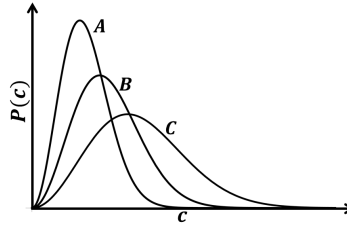


JAM (2020-2021)
Mock Test No: 3
Answer sheet of Kinetic Theory of Gas
Date: 14/02/2020

- The correct option has been highlighted by bold font.

1. As per the kinetic theory of gases, which of the following statements is not correct?
 - (a) Gas particles have mass but no volume.
 - (b) Particles are in Brownian motion between collisions.
 - (c) During the collision, the system does not lose energy.
 - (d) Particles exert same force per unit area on all sides of the container.**
2. An ideal gas is composed of particles of mass M in thermal equilibrium at a temperature T in one container. Another container contains ideal gas particles of mass $2M$ at a temperature $2T$. The correct statement about the two gases is
 - (a) average kinetic energy and average speed will be same in the two cases.
 - (b) both the averages will be doubled in the second case.
 - (c) only the average kinetic energy will be doubled in the second case.**
 - (d) only the average speed will be doubled in the second case.
3. The standard deviation of speed (σ_c) for Maxwell's distribution satisfies the relation
 - (a) $\sigma_c \propto T$
 - (b) $\sigma_c \propto \sqrt{T}$**
 - (c) $\sigma_c \propto \frac{1}{T}$
 - (d) $\sigma_c \propto \frac{1}{\sqrt{T}}$
4. Heat capacity of a species is independent of temperature if it is
 - (a) tetratomic
 - (b) triatomic
 - (c) diatomic
 - (d) monoatomic**
5. Identify the speed distribution functions of Ne, Ar and Kr with the curves in the figure below.

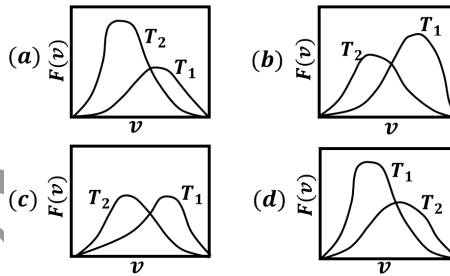


- (a) Ne-A, Ar-B, Kr-C (b) Ne-B, Ar-C, Kr-A
(c) Ne-C, Ar-B, Kr-A (d) Ne-C, Ar-A, Kr-B

6. The speed v of the molecules of mass m of an ideal gas obeys Maxwell's velocity distribution law at an equilibrium temperature T . Let (v_x, v_y, v_z) denote the components of the velocity and k_B the Boltzmann constant. The average value of $(\alpha v_x - \beta v_y)^2$, where α and β are constants, where α and β are constants, is

- (a) $(\alpha^2 - \beta^2) \frac{k_B T}{m}$ (b) $(\alpha^2 + \beta^2) \frac{k_B T}{m}$
(c) $(\alpha + \beta)^2 \frac{k_B T}{m}$ (d) $(\alpha - \beta)^2 \frac{k_B T}{m}$.

7. For temperature $T_1 > T_2$, the qualitative temperature dependence of the probability distribution $F(v)$ of the speed v of a molecule in three dimensions is correctly represented by the following figure



Ans: (a)

8. In low density oxygen gas at low temperature, only the translational and rotational modes of the molecules are excited. The specific heat per molecule of the gas is

- (a) $\frac{1}{2} k_B$ (b) k_B (c) $\frac{3}{2} k_B$ (d) $\frac{5}{2} k_B$.

