# C10 - 1.1 - History

History
Wedge 2.5M yo
Fire 300K yo
Atlatl 20K yo

(3000BC) - Numbers, measurement, and arithmetic, (America, Egypt, Mesopotamia).
(2650BC) - Cubit-rod, Nippur, (Iraq).
(2600BC) - Scale, (Egypt).
(2100BC) - Area, Volume, Triangle Ratios, Quadratics, (Egypt, Babylon).
(2000BC) - Pythagorean Triples, Multiplication, (Egypt, Babylon).
(1700BC) - Square Roots, (Babylon).
(1800BC) - Fractions, (Egypt).
Baudhayana (700BC) - Pythagoras Theorem, (India).
Hippasus (500BC) - Irrational Numbers.
(500BC) - Spherical Earth, Straight Edge, Compass. (Greece).
Empedocles (420BC) - Earth/Air/Fire/Water.
Menaechmus (400BC) - Co-ordinate Geometry, Conic Sections.
Aristotle (400BC) - Philosophy. (Greece)
Democritus (380BC) - Atom (idea).
Euclid (300BC) - Elements, Law of Co/Sine, Optics.
Pingala (300BC) - Pascal's Triangle, (India).
Archimedes (300BC) - Lever/Pulley/Screw/Gear - Wheel/Axle/Inclined Plane, Volume Sphere, Trig Sum & Difference ID.
Eratosthenes (300BC) - Earth Circumference.
Hipparchos (200BC) - Distance to Moon & Sun.

(210) - Negative Numbers, (China).
Aryabhata (499) - Zero, Cube Roots, Eclipse Chart.
Brahmagupta (628) - Quadratic Equation, Notation.
Mahavira (850) - nCr.
Halayudha (975) - Binomial Coefficients into Pascal's Triangle.
Madhava of Sangamagrama (1380) - Taylor Series Co/Sine, Pi.
Gerolamo Cardono (1500's) - Complex Numbers, General Cubics, Probability.
Scipione del Ferro (1500) - Depressed Cubic.
Nicolaus Copernicus (1543) - Heliocentric Model.
Niccolo Tartaglia (1556) - Parentheses.
Robert Recorde (1557) - Equal Sign.
William Gilbeet (1600) - Earth's Magnetic Field.
Johannes Kepler (1609-19)- Three Laws of Planetary Motion.
Galileo Galilei (1610) - Telescope Observations.
Robert Boyle (1660) - $P \approx \frac{1}{V}$
Sir Isaac Newton (1672) - Visible Light Spectrum, Principia*.
Leibniz/Newton (1675) - Infinitesimal Calculus.
Anton Van Leeuwennhoek (1675) - Microscope.
Ole Romee (1676) - Speed of Light.
Thomas Bayes (1763) - Bayes Theorem.
Lussac/Jacques Charles (1788) - Ideal Gas Law
Alessandro Volta (1800) - Electrochemical Series & Battery.
Lavoisier (1780) - Father of Chemistry, Conservation of Mass Law
J. Dalton (1805) - Law of Partial Pressure (Father of Atomic Theory)
Avogadro (1811) - Avogadro's Hypothesis
Hans Christian Orsted (1820) - Electromagnetism.
George Ohm (1827) - Ohm's Law.
Amedeo Avagadro (1827) - Avogadro's Law.
Nicolai Lobachevsky (1830) - Non-Euclidean Geometry.
Michael Faraday (1831) - Electromagnetic Induction.
Charles Babbage (1837) - Analytical Engine.
James Joule (1843) - Conservation of Energy Law
Kelvin (1848) - Kelvin Temperature Scale
James Clerk Maxwell (1864) - Theory of Electromagnetism.
Mendeleev (1869) - Periodic Table
Gibbs (1878) - Applied Statistics to Chemistry
Maxwell (1877) - Distributions of Molecular Velocities and Entropy
Arrhenius (1883) - Theories of Ions and Acids
Le Chatalier (1885) - Dynamic Equilibrium (Le C's Principle)
J.J. Thompson (1897) - Electron
Marie Curry (1898) - Radium.
Max Plank (1900) - Quantum Theory/Plank's Constant $E = hf$
Ernest Rutherford (1905) - Protons & dense Nucleus
Albert Einstein (1905) - $E = mc^2$ /Space Time
Neils Bohr (1915) - Bohr Model
Lewis (1910) - Lewis Structure
Edwin Hubble (1924) - Hubble Telescope.
Erwin Schrödinger (1925) - Wave Equation/Function (S's Cat)
Werner Heisenberg (1925) - Uncertainty Principle (Position & Momentum)
LIGO (2016) - Gravitational Waves.
(2019) - Black Whole Image.

