that the fan engaged above the target temperature.
- The safe range for the fan to engage is 10 degrees above or below the target temperature.

Which of the following best states which thermostat the car manufacturer is likely to choose and why?

A) Thermostat A because the median of the data is 0, and the range is greater than that of Thermostat B

B) Thermostat B because the median of the data is 0, and the range is less than that of Thermostat A

C) Thermostat A because the mode of the data is 0, which indicates a more consistent thermostat

D) Thermostat B because the data is bimodal (has two modes), which indicates a more consistent thermostat

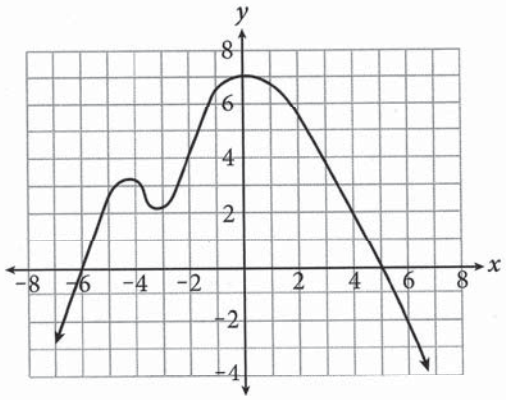
19. If p and q represent the zeros of a quadratic function and $p + q = -3$, which of the following could be the factored form of the function?

A) $f(x) = (x - 3)(x + 3)$

B) $f(x) = (x - 4)(x + 1)$

C) $f(x) = (x - 1)(x + 4)$

D) $f(x) = (x - 6)(x + 3)$



20. The figure above shows the graph of $p(x) - 4$. What is the value of $p(0)$?

A) 3

B) 4

C) 7

D) 11

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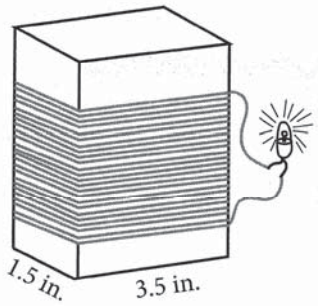
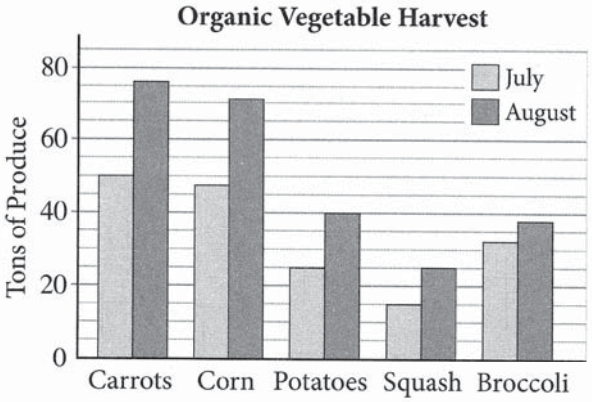


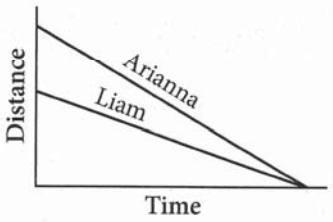
21. Geraldine is making a simple AC electric generator for a science project using copper wire, cardboard, a nail, and magnets. The first step in building the generator is wrapping the wire around and around a rectangular prism made from the cardboard and connecting it to a small lightbulb, as shown in the figure. If Geraldine has 18 feet of wire and needs to leave 3 inches on each end to connect to the lightbulb, how many times can she wrap the wire around the cardboard prism?

A) 21
B) 28
C) 35
D) 42



22. The bar graph above shows the vegetable harvest, in tons, at an organic produce farm during July and August. Of the following, which best approximates the percent increase in the harvest of squash at this farm from July to August?

A) 67%
B) 60%
C) 53%
D) 40%



23. Arianna and her brother Liam both walk home from school each day, but they go to different schools. The figure shows their trip home on Monday. Based on the graph, which of the following statements is true?

A) It took Liam longer to walk home because his school is farther away.
B) It took Arianna longer to walk home because her school is farther away.
C) Arianna and Liam walked home at the same rate.
D) Arianna walked home at a faster rate than Liam.

24. If line L passes through the points $(-4, -8)$ and $(8, 1)$, which of the following points does line L not pass through?

A) $(0, -5)$
B) $(4, -1)$
C) $(12, 4)$
D) $(16, 7)$

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	Unemployed	Employed	Totals
Female Degree	12	188	200
Female No Degree	44	156	200
Male Degree	23	177	200
Male No Degree	41	159	200
Totals	120	680	800

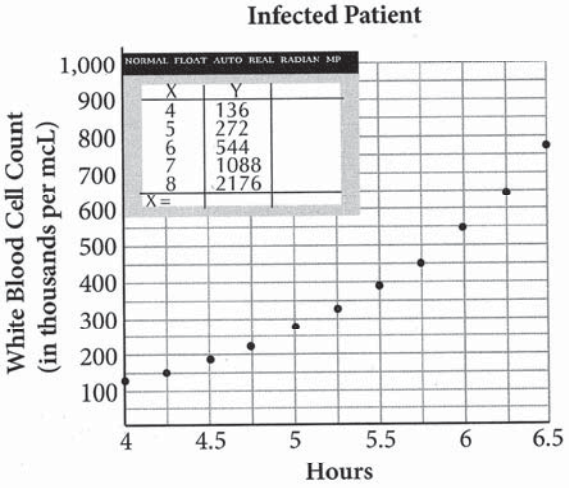
25. The table above shows the results of a sociological study identifying the number of males and females with and without college degrees who were unemployed or employed at the time of the study. If one person from the study is chosen at random, what is the probability that that person is an employed person with a college degree?

A) $\frac{73}{160}$

B) $\frac{10}{17}$

C) $\frac{17}{20}$

D) $\frac{73}{80}$



26. Typically, when people contract an infectious disease, their immune system immediately begins to produce extra white blood cells to fight the disease. The scatterplot shows the white blood cells reproducing in an infected patient, along with several values found when modeling the data using a graphing calculator. According to this model, how many white blood cells per microliter of blood did the patient have before he contracted the disease?

A) 3,400

B) 8,500

C) 10,000

D) 13,600

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27. A rodeo is building a circular arena. The arena will have a total area of 64π square yards and can either be left open for rodeo competitions or divided into 12 equal sections through the center for auctions. When holding auctions, the rodeo has an average of 4 bulls and 8 horses for sale. A bull cannot be placed in a section directly beside another section containing a bull, and all edges of these sections must be reinforced with strong steel to keep the bulls from getting out. Which of the following represents how much steel in yards the rodeo will need to reinforce the four bull sections?

A) 32π

B) 64π

C) $32 + \frac{16\pi}{3}$

D) $64 + \frac{16\pi}{3}$

28. Lena bought a saltwater fish tank that holds 400 gallons of water. She started filling the tank on Friday, but then stopped after putting only 70 gallons of water in the tank. On Saturday, she bought a bigger hose and began filling the tank again. It took her 1 hour and 50 minutes on Saturday to completely fill the tank. Which equation represents the number of gallons of water in the fish tank on Saturday, given the amount of time in minutes that Lena spent filling the tank?

A) $y = 3x + 70$

B) $y = 3x + 330$

C) $y = 70x + 330$

D) $y = 110x + 70$

29. A self-storage company has three sizes of storage units. The ratio of small to medium units is 3:5. The ratio of medium to large units is 3:2. The company analyzes its business model and current consumer demand and determines that it can benefit from utilizing larger economies of scale. In other words, it decides to grow its business based on current economic conditions and plans to build a second, larger self-storage building. The company's research indicates that the new market would benefit from having only two sizes of storage units, small and large, in the same ratio as its current facility. What ratio of small to large units should it use?