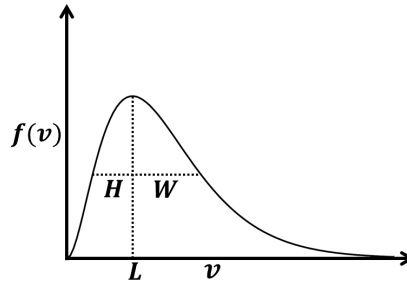
9. For an assembly of molecules (molar mass = M) at temperature T , the standard deviation of Maxwell's speed is approximately

- (a) $0.7 \sqrt{\frac{RT}{M}}$ (b) $1.4 \sqrt{\frac{RT}{M}}$ (c) $0.7 \sqrt{\frac{M}{RT}}$ (d) $1.4 \sqrt{\frac{M}{RT}}$

10. The heat capacity of 10 moles of an ideal gas at a certain temperature is 300 J K^{-1} at constant pressure. The heat capacity of the same gas at the same temperature and at constant volume would be
- (a) 383 J K^{-1} (b) 217 J K^{-1}
(c) 134 J K^{-1} (d) 466 J K^{-1} .
11. The pressure of a gas inside a spherical container is maintained at 2 atm. If the average velocity of the gas molecules inside the container is increased by a factor of two, keeping the pressure the same, by how much would the surface area of the container increase?
- (a) $2^{\frac{2}{3}}$ (b) $2^{\frac{4}{3}}$ (c) $2^{-\frac{1}{3}}$ (d) 1
12. The Maxwell distribution of molecular velocities is said to be the distribution of wealth in a society
- (a) The statement is absurd
(b) The statement is correct as because the Maxwell distribution curve shows negligible zero to infinite velocity and majority with most probable velocity.
(c) There cannot be an analogy between two distinctly different domains.
(d) Has an analogy between two domains.
13. According to the kinetic theory of gases, the ratio of the root mean square velocity of molecular oxygen and molecular hydrogen at 300 K is
- (a) 1:1 (b) $1 : 2\sqrt{2}$ (c) 1 : 4 (d) 1 : 16
14. The value of C_V for 1 mol of N_2 gas predicted from the principle of equipartition of energy, ignoring vibrational contribution, is _____ $\text{J K}^{-1} \text{ mol}^{-1}$ (rounded up to two decimal places)
- (a) 2.01 (b) 20.1 (c) 12.1 (d) 25.3
15. Assuming ideal gas behavior, the density of O_2 gas at 300 K and 1.0 atm is _____ g L^{-1} (rounded up to two decimal places). Given : $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$, molar mass of O_2 is 32.
- (a) 1.30 (b) 5.20 (c) 2.40 (d) 4.65
16. A vessel contains a mixture of H_2 and N_2 gas. The density of this gas mixture is 0.2 g L^{-1} at 300 K and 1 atm. Assuming that both the gases behave ideally, the mole fraction of $\text{N}_2(\text{g})$ in the vessel is _____. [Given $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$, atomic weight of hydrogen = 1.0 and atomic weight of nitrogen = 14.0.]
- (a) 0.095 (b) 0.08 (c) 0.64 (d) 0.25
17. From the kinetic theory of gases, the ratio of most probable speed (c_{mp}) to root mean square speed (c_{rms}) is
- (a) $\sqrt{3}$ (b) $\frac{\sqrt{2}}{\sqrt{3}}$ (c) $\frac{\sqrt{3}}{\sqrt{2}}$ (d) $\frac{3}{\sqrt{2}}$.

