TOOL BOX

Definitions, formulas, and mathematical ideas are all tools that you can use as a student.
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Coefficient	The coefficient is the number right before and multiplying by the variable. *Ex: In 2x, coefficient is 2*
Constant	A constant is something that never varies. *Examples of constants are numbers not attached to variables. Their value never changes.*
Expression	An expression is a mathematical sentence composed of variables and numbers. *Ex: 2x+3 is an expression*
Slope	Slope is the ratio of the vertical change to the horizontal change. Also known as the constant rate of change. We can find this on a table or a graph by finding $\frac{\Delta y}{\Delta x}$ on a graph. The slope is the coefficient of x. Slope is represented by **m**.
Slope Formula	The slope formula is based off of the fact that slope can be found by $\frac{\Delta y}{\Delta x}$. The **Δy** can be found by finding the difference between y-values, and the **Δx** can be found by finding the difference between x-values. So, slope formula is $\frac{y_2 - y_1}{x_2 - x_1}$, where the points are $(x_1, y_1)$and (x_2, y_2).
Y-Intercept	The y-intercept is the point at which the line crosses the y-axis, or the y-value when x=0. The *y*-intercept is represented by **b**, and is a constant.
Proportional	A relationship is proportional if it has both a constant rate of change (linear slope) and a constant ratio (comparing y/x gives us the same ratio every time). Proportional relationships go through (0,0) and have the equation **y=mx**.
Linear	A linear relationship is one that has a constant rate of change. On a graph this looks like a straight line. One of the equations for linear relationships is **y=mx+b**.
Function	A relation in which one input is paired with one output. Functions can be seen on tables, graphs, and in equations.
Function Notation	**f(x) = y** This is just a note to remind us that we are working with a function with the input of x. We say this as "function of x equals *y*".

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Independent	The variable that we can change/creates the change. Usually *x*.
Dependent	The variable that changes as a result. Usually *y*.
Continuous	Data that can take on any value. There is no space between data values. *Ex: Height and weight are continuous.*
Discrete	Data with space between data values. *Ex: The number of people in a room is discrete.*
Slope-Intercept Form	y=*m*x+*b*, where *m*= slope and *b*=y-intercept Note: *b* can be identified as where you *begin* when you are graphing, and *m* can remind us of how the line *moves*
Point-Slope Form	$y - y_1 = m(x - x_1)$, where *m* = slope and (x_1, y_1)= point This is a way to represent linear relationships when you don't know the *y*-intercept.
Standard Form	A*x*+B*y*=C, where A, B, and C are all numbers. This is another way to represent linear relationships and can easily show us the *x*- and *y*-intercepts of the relationship. To find the *x*-intercept, substitute *y*=0 and solve. To find the *y*-intercept, substitute *x*=0 and solve.
System of Equations	Two or more equations that contain the same set of variables.
Substitution	A way to solve algebraic problems by replacing equal values. You can substitute numbers, variables, or even expressions. *Ex: If x=3 and you are asked to solve 2x+4y=30, you can substitute the number 3 into the place of x in the equation, so 2(3)+4y=30.*
Rational Number	Any number that can be expressed as the ratio of two integers. • Can be decimals (will either terminate or repeat the same sequences of numbers) •
Irrational Number	Any number that is **not** rational and therefore cannot be represented as a ratio of two integers.

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Monomial	A number, a variable, or a product of a number and one or more variables. *Ex: 2, x, 2x, or* $2x^2$
Powers	A product of repeated factors, using an **exponent** and a **base.** *Ex:* $2\cdot 2\cdot 2\cdot 2 = 2^4$*, where 2 is the base, and 4 is the exponent.*
Product of Powers	To multiply powers with the same base, add their exponents. *Ex:* $2^4\cdot 2^5 = 2^{4+5} = 2^9$
Quotient of Powers	To divide powers with the same base, subtract their exponents. *Ex:* $\frac{2^9}{2^5} = 2^{9-5} = 2^4$
Product of Powers	To find the power of a power, multiply the exponents. *Ex:* $(2^4)^5 = 2^{4\cdot 5} = 2^{20}$
Power of a Power	To find the power of a product, find the power of each factor and multiply. *Ex:* $(6x^2)^3 = 6^{1\cdot 3}\cdot x^{2\cdot 3} = 6^3x^6$
Zero Exponent	Any nonzero number to the zero power is 1. *Ex:* $6^0 = 1$
Negative Exponents	Any nonzero number to the negative power is the multiplicative inverse of its power. *Ex:* $7^{-3} = \frac{1}{7^3}$
Roots	Roots are the inverse of exponents. A square root of a number is one of its two equal factors. A cube root of a number is one of its three equal factors.
Number System	All Real Numbers Rational Numbers: $\frac{1}{2}$, $0.\overline{4}$, 0.45, $-\frac{1}{2}$, 18% Integers: …-5, -4, -3, -2, -1 Whole Numbers: 0 Natural Numbers: 1, 2, 3, 4, 5…. Irrational Numbers: π, 0.112123123412345…, $\sqrt{17}$, -0.1011011101111…., $-\sqrt{73}$