# C10 - 1.2 - Properties/Phases

Chemistry : The study of matter and it's properties, composition and structure, and how it changes and energy absorbed or released.

Matter : Anything that exists that has definite mass and volume.

Mass : Quantity of matter in an object.

Weight : Force of gravity on an object.

Physical Property : A substance characteristic that can be observed or measured without changing identity of substance. (color, density, hardness, conductivity, melting/boiling points.)

Chemical Property : A substance characteristic observed in a chemical reaction. (flammability, toxicity, acidity, reactivity, chemical stability, heat of combustion.)

Physical change : Melting, boiling, freezing, dissolving, evaporation, condensing, crushing, breaking, cutting, bending, stretching.

Chemical change : Corrosion, rusting, rotting, burning, cooking, combustion, chemical decomposition.

Intensive properties : Depends on the makeup of the substance like boiling point, density and hardness.

Extensive properties : Depends on how much of the substance is present like mass, energy and volume.

Inter Molecular Forces (IMF) : Attractive forces between molecules. (Opposites attract)

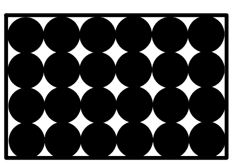
Phases of Matter :

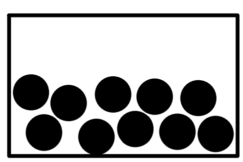
Solids : (s)
-Strong attractive forces.
-Molecules, atoms or ions are arranged in a regular geometric pattern (Crystal Lattice) and vibrate in one place but do not move relative to each other.
-Definite shape or volume.

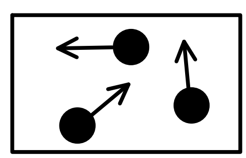
Liquids : (l)
Strong attractive forces.
-Molecules, atoms or ions can flow past each other.
-Viscosity is the resistance to flow (increases as temperature decreases).
-In absence of gravity form a perfect sphere.

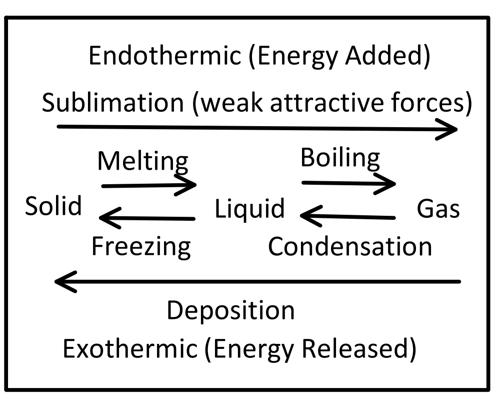
Gases : (g)
-Weak attractive forces.
-Molecules are extremely far apart relative to the size of the molecules.
-Travel in straight lines until elastic collisions (don't lose kinetic energy).
-Move faster at higher temperature.
-Only phase affected by changes in pressure.
-Take shape of container.

