GRE QUANTITATIVE REASONING

PRACTICE QUESTIONS & ANSWER KEY

[SET 1]

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Source: ets.org/gre
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.

- **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.

### 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.
$O$ is the center of the circle above.

Quantity A  

Quantity B  

1. $x$  

5

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 the figure accompanying this question, $x$ is the length of one of the two line segments from the center of the circle to a point inside the circle. In the question you are asked to compare $x$ with 5.

In a circle the easiest line segments to deal with are the radius and the diameter.
In the figure accompanying the question, you can add two radii, each of which “completes” a right triangle, as shown in the figure below.

![Diagram of a circle with two radii forming right triangles]

Since in one of the triangles, the lengths of both legs are known, you can use that triangle to determine the length of the radius of the circle. The triangle has legs of length 3 and 4. If the length of the radius is $r$, then, using the Pythagorean theorem, you get

$$ r^2 = 3^2 + 4^2 \quad \text{or} \quad r^2 = 9 + 16 \quad \text{or} \quad r^2 = 25, \text{ and thus, } r = 5 $$

Since the length of the radius of the circle is 5 and the line segment of length $x$ is clearly shorter than the radius, you know that $x < 5$, and the correct answer is Choice B.

You could also notice that the two triangles are congruent, and so $x = 4$, again yielding Choice B.
Runner \( A \) ran \( \frac{4}{5} \) kilometer and Runner \( B \) ran 800 meters.

\[
\begin{array}{|c|c|}
\hline
\text{Quantity A} & \text{Quantity B} \\
\hline
\text{The distance that } A \text{ ran} & \text{The distance that } B \text{ ran} \\
\hline
\end{array}
\]

\( A \) 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 two measurements, one given in kilometers and the other in meters. It would be easier to compare these measurements if they were both given in meters or both given in kilometers.

If you choose to convert the distance that Runner \( B \) ran from meters to kilometers, you need to use the conversion \( 1 \) meter is equal to \( \frac{1}{1,000} \) kilometer. Since \( B \) ran 800 meters, it follows that \( B \) ran \( (800) \left( \frac{1}{1,000} \right) \), or \( \frac{4}{5} \) kilometer, which is the same distance that \( A \) ran.

If you choose to convert the distance that Runner \( A \) ran from kilometers to meters, you need to use the conversion \( 1 \) kilometer is equal to 1,000 meters. Since \( A \) ran \( \frac{4}{5} \) kilometer, it follows that \( A \) ran \( \left( \frac{4}{5} \right)(1,000) \), or 800 meters, which is the same distance that \( B \) ran.

Either way, \( A \) and \( B \) ran the same distance, and the correct answer is Choice C.
\[ x < y < z \]

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{x + y + z}{3} )</td>
<td>( y )</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 \( x < y < z \), and you are asked to compare \( \frac{x + y + z}{3} \) with \( y \).

Two approaches that you could use to solve this problem are:

**Approach 1:** Search for a mathematical relationship between the two quantities.
**Approach 2:** Plug in numbers for the variables.

**Approach 1:** Note that \( \frac{x + y + z}{3} \) is the average of the three numbers \( x \), \( y \), and \( z \) and that \( y \) is the median. Is the average of 3 numbers always equal to the median? The average could equal the median, but in general they do not have to be equal. Therefore, the correct answer is Choice D.
**Approach 2:** When you plug in numbers for the variables, it is a good idea to consider what kind of numbers are appropriate to plug in and to choose numbers that are easy to work with, if possible.

Since \( \frac{x + y + z}{3} \) is the average of the three numbers \( x, y, \) and \( z \) and you are comparing it to the median, you may want to try plugging in numbers that are evenly spaced and plugging in numbers that are not evenly spaced.

You can plug in numbers that are both evenly spaced and easy to work with. For example, you can plug in \( x = 1, \ y = 2, \) and \( z = 3. \) In this case, \( \frac{x + y + z}{3} = \frac{1 + 2 + 3}{3} = \frac{6}{3} = 2, \) and so \( \frac{x + y + z}{3} = y. \)

You can also plug in numbers that are not evenly spaced and are easy to work with. For example, you can plug in \( x = 3, \ y = 6, \) and \( z = 12. \) In this case, \( \frac{x + y + z}{3} = \frac{3 + 6 + 12}{3} = \frac{21}{3} = 7, \) and \( \frac{x + y + z}{3} > y. \) Since in the first case, \( \frac{x + y + z}{3} \) is equal to \( y \) and in the second case, it is greater than \( y, \) the relationship between the two quantities \( \frac{x + y + z}{3} \) and \( y \) cannot be determined from the information given. The correct answer is Choice D.
4. \( \frac{x}{y} \)

<table>
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<th>Quantity A</th>
<th>Quantity B</th>
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<tbody>
<tr>
<td>( \frac{x}{y} )</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 the figure accompanying this question, \( x \) and \( y \) are the lengths of the two legs of a triangle, and the leg of length \( x \) is opposite a 50° angle. In this question you are asked to compare \( \frac{x}{y} \) with 1.

