CHAPTER-2

Gas Laws And Mole concept

* Each gas contains numerous minute molecules.
* The molecules of a gas are in a state of rapid random motion in all directions.
* As a result of this random motion, the gas molecules collide with each other and also with the walls of the container in which it kept.
* As the collisions of the molecules are perfectly elastic in nature, there is no loss of energy
* There is no attraction between the gas molecules and with the walls of the vessel.
* Volume of a gas:- is the volume of the vessel in which it kept
* Pressure of a gas:- is the force exerted by it on unit area of the vessel
* Temperature of a substance:- is the average kinetic energy of the molecules in it
* Boyle's law:- At constant temperature, the volume of a definite mass of gas is inversely proportional to its pressure. If P is the pressure and V is the volume of a definite mass of gas, then P x V is a constant.
* Charle's law :- At constant pressure the volume of a definite mass of gas is directly proportional to its temperature in Kelvin scale. If V is the volume and T the temperature in Kelvin Scale, then V/T is a constant.
* Avogadro's law :- At constant temperature and pressure, the volume of gas is directly proportional to the number of molecules.

  OR

  At constant temperature and pressure, equal volumes of all gases contain equal number of molecules.
* GAM :- The mass of an element in gram equal to its atomic mass is known as 1 Gram Atomic Mass (1GAM) or 1 Gram Atom of the element
* 1 GAM of any element contain 6.022×10^{23} atoms
* 6.022×10^{23} atoms = 1GAM
* GMM :- the mass of a substance in gram equal to its molecular mass is known as 1 Gram Molecular Mass (1 GMM) or a Gram mole of the substance.
* 1 GMM of any substance contain 6.022×10^{23} molecules.

* 6.022×10^{23} molecules = 1 GMM
* The number 6.022×10^{23} is known as Avogadro Number (N_A)
* The amount of substance containing 6.022×10^{23} particles is known as 1 mole (the particles may be atoms, ions, molecules etc) The symbol of mole is "mol"

6.022×10^{23} atoms	= 1 mole atoms
6.022×10^{23} molecules	= 1 mole molecules (1mol)
6.022×10^{23}atoms	= 1 mole atoms = 1GAM
6.022×10^{23}molecules	= 1 mole molecules (1mol)= 1GMM

For Atoms:-

Number of GAMs (or mole atoms) = $\frac{\text{given mass in gram}}{\text{GAM}}$

Mass in gram = Number of GAMs (or number of mole atoms) x GAM

Number of atoms =Number of GAMs (or number of mole atoms) x 6.022×10^{23}

For Molecules :-

Number of GMMs (or moles) = $\frac{\text{given mass in gram}}{\text{GMM}}$

Mass in gram = Number of GMMs (or number of moles) x GMM

Number of molecules =Number of GMMs (or number of moles) x 6.022×10^{23}

For Gases:-

Volume of 1 mole of a gas is known as its molar volume

At STP Molar volume= 22.4 L

Number of moles = $\frac{\text{Volume in litre at STP}}{\text{22.4 L}}$

Volume at STP = Number of moles x 22.4 L

QUESTIONS

SECTION – A (Score- 1)

1. Which of the following is not a gas law
   a. Boyle's Law
   b. Joule's Law
   c. Charle's Law

2. The mathematical form of Boyle's Las is
   a. PV= a constant, b. V/T = a constant, c. P/v = a constant, TV = a constant.

3. The molecular mass of H_2O is ———— (Hint- atomic mass: H-1, O-16)

4. The molecular mass of ammonia(NH_3) is 17. what will be the mass of 2 GMM ammonia

5. 1 mole of CO_2 contains 6.022 x10^{23} molecules. How many molecules are there in 2 mole CO_2

6. The atomic mass of Chlorine is 35.5. What will be the mass of 1 GMM Chlorine

7. When an inflated balloon is kept in sunlight, it burst. Write the gas law behind it

8. The mass of 1/4 x 6.022 x 10^{23} molecules of Oxygen is ..... (Hint;- gram molecular mass of Oxygen is 32g)

9. Volume of 6.022 x 10^{23} molecules of NH_3 at STP is.....

10. Number of atoms in 12g carbon is.....

11. At STP the volume of 1 mole Hydrogen is 22.4 L. What will be the volume of 1 mole NH_3 at STP?

12. A gas kept in a 5L cylinder is completely transferred to another cylinder of 20L, what will be the new volume of the gas?

