Homework 26

$$J = N \cdot m = Pa \cdot m^3$$

$$R = 8.31 \ \frac{Pa \cdot m^3}{mole \cdot K}$$

1. $n = 1 \text{ mole}$

$$\boxed{pV = nRT} \Rightarrow V = \frac{nRT}{p}$$

$$V = 22.4 \cdot 10^{-3} m^3 = 22.4 L \simeq 6 \text{ gal}$$

$$1 \text{ liter} = 10^{-3} m^3 = 10^3 cm^3$$

2. $$\boxed{n = \frac{p \cdot V}{R \cdot T} = 44.7 \text{ moles}}$$

$T = 273 K$ $\quad V = 1 m^3$

$p = 101.3 \ kPa$

3.

$$V_1 = 0.5 \frac{m^3}{\underset{5}{\cancel{60}}\,sec.} \cdot \cancel{12}\,sec. = 0.1\, m^3$$

$$n = 4.47 \text{ moles}$$

$$P_2 V_2 = n \cdot R T_2$$

$$T_2 = 295\,K \quad , \quad V_2 = 0.105\, m^3$$

$$P_2 = \frac{n \cdot R T_2}{V_2}$$

$$\boxed{P_2 \simeq 104.4\, kPa}$$

or:

$$\boxed{\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}}$$

Classwork

Molar mass

Work done by gas

Molar mass

How do we measure n?

$$n = \frac{N}{N_A}, \quad N_A = 6.02 \cdot 10^{23} \frac{1}{mole}$$

$$\Rightarrow \boxed{[n] = mole}$$

through the ideal gas law.

What if it is a liquid?

Count N – the number of molecules

We have a homogeneous substance $\Rightarrow$ all molecules are the same!

$\Rightarrow$ $m_{molecule}$

What is the mass of substance per mole if we know $m_{molecule}$?

$$\boxed{M = N_A \cdot m_{molecule}}$$ molar mass.

$$[M] = \frac{g}{mol}$$

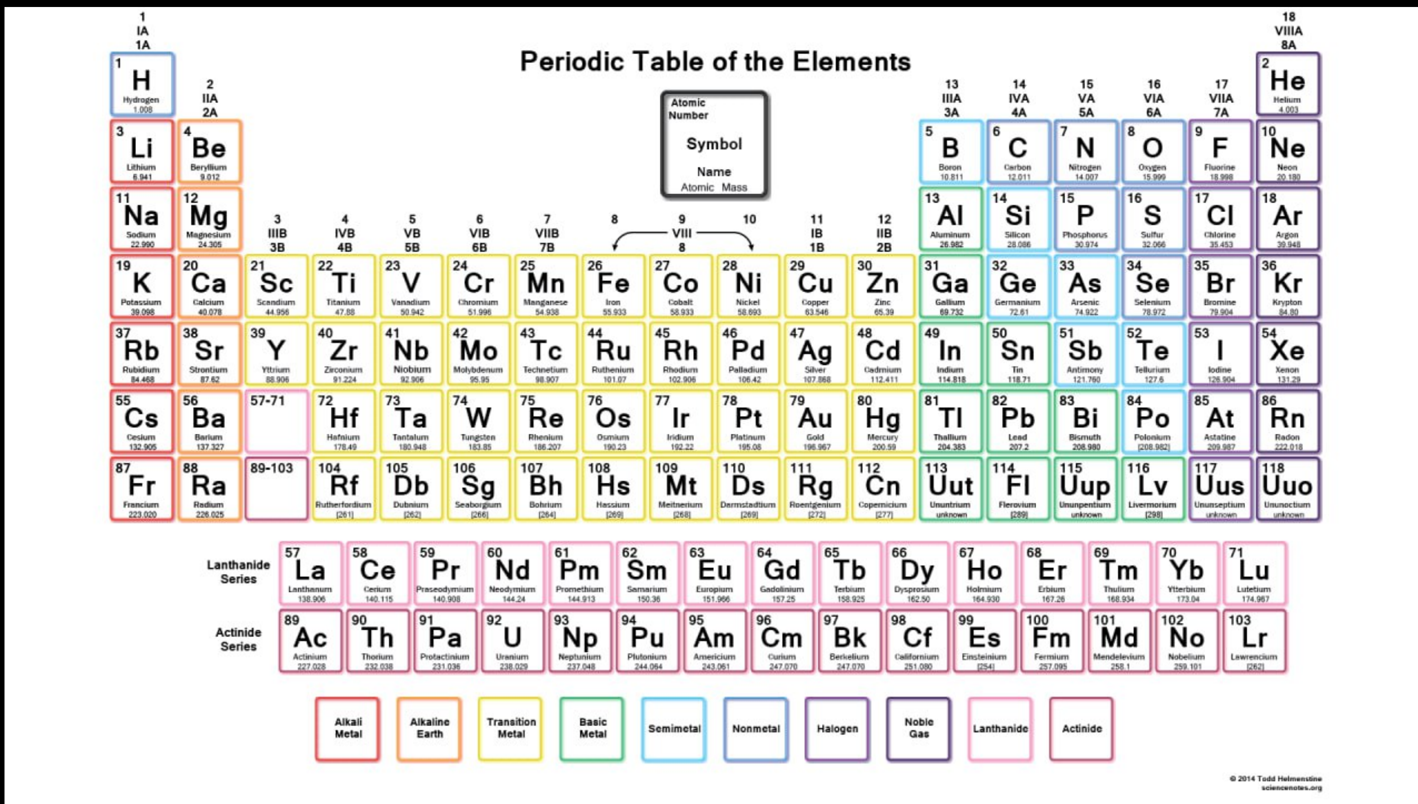
$$\Rightarrow \boxed{n = \frac{m_{subst.}}{M_{subst.}}}$$

