

Real Gas Non-Ideal Behavior Analysis

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Response: To determine which statements **do not** give valid reasons for the observed non-ideal behavior ($P_{\text{real}} < P_{\text{ideal}}$), let's evaluate each statement step-by-step:

1. Observed Non-Ideal Behavior:

- $P_{\text{real}} < P_{\text{ideal}}$ occurs primarily because **intermolecular attractive forces** pull molecules back into the bulk of the gas just before they strike the container walls, reducing the impact force and momentum transfer per unit area against the walls.

2. Analysis of Statements:

- **(a)** *The volume of the real gas molecules cannot be neglected...*
 - Non-zero molecular volume (b) reduces the free volume available ($V - nb$), which tends to **increase** the pressure relative to an ideal gas. Therefore, significant molecular volume is **not** a valid reason why P_{real} is *lower* than P_{ideal} .
- **(b)** *Velocities of the real gas molecules are lower than that of an ideal gas.*
 - Temperature is a measure of the average kinetic energy ($\frac{1}{2}m\bar{v}^2$). At a given temperature, the average velocity distribution of gas molecules of a given molar mass is determined solely by temperature, not whether the gas is ideal or real. Therefore, this statement is false and **not** a valid reason.
- **(c)** *Because the molecules of the real gas are attracted to each other, they do not exert a force on the container walls which is equal to that exerted by an ideal gas.*
 - Intermolecular attractions pull colliding molecules backward toward neighboring bulk molecules. This decreases the force exerted per collision on the walls, correctly explaining why $P_{\text{real}} < P_{\text{ideal}}$. This **is** a valid reason.
- **(d)** *The molecules of the real gas are attracted towards the walls of the container.*
 - Kinetic-molecular theory assumes wall interactions are purely elastic collisions without attractive wall forces. If molecules were attracted to the walls, it would increase collision frequency/force rather than lower the measured pressure. Therefore, this statement is **not** a valid reason.

3. Conclusion:

- Statements **(a)**, **(b)**, and **(d)** **do not** give valid reasons for the observed behavior.

Correct Combination: (a), (b), and (d)

