# Homework 25

**1.** $\frac{p \cdot V}{T} = const$

$p = const \Rightarrow p_1 = p_2 = p$

$$\frac{p \cdot V_1}{T_1} = \frac{p \cdot V_2}{T_2} \Rightarrow \boxed{\frac{V}{T} = const}$$

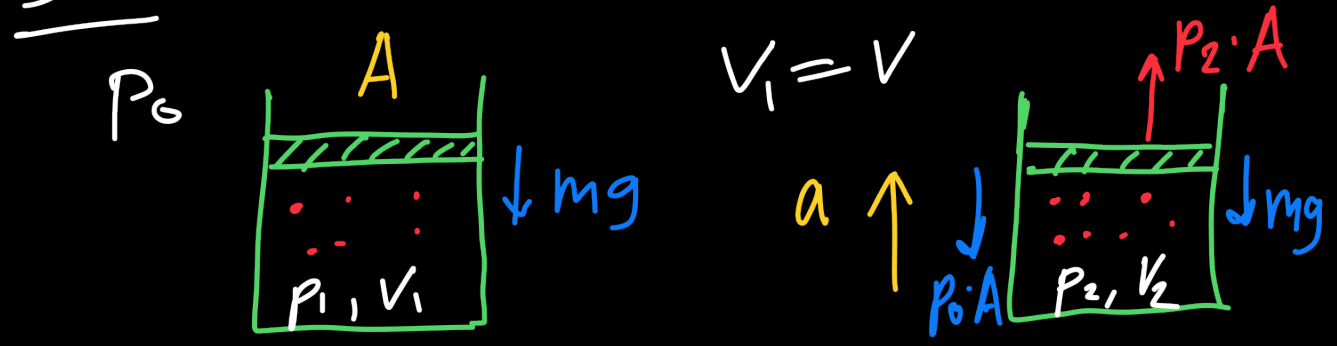
**2.** $T_2 = 2 \cdot T_1$ , $V_2 = \frac{V_1}{3}$

$p_2 = ?$

$$\frac{p_1 \cdot V_1}{T_1} = \frac{p_2 \cdot V_2}{T_2} = \frac{p_2 \cdot V_1/3}{2 \cdot T_1} = \frac{p_2 V_1}{6 T_1}$$

$$\Rightarrow \boxed{p_2 = 6 \cdot p_1}$$

3.




$$p_1 \cdot A = mg + p_0 \cdot A$$

$$p_2 \cdot A - mg - p_0 A = m \cdot a$$

$$p_2 \cdot A = m \cdot a + m \cdot g + p_0 \cdot A$$

$T = const \Rightarrow \quad p_1 \cdot V_1 = p_2 \cdot V_2$

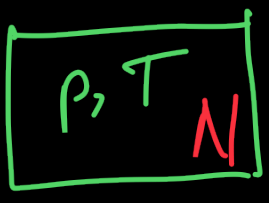
$$V_2 = \frac{p_1}{p_2} \cdot V = \frac{p_0 \cdot A + m \cdot g}{p_0 \cdot A + m(g+a)}$$

# Classwork  Ideal gas law

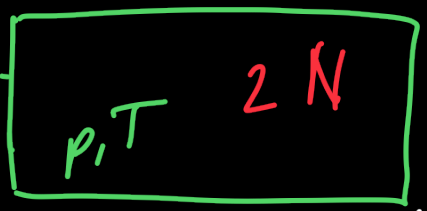
**Recall:** Combined gas law

$$\frac{p \cdot V}{T} = \text{const}$$

What is the constant?
it is related to mass!
In particular, to number of molecules $N$.




$V_1$




$V_2 = 2V_1$

$$\frac{p \cdot V_1}{T} = C_1 \qquad \frac{p \cdot V_2}{T} = C_2$$

$$\frac{p \cdot V_2}{T} = 2 \frac{p \cdot V_1}{T} = 2 \cdot C_1$$

$$\boxed{C_2 = 2 \cdot C_1}$$

$$N_2 = 2 \cdot N_1$$

Conclusion: const $\sim N$

$N$ is the number of molecules of gas.

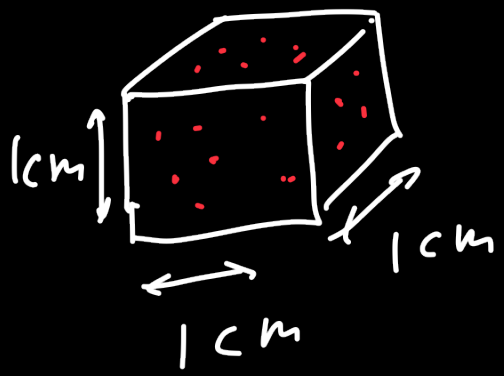
How do we know $N$?

Consider air at normal conditions:

$p = 10^5$ Pa

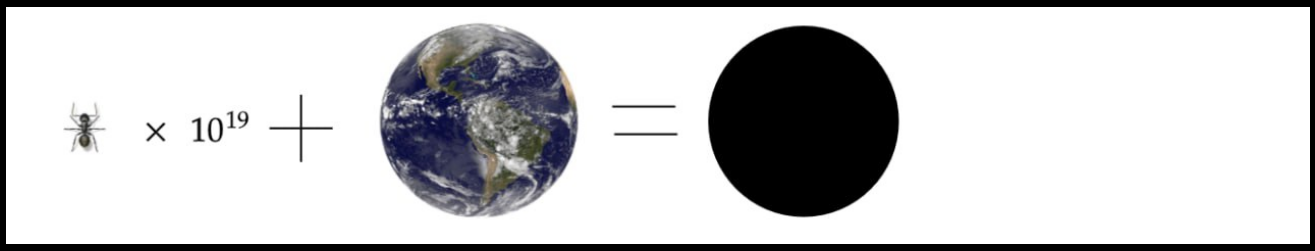
$T = 273$ K

$1\ cm^3 = V$




$N = 2.6 \cdot 10^{19}$ molecules

Let's relate this number to something more relatable




Such numbers are not easy to work with.

$$N_A = 6.02 \cdot 10^{23}$$

Avogadro number

Amount of substance is measured in moles

$$n = \frac{N}{N_A}$$

If we have $6.02 \cdot 10^{23}$ molecules of the substance, we say that we have 1 mole of this substance

$6.02 \cdot 10^{23}$ molecules of air $\rightarrow$ 1 mole

$N_A$ molecules of $N_2$ $\rightarrow$ 1 mole

$2 \cdot N_A$ molecules of $He$ $\rightarrow$ 2 moles

Amount of substance is measured in moles:

$$n = \frac{N}{N_A} \text{ moles}$$

# Ideal gas law
(equation of state of ideal gas)

$$\frac{pV}{T} = n \cdot R$$

$R$ – universal gas constant

$$R = 8.31 \ \frac{J}{moles \cdot K}$$

$$p \cdot V = n \cdot R T$$

Ideal gas law

**Ex.** How many moles of air are there in $1\ m^3$? (at normal conditions)

in $1\ cm^3$ — $2.6 \cdot 10^{19}$ molecules

$1\ m^3$ — $N$ air molecules

$n = ?$

$$N = \frac{1\ m^3}{1\ cm^3} \cdot 2.6 \cdot 10^{19}$$

$$10^6 \cdot 2.6 \cdot 10^{19}$$

$$N = 2.6 \cdot 10^{25}$$

$$n = \frac{N}{N_A} = \frac{2.6 \cdot 10^{25}}{6.02 \cdot 10^{23}} = 43 \text{ moles.}$$

Check this using Ideal gas law.