

Conversions to Memorize

1. Simple conversions

$$1 \text{ in} = 2.54 \text{ cm}$$

$$1 \text{ mi} = 1.6 \text{ km}$$

$$1 \text{ mi} = 5,280 \text{ ft}$$

$$1 \text{ m} = 39.37 \text{ in}$$

$$1 \text{ qt} = 0.946 \text{ L}$$

$$1 \text{ kg} = 2.2 \text{ lb}$$

$$1 \text{ year} = 52 \text{ weeks} = 365 \text{ days}$$

2. Science: Metric Standards and Conversions

$$\text{Water: } 1 \text{ cm}^3 = 1 \text{ mL} = 1 \text{ g @ } 4^\circ\text{C}$$

$$\text{Specific Heat Capacity: } 4.186 \text{ J raises } 1 \text{ mL of water } 1^\circ\text{C}$$

Key to Abbreviations:

°C	-	degrees Celsius	km	-	kilometer
cm	-	centimeter	L	-	liter (litre, international spelling)
ft	-	feet	lb	-	pound
g	-	gram (mass)	m	-	meter
in	-	inch	mi	-	mile
J	-	Joule	mL	-	milliliter
kg	-	kilogram	qt	-	quart

Commonly used Metric Prefixes

Large Quantities	Small Quantities
Deca- 10^1	Deci- 10^{-1} (tenth)
Hect- 10^2 (hundred)	Centi- 10^{-2} (hundredth)
Kilo- 10^3 (thousand)	Milli- 10^{-3} (thousandth)
Mega- 10^6 (million)	Micro- 10^{-6} (millionth)
Giga- 10^9 (billion)	Nano- 10^{-9} (billionth)
Tera- 10^{12} (trillion)	Pico- 10^{-12} (trillionth)

SAMS Physics 3211 Semester 1 Formulas

1. Motion

a. Speed

$$s = \frac{d}{t}, \text{ and } v = \frac{\Delta x}{t} = \frac{x_f - x_i}{t}$$

$$\text{velocity average} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

b. Acceleration

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

$$v_f = v_i + at$$

$$x_f = x_i + v_i t + \frac{1}{2} at^2$$

$$v_f^2 = v_i^2 + 2a(x_f - x_i)$$

i. Displacement

$$\Delta x = vt$$

$$\Delta x = v_i t + \frac{1}{2}(v_f - v_i)t$$

c. Vectors

$$\text{Pythagorean Theorem } R^2 = x^2 + y^2$$

d. Projectile Motion

i. Horizontal

$$v_x = \text{constant}$$

$$\Delta x = v_x \Delta t = v_x(t_f - t_i)$$

ii. Vertical

$$v_y = a_y \Delta t = a_y(t_f - t_i)$$

$$v_y^2 = a_y \Delta y = a_y(y_f - y_i)$$

$$\Delta y = \frac{1}{2} a_y (\Delta y)^2 = \frac{1}{2} a_y (y_f - y_i)^2$$

iii. Trigonometric Horizontal

$$v_x = v_{xi} = v_i \cos \theta = \text{constant}$$

$$\Delta x = (v_i \cos \theta) \Delta t$$

iv. Trigonometric Vertical

$$v_{yf} = v_i \sin \theta + a_y \Delta t$$

$$(v_{yf})^2 = v_i^2 (\sin \theta)^2 + 2a_y \Delta y$$

$$\Delta y = (v_i \sin \theta) \Delta t + \frac{1}{2} a_y (\Delta t)^2$$

2. Forces

a. Introduction

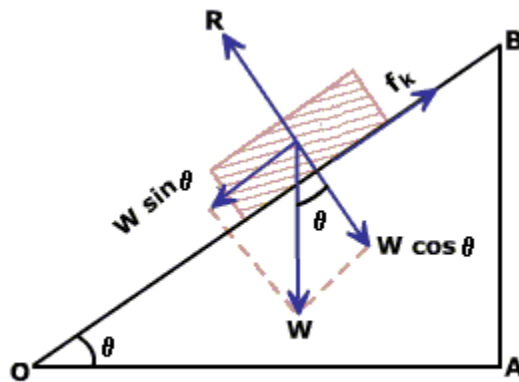
$$1 \text{ N} = \frac{1 \text{ kg} \cdot \text{m}}{\text{s}^2}$$

b. Newton's 1st and 3rd Laws (No computations)

c. Newton's 2nd Law

$$F = ma$$

$$F_{\text{gravity}} = mg, \text{ where } g = \frac{9.8 \text{ m}}{\text{s}^2}, \text{ or } \frac{32 \text{ ft}}{\text{s}^2}$$



