GRE QUANTITATIVE REASONING

PRACTICE QUESTIONS & ANSWER KEY

(SET 2)

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Quantitative Reasoning 25 Questions

Directions: For each question, indicate the best answer using the directions given.

Notes: All numbers used are real numbers.

All figures are assumed to lie in a plane unless otherwise indicated.

Geometric figures, such as lines, circles, triangles, and quadrilaterals, are not necessarily drawn to scale. That is, you should not assume that quantities such as lengths and angle measures are as they appear in a figure. You should assume, however, that lines shown as straight are actually straight, points on a line are in the order shown, and more generally, all geometric objects are in the relative positions shown. For questions with geometric figures, you should base your answers on geometric reasoning, not on estimating or comparing quantities from how they are drawn in the geometric figure.

Coordinate systems, such as xy-planes and number lines, are drawn to scale; therefore, you can read, estimate, or compare quantities in such figures from how they are drawn in the coordinate system.

Graphical data presentations, such as bar graphs, circle graphs, and line graphs, are drawn to scale; therefore, you can read, estimate, or compare data values from how they are drawn in the graphical data presentation.
For each of Questions 1–9, compare Quantity A and Quantity B, using additional information centered above the two quantities if such information is given. Select one of the following four answer choices. A symbol that appears more than once in a question has the same meaning throughout the question.

- Quantity A is greater.
- Quantity B is greater.
- The two quantities are equal.
- The relationship cannot be determined from the information given.

**Example 1:** \((2)(6)\) \(2 + 6\)
The correct answer choice for Example 1 is (A). \((2)(6)\), or 12, is greater than \(2 + 6\), or 8.

**Example 2:** \(PS\) \(SR\)
The correct answer choice is (D). The relationship between \(PS\) and \(SR\) cannot be determined from the information given since equal measures cannot be assumed, even though \(PS\) and \(SR\) appear to be equal in the figure.
The value of 1 United States dollar is 0.93 Argentine peso and the value of 1 United States dollar is 32.08 Kenyan shillings.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>The dollar value of 1 Argentine peso</td>
<td>The dollar value of 1 Kenyan shilling</td>
</tr>
</tbody>
</table>

- A Quantity A is greater.
- B Quantity B is greater.
- C The two quantities are equal.
- D The relationship cannot be determined from the information given.

**Explanation**

In this question you are given the value of 1 United States dollar in Argentine pesos and in Kenyan shillings, and you are asked to compare the dollar value of 1 Argentine peso with the dollar value of 1 Kenyan shilling. When you are answering Quantitative Comparison questions, it is a good time-saving idea to see whether you can determine the relative sizes of the two quantities being compared without doing any calculations.

Without doing any calculations, you can see from the information given that 1 United States dollar is worth a little less than 1 Argentine peso, so 1 peso is worth more than 1 United States dollar. On the other hand, 1 United States dollar is worth 32.08 Kenyan shillings, so 1 Kenyan shilling is worth only a small fraction of 1 United States dollar. The correct answer is Choice A.
$k$ is a digit in the decimal $1.3k5$, and $1.3k5$ is less than 1.33.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k$</td>
<td>1</td>
</tr>
</tbody>
</table>

- **A** Quantity A is greater.
- **B** Quantity B is greater.
- **C** The two quantities are equal.
- **D** The relationship cannot be determined from the information given.

**Explanation**

In this question, you are given that $k$ is a digit in the decimal $1.3k5$ and that $1.3k5$ is less than 1.33, and you are asked to compare $k$ with 1.

Because $1.3k5$ is less than 1.33, you can conclude that $1.30 < 1.3k5 < 1.33$. Therefore, $1.3k5$ must equal 1.305 or 1.315 or 1.325, and the digit $k$ must be 0, 1, or 2. The correct answer is Choice D.

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$AB$ is a diameter of the circle above.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>AB</td>
</tr>
</tbody>
</table>
3. The length of $AB$  The average (arithmetic mean) of the lengths of $AC$ and $AD$

- **A** Quantity A is greater.
- **B** Quantity B is greater.
- **C** The two quantities are equal.
- **D** The relationship cannot be determined from the information given.

**Explanation**

In this question you are given a circle and you are asked to compare the length of a diameter of the circle with the average of the lengths of two chords of the circle. Recall that in a circle, any diameter is longer than any other chord that is not a diameter. You are given that $AB$ is a diameter of the circle. It follows that $AC$ and $AD$ are chords that are not diameters, since there is only one diameter with endpoint $A$. Hence, $AB$ is longer than both $AC$ and $AD$. Note that the average of two numbers is always less than or equal to the greater of the two numbers. Therefore, the average of the lengths of $AC$ and $AD$, which is Quantity B, must be less than the length of $AB$, which is Quantity A. The correct answer is Choice A.
\[ st = \sqrt{10} \]

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>( s^2 )</td>
<td>( \frac{10}{t^2} )</td>
</tr>
</tbody>
</table>

(A) Quantity A is greater.
(B) Quantity B is greater.
(C) The two quantities are equal.
(D) The relationship cannot be determined from the information given.

**Explanation**

In this question you are asked to compare \( s^2 \) with \( \frac{10}{t^2} \). Since it is given that \( st = \sqrt{10} \), it follows that \( (st)^2 = (\sqrt{10})^2 \), and \( s^2t^2 = 10 \).

Dividing both sides of the equation \( s^2t^2 = 10 \) by \( t^2 \), you get \( s^2 = \frac{10}{t^2} \). The correct answer is Choice C.