One way you can solve this problem is by using the following fact:

**Fact:** If \( ABC \) is a triangle and the measure of angle \( A \) is greater than the measure of angle \( B \), then the side opposite angle \( A \) is longer than the side opposite angle \( B \).

Since the third angle of the triangle measures 40°, you can use the fact above to conclude that the side opposite the 50° angle is longer than the side opposite the 40° angle. So \( x > y \) and \( \frac{x}{y} > 1 \), which yields Choice A.

You can also solve this problem without using the fact above. Instead, you can use the strategy of adapting solutions to related problems to determine the relationship between \( x \) and \( y \).
Note that the angles in the $40^\circ - 50^\circ - 90^\circ$ triangle in the question differ only a little from the angles in a $45^\circ - 45^\circ - 90^\circ$ triangle. How do the lengths of the legs of a $45^\circ - 45^\circ - 90^\circ$ triangle compare to the lengths of the legs of the triangle in the question? To make the comparison, add a line segment to the $40^\circ - 50^\circ - 90^\circ$ triangle so that the line segment cuts the $50^\circ$ angle in two parts, making a $45^\circ$ angle with the horizontal side, as shown in the figure below.

![Diagram of a triangle with a line segment added to create a $45^\circ$ angle with the horizontal side]

The $45^\circ - 45^\circ - 90^\circ$ triangle has two $45^\circ$ angles, so $z = y$, and \[\frac{z}{y} = 1.\] Since \[\frac{z}{y} = 1\] and $x > z$, it follows that \[\frac{x}{y} > 1.\] The correct answer is Choice A.

\[
0 < x < y < 1
\]

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
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<tbody>
<tr>
<td>5. $1 - y$</td>
<td>$y - x$</td>
</tr>
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</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 $0 < x < y < 1$ and you are asked to compare $1 - y$ with $y - x$.

Two approaches that you could use to solve this problem are:

**Approach 1:** Translate from algebra to a number line.
**Approach 2:** Plug in values for the variables.

**Approach 1:** The figure below represents the information given in the problem on a number line.

![Number Line Diagram](image)

On the number line, $1 - y$ is the distance between 1 and $y$, and $y - x$ is the distance between $y$ and $x$. If $y$ is exactly halfway between $x$ and 1, then $1 - y$ is equal to $y - x$; and if $y$ is not halfway between $x$ and 1, then $1 - y$ is not equal to $y - x$. But $y$ can be any number between $x$ and 1, so the correct answer is Choice D.

**Approach 2:** Since this problem involves subtraction, it is a good idea to choose values for $x$ and $y$ that are close to each other as well as values that are far apart. For example, if $x = 0.4$ and $y = 0.5$, then $1 - y = 0.5$ and $y - x = 0.1$; and if $x = 0.1$ and $y = 0.9$, then $1 - y = 0.1$ and $y - x = 0.8$. This shows that the relationship cannot be determined, and the correct answer is Choice D.
$p$ is the probability that event $E$ will occur, and $s$ is the probability that event $E$ will not occur.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
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<tbody>
<tr>
<td>$p + s$</td>
<td>$ps$</td>
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</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 $p$ is the probability that event $E$ will occur, and $s$ is the probability that event $E$ will not occur and you are asked to compare $p + s$ with $ps$.

Since event $E$ will either occur or not occur, it follows that $p + s = 1$, and the value of Quantity A is always 1. Since Quantity B is the product of the two probabilities $p$ and $s$, you need to look at its value for the three cases $p = 1$, $p = 0$, and $0 < p < 1$.

If $p = 1$, then $s = 0$; similarly, if $p = 0$, then $s = 1$. In both cases, $ps$ is equal to 0.

If $0 < p < 1$, both $p$ and $s$ are positive and less than 1, so $ps$ is positive and less than 1.

Since Quantity A is always equal to 1 and for all three cases Quantity B is less than 1, the correct answer is Choice A.
X is the set of all integers n that satisfy the inequality $2 \leq |n| \leq 5$.

<table>
<thead>
<tr>
<th>Quantity A</th>
<th>Quantity B</th>
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<tbody>
<tr>
<td>The absolute value of</td>
<td>The absolute value of</td>
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<tr>
<td>the greatest integer in X</td>
<td>the least integer in X</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 X is the set of all integers n that satisfy the inequality $2 \leq |n| \leq 5$, and you are asked to compare the absolute value of the greatest integer in X with the absolute value of the least integer in X.

