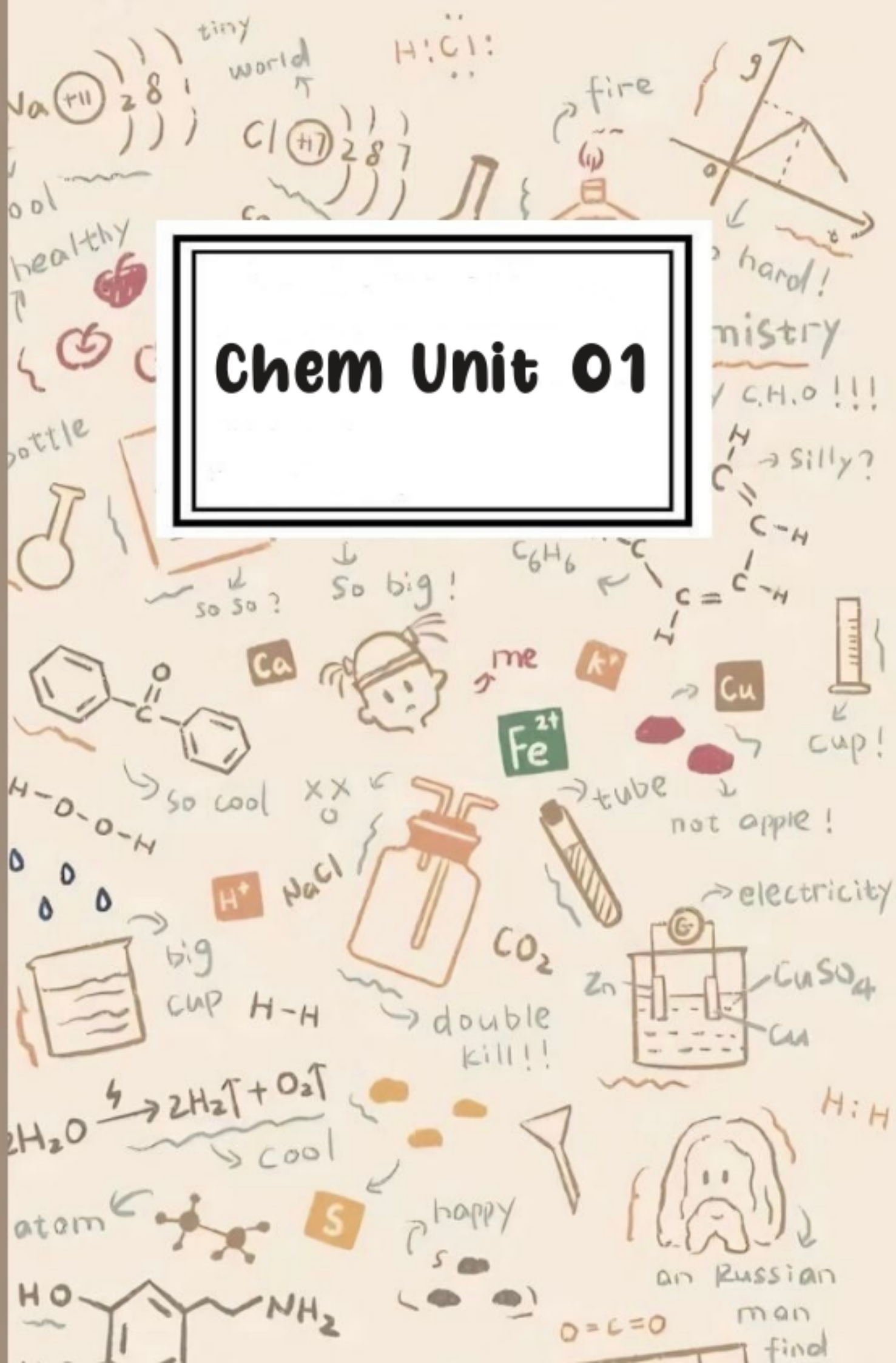


Chem Unit 01



stoichiometry

keywords

atoms 	the smallest part of an element that has the properties of this element.
elements 	a substance made of only one type of atoms
Ion 	A charged atom or group of atoms formed by gaining or losing • Cations positive ions formed by losing electrons • Anion negative ions formed by gaining electrons.
Molecule 	Two or more atoms bonded together
Compound 	A substance made up of two or more elements chemically bonded together
Empirical formula	The formula that tells us the simplest ratio of the different atoms present in a molecule
Molecular formula	The formula that tells as the actual numbers of each type of atom in a molecule
Mole (n)	The SI unit that corresponds to the number of carbons in exactly 12 g of carbon-12 isotope
molar mass	mass per mole of any substance (g/mol)
Avogadro's constant 6.02×10^{23}	the number of particles in one mole of any substance (whether it be electrons, ions, atoms or molecules)

Formulae

$$\text{Atom economy} = \frac{\text{Molar mass of desired product}}{\text{Sum of the molar masses of all products}} \times 100$$

$$m = n \times M_r$$

Mass (g) number of moles (mol) molar mass (g/mol)

number of moles (mol)

$$n = c \times V$$

Volume (dm^3)

concentration (mol dm^{-3})

$$\text{mass concentration} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Molar concentration} = \frac{\text{Moles}}{\text{Volume}}$$

$$\text{g dm}^{-3} \xrightarrow{\div M_r} \text{mol dm}^{-3}$$

$$\text{mol dm}^{-3} \xrightarrow{\times M_r} \text{g dm}^{-3}$$

Volume (dm^3)

