

1. **Level:** Easy | **Domain:** ALGEBRA

**Skill/Knowledge:** Linear equations in one variable

**Testing point:** Solving for  $x$  in a linear equation

**Key Explanation:** Choice B is correct. To solve for this, start by factoring out the 7 which yields  $7(x + 4) = 112$ . Then divide both sides of the equation by 7 which yields  $(x + 4) = \frac{112}{7}$  or  $x + 4 = 16$ .

**Distractor Explanations:** Choice A is incorrect and may result from solving the value of  $x$  when  $x + 4 = 0$ . Choice C is incorrect and may result from a miscalculation or conceptual error. Choice D is incorrect and may result from only solving for the value of  $x$ .

2. **Level:** Medium | **Domain:** GEOMETRY AND TRIGONOMETRY

**Skill/Knowledge:** Area and volume | **Testing point:** Using ratios similar figures

**Key Explanation:** The ratio of the radius of the ball to that of the prototype is 3 : 1. Since the volume of a sphere is directly proportional to the cube of its radius ( $V \propto r^3$ ), the ratio of their volumes should be  $3^3 : 1^3$  or 27 : 1. And given that the volume of the prototype is  $10\text{cm}^3$ , the volume of the ball will be  $27 \times 10 = 270\text{cm}^3$ .

3. **Level:** Easy | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear equations in one variable and systems of equations in two variables  
**Testing point:** Using the discriminant to find the number of solutions of a quadratic equation

**Key Explanation:** Choice A is correct. A quadratic with one solution has a discriminant equal to 0 which means  $b^2 - 4ac = 0$ .

To get the values of  $a$ ,  $b$ , and  $c$ , equate the two equations which yield  $2x + k = x^2 - 10x + 30$ . Subtracting  $2x$  and  $k$  from both sides of the equation yields  $0 = x^2 - 12x + 30 - k$ . This means that  $a = 1$ ,  $b = -12$ , and  $c = 30 - k$ .

Substituting the values of  $a$ ,  $b$ , and  $c$  to the discriminant yields  $(-12)^2 - 4(1)(30 - k) = 0$ .

Using the distributive property yields  $144 - 120 + 4k = 0$ .

Combining like terms yields  $24 + 4k = 0$ .

Subtracting 24 from both sides of the equation yields  $4k = -24$ .

Dividing both sides of the equation by 4 yields  $k = -6$ .

**Distractor Explanations:** Choices B and D are incorrect and could be a result of miscalculation or conceptual error. Choice C is incorrect because this is the negative value of  $k$ .

4. **Level:** Hard | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear equations in one variable and systems of equations in two variables  
**Testing point:** Using exponent rules

**Key Explanation:** Choice D is correct.

To solve for this, equate the exponents by making the bases the same. Since 9, 27 and 81 are multiples of 3, then every base will be converted to 3. This yields  $9 = 3^2$ ,  $27 = 3^3$ , and  $81 = 3^4$ . Hence

the equation will now become  $\frac{3^{3(x-1)}}{3^{4y}} = 3^2$  or

$$\frac{3^{3x-3}}{3^{4y}} = 3^2.$$

Since the terms on the left side of the equation are being divided, the exponents will be subtracted. This yields  $3^{3x-3-4y} = 3^2$ . Equating the exponents yields  $3x - 3 - 4y = 2$ . Adding 3 to both sides of the equation yields  $3x - 4y = 5$ . To find the value of  $6x - 8y$ , multiply both sides of the equation by

2 which yields  $2(3x - 4y) = 2(5)$ .

Using the distributive property yields  $6x - 8y = 10$ .

**Distractor Explanations:** **Choice A** is incorrect and may result from solving the value of  $\frac{6x - 8y}{5}$ .

**Choice B** is incorrect and may result from solving the value of  $3x - 4y$ . **Choice C** is incorrect and may result from solving the value of  $\frac{2(6x - 8y)}{5}$ .

5. **Level:** Medium | **Domain:** GEOMETRY AND TRIGONOMETRY

**Skill/Knowledge:** Right triangles and trigonometry | **Testing point:** Using the pythagorean theorem

**Key Explanation:** The sides of a square are equal. Therefore, if the sides are  $s$ , then the diagonal will be  $s\sqrt{2}$ , which can be proven using the Pythagorean theorem  $a^2 + b^2 = c^2$ . Since  $s\sqrt{2} = 16\sqrt{2}$ , then  $s = 16$ . The perimeter of a square can be found by  $4s$  which is  $4(16) = 64$ .

