PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

THE KINETIC THEORY OF GASES

Sample Problem

1. A vessel of volume V is evacuated by means of a piston air pump Upon cach double stroke

a piston pump sucks in a volume V of air and expels it. The process is assumed to be isothermal, and the gas is ideal. When this pump is used to evacuate the air from a vessel with a volume V, it performs n double strokes. The initial pressure inside the vessel is p_0 which is equal to the atmospheric pressure. (a) Calculate the final pressure inside the vessel.

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2. After that, another pump with the same chamber volume V, begins to suck in the atmospheric air, also making n double strokes. What will be the pressure inside the vessel?

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3. A horizontally kept cylindrical vessel closed at both ends is separated into two equal (42 cm each) parts by an adiabatic piston. Both parts contain gas having equal mass at a

temperature of $27^{\circ} C$ and a pressure of 1 atm. How much should the gas be heated in one part of the cylinder to shift the piston by 2 cm? Find the pressure p of the gas after shifting of the piston.

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4. Before starting out on a long drive , you check the air in you car's tires to make sure they are properly inflated . The pressure gauge reads 209 k Pa, and temperature is $37^{\circ} C$.

after a few hours of highway driving you stop and check the pressure again . Now the gauge reads 239 kPa. what is the temperature of the air in the tires now ? Assume that the volume of the tire remains constant .

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5. Here are five numbers : 5,11,32,67 and 89

(a) what is the average value n_{avg} of these numbers ?

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6. Here are five numbers : 5,11,32,67 and 89

(b) what is the rms value n_{rms} of these numbers ?

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7. In oxygen (molar mass M = 0.0320 kg/mol) at room temperature (300 K), what fraction of the molecules have speeds in the interval 599 to 601 m/s?

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8. The molar mass M of oxgyen is $0.0320kg$ / mol

what is the average speed v_{avg} of oxygen gas molecules at T = 300 K ?

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9. The molar mass M of oxgyen is $0.0320kg$ / mol

What is the root - mean - square speed v_{rms} at 300 K

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10. The molar mass M of oxgyen is $0.0320kg$ / mol

What is the most probable speed V_p at 300 K `?

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11. Five molecules have speeds of 12 ,16,32,40, and 48 m/s find (a) the average speed v_{avg} and (b) the rootmean - square speed v_{rms} for these molecules (c) show that for any distribution of speeds , $v_{rms} \geq V_{avg}$

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12. What are the average translation kinetic energies K_{Avg} of the oxygen molecules and nitrogen molecules in the air that breathe ?

Assume that air is an ideal gas at a temperature of 300 K , which is the traditional value taken for room temperature .

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13. The mass of an oxgyen molecule differs from that of a nitrogen molecule . Do the oxygen molecules and the nitrogen molecules in air have the same rms speed v_{rms} ?

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Check Point

1. Supposein the above problem , you decide to leak some air from the tires since the manufacturer suggests keeping the pressure at 210 kPa. .(the manufacturer's specification are for the tires which are " cold ") . If you let out sufficient air so that the pressure returs to 210 k P.a . what percentage of the air molecules did you let out of the tires ? suppose that you leave the car and go for a lunch and when come back the tires have

cooled down to $37^{\circ} C$ Now what is the gauge pressure ?

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2. A gas mixture consists of molecules of A,B and C with masses $m_A > m_B > m_C$. Rank the three types of molecules in decreasing order of (a) average KE (b) rms speeds.

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Problems

1. The speed s of 22 particles are as follows (N_i represents the number of particles that have speed V_i) :

N_i	2	4	6	8	2
v_i (cm/s)	1.0	2.0	3.0	5.0	6.0

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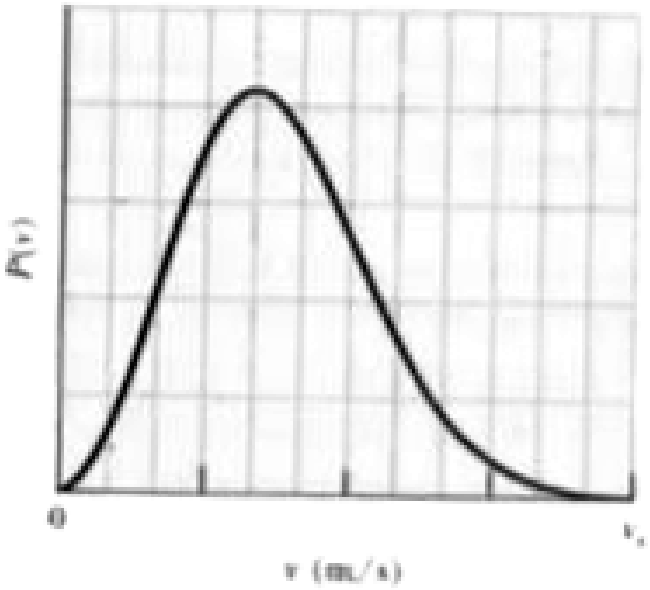
2. gives the probaility distribution for nitrogen gas . The scale of the horizontal axis is set by

$v_s = 2400$ m/s what are the (a)gas temperature and (b) rms speed of the molecules ?



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3. Find the rms speed of argon atoms at 323 K . Sec apprndix F for molar mass of argon atoms .

