# Department of Education

# Science 9

# The Mole Concept

Second Quarter - Week 7



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In this module, the learners demonstrate the understanding of the unit, mole that quantitatively measures the number of very small particles of matter.

# Use the mole concept to express mass of substances; (S9MT-IIi-19)

Specifically the learners should be able to:

- Define and discuss the mole concept;
- Differentiate molecular unit from formula unit and compute for the molecular mass and formula mass;
- Calculate for the number of moles of given compounds;
- Explain the relation between mass, mole and number of atoms or molecules, and perform calculations deriving these quantities from one another.



## PRE-TEST

**Directions:** Choose the letter of the correct answer.

1. What do you call to the unit amount of a substance used for measuring large quantities of very small entities such as atoms, molecules, or other specified particle like counting molecules of medicine in 0.20g infusion?

A. Mole

C. Molecules

B. Molecular Unit

D. Formula Unit

2. Who was credited for the idea of that the number of molecules in the substance proportional to its physical mass?

A. Amadeo Avogadro

C. Jean Baptiste Perrin

B. EmedeoAvogrado

D. Jean Loschmidt

3. In Hubei China, Ten hospitals were used to do a trial for Remdesivir- $(C_{27}H_{35}N_6O_8P)$  drugs. Patients age 18 and above was admitted with a laboratory confirmed SARS COV 2 infection. Patients were assigned to intake 0.20 g of (Remdesivir- $C_{27}H_{35}N_6O_8P$ ) on the first day and followed by 0.10 g on the following days. How much molecules of Remdesivir- $C_{27}H_{35}N_6O_8P$  (molar mass; 602.6 g/mol) was used on the first day of trial?

A.  $1.998 \times 10^{18}$  molecules of  $C_{27}H_{35}N_6O_8P$ B.  $1.998 \times 10^{19}$  molecules of  $C_{27}H_{35}N_6O_8P$ C.  $1.998 \times 10^{20}$  molecules of  $C_{27}H_{35}N_6O_8P$ D.  $1.998 \times 10^{21}$  molecules of  $C_{27}H_{35}N_6O_8P$ 

4. A mole consists of how many particles?

A.  $6.02 \times 10^{21}$  particles

C.  $6.02 \times 10^{23}$  particles

B.  $6.02 \times 10^{22}$  particles

D.  $6.02 \times 10^{24}$  particles

5. What do you call to the number of nits in one mole of any substance numerically equal to 6.022x10<sup>23</sup> particles?

A. Avogadro's Number

C. Perrin's Number

B. Avogadro's calculation

D. Loschmidt constant

6. Which of the following best describes why mole is important? A. In a laboratory, chemists weigh out amounts of substances like iron and sulfur to count the equal numbers of atoms on it. B. Japan pharmaceutical scientists use the unit of mole to count the Favipiravir molecule in a substance. C. It is used to count Niacinamide molecules in some specific beauty products D. All of the above. 7. Which of the following units used to express the amount of substances in getting the number of particles? A. Formula unit B. Gram C. Milliliter D. Mole 8. Carbon disulfide is a liquid that can be used in the production of rayon and cellophane. It is manufactured from methane and elemental sulfur according to the following chemical equation:  $CH_{4 (g)} + 4S_{(s)} \longrightarrow CS_{2 (l)} + 2H_2S_{(g)}$ . How many moles of CS<sub>2</sub> can be formed by the complete reaction of 10.6 mole of S? A. 1.00 mol B. 10.60 mol C. 2.65 mol D. 42.40 mol 9. Nitrous oxide  $(N_2O)$ , is one of the greenhouse gasses, always use to add power to some cars but in reality it makes our ozone layer to deplete. If 200g of nitrous oxide was used, how many molecules of nitrous oxide (molar mass = 44.013 g/mol) will be added in the atmosphere? 10. Using a periodic table, what is the mass of Oxygen? A. 113 B. 14 C. 16 D. 17 11. Concentrated ammonia gas can kill us due to their chemical properties; specifically it targets our lungs. How many molar mass does ammonia (NH<sub>3</sub>) have? A. 17.01 g/mol C. 19.01g/mol B. 18. O1 g/mol D. 20.01 g/mol 12. A cup contains 20g water. How many moles does the water have? A. 0.76 mol B. 0.81 mol C. 0.93 mol D. 1.11 mol 13. CO<sub>2</sub> is one of the greenhouse gasses. If 60g of CO<sub>2</sub> released, how many molecules will be added? 

14. Romeo preserves a dozen of milkfish for his birthday celebration. He used 200g of NaCl to fully preserve it in just 3 days. How many moles of NaCl do the 200g have?