6. **Level:** Easy | **Domain:** ALGEBRA

**Skill/Knowledge:** Linear functions | **Testing point:** Matching a linear equation to its graph

**Key Explanation:** **Choice C** is correct. Rewrite the given equation into slope-intercept form of  $y = mx + b$  where  $m$  is the slope of the line and  $b$  is the  $y$ -intercept.

Subtracting  $12x$  from both sides of the equation yields  $4y = -12x + 8$ .

Dividing both sides of the equation by 4 yields  $y = -3x + 2$ . Thus, the slope of the line is  $-3$  and a  $y$ -intercept of 2. Since the slope is negative, the graph goes down from left to right. Hence, the answer can only be **choice C** or **D**. To determine the correct answer between the two choices, solve for the  $x$ -intercept by substituting 0 to  $y$  in the

equation. This yields  $0 = -3x + 2$ . Adding  $3x$  to both sides of the equation yields  $3x = 2$ . Dividing 3 from both sides of the equation yields  $x = \frac{2}{3}$ .

Since **choice C** is the only graph that has a  $y$ -intercept of 2, an  $x$ -intercept of  $\frac{2}{3}$ , and a negative slope, it is the correct answer.

**Distractor Explanations:** **Choices A** and **B** are incorrect because they both represent a linear equation with a positive slope. **Choice D** is incorrect because it has an  $x$ -intercept of 6.

7. **Level:** Easy | **Domain:** ALGEBRA

**Skill/Knowledge:** Systems of two linear equations in two variables | **Testing point:** Working with parallel lines and linear systems with no solution

**Key Explanation:** To have no solutions means that the lines are parallel and have the same slope. The slope of the first linear equation is  $\frac{3}{2}$ . Since  $p$  represents the slope of the second equation, then  $p = \frac{3}{2}$  which makes both lines parallel.

8. **Level:** Hard | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear functions | **Testing point:** Using exponential growth equation

**Key Explanation:** **Choice C** is correct. The original equation requires  $t$  in years. Since a year has 12 months, then  $\frac{m}{12} = t$ . This can be best represented by the model in **C**.

**Distractor Explanations:** **Choices A, B, and D** are incorrect and may result from a conceptual error.

9. **Level:** Medium | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Equivalent expressions

**Testing point:** Rewriting the equation and solving for the variable

**Key Explanation:** Choice A is correct. Solve for A by isolating it and then simplifying the

equation. Subtracting  $\frac{7}{x-3}$  from both sides of

the equation yields  $\frac{-2x^2 + 5x + 10}{x-3} - \frac{7}{x-3} = A$

or  $\frac{-2x^2 + 5x + 3}{x-3} = A$ . Factoring the numerator

on the left side of the equation yields

$\frac{(-2x-1)(x-3)}{x-3} = A$ . Canceling out  $(x-3)$  yields

$-2x - 1 = A$  or  $A = -2x - 1$ .

**Distractor Explanations:** Choice B is incorrect and may result due to calculation errors. Choice C is incorrect and may result from solving the value of  $-A$ . Choice D is incorrect. This would be the difference between  $-2x^2 + 5x + 10$  and  $x - 3$ .

10. **Level:** Easy | **Domain:** ALGEBRA

**Skill/Knowledge:** Systems of two linear equations in two variables | **Testing point:** Solving the system of linear equations

**Key Explanation:** Choice B is correct. Solve the system of equations by solving for  $y$  in the first equation and substituting it to the second equation.

Dividing both sides of the first equation by  $-5$  yields  $-\frac{3}{5}x = y$ .

Substituting  $y$  to the second equation yields

$2x + 3(-\frac{3}{5}x) = -1$  or  $2x - \frac{9}{5}x = -1$ .

Combining like terms yields  $\frac{1}{5}x = -1$ .

Multiplying 5 to both sides of the equation yields

$x = -5$ .

**Distractor Explanations:** Choice A is incorrect.

This is the value of  $y$ . Choices C and D are incorrect and may result due to a calculation or conceptual error.