A) 1:1

B) 3:2

C) 5:3

D) 9:10

$$\frac{1}{x} + \frac{3}{x} = \frac{1}{7}$$

30. The equation shown above represents the following scenario: A chemical laboratory uses two air purifiers to clean the air of contaminants emitted while working with hazardous materials. One is an older model, and the other is a new model that is considerably more energy efficient. The new model can clean the air of contaminants three times as quickly as the older model. Working together, the two air purifiers can clean the air in the lab in 7 hours. Which of the following describes what the term $\frac{1}{x}$ in the equation represents?

A) The portion of the air the older model can clean in 1 hour

B) The portion of the air the new model can clean in 1 hour

C) The time it takes the older model to clean the air by itself

D) The time it takes the older model to clean $\frac{1}{7}$ of the air by itself

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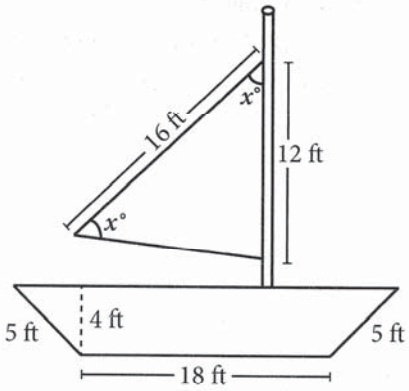
$$\frac{1}{3}(90x - 12) = \frac{1}{2}(8x + 10)$$

31. What is the solution to the equation shown?

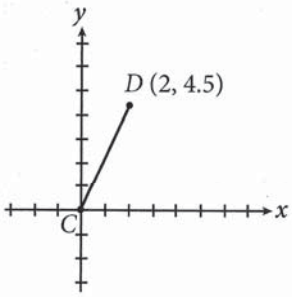
32. If $n^{\frac{5}{2}} = 32$, what is the value of n?

33. When a thrift store gets used furniture in good condition to sell, it researches the original price and then marks the used piece down by 40% of that price. On the first day of each of the following months, the price is marked down an additional 15% until it is sold or it reaches 30% of its original price. Suppose the store gets a piece of used furniture on January 15th. If the piece of furniture costs $1,848 new, and it is sold on March 10th of the same year, what is the final selling price, not including tax? Round your answer to the nearest whole dollar.



Note: Figure not drawn to scale.

34. Many sailboat manufacturers sell kits that include instructions and all the materials needed to build a simple sailboat. The figure shows the finished dimensions of a sailboat from such a kit. The instructions indicate that $\cos x° = b$, but do not give the value of b. What is the value of b?



35. In the figure shown, line B (not shown) is parallel to $\overline{CD}$ and passes through the point $(0, -1)$. If line B also passes through the point $(2, y)$, what is the value of y?

36. Recycling of certain metals has been a common practice dating back to preindustrial times. For example, there is evidence of scrap bronze and silver being collected and melted down for reuse in a number of European countries. Today, there are recycling companies and even curbside collection bins for recycling. As a general rule, recycling companies pay for metals by weight. Suppose a person brings in 3 pounds of copper and receives $8.64, and 24 ounces of nickel and receives $10.08. If another person brings in equal weights of copper and nickel, what fractional portion of the money would he receive from the copper? (There are 16 ounces in 1 pound.)

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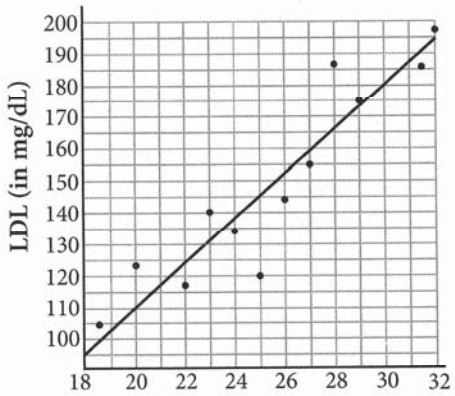
Questions 37 and 38 refer to the following information.

Body mass index, or BMI, is one of several measures used by doctors to determine a person's health as indicated by weight and height. Low-density lipoprotein, or LDL cholesterol, known as the "bad" cholesterol, is another health indicator and consists of fat proteins that clog arteries. Following are the results of a study showing the relationship between BMI and LDL for 12 individuals and the line of best fit for the data.



37. How many of the 12 people have an actual LDL that differs by 10 or more mg/dL from the LDL predicted by the line of best fit?

38. According to the line of best fit, what is the closest whole number BMI approximation for a person that has an estimated LDL level of 140 mg/dL ?

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS SECTION ONLY. DO NOT TURN TO ANY OTHER SECTION IN THE TEST. STOP

MATH—NO CALCULATOR TEST

1. B	**6. B**	**11. D**	**16. 15**
2. C	**7. A**	**12. D**	**17. 10.5** or **21/2**
3. C	**8. D**	**13. C**	**18. 4**
4. A	**9. A**	**14. B**	**19. 10**
5. B	**10. D**	**15. C**	**20. 50.5**

MATH—CALCULATOR TEST

1. D	**11. B**	**21. A**	**31. 9/26** or **.346**
2. B	**12. D**	**22. A**	**32. 4**
3. C	**13. C**	**23. D**	**33. 801**
4. D	**14. A**	**24. B**	**34. 2/3** or **.666** or **.667**
5. C	**15. B**	**25. A**	**35. 3.5** or **7/2**
6. A	**16. A**	**26. B**	**36. 3/10**
7. A	**17. A**	**27. D**	**37. 3**
8. D	**18. B**	**28. A**	**38. 24**
9. C	**19. C**	**29. D**	
10. A	**20. D**	**30. A**	

match the antecedent. Use the word "everyone" in a simple sentence to determine if it's singular or plural: for example, "Everyone goes." "Everyone" is a singular pronoun referring to a person, so it requires a singular possessive pronoun. Using the plural "their" is accepted only in informal usage. Choice (D) is the correct answer because it correctly matches the antecedent in number and appropriately identifies both gender options, since the antecedent did not specify a gender.

40. A **Difficulty:** Medium

Category: Punctuation

Getting to the Answer: Determine the need for punctuation within the sentence. "For" and "from" are both prepositions, a clue that both phrases are correctly set off with commas. Because both phrases are dependent on the remainder of the sentence, they are correctly connected with commas. Choice (A) is correct.

41. B **Difficulty:** Easy

Category: Sentence Formation

Getting to the Answer: In a sentence with a series of actions, make sure all verbs or verb forms are parallel. Focusing on the action verbs, it becomes clear that they should all end in "*-ing*." Inconsistencies in this pattern result in a lack of parallel structure. Choice (B) is correct, as it uses the gerund form (nouns formed by adding "*-ing*" to verbs) of all four action verbs.

42. D **Difficulty:** Medium

Category: Sentence Formation

Getting to the Answer: Identify the subject and predicate of each sentence to determine if it is a complete sentence or a fragment. As the sentences are written in A, the first one is an incomplete sentence, or fragment. Only (D) correctly and concisely combines the two to eliminate the fragment.

43. C **Difficulty:** Medium

Category: Effective Language Use

Getting to the Answer: Often, when a sentence is long, it's a good idea to see if there are ways to edit out certain words or phrases to make the sentence more concise. Choice (C) is correct. By leaving out the phrase "though she is losing her summer," this answer choice conveys the intended meaning of the sentence with logical and concise language.

44. B **Difficulty:** Medium

Category: Quantitative

Getting to the Answer: Make sure you understand the information conveyed by the graphic's labels before you attempt to choose the correct answer. The passage informs you that Kelli's chosen field is oil and energy, represented by the bar on the far right of the graphic. Choice (B) is the correct answer, as it matches the number of oil and energy interns per 1,000 hires noted on the *y*-axis.

