Express $J/(K\text{mol})$ in terms of $m^3$.

1. $m^3/(K\text{mol})$
2. $\text{Pa}\ m^3/(K\text{mol})$
3. $L\ m^3/(K\text{mol})$
4. Something else

Units of pressure and of gas constant $R$

In CH101 Fall 2016 (lecture 12) we discussed units of pressure:

1. $\text{Pa} = \text{force/area} = 1\ \text{kg}\/\text{m}\/\text{s}^2/\text{m}^2 = 1\ \text{kg}\/\text{m}^{-1}\text{s}^{-2}$
2. $1\ \text{bar} = 100\ \text{kPa (exactly)}$
3. $1\ \text{atm} = 101.325\ \text{kPa (exactly)}$

Please see me: clicker "66F88E" and clicker "19"

- Units of pressure and of gas constant $R$
- Real gases: Effect of molecular attraction
- Real gases: Effect of molecular size

Next: Continue ch11: Real gases: van der Waals equation; phase diagrams
Pressure = Force/Area

\[ \text{Pa} = \frac{\text{J}}{\text{m}^3} \]

1 atm = 101325 Pa

\[ \text{m}^3 = 1000 \text{ L} \]

Convert \( R = 8.314 \text{ J} / (\text{K mol}) \) to \( \text{L atm} / (\text{K mol}) \).

**Effect of intermolecular attraction**

Gas particles attract one another: van der Waals

\[ P_{\text{observed}} = P_{\text{empty}} - a \left( \frac{n}{V} \right)^2 \]

# hitting wall \( \propto \frac{n}{V} \)

# pulling back \( \propto \frac{n}{V} \)

combined effect \( \propto \left( \frac{n}{V} \right)^2 \)

**TP** Predict the effect of intermolecular attraction on the pressure exerted by a gaseous molecule in a collision with the wall of its container. The stronger the attraction, the ...

20% 1. greater the pressure
20% 2. smaller the pressure
20% 3. The pressure will not be affected
20% 4. Cannot answer without knowing the temperature
20% 5. Cannot answer without knowing the polarity of the molecule

**TP** Equal amounts of gases A and C are in a single container. The molar masses of the gases are identical, but gas C has stronger intermolecular forces. The container is pierced with a hole 0.003 mm in diameter. After 5 minutes, the container will contain ...

33% 1. more A than C
33% 2. the same amount of A and C
33% 3. more C than A
**Quiz** Which of the following is the correct order of species for increasing value of van der Waals a?

20%  1. H₂ < Kr < CO₂ < H₂O

20%  2. H₂ < Kr < H₂O < CO₂

20%  3. Kr < H₂ < CO₂ < H₂O

20%  4. Kr < H₂ < H₂O < CO₂

20%  5. H₂ < H₂O < Kr < CO₂

**Contributions to van der Waals a**

Van der Waals a reflects intermolecular attractions present when gas particles encounter one another.

Therefore, hydrogen bonding can make a contribution.

**Effect of molecular size**

While gas particles are tiny compared to the volume of their container, they do take up some space.

The graphic illustrates the electron cloud of SF₆.

**TP** A gas in a rigid 2.5 L container has a pressure of 1.3 bar = 130 kPa. If 1.2 grams of small glass beads are added to the container (without changing the temperature), the pressure of the gas will ...
Effect of molecular size

Gas particles have a volume: van der Waals' b

\[ V_{\text{container}} = V_{\text{empty}} + b \cdot n \]

For SF\textsubscript{6}, \( b = 88 \text{ mL/mol} \). The percent of gas container volume taken up by the SF\textsubscript{6} molecules themselves is ...

- 17% 1. 0.01%
- 17% 2. 0.05%
- 17% 3. 0.1%
- 17% 4. 0.5%
- 17% 5. 1%
- 17% 6. 5%

\[ (0.088 / 22) \times 100\% = 0.40\% \]