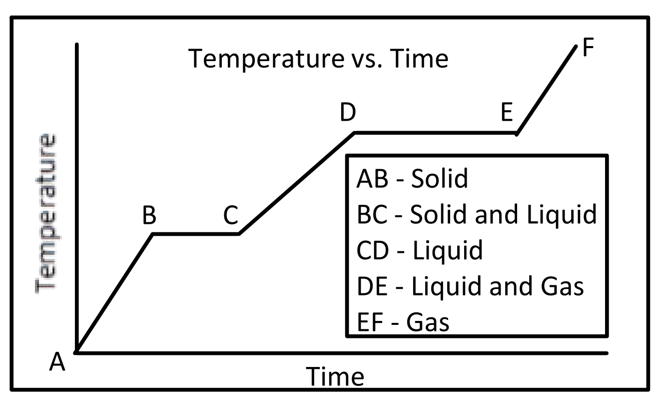
Aqueous : (aq)
-A solution in which the solvent is water.










Equilibrium : A condition where rates of opposing changes are equal.

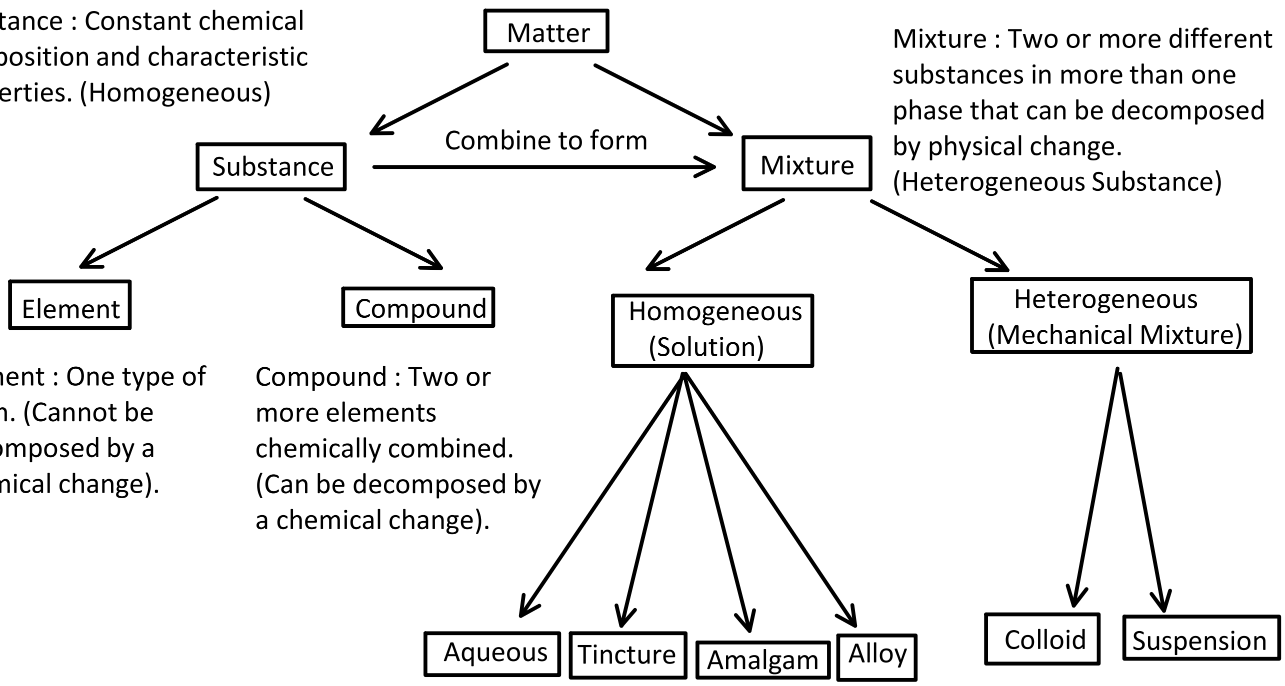
Phase equilibrium : During a phase change, both phases exist at equilibrium.

# C10 - 1.3 - Matter Chart

Homogeneous : Composition is uniform throughout. Pure. Only one phase.
Heterogeneous : Visibly different substances or phases.

Substance : Constant chemical composition and characteristic properties. (Homogeneous)

Mixture : Two or more different substances in more than one phase that can be decomposed by physical change. (Heterogeneous Substance)




Element : One type of atom. (Cannot be decomposed by a chemical change).

