PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

KINETIC THEORY OF GASES

Example

1. A vessel of volume $8.0 \times 10^{-3} m^3$ contains an ideal gas at $300K$ and pressure $200kPa$. The gas is allowed to leak till the pressure falls to $125kPa$. Calculate the amount of the gas (in moles) leaked assuming that the temperature remains constants.

2. Oxygen is filled in a closed metal jar of volume $1.0 \times 10^{-3} m^3$ at a pressure of $1.5 \times 10^5 Pa.$ and temperature $400K$. The jar has a small leak in it. The atmospheric pressure is $1.0 \times 10^5 Pa$ and the atmospheric temperature is $300K$. Find the mass of the gas that leaks out by time the pressure and the temperature inside the jar equalise with the surrounding.

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3. During an experiment, an ideal gas is found to obey an additional law $p/V^2 =$ constant. The gas is initially at a temperature T and volume V. Find the temperature when it expands to a volume $2V$.

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4. The pressure of an ideal gas varies according to the law $P = P_0 - AV^2$, where P_0 and A are positive constants. Find the highest temperature that can be attained by the gas

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5. Calculate the rms speed of nitrogen at STP (pressure $= 1$ atm and temperature $= 0^0C$. The density of nitrgoen in these conditions is $1.25kgm^{-3}$

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6. Find rms speed of oxygen molecules at temperature $27^\circ C$.

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7. Calculate the rms speed of smoke particles of mass $5 \times 10^{-17} kg$ in their Brownian motion in air at NTP. Given $k_B = 1.38 \times 10^{-23} J/K$

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8. The average translational kinetic energy of air molecules is $0.040 eV (1 eV = 1.6 \times 10^{-19} J)$. Calculate the temperature of the air.

Boltzmann constant $K = 1.38 \times 10^{-23} JK^{-1}$.

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9. Consider a sample of oxygen at $300K$. Find the average time taken by a molecule to travel a distance equal to the diameter of the earth.

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10. At what temperature the mean speed of the molecules of hydrogen gas equals the escape speed from the earth?

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11. At what temperature , will the rms speed of oxygen molecules be sufficient for escaping from the earth ? Take $m = 2.76 \times 10^{-26} kg, k = 1.38 \times 10^{-23} J/K$ and $v_e = 11.2 km/s$

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12. Two perfect gases at absolute temperature T_1 and T_2 are mixed. There is no loss of energy. The masses of the molecules are m_1 and m_2. The number of molecules in the gases are n_1 and n_2. The temperature of the mixture is

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13. A closed container of volume $0.02m^3$contains a mixture of neon and argon gases, at a temperature of $27^\circ C$ and pressure of $1 \times 10^5 Nm^{-2}$. The total mass of the mixture is 28g. If the molar masses of neon and argon are $20 \text{ and } 40 gmol^{-1}$ respectively, find the masses of the individual gasses in the container assuming them to be ideal (Universal gas constant $R = 8.314 J/mol - K$).

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14. A vessel of volume , $V = 5.0$ litre contains $1.4g$ of nitrogen at a temperature $T = 1800K$. Find the pressure of the gas if 30% of its molecules are dissociated into atoms at this temperature.

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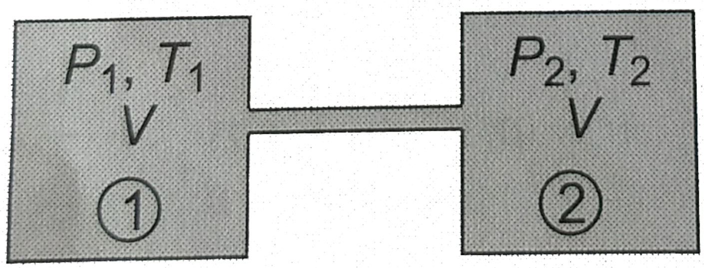
15. Two vessels A and B with rigid walls containing ideal gases. The pressure, temperature and the volume are P_1, T_1, V in the vessel A and P_2, T_2, V in the vessel B. The vessels are now connected through a small tube. In equilibrium, pressure P and temerature T becomes same in two vessels. Find the value of P/T.



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16. Two glass bulbs of equal volume are connected by a narrow tube and are filled with a gas at $0^{\circ} C$ and a pressure of 76cm of mercury. One of the bulbs is then placed in melting ice and the other is placed in a water bath maintained at $62^{\circ} C$. What is the new value of the pressure inside the bulbs? The volume of the connecting tube is negligible.

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17. Figure shows a cylindrical tube of length $30 cm$ which is partitioned by a tight-fitting separator.The separator is very weakly conducting and can freely slide along the tube. Ideal gases are filled in the two parts of the vessel. In the beginning, the temperature in the parts A and B are $400 K$ and $100 K$

respectively. The separator slides to a momentary equilibrium position shown in the figure. Find the final equilibrium position of the separator, reached after a long time.