13. Which of the following is 1 mole Nitrogen ? (Hint:- Atomic mass of Nitrogen is 14)
   a. 7g N_2 b. 14g N_2, 28g N_2

14. Find the odd one
   a. 64g SO_2, b. 2 X 6.022x10^{23} H_2 molecules, c. 64g O_2, d.44.8 L CO_2 at STP
   (Hint:- atomic mass H-1, C-12, O- 16,S-32)

15. The mass of 4 GAM of an element is 80g, then the atomic mass of the element is .....

SECTION B (Score-2)

16. The size of a gas bubble raising from the bottom of an aquarium increase. Why? State the gas law behind it.

17. Write the gas laws related to the following statements.
    a. The size of inflating balloon increase
    b. Inflated balloon burst when kept in sunlight.

18. a. Complete the table

Temperature(T)K	Volume (V) L	V/T
100	200	2
300	.....(a).....	2
....(b).....	800	2

    b. Which is the gas law related to this?

19. a. If the temperature of a fixed mass of gas taken in a cylinder with frictionless piston is increased, what will be the Changes to- a. Kinetic energy of the molecule
    b.Volume of the gas

20 Which of the following has more atoms (Atomic mass :- Hydrogen-1, Oxygen-16)
    a. 16 g Oxygen
    b. 16 g Hydrogen

21. Calculate the molecular mass of
    a. H_2SO_4, b. $CaCO_3$ (Atomic mass H-1, C-12, O-16, S-32 Ca-4O)

22. Calculate the number of GMM and number of molecules in 500g $CaCO_3$

23. Calculate the mass of 5 mole H_2O

24. Select the statements suitable to gases from those given below.
    a) Intermolecular distance is very low.
    b)The volume of gas depends on the volume of the container in which it is occupied.
    c)The energy of gaseous molecules is very high.
    d)The attractive force between gaseous molecules is very high.

25. a) How many moles are there in 140g Nitrogen?.
    b) How many atoms are there in 140g Nitrogen? (Atomic mass : N- 14)

26. Find out the molecular mass of the following compounds

(Atomic Mass : Ca - 40 , N- 14 , C - 12 , O -16 , H- 1)

a) $Ca(NO_3)_2$, b) $C_{12}H_{22}O_{11}$

27. Which of the following have the same number of moles ?

4 GMM H_2 , 88g CO_2 , 89.6 L O_2 , at STP 4g He

28, Which one contains 2 x 6.022 $x10^{23}$ Molecules ?

28g N_2 , 2g H_2 , 32g O_2 , 44.8 L CO_2 at STP

29. 360 g glucose [$C_6H_{12}O_6$] is given. (Hints: Molecular mass $C_6H_{12}O_6$ = 180)

a) How many molecules are there in the sample ?

b) What is the total number of atoms in the sample?

30. Choose the correct statements from those given below

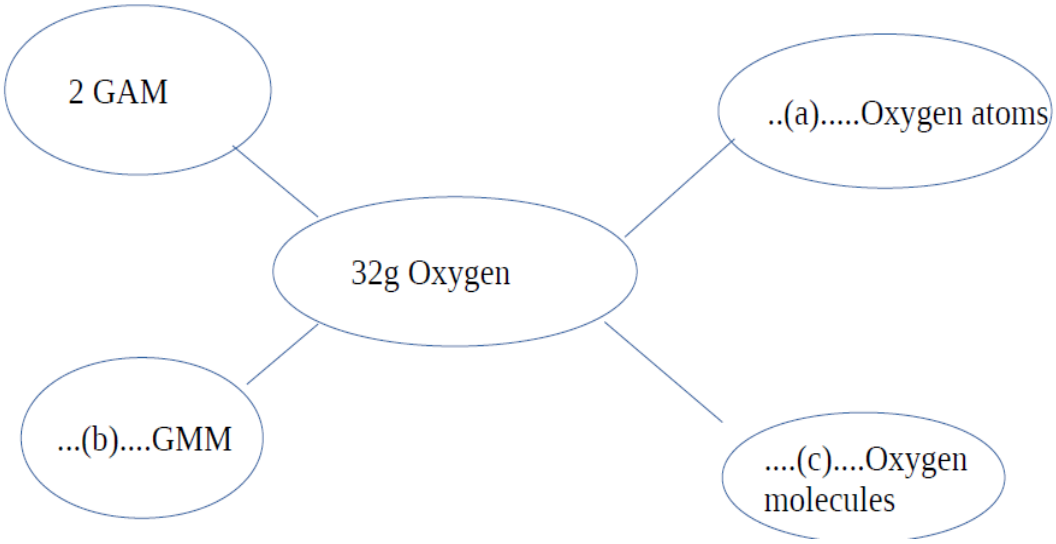
a) 1GMM of any substance contains 6.022$x10^{23}$ molecules.