$$V = n \times 24$$

number of moles (mol) Molar volume ($24 \text{ dm}^3 / 24000 \text{ cm}^3$)

$$\text{Concentration (ppm) by mass} = \frac{\text{Mass of substance}}{\text{Mass of solvent}} \times 100$$

$$\text{Concentration (ppm) by volume} = \frac{\text{Volume of gas}}{\text{Volume of air}} \times 10^6$$

Volume (m^3)

Constant (8.31)

Pressure (Pa)

$$pV = nRT$$

temperature (K)

Number of moles (mol)

$$1 \text{ g} \xrightarrow{\times 10^3} 1 \text{ kg} \xrightarrow{\times 10^3} 1 \text{ tonne}$$

$$1 \text{ cm}^3 \xrightarrow{\times 10^3} 1 \text{ dm}^3 \xrightarrow{\times 10^3} 1 \text{ m}^3$$

$\times 10^6$ (from 1 g to 1 m^3)

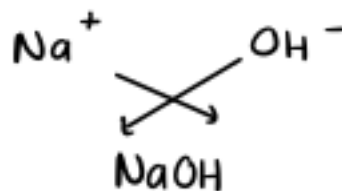
$$1^\circ\text{C} \xrightarrow{+273} 1 \text{ K}$$

$$1 \text{ K} \xrightarrow{-273} 1^\circ\text{C}$$

to write chemical formulae:

1. Write Symbols for each element
2. Put valency of one under the other
3. Simplify if needed

polyatomic ions



Hydroxide $\rightarrow \text{OH}^-$

Hydrogen carbonate $\rightarrow \text{HCO}_3^-$

hydrogen sulfate $\rightarrow \text{HSO}_4^-$

Dihydrogen phosphate $\rightarrow \text{H}_2\text{PO}_4^-$

nitrate $\rightarrow \text{NO}_3^-$

nitrite $\rightarrow \text{NO}_2^-$

manganate $\rightarrow \text{MnO}_4^-$

cyanide $\rightarrow \text{CN}^-$

carbonate $\rightarrow \text{CO}_3^{2-}$

sulfate $\rightarrow \text{SO}_4^{2-}$

Sulfite $\rightarrow \text{SO}_3^{2-}$

Thiosulfate $\rightarrow \text{S}_2\text{O}_3^{2-}$

chromate (VI) $\rightarrow \text{CrO}_4^{2-}$

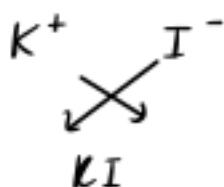
dichromate(VI) $\rightarrow \text{Cr}_2\text{O}_7^{2-}$