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18. A glass tube sealed at both ends is $100cm$ long, It lies horizontally with the middle $10cm$ containing mercury. The two ends of the tube contain air at $27^{\circ}C$and at a pressure $76cm$ of mercury. The air column on one side is maintained at $0^{\circ}C$ and the other side is maintained at $127^{\circ}C$. Calculate the length of the air column on the cooler side. Neglect the changes in the volume of mercury and of the glass.

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19. A uniform tube closed at one end, contains a pellet of mercury $10cm$ long. When the tube is kept vertically with the closed-end upward, the length of the air column trapped is $20cm$. Find the length of the air column trapped when the tube is inverted so that the closed-end goes down. Atmospheric pressure $= 75cm$ of mercury.

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20. An ideal gas is trapped between a mercury column and the closed-end of a narrow vertical tube of uniform base containing the column. The upper end of the tube is open to the atmosphere. The atmospheric pressure equals $76cm$ of mercury. The lenghts of the mercury column and the trapped air column are $20cm$ and $43cm$ respectively. What will be the length of the air column when the tube is tilted slowly in a vertical plane through an angle of 60°? Assume the temperature to remain constant.

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21. OSin Leg (core) dhesce (4x2 – 3x) dxxe(1 + r) areEDSet (2-2) ok(1-)?stage vaginya de

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22. The mercury manometer consists of two unequal arms of equal cross section $1cm^2$ and lengths $100cm$ and $50cm$. The two open ends are sealed with air in the tube at a pressure of $80cm$ of mercury. Some amount of mercury is now introduced in the manometer through the stopcock connected to it. If mercury rises in the shorter tube to a length $10cm$ in steady state, find the length of the mercury column risen in the longer tube.

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23. Figure shows a cylindrical tube of radius $5cm$ and length $20cm$. It is closed by a tight-fitting cork. The friction coefficient between the cork and the tube is 0.20. The tube contains an ideal gas at a pressure of $1atm$ and a temperature of $300K$. The tube is slowly heated and it is found that the cork pops out when the temperature reaches $600K$. Let dN denote the magnitude of the normal contact force exerted by a small length dl of the cork along the periphery (see the figure). Assuming that the temperature of the gas is uniform at any instant, calculate $\frac{dN}{dl}$.

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24. Show a vertical cylindrical vesse seperated in two parts by a frictionless piston free to move along the length of vessel. The length of the cylilender is 90 cm and the piston divides the cylinder in the ratio of 5:4. Each of the two parts of the vessel contains 0.1 mole of an ideal gas. The temoerature of the gas is 300K in each part. Calculate the mass of the piston.(figure)

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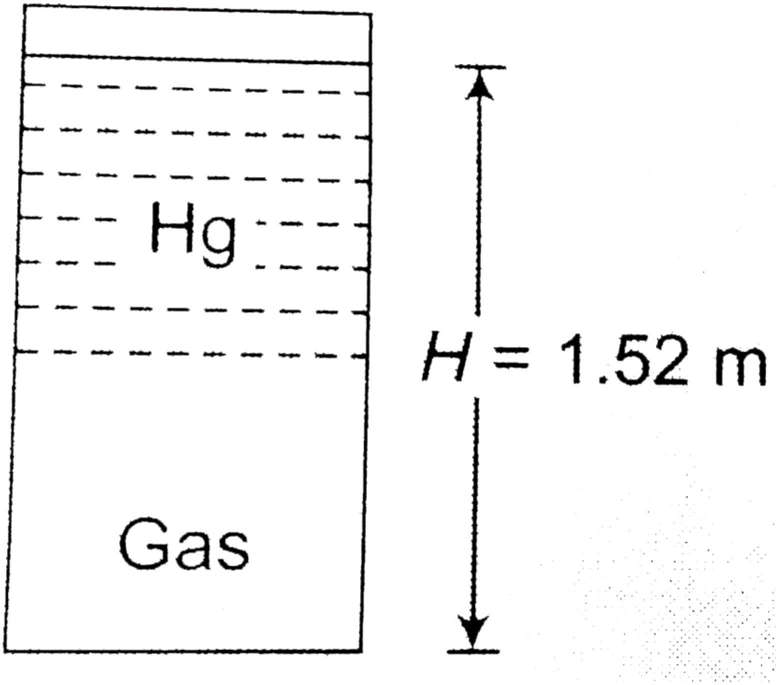
25. A vertical hollow cyclinder of height $1.52m$ is fitted with a movable piston of negligible mass and thickness. The lower half portion of the cyclinder contains an ideal gas and the upper half is filled with mercury. The cyclinder is initially at $300K$. When the temperature is raised half of the mercury comes out of the cyclinder. Find the this temperature assuming the thermal expansion of the mercury to be negligible.