Body accelerating down an inclined plane

Note: R is the Normal Force (usually N)

d. Impulse and Momentum

$$\text{momentum } p = mv, \text{ in units } \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

$$\text{impulse } J = F \Delta t, \text{ in units } \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

e. Conservation of Momentum

$$p_{\text{total}} = p_1 + p_2 + \cdots p_n$$

$$p_{\text{total}} = m_1 v_1 + m_2 v_2 + \cdots m_n v_n$$

$$p_{initial} = p_{final}$$

i. For Infinitely Elastic Collisions

$$m_1v_1 + m_2v_2 = (m_1 + m_2)v_f$$

$$\text{or } v_f = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$$

ii. Elastics Collisions

$$m_{1i}v_{1i} + m_{2i}v_{2i} = m_{1f}v_{1f} + m_{2f}v_{2f}$$

3. Gravity

a. Universal Law of Gravitation

$$F_{gravity} = G \frac{m_1m_2}{r^2}$$

b. Centripetal Acceleration

i. Tangential Speed

$$v_t = \frac{2\pi r}{t}$$

ii. Centripetal Acceleration

$$a_c = \frac{v^2}{r}, \text{ and for } T = \text{period}, a_c = \frac{4\pi^2 r}{T^2}$$

c. Circular Motion

i. Centripetal Force

$$F_c = \frac{mv^2}{r}$$

d. Orbital Motion

$$v^2 = G \frac{m_{central}}{r}$$

e. Earth-Moon-Sun System

i. Kepler's 3rd Law

$$\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{d_A}{d_B}\right)^3$$

ii. Newton's Version of Kepler's 3rd Law

$$T^2 = \left(\frac{4\pi^2}{Gm_s}\right) d^3$$

Note: if T is in earth years, d is in Astronomic Units (AU), and m is in solar masses, then

$$\frac{4\pi^2}{G} = 1$$

- f. Simple Harmonic Motion
 - i. Hooke's Law

$$F = k\Delta x, \text{ where } k \text{ is the spring constant}$$

4. Work and Energy

- a. Work and Power

$$W = F \cdot d$$

- i. Note: work is a vector, so W is often a horizontal component

$$W = F \cdot d \cdot \cos\theta$$

- b. Kinetic Energy

$$KE = \frac{1}{2}mv^2$$

$$W = \Delta KE = \frac{1}{2}m(v_f^2 - v_i^2)$$

- c. Potential Energy

$$PE_{\text{spring}} = \frac{1}{2}kx^2$$

$$\text{for gravity, } PE_g = mgh$$

- d. Energy Transformations

- i. Mechanical Energy

$$ME = KE + PE$$

- e. Conservation of Energy

$$KE_i + PE_i = KE_f + PE_f$$

$$\text{Efficiency} = \frac{W_{\text{out}}}{W_{\text{in}}}$$

5. Thermodynamics

- a. Temperature and Heat

- i. Specific Heat (c): Energy required to change temperature of 1 gram by 1 degree Celsius

$$c = \frac{4.186J}{g^\circ C}$$

- ii. Heat Equation

$$Q = mc\Delta T$$

$$Q_{lost} = Q_{gained}$$

$$m_1 c_1 \Delta T_1 = m_2 c_2 \Delta T_2$$

$$m_1 c_1 (T_i - T_f) = m_2 c_2 (T_f - T_i)$$

$$T_f = \frac{m_1 c_1 \Delta T_{i1} + m_2 c_2 \Delta T_{i2}}{m_1 c_1 + m_2 c_2}$$

- b. Heat Transfer (no computations)
- c. States of Matter (no computations)
- d. Changes of State
 - i. Latent Heat of Fusion

For solid ↔ liquid, $Q = \pm mL_f$, where L_f is latent heat of fusion for substance

- ii. Latent Heat of Vaporization

For gas ↔ liquid, $Q = \pm mL_v$, where L_v is latent heat of vaporization for substance

- e. 1st Law of Thermodynamics

$$Q = \Delta U + W, \text{ where } Q \text{ is heat and } W \text{ is Work}$$

$$\Delta U = \Delta E_{internal}$$

- f. 2nd Law of Thermodynamics (no computations)