phosphate $\rightarrow \text{PO}_4^{3-}$

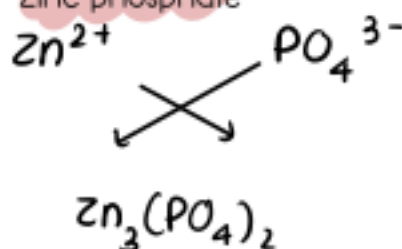
ammonium $\rightarrow \text{NH}_4^+$

Examples of chemical formulae

Potassium iodide



Zinc phosphate



Types of reactions

Acids with metals

Metals + acid $\rightarrow$ salt + hydrogen

acids with metal oxide

Metal oxide + acid $\rightarrow$ salt + water

Acids with metal hydroxide

Metal oxide + acid $\rightarrow$ salt + water

Acids with metal carbonate

Metal carbonate + acid $\rightarrow$ salt + water + carbon dioxide

Acids with metal hydroxides

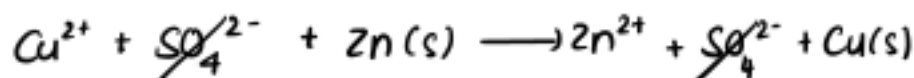
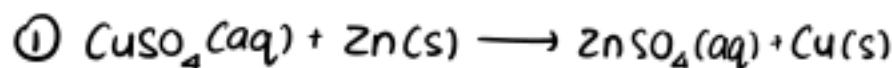
Metal hydroxide + Acid $\rightarrow$ salt + water + carbon dioxide
carbonates

ionic equations

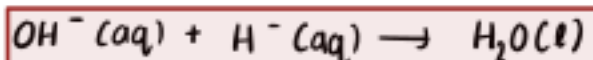
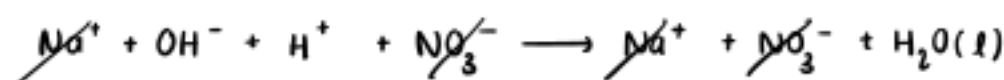
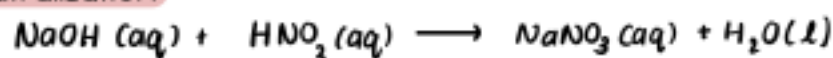
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rules:

- aqueous ionic compounds can be separated into ions
- Ionic solids, covalent compounds (liquids or gases) cannot be separated into ions

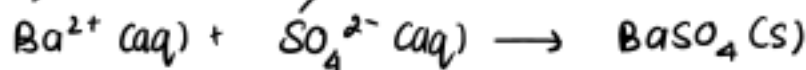
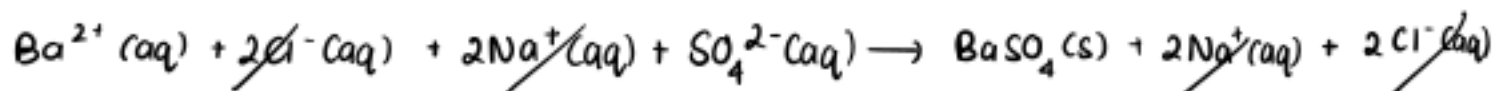
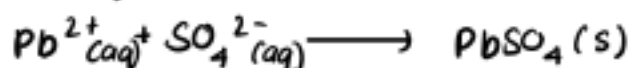
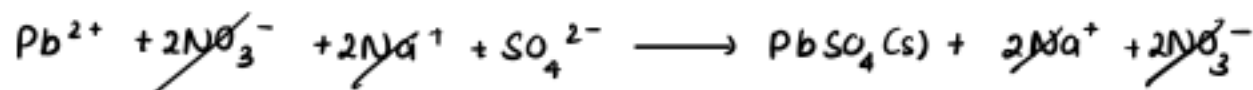