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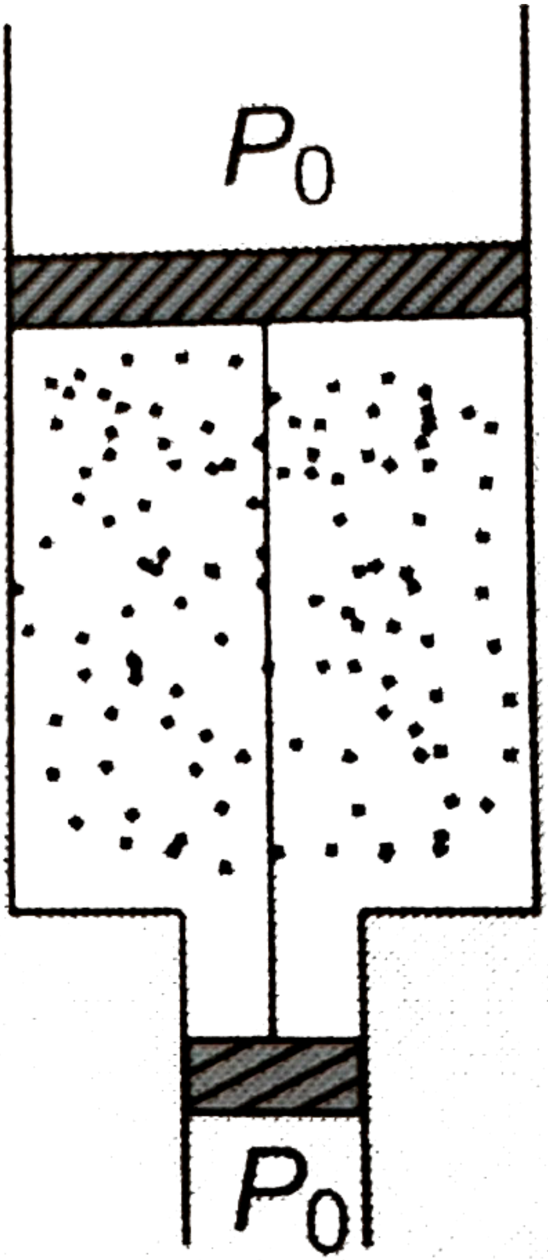
26. Asmooth vertical tibe having two different sections, is open at both ends and equipped with two pistons of different areas. Each piston slides within a respective tube section. The pistons are tied with an inextensible weightless string. One mole of ideal gas is enclosed between them. The cross-section area of upper piston is $\Delta A = 10cm^2$greater than that of lower one. The combined mass of two piston is equal to $M = 5.0kg$. The external pressure is $P_0 = 1.0atm$. By how much must the gas between the pistons the heated to shift pistons through

$l = 5.0cm. \left(1atm = 1.0 \times 10^5 Pa\right)$



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27. A cubical box of side $1m$ contains helium gas (atomic weight 4) at a pressure of $100N/m^2$. During an observation time of $1 \sec ond$, an atom travelling with the root - mean - square speed parallel to one of the edges of the cube, was found to make $500 hits$ with a particular wall, without any collision with other atoms . Take $R = \frac{25}{3} j/mol - K$ and $k = 1.38 \times 10^{-23} J/K$.

(a) Evaluate the temperature of the gas.

(b) Evaluate the average kinetic energy per atom.

(c) Evaluate the total mass of helium gas in the box.

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28. One gram mole of oxygen at 27° and one atmospheric pressure is enclosed in vessel.

(i) Assuming the molecules to be moving the V_{rms}, Find the number of collisions per second which the molecules make with one square metre area of the vessel wall.

(ii) The vessel is next thermally insulated and moved with a constant speed V_0. It is then suddenly stopped. The process results in a rise of the temperature of the gas by $1^\circ C$. Calculate the speed V_0.

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29. Hydrogen gas is contained in a closed vessel at $1atm(100kPa)$ and $300K$.

(a) Calculate the mean speed pf the molecules.

(b) Suppose the molecules strike the wall with this speed making an average angle of 45° with it. How many molecules strike each square metre of the wall per second?

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30. Assume that the temperature remains essentially constant in the upper part of the atmosphere. Obtain an expression for the variation in pressure in the upper atmosphere with height, the mean molecular weight of air is M.

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31. A horizontal tube of length I closed at both ends contains an ideal gas of molecular weight M, The tube is rotated at a constant angular velocity ω about a vertical axis passing through an end. Assuming the temperature to be uniform and constant, show that

$$p_2 = p_1 e^{\frac{M\omega^2 l^2}{2RT}},$$

where p_2 and p_1 denote the pressures at the free end and the fixed end respectively.

