

1. **D** - To evaluate the expression, we can regroup the numbers and the powers of ten, multiply, and adjust the decimal and exponent to put the answer in correct scientific notation format:

$$\begin{aligned} 5 \times 10^{-3} \times 3 \times 10^7 &= 5 \times 3 \times 10^{-3} \times 10^7 \\ &= 15 \times 10^4 \\ &= 1.5 \times 10^5 \end{aligned}$$

2. **D** - We are given the perimeter of a square and asked to find the square's area. If the perimeter is 20, then each side has a length of $\frac{1}{4}$ of 20, or 5. To find the area, we square the length of a side of the square: $5^2 = 25$.

3. **B** - We may approximate the value of the expression by either using the calculator or by using scientific notation to help rewrite and simplify the expression:

$$\begin{aligned} \frac{(.01)^2(\sqrt{.16} + 4.5)}{.003} &= \frac{(1 \times 10^{-2})^2(\sqrt{.16} + 4.5)}{3 \times 10^{-3}} \\ &= \frac{(1 \times 10^{-4})(\sqrt{.16} + 4.5)}{3 \times 10^{-3}} \\ &= \left(\frac{1}{3} \times 10^{-1}\right)(\sqrt{.16} + 4.5) \\ &\approx (0.33 \times 10^{-1})(5) \\ &\approx 1.65 \times 10^{-1} = 0.165 ; \text{Choice B is closest} \end{aligned}$$

4. **A** - The easiest way to find which value is smallest is to use the calculator to convert each fraction to decimal form. Doing so, we find that the smallest value is $11/15 = 0.73333 \dots$
5. **B** - The ratio of men to women makes it clear that less than half of the 352 attendees are men, so we can eliminate Choices D and E by inspection. We can rewrite the ratio of men to women as $3x$ to $8x$, where $3x$ and $8x$ may be considered to represent the actual numbers of men and women respectively. This allows us to set up an equation and solve:

$$\begin{aligned} \text{men} + \text{women} &= \text{total attendees} \\ 3x + 8x &= 352 \\ 11x &= 352 \\ x &= 32 \\ \therefore \text{men} &= 3x = 3(32) = 96 \end{aligned}$$

6. **E** - To find the value of the expression, we can plug in the values given for x and z and simplify:

$$\begin{aligned}
 \frac{1}{x} \div z &= \frac{1}{\frac{1}{2}} \div \frac{14}{35} \\
 &= \frac{2}{1} \times \frac{35}{14} \\
 &= \frac{70}{14} = \frac{35}{7} = 5
 \end{aligned}$$

7. **B** - To find the value of the square root expression, we can use the calculator, or we can rewrite the expression using scientific notation and simplify:

$$\begin{aligned}
 \sqrt{.00000009} &= (9 \times 10^{-8})^{\frac{1}{2}} \\
 &= 9^{\frac{1}{2}} \times 10^{-4} \\
 &= 3 \times 10^{-4} \\
 &= .0003
 \end{aligned}$$

8. **D** - To find the indicated percentage, we can convert the question into an equation and solve. Be alert for opportunities to simplify fractions; in this case, we can avoid having to find a common denominator for fractions because all of them simplify to integers:

$$\begin{aligned}
 \frac{81}{3} + \frac{42}{7} - \frac{54}{3} &= \left(\frac{x}{100}\right) \left(\frac{45}{3}\right) \\
 \therefore 27 + 6 - 18 &= \left(\frac{x}{100}\right) 15 \\
 \therefore 15 &= \left(\frac{x}{100}\right) 15 \\
 x &= 100 \%
 \end{aligned}$$

9. **A** - The question asks us to find a diagonal drawn through three dimensions from a bottom corner of the room to the opposite, top corner of the room. One approach is to change the 3-dimensional problem into a couple of 2-dimensional problems and apply Pythagorean Theorem twice. First we'll solve for the hypotenuse of a right triangle that goes from the northeast corner at the floor to the southwest corner at the floor:

$$\begin{aligned}
 3^2 + 4^2 &= c^2 \\
 25 &= c^2 \\
 5 &= c
 \end{aligned}$$

Then we solve for the hypotenuse of the triangle that uses the "5" that we just found as one leg, and the 2 meter height of the room as the other leg:

$$\begin{aligned}
 5^2 + 2^2 &= c^2 \\
 29 &= c^2 \\
 \sqrt{29} &= c
 \end{aligned}$$