MATH—NO CALCULATOR TEST

1. B **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: In a real-world scenario, the slope of a line represents a unit rate and the *y*-intercept represents a flat fee or a starting amount. The cost of one linear foot is the same as the unit rate (the cost per linear foot), which is represented by the slope of the line. Use the grid-lines and the axis labels to count the rise and the run from the *y*-intercept of the line (0, 150) to the next point that hits an intersection of two grid-lines. Pay careful attention to how the grid-lines are marked (by 5s on the *x*-axis and by 25s on the *y*-axis). The line rises 75 units and runs 5 units, so the slope is $\frac{75}{5} = 15$ dollars per linear foot of fence, which is (B). Note that you could also use the slope formula and two points from the graph to find the unit rate.

2. C **Difficulty:** Easy

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Don't be tempted—you can't simply cancel one term when a polynomial is divided by a monomial. Instead, find the greatest common factor of *both* the numerator and the denominator. Factor out the GCF from the numerator and from the denominator, and then you can cancel it. The GCF is $12x^2$.

$$\frac{24x^4 + 36x^3 - 12x^2}{12x^2}$$
$$= \frac{\cancel{12x^2}(2x^2 + 3x - 1)}{\cancel{12x^2}}$$
$$= 2x^2 + 3x - 1$$

This matches (C).

3. C **Difficulty:** Easy

Category: Additional Topics in Math / Geometry

Getting to the Answer: Corresponding sides of similar triangles are proportional, so write a proportion (paying careful attention to the order of the sides) using the sides that you know and the side that you're looking for. Then, solve the proportion for the missing side.

Call the missing side x. Write a proportion using words first, and then fill in the lengths of the sides that you know:

$$\frac{\text{right side small}\Delta}{\text{base of small}\Delta} = \frac{\text{right side large}\Delta}{\text{base of large}\Delta}$$
$$\frac{x}{4} = \frac{2 + x}{6}$$
$$6x = 4(2 + x)$$
$$6x = 8 + 4x$$
$$2x = 8$$
$$x = 4$$

The length of $\overline{BE}$ is 4, so (C) is correct.

4. A **Difficulty:** Easy

Category: Passport to Advanced Math / Quadratics

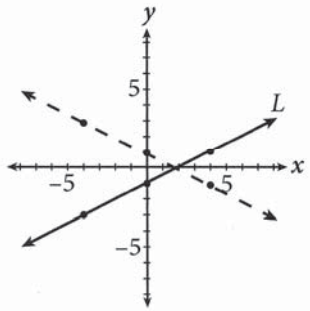
Getting to the Answer: Recognizing the different forms of a quadratic equation can save valuable time on Test Day. Each of the answer choices is given in vertex form, so start by matching the vertex of the parabola in the graph to the correct equation.

When a quadratic equation is written in vertex form, $y = a(x - h)^2 + k$, the vertex is (h, k). The vertex of the parabola in the graph is (2, 5); therefore, the equation should look like $y = a(x - 2)^2 + 5$. This means you can eliminate B and C. To choose between (A) and D, consider the value of a. The parabola in the graph opens downward, so a must be negative. This means (A) is correct.

5. B **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: You can approach this question conceptually or concretely. Drawing a quick sketch is most likely the safest approach. Line L shown in the graph rises from left to right, so it has a positive slope. Once reflected over the x-axis, it will fall from left to right, so the new line will have a negative slope. This means you can eliminate C and D. Now, draw a quick sketch of the reflected line on the coordinate plane in your test booklet and count the rise (or fall) and the run from one point to the next.



The reflected line falls 2 units and runs 4 units, so the slope is $-\frac{2}{4}$, which reduces to $-\frac{1}{2}$, making (B) the correct choice.

6. B **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: To answer this question, you need to combine like terms, being careful to distribute negative signs where appropriate. Break the calculation into steps: Find $2p$, find $q + r$, and then subtract the results. Arranging the terms in descending order will help keep them organized.

$$2p = 2(4x^3 + x - 2) = 8x^3 + 2x - 4$$
$$q + r = x^2 - 1 + 3x - 5 = x^2 + 3x - 6$$
$$\begin{aligned} 2p - (q + r) &= 8x^3 + 2x - 4 - (x^2 + 3x - 6) \\ &= 8x^3 + 2x - 4 - x^2 - 3x + 6 \\ &= 8x^3 - x^2 + 2x - 3x - 4 + 6 \\ &= 8x^3 - x^2 - x + 2 \end{aligned}$$

This matches (B).

7. A **Difficulty:** Medium

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: The roots of an equation are the same as its solutions. The answer choices contain radicals, which tells you that the equation can't be factored. Instead, either complete the square or solve the equation using the quadratic formula, whichever you are most comfortable using. The equation is already written in the form $y = ax^2 + bx + c$ and the coefficients are fairly small, so using the quadratic formula is probably the quickest method. Jot down the values that you'll need: $a = 2$, $b = 4$, and $c = -3$. Then, substitute these values into the quadratic formula and simplify:

$$\begin{aligned} x &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\ &= \frac{-(4) \pm \sqrt{(4)^2 - 4(2)(-3)}}{2(2)} \\ &= \frac{-4 \pm \sqrt{16 + 24}}{4} \\ &= \frac{-4 \pm \sqrt{40}}{4} \end{aligned}$$

This is not one of the answer choices, so simplify the radical. To do this, look for a perfect square that divides into 40 and take its square root.

$$\begin{aligned} x &= \frac{-4 \pm \sqrt{4 \times 10}}{4} \\ &= \frac{-4 \pm 2\sqrt{10}}{4} \\ &= \frac{-2 \pm \sqrt{10}}{2} \end{aligned}$$

Be careful—you can't simplify the answer any further because you cannot divide the square root of 10 by 2, so (A) is correct.

8. D **Difficulty:** Medium

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Although this question asks where the *graphs* of the functions intersect, it is not necessary to actually graph them. Two graphs intersect at the point where they have the same x-value and the same y-value. The notations $g(x)$ and $h(x)$ can both be interpreted as "the y-value at a given value of x," so set $g(x)$ equal to $h(x)$ and solve for x. Then, if needed, plug this value into either function to find the corresponding y-value. Don't let the fraction intimidate you—you can write $g(x)$ as a fraction over 1 and use cross-multiplication.

$$\frac{3x-5}{1} = \frac{7x+10}{4}$$
$$4(3x-5) = 7x+10$$
$$12x-20 = 7x+10$$
$$5x = 30$$
$$x = 6$$

There is only one answer choice for which the x-coordinate is 6, (D), so the graphs of the functions will intersect at (6, 13).

9. A **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: When you write an equation *in terms of* a specific variable, you are simply solving the equation for that variable. In this question, you'll need to relate fractional exponents to radicals and understand how to use negative exponents. Be careful—you're not just rewriting the equation, you're solving it for k.

Raising a quantity to the one-third power is the same as taking its cube root. Applying a negative exponent to a quantity is the same as writing its reciprocal. Rewrite the equation using these properties and then solve for k using inverse operations. Note that the inverse of taking a cube root of a quantity is cubing the quantity.

$$x = k^{-\frac{1}{3}}$$
$$x = \frac{1}{\sqrt[3]{k}}$$
$$(x)^3 = \left(\frac{1}{\sqrt[3]{k}}\right)^3$$
$$x^3 = \frac{1}{k}$$
$$kx^3 = 1$$
$$k = \frac{1}{x^3}$$

Choice (A) is correct.

10. D **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: There are two variables and only one equation, so you can't actually solve the equation for c. Instead, recall that an equation has infinitely many solutions when the left side is identical to the right side. When this happens, everything cancels out and you get the equation $0 = 0$, which is always true.