A. 1.42 mole NaCl

C. 3.42 mole NaCl

B. 2.42 mole NaCl

D. 4.42 mole NaCl

15. Which of the following can be used mole as a unit to count particles/atoms?

A. Pharmaceutical scientists count  $C_{27}H_{35}N_6O_8P$  particles in a Remdesivir drug to treat the severity of the CoVid 19 patients.

- B. Farmers weigh 500 grams of rice to count how many rice are present.
- C. A buyer counts the oranges inside of a 500 g box.
- D. Count of Face masks given in 2 barangays.



**Directions:** Complete the word or group of words being described in each statement.

- 1. it is the measure of the amount of matter in an object.
  - M S
- 2. It is made up of particles which may be atom, ion, or molecules.
  - M \_\_\_ T \_\_\_ R
- 3. It is the simplest ratio of the ions represented in an ionic compound.
  - FO \_\_M U L \_\_ IU\_\_I \_\_
- 4. The average of the masses of a naturally occurring isotopes.
- 5. The product form when two nonmetallic elements share their electrons.

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# BRIEF INTRODUCTION

#### What is a Mole?

Have you tried counting the stars in the night sky or the sand in the beach? You might have thought of it as impossible. Scientists can relate to that feeling whenever they attempt to count atoms, particles, molecules or ions because as you know, they are too small that they can't be seen by our eyes. How do they do it? The Scientists use the **Mole Concept.** 

**Mole** is the unit for counting the number of particles (atoms, molecules and ions), in a substance. In chemistry, *mole* is a Latin word which means "heap" or a "huge pile" and the SI symbol is *mol* and is equivalent to Avogadro's number (N), 6.022 x  $10^{23}$  or 602,214,179,000,000,000,000,000, named after an Italian Physicist Scientist named Amadeo Avogadro.

One mole of any element has  $6.022x10^{23}$  atoms, and one mole of any compound has  $6.022x10^{23}$  molecules.

Formula	Molecular
Mass	Mass
The sum of atomic masses of the ions	The sum of the atomic masses of the
present in the formula unit of an ionic	tom in a molecule
compound	
Calculated from atomic mass unit	Calculated from g/mol units
(amu) units	
Calculated using the empirical formula	Calculated using the molecular
	formula
May or may not give the exact	Always give the exact mass of a
mass of a molecule	mole of a molecule

**Formula mass** is more general term than molecular mass and maybe used in referring to all compounds but not molecular mass.

# **Example of Formula Mass Calculation:**

To find the Formula Mass of NaCl;

Element	Quantity	Multiply	Atomic Mass	Ato	omic Mass Unit
Na	1	X	23	=	23
C1	1	X	35	=	35
Formula Mass					58 amu

To find the Formula Mass of  $CuSO_4$ .  $5H_2O$ 

Element	Quantity	Multiply	Atomic Mass	Ato	omic Mass Unit
Cu	1	X	23	=	23
S	1	X	35	=	35
О	4	X	16	=	35
For 5H <sub>2</sub> O					
Н	10	X	10	=	100
О	1	X	16	=	16
	Formula	-	209 amu		

# **Example of Molecular Mass Calculation:**

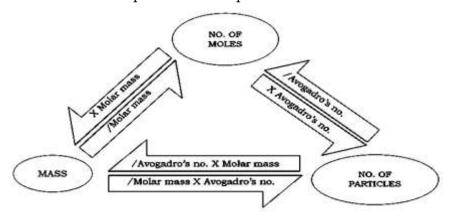
To find the Molecular Mass of NH3

Element	Quantity	Multiply	Atomic Mass	C	Fram per Mole
N	1	X	14	=	14
Н	3	X	1	=	3
	Molecular	=	17 g/mol		

To find the molecular mass of  $H_2O$ 

Element	Quantity	Multiply	Atomic Mass	C	Gram per Mole
Н	2	X	1	=	2
О	1	X	16	=	16
Molecular Mass					18 g/mol

The diagram summarizes the relationship between mass, number of moles and number of particles. It also simplified the computation from one unknown to another.



#### Mole to Mass

•What is the mass of 1.38 mole of sulfuric acid, H<sub>2</sub>SO<sub>4</sub>?