neutralization

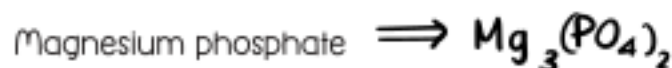


general ionic equation for neutralization

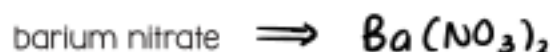
precipitation



determining The mass of one mole (molecular mass)



$$\begin{aligned}\text{Mr}(\text{Mg}_3(\text{PO}_4)_2) &= (24 \times 3) + (31 \times 2) + (16 \times 8) \\ &= 72 + 62 + 128 \\ &= 262\end{aligned}$$



$$\begin{aligned}&= (137 \times 1) + (14 \times 2) + (16 \times 6) \\ &= 137 + 28 + 96 \\ &= \underline{261}\end{aligned}$$

1. there are 3 magnesium atoms
therefore 3×24

2. Phosphate is within a bracket
along with a subscript of 2. Hence,
there are 2 phosphorous atoms
and 8 oxygen atoms (4×2). Total
Mr of phosphate is $(2 \times 31) + (8 \times 16)$

Finding the empirical formula

A sample of hydrocarbon with mass 7.2g contained 6.0g of carbon

What is the empirical formula of the hydrocarbon ?

- A. CH_2
- B. C_5H_{12}
- C. C_6H_6
- D. C_7H_6

$\hookrightarrow$ two elements : C, H

$$\begin{aligned}\text{m of H} &= 7.2 - 6.0 \\ &= 1.2\end{aligned}$$

	C	H
no. of moles	$\frac{m}{\text{Mr}}$ $\frac{6.0}{12}$	$\frac{m}{\text{Mr}}$ $\frac{1.2}{1}$
ratio	$\frac{0.5}{0.5}$	$\frac{1.2}{0.5}$
	5×1 5	$\frac{12}{5} \times 5$ 12
final ratio	5	12

Divide all mole values by
the smallest mole value.

Calculate moles = mass $\div$ Mr.

If the answers are not whole
numbers, multiply all ratios by
the same number until they
become whole numbers.

A compound has 18.2% potassium, 59.4% iodine and the rest is oxygen

Determine its empirical formula

$$\begin{aligned}\% \text{ of oxygen} &= 100 - (18.2 + 59.4) \\ &= 100 - 77.6 \\ &= 22.4\end{aligned}$$

$$\therefore \text{empirical formula} = \underline{\underline{\text{KIO}_3}}$$

	K	I	O
n	$\frac{18.2}{39}$	$\frac{59.4}{127}$	$\frac{22.4}{16}$
ratio	$\frac{0.47}{0.47}$	$\frac{0.47}{0.47}$	$\frac{1.4}{0.47}$
final ratio	1	1	$\frac{2.98...}{\approx 3}$

Finding Mass, Concentration, Volume, number of moles

calculate the number of moles of sulfuric acid in 20.0 cm^3 of a 1.0 mol dm^{-3} solution

$$\begin{aligned} n &= c \times v \\ &= 1.00 \times \frac{20.0}{1000} \\ &= \underline{\underline{0.02 \text{ mol}}} \end{aligned}$$

What is the concentration, in mol dm^{-3} , of a solution containing 7.84 g of phosphoric(V) acid, H_3PO_4 , in 400 cm^3 of solution?

- ☐ A 0.02 ① $n = \frac{m}{M_r} = \frac{7.84}{(3 + 31 + (16 \times 4))} = 0.08 \text{ mol}$
- ☐ B 0.08
- ☒ C 0.20 ② $c = \frac{n}{V} = \frac{0.08}{0.400} = 0.2 \text{ mol dm}^{-3}$
- ☐ D 19.6

Calculating using ideal gas equation

0.960 g of oxygen gas is contained in a vessel of volume $7.00 \times 10^{-3} \text{ m}^3$ at a temperature of 30°C .

Assume that the gas behaves as an ideal gas. ① $n = \frac{m}{M_r}$

What is the pressure in the vessel?