Another approach is to use the 3-dimensional distance formula:

$$Distance = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

where (x_1, y_1, z_1) and (x_2, y_2, z_2) are 2 points expressed in 3-D coordinates:

Here, we can use $(0, 0, 0)$ and $(3, 4, 2)$ as the coordinates of the corners of the room.

$$\begin{aligned}
 \text{so, Distance from corner-to-corner} &= \sqrt{(3 - 0)^2 + (4 - 0)^2 + (2 - 0)^2} \\
 &= \sqrt{(3)^2 + (4)^2 + (2)^2} = \sqrt{9 + 16 + 4} = \sqrt{29}
 \end{aligned}$$

10. **C** - We can use the basic concept $distance = (rate)(time)$ to derive a formula for this problem: $Average\ speed = (Total\ distance)/(Total\ time)$. Since we don't have an actual number for the distance from home to work, let's call the distance D . The total distance travelled by the person from home to work and then back home is then $2D$. The time to travel the distance D at 40 mph is $me = \frac{distance}{rate} = \frac{D}{40}$. Similarly, the time to travel the distance D at 60 mph is $me = \frac{distance}{rate} = \frac{D}{60}$. Plugging the expressions into the "Average speed" formula and simplifying, we find that:

$$Average\ speed = \frac{Total\ distance}{Total\ time} = \frac{2D}{\frac{D}{40} + \frac{D}{60}} = \frac{2D}{\frac{3D + 2D}{120}} = \frac{2D}{\frac{5D}{120}} = \frac{2D}{1} \times \frac{120}{5D} = \frac{240}{5} = 48$$

11. **A** - The equation tells us that the expression on the left side is equal to the nonzero value on the right side. If we substitute zero for variable a , the entire left side of the equation would become zero, because a is multiplied by the every term enclosed in the bracket. It's impossible for a nonzero value to be equal to zero, so variable a cannot be zero.
12. **E** - Perpendicular lines have slopes that are opposite reciprocals. The slope of the given line is 3, so the slope of a line perpendicular to that line is $-\frac{1}{3}$. We can eliminate Answer Choices A and B. To confirm the specific equation, we can plug the values we know (slope and (x,y) coordinate) into slope-intercept form and solve for b , the y -intercept:

$$\begin{aligned}
 y &= mx + b \\
 -1 &= \left(-\frac{1}{3}\right)(3) + b \\
 -1 &= -1 + b \\
 0 &= b
 \end{aligned}$$

so, the equation of the line is $y = -\frac{1}{3}x + 0$, or $y = -\frac{1}{3}x$

13. **B** - The format of the question is ideal for restating as a proportion:

$$\begin{aligned}
 \frac{10}{2y} &= \frac{25x}{?} \\
 10? &= (2y)(25x) \\
 10? &= 50xy \\
 ? &= \frac{50xy}{10} \\
 ? &= 5xy
 \end{aligned}$$

14. **E** - The percentage of orange juice in the mixture is the number of liters of orange juice divided by the total liters of mixture. The total liters of mixture is: 3 liters + 1 liter = 4 liters.

The number of liters of orange juice is 40% of 3 liters plus 50% of 1 liter, or $(.4)(3) + (.5)(1) = 1.7$ liters. So the percentage of orange juice in the mixture is:

$$\frac{1.7 \text{ liters}}{4 \text{ liters}} = .425 = 42.5\%$$

15. **E** - Solving the inequality for x , we find that:

$$\begin{aligned}
 2x - 3 &> 3x + 7 \\
 -3 &> x + 7 \\
 -10 &> x
 \end{aligned}$$

16. **D** - We can find the equivalent value by converting the percentages to decimals and multiplying with the calculator or using scientific notation:

$$\begin{aligned}
 5\% \text{ of } 2\% \text{ of } 0.4 &= (.05)(.02)(0.4) \\
 &= (5 \times 10^{-2})(2 \times 10^{-2})(4 \times 10^{-1}) \\
 &= 40 \times 10^{-5} \\
 &= 0.0004
 \end{aligned}$$

17. **B** - In 1 minute, the first pump can fill $1/10$ of the vat. The second pump can fill $1/15$ of the vat in one minute. Thus the combined rate of both pumps operating together is:

$$\frac{1}{10} + \frac{1}{15} = \frac{3}{30} + \frac{2}{30} = \frac{5}{30} = \frac{1}{6}$$

This tells us that both pumps operating together could fill $\frac{1}{6}$ of the vat in 1 minute; therefore, it will take 6 minutes for both pumps together to fill the vat.