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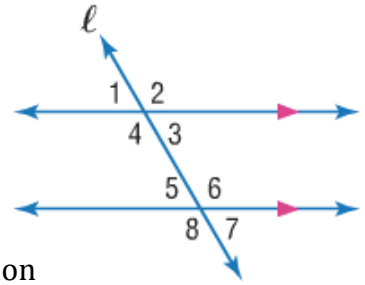
The Pythagorean Theorem	If a triangle is a right triangle, then the sum of the squares of the legs will be equal to the square of the hypotenuse, so $a^2 + b^2 = c^2$. hypotenuse c a b where a, b are the legs Converse: If $a^2 + b^2 = c^2$, then the triangle is a right triangle.
Angle Relationships	Transversal: The line intersecting the two parallel lines, here shown as line *l*.  *Complementary:* The sum of the angles is 90°. *Supplementary:* The sum of the angles is 180°. Examples: $m\angle 1 = m\angle 2$, $m\angle 2 = m\angle 3$, as well as $m\angle 1 = m\angle 6$ or $m\angle 4 = m\angle 7$ *Corresponding:* The angles are in the same position on the two parallel lines in relation to the transversal. Examples: $m\angle 1 = m\angle 5$, $m\angle 2 = m\angle 6$, $m\angle 3 = m\angle 7$, $m\angle 4 = m\angle 8$ *Vertical:* The angles are opposite of the intersection. Examples: $m\angle 1 = m\angle 3$, $m\angle 2 = m\angle 4$, $m\angle 5 = m\angle 7$, $m\angle 6 = m\angle 8$ *Alternate Interior:* The angles are on opposite sides of the transversal and inside the parallel lines. Examples: $m\angle 4 = m\angle 6$, $m\angle 3 = m\angle 5$ *Alternate Exterior:* The angles are on opposite sides of the transversal and outside the parallel lines. Examples: $m\angle 1 = m\angle 7$, $m\angle 2 = m\angle 8$ Note: Corresponding, vertical, alternate interior, and alternate exterior angles are all congruent angle relationships.
Triangle Angle Sum	The sum of the interior angles in a triangle is 180°.

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Transformation	A **transformation** is the change in the size or position of a figure.
Translation	A transformation in which each point of a figure moves the same distance and in the same direction. **Translation Notation:** (x+a, y+b) which notates how a translation occurred. *Ex: The translation notation (x – 4, y + 5) tells us that the translation moved four units to the left and five units up.*
Reflection	A transformation that is a mirror image of the original figure. It is the transformed over a line called the *line of reflection*. In a reflection, each point of the preimage and its image are the same distance from the line of reflection. **Rules:** To reflect over the x-axis, the x-value stays the same. (x, y) -> (x, -y) To reflect over the y-axis, the y-value stays the same. (x, y) -> (-x, y)
Rotation	A transformation in which a figure is turned about a fixed point. The *center of rotation* is the fixed point. Each point of the original figure and its image are the same distance from the center of rotation. **Rules:** 90-degree rotation clockwise: (x, y) -> (y, -x) 180-degree rotation clockwise: (x, y) -> (-x, -y) 270-degree rotation clockwise: (x, y) -> (-y, x)
Scale Factor	The scale factor is the ratio between the corresponding parts of the preimage and the image. To find the scale factor, k, divide the image by the original. So, $k = \frac{I}{O}$. If k>1, then the figure is enlarged. If k<1, the figure is reduced.
Dilation	A transformation that enlarges or reduces a figure by a *scale factor* relative to a center point. That point is called the *center of dilation*. When the center of dilation is the origin, each coordinate of the preimage is multiplied by the scale factor k to find the coordinates of the image. **Rule:** (x, y) -> (kx, ky)
Congruent	Two figures are congruent if the second can be obtained from the first by a series of rotations, reflections, and/or translations. What stays the same: angles, side lengths, size, area, perimeter What (potentially) changes: orientation, location, slope
Similar	Similar figures have the same shape, but may have different sizes. Two figures are similar if the second can be obtained from the first by a series of rotations, reflections, translations, and/or *dilations*.