A 1.07 kPa

B 2.14 kPa

☒ C 10.8 kPa

D 21.6 kPa

$$\begin{aligned} \text{② } P &= \frac{nRT}{V} \\ \therefore P &= \frac{mRT}{M_r V} = \frac{0.96 \times 8.31 \times 303}{32 \times 7 \times 10^{-3}} = 10791 \text{ Pa} \\ &= \underline{\underline{10.8 \text{ kPa}}} \end{aligned}$$

What is the volume of steam produced when 1.00 g of ice is heated to 323°C at a pressure of 101 kPa ?

☐ A 0.27 dm^3

☐ B 1.3 dm^3

☒ C 2.7 dm^3

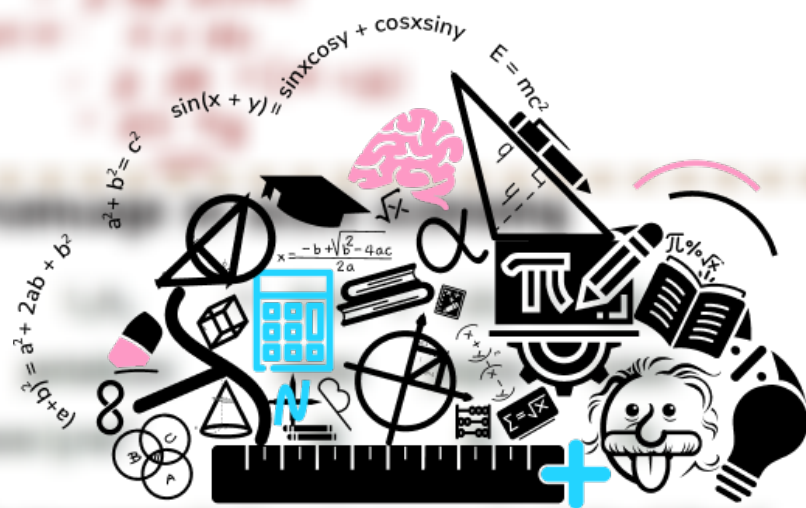
☐ D 48 dm^3

$$\begin{aligned} \text{① } n &= \frac{m}{M_r} = \frac{1.00}{18} = 0.0556 \\ \text{② } T &= 323 + 273 = 596 \text{ K} \\ \text{③ } P &= 101 \text{ kPa} = 101000 \text{ Pa} \\ V &= \frac{0.0556 \times 8.31 \times 596}{101000} \\ &= 2.7 \times 10^{-3} \text{ m}^3 \times 10^3 \\ &= \underline{\underline{2.7 \text{ dm}^3}} \end{aligned}$$

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A central collage of mathematical and scientific symbols and icons. At the top, the sine addition formula $\sin(x+y) = \sin x \cos y + \cos x \sin y$ is written in a curved path. Below it, the Pythagorean theorem $a^2 + b^2 = c^2$ is on the left, and the mass-energy equivalence formula $E = mc^2$ is on the right. In the center, there is a pink brain icon, a black graduation cap, a blue calculator, a stack of books, a lightbulb, and a cartoon drawing of Albert Einstein's head. Various mathematical symbols like π , α , β , γ , δ , ϵ , ζ , η , θ , ι , κ , λ , μ , ν , ξ , $\omicron$, π , ρ , σ , τ , υ , ϕ , χ , ψ , ω are scattered throughout. A large blue plus sign is at the bottom center. The background is a light blue gradient with a subtle grid pattern.