18. **E** - We can convert meters to inches by setting up conversion factors and multiplying:

$$\left(\frac{25 \text{ meters}}{1}\right) \left(\frac{100 \text{ centimeters}}{1 \text{ meter}}\right) \left(\frac{1 \text{ inch}}{2.5 \text{ centimeters}}\right) = \frac{2500 \text{ inches}}{2.5} = \frac{25,000 \text{ inches}}{25} = 1,000 \text{ inches}$$

19. **B** - We can set the desired semester average of 90 equal to the weighted average of the preliminary exam grades and the unknown final exam grade, and solve:

$$\begin{aligned} 90 &= \frac{2}{3} \left(\frac{81 + 85 + 95}{3} \right) + \frac{1}{3}(x) \\ 90 &= \frac{2}{3}(87) + \frac{1}{3}(x) \\ 90 &= 58 + \frac{x}{3} \\ 32 &= \frac{x}{3} \\ 96 &= x \end{aligned}$$

20. **C** - We can evaluate the function value when $z = -1$ by plugging in and simplifying:

$$f(-1) = 3(-1)^2 - 2(-1) = 3(1) + 2 = 5$$

21. **C** - The rate at which Mary walks is $\frac{3}{8}$ mile per 9 minutes, which means that she takes 3 minutes to walk $\frac{1}{8}$ mile. Therefore, it will take Mary 15 minutes to walk $\frac{5}{8}$ mile. Alternatively, we can use Distance = rate \times time to set up and solve for Mary's time to walk the remaining $\frac{5}{8}$ of the mile:

$$\begin{aligned} \text{Distance} &= \text{rate} \times \text{time} \\ \frac{5}{8} \text{ mile} &= \frac{\frac{3}{8} \text{ mile}}{9 \text{ minutes}} \times \text{time} \\ \therefore \text{time} &= \left(\frac{\frac{5}{8} \text{ mile}}{1}\right) \left(\frac{9 \text{ minutes}}{\frac{3}{8} \text{ mile}}\right) = \left(\frac{5}{8}\right) \left(\frac{8}{3}\right) \left(\frac{9}{1}\right) \text{ minutes} = \left(\frac{5}{3}\right) \left(\frac{9}{1}\right) \text{ minutes} = 15 \text{ minutes} \end{aligned}$$

22. **C** - To find the specified distance, we can plug the coordinates of the two points into the distance formula:

$$\text{Distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} = \sqrt{(7 - 2)^2 + (6 - (-6))^2} = \sqrt{5^2 + 12^2} = \sqrt{169} = 13$$

23. **E** - Since the right angle of the triangle is at C, we know that AB is the triangle's hypotenuse. If we note that the length of the hypotenuse AB is exactly twice as long as leg BC, we realize that we are dealing with a 30-60-90 right triangle. Comparing the general side proportions for a 30-60-90 triangle to the side lengths of triangle ABC, we can see that $x : x\sqrt{3} : 2x$ is proportional to $3 : 3\sqrt{3} : 6$, so $AC = 3\sqrt{3}$. Alternatively, we can plug the two sides we know into Pythagorean Theorem and solve:

$$\begin{aligned}(AB)^2 &= (BC)^2 + (AC)^2 \\ (6)^2 &= (3)^2 + (AC)^2 \\ \therefore (AC)^2 &= 6^2 - 3^2 = 36 - 9 = 27 \\ \therefore AC &= \sqrt{27} = 3\sqrt{3}\end{aligned}$$

24. **B** - If we designate that the original square has a side length of x , then the side length of the new square is $x + 1$. The area of the original square is therefore x^2 , and the area of the new square is $(x + 1)^2$. We are told that the difference between the areas is 53, so we can set up the following equation and solve for x :

$$\begin{aligned}53 &= (x + 1)^2 - x^2 \\ 53 &= (x + 1)(x + 1) - x^2 \\ 53 &= x^2 + 2x + 1 - x^2 \\ 53 &= 2x + 1 \\ 26 &= x\end{aligned}$$