Start by simplifying the left side of the equation. Don't forget to distribute the negative sign to both terms inside the parentheses.

$$4x - (10 - 2x) = c(3x - 5)$$
$$4x - 10 + 2x = c(3x - 5)$$
$$6x - 10 = c(3x - 5)$$

Next, quickly compare the left side of the equation to the right side. Rather than distributing the c, notice that if c were 2, then both sides of the equation would equal $6x - 10$, and it would have infinitely many solutions. Therefore, c is 2, which is (D).

11. D **Difficulty:** Medium

Category: Heart of Algebra / Inequalities

Getting to the Answer: You don't need to separate this compound inequality into pieces. Just remember, whatever you do to one piece, you must do to all three pieces. Don't forget to flip the inequality symbols if you multiply or divide by a negative number. Here, the fractions make it look more complicated than it really is, so start by clearing the fractions by multiplying everything by the least common denominator, 6.

$$0 < 1 - \frac{a}{3} \leq \frac{1}{2}$$
$$6(0) < 6\left(1 - \frac{a}{3}\right) \leq 6\left(\frac{1}{2}\right)$$
$$0 < 6 - 2a \leq 3$$
$$-6 < -2a \leq -3$$
$$3 > a \geq \frac{3}{2}$$
$$1.5 \leq a < 3$$

Now, read the inequality symbols carefully. The value of a is between 1.5 and 3, including 1.5, but *not* including 3, so (D) is the correct answer.

12. D **Difficulty:** Hard

Category: Heart of Algebra / Inequalities

Getting to the Answer: The only way a system of inequalities can have no solution is if the graph consists of two parallel lines with shading in opposite directions so that there is no overlap.

Start by writing each equation in slope-intercept form to help you envision what the graphs will look like. You'll need to multiply the second equation by −2, so don't forget to flip the inequality symbol.

$$y - \frac{2}{k}x \leq 0 \rightarrow y \leq \frac{2}{k}x$$

$$\frac{1}{k}x - \frac{1}{2}y \leq -1 \rightarrow -\frac{1}{2}y \leq -\frac{1}{k}x - 1$$

$$\rightarrow y \geq \frac{2}{k}x + 2$$

Now, think about the graphs. The first equation has a slope of $\frac{2}{k}$, a y-intercept of 0, and is shaded below the line. The second equation also has a slope of $\frac{2}{k}$, but it has a y-intercept of 2 and is shaded above the line. This means that no matter what value of k is used (other than 0), the two lines are parallel and shaded in opposite directions, and thus there are infinitely many values of k that result in a system with no solution, (D).

13. C **Difficulty:** Hard

Category: Passport to Advanced Math / Exponents

Getting to the Answer: When solving a rational equation, start by getting a common denominator. Then, you can set the numerators equal and solve for the variable. Don't forget, however: If the answer produces zero in any denominator, then it is not a valid answer. The denominators are almost the same already; you just need to multiply the top and bottom of the first term by 2, factor the denominator of the second term, and you'll be ready to solve the equation.

$$\frac{2}{2}\left(\frac{4x}{x-7}\right) + \frac{2x}{2x-14} = \frac{70}{2(x-7)}$$

$$\frac{8x}{2(x-7)} + \frac{2x}{2(x-7)} = \frac{70}{2(x-7)}$$

Now that the denominators are all the same, you can solve the equation represented by the numerators.

$$8x + 2x = 70$$
$$10x = 70$$
$$x = 7$$

Be careful—this isn't the correct answer. Because there are variables in the denominator, you must check the solution to make sure it isn't extraneous, or in other words, doesn't cause a 0 in the denominator of any term. Here, if $x = 7$, then all of the denominators are zero (and division by zero is not possible), so the equation has no solution, (C).

14. B **Difficulty:** Hard

Category: Additional Topics in Math / Geometry

Getting to the Answer: The shortest distance from A to B is through the center of the circle, along the diameter, which is twice the radius. When the equation of a circle is written in the form $(x-h)^2 + (y-k)^2 = r^2$, you can easily find the center and the radius of the circle. To find r, complete the square for the x terms and for the y terms. Start by reordering the terms. Then, take the coefficient of the x term and divide it by 2, square it, and add the result to the two terms with x variables. Do the same with the y term. Remember, you must also add these amounts to the other side of the equation. This creates a perfect square of x terms and y terms, and the equation will look more like a circle.

$$x^2 + y^2 + 6x - 4y = 12$$
$$x^2 + 6x + y^2 - 4y = 12$$
$$(x^2 + 6x + 9) + (y^2 - 4y + 4) = 12 + 9 + 4$$
$$(x + 3)^2 - (y - 2)^2 = 25$$

This means that the radius of the circle is $\sqrt{25} = 5$, so the diameter is 10, which is also the distance from *A* to *B*, making (B) correct. Note that you can do a quick check of your work by looking at the center; according to the equation, the center is (−3, 2), which appears to match the location of the center on the graph.

15. C **Difficulty:** Hard

Category: Passport to Advanced Math / Functions

Getting to the Answer: The key to answering this question is in having a conceptual understanding of function notation. Here, the input $(x - 1)$ has already been substituted and simplified in the given function. Your job is to determine what the function would have looked like had x been the input.

To keep things organized, let $u = x - 1$, the old input. This means $x = u + 1$. Substitute this into g and simplify:

$$\begin{aligned} g(x - 1) &= 3x^2 + 5x - 7 \\ g(u) &= 3(u + 1)^2 + 5(u + 1) - 7 \\ &= 3(u^2 + 2u + 1) + 5u + 5 - 7 \\ &= 3u^2 + 6u + 3 + 5u + 5 - 7 \\ &= 3u^2 + 11u + 1 \end{aligned}$$

This means $g(u) = 3u^2 + 11u + 1$. When working with function notation, you evaluate the function by substituting a given input value for the variable in the parentheses. Here, if the input value is x, then $g(x) = 3x^2 + 11x + 1$, which matches (C).

16. 15 **Difficulty:** Easy

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: The equilibrium price occurs when the supply and demand are equal. Graphically, this means where the two lines intersect. The lines intersect at the point (6, 15). You can see from the axis labels that price is plotted along the *y*-axis, so the equilibrium price is $15.

17. 10.5 or **21/2** **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: The key word in this question is *linear*. In a real-world scenario that involves a constant rate of change, you almost always need to find the slope and the initial amount so you can write an equation. The question states that the initial mass of the larva was 10 grams, so all you need to do is find the slope.

Write the information given in the question as ordered pairs (time, mass) so you can find the slope. At $t = 0$, the larva has a mass of 10 grams, so one pair is (0, 10). After 48 hours, the larva has a mass of 14 grams, so a second pair is (48, 14). Now, use the slope formula:

$$\begin{aligned} m &= \frac{y_2 - y_1}{x_2 - x_1} \\ &= \frac{14 - 10}{48 - 0} \\ &= \frac{4}{48} = \frac{1}{12} \end{aligned}$$

The equation is $y = \frac{1}{12}x + 10$, where y represents the mass of the larva after x hours. Substitute 6 for x to find the mass after 6 hours: $\frac{1}{12}(6) + 10 = \frac{6}{12} + 10 = 10.5$ grams.

18. 4 **Difficulty:** Medium

Category: Passport to Advanced Math / Functions

Getting to the Answer: The notation $f(g(x))$ indicates a composition of two functions which is read "f of g of x." It means that the output when x is substituted in $g(x)$ becomes the input for $f(x)$. Use the second table to find that $g(-1)$ is 2. This is your new input. Now, use the first table to find $f(2)$, which is 4.