You can look at this problem in another way. You can use the fact that \( st = \sqrt{10} \) to express Quantity A in terms of t. Since \( st = \sqrt{10} \), it follows that \( s = \frac{\sqrt{10}}{t} \), and Quantity A is equal to \( \left( \frac{\sqrt{10}}{t} \right)^2 = \frac{10}{t^2} \), which is the same as Quantity B. The correct answer is Choice C.
Three consecutive integers have a sum of $-84$.

### Quantity A

The least of the three integers

### Quantity B

$-28$

- A Quantity A is greater.
- B Quantity B is greater.
- C The two quantities are equal.
- D The relationship cannot be determined from the information given.

**Explanation**

In this question it is given that three consecutive integers have a sum of $-84$. You are asked to compare the least of the three integers with $-28$.

Two approaches you could use to solve this problem are:

**Approach 1:** Translate from words to algebra.
**Approach 2:** Determine a mathematical relationship between the two quantities.

**Approach 1:** You can represent the least of the three consecutive integers by $x$, and then the three integers would be represented by $x$, $x + 1$, and $x + 2$. It is given that the sum of the three integers is $-84$, so $x + (x + 1) + (x + 2) = -84$. You can solve this equation for $x$ as follows.

\[
x + (x + 1) + (x + 2) = -84
\]

\[
3x + 3 = -84
\]

\[
3x = -87
\]

\[
x = -29
\]
Since the least of the three integers, $-29$, is less than $-28$, the correct answer is Choice B.

**Approach 2:** You could ask yourself what would happen if the least of the three consecutive integers was $-28$. The three consecutive integers would then be $-28$, $-27$, and $-26$, and their sum would be $-81$. But you were given that the sum of the three consecutive integers is $-84$, which is less than $-81$. Therefore, $-28$ is greater than the least of the three consecutive integers, and the correct answer is Choice B.

In the $xy$-plane, the equation of line $k$ is $3x - 2y = 0$.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. The $x$-intercept of line $k$</td>
<td>The $y$-intercept of line $k$</td>
</tr>
</tbody>
</table>

- **A** Quantity A is greater.
- **B** Quantity B is greater.
- **C** The two quantities are equal.
- **D** The relationship cannot be determined from the information given.

**Explanation**

In this question it is given that the equation of line $k$ in the $xy$-plane is $3x - 2y = 0$. You are asked to compare the $x$-intercept of line $k$ with the $y$-intercept of line $k$.

Two approaches you could use to solve this problem are:

- **Approach 1:** Reason algebraically.
- **Approach 2:** Reason geometrically.
Approach 1: To solve this problem algebraically, note that given the equation of a line in the $xy$-plane, the $x$-intercept of the line is the value of $x$ when $y$ equals 0, and the $y$-intercept of the line is the value of $y$ when $x$ equals 0. The equation of line $k$ is $3x - 2y = 0$. If $y = 0$, then $x = 0$; and if $x = 0$, then $y = 0$. Therefore, both the $x$-intercept and $y$-intercept of the line are equal to 0, which means that the line passes through the origin. The correct answer is Choice C.

Approach 2: To solve this problem geometrically, graph the line with equation $3x - 2y = 0$ in the $xy$-plane. Since two points determine a straight line, you can do this by plotting two points on the line and drawing the line they determine. The points $(0, 0)$ and $(2, 3)$ lie on the line, and the graph of the line in the $xy$-plane, with the points $(0, 0)$ and $(2, 3)$ labeled, is shown in the figure below.

The line passes through the origin, and so it crosses both the $x$-axis and the $y$-axis at $(0, 0)$. The correct answer is Choice C.
$n$ is a positive integer that is divisible by 6.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>The remainder when $n$ is divided by 12</td>
<td>The remainder when $n$ is divided by 18</td>
</tr>
</tbody>
</table>

A) Quantity A is greater.
B) Quantity B is greater.
C) The two quantities are equal.
D) The relationship cannot be determined from the information given.

**Explanation**

In this question it is given that $n$ is a positive integer that is divisible by 6. You are asked to compare the remainder when $n$ is divided by 12 with the remainder when $n$ is divided by 18.

One way to compare the two quantities is to plug in a few values of $n$. If you plug in $n = 36$, you find that both the remainder when $n$ is divided by 12 and the remainder when $n$ is divided by 18 are equal to 0, so Quantity A is equal to Quantity B. However, if you plug in $n = 18$, you find that the remainder when $n$ is divided by 12 is 6 and the remainder when $n$ is divided by 18 is 0, so Quantity B is greater than Quantity A. Therefore, the correct answer is Choice D.

Another way to compare the two quantities is to find all of the possible values of Quantity A and Quantity B. The positive integers that are divisible by 6 are 6, 12, 18, 24, 30, 36, etc. When dividing each of these integers by 12, you get a remainder of either 0 or 6, so Quantity A is either 0 or 6. When dividing each of these integers by 18, you get a remainder of either 0 or 6 or 12,
so Quantity B is either 0 or 6 or 12. Note that when the value of Quantity B is 12, the value of Quantity A, 0 or 6, is less than the value of Quantity B; but when the value of Quantity B is 0, the value of Quantity A is greater than or equal to the value of Quantity B. Thus, the correct answer is Choice D.

\[
\frac{1 - x}{x - 1} = \frac{1}{x}
\]

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x)</td>
<td>(-\frac{1}{2})</td>
</tr>
</tbody>
</table>

- **A** Quantity A is greater.
- **B** Quantity B is greater.
- **C** The two quantities are equal.
- **D** The relationship cannot be determined from the information given.