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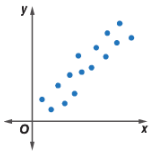
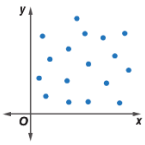
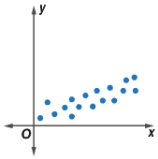
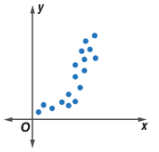
Volume of a Prism	If you think of a geometric prism as a base shape split into h number of layers, where h is also the height, then the area of the base (B) tells us the number of cubic units in one layer. Therefore, the volume of any prism can be found by $V = Bh$.
Volume of a Cylinder	As with prisms, the area of the base of a **cylinder** tells the number of cubic units in one layer. The height tells how many layers there are in the cylinder. $V = Bh$, where $B = \pi r^2$, and $V = \pi r^2 \cdot h$
Volume of a Cone	A **cone** is a three-dimensional shape with one circular base. $V = \frac{\pi r^2 \cdot h}{3}$
Volume of a Sphere	A **sphere** is a set of all points in space that are a given distance from a given point. $V = \frac{4\pi r^3}{3}$
Scatter Plot	Data with two variables are called *bivariate data*. A scatter plot shows the relationship between bivariate data graphed as ordered pairs on a coordinate plane.
Variable Associations	Positive Association: As x increases, y increases.  Negative Association: As x increases, y decreases.  No Association: No obvious pattern. 
Linear Associations	Linear: The data points lie close to a line.  Nonlinear: The data points lie in the shape of a curve. 

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<table>
<tr><td>Line of Best Fit</td><td>When data are collected, the points graphed usually do not form a straight line, but may approximate a linear relationship. A line of best fit is a line that is very close to most of the data points.
These lines can be used to make estimations and approximations regarding the data and the trend.</td></tr>
<tr><td>Two-Way Table</td><td>A two-way table shows data from one sample group as it relates to two different categories. It is called a two-way table because data can be viewed two ways, by column or by row. Each column and row has its own total.

Note: the totals from the columns should add to the same sum as the totals from the rows.</td></tr>
<tr><td>Relative Frequency</td><td>A two-way table can show relative frequencies for rows or columns.

To find the relative frequencies by row, write the ratios of each value to the total in that row, and round to the nearest hundredth.
To find the relative frequencies by column, write the ratio of each value ot the total in that column, and round the nearest hundredth.

Please note: Relative frequencies are based on the total for the row or column, NOT the entire sample group’s total. When interpreting relative frequencies, it is important to recognize where the total for that percentage comes from. The relative frequencies by row should add to a total of 1.00 on each row.

Example:
<table>
<tr><th></th><th>MP3 Player</th><th>No MP3 Player</th><th>Total</th></tr>
<tr><td>Cell Phone</td><td>57; $\frac{57}{78} \approx 0.73$</td><td>21; $\frac{21}{78} \approx 0.27$</td><td>78; 1.00</td></tr>
<tr><td>No Cell Phone</td><td>13; $\frac{13}{22} \approx 0.59$</td><td>9; $\frac{9}{22} \approx 0.41$</td><td>22; 1.00</td></tr>
</table>

The relative frequency of 0.73 means that 73% of the total number of people with cell phones also have an MP3 Player.</td></tr>
<tr><td>Association</td><td>On a two-way table, one can determine if there is an association between the categories if the relative frequency is a majority.

In the example above, there is an association between not having a cell phone but having an MP3 player, which means that more than half of students that do not own a cell phone will own an MP3 Player.</td></tr>
<tr><td>Scientific Notation</td><td>Scientific Notation is when a number is written as the product of a factor and an integer power of 10. The factor must be greater than or equal to 1 and less than 10.
Example: $425{,}000{,}000 = 4.25 \times 10^8$</td></tr>
</table>

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