1. 1 gram of CH_4 is added to a 1L flask and pressurized to 4 atm. What temperature is the flask at?

2. A child is handed a **2 L** birthday balloon containing helium inside his house where the room temperature is **25 °C** – this, of course, makes little Bobby really happy! When Bobby walks outside to the frigid Minnesota winter day, the balloon **loses 25% of its volume** – Bobby cries. Stupid gas laws made a kid cry on his birthday. What is the temperature outside? Assume that the pressure is the same inside and outside. Report your answer in °C.

3. 100 grams of a **noble gas** is added to a 10 L flask at 300 K. The pressure of this flask is 2.94 atm. What is this gas? Hint: the only way to identify a gas is by determining the molar mass.

4. 4 liters of N_2O_4 (g) decomposes to nitrogen and oxygen gas. If this decomposition occurs at **STP** (so constant temperature and pressure!), determine the **total volume** of gas that is produced.

5. 5 grams of solid phosphorus trichloride is added to a 4 L reaction flask that contains chlorine gas at STP. Solid pohosphorus pentachloride is produced. During this reaction, the temperature increases to 300 K. Assuming that the volume does not change, what is the pressure in the flask after the reaction?

6. 1 gram of C_5H_{12} is combusted in a 2.5 L reaction flask at 400 K.
    a. How many moles of O_2 is needed to react with C_5H_{12}?
    b. Under the conditions listed above, what pressure of O_2 is needed to react with all of the C_5H_{12}?
    c. Assuming that all of the reactants are consumed:
        i. What is the partial pressure of O_2 in the flask after the reaction?
        ii. What is the partial pressure of CO_2 in the flask after the reaction?
        iii. What is the partial pressure of H_2O in the flask after the reaction?
        iv. What is the total pressure in the flask?

7. 14g of dry ice (CO_2 (s)) is put into a 4.2 L chamber that has some amount of N_2 in it. This chamber is held at a constant temperature of 212 K as all of the CO_2 sublimates (s→g). After this process has finished, it is determined that CO_2 accounts for 87% of the total pressure.
    a. What is the pressure of CO_2?
    b. What is the pressure in the chamber after the sublimation finishes?
    c. How many moles of N_2 is present in the chamber?
    d. What was the total pressure in the chamber prior to the sublimation?

8. 1.8 grams of glucose ($C_6H_{12}O_6$) is combusted in a 2.6 L reaction chamber at pressurized to 3 atm. with oxygen at 400 K. Determine the total pressure in the flask after the reaction is complete.

① Need temperature of a gas ... so use the ideal gas law: $PV = nRT$

$T = \frac{PV}{nR}$

$P = 4\,atm$
$V = 1\,L$
$R = 0.08206\ \frac{L \cdot atm}{mol \cdot K}$

$n = ?$ $\quad \frac{1\,g\,CH_4 \mid mol}{\mid 16.05\,g} = 0.0623\ mol$

$$T = \frac{(4\,atm)(1\,L)}{(0.0623\,mol)(0.08206\ \frac{L\,atm}{mol \cdot K})} = 782.35\ K$$

② Lots of junk words here. What's important: $V_1 = 2L$ $\quad T_1 = 25°C = 298.15\,K$

Loses 25% of Volume → 25% of 2 = 0.5 L
$V_2 = 2L - 0.5L = 1.5\,L$

$PV = nRT$
↑ ↑↑
constants

$\frac{V}{T} = \frac{nR}{P} = constant$ $\qquad \frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$T_2 = \frac{V_2 T_1}{V_1} = \frac{1.5L(298.15\,K)}{2L} = 223.6\,K$$

$T_2 = 223.6\,K - 273.15 = -49.5\,°C$

COLD

③ Molar Mass = $\frac{g}{mol}$ ← this we know! (100g)

mol ← calculate from $n = \frac{PV}{RT} = \frac{(2.94\,atm)(10\,L)}{0.08206\ \frac{L\,atm}{mol\,K} \cdot 300\,K} = 1.194\,mol$

$\frac{100g}{1.19\,mol} = 83.7\ g/mol$ ← Krypton!

④ Constant P + T, so we can treat V like moles for stoichiometry steps!

$$N_2O_4(g) \longrightarrow N_2(g) + 2\,O_2(g)$$

$\frac{4\,L\,N_2O_4 \mid 1L\,N_2}{\mid 1L\,N_2O_4} = 4L\,N_2$ $\qquad \frac{4L\,N_2O_4 \mid 2L\,O_2}{\mid 1L\,N_2O_4} = 8L\,O_2$ $\qquad V_{TOT} = 8L + 4L$

$V_{TOT} = 12L$

(5) $PCl_3(s) + Cl_2(g) \rightarrow PCl_5(s)$

5g   4L STP

Need Pressure <u>AFTER</u> the reaction. <u>ONLY</u> gas contributes to pressure, so:

1. figure out how many moles of gas are produced or remain
2. convert to pressure

$$\frac{5g}{} \Big| \frac{mol}{137.32\,g} \Big| \frac{1\,mol\,PCl_5}{1\,mol\,PCl_3} = 0.0364\ mol\ PCl_5\ made$$

$$n_{Cl_2} = \frac{PV}{RT} = \frac{1\,atm \cdot 4L}{0.08206\,\frac{L\,atm}{mol\,K} \cdot 273.15K} = 0.178\,mol\,Cl_2 \Big| \frac{1\,mol\,PCl_5}{1\,mol\,Cl_2} = 0.178\,mol\ PCl_5$$

PCl_3 = L.R. so there <u>will</u> be some $Cl_2(g)$ left

$$0.0364\ mol\ PCl_5\ made \Big| \frac{1\,mol\ Cl_2}{1\,mol\ PCl_5} = 0.0364\ mol\ Cl_2\ consumed$$

$$0.178\ mol\ Cl_2 - 0.0364\ mol\ Cl_2 = 0.1421\ mol\ Cl_2\ remaining$$

P = ?