**Explanation**

In this question it is given that \(\frac{1 - x}{x - 1} = \frac{1}{x}\) and you are asked to compare \(x\) with \(-\frac{1}{2}\).

One approach you could use to solve this problem is to solve the equation \(\frac{1 - x}{x - 1} = \frac{1}{x}\) for \(x\). Since fractions are defined only
when the denominator is not equal to 0, the denominators of both of the fractions in the equation are nonzero. Therefore, $x \neq 0$ and $x \neq 1$.

To solve the equation for $x$, begin by multiplying both sides of the equation by the common denominator $x(x + 1)$ to get $x(1 - x) = (x - 1)(1)$. Then proceed as follows.

\[
x(1 - x) = (x - 1)(1) \\
x - x^2 = x - 1 \\
x^2 = 1
\]

Since $x^2 = 1$ and $x \neq 1$, it follows that $x = -1$.

Quantity A is equal to $-1$ and Quantity B is equal to $-\frac{1}{2}$. Therefore, Quantity B is greater, and the correct answer is Choice B.

Another approach is to notice that for all values of $x \neq 1$, the value of $\frac{1 - x}{x - 1}$ is equal to $-1$. You can try plugging in a few numbers for $x$ to see that this is true. For example, if you plug in $x = 7$, you get $\frac{7 - 1}{1 - 7} = \frac{6}{-6} = -1$.

You can also show that for all values of $x \neq 1$, the value of $\frac{1 - x}{x - 1}$ is equal to $-1$ algebraically by rewriting $1 - x$ as $-(x - 1)$. Thus,
\[
\frac{1 - x}{x - 1} = \frac{-x}{x - 1} = -1. \text{ Because the left side of the equation is equal to } -1, \text{ it follows that } -1 = \frac{1}{x}, \text{ and so } x = -1. \text{ Therefore, Quantity A is equal to } -1, \text{ which is less than Quantity B, } -\frac{1}{2}, \text{ and the correct answer is Choice B.}
\]

In a set of 24 positive integers, 12 of the integers are less than 50. The rest are greater than 50.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. The median of the 24 integers</td>
<td>50</td>
</tr>
</tbody>
</table>

A Quantity A is greater.
B Quantity B is greater.
C The two quantities are equal.
D The relationship cannot be determined from the information given.

**Explanation**

In this question you are asked to compare the median of 24 integers with 50, given that 12 of the integers are less than 50 and 12 of the integers are greater than 50. In general, the median of a set of \( n \) positive integers, where \( n \) is even, is obtained by ordering the integers from least to greatest and then calculating the average (arithmetic mean) of the two middle integers. For this set of 24 integers, you do not know the values of the two middle integers;
you know only that half of the integers are less than 50 and the other half are greater than 50. If the two middle integers in the list are 49 and 51, the median is 50; and if the two middle integers are 49 and 53, the median is 51. Thus the relationship cannot be determined from the information given, and the correct answer is Choice D.

Questions 10–25 have several different formats, including both selecting answers from a list of answer choices and numeric entry. With each question, answer format instructions will be given.

Numeric-Entry Questions

These questions require a number to be entered by circling entries in a grid. If you are not entering your own answers, your scribe should be familiar with these instructions.

1. Your answer may be an integer, a decimal, or a fraction, and it may be negative.
2. Equivalent forms of the correct answer, such as 2.5 and 2.50, are all correct. Although fractions do not need to be reduced to lowest terms, they may need to be reduced to fit in the grid.
3. Enter the exact answer unless the question asks you to round your answer.
4. If a question asks for a fraction, the grid will have a built-in division slash (/). Otherwise, the grid will have a decimal point.
5. Start your answer in any column, space permitting. Circle no more than one entry in any column of the grid. Columns not needed should be left blank.
6. Write your answer in the boxes at the top of the grid and circle the corresponding entries. You will receive credit only if your grid entries are clearly marked, regardless of the number written in the boxes at the top.
Examples of acceptable ways to use the grid:
Integer answer: 502 (either position is correct)

Decimal answer: –4.13
Fraction answer: \(-\frac{2}{10}\)

<table>
<thead>
<tr>
<th></th>
<th>2</th>
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<tbody>
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<td>-</td>
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<td>⊙</td>
<td>0</td>
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<td>9</td>
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</tbody>
</table>

**Explanation**

Since 1.6 yards of fabric are required for each curtain, it follows that \((3)(1.6)\), or 4.8, yards of fabric are required to make the 3 curtains. The fabric can be purchased only by the full yard, so 5 yards of fabric would need to be purchased. Since the fabric sells for $8.00 per yard, the total cost of the fabric is $40.00. The correct answer is Choice A, $40.00.

This question has three answer choices. Select all the answer choices that apply. The correct answer to a question of this type could consist of as few as one, and as many as all three of the answer choices.

11. In the \(xy\)-plane, line \(k\) is a line that does not pass through the origin.

Which of the following statements individually provide(s)
sufficient additional information to determine whether the slope of line \( k \) is negative?

Indicate all such statements.

A The \( x \)-intercept of line \( k \) is twice the \( y \)-intercept of line \( k \).

B The product of the \( x \)-intercept and the \( y \)-intercept of line \( k \) is positive.

C Line \( k \) passes through the points \((a, b)\) and \((r, s)\), where \((a - r)(b - s) < 0\).