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4. Water standing in the open at 10.0°C evaporates because of the escape of some of the surface molecules. The heat of vaporization (539 cal/g) is approximately equal to en, where e is the average energy of the

escaping molecules and n is the number of molecules per gram. (a) Find ε. (b) What is the ratio of ε to the average kinetic energy of H_2O molecules, assuming the latter is related to temperature in the same way as it is for gases?

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5. The speeds of 11 molecules are 2.0, 3.0, 4.0, ..., 12 km/s. What are their (a) average speed and (b) rms speed?

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6. A beam of hydrogen molecules (H_2) is directed toward a wall, at an angle of 32° with the normal to the wall. Each molecule in the beam has a speed of 1.0 km/s and a mass of 3.3×10^{-24} g. The beam strikes the wall over an area of 2.0 cm?, at the rate of 4.0×10^{23} molecules per second. What is the beam's pressure on the wall?

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7. Ten particles are moving with the following speeds: four at 300 m/s, two at 500 m/s, and four at 600 m/s. Calculate their (a) average and (b)rms speeds. (c) Is $v_{rms} > v_{avg}$?

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8. What is the average translational kinetic energy of nitrogen molecules at 1500 K?

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9. Suppose 10.0 g of oxygen (O_2) gas is heated at constant atmospheric pressure from $25.0^\circ C$ to $125^\circ C$. (a) How many moles of oxygen are present? (See Table 20-1 for the molar mass.) (b) How much energy is transferred to the oxygen as heat? (The molecules rotate but do not oscillate.) (c) What fraction of the heat is used to raise the internal energy of the oxygen?

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10. The most probable speed of the molecules in a gas at temperature T_2 is equal to the average speed of the molecules at temperature T_1 Find T_2 / T_1

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11. Oxygen gas having a volume of 1200 cm at $40.0^\circ C$ and 1.01×10^5 Pa expands until its temperature is 493 k and its pressure is 1.06 x

109 Pa. Find (a) the number of moles of oxygen present and (b) the final volume of the sample.

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12. Water bottle in a hot car. In the American Southwest, the temperature in a closed car parked in sunlight during the summer can be high enough to burn flesh. Suppose a bottle of water at a refrigerator temperature of $5.00^{\circ} C$ is opened, then closed, and then left in a closed car with an internal temperature of

$65.0^{\circ} C$. Neglecting the thermal expansion of the water and the bottle, find the pressure in the air pocket trapped in the bottle. (The pressure can be enough to push the bottle cap past the threads that are intended to keep the bottle closed.)

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13. The lowest possible temperature in outer space is 2.7 K,which is associated with the microwave background radiation left over

from the formation of the universe. What is the rms speed of hydrogen molecules at this temperature? (The molar mass is given in Table 20-1.)

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14. A container encloses 1.5 mol of an ideal gas that has molar mass M, and 0.50 mol of a second ideal gas that has molar mass M, 3.0M What fraction of the total pressure on the container wall is attributable to the second

gas? (The kinetic theory explanation of pressure leads to the experimentally discovered law of partial pressures for a mixture of gases that do not react chemically: The total pressure exerted by the mixture is equal to the sum of the pressures that the several gases would exert separately if each were to occupy the vessel alone. The molecule-vessel collisions of one type would not be altered by the presence of another type.)

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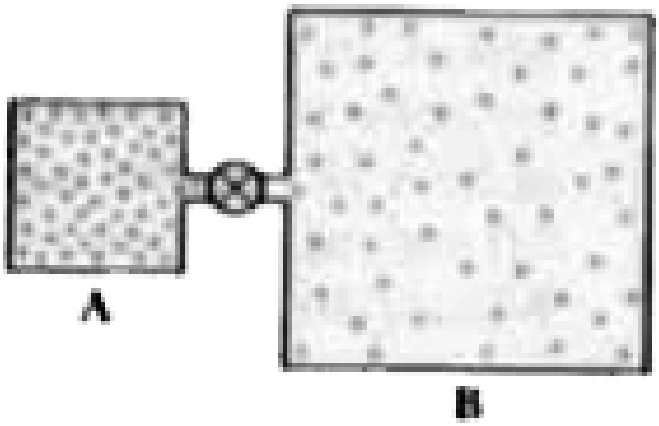
15. Container A in holds an ideal gas at a pressure of 8.0×10^5 Pa and a temperature of 250 K. It is connected by a thin tube (and a closed valve) to container B, with four times the volume of A Container B holds the same ideal gas at a pressure of 1.0×10^5 Pa and a temperature of 450 K. The valve is opened to allow the pressures to equalize, but the temperature of each container is main tained.

What then is the pressure?



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16. Determine the average value of the translational kinetic energy of the molecules of an ideal gas at temperatures (a)

$20.0^\circ C$ and $(b) 80.0^\circ C$. What is the translational kinetic energy per mole of an ideal gas at (c) $20.0^\circ C$ and $(d) 80.0^\circ C$?

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17. At $127^\circ C$ and 1.00×10^{-2} atm pressure, the density of a gas is $1.24 \times 10^{-2} kgm^{-3}$.

a. Find v_{rms} for the gas molecules.

b. Find the molecular weight of the gas and identify it.

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18. If vacuum techniques have reduced a gas to only 45 molecules/cm when the temperature is 293 K, what is the pressure in the gas?