SAMS Physics 3211 Semester 2 Formulas

1. Waves and Sound

- a. Intro to Waves
 - i. Speed of Light

$$c = 3 \times 10^8 \text{ meters/second}$$

- ii. Velocity Formula

$$v = \frac{d}{t}$$

- b. Wave Properties
 - i. Amplitude is peak amplitude, not peak to peak amplitude
 - ii. Period (T) is time for one complete cycle

$$\text{frequency} = \frac{\text{cycles}}{\text{time}}$$

- c. Wave Interactions: No Formulas
- d. Sound Waves: No Formulas
- e. Properties of Sound Waves

$$\text{Intensity } I = \frac{\text{Energy}}{\text{Time or Area}} = \frac{\text{Power}}{\text{Area}}, \text{ measured in dB (decibels)}$$

Intensity is proportional to the square of the amplitude.

$$I \propto A^2$$

2. Light

a. Electromagnetic Waves

i. Energy = Planck's Constant * Frequency

$$E = hf$$

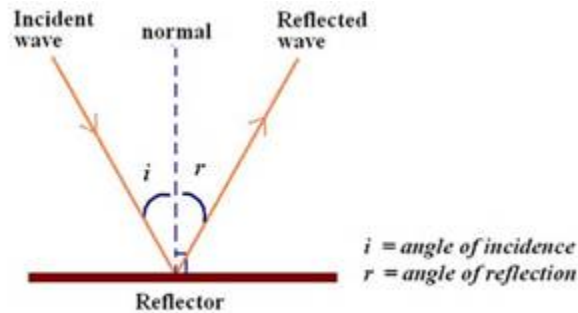
$$\text{where } h = 6.63 \times 10^{-34} \text{ J}, \text{ or } h = 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$$

In a vacuum $c = f\lambda$, where $c = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$, f is frequency (Hz), λ is wavelength

$$\text{Non - vacuum: } s = f\lambda$$

b. Reflection and Refraction

i. Incident and reflected wave are measured for the Normal Vector



ii. Incident and refracted wave are measured for the Normal Vector

iii. Index of Refraction (n)

$$n = \frac{\text{speed of light (vacuum)}}{\text{speed of light in medium}} = \frac{c}{s}$$

iv. Snell's Law

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

c. Mirrors (need illustrations for convex and concave)

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

Where d_o is distance of object to mirror and d_i is distance of image to mirror.

$$\text{magnification: } m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

Where h_o is height of object and h_i is height of image.

d. Lenses (need illustrations for convex and concave)

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

Where d_o is distance of object to mirror and d_i is distance of image to mirror.

$$\text{magnification: } m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

Where h_o is height of object and h_i is height of image.

e. Diffraction

Path Difference = $d \sin \theta$

Constructive Interference: $d \sin \theta = n\lambda$ Destructive Interference: $d \sin \theta = (n + \frac{1}{2})\lambda$

Where d is distance derived from diffraction grating

$$d = \frac{1 \text{ line}}{\# \text{lines/distance}} = \frac{\text{distance}}{\text{line}}$$

3. Electricity

a. Electrostatics

Electric force = (electric charge)(electric field) $\rightarrow F = qE$, with q in Coulombs

Electric potential energy $\rightarrow U = Fd$

Electric Potential $\rightarrow \text{Volts } V = \frac{U}{q}$ in joules/coulomb

Coulomb's Law $\rightarrow F_e = k \frac{q_1 q_2}{r^2}$ where $k = 8.99 \times 10^9 \frac{N \cdot m^2}{C^2}$

b. Electric Fields

$$F_e = qE, \text{ so } E = \frac{F_e}{q}, \text{ so } E = k \frac{q}{d^2}$$

c. Electric Potential Difference

Electric Potential Energy = charge * Electric Field Strength * distance

$$U = qEd$$

$$\text{Electric Potential (Volt) } V = \frac{U}{q}$$

$$V = Ed \text{ and } E = k \frac{q}{d^2} \text{ therefore } V = k \frac{q}{d}$$

$$\Delta V = V_2 - V_1 = \frac{\Delta U}{q} = Ed$$

$$\Delta U = W, \text{ so } W = q\Delta V$$

d. Electrical Energy Storage

i. Capacitance

$$C = \frac{Q}{V}, \text{ charge per volt}$$

$$C = \epsilon_0 \frac{A}{d} \text{ where } \epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N \cdot m^2} \text{ permittivity of free space}$$

