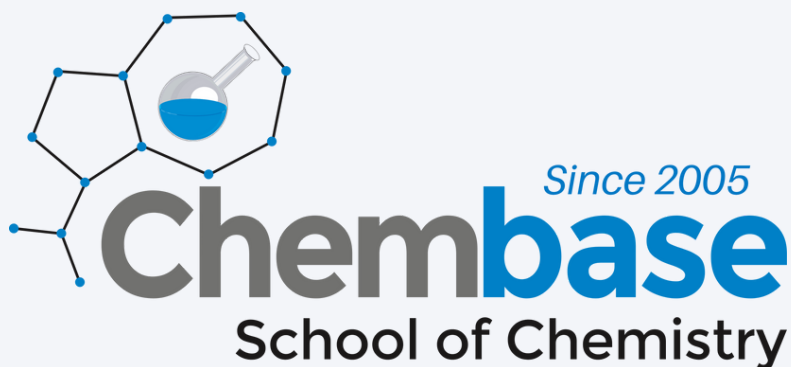


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STUDY PACK 1.2

MOLES, MOLAR VOLUMES & FORMULAE



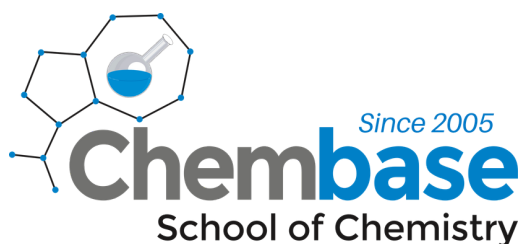
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Concept of Moles

(01) **A.** What is the unit of measurement of substance?

B. Define the term “**mole**” in terms of particles?

C. What is the relationship between the no. of moles & relative atomic mass (or molar mass) of a substance?

D. Write an equation for the calculation of moles?

E. What is the value & units of Avogadro’s constant?

F. If you are aware of the no. of moles of a substance, write an expression to calculate the no. of particles present in that substance?

(02) **A.** Calculate the no. of **moles** present in:

Cu	63.5g	CO ₂	44g	Mg	0.024g
Cl	35.5g	F	0.0019g	Ca	4.0g

B. Calculate the no. of **Atoms** present in:

Na	1.25 mol	Cu	0.00635g	H ₂ SO ₄	98g
Al	2.50 mol	Fe	0.0080g	C ₆ H ₁₂ O ₆	0.18g

C. Calculate in how many **moles** the following no. of Atoms are present?

Ba	6.023×10^{25}	S	12.044×10^{22}
Zn	3.011×10^{20}	Ni	4

D. Calculate the no. of **molecules** & **atoms** in the following moles?

O ₃	4 mol	H ₂ O	2.50 mol
P ₄	0.25 mol	HNO ₃	1×10^{-20} mol

E. Calculate the **mass** of the following:

Na ₂ O	0.004 mol	H ₂ SO ₄	1.5 mol	Na ₂ S ₂ O ₃ .5H ₂ O	8 moles
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- (03) **A.** In 5 mol of H_2SO_4 Calculate,
1. The no. of molecules
 2. Total no. of atoms
 3. No. of Oxygen atoms

- B.** In 0.10 mol of N_2O_5 calculate,
1. The no. of molecules
 2. Total no. of atoms
 3. No. of Oxygen atoms
 4. No. of Nitrogen atoms

- (04) **A.** Calculate the molar mass & RAM of the substance which has 0.10 mol in 6.3g
B. Calculate the relative atomic mass of Yttrium (Y) 3 mol in 2.6672 kg.

- (05) **A.** Mass of a substance "X" which has 1×10^{22} molecules is 2g. Calculate the Molar mass of "X"?
B. Calculate mass of one atom of below elements (molar masses are provided)
P, N, U, Cr.
C. Calculate the mass of one molecule of each of the following compounds
 CH_4 , P_2O_5 , CO .

- (06) **A.** How many moles does "Mg" atoms 2×10^{24} contain?
B. How many water moles does 3.011×10^{22} H_2O molecules contain?
C. Calculate the number of moles of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ in 100g of the solid?

Answers

Volumes of Gases.

1. What is meant by “**molar volume**” of a gas?
2. What is meant by “**standard state**” of a substance? Why it is important to mention the standard state when mentioning molar volume?
3. What is the value of molar volume of any gas under room temperature (298K) & pressure (1atm) ?

What is the value of molar volume of any gas under standard temperature (273K) & pressure (1atm)? Explain why the above two different values.