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Exercises

1. A gas behaves more closely as an ideal gas at

A. low pressure and low temperature

B. low pressure and high temperature

C. high pressure and low temperature

D. high pressure and high temperature

Answer: B

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2. The mass of 1 litre of helium under a pressure of $2atm$ and at a temperature of $27^\circ C$ is

A. $0.16g$

B. $0.32g$

C. $0.48g$

D. $0.65g$

Answer: B

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3. A gas is enclosed in a vessel at a pressure of $2.5atm$. Due to leak in the vessel., after some time the pressure is reduced to $2atm$, temperature remaining unchanged. The percentage of gas that has leaked out is

A. 20

B. 25

C. 80

D. 75

Answer: A

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4. The gas equation $PV/T =$ constant is true for a constant mass of an ideal gas undergoing

A. isothermal change

B. adiabatic change

C. isobaric change

D. any type of change

Answer: D

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5. The density of a certain mass of a gas at STP is d. If the pressure of the gas is doubled and the temperature is made one-third of its initial value, the new density will be

A. $3d$

B. $4.5d$

C. $6d$

D. $9d$

Answer: C

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6. The quantity PV / kT represents

A. mass of the gas

B. kinetic energy of the gas

C. number of moles of the gas

D. number of molecules in the gas

Answer: D

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7. If pressure of a gas contained in a closed vessel is increased by 0.4% when heated by $1^{\circ}C$, the initial temperature must be

A. $250K$

B. $250^{\circ}C$

C. $2500K$

D. $25^\circ C$

Answer: A

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8. The pressure P, volume V and temperature T of a gas in the jqar A and other gas in the jar B as 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

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: D

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9. A vessel contains 1 mole of O_2 gas (relative molar mass 32) at a temperature T. The pressure of the gas is P. An identical vessel containing one mole of He gas (relative molar mass 4) at temperature 2T has a pressure of

A. $P/8$

B. P

C. $2P$

D. $8P$

Answer: C

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10. The pressure of a gas kept in an isothermal container is $200 Kpa$. If half the gas is removed from it, the pressure will be

A. $100 kPa$

B. $200 kPa$

C. $400 kPa$

D. $800 kPa$

Answer: A

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

A. $8.5 atm$

B. $10.8 atm$

C. $11.7 atm$

D. $17 atm$

Answer: C

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12. Two identical cylinders at same temp contains hydrogen at 2.5 atm and oxygen at 1.5 atmosphere. If both the gases were filled in one of the cylinders, what will be the pressure?

A. $1.75 atm$

B. $3.5atm$

C. $4.75atm$

D. $7.0atm$

Answer: B

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13. A vessel A has volume V and a vessel B has volume $2V$. Both contain some water which has constant volume. The pressure in the space above water is p_a for vessel A and p_b for vessel B.

A. $P_a = P_b$

B. $P_a = 2P_b$

C. $P_b = 2P_a$

D. $P_b = 4P_a$

Answer: A

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14. A flask is filled with $13g$ of an ideal gas at $27^{\circ}C$ and its temperature is raised to $52^{\circ}C$. The mass of the gas that has to be released to maintain the temperature of the gas in the flask at $52^{\circ}C$, the pressure remaining the same is

A. $2.5g$

B. $2.0g$

C. $1.5g$

D. $1.0g$

Answer: D

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15. Air is filled in a bottle and it is corked at $35^{\circ} C$. If the cork can come out at 3 atmospheric pressure, then upto what temperature should the bottle be heated to remove the cork ?

A. $325^{\circ} C$

B. $851^{\circ} C$

C. $651^{\circ} C$

D. none of the these

Answer: C

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16. Consider the quantity $\frac{MkT}{pV}$ of an ideal gas where M is the mass of the gas. It depends on the

A. temperature of the gas

B. volume of the gas

C. pressure of the gas

D. nature of the gas

Answer: D

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17. Two ballons are filled, one with pure He gas and other by air, repectively. If the pressure and temperature of these ballons are same then the number of molecules per unit volume is:

A. more in the He filled balloon

B. same in both balloons

C. more in air filled balloon

D. in the rato $1:4$

Answer: B

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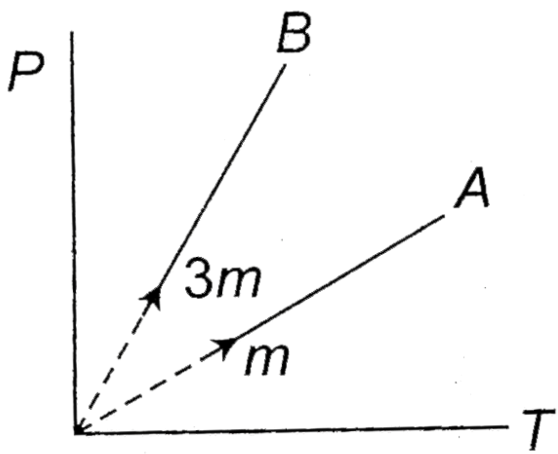
18. Two different masses m and $3m$ of an ideal gas are heated separately in a vessel of constant volume, the pressure P and absolute temperature T, graphs for these two cases are shown in the figure as A and B. The ratio of slopes of curves B to A is



A. $3:1$

B. $1:3$

C. $9:1$

D. $1:9$

Answer: A

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19. The pressure exterted on the walls of the container by a gas is due to the fact that the gas molecules

A. lose their kinetic energy

B. stick to the walls

C. are accelerated towards the walls

D. change their momenta due to collision with the walls

Answer: D

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20. At constant volume, temperature is increased. Then

A. collision on walls be less

B. number of collisions per unit time will increase

C. collisions will be in straight lines

D. collisions will not change

Answer: B

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21. When an ideal gas undergoes an isothermal expansion, the pressure of the gas in the enclosure falls. This is due to

A. decrease in the change of momentum per collision

B. decrease in the frequency of collision

C. decrease in both the frequency of collision and the change of momentum per collision

D. decrease in neither the frequency of collision nor the change of momentum per collision

Answer: B

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22. According to the kinetic theory of gases

(i) $P \propto v_{rms}$

(ii) $v_{rms} \propto T$

(iii) $v_{rms} \propto T^{1/2}$

(iv) $P \propto v_{rms}^2$

A. (i), (iii)

B. (ii), (iii)

C. (iii), (iv)

D. (i), (iv)

Answer: C

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23. The pressure of an ideal gas is written as $p = \frac{2E}{3V}$.Here E refers to

A. translational kinetic energy

B. rotational kinetic energy

C. vibrational kinetic energy

D. total kinetic energy

Answer: A

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24. Pressure exerted by a perfect gas equal to

A. mean $K.E.$ per unit volume

B. half of mean $K.E.$ per unit volume

C. one-third of mean $K.E.$ per unit volume

D. two-third of mean $K.E.$ per unit volume

Answer: D

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25. At a given temperature, the pressure of an ideal gas of density ρ is proportional to

A. $\frac{1}{\rho^2}$

B. $\frac{1}{\rho}$

C. ρ^2

D. ρ

Answer: D

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26. According to the kinetic theory of gases, at absolute temperature

A. water freezes

B. liquid helium freezes

C. molecular motion stops

D. liquid hydrogen freezes

Answer: C

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27. Gas at a pressure P_0 in contained as a vessel. If the masses of all the molecules are halved and their speeds are doubles. The resulting pressure P will be equal to

A. $4P_0$

B. $2P_0$

C. P_0

D. $\frac{P_0}{2}$

Answer: B

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28. Three containes 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. $P > (P_1 + P_2 + P_3)$

Answer: C

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29. Four molecules have speeds $2m/s, 3km/s, 4km/s$ and $5km/s$. The rms speed of these molecules in km/s is

A. $\frac{\sqrt{27}}{2}$

B. $\sqrt{27}$

C. $2\sqrt{27}$

D. $\sqrt{54}$

Answer: A

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30. Speed of sound in a gas is v and rms velocity of the gas molecules is c. The ratio of v to c is

A. $\frac{3}{\gamma}$

B. $\frac{\gamma}{3}$

C. $\sqrt{\frac{3}{\gamma}}$

D. $\sqrt{\frac{\gamma}{3}}$

Answer: D

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31. The mean square speed of the molecules of a gas at absolute temperature T is proportional to

A. T^{-1}

B. $\sqrt{T}$

C. T

D. T^2

Answer: C

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32. At room temperature, the rms speed of the molecules of a certain diatomic gas is found to be $1930 m/s$. The gas is

A. H_2

B. F_2

C. O_2

D. CI_2

Answer: A

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33. Which of the following gases has maximum rms speed at a given temperature?

