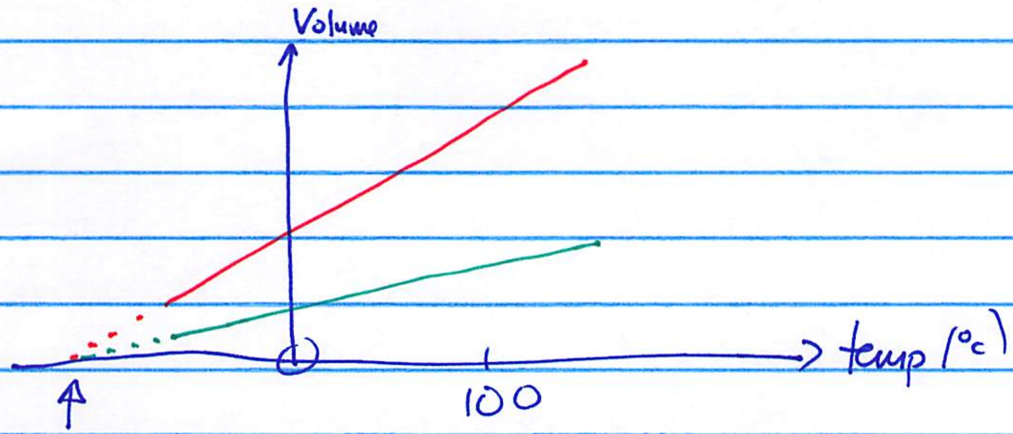
Charles's Law

$V \propto T$ (n, p const)

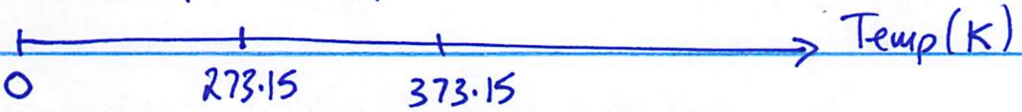


$-273.15°c$ (absolute zero)

- coldest possible temp!

Kelvin

10/19/2018



(absolute temp scale)

$$T(K) = t(°c) + 273.15$$

ex: $37°c \longrightarrow \underset{(0dp)}{37} + \underset{(2dp)}{273.15} = \underset{(0dp.)}{310.\cancel{15}} = 310.K$

When we use Charles's law, we really need to convert $t(°c) \rightarrow T(K)$

T is a measure of the $\overbrace{\text{Kinetic Energy}}^{\text{movement}}$ of gas particles.

as $T\uparrow$, movement $\uparrow$

- hit walls w/ greater force

$\Rightarrow$ pressure wants to $\uparrow$ $\Rightarrow$ Walls expand : $V\uparrow$

if. $V \propto T$

then $V = (\text{constant}) \times T$

so $\frac{V}{T} = \text{constant}$

or $\frac{V_1}{T_1} = \text{constant} = \frac{V_2}{T_2}$

OR: $\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}}$ Charles's law.

- const p, n

ex: A sample of gas w/ a vol. of 2.80L (V_1) @ unknown temp T_1 is submerged into ice-water w/ $t = 0.00°C$ (t_2). If the final vol was 2.57L (V_2), what was init temp? (K, °C)

assuming const p, n →

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$T_2 = t_2 + 273.15$
$= 273.15K$

$$\Rightarrow \frac{V_1 \cdot T_2}{V_2} = \frac{T_1 \cdot \cancel{V_2}}{\cancel{V_2}}$$

$$T_1 = \frac{V_1 \cdot T_2}{V_2}$$

$$= \frac{2.80L \times 273.15K}{2.57L}$$

$= 297.60K$

$= 298K$

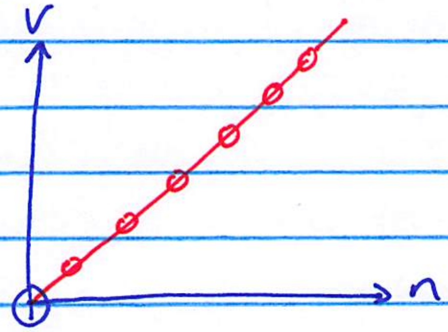
$t_2 \overset{?}{=} 298 - 273.15$
$= 25°C$

$t_2 = 297.60K - 273.15$
$= 24.45°C$
$= 24°C$

Avogadro's Law

So far, we've held 'n' constant
let's change it!

$V \propto n$
(p, T const)



$V \propto n$

$V = (\text{constant}) \times n \rightarrow \dfrac{V}{n} = (\text{constant})$

$$\boxed{\frac{V_1}{n_1} = \frac{V_2}{n_2}} \quad (\text{const } p, T)$$

ex: A balloon contains 0.18 mol (n_1) gas w/ vol = 4.3 L (V_1)
Q: how many mol (n_2?) will inflate it to 7.5 L (V_2)?

$$\frac{V_1}{n_1} = \frac{V_2}{n_2} \Rightarrow \frac{\cancel{V_1} n_2}{\cancel{V_1}} = \frac{n_1 V_2}{V_1}$$

$$\Rightarrow n_2 = \frac{n_1 V_2}{V_1} = \frac{0.18\,\text{mol} \times 7.5\,\cancel{L}}{4.3\,\cancel{L}} = 0.31\,\text{mol (2 s.f.)}$$

The ideal gas law

can combine the last 3 laws:

$$V \propto 1/p \quad \text{(Boyle)}$$
$$V \propto T \quad \text{(Charles)}$$
$$V \propto n \quad \text{(Avogadro)}$$

$$V \propto \frac{nT}{p}$$

$$V = (\text{const}) \times \frac{nT}{p}$$

$$V = R \cdot \frac{nT}{p}$$ R = ideal gas constant

$$\boxed{pV = nRT}$$ ideal gas eq.

$$R = 0.08206 \ \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}}$$

- can use this eq. in way more situations than A, B, C...!