25. **E** - We can translate the statements into a system of equations and use substitution to solve for the mother's current age:

$$\begin{aligned}M &= 3D \\ M + 12 &= 2(D + 12) \\ 3D + 12 &= 2D + 24 \\ D &= 12 \\ M &= 3D = 3(12) = 36\end{aligned}$$

26. **C** - To find the average weight, we add the weights and divide by 3. We can make the process easier by strategically re-grouping the pounds and ounces:

$$\begin{aligned}
 \text{total weight} &= (3 \text{ lb.} + 4 \text{ lb} + 9 \text{ lb}) + (2 \text{ oz} + 6 \text{ oz} + 10 \text{ oz}) \\
 &= (16 \text{ lb}) + (2 \text{ oz} + (6 \text{ oz} + 10 \text{ oz})) \\
 &= (16 \text{ lb}) + (2 \text{ oz} + (1 \text{ lb})) \\
 \text{total weight} &= 17 \text{ lb} + 2 \text{ oz} \\
 \text{average weight} &= \frac{\text{total weight}}{3} = \frac{17 \text{ lb} + 2 \text{ oz}}{3} = \frac{15 \text{ lb} + 2 \text{ lb} + 2 \text{ oz}}{3} = \frac{15 \text{ lb} + 34 \text{ oz}}{3} = 5 \text{ lb} + 11 \frac{1}{3} \text{ oz}
 \end{aligned}$$

27. **B** - We can find the percentage by setting up the expressions as a fraction, plugging in the value of x, simplifying, and converting the resulting decimal into a percent:

$$\frac{x + 4}{x^2 + 2} = \frac{(5) + 4}{(5)^2 + 2} = \frac{9}{27} = \frac{1}{3} = 0.333 \dots = 33 \frac{1}{3} \%$$

28. **A** - If we had to, we could use the Law of Cosines to solve for BD, then use Law of Sines to find angle ABD and angle ADB, and then subtraction to find angle BDC. Finally, we could use SohCahToa to find BC. However, there's a shortcut if we realize that this is a 30-60-90 triangle. The side opposite the 30 degree angle in a 30-60-90 triangle is always half the length of the hypotenuse, so $BC = \frac{1}{2}AB = \frac{1}{2}(14) = 7$.

29. **D** - We can find the area occupied by the frame by subtracting the area of the picture alone from the combined area of the picture and frame. The combined rectangular area of the picture and frame is:

$$\begin{aligned}
 \text{Area}_{\text{combined}} &= \text{length} \times \text{width} = (0.5 \text{ ft} + 5 \text{ ft} + 0.5 \text{ ft}) \times (0.5 \text{ ft} + 4 \text{ ft} + 0.5 \text{ ft}) \\
 &= (6 \text{ ft}) \times (5 \text{ ft}) = 30 \text{ ft}^2
 \end{aligned}$$

$$\text{Area}_{\text{picture only}} = (4 \text{ ft}) \times (5 \text{ ft}) = 20 \text{ ft}^2$$

$$\text{Area}_{\text{frame only}} = \text{Area}_{\text{combined}} - \text{Area}_{\text{picture only}} = 30 \text{ ft}^2 - 20 \text{ ft}^2 = 10 \text{ ft}^2$$

To find the percentage of total area occupied by the frame, we divide and convert to a percent:

$$\frac{\text{Area}_{\text{frame only}}}{\text{Area}_{\text{combined}}} = \frac{10 \text{ ft}^2}{30 \text{ ft}^2} = \frac{1}{3} = 0.3333 \dots = 33 \frac{1}{3} \%$$

30. **A** - Drawing the marbles from the bowl without replacement will decrease the total number of marbles available for the next draw; likewise, drawing a red marble the first time will decrease the number of red marbles available for the second draw. Even so, the two draws may be considered as independent events, so we can find

the probability of each draw separately and then multiply the individual probabilities to get the probability of the events happening together:

$$P_1 = \text{Probability of drawing red marble the first time} = \frac{3}{10}$$

$$P_2 = \text{Probability of drawing red marble the second time} = \frac{2}{9}$$

$$\text{Probability of red both times} = (P_1)(P_2) = \left(\frac{3}{10}\right)\left(\frac{2}{9}\right) = \frac{6}{90} = \frac{1}{15}$$