19. 10 **Difficulty:** Medium

Category: Additional Topics in Math / Imaginary Numbers

Getting to the Answer: Multiply the two complex numbers just as you would two binomials (using FOIL). Then, combine like terms. The question tells you that $i = \sqrt{-1}$. If you square both sides of the equation, this is the same as $i^2 = -1$, which is a more useful fact.

$$\begin{aligned}(4 + 3i)(1 - 2i) &= 4(1 - 2i) + 3i(1 - 2i)\\ &= 4 - 8i + 3i - 6i^2\\ &= 4 - 5i - 6(-1)\\ &= 4 - 5i + 6\\ &= 10 - 5i\end{aligned}$$

The question asks for a in $a + bi$, so the correct answer is 10.

20. 50.5 **Difficulty:** Hard

Category: Passport to Advanced Math / Scatterplots

Getting to the Answer: This question requires a conceptual understanding of modeling data and properties of quadratic functions. Because the regression model fits the data exactly, you can use what you know about quadratic functions to answer the question.

The graph of a quadratic function is symmetric with respect to its axis of symmetry. The axis of symmetry occurs at the x-value of the vertex, which also happens to be where the maximum (or minimum) of the function occurs. The question tells you this value—it's $x = 56.25$. Because $x = 90$ is 33.75 (because $90 - 56.25 = 33.75$) units to the right of the axis of symmetry, you know that the y-value will be the same as the point that is 33.75 units to the left of the axis of symmetry. This occurs at $x = 56.25 - 33.75 = 22.5$. Read the y-value from the graphing calculator screenshot to find the answer, which is 50.5.

MATH—CALCULATOR TEST

1. D **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: To reduce the margin of error, the society should use a larger sample size selected from a better representation of the population. The target population is *all* adults, not just those that have gym memberships. Using only adults with gym memberships is likely to skew the results because these respondents probably exercise considerably more than people who do not have gym memberships. This means (D) is correct.

2. B **Difficulty:** Easy

Category: Heart of Algebra / Inequalities

Getting to the Answer: Think about this question conceptually. If the box cannot weigh *more than* 20 pounds (or 20×16 ounces), this means it can weigh *that much or less*, so the right half of the inequality you are looking for is $\leq 20 \times 16$. This means you can eliminate A and C based on the inequality symbol. A box is made up of ballpoint pens, b, and mechanical pencils, m. Each pen weighs 0.3 ounces, and each pencil weighs 0.2 ounces. The total weight of the box would be the number of pens, b, multiplied by their weight, 0.3, added to the number of pencils, m, multiplied by their weight, 0.2. So the inequality is $0.3b + 0.2m \leq 20 \times 16$, which matches (B).

3. C **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Finding an *x*-intercept is easy when you know the equation of the line—it's the value of *x* when *y* is 0. Everything you need to write the equation is shown on the graph. The *y*-intercept is 5 and the line falls 1 unit and runs 3 units from one point to the next, so the slope is $-\frac{1}{3}$. This means the equation of the line, in slope-intercept form, is $y = -\frac{1}{3}x + 5$. Now, set the equation equal to zero and solve for *x*:

$$0 = -\frac{1}{3}x + 5$$
$$\frac{1}{3}x = 5$$
$$x = 15$$

Line *Q* will intercept the *x*-axis at 15, which is (C).

4. D **Difficulty:** Easy

Category: Passport to Advanced Math / Functions

Getting to the Answer: When you see an expression such as $f(x)$, it means to substitute the given value for *x* in the function's equation. When there is more than one function involved, pay careful attention to which function should be evaluated first. You are looking for the value of $f(x)$ at $x = 3$. Because $f(x)$ is defined in terms of $g(x)$, evaluate $g(3)$ first by substituting 3 for *x* in the expression $x + 5$.

$$g(3) = 3 + 5 = 8$$
$$f(3) = 2g(3) = 2(8) = 16$$

Choice (D) is correct.

5. C **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Pay careful attention to the units. As you read the question, decide how and when you will need to convert units. In this problem, work backward—you need to know how many pages of cards will be printed. To find this number, you first need to know how many cards will be printed. So, start with the number of agents (which tells you the number of boxes) and multiply by the number of cards per box:

$$12 \text{ agents} \times \frac{2 \text{ boxes}}{1 \text{ agent}} \times \frac{225 \text{ cards}}{1 \text{ box}} = 5{,}400 \text{ cards}$$

Next, use the information about *pages* to finish the calculations:

$$5{,}400 \text{ cards} \times \frac{1 \text{ page}}{10 \text{ cards}} \times \frac{1 \text{ minute}}{18 \text{ pages}} = 30 \text{ minutes}$$

This means (C) is correct.

6. A **Difficulty:** Medium

Category: Heart of Algebra / Inequalities

Getting to the Answer: The question is asking about $\frac{x}{y}$, so think about how fractions work. Larger numerators result in larger values $\left(\frac{3}{2}\right.$, for example, is greater than $\left.\frac{1}{2}\right)$, and smaller denominators result in larger values $\left(\frac{1}{2}\right.$, for example, is greater than $\left.\frac{1}{4}\right)$. The largest possible value of $\frac{x}{y}$ is found by choosing the largest possible value for *x* and the smallest possible value for *y* which gives $\frac{0.2}{5} = 0.04$, or (A).

7. A **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: Results from a study can only be generalized to the population from which the sample was taken. Also, keep in mind that positive correlations do not prove causation. The study was conducted by the American Academy of Pediatrics on children in the United States under three, so the sample is American children under three, which

means conclusions can only be drawn about *this* population. Also, because correlations do not prove causation, the only conclusion that can be drawn is that there is an association between television time and attention disorders for American children under three years old, (A).

8. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: The greatest change (in absolute value) in miles ridden per week could be an increase or a decrease. You don't have to worry about whether the change is positive or negative, so to keep things simple, always subtract the smaller number from the larger number. Make a list to show the changes in miles ridden per week between each pair of consecutive weeks. Save yourself some time by skipping weeks that clearly have smaller changes, such as between weeks 1 and 2 and between weeks 3 and 4.

Weeks 2-3: $72 - 64 = 8$

Weeks 4-5: $78 - 70 = 8$

Weeks 5-6: $85 - 78 = 7$

Weeks 6-7: $85 - 75 = 10$

Weeks 7-8: $82 - 75 = 7$

Of the differences, the greatest is from week 6 to week 7, which is a change of 10 miles, making (D) correct.

9. C **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Given two points (even when the coordinates are variables), the slope of the line is $\frac{y_2 - y_1}{x_2 - x_1}$. You are given a numerical value for the slope and a pair of coordinate points with variables. To find the value of a, plug the points into the slope formula, and then solve for a:

$$\begin{aligned}
\text{Slope} &= \frac{y_2 - y_1}{x_2 - x_1} \\
5 &= \frac{6 - 2a}{a - (a - 1)} \\
5 &= \frac{6 - 2a}{1} \\
5 &= 6 - 2a \\
-1 &= -2a \\
\frac{1}{2} &= a
\end{aligned}$$

Choice (C) is correct.

10. A **Difficulty:** Hard

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Questions about breaking even usually involve creating a system of equations (one for cost and one for revenue), setting the equations equal to each other, and solving for the variable. Create a system of equations at each price point using n for the number of bathtub lifts. Then solve each system. Note that the cost equation will be the same for both systems, and it is already given to you in the question.

$$\begin{aligned}
\text{Old Price: } C &= 225n + 3{,}150; R = 450n \\
C &= R \\
225n + 3{,}150 &= 450n \\
3{,}150 &= 225n \\
14 &= n
\end{aligned}$$

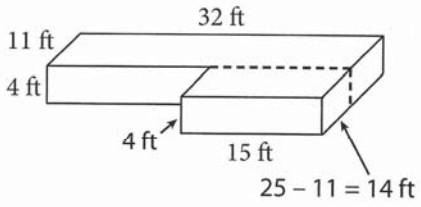
$$\begin{aligned}
\text{New Price: } C &= 225n + 3{,}150; R = 375n \\
C &= R \\
225n + 3{,}150 &= 375n \\
3{,}150 &= 150n \\
21 &= n
\end{aligned}$$

At the old price, the company needed to sell 14 lifts to break even. At the new price, it needs to sell 21 lifts, so it needs to sell $21 - 14 = 7$ more lifts at the new price to break even, which is (A).