18. According to the equipartition principle, the predicted high temperature limiting value of the molar heat capacity at constant volume for C_2H_2 is
 (a) $5.5R$ (b) $6.0R$ (c) $9.0R$ (d) $9.5R$.
19. In an ideal monoatomic gas, the speed of sound is given by $\sqrt{\frac{5RT}{3M}}$, if the speed of sound in argon at $25^\circ C$ is 1245 km h^{-1} , the root mean square velocity in ms^{-1} is _____.
 Ans: 463.98 m s^{-1} .
20. The average speed of H_2 , N_2 and O_2 gas molecules is in the order
 (a) $H_2 > N_2 > O_2$ (b) $O_2 > N_2 > H_2$
 (c) $H_2 > O_2 > N_2$ (d) $N_2 > O_2 > H_2$.
21. Based on the principle of equipartition of energy, the molar heat capacity of CO_2 at constant volume $\bar{C}_V$ is
 (a) $3.5R$ (b) $6R$ (c) $6.5R$ (d) $9R$.
22. For an ideal gas, the plot that is nonlinear is
 (a) PV vs T
 (b) PV vs P at constant T
 (c) P vs V at constant T
 (d) $\ln P$ vs $\ln V$ at constant T .
23. Consider the two identical containers, one with 1 mole of H_2 and other with 1 mole of He. If the root mean square (RMS) velocities of two gases are the same, then the ratio of the temperatures, $\frac{T_{H_2}}{T_{He}}$ is,
 (a) $\frac{1}{2}$ (b) 2 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$.
24. Given that the most probable speed of Oxygen gas is 1000 m s^{-1} , the mean or average speed under the same condition is,
 (a) 1224 (b) 1128 (c) 886 (d) 816.
25. A stream of oxygen molecules at 500 K exits from a pin-hole in an oven and strikes a slit that selects the molecules traveling in a specific direction. Given that the pressure outside the oven is $2.5 \times 10^{-7} \text{ atm}$, estimate the maximum distance at which the slit must be placed from the pin-hole in order to produce a collimated beam of oxygen. (Radius of $O_2 = 1.8 \times 10^{-10} \text{ m}$).
 (a) 0.473 m (b) 0.562 m (c) 0.120 m (d) 0.320 m.

26. The molar heat capacity at constant volume of a colorless gas is found to be $25 \text{ J mol}^{-1} \text{ K}^{-1}$ at room temperature. The gas must be
 (a) N_2 (b) O_2 (c) CO_2 (d) SO_2 .
27. The Maxwell-Boltzmann distribution of molecular speed is shown in the following figure



In the figure, H is the height of the peak, L is the location of the maximum and W is the width at half height. As the temperature is decreased,

- (a) H increases, L decreases and W increases
 (b) H increases, L decreases and W decreases
 (c) H decreases, L increases and W increases
 (d) H decreases, L decreases and W decreases
28. According to the ideal gas laws, the molar volume of a gas is given by
 (a) 2.24 L (b) $\frac{RT}{P}$ (c) $\frac{8RT}{PV}$ (d) $\frac{RT}{PV}$
29. The kinetic theory of gases predicts that total kinetic energy of a gaseous assembly depends on
 (a) pressure of the gas (b) temperature of the gas
 (c) volume of the gas (d) pressure, volume and temperature of the gas.
30. At a certain temperature, hydrogen molecules have r.m.s. velocity of 3 km s^{-1} . What is the r.m.s. velocity of the oxygen molecules at the same temperature?
 (a) 0.25 km s^{-1} (b) 0.5 km s^{-1} (c) 0.75 km s^{-1} (d) 6 km s^{-1} .
31. A wall is hit elastically and normally by n balls per second per unit area. All the balls have the same mass m and are moving with the same velocity u . The force exerted by the balls on the wall is
 (a) mnu^2 (b) $2mnu^2$ (c) $2mnu$ (d) $\frac{1}{2}mnu^2$.
32. Which of the statement is true?
 (a) $R = (\gamma - 1)\overline{C}_V$ (b) $R = (\gamma + 1)\overline{C}_V$
 (c) $R = \frac{\gamma - 1}{\overline{C}_V}$ (d) $R = (\gamma + 1)\overline{C}_P$.