When comparing these quantities, it is important to remember that a nonzero number and its negative have the same absolute value. For example, $|-2| = |2| = 2$. Keeping this in mind, you can see that the positive integers 2, 3, 4, and 5 and the negative integers $-2$, $-3$, $-4$, and $-5$ all satisfy the inequalities $2 \leq |n| \leq 5$, and that these are the only such integers. Thus, the set X consists of the integers $-5$, $-4$, $-3$, $-2$, 2, 3, 4, and 5. The greatest of these integers is 5, and its absolute value is 5. The least of these integers is $-5$, and its absolute value is also 5. Therefore, Quantity A is equal to Quantity B. The correct answer is Choice C.
If $m = 3$, then $\frac{x^m}{x^3} = 1$ and $x^3 = x$. Since $x^3$ can be any real number, its relationship to 1 cannot be determined from the information given. This example is sufficient to show that

(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 $x$ and $m$ are positive numbers, and $m$ is a multiple of 3. You are asked to compare $\frac{x^m}{x^3}$ with $\frac{m}{x^3}$.

Since $\frac{x^m}{x^3} = x^{m-3}$, you need to compare $x^{m-3}$ with $\frac{m}{x^3}$. Since the base in both expressions is the same, a good strategy to use to solve this problem is to plug in numbers for $m$ in both expressions and compare them.

You know that $m$ is a multiple of 3, so the least positive integer you can plug in for $m$ is 3.

If $m = 3$, then $x^{m-3} = 1$ and $x^3 = x$. Since $x$ can be any real number, its relationship to 1 cannot be determined from the information given. This example is sufficient to show that
the relationship between \( \frac{x^m}{x^3} \) and \( x^3 \) cannot be determined from the information given. The correct answer is Choice D.

A random variable \( Y \) is normally distributed with a mean of 200 and a standard deviation of 10.

<table>
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<th>Quantity A</th>
<th>Quantity B</th>
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<tr>
<td>9. The probability of the event that the value of ( Y ) is greater than 220</td>
<td>1/6</td>
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</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 a random variable \( Y \) is normally distributed with mean 200 and standard deviation 10 and you are asked to compare the probability of the event that the value of \( Y \) is greater than 220 with \( \frac{1}{6} \).

In a normal distribution with mean 200 and standard deviation 10, the value of 210 is 1 standard deviation above the mean, and the value of 220 is 2 standard deviations above the mean. To compare Quantity A with Quantity B, it is not necessary to exactly determine the probability of the event that the value of \( Y \) is greater than 220.
Remember that in any normal distribution, almost all of the data values, or about 95% of them, fall within 2 standard deviations on either side of the mean. This means that less than 5% of the values in this distribution will be greater than 220. Thus, the probability of the event that the value of \( Y \) is greater than 220 must be less than 5%, or \( \frac{1}{20} \), and this is certainly less than \( \frac{1}{6} \). The correct answer is Choice B.

Another approach to this problem is to draw a normal curve, or “bell-shaped curve,” that represents the probability distribution of the random variable \( Y \), as shown in the figure below.

The curve is symmetric about the mean 200. The values of 210, 220, and 230 are equally spaced to the right of 200 and represent 1, 2, and 3 standard deviations, respectively, above the mean. Similarly,
the values of 190, 180, and 170 are 1, 2, and 3 standard deviations, respectively, below the mean. Quantity A, the probability of the event that the value of \( Y \) is greater than 220, is equal to the area of the shaded region as a fraction of the total area under the curve.

In the figure, the area under the normal curve has been divided into 6 regions and these regions are not equal in area. The shaded region is one of the two smallest of the 6 regions, so its area must be less than \( \frac{1}{6} \) of the total area under the curve. The correct answer is Choice B.

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 in 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)

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Decimal answer: $-4.13$

\[
\begin{array}{c|c|c|c}
- & 4 & . & 13 \\
\hline
- & . & . & . & . \\
\end{array}
\]

Fraction answer: $\frac{-2}{10}$

\[
\begin{array}{c|c|c|c}
- & 2 & / & 10 \\
\hline
- & 0 & 0 & 0 \\
\end{array}
\]
This question has five answer choices. Select the best one of the answer choices given.

10. The ratio of \( \frac{1}{3} \) to \( \frac{3}{8} \) is equal to the ratio of

   - A  1 to 8
   - B  8 to 1
   - C  8 to 3
   - D  8 to 9
   - E  9 to 8

**Explanation**

In this question you are asked to determine which of the answer choices is equivalent to the ratio \( \frac{1}{3} \) to \( \frac{3}{8} \).