11. B **Difficulty:** Medium

Category: Additional Topics in Math / Geometry

Getting to the Answer: The amount of water needed to create the ice portion of the exhibit is another way of saying the *volume* of the ice. So, you need to find the volume of the entire space and then subtract the volume of the cylinder that runs through the ice. The volume of a rectangular prism is given by $V = l \times w \times h$, and the volume of a cylinder equals the area of its base times its height, or $\pi r^2 h$. To determine the volume of the ice, start by decomposing the figure into two rectangular prisms and adding their volumes. You can decompose the figure left to right or front to back. Front to back, it looks like the following figure:



The prism in the back has a volume of 32 × 11 × 4 = 1,408 cubic feet. The prism in the front has a length of 15 feet and a height of 4 feet, but the width is missing. Find the missing width by subtracting 11 from 25, which is 14 feet. So, the volume of the prism in the front is 15 × 14 × 4 = 840 cubic feet. The total volume of the prisms is 1,408 + 840 = 2,248 cubic feet. Be careful—that's not the answer. You still need to find the amount of space taken up by the glycol pipe and subtract it. The diameter of the pipe is 2 feet, so its radius is 1 foot, and the height (or the length in this question) is 32 feet, so the volume is $\pi(1)^2(32) \approx 100.53$ cubic feet. This means the amount of ice needed is 2,248 – 100.53 = 2,147.47, or about 2,150 cubic feet, (B).

12. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Let the units in this question guide you to the answer. You'll also need to use the answer you found in the previous question. The company will use two hoses, each of which pumps at a rate of 60 gallons per minute, so the rate is actually 120 gallons per minute. Convert the volume you found earlier from cubic feet to gallons, and then use the rate to find the time.

$$2{,}150\ \cancel{ft^3} \times \frac{7.48\ \cancel{gal}}{1\ \cancel{ft^3}} \times \frac{1\ \text{min}}{120\ \cancel{gal}} = 134\ \text{minutes}$$

The answers are given in hours and minutes, so write 134 minutes as 2 hours and 14 minutes, or about 2 hours and 15 minutes, which is (D).

13. C **Difficulty:** Medium

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: The graph of every quadratic equation is a parabola, which may or may not cross the *x*-axis, depending on where its vertex is and which way it opens. Don't forget—if the equation is written in vertex form, $y = a(x - h)^2 + k$, then the vertex is (h, k), and the value of a tells you which way the parabola opens. The graph of an equation that has *no solution* does not cross the *x*-axis, so try to envision the graph of each of the answer choices. When a quadratic is written in factored form, the factors tell you the *x*-intercepts, which means every quadratic equation that can be written in factored form (over the set of real numbers) must have solutions. This means you can eliminate B and D. Now, imagine the graph of the equation in A: The vertex is (5, 3) and a is negative, so the parabola opens downward and consequently must cross the *x*-axis. This means you can eliminate A, and (C) must be correct. The graph of the equation in (C) has a vertex of (5, 3) and opens *up*, so it does not cross the *x*-axis and, therefore, has no solution.

You could also graph each of the answer choices in

your graphing calculator, but this is not the most time-efficient way to answer the question.

14. A **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Questions that involve distance, rate, and time can almost always be solved using the formula Distance = rate × time. Use the speed, or rate, of the plane from Boston, 360 mph, and its distance from Chicago, 864 mi, to determine when it arrived. You don't know the time, so call it t.

$$\begin{aligned} \text{Distance} &= \text{rate} \times \text{time} \\ 864 &= 360t \\ 2.4 &= t \end{aligned}$$

This means it took 2.4 hours for the plane to arrive. This is more than 2 full hours, so multiply 2.4 by 60 to find the number of minutes it took: 60 × 2.4 = 144 minutes. Now determine how long it took the plane from Kansas City. It left at 8:30 AM and arrived at 10:34 AM, so it took 2 hours and 4 minutes, or 124 minutes. This means the plane from Kansas City arrived 144 − 124 = 20 minutes before the plane from Boston, (A).

15. B **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Break the question into short steps (first part of trip, second part of trip, circling overhead). To get started, you'll need to find the distance for each part of the trip—the question only tells you the total distance. Then, use the formula Distance = rate × time to find how long the plane flew at 200 mph and then how long it flew at 450 mph.

$$\begin{aligned} \text{First part of trip: } \frac{1}{4} \times 1{,}200 &= 300 \text{ mi} \\ 300 &= 200t \\ t &= \frac{300}{200} = 1.5 \text{ hours} \\ 1.5 \times 60 &= 90 \text{ minutes} \end{aligned}$$

$$\begin{aligned} \text{Second part of trip: } \frac{3}{4} \times 1{,}200 &= 900 \text{ mi} \\ 900 &= 450t \\ t &= \frac{900}{450} = 2 \text{ hours} \\ 2 \times 60 &= 120 \text{ minutes} \end{aligned}$$

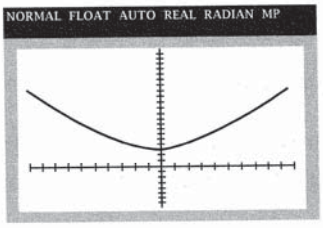
This means the plane flew for a total of 90 + 120 = 210 minutes. Next, add the time the plane circled overhead: 210 + 25 = 235 minutes. The total trip took 235 minutes (3 hours and 55 minutes), which means the plane landed at 8:30 + 3 hours = 11:30 + 55 minutes = 12:25 PM, (B).

16. A **Difficulty:** Medium

Category: Passport to Advanced Math / Functions

Getting to the Answer: The range of a function is the set of possible outputs, or y-values on a graph. For all real values of any number t, the value of t^2 cannot be negative. This means the smallest possible value of t^2 is 0 and, consequently, the smallest possible value of $h(t)$ is $h(0) = \sqrt{0^2 + 9} = \sqrt{9} = 3$. Thus, the number 1 is not in the range of the function, making (A) correct.

You could also graph the function in your graphing calculator and examine the possible y-values. The graph follows here:



Notice that the lowest point on the graph is (0, 3), which tells you that the range of the function is $h(t) \geq 3$.

17. A **Difficulty:** Medium

Category: Heart of Algebra / Systems of Linear Equations

Getting to the Answer: Graphically, the solution to a system of equations is the point or points where the graphs intersect. Whenever a graph with no grid-lines or axis labels is shown, you are usually interested primarily in the sign of the coordinates of a point, not the actual values. The graphs intersect in Quadrant 2 of the coordinate plane, so the x-value of the point of intersection (or a) is negative, and the y-value (or b) is positive. The question states that $a = -3b$, so you can eliminate B right away—the coordinates would have to be equal if their sum was 0. Now try Picking Numbers. Let $b = 1$, which means $a = -3$ and the sum of $a + b$ is -2, which is not one of the answer choices. Try another pair: If $b = 2$, then $a = -6$, and the sum is -4. This is still not one of the answer choices, but you should see a pattern—the x-coordinate will always overpower the y-coordinate, resulting in a negative sum, so the correct answer must be (A).

18. B **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: When comparing two data sets for consistency, consider both the data center (mean or median) and the spread (standard deviation or range). Each set of data has a median of 0, and Thermostat A also has a mode of 0. Both of these measures indicate good test results. However, Thermostat A has a greater range of data. If the company chooses this thermostat, the cooling fan is likely to engage anywhere from –9 degrees below the target temperature to 10 degrees above the target temperature. Although this is within the safe temperature range, it is not as consistent as Thermostat B, which engaged the fan within 6 degrees on either side of the target temperature. This means (B) is correct.