A. hydrogen

B. nitrogen

C. oxygen

D. carbon dioxide

Answer: A

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34. The temperature at which the rms speed of air molecules is double of that at STP is

A. 819°

B. $819K$

C. $1092^{\circ}C$

D. $1192K$

Answer: A

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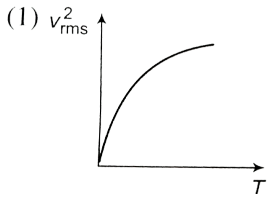
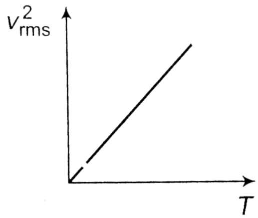
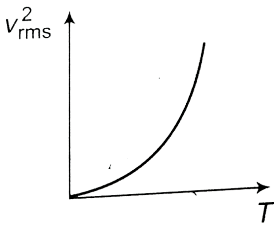
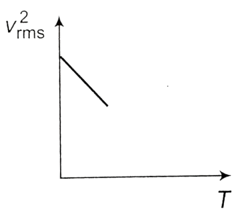
35. The curve between absolute temperature and v_{rms}^2 is

A. 

B. 

C. 

D. 

Answer: B

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36. The rms speed of oxygen molecules in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become

A. v

B. $v\sqrt{2}$

C. $2v$

D. $4v$

Answer: C

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37. A mixture of 2 moles of helium gas ($(a \rightarrow micmass) = 4a.\,m.\,u)$ and 1 mole of argon gas (

$(a \rightarrow micmass) = 40a.\,m.\,u)$ is kept at 300K in a container. The ratio of the rms speeds $\left(\frac{v_{rms}(helium)}{(v_{rms}(argon))}\right)$ is

A. 0.32

B. 0.45

C. 2.24

D. 3.16

Answer: D

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38. For gas at a temperature T the root-mean-square speed v_{rms}, the most probable speed v_{mp}, and the average speed v_{av} obey the relationship

A. $v_{av} > v_{rms} > v_{mp}$

B. $v_{rms} > v_{av} > v_{mp}$

C. $v_{mp} > v_{av} > v_{rms}$

D. $v_{mp} > v_{rms} > v_{av}$

Answer: B

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39. The root mean square velocity of hydrogen molecules at 300 K is $1930 ms^{-1}$. The rms velocity of oxygen molecules at 1200 K will be

A. $1930 m/s$

B. $965 m/s$

C. $3960 m/s$

D. $482.5 m/s$

Answer: B

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40. 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 $0^\circ C$, then the temperature of the helium sample is about

A. $0^\circ C$

B. $0K$

C. $273^\circ C$

D. $100^\circ C$

Answer: A

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41. At what temperature is the root mean square velocity of gaseous hydrogen molecules is equal to that of oxygen molecules at $47^\circ C$?

A. $20k$

B. $80K$

C. $-73K$

D. $3K$

Answer: A

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42. The molecules of a given mass of gas have a rms velocity of $200m/\sec at 127^\circ C$ and $1.0 \times 10^5 N/m^2$ pressure. When the temperature is $127^{\circ} C$ and pressure is $0.5 \times 10^5 N / m^2$ the rms velocity in $m / \sec$ will be

A. $\frac{100\sqrt{2}}{3}$

B. $100\sqrt{2}$

C. $\frac{400}{\sqrt{3}}$

D. none of the above

Answer: C

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43. A cubical box with porous walls containing an equal number of O_2 and H_2 molecules is placed in a larger evacuated chamber. The entire system is maintained at constant temperature T. The ratio of v_{rms} of O_2 molecules to that of the v_{rms} of H_2

molecules, found in the chamber outside the box after a short interval is

A. $\frac{1}{2\sqrt{2}}$

B. $\frac{1}{4}$

C. $\frac{1}{\sqrt{2}}$

D. $\sqrt{2}$

Answer: B

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44. Two vessels have equal volums. One of them contains hydrogen at one atmosphere and the other helium at two atmosphere. If both the samples are at the same temperature, the rms velocity of the hydrogen molecules is

A. equal to that of the helium molecules

B. twice that of the helium molecules

C. half that of the helium molecules

D. $\sqrt{2}$ times that of the helium molecules

Answer: D

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45. The remperature at which the rms speed of hydrogen molecules is equal to escape velocity on earth surface, will be

A. $1060K$

B. $5030K$

C. $8270K$

D. $10063K$

Answer: D

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46. Suppose a container is evacuated to leave just one molecule of a gas in it. Let v_a and v_{rms} represents the average speed and the rms speed of the gas.

A. $v_a > v_{rms}$

B. $v_a < v_{rms}$

C. $v_a = v_{rms}$

D. v_{rms} is undefined

Answer: C

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47. 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 (where M is the mass of an oxygen molecules)

A. $(V_1 + V_2)/2$

B. V_1

C. $(V_1 V_2)^{1/2}$

D. $\sqrt{3kT/M}$

Answer: B

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48. Let $\bar{v}$, v_{rms} and v_p respectively denote the mean speed. Root mean square speed, and most probable speed of the molecules in an ideal monoatomic gas at absolute temperature T. The mass of a molecule is m. Then

A. (i),(ii)

B. (ii), (iii)

C. (iii), (iv)

D. (i), (iv)

Answer: C

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49. The average momentum of a molecule in a sample of an ideal gas depends on

A. temperature

B. number of moles

C. volume

D. none of these

Answer: D

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50. Keeping the number of moles, volume and temperature the same, which of the following are the same for all ideal gases?