Compound : Two or more elements chemically combined. (Can be decomposed by a chemical change).

Solution : A homogeneous mixture of two or more substances. (Saturated when solvent dissolved maximum solute.)
Solvent : Able to dissolve other substances.
Solute : Minor component in a solution.

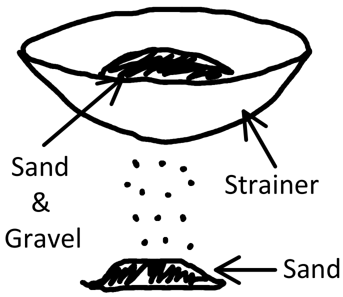
Aqueous : Dissolved in water. Cannot be separated by filtering. Transparent.
Tinctures : Solute is dissolved in alcohol. (Some things cannot dissolve in water)
Amalgam : A solid solution where metal is dissolved into mercury. Commonly Ag and Au.
Alloys : Metals can not chemically bond with each other, but can be mixed to enhance their properties.

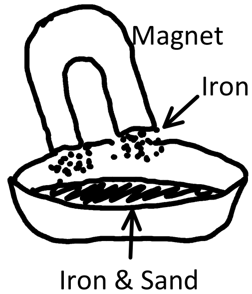
Colloid : Microscopically dispersed, translucent (allows passage of light). Milk, Fog. Smoke. Blood.
Suspension : Fluid containing solid particles large enough to form sedimentation, opaque (blocks passage of light). Dust in air. Oil in Water. Sand/Mud in water.

# C10 - 1.4 - Separation Types

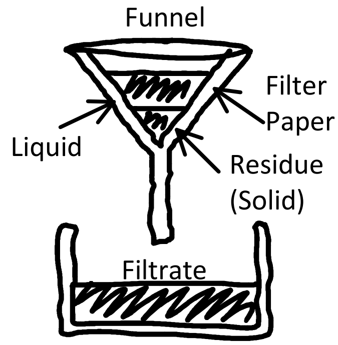
Mechanical Mixtures :

Hand Separation : By Sieve, or Magnet.

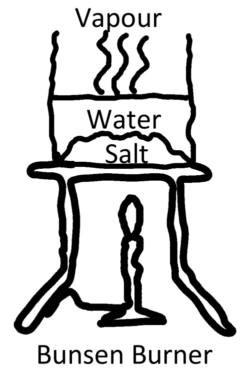



Filtration : Solid particles are removed from a liquid or gas through a filter.

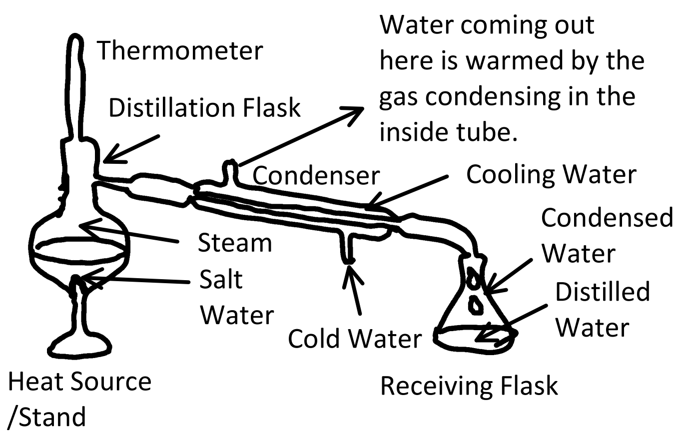



Evaporation : Type of vaporization (conversion of liquid or solid into gas).



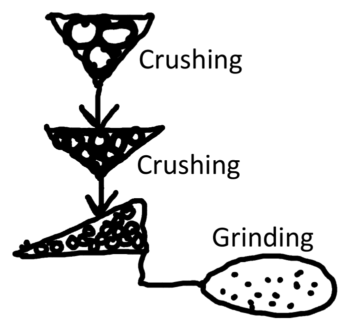

Solutions :

Distillation : Process involving the conversion of a liquid into vapour form that is subsequently condensed back into liquid form.