19. C **Difficulty:** Medium

Category: Passport to Advanced Math / Quadratics

Getting to the Answer: When a quadratic function is written in factored form, you can find its zeros by setting each factor equal to 0 and solving for the variable. Each of the answer choices is written in factored form, so mentally solve each one by asking yourself what number would make each factor equal to 0. Then find the sum of the results:

Choice A: $3 + (-3) \neq -3$. Eliminate.

Choice B: $4 + (-1) \neq -3$. Eliminate.

Choice (C): $1 + (-4) = -3$, so (C) is correct.

Choice D: $6 + (-3) \neq -3$. Eliminate.

20. D **Difficulty:** Hard

Category: Passport to Advanced Math / Functions

Getting to the Answer: A constant added or subtracted inside a function will shift the function left or right, while a constant added or subtracted from the outside will shift the function up or down. You're looking for the value of $p(0)$, but the graph shows $p(x) - 4$, which means the original graph has been shifted down 4 units. You'll need to find the y-value of the graph when $x = 0$, then add 4 to get back up to the original function. The graph passes through the point (0, 7), so $p(0) - 4 = 7$. Add 4 to both sides of the equation to get $p(0) = 7 + 4 = 11$, which is (D).

21. A **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Sometimes writing an equation is the quickest route to answering a question. Assign a variable to the unknown, write the equation in words, and then translate from English into math. The unknown in this question is the number of times Geraldine can wrap the wire around the

prism. Call this n. Now, write an equation in words: Total amount of wire equals distance around the prism times the number of wraps plus the extra on the ends. To fill in the numbers, you'll need to make a few calculations. Because the dimensions of the prism are given in inches, convert the amount of wire to inches as well: 18 ft = 18 × 12 = 216 inches. Next, figure out the distance around the prism using the picture. Don't forget, you have to go all the way around: 1.5 + 3.5 + 1.5 + 3.5 = 10 inches. Finally, read the question again to determine that the *extra on the ends* is 3 + 3 = 6 inches. Now you're ready to translate from English into math to write your equation, and then solve it.

$$\begin{aligned} 216 &= 10n + 6 \\ 210 &= 10n \\ 21 &= n \end{aligned}$$

Geraldine can wrap the wire around the prism 21 times, (A).

22. A **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: To find a percent change (increase or decrease), use the percent change formula:

$$\text{Percent change} = \frac{\text{new amount} - \text{original amount}}{\text{original amount}}$$

The question asks about the increase from July to August, so the original amount is the July harvest of squash and the new amount is the August harvest. Read the graph's key and the axis labels carefully. Each grid-line represents 5 tons, so the July squash harvest was 15 tons and the August harvest was 25 tons. Substitute these numbers into the percent change formula and simplify:

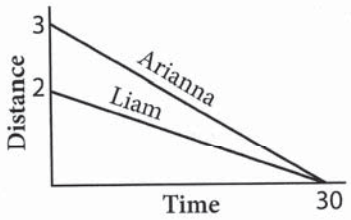
$$\begin{aligned} \text{Percent change} &= \frac{\text{new amount} - \text{original amount}}{\text{original amount}} \\ &= \frac{25 - 15}{15} \\ &= \frac{10}{15} \approx 0.667 \end{aligned}$$

This is equal to an increase of about 67%, which is (A).

23. D **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Add reasonable numbers to the graph to help you answer the question. An example follows:



Use the numbers to help you evaluate each statement. It took Liam and Arianna each 30 minutes to walk home, so A and B are incorrect. Arianna walked 3 miles in 30 minutes, while Liam only walked 2 miles in 30 minutes; their rates are not the same, so C is also incorrect. This means (D) must be true. Arianna started out farther away than Liam, so she must have walked at a faster rate to arrive at home in the same amount of time.

24. B **Difficulty:** Medium

Category: Heart of Algebra / Linear Equations

Getting to the Answer: The slopes between sets of points that lie on the same line are equal. You can find the slope between points using the slope formula or by looking for patterns. Before immediately jumping to the slope formula, take a peek at the answer choices—all the x-coordinates of the points are multiples of 4, so looking for a pattern is the quickest way to answer this question. It may help to put all the points in a table (including those given in the

question stem), with the x-coordinates arranged from smallest to largest, and then see which point doesn't fit the pattern.

x	y
−4	−8
0	−5
4	−1
8	1
12	4
16	7

Notice that all the x-coordinates increase by 4, while most of the y-coordinates increase by 3. For the slope between each pair of points to be equal, the y-coordinate at $x = 4$ would need to be −2, not −1, so the point given in (B) does not lie on the line.

25. A **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Statistics and Probability

Getting to the Answer: Identify which pieces of information from the table you need. The question asks for the probability that a randomly chosen person from the study is employed and has a college degree, so you need the total of both females and males with college degrees who are employed compared to all the participants in the study. There are 188 employed females with a college degree and 177 employed males with a college degree for a total of 365 employed people with a college degree out of 800 participants, so the probability is $\frac{365}{800}$, which reduces to $\frac{73}{160}$, (A).

26. B **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Scatterplots

Getting to the Answer: Translate from English into math: The number of cells in the original sample means the value of the function at 0 hours, or $f(0)$. The first x-value on the graph is 4, not 0, so you'll need to use the values shown in the calculator screenshot to write an equation for the model. Notice that the y-values in the calculator screenshot double as the x-values increase by 1. This means that the model is an exponential growth function of the form $f(x) = f(0) \cdot 2^x$. Choose a point from the calculator screenshot such as (4, 136), substitute the values into the function, and solve for $f(0)$:

$$136 = f(0) \cdot (2)^4$$
$$136 = f(0) \cdot 16$$
$$\frac{136}{16} = f(0)$$
$$8.5 = f(0)$$

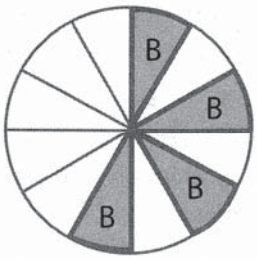
The y-axis title tells you that the numbers are given in thousands, so there were 8,500 white blood cells per microliter in the original sample, (B).

You could also work backward from the calculator screenshot by dividing by 2 four times (from 4 hours to 3 hours, 3 hours to 2 hours, 2 hours to 1 hour, and 1 hour to before the patient contracted the disease). The result is $136 \div 2^4 = 136 \div 16 = 8.5$, which in thousands is 8,500, (B).

27. D **Difficulty:** Hard

Category: Additional Topics in Math / Geometry

Getting to the Answer: Drawing a sketch is the key to answering this question. Your sketch might look like the one below.



Notice that two radii and an arc form each section, so the amount of steel needed for one section is the length of the radius times 2, plus the length of the outer arc. Once you know this, you can simply multiply by 4.

You are given the total area, which means you can find the radius by substituting 64π for A in the area formula, $A = \pi r^2$.

$$\begin{aligned} 64\pi &= \pi r^2 \\ 64 &= r^2 \\ 8 &= r \end{aligned}$$

For auctions, the arena is divided into 12 equal sections through the center, so divide 360 by 12 to find that the central angle measure for each section is 30°. Now use the arc length formula:

$$\begin{aligned} \frac{n^\circ}{360^\circ} \times 2\pi r &= \frac{30^\circ}{360^\circ} \times 2\pi(8) \\ &= \frac{1}{12} \times 16\pi \\ &= \frac{4\pi}{3} \end{aligned}$$

The amount of steel needed for one section is $8 + 8 + \frac{4\pi}{3} = 16 + \frac{4\pi}{3}$, so the amount needed for all four sections is $4\left(16 + \frac{4\pi}{3}\right) = 64 + \frac{16\pi}{3}$, which is (D).