b) The mass of 6.022$x10^{23}$ O_2 molecules is 16g .

c) The mass of 22.4L of oxygen at 273K and 1atm pressure is 32 g

SECTION-C (Score-3)

31.Complete the flow diagram:



32. The tyres of vehicles do not filled completely in summer.
    a. What is the gas law behind it?
    b. Write the mathematical form of this law
    c. State the law

33. Calculate the volume of 90g steam (H_2O) at STP. How many molecules will it contain?

34. 1mL of oxygen at constant temperature and pressure contains X molecules.
    write answer related to the following gases at same temperature and pressure.
    a) Number of molecules in 1mL hydrogen
    b)Number of molecules in 5mL nitrogen
    c)Volume of 3X molecules of CO_2

35. If at a given temperature and pressure 2 L of a gas contain X molecules ,then complete the table:

Gas	Volume (L)	Number of molecules
Ammonia	2	X
Carbon dioxide	4	.....(a).....
Hydrogen	.....(b).....	3X
Oxygen	1	.....(c).....

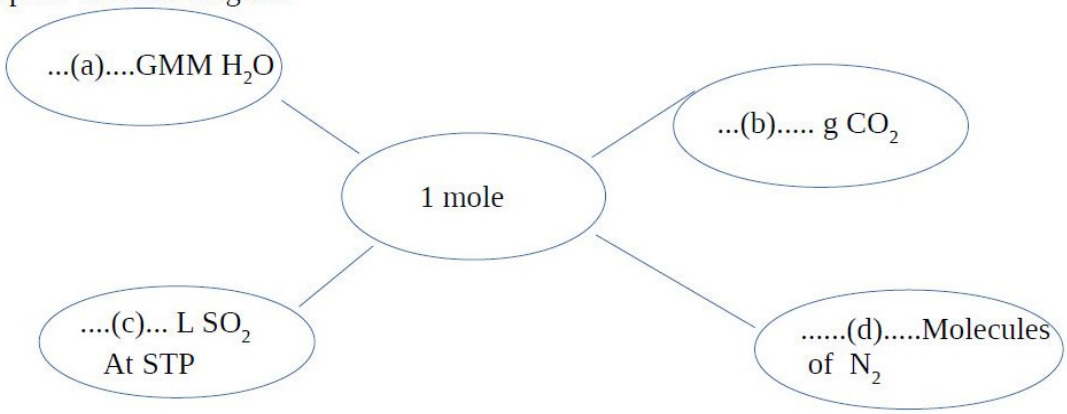
36. Calculate the number of moles, mass and number of molecules in 67.2 L CO_2 at STP

37. Match the following:

64 g O_2	54 g H_2O
22.4 L At STP	2 x N_A atoms
3 x N_A molecules of H_2O	17 g NH_3
	2 moles

38. Complete the flow chart

39. Complete the flow diagram



SECTION -D (Score -4)

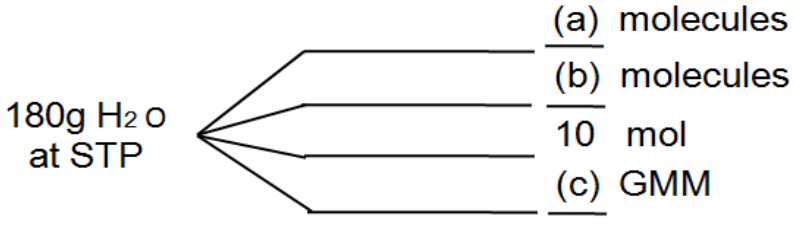
40. Calculate the volume and number of molecules in 440g CO_2 kept at STP.
Also calculate number of each atoms in it.

41. 1 GAM of any substance contain Avogadro Number of atoms.

a. Wtite Avogadro Number

b. Calculate the number of atoms in the following samples and arrange them in increasing order of number of atoms

1.) 32g Sulphur, 2.) 32g Oxygen, 3.) 60g Carbon



i) Find a,b and c

ii) How many grams of H_2O is required to get 20 x 6.022 x 10^{23} molecules ?