4. Calculate the **volume** of the number of moles of below stated gases under room temperature & pressure (r.t.p)

- | | |
|-----------------------------|---------------------------------------|
| a) 2 mol of CO_2 | e) 10 mol of C_2H_6 |
| b) 0.5 mol of Cl_2 | f) 0.45 mol of C_2H_4 |
| c) 0.12 mol of HBr | g) 8.0 mol of SO_2 |
| d) 3.4 mol of NO_2 | h) 3.0 mol of N_2 |

5. Calculate the number of **moles** of below given volumes of the gases (r.t.p)

- | | |
|---------------------------------------|--|
| a) 500 cm^3 of CO_2 | e) 2 liters of H_2 |
| b) 200 ml of C_2H_4 | f) 234 cm^3 of SO_3 |
| c) 220 ml of NO | g) 800 dm^3 of HCl |
| d) 20 liters of NO_2 | h) 700 dm^3 of C_2H_6 |

6. Calculate the **mass** of the volume of Gases stated in the above Question.

7. Calculate the **Volume** of the masses of gases stated below (r.t.p)

- | | |
|---|----------------------------|
| a) 20 g of CO ₂ | e) 46 g of NO ₂ |
| b) 100 g of C ₂ H ₄ | f) 420 g of F ₂ |
| c) 20 g NO | g) 56 g of HBr |
| d) 2.34 g of SO ₂ | h) 70 g of NH ₃ |

8. Calculate the **Relative Molecular Mass** of the below given mass & volumes of gases

- | | |
|---|--|
| a) 0.467 g of gas occupy 140cm ³ | g) 0.175 g of gas occupy 150 cm ³ |
| b) 0.0833 g of gas occupy 1 dm ³ | h) 0.338 g of gas occupy 100 cm ³ |
| c) 1.63 g of gas occupy 1.4 dm ³ | i) 0.0513 g of gas occupy 44 ml |
| d) 0.0602 g of gas occupy 38 ml | j) 0.397 g of gas occupy 280 ml |

9. a) If 4.5 g of liquid "A" evaporates to give 1.12dm³ of vapor at room temperature & pressure (s.t.p), What is the Relative Molecular Mass of "A"
- b) 1.1 g of "B" evaporates to give 560 ml at s.t.p. What is the Relative Molecular Mass of "B"

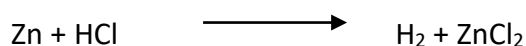
10. a) What volume of CO₂ is obtained at r.t.p. if 5 mols of CaCO₃ is heated?
- b) 1 x 10⁶ ml of CO₂ is absorbed by the leaves of a tree every day. How many mols & mass present in this volume?
- c) 240 cm³ of a gaseous oxide of carbon measured at r.t.p. has a mass of 0.35 grams. What mass one mole of this Oxide is obtained?

11. A sample of CO has a volume of 6 liters at room temperature & pressure

- a) How many moles of the gas are there in the sample?
- b) How many gas molecules are there in the sample?

12. What volume of Oxygen gas is required for the complete combustion of 120 cm³ of butane (C₄H₁₀) under s.t.p

13. What volume of H₂ at room temperature pressure (s.t.p) is given out when 0.325 g of Zinc (Zn) reacts with dilute HCl



Answers

1. Molar volume of a gas is the volume occupied by 1 mole of any gas
Units: $\text{dm}^3\text{mol}^{-1}$
2. Standard state of a substance is the stable pure form of a substance under standard atmospheric pressure (1 atm) & specified temperature (0°C)

It is important to mention the standard state as the molar volume changes with temperature. The Charles law further explains this. Charles law states that the volume of a gas is directly proportional to the temperature at constant pressure.

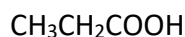
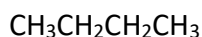
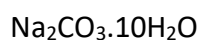
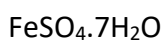
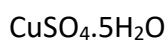
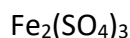
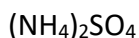
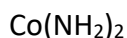
3. Room temperature & pressure (RTP) (25°C , 298K, 1atm) :
 24dm^3 , 24L, 24000cm^3 , 24000ml

Standard temperature & pressure (STP) (0°C , 273K, 1atm) :
 22.4dm^3 , 22.4L, 22400cm^3 , 22400ml

Answers

Chemical Formulae

1. Explain in detail an experiment to find the formula of Copper (II) Oxide.
2. Explain how you can modify the above apparatus to determine the formula of water?
3. What is Empirical formula & Molecular formula? Hence write an equation to show the relationship between the two.
4. The empirical formula of a compound X is C_2H_5 . It has a molar mass of 58 gmol^{-1} , what is the molecular formula of X?
5. The empirical formula of a hydrocarbon is CH. It has a RMM of 78. What is the molecular formula?
6. The empirical formula of a compound is C_3H_6O . It has a molar mass of 58 gmol^{-1} what is the molecular formula?
7. Find the percentage composition of **each** element in following compounds



