13. Kinetic Theory of Gases – Multiple Choice Questions

1. Gas Laws

1. Which of the following statements about kinetic theory of gases is wrong?

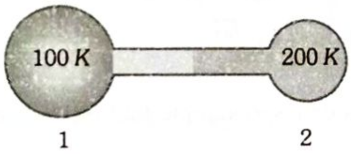
(a) The molecules of a gas are in continuous random motion

(b) The molecules continuously undergo inelastic collisions

(c) The molecules do not interact with each other except during collisions

(d) The collisions amongst the molecules are of short duration

2. Figure shows two flasks connected to each other. The volume of the flask 1 is twice that of flask 2. The system is filled with an ideal gas at temperature 100 K and 200 K respectively. If the mass of the gas in 1 be m then what is the mass of the gas in flask 2



(a) m (b) $m/2$

(c) $m/4$ (d) $m/8$

3. A balloon contains $500\,m^3$ of helium at 27°C and 1 atmosphere pressure. The volume of the helium at – 3°C temperature and 0.5 atmosphere pressure will be

(a) $500\,m^3$ (b) $700\,m^3$

(c) $900\,m^3$ (d) $1000\,m^3$

4. A gas at 27°C temperature and 30 atmospheric pressure is allowed to expand to the atmospheric pressure. If the volume becomes 10 times its initial volume, then the final temperature becomes

(a) 100°C (b) 173°C

(c) 273°C (d) – 173°C

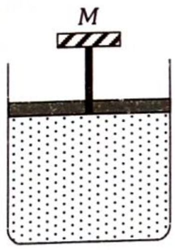
5. The equation of state for 5 g of oxygen at a pressure P and temperature T, when occupying a volume V, will be

(a) $PV = (5/32)RT$ (b) $PV = 5RT$

(c) $PV = (5/2)RT$ (d) $PV = (5/16)RT$

(Where R is the gas constant)

6. A cylinder containing an ideal gas is in vertical position and has a piston of mass M that is able to move up or down without friction (figure). If the temperature is increased



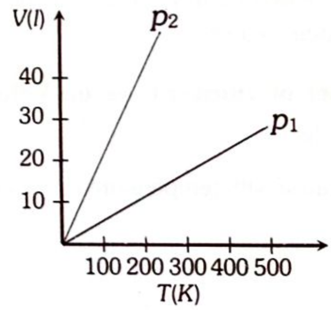
(a) Both p and V of the gas will change

(b) Only p will increase according to Charles' law

(c) V will change but not p

(d) p will change but not V

7. Volume versus temperature graphs for a given mass of an ideal gas is shown in figure. At two different values of constant pressure. What can be inferred about relation between p_1 and p_2



(a) $p_1 > p_2$ (b) $p_1 = p_2$

(c) $p_1 < p_2$ (d) Data is insufficient

8. An inflated rubber balloon contains one mole of an ideal gas, has a pressure p, volume V and temperature T. If the temperature rises to $1.1T$, and the volume is increased to $1.05V$, the final pressure will be

(a) $1.1p$ (b) p

(c) Less than p (d) Between p and $1.1p$

9. At 0°C the density of a fixed mass of a gas divided by pressure is x. At 100°C, the ratio will be

(a) x (b) $\frac{273}{373}x$

(c) $\frac{373}{273}x$ (d) $\frac{100}{273}x$

10. A flask is filled with 13 g of an ideal gas at 27°C and its temperature is raised to 52°C. The mass of the gas that has to be released to maintain the temperature of the gas in the flask at 52°C and the pressure remaining the same is

(a) 2.5 g (b) 2.0 g

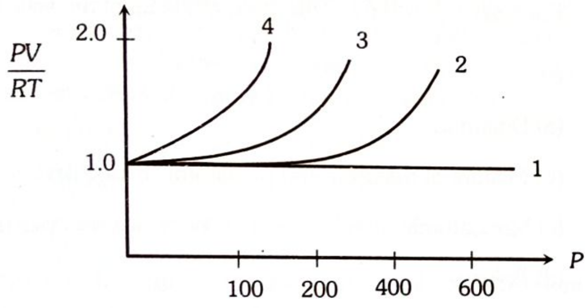
(c) 1.5 g (d) 1.0 g

11. The gas in vessel is subjected to a pressure of 20 atmosphere at a temperature 27°C. The pressure of the gas in a vessel after one half of the gas is released from the vessel and the temperature of the remainder is raised by 50°C is

(a) 8.5 *atm* (b) 10.8 *atm*

(c) 11.7 *atm* (d) 17 *atm*

12. A fix amount of nitrogen gas (1 mole) is taken and is subjected to pressure and temperature variation. The experiment is performed at high pressure as well as high temperatures. The results obtained are shown in the figures. The correct variation of PV/RT with P will be exhibited by