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19. Submarine rescue. When the U.S. submarine Squalus became disabled at a depth of 80 m, a cylindrical chamber was lowered from a ship to rescue the crew. The chamber had a radius of 1.00 m and a height of 3.50 m, was open at

the bottom, and held two rescuers. It slid along a guide cable that a diver had attached to a hatch on the submarine. Once the chamber reached the hatch and clamped to the hull, the crew could escape into the chamber. During the descent, air was released from tanks to prevent water from flooding the chamber. Assume that the interior air pressure matched the water pressure at depth h as given by $P_0 + \rho gh$, where P_0 = 1.000 atm is the surface pressure and p= 1024 kg/m^3 is the density of seawater. Assume a surface temperature of 20.0°C and a submerged water

temperature of -40.0°C. (a) What is the air volume in the chamber at the surface? (b) If air had not been released from the tanks, what would have been the air volume in the chamber at depth h = 80.0 m? (c) How many moles of air were needed to be released to maintain the original air volume in the chamber?

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20. An air bubble of volume 15 cm is at the bottom of a lake 40 m deep, where the temperature is $4.0^{\circ} C$. The bubble rises to the surface, which is at a temperature of$20^{\circ} C$ Take the temperature of the bubble's air to be the same as that of the surrounding water. Just as the bubble reaches the surface, what is its volume?

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21. What is the internal energy of 2.0 mol of an ideal monatomic gas at 273 K?

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22. Gold has a molar mass of 197 g/mol. (a) How many moles of gold are in a 1.50 g sample of pure gold? (b) How many atoms are in the sample?

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23. A quantity of ideal gas at $10.0^\circ C$ and 100 kPa occupies a volume of 3.00 m. (a) How many moles of the gas are present? (b) If the pressure is now raised to 300 kPa and the temperature is raised to $30.0^\circ C$, how much volume does the gas occupy? Assume no leaks.

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24. The temperature and pressure in the Sun's atmosphere are 2.00×10^6 K and 0.0300 Pa. Calculate the rms speed of free electrons

(mass 9.11×10^{-31} kg) there, assuming they are an ideal gas.

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25. Calculate the rms speed of helium atoms at 1200 K. See Appendix F for the molar mass of helium atoms.

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26. Find the mass in kilograms of 3.23×10^{24} atoms of aluminum, which has a molar mass of 26.98 g/mol.

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27. Compute (a) the number of moles and (b) the number of molecules in 1.00 cm of an ideal gas at a pressure of 75.0 Pa and a temperature of 285 K.

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28. (a) Compute the rms speed of a nitrogen molecule at $80.0^{\circ}\mathrm{C}$. The molar mass of nitrogen molecules (N.) is given in Table 20-1. At what temperatures will the rms speed be (b) half that value and (c) twice that value?

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Practice Questions Single Correct Choice Type

1. Which one of the following statements concerning the mole is false?

A. The mole is related to Avogadro's number.

B. The mole is defined in terms of the carbon-12 isotope.

C. The mole is the SI base unit for expressing the "amount of a substance.

D. One mole of a substance has the same mass as one mole of any other substance.

Answer: D

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Practice Questions

1. According to the kinetic theory of gases, the pressure of a gas is due to

A. change of kinetic energy of molecules as they strike the wall.

B. change of momentum of molecules as they strike the wall.

C. average kinetic energy of the molecules.

D. force of repulsion between the molecules.

Answer: B

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2. Which one of the following properties of a gas is not consistent with kinetic theory?

A. The average speed of the gas molecules is smaller at high temperatures.

B. Gas molecules are widely separated.

C. Gases fill whatever space is available to them.

D. Gas molecules move rapidly in a random fashion.

Answer: A

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3. A closed vessel is maintained at a constant temperture. It is first evacuated and then vapour is injected it continuously. The pressure of the vapour in the vessel

A. increases continuously.

B. first increases and then remains constant.

C. first increases and then decreases.

D. none of the above

Answer: B

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4. Which one of the following statements concerning a collection of gas molecules at a certain temperature is true?

A. All molecules move with the same velocity.

B. Most of the molecules have the same kinetic energy.

C. The lower the temperature, the greater are the molecular speeds.

D. The molecules have a range of kinetic energies.

Answer: D

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5. Under which one of the following conditions do real gases approach the ideal gas behaviour?

A. Low temperature and low pressure.

B. High temperature and high pressure.

C. High temperature and low pressure.

D. Low temperature and high pressure.

Answer: C


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6. It is known that 28 grams of a certain ideal gas occupy 22.4 liters at standard conditions (0°C, 1 atm). The volume occupied by 42 grams of this gas at standard conditions is

A. 14.9 liters

B. 22.4 liters

C. 33.6 liters

D. 42 liters

Answer: C

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7. The approximate number of air molecules in a 1 m^3 volume at room temperature (300 K) and atmospheric pressure is (Use $R = 8.2 \times 10^{-5} m^3$ atm/mol K and $N_A = 6.02 \times 10^{23}$ mol^(-1)`)

A. 41

B. 450

C. 2.4×10^{25}

D. 2.7×10^{26}

Answer: C

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8. What is the internal energy of 1.75 kg of helium (atomic mass $= 4.00260$u) with a temperature of 100°C ?

A. $4.65 \times 10^{3} J$

B. $2.03 \times 10^6 J$

C. $5.44 \times 10^5 J$

D. $8.16 \times 10^6 J$

Answer: B

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9. A runner weighis 580 N (about 130 lb), and 71% of this weight is water. How many moles of water are in the runner's body?

