Exemplar Solutions for Class 11 Physics Chapter 12 – Kinetic Theory

Multiple Choice Questions I

1. A cubic vessel (with faces horizontal + vertical) contains an ideal gas at NTP. The vessel is being carried by a rocket which is moving at a speed of 500 m/s in vertical direction. The pressure of the gas inside the vessel as observed by us on the ground

Options:

a) remains the same because 500 m/s 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

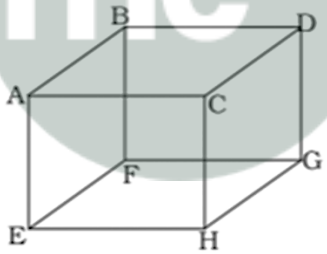
c) will increase by a factor equal to $(v^2\_rms + 500^2)/v^2\_rms$ where v_rms was the original mean square velocity of the gas

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

Answer: 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

Explanation: Pressure depends on the relative motion between gas molecules and container walls. When the entire system moves together, there's no change in relative velocities, hence no change in pressure.

2. 1 mole of an ideal gas is contained in a cubical volume V, ABCDEFGH at 300 K. 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,



Options:

a) the pressure on EFGH would be zero

b) the pressure on all the faces will be equal

c) the pressure on EFGH would be double the pressure on ABCD

d) the pressure on EFGH would be half that on ABCD

Answer: d) the pressure on EFGH would be half that on ABCD

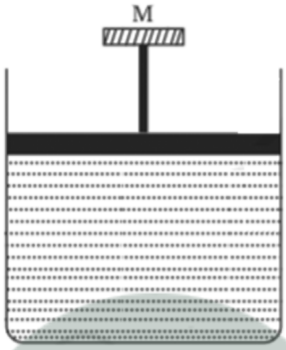
Explanation: When molecules hit EFGH, they are absorbed and don't bounce back. This means no momentum transfer back to the gas, resulting in half the pressure compared to elastic collisions on other faces.

3. Boyle's law is applicable for an

Options:

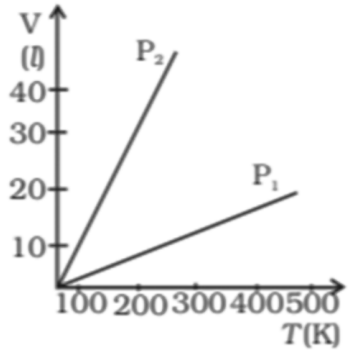
a) adiabatic process
b) isothermal process
c) isobaric process
d) isochoric process
Answer: b) isothermal process
Explanation: Boyle's law (PV = constant) applies when temperature remains constant, which defines an isothermal process.

4. 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. If the temperature is increased,



Options:
a) both p and V of the gas will change
b) only p will increase according to Charles's law
c) V will change but not p
d) p will change but not V
Answer: c) V will change but not p
Explanation: The pressure remains constant because it's determined by atmospheric pressure plus the weight of piston ($p = p_o + Mg/A$). As temperature increases, volume increases according to Charles's law at constant pressure.

5. Volume versus temperature graphs for a given mass of an ideal gas are shown in figure at two different values of constant pressure. What can be inferred about relation between P_1 and P_2?



Options:

a) $P_1 > P_2$

b) $P_1 = P_2$

c) $P_1 < P_2$

d) data is insufficient

Answer: a) $P_1 > P_2$

Explanation: From the V-T graph, the line with steeper slope corresponds to lower pressure. Since P_1 line has a steeper slope than P_2, we have $P_1 > P_2$.

6. 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

Options:

a) same as the pressure initially

b) 2 times the pressure initially

c) 10 times the pressure initially

d) 20 times the pressure initially

Answer: d) 20 times the pressure initially

Explanation:

- Initial: 1 mole H_2 at 300 K
- Final: 2 moles H atoms at 3000 K (dissociation doubles the number of moles)
- Using PV = nRT: P_final/P_initial = (n_final/n_initial) × (T_final/T_initial) = (2/1) × (3000/300) = 20

7. A vessel of volume V contains a mixture of 1 mole of hydrogen and 1 mole of oxygen. Let $f_1(v)dv$ denote the fraction of molecules with speed between v and (v + dv) for hydrogen, with $f_2(v)dv$ similarly for oxygen. Then

Options:

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

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

c) neither $f_1(v)$ nor $f_2(v)$ will obey the Maxwell's distribution law

d) $f_2(v)$ and $f_1(v)$ will be the same

Answer: b) $f_1(v)$, $f_2(v)$ will obey the Maxwell's distribution law separately

Explanation: Each gas component in a mixture follows Maxwell's distribution independently, but with different parameters based on their molecular masses.