(a) 4 (b) 3

(c) 2 (d) 1

13. A tyre kept outside in sunlight bursts off after sometime because of

(a) Increase in pressure (b) Increases in volume

(c) Both (a) and (b) (d) None of these

14. 'Three containers of the same volume contain three different gases. The masses of the molecules are m_1, m_2 and m_3 and the number of molecules in their respective containers are N_1, N_2 and N_3. The gas pressure in the containers are P_1, P_2 and P_3 respectively. All the gases are now mixed and put in one of the containers. The pressure P of mixture will be

(a) $P < (P_1 + P_2 + P_3)$ (b) $P = \frac{P_1 + P_2 + P_3}{3}$

(c) $P = P_1 + P_2 + P_3$ (d) $P > (P_1 + P_2 + P_3)$

15. If pressure of a gas contained in a closed vessel is increased by 0.4% when heated by 1°C, the initial temperature must be

(a) 250 K (b) 250°C

(c) 2500 K (d) 25°C

16. A vessel of volume V contains a mixture of 1 mole of hydrogen and 1 mole oxygen (both considered as ideal). Let $f_1(\upsilon)d\upsilon$, denote the fraction of molecules with speed between υ and $(\upsilon + d\upsilon)$ with $f_2(\upsilon)d\upsilon$, similarly for oxygen. Then,

(a) $f_1(\upsilon) + f_2(\upsilon) = f(\upsilon)$ obeys the Maxwell's distribution law

(b) $f_1(\upsilon), f_2(\upsilon)$ will obey the Maxwell's distribution law separately

(c) Neither $f_1(\upsilon)$, nor $f_2(\upsilon)$ will obey the Maxwell's distribution law

(d) $f_2(\upsilon)$ and $f_1(\upsilon)$ will be the same

17. Boyle's law is applicable for an

(a) Adiabatic process (b) Isothermal process

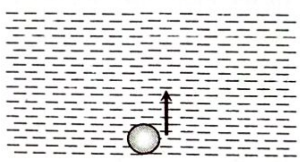
(c) Isobaric process (d) Isochoric process

18. When an air bubble of radius 'r' rises from the bottom to the surface of a lake, its radius becomes $5r/4$ (the pressure of the atmosphere is equal to the 10 m height of water column). If the temperature is constant and the surface tension is neglected, the depth of the lake is

(a) 3.53 m (b) 6.53 m

(c) 9.53 m (d) 12.53 m

19. An air bubble doubles its radius on raising from the bottom of water reservoir to be the surface of water in it. If the atmospheric pressure is equal to 10 m of water, the height of water in the reservoir is



(a) 10 m

(b) 20 m

(c) 70 m

(d) 80 m

20. The equation of state of a gas is given by $\left(P + \frac{aT^2}{V}\right)V^c = (RT + b)$, where a, b, c and R are constants.

The isotherms can be represented by $P = AV^m - BV^n$, where A and B depend only on temperature and

(a) $m = -c$ and $n = -1$ (b) $m = c$ and $n = 1$

(c) $m = -c$ and $n = 1$ (d) $m = c$ and $n = -1$

2. Speed of Gas

1. The $r.m.s.$ speed of the molecules of a gas at a pressure 10^5 Pa and temperature 0°C is $0.5 km\ sec^{-1}$. If the pressure is kept constant but temperature is raised to 819°C, the velocity will become

(a) 1.5 kms^{-1} (b) 2 kms^{-1}

(c) 5 kms^{-1} (d) 1 kms^{-1}

2. When temperature of an ideal gas is increased from $27°C$ to $227°C$, its r.m.s. speed changed from 400 metre/s to V_s. The V_s is

(a) 516 metre/s (b) 450 metre/s

(c) 310 metre/s (d) 746 metre/s

3. At a given temperature the root mean square velocities of oxygen and hydrogen molecules are in the ratio

(a) 16 : 1 (b) 1 : 16

(c) 4 : 1 (d) 1 : 4

4. If the oxygen (O_2) has root mean square velocity of $C\ ms^{-1}$, then root mean square velocity of the hydrogen (H_2) will be

(a) $C ms^{-1}$ (b) $\frac{1}{C} ms^{-1}$

(c) $4 C ms^{-1}$ (d) $\frac{C}{4} ms^{-1}$

5. The root mean square velocity of the molecules in a sample of helium is 5/7th that of the molecules in a sample of hydrogen. If the temperature of hydrogen sample is 0°C, then the temperature of the helium sample is about

(a) 0°C (b) 0 K

(c) 273°C (d) 100°C

6. Gas at a pressure P_0 in contained is a vessel. If the masses of all the molecules are halved and their speeds are doubled, the resulting pressure P will be equal to