43. Complete the table.

Substance	Volume at STP	Number of moles	Mass(g)
CO_2	44.8 L	2	88
CH_4	(a)	(b)	4 g
NH_3	11.2 L	(c)	(d)

44. Arrange the following samples in the increasing order of their mass.

a) 5 GMM CO_2
b) 10 GMM Oxygen
c) 2 mol H_2O
d) 3 mol N_2

45. Complete the table. (Hint : atomic mass : He = 4 , N=14 , O =16 , P = 31)

Substance	Atomic mass	Amount taken(g)	Number of molecules	Number of atoms
He	4	10	(a)	(b)
N_2	14	(c)	6.022×10^{23}	(d)
Cl_2	35.5	(e)	(f)	$10 \times 6.022 \times 10^{23}$
O_2	(g)	80	(h)	$5 \times 6.022 \times 10^{23}$

46, The data of an experiment conducted on a fixed mass of gas at constant temperature are given:

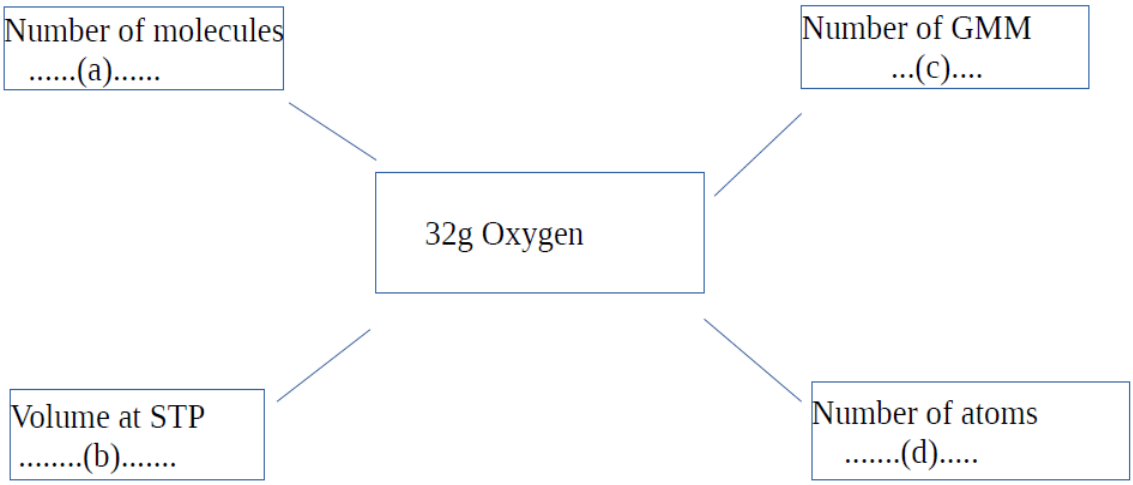
Pressure P(atm)	Volume V(L)	PV
1	10	.....(a)....
2	.....(b).....	10
.....(c).....	2.5	10

i) Complete the table and find out the speciality of PV.

ii) What is the relation between pressure and volume?

iii) Which gas law can be proved by this experiment?

47. Find a, b, c and d from the following flow diagram



ANSWERS SECTION -A

1. (b) Joule's Law
2. (a) PxV= a constant
3. 18
4. 34g
5. 2 x 6.022 x 10^{23}
6. 71g
7. Charle's law
8. 8g
9. 22.4 L
10. 6.022 x 10^{23}
11. 22.4 L
12. 20 L
13. 28g N_2
14. 64g SO_2
15. 20

SECTION -B

16. As the gas bubble raising from the bottom, its pressure decreases and hence its size increases (Volume increases)
Boyle's law. The law states that at constant temperature the volume of a given mass of gas is inversely proportional to its pressure.

17. a. Avogadro's Law, b. Charle's Law

18. a.(a) = 600, (b) = 400
b. Charle's Law

19. a. Kinetic energy of the molecules increase b. Volume of the gas increase

20. 16g Oxygen = 16g / 16g = 1GAM = 6.022×10^{23} atoms
16g Hydrogen = 16g / 1g = 16GAM =$16 \times 6.022 \times 10^{23}$ atoms
16g Hydrogen have more number of atoms.

21. a. 98, b. 100

22. Number of GMM = 500g / 100g = 5
Number of molecules = $5 \times 6.022 \times 10^{23}$

23. Mass of 1mol H_2O =18g
Mass of 5mol H_2O = 5 x 18g =90g

24. b)The volume of gas depends on the volume of the container in which it is occupied.
c)The energy of gaseous molecules is very high.