A. rms speed of a molecule

B. density

C. pressure

D. average magnitude of momentum

Answer: C

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51. At $0K$, which of the following properties of a gas will be zero ?

A. Kinetic energy

B. Potential energy

C. Vibrational energy

D. Density

Answer: A

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52. Which of the following quantities is zero on an average for the molecules of an ideal gas in equilibrium?

A. Kinetic energy

B. Momentum

C. Density

D. Speed

Answer: B

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53. Which of the following parameters is the same for molecules of all gases at a given temperature?

A. Mass

B. Speed

C. Momentum

D. Kinetic energy

Answer: D

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54. Oxygen and hydrogen are at the same temperature T. What is the ratio of kinetic energies of oxygen molecule and hydrogen molecule when oxygen is 16 times heavier than hydrogen ?

A. 16

B. 4

C. 1

D. $1/4$

Answer: C

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55. The mean transitional kinetic energy of a perfect gas molecule at absolute temperature T is (k is the Boltzmann constant)

A. $\frac{1}{2}kT$

B. kT

C. $\frac{3}{2}kT$

D. $\frac{5}{2}kT$

Answer: C

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56. The energy of a given sample of an ideal gas depends only on its

A. volume

B. pressure

C. density

D. temperature

Answer: D

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57. A sealed container contains helium gas at $300k$. If it is heated to $600K$, the average kinetic energy of the helium atoms

A. remains unchanged

B. is doubled

C. become $\sqrt{2}$ times

D. becomes 4 times

Answer: B

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58. The average translational kinetic energy of O_2 (molar mass 32) molecules at a particular temperature is $0.048eV$. The translational kinetic energy of N_2 (molar mass 28) molecules in (eV) at the same temperature is (JEE 1997)

(a) 0.0015 (b) 0.003 (c) 0.048 (d) 0.768

A. 0.0015

B. 0.003

C. 0.048

D. 0.763

Answer: C

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59. Which of the following quantities is the same for all ideal monoatomic gases at the same teperature ?

(i) the $K.E.$ of 1 mole

(ii) the $K.E.$ of $1g$

(iii) the number of molecules in 1 mole

(iv) the number of molecules in $1g$

A. (i), (ii)

B. (ii), (iii)

C. (iii), (iv)

D. (i), (iii)

Answer: D

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60. A gas has volume V and pressure p. The total translational kinetic energy of all the molecules of the gas is

A. $\frac{3}{2}pV$ only if the gas is monoatomic

B. $\frac{3}{p}V$ only if the gas is diatomic

C. $> \frac{3}{2} pV$ if the gas is diatomic

D. $\frac{3}{2} pV$ in all classes

Answer: D

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61. The average translational energy and the rms speed of molecules in a sample of oxygen gas at $300K$ are $6.21 \times 10^{-21} J$ and $484m/s$, respectively. The corresponding values at $600K$ are nearly (assuming ideal gas behaviour)

A. $12.42 \times 10^{-21} J, 968m/s$

B. $8.78 \times 10^{-21} J, 684m/s$

C. $6.21 \times 10^{-21} J, 968m/s$

D. $12.42 \times 10^{-21} J, 684m/s$

Answer: D

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62. A polyatomic gas with (n) degress of freedom has a mean energy per molecule given by.

A. $\frac{nkT}{N}$

B. $\frac{nkT}{2N}$

C. $\frac{nkT}{2}$

D. $\frac{3kT}{2}$

Answer: C

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63. Three perfect gases at absolute temperature T_1, T_2 and T_3 are mixed. The masses f 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

A. $\frac{(T_1 + T_2 + T_3)}{3}$

B. $\frac{n_1 T_1 + n_2 T_2 + n_3 T_3}{n_1 + n_2 + n_3}$

C. $\frac{n_1 T_1^2 + n_2 T_2^2 + n_3 T_3^2}{n_1 T_1 + n_2 T_2 + n_3 T_3}$

D. $\frac{n_1^2 T_1^2 + n_2^2 T_2^2 + n_3^2 T_3^2}{n_1 T_1 + n_2 T_2 + n_3 T_3}$

Answer: B

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64. Consider a mixture of oxygen and hydrogen kept at room temperature, As compared to a hydrogen molecule an oxygen molecule hits the wall

A. with greater average speed

B. with smaller average speed

C. with greater average kinetic energy

D. with smaller average kinetic energy

Answer: B

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65. The temperature of argon, kept in a vessel, is raised by $1^\circ C$ 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%