(a) $4P_0$ (b) $2P_0$

(c) P_0 (d) $\frac{P_0}{2}$

7. At constant volume, temperature is increased. Then

(a) Collision on walls will be less

(b) Number of collisions per unit time will increase

(c) Collisions will be in straight lines

(d) Collisions will not change

8. The temperature of an ideal gas is increased from 27°C to 927°C. The root mean square speed of its molecules becomes

(a) Twice (b) Half

(c) Four times (d) One-fourth

9. The mean free path of molecules of a gas, (radius r) is inversely proportional to

(a) r (b) $\sqrt{r}$

(c) r^3 (d) r^2

3. Degree of Freedom and Specific Heat

1. The number of translational degrees of freedom for a diatomic gas is

(a) 2 (b) 3

(c) 5 (d) 6

2. The temperature of argon, kept in a vessel, is raised by 1°C at a constant volume. The total heat supplied to the gas is a combination of translational and rotational energies. Their respective shares are

(a) 60% and 40% (b) 40% and 60%

(c) 50% and 50% (d) 100% and 0%

3. The degrees of freedom of a triatomic gas is

(a) 2 (b) 4

(c) 6 (d) 8

4. For a gas $\frac{R}{C_V} = 0.67$. This gas is made up of molecules which are

(a) Diatomic

(b) Mixture of diatomic and polyatomic molecules

(c) Monoatomic

(d) Polyatomic

5. A cylinder of fixed capacity (of 44.8 litres) contains 2 moles of helium gas at STP. What is the amount of heat needed to raise the temperature of the gas in the cylinder by 20°C (Use R=8.31 $J\ mol^{-1}K^{-1}$)

(a) 996 J (b) 831 J

(c) 498 J (d) 374 J

6. For the specific heat of 1 mole of an ideal gas at constant pressure (C_P) and at constant volume (C_V) which is correct

(a) C_P of hydrogen gas is $\frac{5}{2}R$

(b) C_V of hydrogen gas is $\frac{7}{2}R$

(c) H_2 has very small values of C_P and C_V

(d) $C_P - C_V = 1.99$ cal/mole-K for H_2

7. The molar specific heat at constant pressure of an ideal gas is (7/2) R. The ratio of specific heat at constant pressure to that at constant volume is

(a) 5/7 (b) 9/7

(c) 7/5 (d) 8/7

8. For a certain gas, the ratio of specific heats is given to be $\gamma = 1.5$, for this gas

(a) $C_V = \frac{3R}{J}$ (b) $C_P = \frac{3R}{J}$

(c) $C_P = \frac{5R}{J}$ (d) $C_V = \frac{5R}{J}$

9. For a gas the difference between the two specific heats is 4150 *J/kg K*. What is the specific heats at constant volume of gas if the ratio of specific heat is 1.4

(a) $8475\ J/kg\ K$ (b) $5186\ J/kg\ K$

(c) $1660\ J/kg\ K$ (d) $10375\ J/kg\ K$

10. 5 moles of oxygen is heated at constant volume from 10°C to 20°C. The change in the internal energy of the gas is (the gram molecular specific heat of oxygen at constant pressure, C_P=8 *cal/mole* °C and R = 8.3 *J/mole* °C)

(a) 200 *cal* (b) 300 *cal*

(c) 100 *cal* (d) None of these

11. One mole of an ideal gas requires 207 *J* heat to raise the temperature by 10 *K* when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by the same 10 *K*, the heat required is

(a) 198.7 *J* (b) 29 *J*

(c) 215.3 *J* (d) 124 *J*

(Given the gas constant R=8.3 *J/mol–K*)

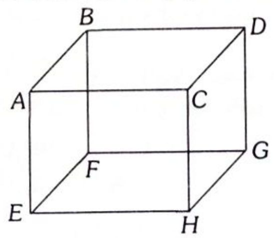
12. For a gas if ratio of specific heats at constant pressure and volume is γ then value of degrees of freedom is

(a) $\frac{3\gamma-1}{2\gamma-1}$ (b) $\frac{2}{\gamma-1}$

(c) $\frac{9}{2}(\gamma-1)$ (d) $\frac{25}{2}(\gamma-1)$

4. Pressure and Energy

1. 1 mole of an ideal gas is contained in a cubical volume V, $ABCDEFGH$ at $300K$ (figure). One face of the cube ($EFGH$) is made up of a material which totally absorbs any gas molecule incident on it. At any given time,



(a) The pressure on $EFGH$ would be zero

(b) The pressure on all the faces will the equal

(c) The pressure of $EFGH$ would be double the pressure on $ABCD$

(d) The pressure of $EFGH$ would be half that on $ABCD$

2. A cubic vessel (with face horizontal + vertical) contains, an ideal gas at NTP. The vessel is being carried by a rocket which is moving at a speed of $500\,ms^{-1}$ in vertical direction. The pressure of the gas inside the vessel as observed by us on the ground