**Explanation**

For questions involving a coordinate system, it is often helpful to draw a figure representing the problem situation. The problem situation in this question involves determining when lines that do not pass through the origin have a negative slope. You can begin to solve this problem by drawing some lines with negative slopes in the \( xy \)-plane, such as those in the figure below.
From the figure you can see that for each line that does not pass through the origin, the $x$- and $y$-intercepts are either both positive or both negative. Conversely, you can see that if the $x$- and $y$-intercepts of a line have the same sign then the slope of the line is negative.

You can use this fact to examine the information given in the first two statements. Remember that you need to evaluate each statement by itself.

Choice A states that the $x$-intercept is twice the $y$-intercept, so you can conclude that both intercepts have the same sign, and thus the slope of line $k$ is negative. So the information in Choice A is sufficient to determine that the slope of line $k$ is negative.

Choice B states that the product of the $x$-intercept and the $y$-intercept is positive. You know that the product of two numbers is positive if both factors have the same sign. So this information is also sufficient to determine that the slope of line $k$ is negative.

To evaluate Choice C, it is helpful to recall the definition of the slope of a line passing through two given points. You may remember it as “rise over run.” If the two points are $(a, b)$ and $(r, s)$, then the slope is $\frac{b-s}{a-r}$.

Choice C states that the product of the quantities $(a-r)$ and $(b-s)$ is negative. Note that these are the denominator and the numerator, respectively, of $\frac{b-s}{a-r}$, the slope of line $k$. So you can conclude that $(a-r)$ and $(b-s)$ have opposite signs and the slope of line $k$ is negative. The information in Choice C is sufficient to determine that the slope of line $k$ is negative.
So each of the three statements individually provides sufficient information to determine whether the slope of line $k$ is negative. The correct answer consists of Choices A, B, and C; that is, the $x$-intercept of line $k$ is twice the $y$-intercept of line $k$, the product of the $x$-intercept and the $y$-intercept of line $k$ is positive, and line $k$ passes through the points $(a, b)$ and $(r, s)$, where $(a - r)(b - s) < 0$.

This question has five answer choices. Select the best one of the answer choices given.

The distance from Centerville to a freight train is given by the expression $-10t + 115$, and the distance from Centerville to a passenger train is given by the expression $-20t + 150$.

12. The expressions above give the distance from Centerville to each of two trains $t$ hours after 12:00 noon. At what time after 12:00 noon will the trains be equidistant from Centerville?

- A 1:30
- B 3:30
- C 5:10
- D 8:50
- E 11:30

**Explanation**

The distance between the freight train and Centerville at $t$ hours past noon is $-10t + 115$. The distance between the passenger train and Centerville at $t$ hours past noon is $-20t + 150$. To find out at what time the distances will be the same you need to equate the two expressions and solve for $t$ as follows.
Therefore, the two trains will be the same distance from Centerville at 3.5 hours past noon, or at 3:30. The correct answer is Choice B, 3:30.

This question has five answer choices. Select the best one of the answer choices given.

13. The company at which Mark is employed has 80 employees, each of whom has a different salary. Mark’s salary of $43,700 is the second-highest salary in the first quartile of the 80 salaries. If the company were to hire 8 new employees at salaries that are less than the lowest of the 80 salaries, what would Mark’s salary be with respect to the quartiles of the 88 salaries at the company, assuming no other changes in the salaries?

- A The fourth-highest salary in the first quartile
- B The highest salary in the first quartile
- C The second-lowest salary in the second quartile
- D The third-lowest salary in the second quartile
- E The fifth-lowest salary in the second quartile

**Explanation**

In this question you are told that Mark’s salary is the second-highest in the first quartile. From this you can conclude that the word **quartile** refers to one of the four groups that are created by listing the data in increasing order and then dividing the data into four groups of equal size. When the salaries of the 80 employees are listed in order, the 20 lowest salaries (that is, the salaries in the first quartile) are the first 20 salaries in the list. Since Mark’s salary is the second-highest in the first quartile, 18 salaries in that quartile are lower than his,
and one salary in that quartile is higher than his. After the salaries of the 8 new employees are added, there are 26 salaries that are lower than Mark’s. The lowest 22 of those would be in the first quartile of the 88 salaries, and the remaining 4 (salaries 23 to 26) would be in the second quartile, followed by Mark’s salary. This puts Mark at the fifth-lowest salary in the second quartile. The correct answer is Choice E.

Another way to approach this problem is to think of all 80 salaries numbered in order from least to greatest, the lowest salary at the number 1 position and the greatest salary at the number 80 position. There are 20 positions in each quartile, and Mark’s salary is at position 19. The table below shows the salary positions and the quartile into which each position falls.

<table>
<thead>
<tr>
<th>First quartile</th>
<th>Second quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21</td>
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<tr>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
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<td>...</td>
<td>...</td>
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<tr>
<td>18</td>
<td>38</td>
</tr>
<tr>
<td>19 • Mark’s salary</td>
<td>39</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third quartile</th>
<th>Fourth quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>61</td>
</tr>
<tr>
<td>42</td>
<td>62</td>
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<tr>
<td>43</td>
<td>63</td>
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<td>58</td>
<td>78</td>
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<tr>
<td>59</td>
<td>79</td>
</tr>
<tr>
<td>60</td>
<td>80</td>
</tr>
</tbody>
</table>
Position 19, where Mark’s salary appears, is second-highest in the first quartile.