Molar Mass of H<sub>2</sub>SO<sub>4</sub>: H = 1 x 1 = 1  
S = 32 x 1 = 32  
O = 16 x 4 = 
$$\underline{64}$$
  
Total = 98 g/mol

Mass = 1.38 mol of 
$$H_2SO_4 \times 98g H_2SO_4 = 135.24 g H_2SO_4$$
  
1 mol  $H_2SO_4$ 

#### Mass to Mole

•How many moles are present in 25.60 g of carbon dioxide,  $CO_2$  (molar mass = 44 g/mol)?

number of moles = 
$$25.60 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44 \text{ g CO}_2}$$
 = **0.58 mol CO<sub>2</sub>**

## Mass to Number of Particles (number of molecules or atoms)

•How many water molecules will there be in 65.00 g sample water,  $H_2O$  (molar mass = 18 g/mol)

number of molecules = 
$$65.00 \text{ g H}_2\text{O} \times \frac{1 \text{ mol of H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{18 \text{ g H}_2\text{O}} = 2.17 \times 10^{24} \text{ molecules of H}_2\text{O}$$

•How many atoms are present in 24.80 g carbon dioxide, CO<sub>2</sub> (molar mass = 44 g/mol)?

number of atoms = 24.80 g 
$$CO_2$$
 x  $\frac{1 \text{ mol } CO_2}{44 \text{ g } CO_2}$  x  $\frac{6.02 \text{ x } 10^{23} \text{ atoms}}{1 \text{ mol } CO_2}$   
= 3.39 x  $10^{23}$  atoms  $CO_2$ 

#### Number of Particles (number of molecules or atoms) to Mass

•What is the mass of 1.64 atoms of carbon, C?

**mass** = 
$$1.64 \times 10^{24}$$
 atoms 6 x  $\frac{1 \text{ mol C}}{6.02 \times 10^{23}}$  atoms 6 1 mol 6

#### Number of Particles to Number of Moles

•How many moles are there in 9.51 x 10  $^{23}$  molecules  $H_2SO_4$  (molar mass = 98 g/mol)?

number of moles = 
$$9.51 \times 10^{23}$$
 molecules  $H_2SO_4 \times 10^{23}$  molecules  $H_2SO_4$   
=  $1.58$  mol  $H_2SO_4$ 

#### **Mass to Mass**

•How many grams of Al can be created when decomposing 9.80 g of Al<sub>2</sub>O<sub>3</sub>?

$$Al_2O_3$$
  $\rightarrow$   $Al + O_2$ 

**Solution:** Balance the given equation and calculate the ratios.

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

mass of Al = 
$$9.80 \text{ g Al}_2O_3 \times \frac{1 \text{ mol Al}_2O_3}{102 \text{ g Al}_2O_3} \times \frac{4 \text{ mol Al}_2}{2 \text{ mol Al}_2O_3} \times \frac{27 \text{ g Al}}{1 \text{ mol Al}_2O_3}$$
  
= 5.19 g Al

#### Mole to Mole

•Two atoms of sulfur react with three molecules of oxygen to form two molecules of sulfur trioxide, which is an air pollutant. How many moles of sulfur react in this way with 9.00 moles of O<sub>2</sub>?

$$2 S + 3 O_2 2 SO_3$$

mole S = 9.00 mols 
$$Q_2$$
 x  $2 \text{ mol S} = 6.00 \text{ mol S}$   
3 mols  $Q_2$ 



**Directions:** Complete the table below by writing the needed data. Express answers in two decimal place value.

A. Substance	Formula	Molar Mass	Mass (g)	No. of Moles	No. of Particles
1. lead (II) chloride			24.67		
2. nickel iodide					$1.95 \times 10^{23}$
3. sodium bicarbonate				28.04	
4. aluminum bromide				37.0 0	
5. magnesium sulfate heptahydrate					4.48 x 10 <sup>24</sup>

B. Use the equation to solve the problems below.

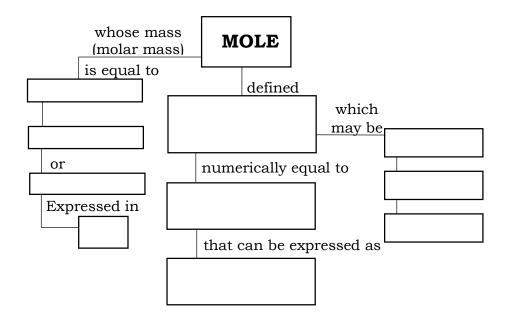
$$Fe_2O_3$$
 (s) + A1 (s - Fe (1) + A1<sub>2</sub>O3 (s)

- 1. What is the mass of iron (III) oxide that must be used to produce 25 g of iron?
- 2. What is the mass of aluminum that must be used to produce 25 g of iron?



**Directions:** Complete the diagram of Mole concept using the following words in the box.

formula mass i	on atomic	mass molecular mass
specific number of pa	articles g/mol	$6.02 \mathrm{x} 10^{23}$





- **A. Directions:** Test your understanding about the mole concept by answering the following problems. Use a separate sheet of paper to show your computation.
- 1. Due to our susceptibility to disease, a nurse in China read an article how Ascorbic acid ( $C_6H_8O_6$ ) can strengthen the body against Covid-19. The article prescribes to intake 0.20 g of Ascorbic Acid every day. How many molecules of Ascorbic Acid is consumed by a person for week?
- 2. A chef uses methane  $(CH_4)$ gas stove to cook food for his restaurant. He always uses 50g of methane gas every day. Methane gas stoves also release methane gas into the air. How many molecules of methane gas are added to the atmosphere?
- 3. A man is driving a car and he usually uses a liter of diesel gasoline. A Liter of gasoline produces around 2620 grams of  $CO_2$ . How many moles of  $CO_2$  did he use?