Multiplying both parts of a ratio by the same number produces an equivalent ratio. While you could multiply both fractions in the ratio of \( \frac{1}{3} \) to \( \frac{3}{8} \) by any number, 24 is a good number to choose because it is the least common multiple of 3 and 8. Thus, multiplying both \( \frac{1}{3} \) and \( \frac{3}{8} \) by 24, you get that the ratio of \( \frac{1}{3} \) to \( \frac{3}{8} \) is equal to the ratio of 8 to 9. The correct answer is Choice D, 8 to 9.
An alternate approach to this problem is to express the ratio of \( \frac{1}{3} \) to \( \frac{3}{8} \) as the fraction \( \frac{1}{3} \cdot \frac{3}{8} \). This fraction is equivalent to \( \left( \frac{1}{3} \right) \left( \frac{8}{3} \right) \), or \( \frac{8}{9} \). The correct answer is Choice D, 8 to 9.

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

11. A reading list for a humanities course consists of 10 books, of which 4 are biographies and the rest are novels. Each student is required to read a selection of 4 books from the list, including 2 or more biographies. How many selections of 4 books satisfy the requirements?

\[ \begin{align*}
\text{A} & \quad 90 \\
\text{B} & \quad 115 \\
\text{C} & \quad 130 \\
\text{D} & \quad 144 \\
\text{E} & \quad 195
\end{align*} \]

**Explanation**

The requirement to select 4 books, including 2 or more biographies, means that you have to consider three cases. A student can choose 4 biographies and no novels, or 3 biographies and 1 novel, or 2 biographies and 2 novels.

**Case 1:** Choose 4 biographies. This case is easy, as there is only 1 way to choose all four biographies and no novels.
In the other two cases, you have to find the number of ways of choosing the biographies and the number of ways of choosing the novels and then multiply these two numbers.

**Case 2:** Choose 3 biographies and 1 novel. First, you need to find the number of ways of choosing 3 biographies out of 4. If you think of this as not choosing 1 out of the 4, you see that there are 4 choices. The number of ways of choosing 1 novel out of the 6 novels is 6. Therefore, the total number of choices is \(4 \times 6 = 24\).

**Case 3:** Choose 2 biographies and 2 novels. First, you need to find the number of ways of choosing 2 biographies out of 4. This number is sometimes called “4 choose 2” or the number of combinations of 4 objects taken 2 at a time. If you remember the combinations formula, you know that the number of combinations is \(\frac{4!}{2!(4-2)!}\) (which is denoted symbolically as \(\binom{4}{2}\) or \(4 \text{C}_2\)). The value of

\[
\frac{4!}{2!(4-2)!} = \frac{(4)(3)(2!)}{(2)(2!)} = \frac{(4)(3)}{2} = 6.
\]

Thus, there are 6 ways to choose 2 biographies out of 4. Similarly, the number of ways to choose 2 novels out of 6 is \(\frac{6!}{2!4!} = \frac{(6)(5)}{2} = 15\). Thus, the total number of ways to choose 2 biographies and 2 novels is \((6)(15) = 90\).

Adding the number of ways to choose the books for each of the three cases, you get a total of \(1 + 24 + 90 = 115\). The correct answer is Choice B, 115.
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.

12. In a graduating class of 236 students, 142 took algebra and 121 took chemistry. What is the greatest possible number of students that could have taken both algebra and chemistry?

\[
\begin{array}{ccccccc}
\text{students} & & & & & & \\
\hline
- & . & . & . & . & . & . \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 & 1 \\
2 & . & . & . & . & . & . \\
3 & . & . & . & . & . & . \\
4 & . & . & . & . & . & . \\
5 & . & . & . & . & . & . \\
6 & . & . & . & . & . & . \\
7 & . & . & . & . & . & . \\
8 & . & . & . & . & . & . \\
9 & . & . & . & . & . & . \\
\end{array}
\]

**Explanation**

This is the type of problem for which drawing a Venn diagram is usually helpful. The figure below is a Venn diagram you could draw to represent the information given in the question.
Note that the algebra and chemistry numbers given do not separate out the number of students who took both algebra and chemistry, and that this question asks for the greatest possible number of such students. It is a good idea, therefore, to redraw the Venn diagram with the number of students who took both algebra and chemistry separated out. The revised Venn diagram looks like the one in the figure below.
To solve this problem you want the greatest possible value of \( x \). It is clear from the diagram that \( x \) cannot be greater than 142 nor greater than 121, otherwise \( 142 - x \) or \( 121 - x \) would be negative. Hence, \( x \) must be less than or equal to 121. Since there is no information to exclude \( x = 121 \), the correct answer is the number 121.