(a) Remains the same because $500\,ms^{-1}$ is very much smaller than v_{rms} of the gas

(b) Remains the same because motion of the vessel as a whole does not affect the relative motion of the gas molecules and the walls

(c) Will increase by a factor equal to $(v_{rms}^2 + (500)^2)/v_{rms}^2$ where v_{rms} was the original mean square velocity of the gas

(d) Will be different on the top wall and bottom wall of the vessel

3. 1 mole of H_2 gas is contained in a box of volume $V = 1.00\,m^3$ at $T = 300\,K$. The gas is heated to a temperature of $T = 3000\,K$ and the gas gets converted to a gas of hydrogen atoms. The final pressure would be (considering all gases to be ideal)

(a) Same as the pressure initially

(b) 2 times the pressure initially

(c) 10 times the pressure initially

(d) 20 times the pressure initially

4. The relation between the gas pressure P and average kinetic energy per unit volume E is

(a) $P = \frac{1}{2}E$ (b) $P = E$

(c) $P = \frac{3}{2}E$ (d) $P = \frac{2}{3}E$

5. N molecules each of mass m of gas A and $2N$ molecules each of mass $2m$ of gas B are contained in the same vessel at temperature T. The mean square of the velocity of molecules of gas B is v^2 and the mean square of x component of the velocity of molecules of gas A is w^2. The ratio $\frac{w^2}{v^2}$ is

(a) 1 (b) 2

(c) 1/3 (d) 2/3

6. A monoatomic gas is kept at room temperature 300*K*. Calculate the average kinetic energy of gas molecule (Use $k = 1.38\times10^{-23}$ *MKS* units)

(a) 0.138eV (b) 0.062eV

(c) 0.039eV (d) 0.013eV

7. The kinetic energy of one g-mole of a gas at normal temperature and pressure is (R = 8.31 *J/mol-K*)

(a) $0.56\times10^4\,J$ (b) $1.3\times10^2\,J$

(c) $2.7\times10^2\,J$ (d) $3.4\times10^3\,J$

8. The ratio of mean kinetic energy of hydrogen and oxygen at a given temperature is

(a) 1 : 16 (b) 1 : 8

(c) 1 : 4 (d) 1 : 1

9. At 0 K which of the following properties of a gas will be zero

(a) Kinetic energy (b) Potential energy

(c) Vibrational energy (d) Density

10. A gas mixture consists of molecules of type 1, 2 and 3, with molar masses $m_1>m_2>m_3$. V_{rms} and $\overline{K}$ are the r.m.s. speed and average kinetic energy of the gases. Which of the following is true?

(a) $(V_{rms})_1 < (V_{rms})_2 < (V_{rms})_3$ and $(\overline{K})_1 = (\overline{K})_2 = (\overline{K}_3)$

(b) $(V_{rms})_1 = (V_{rms})_2 = (V_{rms})_3$ and $(\overline{K})_1 = (\overline{K})_2 > (\overline{K})_3$

(c) $(V_{rms})_1 > (V_{rms})_2 > (V_{rms})_3$ and $(\overline{K})_1 < (\overline{K})_2 > (\overline{K}_3)$

(d) $(V_{rms})_1 > (V_{rms})_2 > (V_{rms})_3$ and $(\overline{K})_1 < (\overline{K})_2 < (\overline{K})_3$

11. The diameter of oxygen atom is 3Å. The fraction of molecular volume to the actual volume occupied by oxygen at STP is

(a) 6×10^{-28} (b) 8×10^{-4}

(c) 4×10^{-10} (d) 4×10^{-4}

5. IIT-JEE/AIEEE

1. Kinetic theory of gases provide a base for **[2002]**

(a) Charle's law

(b) Boyle's law

(c) Charle's law and Boyle's law

(d) None of these

2. When volume of system is increased two times and temperature is decreased half of its initial temperature, then pressure becomes **[2002]**

(a) 2 times (b) 4 times

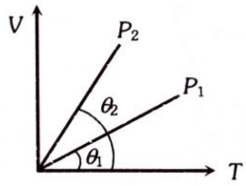
(c) $\frac{1}{4}$ times (d) $\frac{1}{2}$ times

3. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1,T_2) volume (V_1,V_2) and pressure (P_1,P_2) respectively. If the valve joining the two vessels is opened, the temperature inside the vessel at equilibrium will be **[2008]**

(a) $T_1 + T_2$ (b) $(T_1 + T_2)/2$

(c) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$ (d) $\frac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$

4. The figure shows the volume V versus temperature T graphs for a certain mass of a perfect gas at two constant pressures of P_1 and P_2. What inference can you draw from the graphs **[1982]**