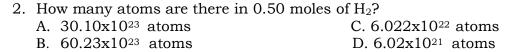
**B. Directions:** Fill up the needed data to complete the table.

Name	Formula	Molar Mass
1.	CoBr <sub>2</sub>	
2. chromium (III) chloride		
3.	$SnS_2$	
4.	Ag <sub>3</sub> P	
5. lead (IV) iodide		



#### POST TEST

1.	Which of the followin	g units used to	express the amor	unt of substances in §	getting
	the number of partic	les?			
	A. Formula unit	B. Gram	C. Milliliter	D. Mole	



- 3. The chemical formula of aspirin is  $C_9H_8O_4$ . What is the mass of 0.40 mol of aspirin?

  A. 72.00 g

  B. 62.00 g

  C. 27.00 g

  D. 74.00 g
- 4. Carbon disulfide is a liquid that can be used in the production of rayon and cellophane. It is manufactured from methane and elemental sulfur according to the following chemical equation: CH<sub>4</sub> (g) + 4S (s) → CS<sub>2</sub> (l) + 2H<sub>2</sub>S (g). How many moles of CS<sub>2</sub> can be formed by the complete reaction of 10.6 mole of S?

  A. 1.00 mol B. 10.60 mol C. 2.65 mol D. 42.40 mol
- 5. Nitrous oxide  $(N_20)$ , is one of the greenhouse gasses, always use to add power to some cars but in reality it makes our ozone layer to deplete. If 200g of nitrous oxide was used, how many molecules of nitrous oxide (molar mass = 44.013 g/mol) will be added in the atmosphere?

6. Using a periodic table, what is the mass of Oxygen?
A. 113
B. 14
C. 16
D. 17

7. Concentrated ammonia gas can kill us due to their chemical properties; specifically it targets our lungs. How many molar mass does ammonia (NH<sub>3</sub>) have?

A. 17.01 g/mol

B. 18. 01 g/mol

C. 19.01g/mol

D. 20.01 g/mol

8. A cup contains 20g water. How many moles does the water have?
A. 0.76 mol B. 0.81 mol C. 0.93 mol D. 1.11 mol

- 9.  $CO_2$  is one of the greenhouse gasses. If 6Og of  $CO_2$  released, how many molecules will be added?
  - A.  $7.20 \times 10^{23}$  particles  $CO_2$

C.  $7.20 \times 10^{23}$  particles  $CO_2$ 

B.  $8.20 \times 10^{23}$  particles  $CO_2$ 

D.  $10.20 \times 10^{23}$  particles $CO_2$ 

10. Romeo preserves a dozen of milkfish for his birthday celebration. He used 200g of NaCl to fully preserve it in just 3 days. How many moles of NaCl do the 200g have?

A. 1.42 mole NaCl

C. 3.42 mole NaCl

B. 2.42 mole NaCl

D. 4.42 mole NaCl



# Post-Test: 1.D 2.A 3.A 4.C 5.D 6.C 7.B 8.D 9.B 10.C

Jounla mass expressed in g/mol.

6.02x102si whose mass (molar mass) is equal to atomic mass, molecular mass or or molecule, numerically equal to Avogadro's number that can be expressed as Remember: A mole is define as specific number of particles which maybe atom, ion Activities: B. 1. 5.71 9 Fe203 2. 12.05 9 Al

4.48 x 10 24	<i>₽</i> 7.0	581	246	7.,o≳gM O₂H	5. magnesium sulfate heptahydrate
2.23x1025	00.78	640,66	792	£1BIA	4. aluminum bromide
3501x99,1	40.82	2322:39	48	NgHCO <sub>3</sub>	3. sodium bicarbonate
1.95 x 10 <sup>23</sup>	SE.0	100.16	818	εliN	<ul><li>A. nickel iodide</li></ul>
5:01x70.E	0.051	79.42	484	₽₽CI³	1. lead (II) chloride
No. of Particles	lo .oV səloM	Mass (g)	Molar Rass (g\mol)	Formula	A. Substance

Looking Back: 1. Mass, 2. Matter 3. Formula Unit, 4. Atomic Mass, 5. Molecule Pre-Test: 1.A 2.A 3.C 4.C 5.A 6.D 7.D 8.C 9.D 10.C 11.B 12.D 13.B 14.C 15.B



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