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

13. In the figure above, if \( m \parallel k \) and \( s = t + 30 \), then \( t = \)

- **A** 30
- **B** 60
- **C** 75
- **D** 80
- **E** 105

**Explanation**

When trying to solve a geometric problem, it is often helpful to add any known information to the figure. Since corresponding angles have equal measures, you could place two more angle measures on the figure accompanying the question. The figure, with the additional information included, is shown below.
Now, from the figure, you can see that $s + t = 180$. Therefore, since it is given that $s = t + 30$, you can substitute $t + 30$ for $s$ into the equation $s + t = 180$ and get that $(t + 30) + t = 180$, which can be simplified as follows.

\[
(t + 30) + t = 180 \\
2t = 150 \\
t = 75
\]

The correct answer is Choice C, 75.

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

14. If $2x = 3y = 4z = 20$, then $12xyz =$

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td>16,000</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td>8,000</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

**Explanation**

In the question you are given that $2x = 3y = 4z = 20$, and you are asked to find the value of $12xyz$. 
One approach you can use to solve this problem is to find the value of all three variables.

\[ 2x = 20, \text{ or } x = 10 \]
\[ 3y = 20, \text{ or } y = \frac{20}{3} \]
\[ 4z = 20, \text{ or } z = 5 \]

So \(12xyz = 12(10)\left(\frac{20}{3}\right)(5) = 4,000\), and the correct answer is Choice C, 4,000.

Another approach you can use to solve this problem is to notice that \(12xyz = \frac{(2x)(3y)(4z)}{2} = \frac{(20)(20)(20)}{2} = 4,000\). Therefore, the correct answer is Choice C, 4,000.

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.

15. The total amount that Mary paid for a book was equal to the price of the book plus a sales tax that was 4 percent of the price of the book. Mary paid for the book with a $10 bill and received the correct change, which was less than $3.00. Which of the following statements must be true?

Indicate all such statements.

\[ \boxed{A} \]  The price of the book was less than $9.50.
\[ \boxed{B} \]  The price of the book was greater than $6.90.
\[ \boxed{C} \]  The sales tax was less than $0.45.
Explanation

For this problem you may find it helpful to translate the given information into an algebraic expression. Since the price of the book is unknown, you can call it $x$ dollars, and then the total amount that Mary paid is $x$ dollars plus 4% of $x$ dollars, or $1.04x$ dollars. The problem states that Mary received some change from a $10$ bill, so $1.04x$ dollars must be less than $10$. Since the change was less than $3.00$, the total amount Mary paid for the book must have been greater than $7.00$. You can express this information algebraically by the inequality

$$7.00 < 1.04x < 10.00$$

Solving the inequality for $x$ by dividing by $1.04$, and rounding, you get

$$6.73 < x < 9.62$$

So you see that $x$, the price of the book, must be between $6.73$ and $9.62$. With this information, you can quickly examine the first two statements. Choice A, the price of the book was less than $9.50$, is not necessarily true because the price could be as high as $9.61$, and Choice B, the price of the book was greater than $6.90$, is not necessarily true because the price could be as low as $6.74$.

To examine Choice C, the sales tax was less than $0.45$, you could compute the tax for the greatest possible price, which would be 4% of $9.61$, or $(0.04)(9.61) = 0.38$. Since this greatest possible tax is less than $0.45$, Choice C must be true.

You can also quickly see that Choice C must be true if you note that 4% of $10.00$ would only be $0.40$, and since the price must be less than $10.00$, the tax must be less than $0.40$. The correct answer consists of one answer choice, Choice C, the sales tax was less than $0.45$. 

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

16. If \( \frac{1}{(2^{11})(5^{17})} \) is expressed as a terminating decimal, how many nonzero digits will the decimal have?

A   One  
B   Two  
C   Four  
D   Six  
E   Eleven

**Explanation**

To convert the fraction \( \frac{1}{(2^{11})(5^{17})} \) to a decimal, it is helpful to first write the fraction in powers of 10. Using the rules of exponents, you can write the following.

\[
\frac{1}{(2^{11})(5^{17})} = \frac{1}{(2^{11})(5^{11+6})} = \frac{1}{(2^{11})(5^{11})(5^{6})} = \frac{1}{(10^{11})(5^{6})} = \left(\frac{1}{5}\right)^{6} \left(10^{-11}\right)
\]
\[
\begin{align*}
&= (0.2)\left(10^{-11}\right) \\
&= (2)(10^{-1})\left(10^{-11}\right) \\
&= 2^6\left(10^{-6}\right)\left(10^{-11}\right) \\
&= 2^6\left(10^{-17}\right) \\
&= 64\left(10^{-17}\right)
\end{align*}
\]

So the decimal has two nonzero digits, 6 and 4. The correct answer is Choice B, two.