33. A balloon containing methane is pricked with a sharp needle and quickly plunged into a tank of hydrogen at same pressure. After sometime, the balloon will
 (a) get enlarged (b) get collapsed
 (c) remain as before (d) reduce to half of its original size.
34. The kinetic theory of gases predicts that total kinetic energy of a gaseous assembly depends on
 (a) pressure of the gas (b) temperature of the gas
 (c) volume of the gas (d) pressure, volume and temperature of the gas.
35. A rubber balloon permeable to all isotopic forms of hydrogen is filled with heavy hydrogen and placed in tank of pure hydrogen (Pressure inside the balloon and the tank are same). After some times, the balloon will
 (a) shrink in size (b) expand
 (c) remain as such (d) shrink to half of its size.
36. Rate of diffusion of a gas is
 (a) directly proportional to its density;
 (b) directly proportional to its molecular mass;
 (c) directly proportional to the square root of its molecular mass;
 (d) inversely proportional to the square root of its molecular mass.
37. The average distance traveled by the molecule between successive collisions is called
 (a) collision path (b) mean free path
 (c) collision diameter (d) collision distance.
38. Three flasks of 2 L capacity were separately filled with argon, oxygen and ozone respectively under similar conditions. The ratio of number of atoms in the flasks is
 (a) 1 : 1 : 1 (b) 1 : 2 : 3 (c) 3 : 2 : 1 (d) 2 : 2 : 3.
39. Which among the following contains Avogadro number of molecules?
 (a) 36 g of water vapors (b) 49 g of hydrogen sulphate
 (c) 17 g of ammonia (d) 4.4 g of carbon dioxide.
40. The r.m.s. velocity of the molecules in the sample of helium is 57th that of the molecules in the sample of hydrogen. If the temperature of the hydrogen sample is 0°C that of helium is
 (a) 0°C (b) 0°K (c) 273°K (d) 100°C .
41. C_P and C_V denote the molar specific heats of a gas at constant pressure and at constant volume respectively. If $\left(\frac{C_P}{C_V}\right) = \gamma$ and $C_P - C_V = R$, then C_V is equal to

(a) $\frac{R}{\gamma-1}$ (b) $\frac{\gamma-1}{R}$ (c) $\frac{\gamma R}{\gamma-1}$ (d) $\sqrt{\frac{R}{\gamma-1}}$

42. The mean kinetic energy of one gram-mole of a perfect gas at absolute temperature T is

(a) $\frac{1}{2}k_B T$ (b) $\frac{1}{2}RT$ (c) $\frac{3}{2}k_B T$ (d) $\frac{3}{2}RT$

43. If for a gas $\left(\frac{R}{C_V}\right) = 0.67$, this gas is made up of molecules which are

- (a) diatomic (b) mixture of diatomic and polyatomic
(c) monoatomic (d) polyatomic

44. At constant volume temperature is increased then

- (a) Collision on walls will be less.
(b) Collision frequency will be increases.
(c) Collision will be in straight line.
(d) Collision will not change

45. An ideal gas exert a pressure P . the mean kinetic energy per unit volume is E . Which of the following relations is correct?

(a) $P = E$ (b) $P = \frac{E}{2}$ (c) $P = \left(\frac{2}{3}\right) E$ (d) $P = \left(\frac{3}{2}\right) E$

46. According to kinetic theory of gasses at absolute zero temperature

- (a) Water freezes (b) Liquid helium freezes
(c) Molecules motion stops (d) Liquid hydrogen freezes

47. A gas in a container A is in thermal equilibrium with another gas of the same mass in container B . if we denote the corresponding pressures and volumes by the suffices A and B , then which of the following statement is most likely to be true

(a) $P_A = P_B, V_A \neq V_B$ (b) $P_A \neq P_B$
(c) $\frac{P_A}{V_A} = \frac{P_B}{V_B}$ (d) $P_A V_A = P_B V_B$

48. Which of the following properties of gas molecule the one that is same for all ideal gases at a particular temperature is

- (a) Mass (b) Velocity (c) Momentum (d) Kinetic energy

49. An ideal gas is that which can

- (a) Be solidified (b) Liquefied
(c) Not be liquefied (d) Not be solidified

50. Moon has no atmosphere because

- (a) It is far away form the surface of the earth
(b) Its surface temperature is 10°C

- (c) The r.m.s. velocity of all the gas molecules is more than the escape velocity of the moon's surface
- (d) The escape velocity of the moon's surface is more than the r.m.s velocity of all molecules

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