Equation of state of a perfect gas, work done in compressing a gas. Kinetic theory of gases - assumptions, concept of pressure. Avogadro's number.

Lecture Recording : https://youtu.be/IHI38Ited-g

13.1 Introduction

1. Kinetic theory explains the behaviour of gases based on the idea that _____.
2. the inter-atomic forces, which are short range forces that are important for solids and liquids, can be neglected for _____.
3. The kinetic theory was developed in the nineteenth century by _____.
4. Atomic Hypothesis was given by _____ and it said , All things are made of _____- little particles that move around in perpetual motion, _____ each other when they are a little distance apart, but _____ upon being squeezed into one another.
5. Atomic Theory was given by _____.
6. Write the two laws of Dalton Atomic theory.
7. Write Gay Lussac's law
8. Write Avogadro Law
9. Mention the spacing between atoms in solids, liquids and gases.
10. Describe the motion of gas molecules and explain why it is dynamic in nature?

11. When do gas molecules obey PV = nRT
12. _____ suggests that the number of molecules per unit volume is the same for all gases at a fixed temperature and pressure.
13. One mole of any gas occupies _____ litres of volume at STP.
14. 44.8 litres of a gas at STP consists of how many moles.
15. Boltzmann Constant = R/N_A. Find its value.
16. What is an ideal gas?
17. At what conditions a real gas behaves like an ideal gas.

18. Explain Dalton's law of partial pressure for a mixture of non - interacting gases.
19. Estimate the fraction of molecular volume to the actual volume occupied by oxygen gas at STP. Take the diameter of an oxygen molecule to be 3 Å.
20. Molar volume is the volume occupied by 1 mol of any (ideal) gas at standard temperature and pressure (STP : 1 atmospheric pressure, 0 °C). Show that it is 22.4 litres.
21. How many moles in 32g of Oxygen gas.
22. What is the weight of 4 moles of Helium gas.
23. What is the molecular weight of following gases in grams.

    Hydrogen , Helium , Nitrogen , Oxygen , Neon , Chlorine , Argon
24. What is the mole fraction of Nitrogen and Oxygen in the following mixture :
    (32 g of Oxygen Gas and 56 g of Nitrogen Gas)
25. 1 atm = _____ Pascal
26. 1 atm = _____ mm of Hg
27. 1 atm = _____ bar
28. R = _____ J/K/moL = _____ L atm /moL/K
29. Kelvin = °C + _____
30. Draw the following curves for an ideal gas :

    P vs V T vs V Z vs P
31. What is compressibility factor?
32. How much is compressibility factor for an ideal gas ?
33. What are the two basic assumptions for an ideal gas?
34. Explain why $P_{real} < P_{ideal}$?
35. Explain why volume available to gas molecules is lesses for real gas compared to an ideal gas.
36. Write the real gas equation.

Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equi-partition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path,

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37. Draw the following curves for a real gas :
    P vs V T vs V Z vs P
38.

    Pressure of an Ideal Gas
39. A ball of mass 2kg is going with 5m/s towards + x axis. Find its momentum
40. A ball of mass 2kg is going with 5m/s towards - x axis. Find its momentum
41. A ball of mass 2kg is going with 5m/s towards + x axis. It gets reflected from a wall and now goes towards -x axis. Find its momentum change. How much impulse did the wall provide. If this reversal of direction happened in 0.1 sec (collision time) , how much average force did the wall provide.
42. The average value of speed is same for all three directions, what is this property called?
43. Two assumptions of Pressure derivation :
    (i) the pressure in any region is same as the overall pressure
    (ii)collisions between gas molecules are ignored
44. From the equation $\mathbf{E = 1.5\ k_B T}$ one can conclude that the average kinetic energy of a molecule is proportional to the absolute temperature of the gas; it is independent of pressure, volume or the nature of the ideal gas.
45. This is a fundamental result relating temperature, a macroscopic measurable parameter of a gas (a thermodynamic variable as it is called) to a molecular quantity, namely the average kinetic energy of a molecule. The two domains are connected by the Boltzmann constant.
46. What is n in Pressure of a gas derivation.
47. All collisions between molecules among themselves or between molecules and the walls are elastic/inelastic?
48. For a mixture of non-reactive ideal gases, the total pressure gets contribution from each gas in the mixture. This law is _____.
49. At a temperature T = 300 K, find the mean square speed of a molecule in nitrogen gas.

50. At a temperature T = 300 K, find the mean square speed of a molecule in Oxygen gas.
51. At a temperature T = 400 K, find the mean square speed of a molecule in Oxygen gas.
52. When a molecule (or an elastic ball) hits a (massive) wall, it rebounds with the same speed. When a ball hits a massive bat held firmly, the same thing happens. However, when the bat is moving towards the ball, the ball rebounds with a different speed. Does the ball move faster or slower? *When gas in a cylinder is compressed by pushing in a piston, its temperature rises. Guess at an explanation of this in terms of kinetic theory using above*
53. Write Energy of one gas molecule at temperature T.
54. How RMS velocity is related to Temperature.
55. Molecules of a monatomic gas like argon have only translational degrees of freedom, therefore they have _____ degrees of freedom
56. Molecules of diatomic gas like Oxygen have both translational and rotational degrees of freedom, so they have _____ degrees of freedom
57. Write the values of f, C_v, C_p, γ for monoatomic gas
58. Write the values of f, C_v, C_p, γ for diatomic gas
59. The RMS speed of gas molecules is independent of the _____.
60. The rate of diffusion of gases is inversely proportional to their molar masses.
61. Why don't the molecules of air settle down at the bottom of the container.
62. What is the law of equipartition of energy?
63. What is the average time of collision between two molecules.
64. What is the mean free path of collision.
65. Molecular mass = n * Vapour Density, n = ?
66. Estimate the mean free path for a water molecule in water vapour at 373 K.
67. At what temperature is the root mean square speed of an atom in an argon gas cylinder equal to the rms speed of a helium gas atom at – 20 °C ?
68.