To find what Mark’s position is with respect to the quartiles of the 88 salaries, you need to add the 8 new salaries to the list, renumber the list from 1 to 88, and put 22 salaries in each quartile. Because the 8 new salaries are less than the original 80 salaries, they must be listed in positions 1 through 8, and all salaries in the original list must move up by 8 positions in the renumbered list. In particular, Mark’s salary moves from position 19 to position 27. The table below shows the renumbered list. Mark’s salary is in position 27, the fifth position in the second quartile.

<table>
<thead>
<tr>
<th>First quartile</th>
<th>Second quartile</th>
<th>Third quartile</th>
<th>Fourth quartile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>45</td>
<td>67</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>46</td>
<td>68</td>
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<tr>
<td>...</td>
<td>25</td>
<td>47</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>26</td>
<td>48</td>
<td>70</td>
</tr>
<tr>
<td>9</td>
<td>27</td>
<td>49</td>
<td>71</td>
</tr>
<tr>
<td>Salary at</td>
<td>Mark’s salary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>position 1</td>
<td>of original list</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>42</td>
<td>64</td>
<td>86</td>
</tr>
<tr>
<td>21</td>
<td>43</td>
<td>65</td>
<td>87</td>
</tr>
<tr>
<td>22</td>
<td>44</td>
<td>66</td>
<td>88</td>
</tr>
</tbody>
</table>

Since Mark’s salary is in the fifth position in the second quartile and the salaries are listed in order from least to greatest, Mark’s salary would be the fifth-lowest in the second quartile. The correct answer is Choice E, the fifth-lowest salary in the second quartile.
This question does not have any answer choices; it is a numeric-entry question. To answer this question, enter a number by circling entries in the grid provided below. The number can include a decimal point, and can be positive, negative, or zero. The number entered cannot be a fraction.

14. In the $xy$-plane, the point with coordinates $(-6, -7)$ is the center of circle $C$. The point with coordinates $(-6, 5)$ lies inside $C$, and the point with coordinates $(8, -7)$ lies outside $C$. If $m$ is the radius of $C$ and $m$ is an integer, what is the value of $m$?

\[
\begin{array}{cccccccc}
& & & & & & & \\
m = & & & & & & & \\
\hline
- & . & . & . & . & . & . & . \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\
2 & 2 & 2 & 2 & 2 & 2 & 2 & 2 \\
3 & 3 & 3 & 3 & 3 & 3 & 3 & 3 \\
4 & 4 & 4 & 4 & 4 & 4 & 4 & 4 \\
5 & 5 & 5 & 5 & 5 & 5 & 5 & 5 \\
6 & 6 & 6 & 6 & 6 & 6 & 6 & 6 \\
7 & 7 & 7 & 7 & 7 & 7 & 7 & 7 \\
8 & 8 & 8 & 8 & 8 & 8 & 8 & 8 \\
9 & 9 & 9 & 9 & 9 & 9 & 9 & 9 \\
\end{array}
\]

**Explanation**

A strategy that is often helpful in working with geometry problems is drawing a figure that represents the given information as accurately as possible.
In this question you are given that the point with coordinates \((-6, -7)\) is the center of circle \(C\), the point with coordinates \((-6, 5)\) lies inside circle \(C\), and the point with coordinates \((8, -7)\) lies outside circle \(C\), so you could draw a circle in the \(xy\)-plane, as the one shown in the figure below.

![Diagram of a circle with center \((-6, -7)\), point \((-6, 5)\) inside, and point \((8, -7)\) outside.]

From the figure, you can conclude that the distance between \((-6, -7)\) and \((-6, 5)\) is \(7 + 5\), or 12, and the radius of \(C\) must be greater than 12. You can also conclude that the distance between \((-6, -7)\) and \((8, -7)\) is \(6 + 8\), or 14, and the radius of \(C\) must be less than 14. Therefore, since the radius is an integer greater than 12 and less than 14, it must be 13. The correct answer is 13.
This question has five answer choices. Select the best one of
the answer choices given.

15. If \(-\frac{m}{19}\) is an even integer, which of the following must be true?

A. \(m\) is a negative number.
B. \(m\) is a positive number.
C. \(m\) is a prime number.
D. \(m\) is an odd integer.
E. \(m\) is an even integer.

**Explanation**

An even integer is a multiple of 2. If \(-\frac{m}{19}\) is an even integer, it must
equal 2 times some integer \(k\). This means that \(-\frac{m}{19} = 2k\), or
\[m = -19(2k) = 2(-19k),\] which is a multiple of 2. Thus \(m\) must be
an even integer, and the correct answer is Choice E, \(m\) is an even
integer. You can see that none of the other choices can be the correct
answer by evaluating them as follows.

(A) \(m\) does not have to be a negative number for \(-\frac{m}{19}\) to be even.
   
   For example, if \(m = 38\), then \(-\frac{m}{19} = -2\), which is an even
   number.

(B) \(m\) does not have to be a positive number for \(-\frac{m}{19}\) to be even.
   
   For example, if \(m = -38\), then \(-\frac{m}{19} = 2\), which is an even
   number.
(C) The number used in (A), \( m = 38 \), shows that \( m \) does not have to be a prime number. In fact, because \( m \) is the product of at least two prime numbers (2 and 19), \( m \) cannot be a prime number.

(D) Since \( m \) must be an even integer, \( m \) cannot be an odd integer.

This question has three answer choices. Select all the answer choices that apply. The correct answer to a question of this type could consist of as few as one, or as many as all three of the answer choices.

16. The integer \( v \) is greater than 1. If \( v \) is the square of an integer, which of the following numbers must also be the square of an integer? Indicate all such numbers.