$$C = k\epsilon_0 \frac{A}{d} \text{ where } k \text{ is dielectric constant}$$

e. Ohm's Law

i. Most common form: voltage = current * resistance

$$V = IR$$

ii. Edgenuity

$$I = \frac{\Delta q}{t} = \frac{\Delta V}{R}$$

f. Electric Circuits

i. Series Circuit

$$R_T = R_1 + R_2 + R_3 + \dots R_n$$

$$\text{Current is constant: } I = \frac{V}{R_T}$$

ii. Parallel Circuit

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}$$

$$\text{Voltage is constant: } V = I_T R_T$$

$$\text{Total Current = Sum of Legs: } I_T = I_1 + I_2 + \dots I_n$$

$$\text{Two resistors: } R_T = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

4. Magnetism

a. Magnets and Magnetism (no formulas)

b. Magnetic Field and Force

$$\text{Tesla: } 1T = 1 \frac{N}{C \cdot m/s} = 1 \frac{N}{A \cdot m}$$

$$F = |q|vB\sin\theta \text{ where } v \text{ is velocity and } B \text{ is the magnetic field}$$

c. Electromagnetic Induction

i. Right Hand Rule: thumb in direction of current, magnetic field wraps as fingers.

ii. No formulas

d. Applications of Magnetic Induction

$$\text{Transformer turns ratio: } \frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$$

Where N is number of coils, V is voltage, and I is current

5. Nuclear Physics

- a. Radioactivity → half life: use a table to analyze
- b. Fission and Fusion

$$E = mc^2 \text{ where } c = 3 \times 10^8 \text{ m/s}$$

- c. Binding Energy

$$E_{\text{binding}} = \Delta mc^2$$

- d. The Sun's Energy: no formulas
- e. Fundamental Forces (4): no formulas
 - i. Gravity, Electromagnetic, Strong and Weak Nuclear Forces

6. Modern Physics

- a. Atomic Spectra: no formulas
- b. Dual Nature of Light

$$\text{Energy } E = hf \text{ where } h = \text{Planck's Constant and } f \text{ is frequency}$$

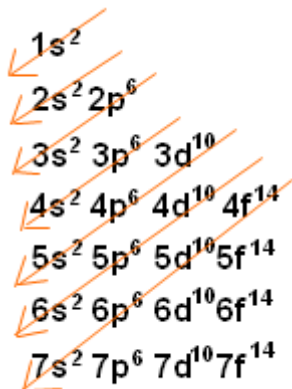
- c. Special Relativity: no formulas
- d. General Relativity: no formulas
- e. Origin and Evolution of Solar System

$$\text{Solar Unit: } 1 \text{ SU} = 3.85 \times 10^{26} \text{ W}$$

$$\text{Critical Probability: } p^* = 1 - \frac{\alpha}{2}$$

Diagonal Rule, or Madelung's Rule

In chemistry, the Diagonal Rule (also known as Madelung's Rule) is a guideline explaining the order in which electrons fill the orbital levels. The $1s^2$ orbital is always filled first, and it can contain 2 electrons. Then the $2s^2$ level is filled, which can also hold 2 electrons. After that, electrons begin to fill the $2p^6$ orbital, and so on. The diagonal rule provides a rule stating the exact order in which these orbitals are filled, and looks like this:



As you can see, the red arrows indicate the filling of orbital levels. Starting at the top, the first red arrow crosses the $1s^2$ orbital. If you follow these arrows down the list, you can easily determine the order that electrons fill the orbital levels.

There is an exception to this rule when filling the orbitals of heavier electrons. For example, when filling the $5s^2$ orbitals, the rule says that $5s^2$ will fill, and then $4d^{10}$ will fill. However, when filling these orbitals for certain metals, only one electron will fill the $5s^2$ orbital, and the next electron will jump into the $4d^{10}$ orbital. This can be predicted, but cannot be exactly determined until it is observed. The same is true for the $6s^2$ orbital—for certain heavy metals, the $6s^2$ will only contain one electron, and the other electrons will jump to the $5d^{10}$ orbital.

http://www.wyzant.com/Help/Science/Chemistry/Electron_Configuration/

Empirical Formula Problem

Find the empirical formula for a compound consisting of 63% Mn and 37% O

Solution for Finding the Empirical Formula

Assuming 100 g of the compound, there would be 63 g Mn and 37 g O

Look up the number of grams per mole for each element using the [Periodic Table](#). There are 54.94 grams in each mole of manganese and 16.00 grams in a mole of oxygen.