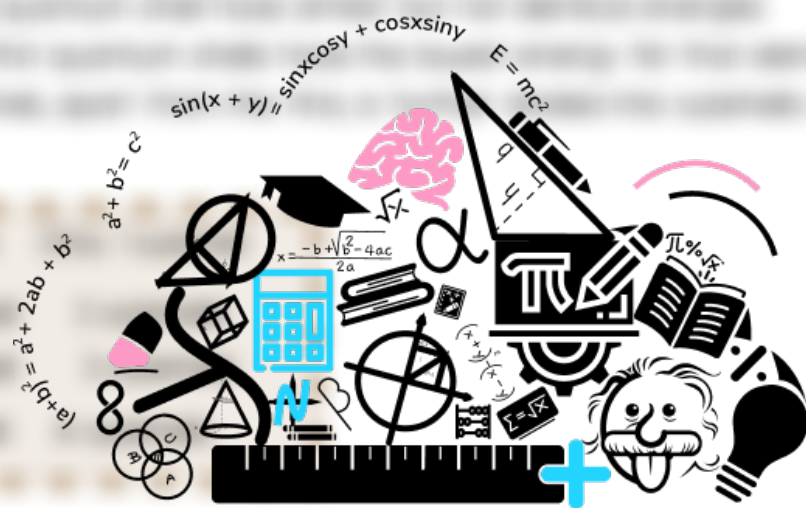
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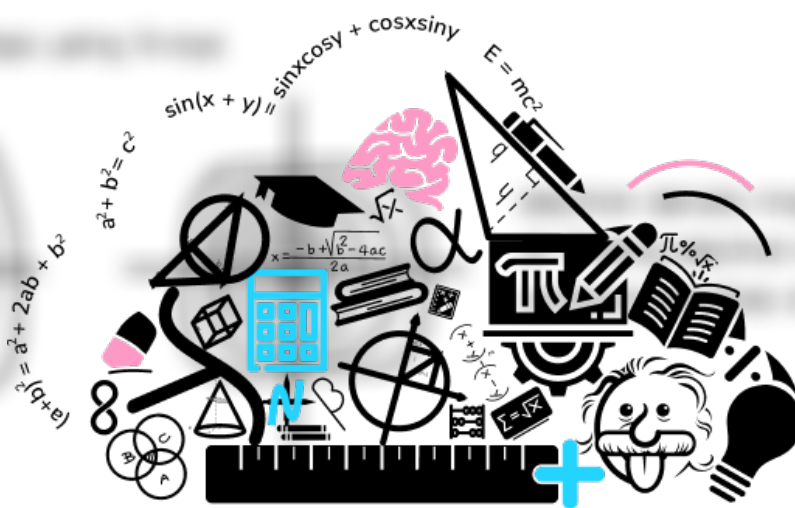
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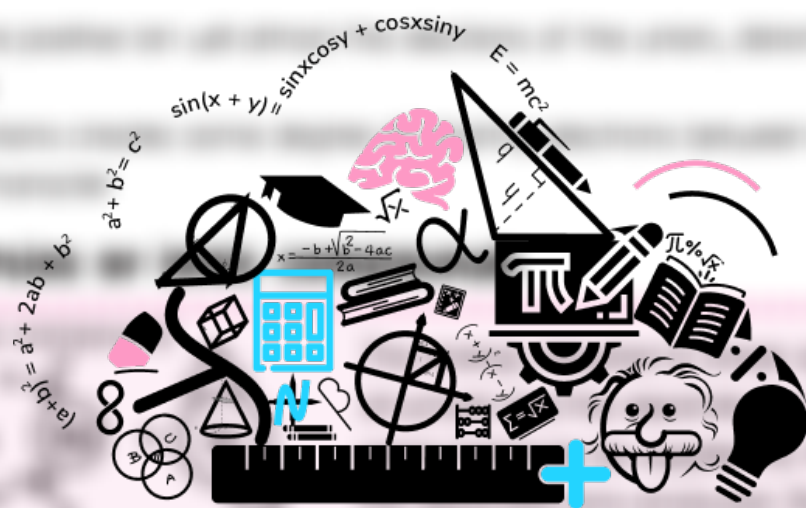
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Small amounts of water can damage wood in 24 hr. The high humidity storage service, however, maintains a relative humidity of 75% throughout storage and storage, keeping your storage in excellent shape.