Questions 17-20 are based on the data presented on the next page. In order to fit on the page, the data presentation has been turned 90 degrees.
Variation in the Amount of Caffeine in Common Beverages and Drugs*

<table>
<thead>
<tr>
<th>Coffee</th>
<th>Decaffeinated coffee</th>
<th>Percolated coffee</th>
<th>Drip-brewed coffee</th>
<th>Instant coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other beverages</td>
<td>Brewed tea</td>
<td>Instant tea</td>
<td>Cocoa</td>
<td>Caffeinated soft drinks</td>
</tr>
<tr>
<td>Drugs</td>
<td>Weight-loss drugs, diuretics, and stimulants</td>
<td>Pain relievers</td>
<td>Cold/allergy remedies</td>
<td></td>
</tr>
</tbody>
</table>

*Based on 5-ounce cups of coffee, tea, and cocoa; 12-ounce cups of soft drinks; and single doses of drugs.

Source: Food and Drug Administration
This question has five answer choices. Select the best one of the answer choices given.

17. The least amount of caffeine in a 5-ounce cup of drip-brewed coffee exceeds the greatest amount of caffeine in a 5-ounce cup of cocoa by approximately how many milligrams?

A   160
B   80
C   60
D   40
E   20

Explanation

Each horizontal bar in the bar graph shows the possible number of milligrams of caffeine in each of the common beverages and drugs. The least possible amount of caffeine in a 5-ounce cup of drip-brewed coffee is about 60 milligrams, and the greatest possible amount of caffeine in a 5-ounce cup of cocoa is about 20 milligrams. So, the difference is approximately $60 - 20$, or 40 milligrams. The correct answer is Choice D, 40.

To check your answer, it is useful to try to solve the problem using another method as well to see if you get the same answer. To solve this problem in another way, note that the distance between each pair of adjacent vertical grid lines represents 25 milligrams of caffeine, and the distance between the high end of the cocoa bar and the low end of the drip-brewed coffee bar is a little more than the distance between a pair of adjacent grid lines. Therefore, the answer is between 25 and 50. Among the choices, only Choice D is between 25 and 50, so the correct answer is Choice D, 40.
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.

18. For how many of the 11 categories of beverages and drugs listed in the graph can the amount of caffeine in the given serving size be less than 50 milligrams?

|   |   |   |   |   |   |   |   | categories |
|---|---|---|---|---|---|---|---|
| - | . | . | . | . | . | . | . |
| 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 |

**Explanation**

In the graph, the left edge of each bar tells you what is the least possible amount of caffeine in the corresponding beverage or drug. A beverage or drug can have less than 50 milligrams of caffeine if the left edge of its bar lies to the left of the vertical line corresponding to 50 milligrams of caffeine. From the graph, you see that there are 9 bars for which this is true. There are only 2 bars that lie entirely to the right of the 50-milligram line—the bar for drip-brewed coffee and the bar for weight-loss drugs, diuretics, and stimulants.
So there are 9 categories of beverages and drugs that can have less than 50 milligrams of caffeine in the given serving size. The correct answer is 9.

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

19. Approximately what is the minimum amount of caffeine, in milligrams, consumed per day by a person who daily drinks two 10-ounce mugs of percolated coffee and one 12-ounce cup of a caffeinated soft drink?

A 230
B 190
C 140
D 110
E 70

Explanation

According to the bar graph, the minimum amount of caffeine in a 5-ounce cup of percolated coffee is approximately 40 milligrams. Therefore, the minimum amount of caffeine in two 10-ounce cups of percolated coffee, which is the same as the minimum amount of caffeine in four 5-ounce cups, is approximately $(40)(4)$, or 160 milligrams. The minimum amount of caffeine in a 12-ounce caffeinated soft drink is approximately 30 milligrams. So, the minimum amount of caffeine in two 10-ounce mugs of percolated coffee and one 12-ounce caffeinated soft drink is approximately $160 + 30$, or 190 milligrams. The correct answer is Choice B, 190.
This question has five answer choices. Select the best one of the answer choices given.

20. Which of the following shows the four types of coffee listed in order according to the range of the amounts of caffeine in a 5-ounce cup, from the least range to the greatest range?