A 81

B \( 25v + 10\sqrt{v} + 1 \)

C \( 4v^2 + 4\sqrt{v} + 1 \)

**Explanation**

If \( v \) is the square of an integer, then \( \sqrt{v} \) is an integer. You can use this fact, together with the fact that the product and the sum of integers are also integers, to examine the first two choices.

Choice A: The square root of 81 is \( 9\sqrt{v} \), which is an integer. So 81 is the square of an integer.

Choice B: \( 25v + 10\sqrt{v} + 1 = (5\sqrt{v} + 1)^2 \) and \( 5\sqrt{v} + 1 \) is an integer. So \( 25v + 10\sqrt{v} + 1 \) is the square of an integer.
Choice C: Since there is no obvious way to factor the given expression, you may suspect that it is not the square of an integer. To show that a given statement is not true, it is sufficient to find one counterexample. In this case, you need to find one value of $v$ such that $v$ is the square of an integer but $4v^2 + 4\sqrt{v} + 1$ is not the square of an integer. If $v = 4$, then $4v^2 + 4\sqrt{v} + 1 = 64 + 8 + 1 = 73$, which is not the square of an integer. This proves that $4v^2 + 4\sqrt{v} + 1$ does not have to be the square of an integer.

The correct answer consists of two choices: A and B; that is $81v$ and $25v + 10\sqrt{v} + 1$.

Questions 17-20 are based on the data presented on this and the next page.
Reaction time is the time period that begins when the driver is signaled to stop and ends when the driver applies the brakes.

Note: Total stopping distance is the sum of the distance traveled during reaction time and the distance traveled after brakes have been applied.

This question has five answer choices. Select the best one of the answer choices given.

17. The speed, in miles per hour, at which the car travels a distance of 52 feet during reaction time is closest to which of the following?
Explanation

It is a good idea to look at the graphs before you try to answer the questions, so you can become familiar with the information contained in the graphs. Then, as you read each question, you should think about which of the graphs contains the information you need to solve the problem. It could be that all the information you need to solve the problem is contained in one of the graphs, or it could be that you need to get information from both of the graphs.

The first graph shows the relationship between the speed of the automobile and the distance it traveled during the reaction time. Therefore, the answer to this question is found using this graph by reading the speed, in miles per hour, corresponding to a distance of 52. A distance of 52 feet is a little above the distance of 50 feet on the vertical axis of the graph. On the graph, the speed corresponding to a distance of 52 feet is a little less than 50 miles per hour. The correct answer is Choice B, 47.

This question has five answer choices. Select the best one of the answer choices given.

18. Approximately what is the total stopping distance, in feet, if the car is traveling at a speed of 40 miles per hour when the driver is signaled to stop?
Explanation

Since the total stopping distance is the sum of the distance traveled during reaction time and the distance traveled after the brakes have been applied, you need information from both graphs to answer this question. At a speed of 40 miles per hour, the distance traveled during reaction time is a little less than 45 feet, and the distance traveled after the brakes have been applied is 88 feet. Since $45 + 88 = 133$, the correct answer is Choice A, 130.

This question has five answer choices. Select the best one of the answer choices given.

19. Of the following, which is the greatest speed, in miles per hour, at which the car can travel and stop with a total stopping distance of less than 200 feet?
   - A 50
   - B 55
   - C 60
   - D 65
   - E 70
Explanation

Since the total stopping distance is the sum of the distance traveled during reaction time and the distance traveled after the brakes have been applied, you need information from both graphs to answer this question. A good strategy for solving this problem is to calculate the total stopping distance for the speeds given in the answer choices. For a speed of 50 miles per hour, the distance traveled during reaction time is about 55 feet, and the distance traveled after the brakes have been applied is 137 feet; therefore, the total stopping distance is about $55 + 137$, or 192 feet. For a speed of 55 miles per hour, the distance traveled during reaction time is about 60 feet, and the distance traveled after the brakes have been applied is about 170 feet; therefore, the total stopping distance is about $60 + 170$, or 230 feet. Since the speeds in the remaining choices are greater than 55 miles per hour and both types of stopping distances increase as the speed increases, it follows that the total stopping distances for all the remaining choices are greater than 200 feet. The correct answer is Choice A, 50.

This question has five answer choices. Select the best one of the answer choices given.

20. The total stopping distance for the car traveling at 60 miles per hour is approximately what percent greater than the total stopping distance for the car traveling at 50 miles per hour?

- A 22%
- B 30%
- C 38%
- D 45%
- E 52%
**Explanation**

To solve this problem you need to find the total stopping distance at 50 miles per hour and at 60 miles per hour, find their difference, and then express the difference as a percent of the shorter total stopping distance. You need to use both graphs to find the total stopping distances. At 50 miles per hour, the total stopping distance is approximately $55 + 137 = 192$ feet; and at 60 miles per hour it is approximately $66 + 198 = 264$ feet. The difference of 72 feet as a percent of 192 feet is \( \frac{72}{192} = 0.375 \), or approximately 38%.

The correct answer is Choice C, 38%.

This question has five answer choices. Select the best one of the answer choices given.

21. What is the least positive integer that is not a factor of 25! and is not a prime number?

   A  26  
   B  28  
   C  36  
   D  56  
   E  58

**Explanation**

In this question you are asked what is the least positive integer that is not a factor of 25! and is not a prime number.