8. Find the empirical formula of the following compounds,
 - a. 4g of "Hg" forms 4.64g of Mercury Sulphide (HgS)
 - b. 0.62g of "P" forms 1.10g of Phosphorus oxide
 - c. 5.60g of "Fe" forms 16.25g of Iron Chloride
9. Calculate the empirical formula of a compound with the following % composition.
C 39.13% **O** 52.17% **H** 8.70%
10. A gaseous compound of "C" & "H" contain 80% "C" by mass. It's molecular mass is 30.2 g/mol , Calculate it's empirical formula & molecular formula.
11. Sodium burns in excess oxygen to give a yellow solid oxide that contains 58.97% of sodium. What is the empirical formula? If the oxide has a molar mass of 78 gmol^{-1} what it's molecular formula?

- 12.** A compound **P** contains 73.47% carbon & 10.20% hydrogen by mass, the remainder being oxygen. It's found from other sources that **P** has a Relative Molecular Mass of 98. Calculate the molecular formula of **P**.
- 13.** 24.6g of a hydrated salt of $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ gives 12g of anhydrous MgSO_4 on heating. What is the value of **x**?
- 14.** An 18.3g sample of a hydrated compound contained 4.0g of Ca, 7.1g of Cl & 7.2g of H_2O only, Calculate the empirical formulae?
- 15.** A 22.3 grams of an oxide of Lead produced 20.7 grams of metallic lead on reduction with hydrogen. Calculate the empirical formulae of the oxide. (A; PbO)
- 16.** A hydrocarbon containing 92.3% of carbon has a relative molecular mass of 26 g mol^{-1} . What is the molecular formula of the hydrocarbon? (Answer: C_2H_2)
- 17.** Determine the formula of the minerals with the following mass compositions.
- Na 12.1%, Al 14.2% Si 22.2% O 42.1% H_2O 9.48
- 18.** When 1.335g of a chloride of Aluminium is added to excess silver nitrate solution 4.305 g of silver chloride is produced. Calculate the empirical formula of the chloride of aluminum. *Hint: you will need to work out how much chlorine is in 4.305g of AgCl . This will be the amount of chlorine in the initial 1.335g of Aluminium chloride* (Answer: AlCl_3)
- 19.** A 16g of a hydrocarbon burn in excess oxygen to produce 44g of carbon dioxide. What is the empirical formula of the hydrocarbon?. *Hint: you will need to work out the mass of carbon in 44g of CO_2 .* (Answer: CH_4)
- 20.** When a chloride of phosphorus containing 85.1% chlorine is heated a second chloride containing 77.5% chlorine is produced. Find the formulae of the chlorides. (Answers: PCl_5 , PCl_3)

Answers

1. The formula of Copper (II) oxide can be found by passing a stream of dry hydrogen gas over a known mass of Copper (II) oxide & weighing the copper formed.

Apparatus:

Dry hydrogen gas is passed over copper oxide before applying heat until all of air is sent out of the apparatus. This is done because a mixture of hydrogen & oxygen may explode when heated. Therefore, it is important to make sure that there is no air in the apparatus before applying heat. Once all the air has been sent out heating is done in the presence of hydrogen gas until a constant mass of copper is obtained in order to ensure that all of copper oxide has turned to copper. At the end of the experiment record the mass of pure copper.

Results:

Mass of the apparatus :	100g
Mass of apparatus + copper (II) oxide :	105g
Therefore mass of copper (II) oxide :	5g
Mass of Copper :	4g
Mass of Oxygen :	1g (5g-4g)

Calculation:

2. Apparatus:

The apparatus of the previous experiment may be modified to determine the formula of water. A 'U' tube containing a known mass of anhydrous CaCl_2 is connected to the end of the combustion tube. Anhydrous CaCl_2 absorbs water & mass of the 'U' is determined at the beginning & at the end of the experiment. The increase in mass of the 'U' tube equals the mass of water.

Results :

Mass of water	: 1.125g
Mass of 'O'	: 1g (from the previous experiment)
Therefore, mass of 'H'	: 0.125g (1.125g-1g)

Calculation:

3. Empirical formula is the formula showing the simplest ratio of elements in a compound. The mass of the substance of this formula will be the smallest mass.

Molecular formula is the multiple of empirical formula.

Molecular formula mass = Empirical formula mass $\times$ n (n= whole number)

Answers

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