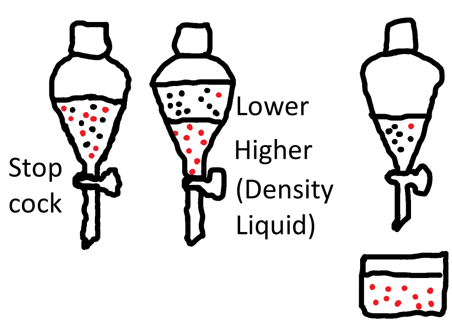



Recrystallization : a purification technique for solid compounds.

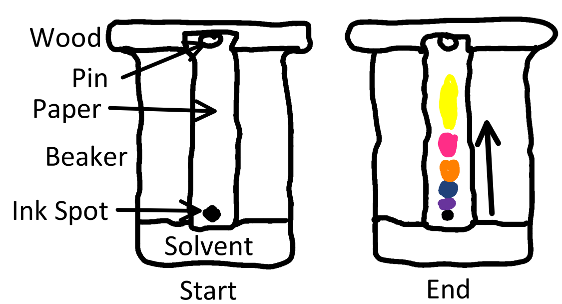
Gravity : Separation is an industrial method of separating two components, either a suspension, or dry granular mixture where separating the components with gravity is sufficiently practical.




Solvent Extraction : The separation of a particular substance from a mixture by dissolving that substance in a solvent that will dissolve it, but which will not dissolve any other substance in the mixture




Chromatography : Process for separating components of a mixture. Mixture is dissolved in a substance called mobile phase, carries it through a second substance called stationary phase.

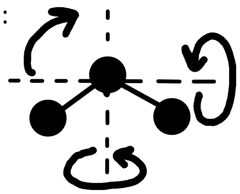



Miscible : Two liquids that combine to form a homogeneous solution.
Immiscible : Little to no miscibility.

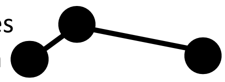
# C11 - 1.5 - Energy/Heat

Energy - Ability to do work*.
Kinetic - Energy of motion (Increase with temperature).
Potential - Stored energy.

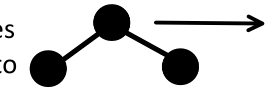
Rotational Energy : Rotation of the molecule around one of its axis or centre of gravity.



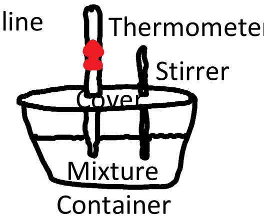
Vibration Energy : Changes the bond length or angle or atoms in a molecule.



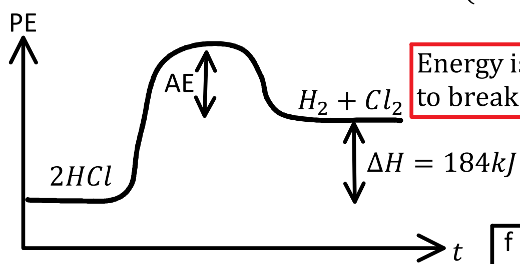
Translation Energy : Causes the molecule to travel in a straight line



Calorimeter : Device used to measure amount of heat involved in a chemical or physical process. For example, when an exothermic reaction occurs in solution in a calorimeter, the heat produced by the reaction is absorbed by the solution, which increases its temperature.

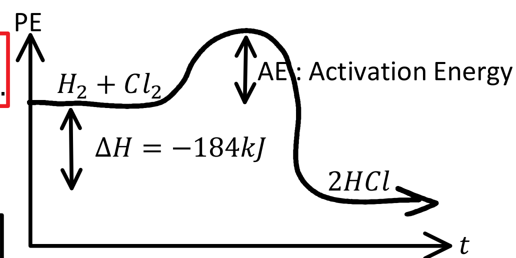



Endothermic Reaction : absorbes heat ($\Delta H = +$).




Energy is needed to break the bond.

