**Math Formula Cheat Sheet**

**Distance/Rate Problems**

Distance = (rate)(time)
Mnemonic: “DIRT”
D = Distance
R = Rate
T = Time

Average Rate = \( \frac{\text{Total Distance Traveled}}{\text{Total Time}} \)

*Important Formula

**Graphing Formulas**

Slope Formulas:
y = mx + b, m = slope and b = y-intercept
\( y_2 - y_1 = m(x_2 - x_1) \)

Parallel lines: Slopes must be equal
Perpendicular lines: slopes will be negative reciprocal (flipped)

Distance between two points = make a right triangle and solve for the hypotenuse, or:
\[ d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \]

Midpoint = average together the x values and the y values, or:
\[ m = \left( \frac{x_1 + x_2}{2} \right), \left( \frac{y_1 + y_2}{2} \right) \]

**Conversions**

K = °C + 273 and °F = \( \frac{9}{5} \)(°C) + 32

0°C = 32°F and −40°C = −40°F

1 in = 2.54 cm
1 mile = 5280 ft
1 ft = 12 in
1 yard = 3 ft
1 m = 1.1 yd
1 kg = 2.2 lbs
1 lb = 454 g = 16 ounces

**Dilution Problems**

\[ C_1 V_1 = C_2 V_2 \]
C = Concentration, V = Volume

*Can use with any concentration unit
(Molarity, molality, % concentration)

**Quadratic Equations**

For any equation in the format:
\[ ax^2 + bx + c = 0 \]

\( (x + y)^2 = x^2 + 2xy + y^2 \)
\( (x - y)^2 = x^2 - 2xy + y^2 \)
\( (x + y)(x - y) = x^2 - y^2 \)

**Exponent Rules**

- \( (x^a)(x^b) = x^{a+b} \)
- \( \frac{x^a}{x^b} = x^{a-b} \)
- \( (x^a)^b = x^{ab} \)
- \( (x^a)(y^b) = (xy)^{b} \)
- \( \left( \frac{x^a}{y^b} \right) = \left( \frac{x}{y} \right)^{b} \)

**Log Rules**

- \( \log (x) + \log (y) = \log (x \cdot y) \)
- \( \log (x) - \log (y) = \log \left( \frac{x}{y} \right) \)
- \( \log_{a}(x^b) = b \cdot \log_{a}(x) \)
- When solving a log problem, remember:
  - \( \log x = b \) can be solved as \( x = 10^b \)

**Percent Increase/Decrease:**

\[ \left( \frac{x_2 - x_1}{x_1} \right) \times 100\% = \text{percent change} \]

**Percent Increase/Decrease Word Problems**

“of” = multiplication
“equal to” = equal sign

Example: 30% of 100 is equal to x

\[ (0.30)(100) = x \]
**Data Sets**

∪ = union. Includes all data but excludes duplicate values

Ex) \(x = \{1,2,3\}\) and \(y = \{1,3,4\}\)
\(X \cup Y = \{1,2,3,4\}\)

∩ = intersection. Includes only data that exists in both \(x\) and \(y\).

Ex) \(x = \{1,2,3\}\) and \(y = \{1,3,4\}\)
\(X \cap Y = \{1,3\}\)

**Probability**

Combination vs. Permutation:
You use **combination** when the order does not matter. (B,C,A / A,B,C / C,B,A are the same)

You use **permutation** when the order does matter. (B,C,A / A,B,C / C,B,A are **not** the same)

Combination formula = \(\frac{n!}{(n-k)! (k)!}\)

- \(n\) = number of objects from which you can choose
- \(k\) = number of objects to be chosen

Permutation formula = \(\frac{n!}{(n-k)!}\)

**Dice Problems**

Rolling 2 Dice: Total number of permutations = \((6)(6) = 36\)

Ex) What is the probability of rolling two dice and having the two numbers add to 4?

Three possibilities: 2+2, 1+3, and 3+1.
Therefore probability = \(\frac{3}{36} = \frac{1}{12}\)

**Deck of Cards**

Total # of Cards = 52 (without jokers)
4 suits (heart, club, ace, diamond)
13 cards per suit

**With Replacement** – Total number of cards must go back to 52 and cards of interest must go back to initial amount

**Without Replacement** – Must decrease total number of cards by 1 and decrease number of cards of interest by one

Ex) Probability of pulling 3 spades in a deck without replacement?

