WJEC England Physics A Level

1.7 Kinetic Theory

Flashcards

What is the ideal gas equation?

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$$pV = nRT$$

p: Pa

R: is the Molar Gas constant, 8.31 $Jmol^{-1}K^{-1}$

n: is the number of mols

T: K

V: m^3

What is an ideal gas?

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What is an ideal gas?

A gas for which:

- The gas molecules don't interact with each other.
- The molecules are thought to be perfectly spheres.

In an ideal gas, how would increasing the volume change the temperature of the gas, while the pressure remains constant?

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As you increase the volume, you also increase the temperature.

Explain how increasing the temperature of a balloon, while keeping the volume the same, will increase the pressure.

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- As the temperature increases, the average kinetic energy increases.
- Therefore the particles are travelling at a higher speed on average.
- There are also more frequent collisions.
- Which means the particles would exert a greater force.
- Which would cause a increased rate of change of momentum.
- Therefore increasing pressure.

What is Avogadro's constant? (in words)

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The number of atoms there are in one mole of a substance.

True or false? ‘All collisions between particles and between particles and the wall are elastic’ is an assumption of an ideal gas.

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True.

State an assumption of an ideal gas related to time.

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The time for each collision is negligible in comparison to the time take between collisions.

Describe 3 other assumptions of the ideal gas equation.

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- The particles move randomly.
- They follow Newton's laws of motion.
- No intermolecular forces between particles.
- Volume of container is negligible compared to the volume of the particles.

Use the kinetic theory of gases to explain why a temperature increase leads to an increase in pressure.

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A temperature increase means the particles have more kinetic energy.

More kinetic energy means a greater change in momentum during collisions with the container. There are also more frequent collisions.

Change in momentum is proportional to force applied, and therefore to pressure as well.

What is Brownian motion?

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Brownian motion is the idea that very small objects have random motion in a liquid or gas due to random bombardment by the molecules in this substance. This movement will be fractionally more on one side than the other so a force will push it for an instant as the net forces shifts directions. This random motion is Brownian Motion and gives evidence for the existence of atoms.

What equation links N, V, p, m and c?

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$$pV = \frac{1}{3}Nm\overline{c^2}$$

Where p = pressure, V = volume, N = number of particles, m = mass of a particle, ‘c’ = mean square speed.

What is meant by the root mean square speed?

What is meant by the root mean square speed?

The square root of the mean of the squares of the speeds of the molecules.

$$C_{rms} = \left(\frac{(c_1{}^2 + c_2{}^2 + \ldots c_n{}^2)}{N} \right)^{½}$$

What equation is used to determine the number of moles?

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The number of moles, n:

$$n = m / M$$

Where m is the mass of the substance, and M is the **molar mass** (in grams, which is the same as the nucleon number for the atom/molecule) of the particles that make up the substance.

Show that the mean kinetic energy of gas molecules is proportional to T.

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We can relate the two pressure equations, $pV = NkT$ and $pV = \frac{1}{3}Nmc^2$ to produce the equation:

$$kT = 1/3mc^2$$

The equation for kinetic energy is $1/2mv^2$, so by adjusting the equation, we can produce:

$$3/2kT = 1/2mc^2$$

This shows that $E_k = 3/2kT$, where E_k is the mean kinetic energy of the gas molecules and proportional to T.

Show that the total translational kinetic energy of a mole of a monatomic gas is $E_k = 3/2RT$.

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We can relate the two pressure equations, $pV = nRT$ and $pV = ⅓Nmc^2$ to produce the equation:

$$nRT = ⅓Nmc^2$$

The equation for kinetic energy is $E_k=1/2mv^2$, in this specific case only N = n as we are fixing the amount, so by adjusting the equation, we can produce:

$$nRT = ⅓N\,2E_k$$

$$3RT = 2E_k$$

This shows that $E_k=3/2RT$, where E_k is the mean kinetic energy of the gas molecules.