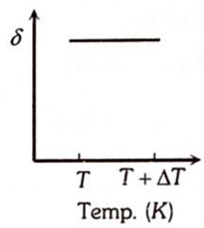
(a) $P_1 > P_2$

(b) $P_1 < P_2$

(c) $P_1 = P_2$

(d) No interference can be drawn due to insufficient information

5. An ideal gas is initially at temperature T and volume V. Its volume is increased by ΔV due to an increase in temperature ΔT, pressure remaining constant. The quantity $\delta = \Delta V/(V\Delta T)$ varies with temperature as **[2000]**

(a)


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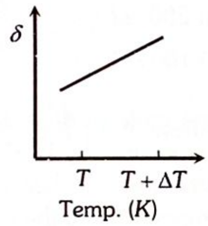

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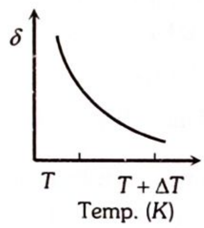

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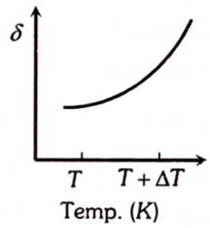
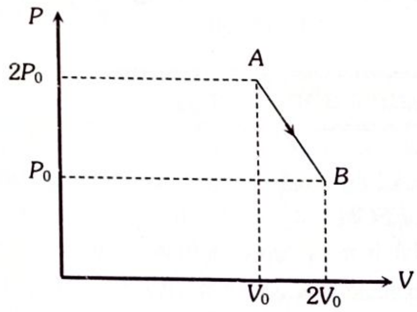


6. 'n' moles of an ideal gas undergoes a process $A \rightarrow B$ as shown in the figure. The maximum temperature of the gas during the process will be **[2016]**



(a) $\frac{3P_0V_0}{2nR}$ (b) $\frac{9P_0V_0}{2nR}$

(c) $\frac{9P_0V_0}{nR}$ (d) $\frac{9P_0V_0}{4nR}$

7. To double the volume of a given mass of an ideal gas at 27°C keeping the pressure constant, one must raise the temperature in degree centigrade to **[1975]**

(a) 54° (b) 270°

(c) 327° (d) 600°

8. A vessel contains 1 mole of O_2 gas (molar mass 32) at a temperature T. The pressure of the gas is P. An identical vessel containing one mole of He gas (molar mass 4) at temperature $2T$ has a pressure of **[1997]**

(a) $P/8$ (b) P

(c) $2P$ (d) $8P$

9. Under which of the following conditions is the law $PV = RT$ obeyed most closely by a real gas **[2010]**

(a) High pressure and high temperature

(b) Low pressure and low temperature

(c) Low pressure and high temperature

(d) High pressure and low temperature

10. The temperature of an open room of volume $30 m^3$ increased from 17°C to 27°C due to the sunshine. The atmospheric pressure in the room remains $1\times10^5 Pa$. If n_i and n_f are the number of molecules in the room before and after heating, then $n_f - n_i$ will be **[2017]**

(a) -2.5×10^{25} (b) -1.61×10^{23}

(c) 1.38×10^{23} (d) 2.5×10^{25}

11. Which of the following statements is true **[1981]**

(a) Absolute zero degree temperature is not zero energy temperature

(b) Two different gases at the same temperature pressure have equal root mean square velocities

(c) The root mean square speed of the molecules of different ideal gases, maintained at the same temperature are the same

(d) Given sample of 1 cc of hydrogen and 1 cc of oxygen both at NTP; oxygen sample has a large number of molecules

12. Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will **[2002]**

(a) Increase

(b) Decrease

(c) Remain same

(d) Decrease for some, while increase for others

13. At what temperature is the root mean square velocity of gaseous hydrogen molecules equal to that of oxygen molecules at 47°C **[2002]**

(a) 20 K (b) 80 K

(c) – 73 K (d) 3 K

14. At room temperature, the *r.m.s.* speed of the molecules of certain diatomic gas is found to be 1930 m/s. The gas is **[1984]**

(a) H_2 (b) F_2

(c) O_2 (d) Cl_2

15. The temperature of an ideal gas is increased from 120 K to 480 K. If at 120 K, the root mean square velocity of the gas molecules is v, at 480 K it becomes **[1996]**

(a) $4v$ (b) $2v$

(c) $v/2$ (d) $v/4$

16. Three closed vessels A, B and C are at the same temperature T and contain gases which obey the Maxwellian distribution of velocities. Vessel A contains only O_2, B only N_2 and C a mixture of equal quantities of O_2 and N_2. If the average speed of the O_2 molecules in vessel A is V_1, that of the N_2 molecules in vessel B is V_2, the average speed of the O_2 molecules in vessel C is **[1992]**