25. a. 5 mol. (140g / 28g)
b. $10 \times 6.022 \times 10^{23}$ atoms

26. a.164, b.342

27. 4 GMM H_2 = 4mol
88g CO_2= 88g/44g = 2mol
89.6 L O_2 = 89.6 L / 22.4L=4 mol
4g He = 4g/4g = 1 mol
4GMM H2 and 89.6L O_2 have the same number of moles

28. 28g N_2 = 1 mol = 6.022×10^{23} molecules
2g H_2= 1 mol = 6.022×10^{23} molecules
32g O_2 = 1 mol = 6.022×10^{23} molecules
44.8 L CO_2 at STP = 2 mol = $2 \times 6.022 \times 10^{23}$ molecules,
44.8 L CO_2 contain $2 \times 6.022 \times 10^{23}$ molecules

29. 360g glucose =360g / 180g =2 mol
Number of molecules = 2 x 6.022 x 10^{23}
Total number of atoms in 1 molecule $C_6H_{12}O_6$ =24
Total number of atoms in the sample = 2x 6.022 x 10^{23} x 24

30. a) 1GMM of any substance contains 6.022x10^{23}molecules.
c) The mass of 22.4L of oxygen at 273K and 1atm pressure is 32 g

SECTION -C

31. a. 2 x 6.022 x 10^{23} atoms
b. 1 GMM
c. 6.022 x 10^{23} molecules.

32. a. Charle's Law
b. V/T = a constant
c. At constant pressure the volume of a given mass of gas is directly proportional to its temperature in Kelvin Scale

33. 90g H_2O = 90g / 18g = 5 mol
Volume at STP = 5 x 22.4 L
Number of molecules = 5 x 6.022 x 10^{23}

34. a. X
b. 5 X
c. 3ML

35. a. 2X
b. 6
c. X/2

36. Number of moles in 67.2 L CO_2 at STP = 67.2 L / 22.4 L = 3
Mass of 3 mol CO_2 = 3 x 44 = 132g
Number of molecules in 3 mol CO_2= 3 x 6.022 x 10^{23}

37. 64 g O_2 - 2 moles
22.4 L At STP - 17 g NH_3
3 x NA molecules of H_2O - 54 g H_2O

38. a. 36 g, b. 2 x 6.022 x 1023 , c. 2

39. a. 1 GMM, b. 44G, c. 22.4 L d, 6.022 x 10^{23}

SECTION – D

40. 440 g CO_2 at STP = 440g / 44g =10 mol
Volume at STP = 10 x 22.4 L
Number of molecules = 10 x 6.022 x 10^{23}
Number of Carbon atoms = 10 x 6.022 x 10^{23}
Number of Oxygen atoms = 2 x 10 x 6.022 x 10^{23}

41. a) 6.022 x 10^{23}
b) i) 32 g Sulphur = 1 GAM = 6.022 x 10^{23} atoms
ii) 32 g Oxygen = 2 GAM = 2 x 6.022 x 10^{23} atoms
iii) 60 g Carbon = 5 GAM = 5 x 6.022 x 10^{23} atoms
Increasing order - 32 g Sulphur <32 g Oxygen < 60 g Carbon

42. i). a = 10 x 6.022 x 10^{23}
b = 10 x 22.4 L
c. 10 GMM
iii). Mass of H_2O required to get 20 x 6.022 x 10^{23} molecules = 20 x 18 g

43. a= 22.4/ *4 =5.6, b =1/*4, c = 1/2,
d = 17/2 = 8.5

44. 5 GMM CO_2 =5 x 44=220g CO_2
10 GMM O_2 = 10 x 32 =320g O_2
2 mol H_2O = 2 x 18 = 36g H_2O
3 mol N_2 = 3 x 28 = 84g N_2
Increasing order of mass is 2 mol H_2O < 3 mol N_2 < 5 GMM CO_2 < 10 GMM O_2

45. a. 2.5 x 6.022 x 10^{23} , b. 2.5 x 6.022 x 10^{23} , c.28, d. 2 x 6.022 x 10^{23}
e. 5 x 35.5 , f. 5 x 6.022 x 10^{23} , g. 16, h. 2.5 x 6.022 x 10^{23}

46. a. 10, b. 5, c. 4
i) PV is a constant
ii) V is inversely proportional to P
iii) Boyle's Law

47. a. 6.022 x 10^{23}, , b. 22.4 L , c.1 GMM, d. 2 x 6.022 x 10^{23}