A. 5.3×10^2 mol

B. 1.6×10^3 mol

C. 9.8×10^2 mol

D. 2.3×10^3mol

Answer: D

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10. A 0.030 m container is initially evacuated. Then, 4.0 g of water is placed in the container and, after some time, all the water evaporates.

If the temperature of the water vapor is 388 K, what is its pressure?

A. $1.5 \times 10^5 Pa$

B. $2.4 \times 10^4 Pa$

C. 6.9×10^4Pa

D. $8.2 \times 10^4 Pa$

Answer: B

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11. What is the density (in kg/m) of nitrogen gas (molecular mass = 28 u) at a pressure of 2.0 atmospheres and a temperature of 310 K?

A. $0.88Kg/m^3$

B. $4.9kg/m^3$

C. $1.1kg/m^3$

D. $2.2kg/m^3$

Answer: D

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12. The capacity of a vessel is 31. It contains 6g O_2,8g N_2 and 5g CO_2 mixture at 27°C. If R = 8.31 J/mol K, then the pressure in the vessel in N/m2 will be (approx.)

A. 5×10^5

B. 5×10^4

C. 1×10^6

D. 1×10^5

Answer: A

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13. If the translational rms speed of the water vapor molecules (H_2O) in air is 648 m/s, what is the translational rms speed of the carbon dioxide molecules (CO_2) in the same air? Both gases are at the same temperature.

A. 239 m/s

B. 338 m/s

C. 414 m/s

D. 307 m/s

Answer: C

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14. Each molecule in a gas has an average kinetic energy. What is the total average kinetic energy of all the molecules in 3.0 mol of a gas whose temperature is 320 K?

A. $12000J$

B. $10000J$

C. $6000J$

D. $8000J$

Answer: A

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15. Helium (He), a monatomic gas, fills a 0.010 m^3 container. The pressure of the gas is $\left(6.2 \times 10^5\right.$ Pa). How long would a 0.25 hp engine have to run (1 hp = 746 W) to produce an amount of energy equal to the internal energy of this gas?

A. $1.0 \times 10^1 s$

B. $5.0 \times 10^1 \mathrm{s}$

C. $2.5 \times 10^1 s$

D. $4.3 \times 10^1 \mathrm{s}$

Answer: B

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16. A gas is confined to a cylindrical container of radius 1 cm and length 1 m. The pressure

exerted on an end face, compared with the pressure exerted on the long-curved face, is

A. smaller because its area is smaller.

B. smaller because most molecules cannot traverse the length of the cylinder without undergoing collisions.

C. larger because the face is flat.

D. none of these.

Answer: D

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

A. $PV = \frac{5RT}{32}$

B. $PV = \frac{5RT}{16}$

C. $PV = \frac{5RT}{2}$

D. $PV = 5RT$

Answer: A

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18. A tank contains 0.85 mol of molecular nitrogen (N_2). Determine the mass (in grams) of nitrogen that must be removed from the tank in order to lower the pressure from 38 to 25 atm. Assume that the volume and temperature of the nitrogen in the tank do not change.

A. 2.1 g

B. 8.1g

C. 4.0g

D. 11g

Answer: B

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19. The force on the walls of a vessel of a contained gas is due to

A. repulsive force between gas molecules.

B. slight loss in average speed of a gas molecule after collision with wall.

C. change in momentum of a gas molecule due to collision with wall.

D. elastic collisions between gas molecules.

Answer: C

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20. Initially, the translational rms speed of a molecule of an ideal gas is 463 m/s. The pressure and volume of this gas are kept constant, while the number of molecules is doubled. What is the final translational rms speed of the molecules?

A. 655 m/s

B. 463 m/s

C. 327 m/s

D. 926 m/s

Answer: C

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21. Two pure samples of atoms, labeled A and B, contain oxygen atoms and carbon atoms, respectively. Each sample contains the same number of atoms. What is the ratio of the mass of sample B to that of sample A, m_B / m_A ? Note the following atomic masses: C = 12 u, 0= 16 u,

A. 1.0

B. 0.75

C. 0.5

D. 1.5

Answer: B

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22. An ideal gas with a fixed number of molecules is maintained at a constant pressure. At $30.0^{\circ} C$, the volume of the gas is

$1.50m^3$. What is the volume of the gas when the temperature is increased to 75.0°C?

A. $0.60m^3$

B. $3.75m^3$

C. $1.72m^3$

D. $1.30m^3$

Answer: C

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23. The density of diamond, a form of carbon, is 3520 kg/m^3 If the atomic mass of carbon is 12.011 u, how many carbon atoms are there in a solid diamond sphere with a radius of 0.033 m?

A. 5.16×10^{26} atoms

B. 1.04×10^{27} atoms

C. 2.08×10^{26} atoms

D. 2.66×10^{25} atoms

Answer: D

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24. A sample of a monatomic ideal gas is originally at $20^\circ C$. What is the final temperature of the gas if both the pressure and volume are doubled?

A. $5^\circ C$

B. $20^\circ C$

C. $80^\circ C$

D. $900^\circ C$

Answer: D

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25. A sample of gas is taken in a closed vessel at $20^\circ C$. The gas is heated until the pressure is doubled. What is the final temperature?