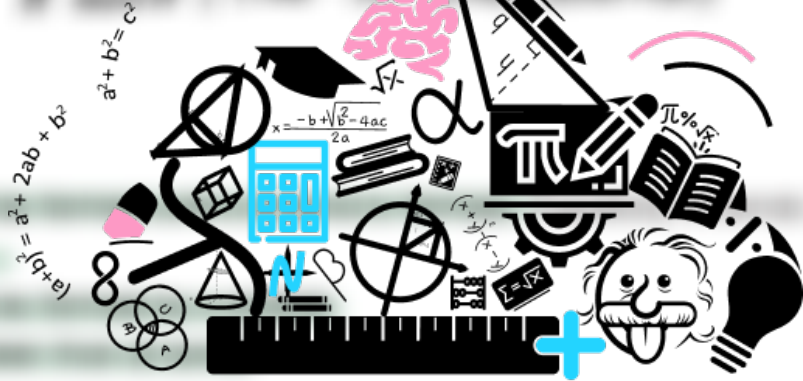
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The experimental structure obtained was made of the ordered layers and the ordered sets of molecules.

Source: <http://www.census.gov/hhes/education/data/tables/2000/2000.ed.education.attainment.attainment.html>



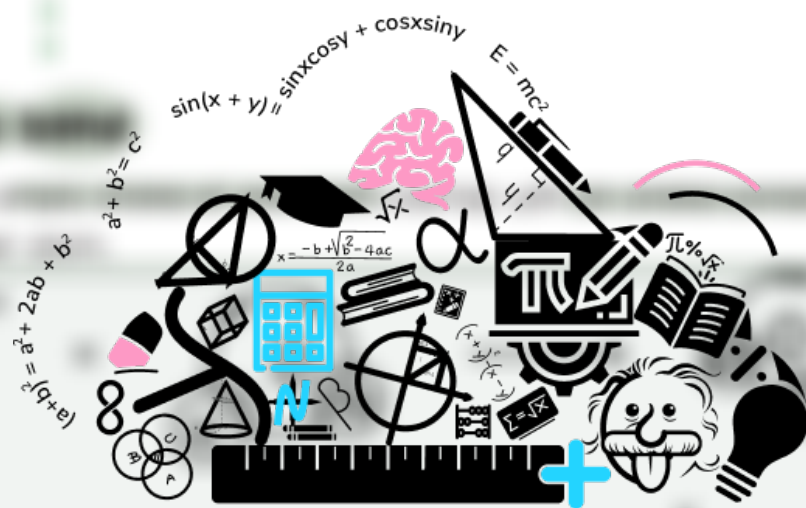
$$E = mc^2$$



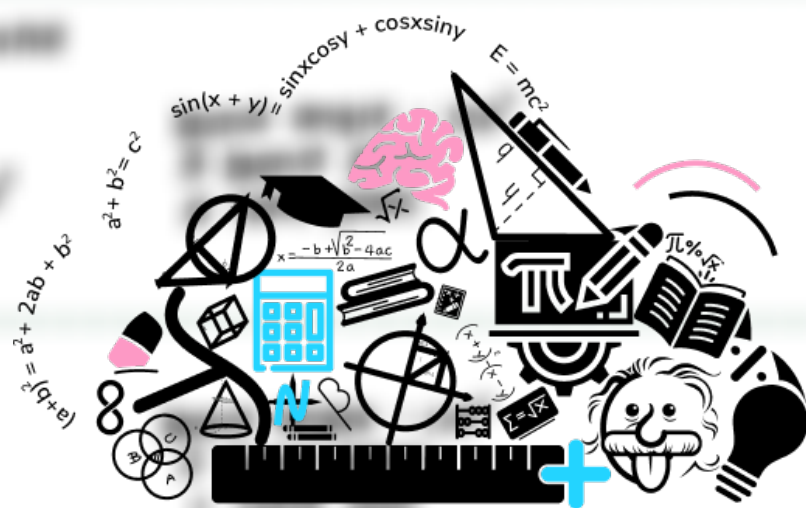
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Source: U.S. Dept. of Commerce, Bureau of Economic Analysis. *Real Gross Domestic Product*. Washington, D.C.: Bureau of Economic Analysis, 1997. The numbers are in billions of dollars.