Exothermic Reaction : Releases heat ($\Delta H = -$).




f - forward
r - reverse

$HCl + energy \rightarrow H + Cl$ Add Energy
$HCl + 184kJ \rightarrow H + Cl$

$HCl \rightarrow H + Cl + energy$ Releases Energy
$H + Cl \rightarrow HCl + 184kJ$
$H + Cl - 184kJ \rightarrow HCl$

Enthalpy : H, KE+PE in a system. $\Delta H = change\ in\ Enthalpy = H_{products} - H_{reactants}$

Specific Heat Capacity - Energy to heat substance $1g$ $1^oC$.

$Q = mc\Delta T$
$Q = mH$

$\Delta T = T_f - T_i$ $\quad Q = Energy\ (Joules, J)$
$1\ calorie\ (cal) = 4.184\ J$

$\Delta Q = -\Delta \boldsymbol{Q}$

*How much Energy,* $50g$ *water* $20^oC \rightarrow 80^oC$

$Q = mc\Delta T$
$Q = (50)(4.184)(80 - 60)$
$Q = 4184\ J$

$C_{H_2O} = 4.184 \dfrac{J}{g^oC}$

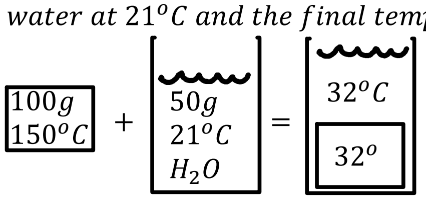
Negative if gives off heat (Cooled)

*Find the final temperature of* $4000\ J$ *heat to a* $70g$ *sample of water at* $35^oC$.

$Q = mc\Delta T$
$4000 = (50)(4.184)(T_f - 60)$
$\dfrac{4000}{209.2} = \dfrac{209.2}{209.2}(T_f - 60)$
$19.12 = T_f - 60$
$+60 \qquad +60$
$T_f = 79.12^oC$

Heat of Fusion - Amount of Energy required to completely melt (convert from (s) to (l)) a substance.
Heat of Vaporization - Amount of Energy required to completely vaporize (convert from (l) to (g)) a substance.

*Find the specific heat capacity of a* $100\ g$ *of an unkown material at* $150^oC$ *in* $50g$ *of water at* $21^oC$ *and the final temperature was* $32^oC$.




$\Delta Q = -\Delta Q$
$mc\Delta T = -mc\Delta T$
$100c(32 - 150) = -50(4.184)(32 - 21)$
$\dfrac{-11800c}{-11800} = -\dfrac{2301.2}{-11800}$
$c = 0.195 \dfrac{J}{g^oC}$

*How much Energy is required to heat* $35.3g$ $H_2O$ *from* $-20^oC$ *to* $115^oC$. $c = 4.184 \dfrac{J}{gC^o}$, $H_f = 334$
$H_v = 2260.$