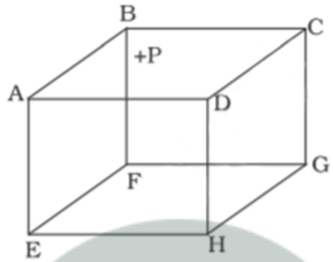
8. An inflated rubber balloon contains one mole of an ideal gas, has a pressure p, volume V, and temperature T. If the temperature rises to 1.1T and the volume is increased to 1.05V, the final pressure will be

Options:

a) 1.1p

b) p
c) less than p
d) between p and 1.1p
Answer: d) between p and 1.1p
Explanation: Using PV = nRT: P_final = P_initial × (T_final/T_initial) × (V_initial/V_final) = p × (1.1T/T) × (V/1.05V) = p × (1.1/1.05) = 1.048p

Multiple Choice Questions II
9. ABCDEFGH is a hollow cube made of an insulator. Face ABCD has positive charge on it. Inside the cube, we have ionized hydrogen. The usual kinetic theory expression for pressure



Options:
a) will be valid
b) will not be valid since the ions would experience forces other than due to collision with the walls
c) will not be valid since collisions with walls would not be elastic
d) will not be valid because isotropy is lost
Answer: b) will not be valid since the ions would experience forces other than due to collision with the walls **and** d) will not be valid because isotropy is lost
Explanation: Charged particles experience electrostatic forces from the charged wall, violating the assumption of no intermolecular forces. Also, the preferred direction due to the electric field destroys isotropy.

10. Diatomic molecules like hydrogen have energies due to both translational as well as rotational motion. From the equation in kinetic theory pV = (2/3)E, E is
Options:
a) the total energy per unit volume
b) only the translational part of energy because rotational energy is very small compared to the translational energy
c) only the translational part of the energy because during collisions with the wall pressure relates to change in linear momentum
d) the translational part of the energy because rotational energies of molecules can be either sign and its average over all the molecules is zero

Answer: c) only the translational part of the energy because during collisions with the wall pressure relates to change in linear momentum

Explanation: Pressure arises from momentum transfer during collisions with walls. Only translational motion contributes to linear momentum change; rotational motion doesn't affect pressure directly.

11. In diatomic molecules, the rotational energy at a given temperature

Options:

a) obeys Maxwell's distribution

b) have the same value for all molecules

c) equals the translational kinetic energy for each molecule

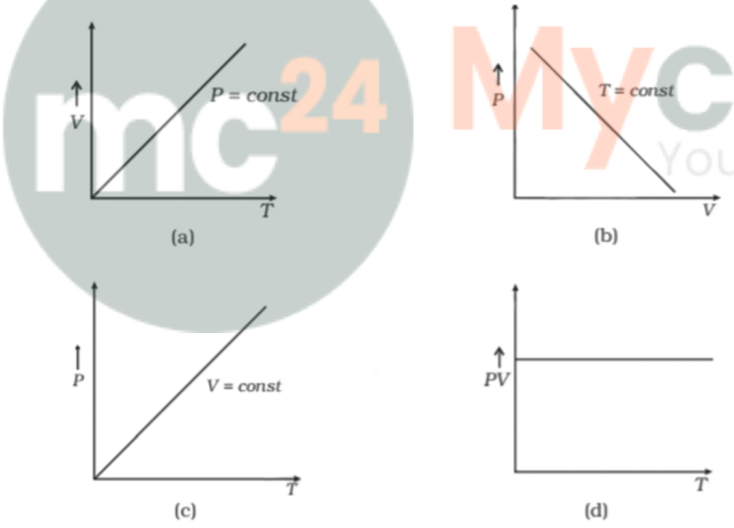
d) is (2/3) the translational kinetic energy for each molecule

Answer: a) obeys Maxwell's distribution **and** d) is (2/3) the translational kinetic energy for each molecule

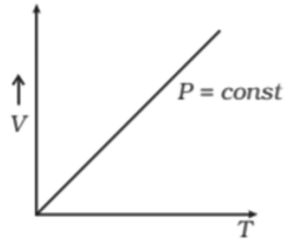
Explanation: Rotational energy follows Maxwell's distribution. By equipartition theorem: translational energy = (3/2)kT, rotational energy = kT, so rotational = (2/3) × translational.

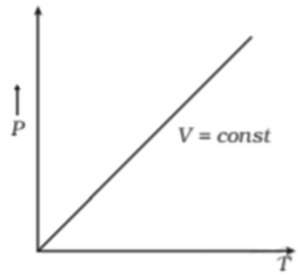
12. Which of the following diagrams depicts ideal gas behaviour?

Answer:



a) The V vs T graph at constant pressure (Charles's law)





Explanation: For an ideal gas at constant pressure, volume varies linearly with temperature ($V \propto T$), which is correctly shown in diagram (a).

13. When an ideal gas is compressed adiabatically, its temperature rises: the molecules on the average have more kinetic energy than before. The kinetic energy increases,
Options:
a) because of collisions with moving parts of the wall only

b) because of collisions with the entire wall
c) because the molecules get accelerated in their motion inside the volume
d) because of redistribution of energy amongst the molecules
Answer:
a) because of collisions with moving parts of the wall only
Explanation: In adiabatic compression, work is done on the gas by moving walls (piston). Molecules gain energy only when they collide with the moving piston, not with stationary walls.