11. **Level:** Hard | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear equations in one variable and systems of equations in two variables

**Testing point:** Using the discriminant to find the number of solutions to a quadratic equation.

**Key Explanation:** For a quadratic equation to have two distinct solutions, the discriminant  $b^2 - 4ac$  must be positive. In the given equation,  $a = 4$ ,  $b = -12$ , and  $c = k$ .

Substituting the values of  $a$ ,  $b$  and  $c$  to get the discriminant yields  $(-12)^2 - 4(4)(k)$  or  $144 - 16k$ . Since the discriminant must be positive, it must be greater than zero which is represented by  $144 - 16k > 0$ .

Adding  $16k$  to both sides of the inequality yields  $144 > 16k$ .

Dividing 16 from both sides of the inequality yields  $9 > k$  or  $k < 9$ .

The next integer number lower than 9 is 8. Therefore, the correct answer is 8.

12. **Level:** Easy | **Domain:** ALGEBRA

**Skill/Knowledge:** Linear equations in one variable

**Testing point:** Finding the solutions to a linear equation

**Key Explanation:** Choice A is correct. Using the distributive property to simplify the equation yields  $3x + 18 + x = 4x + 5$  or  $4x + 18 = 4x + 5$ . Subtracting  $4x$  from both sides of the equation yields  $18 = 5$  or  $13 = 0$  which is a false statement.

This implies that there is no solution.

**Distractor Explanations:** Choice B is incorrect.

For a linear equation to have one solution, the value of the variable can be solved.

**Choice C** is incorrect. Linear systems do not have 2 solutions.

**Choice D** is incorrect. For a linear system to have infinite solutions, the simplified equation must be a true statement.

13. **Level:** Hard | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Equivalent expressions

**Testing point:** Adding rational expressions with fractions

**Key Explanation:** Choice A is correct.

Simplify the denominator first.

$$\text{This yields } \frac{1}{x-2} + \frac{1}{x+2} = \frac{x+2+x-2}{x^2-4} = \frac{2x}{x^2-4}$$

Simplifying the whole fraction yields

$$\frac{\frac{1}{2x}}{\frac{x^2-4}{2x}} = \frac{x^2-4}{2x}$$

**Distractor Explanations:** Choice B is incorrect and may result from an error in adding the contents in the denominator  $x$ . **Choice C** is incorrect because it is only the simplified denominator, not the whole fraction. **Choice D** is incorrect and may result from miscalculation or conceptual errors.

14. **Level:** Hard | **Domain:** GEOMETRY AND TRIGONOMETRY

**Skill/Knowledge:** Circles

**Testing point:** Using circle theorems and converting degrees to radians

**Key Explanation:** Choice C is correct. The measure of a circumscribed angle and its

corresponding central angle are supplementary.

Hence,  $\angle PSR + \angle PQR = 180^\circ$ .

Substituting the value of the central angle  $\angle PSR$  yields  $80^\circ + \angle PQR = 180^\circ$ .

Subtracting  $80^\circ$  from both sides of the equation yields  $\angle PQR = 100^\circ$ .

Converting the value of  $\angle PQR$  to radians yields

$$100^\circ \times \frac{\pi}{180^\circ} = \frac{5}{9}\pi. \text{ Since } \angle PQR = a\pi, \text{ then } a = \frac{5}{9}.$$

**Distractor Explanations:** Choices A, B, and D are incorrect and may result from a conceptual or calculation error.

15. **Level:** Easy | **Domain:** GEOMETRY AND TRIGONOMETRY

**Skill/Knowledge:** Circles | **Testing point:** Finding the area of a circle given its circumference

**Key Explanation:** The circumference of a circle is found by the formula  $\pi D$  where  $D$  is the diameter of the circle. Since the circumference is  $12\pi$  then  $D = 12$ . The radius is therefore 6, and the area of the circle is  $\pi r^2 = \pi(6)^2 = 36\pi$ .

16. **Level:** Easy | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Equivalent expressions

**Testing point:** Converting from exponents to radicals

**Key Explanation:** Choice D is correct. Expressing the radical as exponent yields  $3p^{\frac{1}{3}}p^{\frac{1}{2}}$ . Since the same variables are being multiplied, their exponents will be added.

$$\text{Hence, } \frac{1}{3} + \frac{1}{2} = \frac{5}{6}.$$

The expression now becomes  $3p^{\frac{5}{6}}$ . Converting the

exponent back to radical yields  $3\sqrt[3]{p^5}$ .

