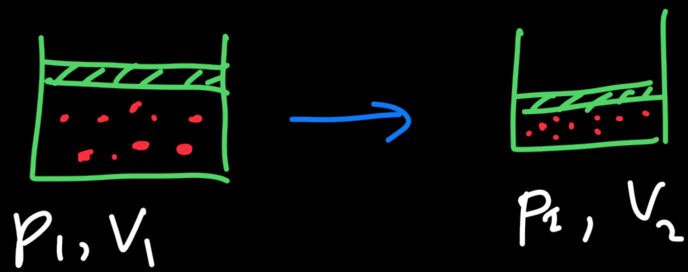
Homework 23

N1.

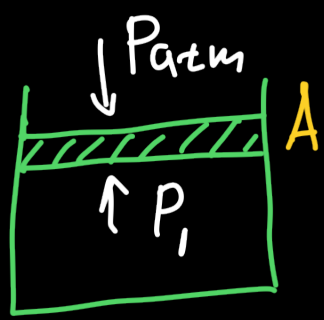
$P_1 = 1000 \ Pa$, $V_2 = \frac{V_1}{2}$

$T_1 = T_2$



$$P_1 \cdot V_1 = P_2 \cdot V_2 \Rightarrow P_2 = 2 \cdot P_1 = 2 \, kPa$$

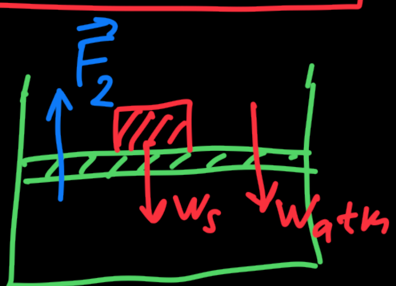
N2



$P_1 = 10^5 \ Pa$

$W_{atm} = P_{atm} \cdot A \downarrow$, $F_1 = P_1 \cdot A \uparrow$

$$\boxed{W_{atm} = F_1} \Rightarrow \boxed{P_{atm} = P_1}$$



$F_2 = P_2 \cdot A$

$W_{atm} = P_{atm} \cdot A$

$W_s = m \cdot g$

№2 $W_s = 100\,N \rightarrow P_s = \frac{W_s}{A}$

$W_s + W_{atm} = F_2$

$W_s + P_{atm} \cdot A = P_2 \cdot A$

$\Downarrow \quad \frac{W_s}{A} + P_{atm} = P_2$

$$\boxed{P_s + P_{atm} = P_2}$$

$P_s = 10^5\,Pa$

$P_2 = 2 \times 10^5\,Pa$

$T = const$

$\Rightarrow \quad p_1 V_1 = p_2 V_2$

$V_2 = \frac{1}{2} V_1 = 500\,cm^3$

Classwork: Gay-Lussac's law

Recap: Boyle's law

$T = const \Rightarrow p \cdot V = const$

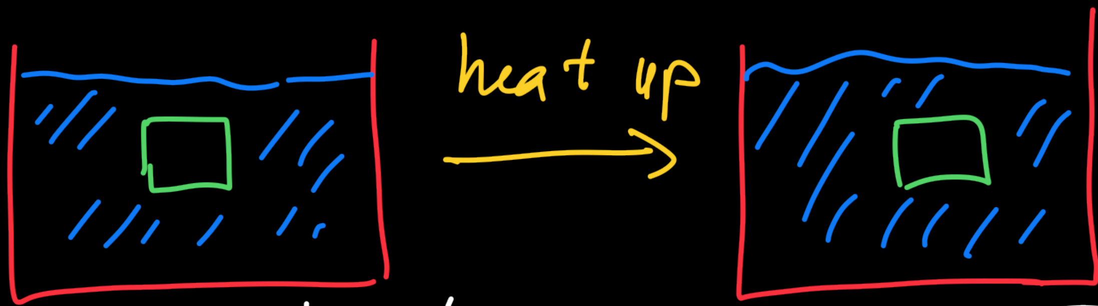
What if we keep

$V = const$?

p, T are changing

← fixed V

Changing the temperature:



water bath at T_1 — temp. is T_2

Gay-Lussac's law:

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

for $V = \text{const.}$

$T \uparrow$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$p \uparrow \times 3$

$\times T_2/p_1$

$T\uparrow$: $\frac{T_2}{T_1} > 1$

$$\frac{T_2}{T_1} = \frac{p_2}{p_1} > 1$$

What scale should we use for the temperature in this law?

$$\frac{p_2}{p_1} = \frac{T_2}{T_1}$$

if $T \downarrow$, then $p \downarrow$

Celsius, Farenheit, Kelvin

Celsius ↘ $t = 0$ water freezes.

Kelvin ↘ $T = 0$ absolute zero

$t < 0$ doesn't make much sense.

If $T_K \to 0 \Rightarrow$ molecules are not moving. so $P \to 0$

Disclaimer: these laws do not work at an absolute zero temperature. (no gases at $T_K = 0$)

In Gay-Lussac's law, the temp is in Kelvins.

We can still rewrite it in Celsius, because

$$T_K = t + 273$$

So:

$$\boxed{\frac{P_2}{P_1} = \frac{t_2 + 273}{t_1 + 273}}$$

t_1, t_2 are in Celsius.

Experimental:

temp. sensor

We will add hot water and monitor changes in T, P

	t, °C	P, kPa
1	25	101.55
2	57.4	113.9
	56	113.5
	54.6	112.8

take these (rows 1 and 2)

$T_1 = 298\ K$, $P_1 = 101.55\ kPa$

$T_2 = 330.4K$, $P_2 = 113\ kPa$

$$\frac{P_2}{P_1} \simeq 1.11 \qquad \frac{T_2}{T_1} \simeq 1.11$$

Indeed, we see that

$$\frac{P_2}{P_1} = \frac{T_2}{T_1} \text{ or } \boxed{\frac{P_1}{T_1} = \frac{P_2}{T_2}}$$