28. A **Difficulty:** Hard

Category: Heart of Algebra / Linear Equations

Getting to the Answer: To write the equation of a line, you need two things—the starting amount (*y*-intercept) and the rate of change (slope). Substitute these values into slope-intercept form of a line ($y = mx + b$), and you have your equation.

The initial amount of water in the tank on Saturday is 70 gallons, so you already know b. To find m, you'll need to use the information given in the question to write two data points.

The amount of water in the tank *depends* on how long Lena has been filling it, so the number of gallons is the dependent variable and time is the independent variable. This tells you that the data points should be written in the form (time, gallons). At time = 0 on Saturday, the number of gallons is 70, so the data point is (0, 70). After 1 hour and 50 minutes, which is 60 + 50 = 110 minutes, the tank is full (400 gallons), so another data point is (110, 400).

Now, use the slope formula to find that the rate of change is $\frac{400 - 70}{110 - 0} = \frac{330}{110} = 3$ gallons per minute. Substituting m and b into slope-intercept form results in the equation $y = 3x + 70$, so (A) is correct.

29. D **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: You need to find the ratio of small units to large units. You're given two ratios: small to medium and medium to large. Both of the given ratios contain medium size units, but the medium amounts (5 and 3) are not identical. To directly compare them, find a common multiple (15). Multiply each ratio by the factor that will make the number of medium units equal to 15.

small to medium: (3:5) × (3:3) = 9:15

medium to large: (3:2) × (5:5) = 15:10

Now that the number of medium units needed is the same in both ratios, you can merge the two ratios to compare small to large directly: 9:15:10. Therefore, the proper ratio of small units to large units is 9:10, which is (D).

30. A **Difficulty:** Hard

Category: Passport to Advanced Math / Exponents

Getting to the Answer: Think of the rate given in the question in terms of the constant term you see on the right-hand side of the equation. Working together, the two air purifiers can clean the air in 7 hours. This is equivalent to saying that they can clean $\frac{1}{7}$ of the air in 1 hour. If $\frac{1}{7}$ is the portion of the air the two purifiers can clean *together* in 1 hour, then each term on the left side of the equation represents the portion that each purifier can clean *individually* in 1 hour. Because the new model is 3 times as fast as the older model, $\frac{3}{x}$ represents the portion

of the air the new model can clean in 1 hour, and $\frac{1}{x}$ represents the portion of the air the older model can clean in 1 hour, which is (A).

31. 9/26 or **.346** **Difficulty:** Easy

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Distribute the fractions because the numbers inside each set of parentheses are evenly divisible by the denominators of the fractions by which they are being multiplied.

$$\frac{1}{3}(90x - 12) = \frac{1}{2}(8x + 10)$$
$$30x - 4 = 4x + 5$$
$$26x = 9$$
$$x = \frac{9}{26}$$

32. 4 **Difficulty:** Medium

Category: Passport to Advanced Math / Exponents

Getting to the Answer: When solving any type of equation, you should always think of inverse operations. The inverse of raising a quantity to the $\frac{5}{2}$ power is raising it to the $\frac{2}{5}$ power. Eliminate the exponent using inverse operations and then go from there.

$$n^{\frac{5}{2}} = 32$$
$$\left(n^{\frac{5}{2}}\right)^{\frac{2}{5}} = (32)^{\frac{2}{5}}$$
$$n = 32^{\frac{2}{5}}$$

Now, you have two choices—you can enter this value into your calculator as 32^(2/5) or you can evaluate the number using rules of exponents:

$$32^{\frac{2}{5}} = (\sqrt[5]{32})^2 = 2^2 = 4$$

33. 801 **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Draw a chart or diagram detailing the various price reductions for each 30-day period. You'll need to make several calculations, so don't round until the final answer.

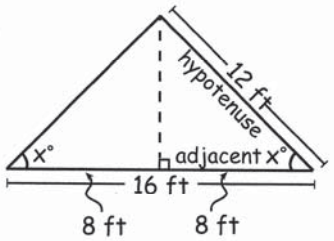
Date	% of Most Recent Price	Resulting Price
Jan. 15	100 – 40% = 60%	\$1,848 × 0.6 = \$1,108.80
Feb. 1	100 – 15% = 85%	\$1,108.80 × 0.85 = \$942.48
March 1	100 – 15% = 85%	\$942.48 × 0.85 = \$801.108

You can stop here because the item was sold on March 10th. Before gridding in your answer, check that \$801 is not less than 30% of the original price: 0.30 × \$1,848 = \$554.40. It's not, so the final selling price, rounded to the nearest whole dollar, was \$801.

34. 2/3 or **.666** or **.667** **Difficulty:** Hard

Category: Additional Topics in Math / Trigonometry

Getting to the Answer: Two angles of the triangle have equal measures, so the triangle is isosceles, which means that drawing an altitude from the top to the base will bisect the base, resulting in two smaller right triangles as shown here:



Now, use $\cos x° = \frac{\text{adjacent}}{\text{hypotenuse}}$ to find that $b = \frac{8}{12}$, which can be simplified to $\frac{2}{3}$.

35. 3.5 or **7/2** **Difficulty:** Hard

Category: Heart of Algebra / Linear Equations

Getting to the Answer: Remember that parallel lines have the same slope. Use the slope formula $m = \frac{y_2 - y_1}{x_2 - x_1}$ to find the slope of $\overline{CD}$. Because $\overline{CD}$ passes through the points (0, 0) and (2, 4.5), its slope is $\frac{4.5 - 0}{2 - 0} = 2.25$. Line B has the same slope and passes through $(0, -1)$, so you can use the slope formula again to find the y-coordinate of the given point, $(2, y)$.

$$2.25 = \frac{y - (-1)}{2 - 0}$$
$$2.25 = \frac{y + 1}{2}$$
$$4.5 = y + 1$$
$$3.5 = y$$

The y-coordinate of the point is 3.5.

36. 3/10 **Difficulty:** Hard

Category: Problem Solving and Data Analysis / Rates, Ratios, Proportions, and Percentages

Getting to the Answer: Whenever rates are given in different units, start by converting to the same units. In most cases, converting to the smaller unit avoids fractions and decimals. Start with nickel because the weight is already in ounces: \$10.08 ÷ 24 = \$0.42 per ounce. Now find the per-ounce rate for copper. There are 16 ounces in one pound, so three pounds is 48 ounces: \$8.64 ÷ 48 = \$0.18 per ounce. So, if a person were to bring in equal amounts of each, he would receive \$0.18 per ounce of copper and \$0.42 per ounce of nickel. To find the fractional portion he would receive from the copper, set up a comparison between the amount received for copper and the total amount received, \$0.18 + \$0.42 = \$0.60. The portion of the total amount he receives from copper would be $\frac{0.18}{0.60}$, which reduces to $\frac{3}{10}$.

37. 3 **Difficulty:** Easy

Category: Problem Solving and Data Analysis / Scatterplots

Getting to the Answer: Each grid-line along the vertical axis represents 5 units, so look for points that are at least two grid-lines away from the line of best fit. The people who have BMIs of 20, 25, and 28 have LDLs that are 10 or more mg/dL greater than the LDLs predicted by the line of best fit. This represents 3 people.

38. 24 **Difficulty:** Medium

Category: Problem Solving and Data Analysis / Scatterplots

Getting to the Answer: A line of best fit serves as an approximation of data from which you can estimate an output for a given input (or vice versa). The key is in reading the axis labels carefully. To determine the requested BMI, find the LDL level of 140 (which is already reported in mg/dL) on the vertical axis. The question says "Based on the line of best fit," so trace over to the line (*not* to the closest data point) and then down to the corresponding value on the horizontal axis, which represents BMI. You should end up just slightly to the right of the 24 line. Be sure to follow directions. The closest whole number approximation is 24.