A. $10^\circ C$

B. $20^\circ C$

C. $40^\circ C$

D. $313^\circ C$

Answer: D

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26. Argon gas at 305 K is confined within a constant volume at a pressure p. If the gas has a pressure p_2 when it is cooled to 195 K, what is the ratio of p_2 to p_1?

A. 0.410

B. 0.717

C. 0.639

D. 1.28

Answer: C

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27. The temperature of a monatomic ideal gas with a mass per mole of 0.00750 kg/mol is 294 K. The absolute pressure of the gas is 1.05×10^5 Pa when its volume is 1.31×10^{-3} m. What is the mass of the gas?

A. $8.04 \times 10^{-5} kg$

B. $4.22 \times 10^{-4} kg$

C. $1.92 \times 10^{-4} kg$

D. 7.66×10^{-4}kg

Answer: B

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28. The temperature of low pressure hydrogen is reduced from $100^{\circ} C$to $20^{\circ} C$. The rms speed of its molecules decreases by, approximately

A. 0.89

B. $79\ \%$

C. $46\ \%$

D. $11.3\ \%$

Answer: D

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29. A mixture of two ideal gases A and B is in thermal equilibrium at 600 K.A molecule of A has one-fourth the mass of a molecule of B

and the rms speed of molecules of A is 400 m/s. Determine the rms speed of molecules of B.

A. $100m/s$

B. $200m/s$

C. $400m/s$

D. $800m/s$

Answer: B

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30. A canister containing 150 kg of an ideal gas has a volume of 8.0 m'. If the gas exerts a pressure of 5.0×10^5 Pa, what is the rms speed of the molecules?

A. 160 m/s

B. 282 m/s

C. 350 m/s

D. 390 m/s

Answer: B

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31. According to the Maxwellian speed distribution, as the temperature increases the most probable speed

A. increases

B. decreases

C. increases at high temperatures and decreases at low

D. decreases at high temperatures and increases at low.

Answer: A

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32. A tank contains 135 moles of the monatomic gas argon at a temperature of $15.3^{\circ} C$. How much energy must be added to the gas to increase its temperature to 45.0° C?

A. $2.50 \times 10^{3} J$

B. $5.00 \times 10^{4} J$

C. $3.33 \times 10^{4} J$

D. $5.70 \times 10^5 J$

Answer: B

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33. How many air molecules are in a room at temperature $23.8^\circ C$ and standard pressure if the dimensions of the room are $3.66m \times 3.66m \times 2.43m$?

A. 1330

B. 16600

C. 3.03×10^{24}

D. 8.05×10^{26}

Answer: D

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34. Platinum has a molar mass of 195 g/mol. If you have a ring that contains 2.3 g of platinum, how many moles does it contain?

A. 0.012 mol

B. 85 mol

C. 450 mol

D. $72 \times 10^{21} mol$

Answer: A

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35. The pressures p and volumes V of the five ideal gases, with the same number of

molecules, are given below. Which has the highest temperature?

A. $p = 1 \times 10^5$ Pa and V = 10 cm^3

B. $p = 3 \times 10^5 Pa$ and $V = 6cm^3$

C. $p = 4 \times 10^5$ Pa and V = 4 cm^3

D. $p = 6 \times 10^5 Pa$ and $V = 2cm^3$

Answer: B

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36. The speeds of 25 molecules are distributed as follows: 5 in the range from 2 to 3 m/s, 10 in the range from 3 to 4 m/s, 5 in the range from 4 to 5 m/s, 3 in the range from 5 to 6 m/s, 1 in the range from 6 to 7 m/s, and 1 in the range from 7 to 8 m/s. Their average speed is about

A. 2m/s

B. 3m/s

C. 4m/s

D. 5m/s

Answer: C

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37. A sample of argon gas (molar mass 40 g) is at four times the absolute temperature of a sample of hydrogen gas (molar mass 2 g). The ratio of the rms speed of the argon molecules to that of the hydrogen is

A. 1

B. 5

C. $1/5$

D. $1/\sqrt{5}$

Answer: D

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38. In a certain gas the molecules are 5.0×10^{-9}m apart on average, have a mean free path of 5.0×10^{-6} m, and have an average speed of 500 m/s. The rate at which a

molecule has collision with other molecules is about

A. $10^{-11}/s$

B. $10^{-8}/S$

C. $1/s$

D. $10^{8}/s$

Answer: D

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39. A certain ideal gas has a temperature 300 K and a pressure 5.0×10^4 Pa. The molecules have a mean free path of 4.0×10^{-7}m. If the temperature is raised to 350 K and the pressure is reduced to 1.0×10^4 Pa the mean free path is then

A. $6.9 \times 10^{-8} m$

B. $9.3 \times 10^{-8} m$

C. $3.4 \times 10^{-7} m$

D. $2.3 \times 10^{-6} m$

Answer: D

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40. The pressure of an ideal gas of diatomic molecules is doubled by halving the volume. The ratio of the new internal energy to the old, both measured relative to the internal energy at 0 K, is

A. $1/4$

B. $1/2$

C. 1

D. 2

Answer: C

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41. Assume that helium behaves as an ideal monatomic gas. If 2 moles of helium undergo a temperature increase of 100 K at constant pressure, how much energy has been transferred to the helium as heat?