$$63 \text{ g Mn} \times (1 \text{ mol Mn}) / (54.94 \text{ g Mn}) = 1.1 \text{ mol Mn}$$

$$37 \text{ g O} \times (1 \text{ mol O}) / (16.00 \text{ g O}) = 2.3 \text{ mol O}$$

Find the smallest whole number ratio by dividing the number of moles of each element by the number of moles for the element present in the smallest molar amount. In this case there is less Mn than O, so divide by the number of moles of Mn:

$$1.1 \text{ mol Mn} / 1.1 = 1 \text{ mol Mn}$$

$$2.3 \text{ mol O} / 1.1 = 2.1 \text{ mol O}$$

The best ratio is Mn:O of 1:2 and the formula is MnO_2

The empirical formula is MnO_2

Ideal Gas Law

An ideal gas is defined as one in which all collisions between atoms or molecules are perfectly elastic and in which there are no intermolecular attractive forces. One can visualize it as a collection of perfectly hard spheres which collide but which otherwise do not interact with each other. In such a gas, all the [internal energy](#) is in the form of kinetic energy and any change in internal energy is accompanied by a change in [temperature](#).

An ideal gas can be characterized by three [state variables](#): absolute pressure (P), volume (V), and absolute temperature (T). The relationship between them may be deduced from [kinetic theory](#) and is called the

$$\text{Ideal gas law: } PV = nRT = NkT$$

- n = number of [moles](#)
- R = universal gas constant = 8.3145 J/mol K
- N = number of molecules
- k = Boltzmann constant = 1.38066×10^{-23} J/K = 8.617385×10^{-5} eV/K
- $k = R/N_A$
- N_A = Avogadro's number = 6.0221×10^{23} /mol

The ideal gas law can be viewed as arising from the [kinetic pressure](#) of gas molecules colliding with the walls of a container in accordance with Newton's laws. But there is also a statistical element in the determination of the average kinetic energy of those molecules. The temperature is taken to be proportional to this average kinetic energy; this invokes the idea of [kinetic temperature](#). One mole of an ideal gas at [STP](#) occupies 22.4 liters.

<http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/idegas.html>

What is pH?

The Simple Definition

pH is a logarithmic measure of hydrogen ion concentration, originally defined by Danish biochemist Søren Peter Lauritz Sørensen in 1909 [1].

$$\text{pH} = -\log[\text{H}^+]$$

where **log** is a base-10 logarithm and **[H⁺]** is the concentration of hydrogen ions in moles per liter of solution. According to the Compact Oxford English Dictionary, the "p" stands for the German word for "power", *potenz*, so pH is an abbreviation for "power of hydrogen" [2].

The pH scale was defined because the enormous range of hydrogen ion concentrations found in aqueous solutions make using H⁺ molarity awkward. For example, in a typical acid-base titration, [H⁺] may vary from about 0.01 M to 0.000000000001 M. It is easier to write "the pH varies from 2 to 13".

The hydrogen ion concentration in pure water around room temperature is about $1.0 \times 10^{-7} \text{ M}$. A pH of 7 is considered "neutral", because the concentration of hydrogen ions is exactly equal to the concentration of hydroxide (OH⁻) ions produced by dissociation of the water. Increasing the concentration of hydrogen ions above $1.0 \times 10^{-7} \text{ M}$ produces a solution with a pH of less than 7, and the solution is considered "acidic". Decreasing the concentration below $1.0 \times 10^{-7} \text{ M}$ produces a solution with a pH above 7, and the solution is considered "alkaline" or "basic".

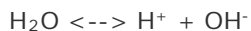
pH is often used to compare solution acidities. For example, a solution of pH 1 is said to be 10 times as acidic as a solution of pH 2, because the hydrogen ion concentration at pH 1 is ten times the hydrogen ion concentration at pH 2. This is correct as long as the solutions being compared both use the same solvent. You can't use pH to compare the acidities in different solvents because the neutral pH is different for each solvent. For example, the concentration of hydrogen ions in pure ethanol is about $1.58 \times 10^{-10} \text{ M}$, so ethanol is neutral at pH 9.8. A solution with a pH of 8 would be considered acidic in ethanol, but basic in water!