\(\frac{13}{52} \times \frac{12}{51} \times \frac{11}{50} = \frac{33}{2550}\)

**Letter Problems**

Ex) How many ways can the letters in APPALOOSA be arranged?

If no repeating letters = 9!

If repeating letters, we must divide by the factorials of numbers of repeats:

Repeats of A = 3
Repeats of P = 2
Repeats of O = 2

Number of Total Probability = \(\frac{9!}{3!2!2!} = 15120\)

**Statistics**

Mean: average

Median: middle number of a set of data (remember to order them numerically and then find the middle number)

Mode: number that occurs most often in a set

\(\text{st. dev} = \sigma = \sqrt{\frac{\sum (x - x_{\text{avg}})^2}{N}}\)

variance = \(\sigma^2\)
In a normal distribution, 68% of the data fall within 1 standard deviation of the mean. 95% of the data fall within 2 standard deviations of the mean, and 99.7% of the data fall within 3 standard deviations of the mean.

Rate Problems

When two things travel toward each other, we need to add the two velocities together.
Ex) Train 1 going East 50 mph. Train 2 going West on 40 mph. They are 135 miles apart. How long before they collide?

\[ t = \frac{135 \text{ miles}}{40 \text{ mph} + 50 \text{ mph}} = \frac{135}{90} = 1.5 \text{ hours} \]

Geometry

Area formulas
Circle = \( \pi r^2 \), \( r \) = radius
Triangle = \( \frac{1}{2} (bh) \), \( b \) = base and \( h \) = height of triangle

Volume Formulas
Sphere = \( \frac{4}{3} \pi r^3 \)
Cylinder = \( \pi r^2 h \)

Trigonometry
\[ \sin A = \frac{\text{opposite}}{\text{hypotenuse}} \]
\[ \cos A = \frac{\text{adjacent}}{\text{hypotenuse}} \]
\[ \tan A = \frac{\text{opposite}}{\text{adjacent}} \]
\[ \frac{\sin A}{\cos A} = \tan A \]

Combined Work Questions

\[ \frac{1}{t_1} + \frac{1}{t_2} = \frac{1}{t_{\text{total}}} \]

Ex. If Tom gets a job done in 4 hours \( t_1 \) and Jerry gets it done in 3 hours \( t_2 \), how many hours does it take to get the job done working together \( t_{\text{total}} \)?

\[ \frac{1}{4 \text{ hours}} + \frac{1}{3 \text{ hours}} = \frac{1}{t_{\text{total}}} \]
\[ \frac{3}{12 \text{ hours}} + \frac{4}{12 \text{ hours}} = \frac{1}{t_{\text{total}}} \]
\[ \frac{1}{7} = \frac{1}{t_{\text{total}}} \]
\[ (7)(t_{\text{total}}) = (12 \text{ hours})(1) \]
\[ t_{\text{total}} = \frac{12 \text{ hrs}}{7} = \frac{12}{7} \text{ hrs} = 1.714 \text{ hrs} \]

Simple and Compound Interest

<table>
<thead>
<tr>
<th>Simple Interest</th>
<th>Compound Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I = PRT )</td>
<td>( FV = PV(1+r)^n )</td>
</tr>
<tr>
<td>( I = \text{Interest} )</td>
<td>( FV = \text{Future Value} )</td>
</tr>
<tr>
<td>( P = \text{Principal (Initial Amount)} )</td>
<td>( PV = \text{Present Value} )</td>
</tr>
<tr>
<td>( R = \text{Annual Rate} )</td>
<td>( r = \text{annual interest rate} )</td>
</tr>
<tr>
<td>( T = \text{Time in years} )</td>
<td>( n = \text{number of periods} )</td>
</tr>
</tbody>
</table>

Compound Interest Example:
If the interest is compounded quarterly (every 3 months), and the length of the investment is one year, then \( n = 4 \) periods.