A. $1700J$

B. $2500J$

C. $4200J$

D. $5000J$

Answer: C

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42. $A1.00 \times 10^{-2}m^3$ flask contains 0.0160 kg of oxygen gas,O_2at $770^\circ C$. What is the pressure exerted on the inner walls of the flask

by the oxygen gas? (The atomic mass of O is 15.9994 u.)

A. $3.19 \times 10^4 Pa$

B. $1.45 \times 10^5 Pa$

C. $2.90 \times 10^5 Pa$

D. $5.79 \times 10^5 Pa$

Answer: B

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43. An air bubble in a water tank rises from the bottom to the top. Which of the following statements are true?

A. The temperature at the bottom is cooler than it is at the top.

B. The amount of carbon dioxide in the bubble increases.

C. The fluid pressure of the soda is greater at the bottom of the glass than at the top.

D. The pressure inside the bubble decreases as it rises.

Answer: B

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44. The root-mean-square (rms) speed of oxygen molecules (O_2) at a certain absolute temperature is v.If the temperature is double and the oxygen gas dissociated into atomic oxygen, the rms speed would be

A. v

B. $\sqrt{2}v$

C. $2V$

D. $2\sqrt{2}v$

Answer: C

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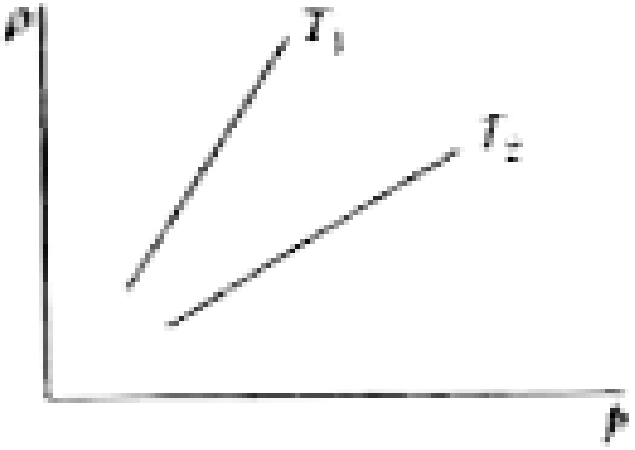
45. Figure shows graphs of pressure versus density for an ideal gas at two temperatures

T_1 and T_2 Then



A. $T_1 > T_2$

B. $T_1 = T_2$

C. $T_1 < T_2$

D. any of these is possible

Answer: A

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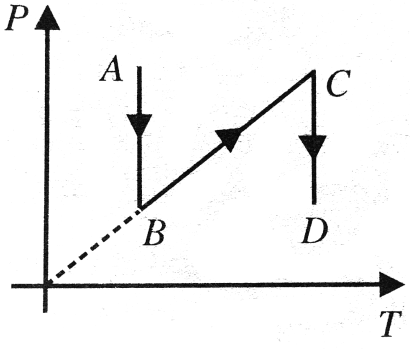
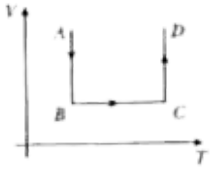
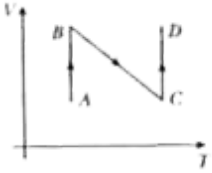
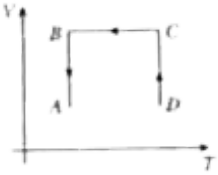
46. $P-T$ diagram is shown in Fig. Choose the corresponding $V-T$ diagram.

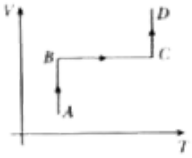


A.



B. 

C. 

D. 

Answer: D

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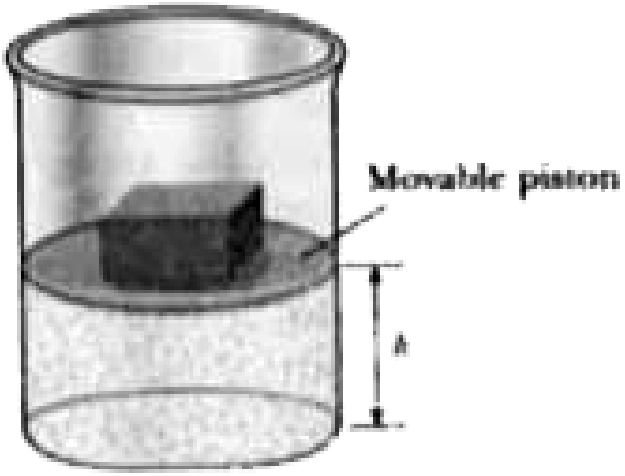
47. A frictionless gas-filled cylinder is fitted with a movable piston, as shown in the figure. The block resting on the top of the piston determines the constant pressure that the gas has. The height his 0.120 m when the temperature is 273 K and increases as the temperature increases. What is the value of h

when the temperature reaches 318 K?



A. 0.140 m

B. 0.130 m

C. 0.150 m

D. 0.125 m

Answer: A

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48. A bulb contains 1 mol of hydrogen mixed with one mole of oxygen at temperature T. The ratio of rms values of velocity of hydrogen molecules to that of oxygen molecules is

A. $1:16$

B. $1:4$

C. $4:1$

D. $16:1$

Answer: C

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49. A primitive diving bell consists of a cylindrical tank with one end open and one end closed. The tank is lowered into a freshwater lake, open end downward. Water rises into the tank, compressing the trapped air, whose temperature remains constant during the descent. The tank is brought to a halt when the distance between the surface of

the water in the tank and the surface of the lake is 40.0 m. Atmospheric pressure at the surface of the lake is 1.01×10^5 Pa. Find the fraction of the tank's volume that is filled with air.