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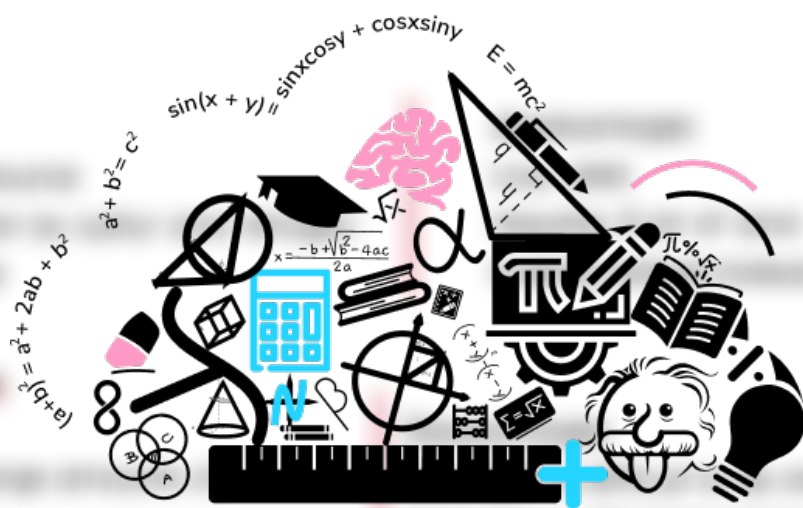




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A vibrant collage of mathematical and scientific symbols and icons. At the top, the sine addition formula $\sin(x+y) = \sin x \cos y + \cos x \sin y$ is written in a curved path. Below it, the Pythagorean theorem $a^2 + b^2 = c^2$ is displayed. On the left, the binomial expansion $(a+b)^2 = a^2 + 2ab + b^2$ is shown. In the center, a pink brain is depicted above a black graduation cap. To the right, the equation $E=mc^2$ is written above a diagram of a right-angled triangle with sides labeled 'a', 'b', and 'c'. Below the brain, the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ is shown. A blue calculator is positioned below the quadratic formula. To the right of the calculator, a large Greek letter alpha α is visible. Further right, a large Greek letter pi π is shown next to a pencil and a book. A lightbulb is at the bottom right, and a portrait of Albert Einstein is at the bottom center. A ruler is at the bottom left, and a large blue plus sign is at the bottom center. Various other mathematical symbols like infinity, sigma, and geometric shapes are scattered throughout the collage.



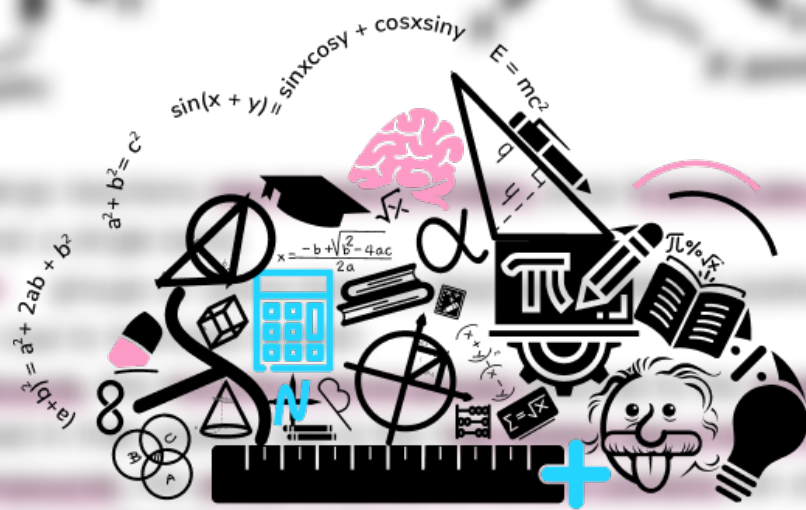


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POLYMERIZATION

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