Let's show that these definitions agree:

$$n = \frac{m_{subst.}}{M_{subst.}} = \frac{N \cdot \cancel{m_{molecule}}}{N_A \cdot \cancel{m_{molecule}}}$$

$$\Rightarrow \boxed{n = \frac{N}{N_A}}$$ Agreement

But how do we know M?



$$M(H) = 1\,\frac{g}{mole}$$

$$m_H = 1g \Rightarrow \quad n = \frac{m_H}{M(H)} = \frac{1g}{1\,\frac{g}{mole}}$$

$$n = 1\ mole$$

$$M(C) = 12\,\frac{g}{mole}$$

$$M(N_2) = M(N) + M(N) =$$

$$= 2 \cdot M(N)$$

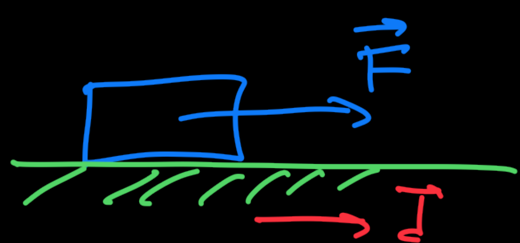
$$M(N_2) = 2 \cdot 14 \frac{g}{mole} = 28 \frac{g}{mole}$$

$$M(CO_2) = M(C) + 2 \cdot M(O)$$

$$M(CO_2) = 12 + 2 \cdot 16 \frac{g}{mole}$$

$$= 44 \frac{g}{mole}$$

Work done by gas

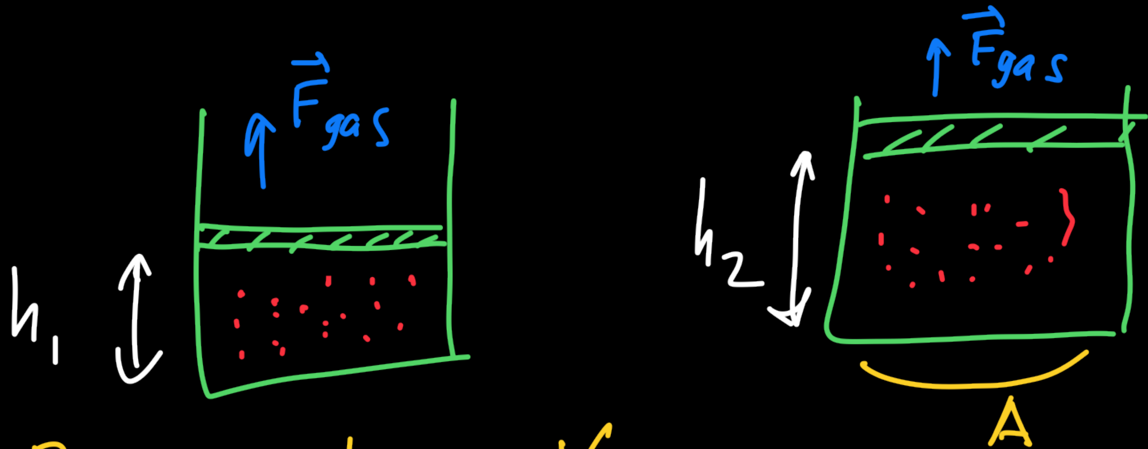


$$\vec{d} \uparrow\uparrow \vec{F}$$

$$W = F \cdot d$$

$$\vec{d} \uparrow\downarrow \vec{F}$$

$$W = -F \cdot d$$



$p = const$ $\qquad$ $\frac{V}{T} = const$

$$F_{gas} = p \cdot A$$

$$W_{gas} = F_{gas} \cdot (h_2 - h_1) =$$

$$= p \cdot A\,(h_2 - h_1) =$$

$$= p\,(A \cdot h_2 - A \cdot h_1) = p\,(V_2 - V_1)$$

$$\boxed{W_{gas} = p \cdot \Delta V}$$ when $p = const.$

$\Delta V > 0 \Rightarrow W_{gas} > 0$

$\Delta V < 0 \Rightarrow W_{gas} < 0$