A. 0.205

B. 0.333

C. 0.257

D. 0.435

Answer: A

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50. Near the surface of Venus, the rms speed of carbon diox ide molecules (CO_2) is 650 m/s. What is the temperature (in kelvins) of the atmosphere at that point?

A. 250 K

B. 920 K

C. 750 K

D. 1800 K

Answer: C

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51. Consider a collision between an oxygen molecule and a hydrogen molecule in a mixture of oxygen and hydrogen kept at room temperature. Which of the following are possible?

A. The kinetic energy of both the molecules increase.

B. The kinetic energies of both the molecules decrease.

C. The kinetic energy of the oxygen molecule increases and that of the hydrogen molecule decreases.

D. The kinetic energy of the hydrogen molecule increases and that of the oxygen molecule decreases.

Answer: C::D

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52. 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. no molecules can have speed greater thanv_{rms}

B. no molecule can have speed less than $v_p / \sqrt{2}$

C. $v_p < V_{avg} < v_{rms}$

D. the average kinetic energy of a molecule is $(3/4)mv_f^2$.

Answer: C::D

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53. Which of the following statements are correct?

A. At a given temperature, the internal energy of all ideal gases is the same.

B. At a given temperature, the energy associated with each degree of freedom is (1/2)KT.

C. At a given temperature, the energy associated with each degree of freedom

is (1/3)KT.

D. At a given temperature, all ideal gas molecules, irrespective of their mass, have average kinetic energy equal to (3/2)KT.

Answer: B::D

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54. A box contains a mixture of H, and He gases. Which of the following statements are correct?

A. The average translational kinetic energies of H, molecules and He atoms are same.

B. The average energies of H_2 molecules and He atoms are same.

C. H_2 molecules have greater average energy than that of He atoms

D. The average speed of H_2 molecules and He atoms is same.

Answer: A::C

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55. Which of the following quantities is the same for all ideal gases at the same temperature?

A. The kinetic energy of 1 mol.

B. The kinetic energy of 1 g.

C. The number of molecules in 1 mol.

D. The number of molecules in 1 g.

Answer: A::C

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56. Two vessels of the same volume and filled with the same gas at the same temperature. If the pressure of the gas in these vessel be in the ratio 1:2, then state : (i) the ratio of the

rms speeds of the molecules, (ii) the ratio of the number of molecules.

A. the ratio of the average energy is 1:2.

B. the ratio of the root mean square velocity is 1:1.

C. the ratio of the average velocity is 1:2.

D. the ratio of number of molecules is 1:2.

Answer: B::D

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57. The total kinetic energy of translational motion of all the molecules of 5 L of nitrogen exerting a pressure P is 3000 J.

A. The total kinetic energy of 10 L of N_2 at a pressure of 2P is 3000 J.

B. The total kinetic energy of 10 L of He at a pressure of 2P is 3000 J.

C. The total kinetic energy of 10 L of O_2 at a pressure of 2P is 20,000 J.

D. The total kinetic energy of 10 L of Ne at a pressure of 2P is 12,000 J.

Answer: C::D

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58. If the atoms in a diatomic molecule can vibrate, the molecule has

A. two rotational degrees of freedom.

B. three rotational degrees of freedom.

C. one vibrational degree of freedom.

D. two vibrational degrees of freedom.

Answer: A::D

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59. A vessel contains an ideal gas at $27^\circ C$ and pressure 200 kPa. The volume of the gas is 8.0 L. The molecules of the gas collide with the walls of the vessel and exert a pressure. The gas is allowed to leak till the pressure falls to

150 kPa and the temperature remains the same. The diameter of the ideal gas molecule is 300 pm. The average distance traveled by the molecule between collisions is termed as the mean free path. The mean free path of a gas molecule varies directly proportional to the temperature and inversely proportional to the pressure. Take, R = 8.3 J/mol K and $N_A = 6.02 \times 10^{23}$/mol.

The number of moles of the gas in the vessel before the gas was leaked is

A. 0.64

B. 0.48

C. 0.16

D. 0.8

Answer: A

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60. A vessel contains an ideal gas at $27^{\circ} C$ and pressure 200 kPa. The volume of the gas is 8.0 L. The molecules of the gas collide with the walls of the vessel and exert a pressure. The

gas is allowed to leak till the pressure falls to 150 kPa and the temperature remains the same. The diameter of the ideal gas molecule is 300 pm. The average distance traveled by the molecule between collisions is termed as the mean free path. The mean free path of a gas molecule varies directly proportional to the temperature and inversely proportional to the pressure. Take, R = 8.3 J/mol K and $N_A = 6.02 \times 10^{23}$/mol.