(a) $(V_1 + V_2)/2$ (b) V_1

(c) $(V_1V_2)^{1/2}$ (d) $\sqrt{3kT/M}$

17. A mixture of 2 moles of helium gas (atomic mass=4 *amu*), and 1 mole of argon gas (atomic mass=40 *amu*) is kept at 300K in a container. The ratio of the *rms* speeds $\left[\frac{V_{rms}(\text{helium})}{V_{rms}(\text{argon})}\right]$ is **[2012]**

(a) 0.32 (b) 0.45

(c) 2.24 (d) 3.16

18. If C_p and C_v denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then **[2007]**

(a) $C_p - C_v = R/28$ (b) $C_p - C_v = R/14$

(c) $C_p - C_v = R$ (d) $C_p - C_v = 28R$

19. An ideal gas undergoes a quasi static, reversible process in which its molar heat capacity C remains constant. If during this process the relation of pressure P and volume V is given by PV^n = constant, then n is given by (Here C_P and C_v are molar specific heat at constant pressure and constant volume, respectively) **[2016]**

(a) $n = \frac{C - C_P}{C - C_v}$ (b) $n = \frac{C_P - C}{C - C_v}$

(c) $n = \frac{C - C_v}{C - C_P}$ (d) $n = \frac{C_P}{C_v}$

20. 70 calories of heat are required to raise the temperature of 2 *moles* of an ideal gas at constant pressure from 30°C to 35°C. The amount of heat required to raise the temperature of same gas through the same range (30°C to 35°C) at constant volume (R = 2 *cal/mol/K*) is **[1985]**

(a) 30 *cal* (b) 50 *cal*

(c) 70 *cal* (d) 90 *cal*

21. A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. Neglecting all vibrational modes, the total internal energy of the system is **[1999]**

(a) $4\,RT$ (b) $15\,RT$

(c) $9\,RT$ (d) $11\,RT$

22. One mole of ideal monoatomic gas $(\gamma = 5/3)$ is mixed with one mole of diatomic gas $(\gamma = 7/5)$. What is γ for the mixture? γ denotes the ratio of specific heat at constant pressure, to that at constant volume **[1986]**

(a) 3/2 (b) 23/15

(c) 35/23 (d) 4/3

23. A gaseous mixture consists of 16g of helium and 16g of oxygen. The ratio $\frac{C_P}{C_V}$ of the mixture is **[2005]**

(a) 1.4 (b) 1.54

(c) 1.59 (d) 1.62

24. C_p and C_v are specific heats at constant pressure and constant volume respectively. It is observed that $C_p - C_v = a$ for hydrogen gas, $C_p - C_v = b$ for nitrogen gas **[2017]**

(a) $a = 28b$ (b) $a = \frac{1}{14}b$

(c) $a = b$ (d) $a = 14b$

25. A closed compartment containing gas is moving with some acceleration in horizontal direction. Neglect effect of gravity. Then the pressure in the compartment is **[1999]**

(a) Same everywhere (b) Lower in the front side

(c) Lower in the rear side (d) Lower in the upper side

26. The average translational kinetic energy of O_2 (molar mass 32) molecules at a particular temperature is 0.048 eV. The translational kinetic energy of N_2 (molar mass 28) molecules in eV at the same temperature is **[1997]**

(a) 0.0015 (b) 0.003

(c) 0.048 (d) 0.768

27. A vessel contains a mixture of one mole of oxygen and two moles of nitrogen at 300 K. The ratio of the average rotational kinetic energy per O_2 molecule to that per N_2 molecule is **[1998]**

(a) 1 : 1

(b) 1 : 2

(c) 2 : 1

(d) Depends on the moments of inertia of the two molecules

28. One kg of a diatomic gas is at a pressure of $8\times10^4\,N/m^2$. The density of the gas is 4 kg/m^3. What is the energy of the gas due to its thermal motion **[2009]**

(a) $3\times10^4\,J$ (b) $5\times10^4\,J$

(c) $6\times10^4\,J$ (d) $7\times10^4\,J$

29. The average translational energy and the $r.m.s.$ speed of molecules in a sample of oxygen gas at 300 K are $6.21\times10^{-21}\,J$ and 484 m/s respectively. The corresponding values at 600 K are nearly (assuming ideal gas behaviour) **[1997]**

(a) $12.42\times10^{21}\,J, 968\,m/s$ (b) $8.78\times10^{21}\,J, 684\,m/s$

(c) $6.21\times10^{21}\,J, 968\,m/s$ (d) $12.42\times10^{21}\,J, 684\,m/s$

30. Three perfect gases at absolute temperature T_1, T_2 and T_3 are mixed. The masses of molecules are m_1, m_2 and m_3 and the number of molecules are n_1, n_2 and n_3 respectively. Assuming no loss of energy, the final temperature of the mixture is **[2011]**

(a) $\frac{(T_1 + T_2 + T_3)}{3}$ (b) $\frac{n_1T_1 + n_2T_2 + n_3T_3}{n_1 + n_2 + n_3}$