**Distractor Explanations:** Choices A, B, and C are incorrect and may result from a conceptual or calculation error.

17. **Level:** Easy | **Domain:** GEOMETRY AND TRIGONOMETRY

**Skill/Knowledge:** Area and volume | **Testing point:** Finding the volume of a cylinder

**Key Explanation:** Choice B is correct. The volume of a cylinder is found using the formula  $V = \pi r^2 h$  where  $r$  is the radius and  $h$  is the height. Substituting the given radius and height to the formula yields  $V = \pi 9^2 6 = 486\pi$ .

**Distractor Explanations:** Choice A is incorrect and may result from solving the surface area of the cylinder. Choice C is incorrect and may result from solving the area of one base of the cylinder. Choice D is incorrect and may result from solving the lateral area of the cylinder.

18. **Level:** Hard | **Domain:** ALGEBRA

**Skill/Knowledge:** Linear equations in two variables | **Testing point:** Working with parallel lines and their equations

**Key Explanation:** Choice A is correct. For lines to be parallel, they must have proportional coefficients of  $x$  and  $y$ . To make the coefficients of  $x$  to be the same, multiply the first equation by  $-2$ . This yields  $-2(3x + 5y = 6)$  or  $-6x - 10y = -12$ . Matching the coefficients of  $y$  in  $-6x - 10y = -12$  and  $-6x + py = 18$  yields  $p = -10$ .

**Distractor Explanations:** Choices B and D are

incorrect and may result from a conceptual or calculation error. Choice C is incorrect. It is the negative of option A.

19. **Level:** Easy | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Equivalent expressions

**Testing point:** Matching coefficients

**Key Explanation:** Using the distributive property, the left side of the equation becomes  $15x^2y + 6xy + 6xy - 2y$ . Combining like terms yields  $15x^2y + 12xy - 2y = ax^2y + bxy + cy$ . Matching the coefficients yields  $a = 15$ ,  $b = 12$ , and  $c = -2$ . Therefore,  $b$  is equal to 12.

20. **Level :** Easy | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear equations in one variable and systems of equations in two variables

**Testing point:** Finding the number of solutions of an absolute value equation

**Key Explanation:** Choice C is correct. Isolating the absolute value and simplifying the equation

yields  $|x + 4| = \frac{-8}{-2}$  or  $|x + 4| = 4$ . Since the

absolute value is being compared with a positive number, it has two solutions.

**Distractor Explanations:** Choice A is incorrect. For an absolute value to have 0 or no solution, the absolute value should be less than or equal to a negative number. Choice B is incorrect. For an absolute value to have 1 solution, it should be equal to zero. Choice D is incorrect. For an absolute value to have infinite solutions, it should be greater than a negative number.

21. **Level:** Easy | **Domain:** ADVANCED MATH

**Skill/Knowledge:** Nonlinear equations in one variable and systems of equations in two variables

**Testing point:** Using exponent rules and FOILing method to find value of quadratic expression

**Key Explanation:** Choice B is correct. Expanding the expression  $(x + y)^2$  yields  $x^2 + 2xy + y^2$ .

Since  $x^2 + y^2 = 45$ , the expression becomes  $45 + 2xy$ .

Since  $xy = 5$ , the expression becomes  $45 + 2(5)$  or 55.

Therefore,  $(x + y)^2 = 55$ .

**Distractor Explanations:** Choice A is incorrect

and may result from solving the value of  $\frac{x^2 + y^2}{xy}$ .

Choice C is incorrect and may result from solving the value of  $2(x + y)^2$ .

Choice D is incorrect and may result from solving the value of  $(x - y)^2$ .

22. **Level:** Easy | **Domain:** PROBLEM-SOLVING AND DATA ANALYTICS

**Skills/Knowledge:** Inference from sample statistics and margin of error | **Testing Point:** Inferring from a sample to a population

**Key Explanation:** Choice C is correct. From the data surveyed,  $1,200 - 950 = 250$  residents own a different type of pet. We can infer that

$\frac{250}{1,200} \times 62,500 = 13,020$  residents in the town own a different type of pet.

**Distractor Explanations:** Choice A is incorrect.

This option is the total number of residents in the town. Choice B is incorrect. This is the approximate number of residents in the town that own either a dog or a cat. Choice D is incorrect. This is the difference between the number of

residents in the survey that owned a cat or a dog and the total number of residents in the town ( $62,500 - 950$ ).