The amount of gas leaked is

A. 0.64 mol

B. $0.48mol$

C. $0.16mol$

D. $0.8mol$

Answer: C

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61. A vessel contains an ideal gas at $27^{\circ}C$ and pressure 200 kPa. The volume of the gas is 8.0 L. The molecules of the gas collide with the walls of the vessel and exert a pressure. The

gas is allowed to leak till the pressure falls to 150 kPa and the temperature remains the same. The diameter of the ideal gas molecule is 300 pm. The average distance traveled by the molecule between collisions is termed as the mean free path. The mean free path of a gas molecule varies directly proportional to the temperature and inversely proportional to the pressure. Take, R = 8.3 J/mol K and $N_A = 6.02 \times 10^{23}$/mol.

the average translation kinetic energy of the molecules of the gas is

A. $2.07 \times 10^{-19} J$

B. $2.07 \times 10^{-20} J$

C. 2.07×10^{-21} J

D. $2.07 \times 10^{-22} J$

Answer: C

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62. X and Y are two equal size containers. X contains a gas A at a temperature 75°C and Y contains a gas B at a temperature 40°C. Each

gas behaves as an ideal gas and specific heat at constant pressure for both gases has the same value.

From the given information, we can conclude that

A. the molecules in container X are moving as fast as those in container Y.

B. the molecules in container X are moving faster than those in container Y.

C. the molecules in container Y are moving faster than those in container X.

D. no possibility can be ruled out, that is, molecules in X could be moving faster than those in Y or the mole cules in Y could be moving faster than those in X.

Answer: D

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63. X and Y are two equal size containers. X contains a gas A at a temperature 75°C and Y contains a gas B at a temperature 40°C. Each

gas behaves as an ideal gas and specific heat at constant pressure for both gases has the same value.

It can be concluded that the

A. average translational kinetic energy of a molecule in container X is more than that of a molecule in container Y.

B. average translational kinetic energy of a molecule in container Y is more than that of a molecule in container X

C. average translational kinetic energy of a molecule in container X could be more or could also be less than that of a molecule in container Y.

D. average translational kinetic energy of a molecule in container X is equal to that of a molecule in container Y.

Answer: A

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64. X and Y are two equal size containers. X contains a gas A at a temperature 75°C and Y contains a gas B at a temperature 40°C. Each gas behaves as an ideal gas and specific heat at constant pressure for both gases has the same value.

It can be concluded that the

A. internal energy of a gas in container X is more than that of the gas in container Y.

B. internal energy of a gas in container X is less than that of the gas in container Y.

C. internal energy of a gas in container X could be more or could also be less than that of the gas in container Y.

D. internal energy of a gas in container X has the same value as that of the gas in container.

Answer: C

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65. Match the statements in Column I with those in Column II.Any given statement in Column I can have correct matching with one or more statements in Column II.

Column I	Column II
(a) Average translational kinetic energy per molecule	(p) $\sqrt{\frac{2RT}{M}}$
(b) Most probable speed	(q) $-\frac{P}{V}$
(c) Degrees of freedom	(r) $\frac{1}{\gamma-1}$
(d) Molar specific heat at constant volume divided by R	(s) $\frac{3}{2}kT$

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66. In the question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

Column I	Column II	Column III
(I) V_1 = 127 mL	(i) T_1 = 45°C	(J) T_2 = −73.05°C
(II) V_1 = 450 mL	(ii) T_1 = 27°C	(K) T_2 = −5°C
(III) V_1 = 300 mL	(iii) T_1 = 20°C	(L) T_2 = 476.04°C
(IV) V_1 = 1 L	(iv) T_1 = 40°C	(M) T_2 = −28.86°C

Which combination has 379.28 mL as value for V_2?

A. (II) (i) (K)

B. (III) (iv) (J)

C. (II) (ii) (M)

D. (II) (iii) (K)

Answer: A

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67. In the question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four

options is correct.

Column I	Column II	Column III
(I) V_1 = 127 mL	(i) T_1 = 45°C	(J) T_2 = −73.05°C
(II) V_1 = 450 mL	(ii) T_1 = 27°C	(K) T_2 = −5°C
(III) V_1 = 300 mL	(iii) T_1 = 20°C	(L) T_2 = 476.04°C
(IV) V_1 = 1 L	(iv) T_1 = 40°C	(M) T_2 = −28.86°C

Which combination has 317 mL as value for V_2 ?

A. (I) (iii) (K)

B. (IV) (iii) (J)

C. (II) (iii) (M)

D. (I) (ii) (L)

Answer: D

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68. In the question, there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

Column I	Column II	Column III
(I) V_1 = 127 mL	(i) T_1 = 45°C	(J) T_2 = 73.05°C
(II) V_1 = 450 mL	(ii) T_1 = 27°C	(K) T_2 = −5°C
(III) V_1 = 300 mL	(iii) T_1 = 20°C	(L) T_2 = 476.04°C
(IV) V_1 = 1 L	(iv) T_1 = 40°C	(M) T_2 = −28.86°C

Which has combination 250 mL as value for V_2 ?

A. (III) (i) (K)

B. (I) (i) (L)

C. (III) (iii) (M)

D. (I) (iv) (L)

Answer: C

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69. At what temperature is the rms velocity of a hydrogen molecule equal to that of an oxygen molecule at $47^{\circ} C$?

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70. Find the temperature at which oxygen molecules have the same rms speed as N_2 molecules at 7° C.

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71. Nitrogen is in equilibrium state at T=421K .The value of most probable speed,v_{mp} is

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72. What is the degree of freedom of gas? If at STP, the velocity of sound in it is 330 m/s, gas density = 1.3 mg/cm^3

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