(c) $\frac{n_1T_1^2 + n_2T_2^2 + n_3T_3^2}{n_1T_1 + n_2T_2 + n_3T_3}$ (d) $\frac{n_1^2T_1^2 + n_2^2T_2^2 + n_3^2T_3^2}{n_1T_1 + n_2T_2 + n_3T_3}$

6. NEET/AIPMT

1. Two vessels separately contain two ideal gases A to B at the same temperature the pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is **[2015]**

(a) $\frac{3}{4}$ (b) 2

(c) $\frac{1}{2}$ (d) $\frac{2}{3}$

2. At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere

Given :

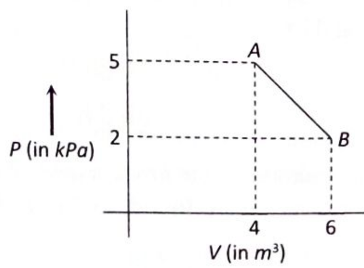
Mass of oxygen molecule $(m) = 2.76\times10^{-26}\,kg$

Boltzmann's constant $k_B = 1.38\times10^{-23}\,JK^{-1}$) **[2018]**

(a) $2.508\times10^4\,K$ (b) $8.360\times10^4\,K$

(c) $5.016\times10^4\,K$ (d) $1.254\times10^4\,K$

3. One mole an ideal diatomic gas undergoes a transition from A to B along a path AB as shown in the figure, The change in internal energy of the gas during the transition is **[2015]**



(a) –20 kJ (b) 20 J

(c) –12 kJ (d) 20 kJ

4. The amount of heat energy required to raise the temperature of 1 g of Helium at NTP, from $T_1 K$ to $T_2 K$ is **[2013]**

(a) $\frac{3}{4}N_a k_B\left(\frac{T_2}{T_1}\right)$ (b) $\frac{3}{8}N_a k_B(T_2 - T_1)$

(c) $\frac{3}{2}N_a k_B(T_2 - T_1)$ (d) $\frac{3}{4}N_a k_B(T_2 - T_1)$

5. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_P and C_V, respectively. If $\gamma = \frac{C_P}{C_V}$ and R is the universal gas constant, then C_V is equal to **[2013]**

(a) γR (b) $\frac{1+\gamma}{1-\gamma}$

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

6. The ratio of the specific heats $\frac{C_P}{C_V} = \gamma$ in terms of degrees of freedom (n) is given by **[2015]**

(a) $\left(1+\frac{f}{3}\right)$ (b) $\left(1+\frac{2}{f}\right)$

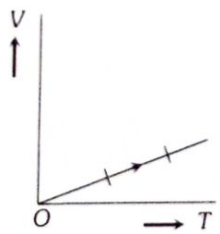
(c) $\left(1+\frac{f}{2}\right)$ (d) $\left(1+\frac{1}{f}\right)$

7. One mole of an ideal monatomic gas undergoes a process described by the equation PV^3 = constant. The heat capacity of the gas during this process is **[2016]**

(a) R (b) $\frac{3}{2}R$

(c) $\frac{5}{2}R$ (d) $2R$

8. The volume (V) of a monatomic gas varies with its temperature (T), as shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it undergoes a change from state A to state B, is **[2018]**



(a) $\frac{2}{5}$ (b) $\frac{2}{3}$

(c) $\frac{1}{3}$ (d) $\frac{2}{7}$

7. AIIMS

1. Two balloons are filled, one with pure He gas and the other by air, respectively. If the pressure and temperature of these balloons are same then the number of molecules per unit volume is **[2006]**

(a) More in the He filled balloon

(b) Same in both balloons

(c) More in air filled balloon

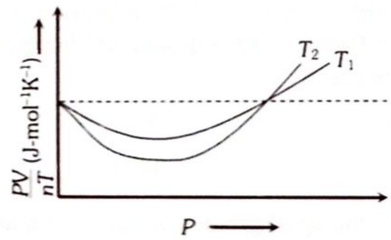
(d) In the ratio of 1 : 4

2. The pressure is P, volume V and temperature T of a gas in the jar A and the other gas in the jar B is at pressure $2P$, volume $V/4$ and temperature $2T$, then the ratio of the number of molecules in the jar A and B will be **[1982]**

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 4 : 1

3. The figure below shows the plot of $\frac{PV}{nT}$ versus P for oxygen gas at two different temperatures. **[2007]**



Read the following statements concerning the above curves :

(i) The dotted line corresponds to the 'ideal' gas behaviour.

(ii) $T_1 > T_2$

(iii) The value of $\frac{PV}{nT}$ at the point where the curves meet on the y-axis is the same for all gases.

Which of the above statement is true?