Note that 25! is equal to the product of all positive integers from 1 to 25, inclusive. Thus, every positive integer less than or equal to 25 is a factor of 25!. Also, any integer greater than 25 that can be expressed as the product of different positive integers less than 25 is a factor of 25!. In view of this, it’s reasonable to consider the next few integers greater than 25, including answer choices A and B.
Choice A, 26, is equal to (2)(13). Both 2 and 13 are factors of 25!, so 26 is also a factor of 25!. The same is true for 27, or (3)(9), and for Choice B, 28, or (4)(7). However, the next integer, 29, is a prime number greater than 25, and as such, it has no positive factors (other than 1) that are less than or equal to 25. Therefore, 29 is the least positive integer that is not a factor of 25!. However, the question asks for an integer that is not a prime number, so 29 is not the answer.

At this point, you could consider 30, 31, 32, etc., but it is quicker to look at the rest of the choices. Choice C, 36, is equal to (4)(9). Both 4 and 9 are factors of 25!, so 36 is also a factor of 25!. Choice D, 56, is equal to (4)(14). Both 4 and 14 are factors of 25!, so 56 is also a factor of 25!. Choice E, 58, is equal to (2)(29). Although 2 is a factor of 25!, the prime number 29, as noted earlier, is not a factor of 25!, and therefore 58 is not a factor of 25!. The correct answer must be Choice E, 58.

The explanation above uses a process of elimination to arrive at Choice E, which is sometimes the most efficient way to find the correct answer. However, one can also show directly that the correct answer is 58. For if a positive integer $n$ is not a factor of 25!, then one of the following must be true:

1. $n$ is a prime number greater than 25, like 29 or 31, or a multiple of such a prime number, like 58 or 62;
2. $n$ is so great a multiple of some prime number less than 25, that it must be greater than 58.
To see that (1) or (2) is true, recall that every integer greater than 1 has a unique prime factorization, and consider the prime factorization of 25!. The prime factors of 25! are 2, 3, 5, 7, 11, 13, 17, 19, and 23, some of which occur more than once in the product 25!. For example, there are 8 positive multiples of 3 less than 25, namely 3, 6, 9, 12, 15, 18, 21, and 24. The prime number 3 occurs once in each of these multiples, except for 9 and 18, in which it occurs twice. Thus, the factor 3 occurs 10 times in the prime factorization of 25!. The same reasoning can be used to find the number of times that each of the prime factors occur, yielding the prime factorization


Any integer whose prime factorization is a combination of one or more of the factors in the prime factorization of 25!, perhaps with lesser exponents, is a factor of 25!. Equivalently, if the positive integer \( n \) is not a factor of 25!, then, restating (1) and (2) above, the prime factorization of \( n \) must

(1) include a prime number greater than 25; or
(2) have a greater exponent for one of the prime numbers in the prime factorization of 25!.

For (2), the least possibilities are \( 2^{23}, 3^{11}, 5^7, 7^4, 11^3, 13^2, 17^2, 19^2, \) and \( 23^2 \). Clearly, all of these are greater than 58. The least possibility for (1) that is not a prime number is 58, and the least possibility for (2) is greater than 58, so Choice E, 58, is the correct answer.

This question has five answer choices. Select the best one of the answer choices given.

22. If \( 0 < a < 1 < b \), which of the following is true about the reciprocals of \( a \) and \( b \)?
A) $1 < \frac{1}{a} < \frac{1}{b}$

B) $\frac{1}{a} < 1 < \frac{1}{b}$

C) $\frac{1}{a} < \frac{1}{b} < 1$

D) $\frac{1}{b} < 1 < \frac{1}{a}$

E) $\frac{1}{b} < \frac{1}{a} < 1$

**Explanation**

In this question it is given that $0 < a < 1 < b$. The question asks which of the answer choices is a true statement about the reciprocals of $a$ and $b$.

To answer this question, you must first look at the answer choices. Note that all of the choices are possible orderings of the quantities $\frac{1}{a}$, $\frac{1}{b}$, and 1 from least to greatest. So to answer the question you must put the three quantities in order from least to greatest. The inequality $0 < a < 1 < b$ tells you that $0 < a < 1$ and that $b > 1$. Since $a$ is a value between 0 and 1, the value of $\frac{1}{a}$ must be greater than 1. Since $b$ is greater than 1, the value of $\frac{1}{b}$ must be less than 1. So you know that $\frac{1}{a} > 1$ and that $\frac{1}{b} < 1$, or combined in one expression, $\frac{1}{b} < 1 < \frac{1}{a}$, and the correct answer is Choice D, $\frac{1}{b} < 1 < \frac{1}{a}$. 
23. In the figure above, $O$ and $P$ are the centers of the two circles. If each circle has radius $r$, what is the area of the shaded region?

A) $\frac{\sqrt{2}}{2} r^2$

B) $\frac{\sqrt{3}}{2} r^2$

C) $\sqrt{2} r^2$

D) $\sqrt{3} r^2$

E) $2\sqrt{3} r^2$

**Explanation**

If a geometric problem contains a figure, it can be helpful to draw additional lines and add information given in the text of the problem to the figure. For circles, the helpful additional lines are often radii or diameters. In this case, drawing radius $OP$ will divide the shaded region into two triangles, as shown in the figure below.
Circle $O$ and circle $P$ have the same radius, $r$. Therefore, in each of the triangles, all three sides have length $r$, and each of the triangles is equilateral. If you remember from geometry that the height of an equilateral triangle with sides of length $r$ is $\frac{\sqrt{3}}{2}r$, you could use that fact in solving the problem. However, if you do not remember what the height is, you can use the figure below to help you find the height.