$Q = mc\Delta T$
$Q = 35.3(2.06)(0 - (-20))$
$Q = 1454.36\ J$

$Q = mH_f$
$Q = 35.3(334)$
$Q = 11790.2\ J$

$Q = mc\Delta T$
$Q = 35.3(4.184)(100 - (0))$
$Q = 14769.52\ J$

$Q = mH_v$
$Q = 35.3(2260)$
$Q = 79778\ J$

$Q = mc\Delta T$
$Q = 35.3(4.184)(115 - (100))$
$Q = 2215.43\ J$

$Q = 1454.36 + 11790.2 + 14769.53 + 79778 + 2215.43 = 110005.52\ J$

LOGIC | Check on Calculator/Reverse

# C10 - 1.6 - Scientific Notation/Ops Notes

**Write in Standard Form (Normal)**

$10^2 = 100$

$5\ E\ 2 = 5 \times 10^2 = 200$

5 | 2nd | , | 2

Comma

Positive Exponent : Decimal to Right

$5.0 \times 10^2 = 500.$ Move Decimal 2 to Right

$8.43 \times 10^5 = 843000.$ Move Decimal 5 to Right

$243. \times 10^{-4} = 0.0243$ Move Decimal 4 to Left

$10^{-4} = \frac{1}{10^4} = \frac{1}{10000} 0.0001$

Negative Exponent : Decimal to Left

**Write in Scientific Notation**

$\#.\#\# \ldots \times 10^{\#}$ $\quad 1\ \#\ (1-9)$ in front of decimal

$9624. = 9.624 \times 10^3$ Move Decimal 3 to Left

$5000000. = 5.0 \times 10^6$ Move Decimal 6 to Left

$0.000000367 = 3.67 \times 10^{-7}$ Move Decimal 7 to Right

$0.00367 \times 10^5 = 367. = 3.67 \times 10^2$

Move the Decimal 5 to the Right
Write in Standard Form
Move the Decimal 2 to the Left

*OR*

$0.00367 \times 10^5 = 3.67 \times 10^2$

Move the Decimal 3 to the Right
Subtract 3 from Exponent

Decimal Right <-> Exponent Down

$5234. \times 10^{-2} = 52.34 = 5.234 \times 10^1$

Move the Decimal 2 to the Left
Write in Standard Form
Move the Decimal 1 to the Left

*OR*

$5234. \times 10^{-2} = 5.234 \times 10^1$

Move the Decimal 3 to the Left
Add 3 to Exponent

Decimal Left <-> Exponent Up

**Operations**

$4.2 \times 10^3 \times 2.1 \times 10^4 = 8.82 \times 10^7$ Add Exponents

$\frac{8.4 \times 10^4}{4.2 \times 10^{-2}} = 2 \times 10^6$ Subtract Exponents

$(3.2 \times 10^3)^{-2} = \frac{1}{(3.2 \times 10^3)^2} = \frac{1}{10.24 \times 10^6}$ Negative Exponents Multiply Exponents

$5 \times 10^0 = 5$

$10^0 = 1$

LOGIC | Check on Calculator/Reverse

# C10 - 1.7 - Conversions Notes

**Conversion Factors**

**Prefixes** | **Attach Prefix Exponent to the Base Unit!**

**How many Litres are in 50 Millilitres?**

$$50\ mL \times \frac{1\ L}{1000\ mL} = 0.05\ L = 5 \times 10^{-2}\ L$$

OR

$$50\ mL \times \frac{10^{-3}\ L}{1\ mL} = 0.05\ L = 5 \times 10^{-2}\ L$$

Calculator $50E - 3 = 0.05$ | $E - 3 : \times 10^{-3}$

**How many Micrometers in 4 Meters?**

$$4\ m \times \frac{1000000\ \mu m}{1\ m} = 4000000\ \mu m$$

OR

$$4\ m \times \frac{1\ \mu m}{10^{-6}\ m} = 4000000\ \mu m$$

Calculator

$40 \div E - 6$

40 | ÷ | 2nd | , | −6

**How many millimeters in 24 kilometers?**

**Base Unit 1st**

$$24km \times \frac{1000m}{1km} = 24000m$$

$$24000m \times \frac{100cm}{1m} = 2400000cm$$

$$2400000cm \times \frac{10mm}{1cm} = 24000000mm$$

OR

$$24km \times \frac{10^3 m}{1km} = 24000m$$

$$24000m \times \frac{1mm}{10^{-3}m} = 24000000mm$$

Convert to the base unit 1st

OR

$$24km \times \frac{10^6 mm}{1km} = 24000000mm$$

$$24km \times \frac{1000m}{1km} \times \frac{100cm}{1m} \times \frac{10mm}{1cm} = 24000000mm = 2.4 \times 10^7 mm$$