(a) (i) only (b) (i) and (ii) only

(c) All of these (d) None of these

4. If pressure of CO_2 (real gas) in a container is given by $P = \frac{RT}{2V - b} - \frac{a}{4b^2}$, then mass of the gas in container is **[2010]**

(a) 11 g (b) 22 g

(c) 33 g (d) 44 g

5. The rate of diffusion is **[1998]**

(a) Faster in solids than in liquids and gases

(b) Faster in liquids than in solids and gases

(c) Equal to solids, liquids and gases

(d) Faster in gases than in liquids and solids

6. The molecules of a given mass of a gas have a *r.m.s.* velocity of 200 *m/s* at 27°C and $1.0\times10^5\ N/m^2$ pressure. When the temperature is 127°C and pressure is $0.5\times10^5\ N/m^2$, the *r.m.s.* velocity in m/s will be **[1985]**

(a) $\frac{100\sqrt{2}}{3}$ (b) $100\sqrt{2}$

(c) $\frac{400}{\sqrt{3}}$ (d) None of the above

7. According to the kinetic theory of gases, at absolute temperature **[1998]**

(a) Water freezes (b) Liquid helium freezes

(c) Molecular motion stops (d) Liquid hydrogen freezes

8. For a gas at a temperature T the root-mean-square velocity v_{rms}, the most probable speed v_{mp}, and the average speed v_{av} obey the relationship **[2004]**

(a) $v_{av} > v_{rms} > v_{mp}$ (b) $v_{rms} > v_{av} > v_{mp}$

(c) $v_{mp} > v_{av} > v_{rms}$ (d) $v_{mp} > v_{rms} > v_{av}$

9. When an ideal monoatomic gas is heated at constant pressure, fraction of heat energy supplied which increases the internal energy of gas, is **[2010]**

(a) $2/5$ (b) $3/5$

(c) $3/7$ (d) $3/4$

10. In kinetic theory of gases, a molecule of mass m of an ideal gas collides with a wall of vessel with velocity V. The change in the linear momentum of the molecule is **[1997]**

(a) $2mV$ (b) mV

(c) $-mV$ (d) Zero

8. Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : In pressure-temperature (P-T) phase diagram of water, the slope of the melting curve is found to be negative.

Reason : Ice contracts on melting to water.

2. Assertion : For gas atom the number of degrees of freedom is 3.

Reason : $\frac{C_P}{C_V} = \gamma$

3. Assertion : A gas can be liquefied at any temperature by increase of pressure alone.

Reason : On increasing pressure the temperature of gas decreases.

4. Assertion : The ratio of specific heat gas at constant pressure and specific heat at constant volume for a diatomic gas is more than that for a monatomic gas.

Reason : The molecules of a monatomic gas have more degree of freedom than those of a diatomic gas.

5. Assertion : For an ideal gas, at constant temperature, the product of the pressure and volume is constant.

Reason : The mean square velocity of the molecules is inversely proportional to mass.

6. Assertion : If a gas container in motion is suddenly stopped, the temperature of the gas rises.

Reason : The kinetic energy of ordered mechanical motion is converted in to the kinetic energy of random motion of gas molecules.

7. Assertion : Internal energy of an ideal gas does not depend upon volume of the gas

Reason : Internal energy of ideal gas depends on temperature of gas.

8. Assertion : Air pressure in a car tyre increases during driving.

Reason : Absolute zero temperature is not zero energy temperature.

9. Assertion : The root mean square and most probable speeds of the molecules in a gas are the same.

Reason : The Maxwell distribution for the speed of molecules in a gas is symmetrical.

13. Kinetic Theory of Gases – Answers Keys

1. Gas Laws

1	b	2	c	3	c	4	d	5	a
6	c	7	a	8	d	9	b	10	d
11	c	12	b	13	a	14	c	15	a
16	b	17	b	18	c	19	c	20	a

2. Speed of Gas

1	d	2	a	3	d	4	c	5	a
6	b	7	b	8	a	9	d		

3. Degree of Freedom and Specific Heat

1	b	2	d	3	c	4	c	5	c
6	d	7	c	8	b	9	d	10	b
11	d	12	b						

4. Pressure and Energy

1	d	2	b	3	d	4	d	5	d
6	c	7	d	8	d	9	a	10	a
11	b								

5. IIT-JEE/AIEEE

1	c	2	c	3	c	4	a	5	c
6	d	7	c	8	c	9	c	10	a
11	a	12	c	13	a	14	a	15	b
16	b	17	d	18	c	19	a	20	b
21	d	22	a	23	d	24	d	25	b
26	c	27	a	28	b	29	d	30	b

6. NEET/AIPMT

1	a	2	b	3	a	4	b	5	c
6	b	7	a	8	a				

7. AIIMS

1	b	2	d	3	c	4	b	5	d
6	c	7	c	8	b	9	b	10	a

8. Assertion and Reason

1	a	2	b	3	d	4	d	5	b
6	a	7	b	8	b	9	d		