<http://antoine.frostburg.edu/chem/senese/101/acidbase/faq/what-is-pH.shtml>

Sometimes you are asked to calculate pOH rather than pH. Here's a review of the pOH definition and an example calculation..

Acids, Bases, pH and pOH

There are several ways to define acids and bases, but pH and pOH only refers to hydrogen ion concentration and hydroxide ion concentration, respectively. pH and pOH are only meaningful when applied to aqueous (water-based) solutions. When water dissociates it yields a hydrogen ion and a hydroxide.



When calculating pOH, remember that [] refers to molarity, M.

$K_w = [\text{H}^+][\text{OH}^-] = 1 \times 10^{-14}$ at 25°C
for pure water $[\text{H}^+] = [\text{OH}^-] = 1 \times 10^{-7}$
Acidic Solution: $[\text{H}^+] > 1 \times 10^{-7}$
Basic Solution: $[\text{H}^+] < 1 \times 10^{-7}$

pOH Calculations

Vocabulary

acid*
activity*
base*
buffer*
hydroxide*
IUPAC*
pH*

$$\begin{aligned} \text{pOH} &= -\log_{10}[\text{OH}^-] \\ [\text{OH}^-] &= 10^{-\text{pOH}} \\ \text{pOH} + \text{pH} &= 14 \text{ for any aqueous solution} \end{aligned}$$

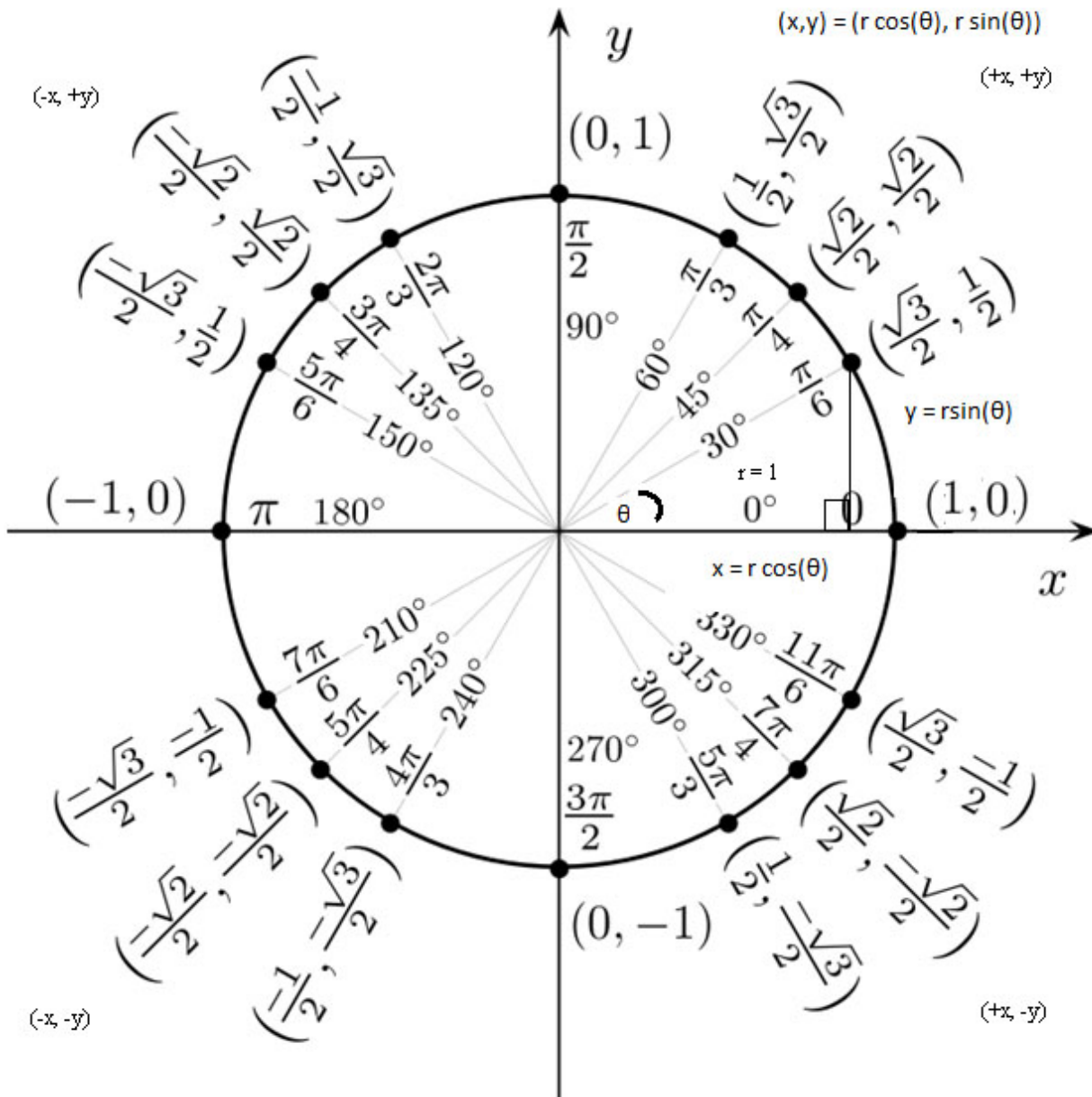
Example:

Find the $[\text{OH}^-]$ given the pH or pOH. If you are given that the pH = 4.5 then,

$$\begin{aligned} \text{pOH} + \text{pH} &= 14 \\ \text{pOH} + 4.5 &= 14 \\ \text{pOH} &= 14 - 4.5 \\ \text{pOH} &= 9.5 \end{aligned}$$

$$\begin{aligned} [\text{OH}^-] &= 10^{-\text{pOH}} \\ [\text{OH}^-] &= 10^{-9.5} \\ [\text{OH}^-] &= 3.2 \times 10^{-10} \text{ M} \end{aligned}$$

<http://chemistry.about.com/od/chemistryquickreview/a/pohcalculation.htm>



$$\sin(\theta) = \frac{\text{opp}}{\text{hyp}} \quad \cos(\theta) = \frac{\text{adj}}{\text{hyp}} \quad \tan(\theta) = \frac{\text{opp}}{\text{adj}} \quad \text{with respect to the angle.}$$

$$\csc(\theta) = \frac{\text{hyp}}{\text{opp}} \quad \sec(\theta) = \frac{\text{hyp}}{\text{adj}} \quad \cot(\theta) = \frac{\text{adj}}{\text{opp}} \quad \text{with respect to the angle.}$$

$$x^2 + y^2 = r^2 \rightarrow r^2 \cos^2 \theta + r^2 \sin^2 \theta = r^2 \rightarrow \cos^2 \theta + \sin^2 \theta = 1 \quad \text{The Pythagorean Theorem}$$

$$m = \left(\frac{y_2 - y_1}{x_2 - x_1} \right) = \frac{r \cdot \sin(\theta)}{r \cdot \cos(\theta)} = \tan(\theta) = \frac{\Delta y}{\Delta x} = \frac{dy}{dx}$$

Algebra (slope) \rightarrow Trigonometry (tangent) \rightarrow Calculus (derivative, i.e. differential calculus)

TRANSFORMATIONS CHEAT-SHEET!

REFLECTIONS:

- ✓ Reflections are a flip.
- ✓ The flip is performed over the “line of reflection.” Lines of symmetry are examples of lines of reflection.
- ✓ Reflections are isometric, but do not preserve orientation.

Coordinate plane rules:

Over the x-axis: $(x, y) \rightarrow (x, -y)$

Over the y-axis: $(x, y) \rightarrow (-x, y)$

Over the line $y = x$: $(x, y) \rightarrow (y, x)$

Through the origin: $(x, y) \rightarrow (-x, -y)$

TRANSLATIONS:

- ✓ Translations are a slide or shift.
- ✓ Translations can be achieved by performing two composite reflections over parallel lines.
- ✓ Translations are isometric, and preserve orientation.

Coordinate plane rules:

$(x, y) \rightarrow (x \pm h, y \pm k)$ where h and k are the horizontal and vertical shifts.

Note: If movement is left, then h is negative. If movement is down, then k is negative.

DILATIONS:

- ✓ Dilations are an enlargement / shrinking.
- ✓ Dilations multiply the distance from the point of projection (point of dilation) by the scale factor.
- ✓ Dilations are not isometric, and preserve orientation only if the scale factor is positive.

Coordinate plane rules:

From the origin dilated by a factor of “ c ”: $(x, y) \rightarrow (cx, cy)$

From non-origin by factor of “ c ”: count slope from point to projection point, multiply by “ c ,” count from projection point.