31. **B** - We can convert feet to meters by multiplying conversion factors:

$$\left(\frac{4 \text{ feet}}{5}\right)\left(\frac{1 \text{ meter}}{3.28 \text{ feet}}\right) \approx .244 \text{ meter} \approx \frac{1}{4} \text{ meter}$$

32. **A** - A glance at the answer choices tells us that we are to solve for x as an expression rather than as a value. So all we have to do is to algebraically isolate x , which we can do with the following steps:

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

33. **E** - This problem is easy if you remember that the cosine function is an even function. The graph of cosine, which is symmetrical about the y -axis, helps remind us that the function is even. For any even function, it is true that $f(x) = f(-x)$. Therefore $\cos(y) = \cos(-y)$ for all y .
34. **A** - A knowledge of where cosine is positive/negative is helpful in solving this problem. $\frac{\pi}{3}$ is a first quadrant angle, and cosine is always positive in the first quadrant. $\frac{2\pi}{3}$ has a reference angle of $\frac{\pi}{3}$, but is in the second quadrant where cosine is negative; therefore $\cos\frac{2\pi}{3} = -\cos\frac{\pi}{3}$. Thus $-\cos\frac{2\pi}{3} = \cos\frac{\pi}{3}$, and Choice A is the correct answer.
35. **A** - The 19 inch side of the rectangle can be divided into 3-inch sections 6 times with 1 inch left over. The 23-inch side of the rectangle can be divided into 3-inch

sections 7 times with 2 inches left over. The squares must be 3 inches on each side, so the maximum number of squares that can be cut from the sheet is $6 \times 7 = 42$.

36. **D** - The triangle shown is made up of 2 radii from each of the three circles. Since we are given the areas of the circles, we can use the circle area formula to solve for each radius length:

$$\begin{aligned} Area_I &= 4\pi = \pi(r_I)^2 \\ \therefore 4 &= (r_I)^2 \\ 2 &= r_I \end{aligned}$$

$$\begin{aligned} Area_{II} &= 9\pi = \pi(r_{II})^2 \\ \therefore 9 &= (r_{II})^2 \\ 3 &= r_{II} \end{aligned}$$

$$\begin{aligned} Area_{III} &= 16\pi = \pi(r_{III})^2 \\ \therefore 16 &= (r_{III})^2 \\ 4 &= r_{III} \end{aligned}$$

$$\text{triangle perimeter} = 2(2) + 2(3) + 2(4) = 4 + 6 + 8 = 18$$

37. **A** - The average is easy to calculate: $\frac{3+6+9+18}{4} = \frac{36}{4} = 9$. Answer Choices B, C, and D are eliminated. The variance takes a bit more work. Variance of a set is defined as the average of the squared differences of set values from the mean. We can set up and solve for the variance with the following steps:

$$\begin{aligned} \text{variance} &= \frac{\text{sum of squares of differences from mean}}{\text{number of values in set}} \\ &= \frac{(3-9)^2 + (6-9)^2 + (9-9)^2 + (18-9)^2}{4} \\ &= \frac{(-6)^2 + (-3)^2 + (0)^2 + (9)^2}{4} \\ &= \frac{36 + 9 + 0 + 81}{4} \\ &= \frac{126}{4} = 31.5 \end{aligned}$$

38. **B** - On Monday, Jill can choose any of the 6 books. On Tuesday, Jill only has 5 books remaining to choose from. We can use the multiplication principle to calculate the total number of possible “paths” Jill could travel in selecting two books from six:

$$\text{number of ways to select 2 different books from 6} = 6 \times 5 = 30$$

39. **E** - We can convert from yards per second to feet per second by multiplying by a conversion factor:

$$\left(\frac{100 \text{ yards}}{12.5 \text{ seconds}}\right) \left(\frac{3 \text{ feet}}{1 \text{ yard}}\right) = \frac{300 \text{ feet}}{12.5 \text{ seconds}} = 24 \text{ feet per second}$$

40. **C** - We can solve the equation for x with the following steps:

$$\sqrt{6 + \frac{1}{x}} = 8$$

$$6 + \frac{1}{x} = 64$$

$$\frac{1}{x} = 58$$

$$x = \frac{1}{58}$$