Answer: D

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66. A vessel contains a mixture of one mole of oxygen and two moles of nitrogen at 300K. The ratio of the average rorational kinetic energy per O_2 molecules to that per N_2 molecules is

A. $1:1$

B. $1:2$

C. $2:1$

D. depends on the momets of inertia of the two molecules

Answer: A

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67. 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

A. $4RT$

B. $15RT$

C. $9RT$

D. $11RT$

Answer: D

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68. A gas is enclosed in a container which is then placed on a fast moving train. The temprature of the gas

A. rises

B. falls

C. remains unchanged

D. becomes unsteady

Answer: C

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69. Mean free path of a gas molecule is

A. inversely proportional to number of molecules per unit

B. inversely proportional to diameter of the molecule

C. directly proportional to the square root of the absolute temperature

D. independence of temperature

Answer: A

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70. If the mean free path of atoms is doubled then the pressure of gas will become

A. $P/4$

B. $P/2$

C. $P/8$

D. P

Answer: B

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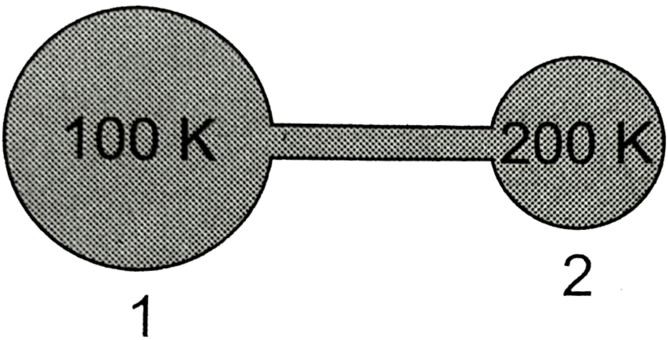
71. Figure shows two flasks connected to each other. The volume of the flask 1 is twice that of flask 2. The system is filled with an ideal gas at temperature $100K$ and $200K$ respectively. If the mass of the gas in 1 be m then what is the mass of the gas in flask 2



A. m

B. $m/2$

C. $m/4$

D. $m/8$

Answer: C

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72. Two containers of equal volume contain the same gas at pressure P_1 and P_2 and absolute temperature T_1 and T_2, respectively. On joining the vessels, the gas reaches a common pressure P and common temperature T. The ratio P/T is equal to

A. $\frac{p_1}{T_1} + \frac{p_2}{T_2}$

B. $\frac{1}{2}\left[\frac{p_1}{T_1} + \frac{p_2}{T_2}\right]$

C. $\frac{p_1 T_2 + p_2 T_1}{T_1 + T_2}$

D. $\dfrac{p_1T_2 - p_2T_1}{T_1 - T_2}$

Answer: C

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73. Two idential container joined by a small pipe initially contain the same gas at pressure p_0 and absolute temperature T_0. One container is now maintained at the same temperature while the other is heated to $2T_0$. The common pressure of the gas

A. $\dfrac{3}{2}p_0$

B. $\dfrac{4}{3}p_0$

C. $\dfrac{5}{p_0}$

D. $2p_0$

Answer: B

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74. In the previous question let V_0 be the volume of each container. All other details remain the same. The number of moles of gas in the container at temperature $2T_0$ will be

A. $\frac{p_0V_0}{2RT_0}$

B. $\frac{p_0V_0}{RT_0}$

C. $\frac{2p_0V_0}{3RT_0}$

D. $\frac{p_0V_0}{3RT_0}$

Answer: D

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75. The temperature at the bottom of a $40cm$ deep lake is $12^\circ C$ and that at the surface is $35^\circ C$. An air bubble of volume $1.0cm^3$ rises from the bottom to the surface. Its volume becomes (atmospheric pressure $= 10m$ of water)

A. $2.0cm^3$

B. $3.2cm^3$

C. $5.4cm$

D. $8.0cm^3$

Answer: C

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76. An air bubble doubles in radius on string from the bottom of a lake to its surface. If the atmospheric pressure is equal to that of a column of water of height H, the depth of the lake is

A. H

B. $2H$

C. $7H$

D. $8H$

Answer: C

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77. 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 $10m$ height of water column). If the temperature is constant and the surface tension is neglected, the depth of the lake is

A. $3.53m$

B. $6.53m$

C. $9.53m$

D. $12.53m$

Answer: C

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78. 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

A. $11g$

B. $22g$

C. $33g$

D. $44g$

Answer: C

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79. The equation of state of gas is given $\left(P+\frac{aT^2}{V}\right)V^c=(RT+b)$ where a, b, c and R are constant. 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 $n=-1$

Answer: A

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