Using the Pythagorean theorem, you get

$$\left(\frac{r}{2}\right)^2 + h^2 = r^2$$
So the area of the equilateral triangle is

\[
\frac{1}{2} \text{ (base)(height)} = \frac{1}{2} (r) \left( \frac{\sqrt{3}}{2} r \right) = \frac{\sqrt{3}}{4} r^2.
\]

Since the shaded region consists of 2 equilateral triangles with sides of length r, the area of the shaded region is 

\[
(2) \left( \frac{\sqrt{3}}{4} r^2 \right) = \frac{\sqrt{3}}{2} r^2,
\]

and the correct answer is Choice B, \( \frac{\sqrt{3}}{2} r^2 \).

This question does not have any answer choices; it is a numeric entry question. To answer this question enter a fraction by circling entries in the grid provided below. The fraction can be positive or negative. Neither the numerator nor the denominator of the fraction can include a decimal point. The fraction does not have to be in lowest terms.

24. Of the 20 lightbulbs in a box, 2 are defective. An inspector will select 2 lightbulbs simultaneously and at random from the box. What is the probability that neither of the lightbulbs selected will be defective?

Give your answer as a fraction.
Explanation

The desired probability corresponds to the fraction

\[
\frac{\text{the number of ways that 2 lightbulbs, both of which are not defective, can be chosen}}{\text{the number of ways that 2 lightbulbs can be chosen}}
\]

In order to calculate the desired probability, you need to calculate the values of the numerator and the denominator of this fraction.

In the box there are 20 lightbulbs, 18 of which are not defective. The numerator of the fraction is the number of ways that 2 lightbulbs can be chosen from the 18 that are not defective, also known as the number of combinations of 18 objects taken 2 at a time.

If you remember the combinations formula, you know that the
number of combinations is \( \frac{18!}{2!(18-2)!} \) (which is denoted symbolically as \( \binom{18}{2} \) or \( 18 \binom{}{2} \)). Simplifying, you get

\[
\frac{18!}{2!16!} = \frac{(18)(17)(16)!}{(2)(16)!} = \frac{(18)(17)}{2} = 153
\]

Similarly, the denominator of the fraction is the number of ways that 2 lightbulbs can be chosen from the 20 in the box, which is

\[
\binom{20}{2} = \frac{20!}{2!18!} = \frac{(20)(19)(18)!}{(2)(18)!} = \frac{(20)(19)}{2} = 190.
\]

Therefore, the probability that neither of the lightbulbs selected will be defective is \( \frac{153}{190} \). The correct answer is \( \frac{153}{190} \).

Another approach is to look at the selection of the two lightbulbs separately. The problem states that lightbulbs are selected simultaneously. However, the timing of the selection only ensures that the same lightbulb is not chosen twice. This is equivalent to choosing one lightbulb first and then choosing a second lightbulb without replacing the first. The probability that the first lightbulb selected will not be defective is \( \frac{18}{20} \). If the first lightbulb selected is not defective, there will be 19 lightbulbs left to choose from, 17 of which are not defective. Thus, the probability that the second lightbulb selected will not be defective is \( \frac{17}{19} \). The probability that both lightbulbs selected will not be defective is the product of these two probabilities. Thus, the desired probability is \( \frac{18}{20} \cdot \frac{17}{19} = \frac{153}{190} \). The correct answer is \( \frac{153}{190} \).
This question has five answer choices. Select the best one of the answer choices given.

25. What is the perimeter, in meters, of a rectangular playground 24 meters wide that has the same area as a rectangular playground 64 meters long and 48 meters wide?

A 112
B 152
C 224
D 256
E 304

Explanation

The area of the rectangular playground that is 64 meters long and 48 meters wide is \((64)(48) = 3,072\) square meters. The second playground, which has the same area, is 24 meters wide and \(\frac{3,072}{24} = 128\) meters long. Therefore, the perimeter of the second playground is \((2)(24) + (2)(128) = 304\) meters. The correct answer is Choice E, 304.

Answer Key on Next Page
Answer Key for Quantitative Reasoning 25 Questions

1. A: Quantity A is greater.

2. D: The relationship cannot be determined from the information given.

3. D: The relationship cannot be determined from the information given.

4. D: The relationship cannot be determined from the information given.

5. B: Quantity B is greater.

6. A: Quantity A is greater.

7. C: The two quantities are equal.

8. A: Quantity A is greater.

9. C: The two quantities are equal.

10. D: \( jk + j \)
11. In question 11 you were asked to enter a fraction. The answer to question 11 is the fraction $\frac{1}{4}$.

12. The answer to question 12 consists of four of the answer choices.
   B: $\$43,350$
   C: $\$47,256$
   D: $\$51,996$
   E: $\$53,808$

13. E: 676,000

14. E: $s^2 - p^2$

15. B: $k - 1$

16. B: 110,000

17. B: 3 to 1

18. E: 1,250

19. C: 948

20. The answer to question 20 consists of two answer choices.
   B: Students majoring in either social sciences or physical sciences constitute more than 50 percent of the total enrollment.
   C: The ratio of the number of males to the number of females in the senior class is less than 2 to 1.
21. B: \(33\frac{1}{3}\%\)

22. A: 12

23. D: 4,400

24. In question 24 you were asked to enter either an integer or a decimal number. The answer to question 24 is 10.

25. The answer to question 25 consists of five answer choices.
   - B: 3.0
   - C: 3.5
   - D: 4.0
   - E: 4.5
   - F: 5.0