A   Decaffeinated, instant, percolated, drip-brewed
B   Decaffeinated, instant, drip-brewed, percolated
C   Instant, decaffeinated, drip-brewed, percolated
D   Instant, drip-brewed, decaffeinated, percolated
E   Instant, percolated, drip-brewed, decaffeinated

Explanation

For each of the four types of coffee, the range of the amounts of caffeine is the greatest possible amount minus the least possible amount. In the graph, this difference is represented by the length of the corresponding bar, so you can order the four types of coffee according to the lengths of their corresponding bars, from shortest to longest. From the graph, you can see that the order is decaffeinated coffee, instant coffee, drip-brewed coffee, percolated coffee. The correct answer is Choice B.
21. If \( s \) is a speed, in miles per hour, at which the energy used per meter during running is twice the energy used per meter during walking, then, according to the graph above, \( s \) is between

- A 2.5 and 3.0
- B 3.0 and 3.5
- C 3.5 and 4.0
- D 4.0 and 4.5
- E 4.5 and 5.0

**Explanation**

The problem asks you to determine the speed at which the energy used per meter during running is twice that used per meter during walking. Graphically, this is the speed for which the running energy is twice as high as the walking energy. The graph indicates that for speeds greater than or equal to 3.0 miles per hour, the running energy is less than twice the walking energy,
so the desired speed must be less than 3.0. In fact, the desired speed is between 2.0 (the lowest speed on the graph) and 3.0. There is only one answer choice that is between 2.0 and 3.0; namely, Choice A, which says the desired speed is between 2.5 and 3.0. The correct answer is Choice A.

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

22. If \( n = 2^3 \), then \( n^n = \)

A  \( 2^6 \)

B  \( 2^{11} \)

C  \( 2^{18} \)

D  \( 2^{24} \)

E  \( 2^{27} \)

Explanation

In this question you are asked to calculate the value of the expression \( n^n \) when \( n = 2^3 \).

When answering a question in which you are asked to calculate the value of an expression, it is often helpful to look at the answer choices first to see what form they are in. In this question the answer choices are all in the form 2 raised to a power, so you should try to achieve that form. It is given that \( n = 2^3 = 8 \). Therefore,

\[ n^n = (2^3)^8 = 2^{24} \]

The correct answer is Choice D, \( 2^{24} \).
This question has five 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.

The length of $AB$ is $10\sqrt{3}$.

23. Which of the following statements individually provide(s) sufficient additional information to determine the area of triangle $ABC$ above? Indicate all such statements.

A. $DBC$ is an equilateral triangle.
B. $ABD$ is an isosceles triangle.
C. The length of $BC$ is equal to the length of $AD$.
D. The length of $BC$ is 10.
E. The length of $AD$ is 10.

**Explanation**

From the figure accompanying this question you know that $ABC$ is a right triangle with its right angle at vertex $B$. You also know that point $D$ is on the hypotenuse $AC$. You are given that the length of $AB$ is $10\sqrt{3}$. However, because the figure is not necessarily drawn to scale, you don’t know the lengths of $AD$, $DC$, and $BC$. In particular, you don’t know where $D$ is on $AC$. 
The area of a triangle is \( \frac{1}{2} \text{(base)} \times \text{(height)} \). Thus, the area of right triangle \( ABC \) is equal to \( \frac{1}{2} \) of the length of \( AB \) times the length of \( BC \).

You already know that the length of \( AB \) is \( 10\sqrt{3} \). Any additional information that would allow you to calculate the length of \( BC \) would be sufficient to find the area of triangle \( ABC \). You need to consider each of the five statements individually, as follows.

**Statement A:** \( DBC \) is an equilateral triangle. This statement implies that angle \( DCB \) is a \( 60^\circ \) angle; and therefore, triangle \( ABC \) is a \( 30^\circ-60^\circ-90^\circ \) triangle. Thus the length of \( BC \) can be determined, and this statement provides sufficient additional information to determine the area of triangle \( ABC \).

**Statement B:** \( ABD \) is an isosceles triangle. There is more than one way in which triangle \( ABD \) can be isosceles. Figures 1 and 2 below are two redrawn figures showing triangle \( ABD \) as isosceles. In Figure 1 the length of \( AD \) is equal to the length of \( DB \); and in Figure 2 the length of \( AB \) is equal to the length of \( AD \).
Either of the figures could have been drawn with the length of $BC$ even longer. So, statement B does not provide sufficient additional information to determine the area of triangle $ABC$.

**Statement C:** The length of $BC$ is equal to the length of $AD$. You have no way of finding the length of $AD$ without making other assumptions, so statement C does not provide sufficient additional information to determine the area of triangle $ABC$.

**Statement D:** The length of $BC$ is 10. The length of $BC$ is known, so the area of triangle $ABC$ can be found. Statement D provides sufficient additional information to determine the area of triangle $ABC$.