**If Granite is 1L=5.5kg :**

**Find the volume, in mL & $cm^3$ of 22kg of granite.**

$$7L \times \frac{5.5kg}{1L} = 37.5kg$$

**Find the mass, in grams, of 5.00mL of granite.**

$$22kg \times \frac{1L}{5.5kg} = 4L$$

$$4L \times \frac{1mL}{10^{-3}L} = 4000mL$$

$1\ ml = 1cm^3$

$$4000mL \times \frac{1cm^3}{1mL} = 4000cm^3$$

**How many kilograms of granite in seven liters?**

$$5.00mL \times \frac{10^{-3}L}{1mL} = 0.005L$$

$$0.005L \times \frac{5.5kg}{L} = 0.0275kg$$

$$0.0275kg \times \frac{1L}{5.5kg} = 0.005L$$

**Express $\frac{45km}{1hr}$ in $\frac{m}{s}$.**

$$v = 45\frac{km}{hr} \times \frac{1000m}{1\ km} \times \frac{1hr}{60min} \times \frac{1min}{60s} = 12.5\ \frac{m}{s}$$

Or do the top and bottom separately

**Express $4\frac{\mu m}{ms}$ to $\frac{Gm}{hr}$.**

$$4\frac{\mu m}{ms} \times \frac{10^{-6}m}{\mu m} \times \frac{1Gm}{10^6 m} \times \frac{1ms}{10^{-3}s} \times \frac{60s}{1min} \times \frac{60min}{hr} = 1.44 \times 10^{-5}\frac{Gm}{hr}$$

**How many meters squared ($m^2$) in 2 kilometers squared ($km^2$)?**

$$2km^2 \times \frac{1000m}{1km} \times \frac{1000m}{1km} = 2000000m^2$$

**How many centimeters cubed ($cm^3$) in 1 meter cubed ($m^3$)**

$$1m^3 \times \frac{100cm}{1m} \times \frac{100cm}{1m} \times \frac{100cm}{1m} = 10000cm^3$$

# C11 - 1.8 - Significant Figures Notes

Accuracy : How close to actual
Precision : quality of exactness.

Natural Numbers (1,2,3…) are Significant

| | |
|---|---|
| 123 | 3 sig figs |
| 12 | 2 sig figs |
| 9876 | 4 sig figs |

**Zero's**

Leading Zeros aren't significant

| | |
|---|---|
| 0.4 | 1 sig fig |
| 0.044 | 2 sig figs |

Middle zeros are Significant

| | |
|---|---|
| 505 | 3 sig figs |

Trailing Zeros

With a Decimals are significant

| | |
|---|---|
| 0.40 | 2 sig figs |
| 10. | 2 sig figs |

If No Decimal, trailing zeros aren't significant

| | |
|---|---|
| 10 | 1 sig fig |
| 100 | 1 sig fig |

Scientific Notation

10 humans No sig figs

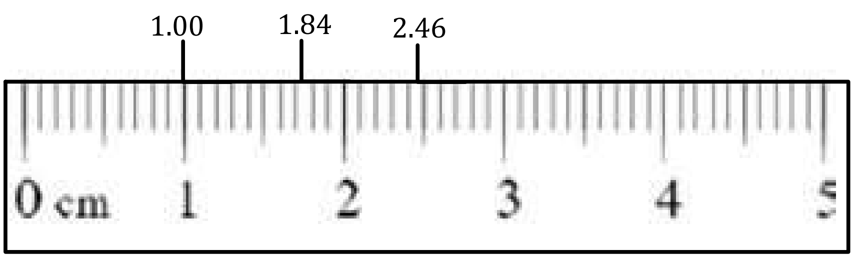
| | |
|---|---|
| $1.0 \times 10^1$ | 2 sig figs |
| $1.00 \times 10^2$ | 3 sig figs |

Adding/Subtracting (Same 10 to the…)
Round answer to least # decimal places

$$5.55 + 5.1 = 10.65 = 10.7$$

Multiplication/Division
Round answer to least # sig figs

$$11 \times 8 = 88 = 90$$




Fluids in beakers*

Read the bottom of the meniscus

$1.84 \pm 0.01 cm$

Certain Digits ↑ (1.8)
Uncertain Digit ↑ (4)
Uncertainty ↑ (0.01)

$\frac{1}{10}$ smallest incremint.

$$Absolute\ Error = Experimental - Actual$$

$$\%\ Error = \frac{|\ Absolute\ Error\ |}{Actual}$$