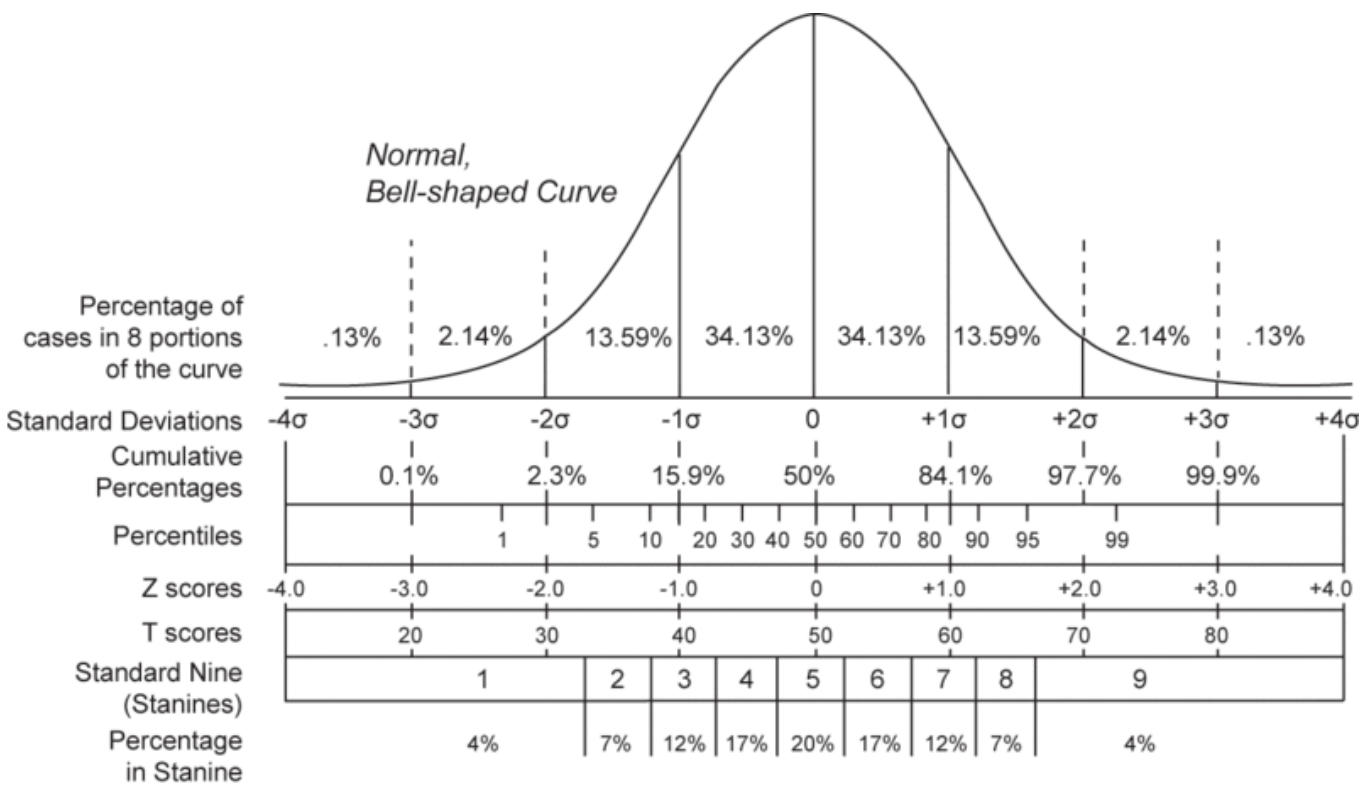
ROTATIONS:

- ✓ Rotations are a turn.
- ✓ Rotations can be achieved by performing two composite reflections over intersecting lines. The resulting rotation will be double the amount of the angle formed by the intersecting lines.
- ✓ Rotations are isometric, and do not preserve orientation unless the rotation is 360° or exhibit rotational symmetry back onto itself.
- ✓ Rotations of 180° are equivalent to a reflection through the origin.

Coordinate plane rules:

Counter-clockwise:	Clockwise:	Rule:
90°	270°	$(x, y) \rightarrow (-y, x)$

180°	180°	$(x, y) \rightarrow (-x, -y)$
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$$Z \text{ score} = \frac{x - \mu}{\sigma} \text{ (for population)}$$

$$Z \text{ score} = \frac{x - \bar{x}}{s} \text{ (for sample)}$$

$$\text{Margin of Error: } 1 - \frac{\text{confidence level}}{100}$$