**Statement E:** The length of $AD$ is 10. The relationship between $AD$ and $BC$ is not known, so statement E does not provide sufficient additional information to determine the area of triangle $ABC$.

Statements A and D individually provide sufficient additional information to determine the area of triangle $ABC$. Therefore, the correct answer consists of two choices A and D; that is, $DBC$ is an equilateral triangle and the length of $BC$ is 10.

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.
24. In the sequence above, each term after the first term is equal to the preceding term plus the constant c. If \( a_1 + a_3 + a_5 = 27 \), what is the value of \( a_2 + a_4 \)?

\[
a_2 + a_4 = \begin{array}{cccccc}
- & . & . & . & . & . \\
0 & 0 & 0 & 0 & 0 & 0 \\
1 & 1 & 1 & 1 & 1 & 1 \\
2 & 2 & 2 & 2 & 2 & 2 \\
3 & 3 & 3 & 3 & 3 & 3 \\
4 & 4 & 4 & 4 & 4 & 4 \\
5 & 5 & 5 & 5 & 5 & 5 \\
6 & 6 & 6 & 6 & 6 & 6 \\
7 & 7 & 7 & 7 & 7 & 7 \\
8 & 8 & 8 & 8 & 8 & 8 \\
9 & 9 & 9 & 9 & 9 & 9 \\
\end{array}
\]

Explanation

This question gives information about a sequence \( a_1, a_2, a_3, \ldots, a_n, \ldots \) and asks you to calculate the value of \( a_2 + a_4 \).

Note that answering this question requires information only about the first five terms of the sequence. So it is a good idea to work with the relationships among these five terms to see what is happening.

Since you are given that in this sequence each term after \( a_1 \) is \( c \) greater than the previous term, you can rewrite the first five terms of the sequence in terms of \( a_1 \) and \( c \) as follows.
\[ a_2 = a_1 + c \\
\]
\[ a_3 = a_2 + c = a_1 + 2c \\
\]
\[ a_4 = a_1 + 3c \\
\]
\[ a_5 = a_1 + 4c \\
\]

From the question, you know that \( a_1 + a_3 + a_5 = 27 \), and from the equations above,
\[ a_1 + a_3 + a_5 = a_1 + (a_1 + 2c) + (a_1 + 4c) = 3a_1 + 6c \]. So you can conclude that \( 3a_1 + 6c = 27 \), or \( a_1 + 2c = 9 \).

To find \( a_2 + a_4 \), you can express \( a_2 \) and \( a_4 \) in terms of \( a_1 \) and \( c \) and simplify as follows.

\[
\begin{align*}
  a_2 + a_4 &= (a_1 + c) + (a_1 + 3c) \\
             &= 2a_1 + 4c \\
             &= 2(a_1 + 2c)
\end{align*}
\]

But \( a_1 + 2c = 9 \), so \( a_2 + a_4 = 2(9) = 18 \). The correct answer is the number 18.

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

25. A desert outpost has a water supply that is sufficient to last 21 days for 15 people. At the same average rate of water consumption per person, how many days would the water supply last for 9 people?
The water supply is enough for 15 people to survive 21 days. Assuming the same average rate of water consumption per person, 1 person would have enough water to last for \( (15)(21) = 315 \) days.

Therefore, 9 people would have enough water for \( \frac{1}{9} \) of the 315 days, or 35 days. The correct answer is Choice C.

Another approach to solving this problem is to recognize that the water supply would last \( \frac{15}{9} \) as many days for 9 people as it would for 15 people. Therefore, since the water supply would last 21 days for 15 people, it would last \( \left(\frac{15}{9}\right)(21) \), or 35 days for 9 people. The correct answer is Choice C, 35.0.
Answer Key for Quantitative Reasoning 25 Questions

1. A: Quantity A is greater.

2. B: Quantity B is greater.

3. B: Quantity B is greater.

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

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

6. A: Quantity A is greater.

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

8. C: The two quantities are equal.

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

10. B: \( \frac{3}{2} \)
11. The answer to question 11 consists of four of the answer choices.
   A: 12°
   B: 15°
   C: 45°
   D: 50°

12. A: 10

13. D: 15


15. In question 15 you were asked to enter either an integer or a decimal number. The answer to question 15 is 3,600.

16. A: 8

17. In question 17 you were asked to enter either an integer or a decimal number. The answer to question 17 is 250.

18. C: Three

19. B: Manufacturing

20. A: 5.2
21. B: More than half of the titles distributed by $M$
are also distributed by $L$.

22. A: $c + d$

23. In question 23 you were asked to enter either an integer or a decimal. The answer to question 23 is 36.5.

24. D: \(\frac{2}{5}\)

25. D: \(\frac{3}{2}\)