V = 4L

T = 300 K

$$P = \frac{nRT}{V} = \frac{0.1421\,mol\,(0.08206\,\frac{L \cdot atm}{mol\,K})(300K)}{4\ L}$$

P = 0.874 atm

(6) $C_5H_{12\,(l)} + 8\,O_{2\,(g)} \rightarrow 5CO_{2\,(g)} + 6H_2O_{(g)}$

1 gram

a) $$1g\ C_5H_{12} \Big| \frac{mol}{72.17g} = 0.01386\,mol\,C_5H_{12} \Big| \frac{8\ mol\ O_2}{1\,mol\,C_5H_{12}} = 0.1108\ mol\ O_2\ needed$$

b) $$P = \frac{nRT}{V} = \frac{0.1108\ mol\ O_2}{2.5L}\left(0.08206\,\frac{L\,atm}{mol \cdot K}\right)(400\,K) = 1.455\ atm$$

c. i) all O_2 is consumed, so **∅ atm**

ii) to get P_{CO_2}, we need moles CO_2

$$\frac{0.01386 \text{ mol } C_5H_{12}}{} \left| \frac{5 \text{ mol } CO_2}{1 \text{ mol } C_5H_{12}} \right. = 0.0693 \text{ mol } CO_2$$

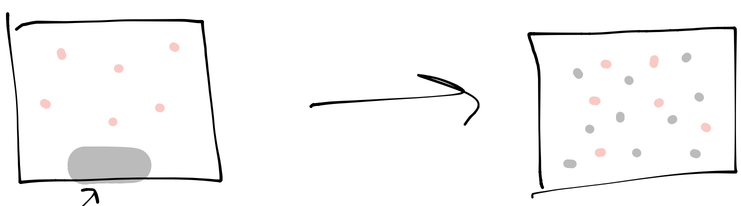
$$P = \frac{0.0693 \text{ mol}}{2.5 L}\left(0.08206 \frac{L\,atm}{mol\,K}\right)(400 K) = \mathbf{0.91 \text{ atm } CO_2}$$

iii) $$\frac{0.01386 \text{ mol } C_5H_{12}}{} \left| \frac{6 \text{ mol } H_2O}{1 \text{ mol } C_5H_{12}} \right. = 0.08316 \text{ mol } H_2O$$

$$P = \frac{0.08316 \text{ mol}}{2.5 L}(0.08206)(400 K) = \mathbf{1.09 \text{ atm}}$$

iv) $P_{TOT} = P_{CO_2} + P_{H_2O} + P_{O_2} = 0.91 \text{ atm} + 1.09 \text{ atm} + 0 \text{ atm} = \mathbf{2.00 \text{ atm}}$

⑦



$$\frac{14 \text{ g } CO_2}{} \left| \frac{\text{mol}}{44.01 \text{ g}} \right. = 0.318 \text{ mol } CO_2$$

a) $$P = \frac{0.318 \text{ mol}}{4.2 L}\left(0.08206 \frac{L\,atm}{mol\,K}\right)(212 K) = \mathbf{1.318 \text{ atm}}$$

b) $P_{CO_2} = 87\%$ of total $\qquad 0.87\, P_{TOT} = 1.318 \text{ atm}$

$\mathbf{P_{TOT} = 1.514 \text{ atm}}$

c) P_{TOT} can be converted to n_{TOT} using ideal gas law.

$$n_{TOT} = \frac{(1.514 \text{ atm})(4.2 L)}{(0.08206)(212 K)} = 0.366 \text{ mol}$$

$n_{TOT} = n_{CO_2} + n_{N_2} \qquad 0.366 - 0.318 = \mathbf{0.0476 \text{ mol } N_2}$

d) Only N_2 is a gas, so $$P = \frac{0.0476\,(0.08206)(212)}{4.2} = \mathbf{0.197 \text{ atm}}$$

(8) $C_6H_{12}O_6 + 6O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(g)}$

Need moles of all gases (O_2, CO_2, H_2O)

$$\frac{1.8\text{ g}}{} \Big| \frac{\text{mol}}{180.18\text{ g}} \Big| \frac{6\text{ mol } CO_2}{1\text{ mol } C_6H_{12}O_6} = 0.0599\text{ mol } CO_2$$

$$O_2: \; n = \frac{(3\text{ atm})(2.6\text{ L})}{(0.08206)(400\text{ K})} = 0.2376\text{ mol } O_2 \Big| \frac{6\text{ mol } CO_2}{6\text{ mol } O_2} = 0.2376\text{ mol } CO_2$$

glucose is L.R. 0.0599 mol CO_2 produced

$$0.0599\text{ mol } CO_2 \Big| \frac{6\text{ mol } H_2O}{6\text{ mol } CO_2} = 0.0599\text{ mol } H_2O\text{ produced}$$

$$O_2: \; 0.0599\text{ mol } H_2O\text{ produced} \Big| \frac{6\text{ mol } O_2}{6\text{ mol } H_2O} = 0.0599\text{ mol } O_2\text{ consumed}$$

$$\underset{(\text{start})}{0.2376\text{ mol}} - \underset{(\text{used})}{0.0599\text{ mol}} = 0.178\text{ mol } O_2\text{ left}$$

$$n_{TOT} = 0.178 + 0.0599 + 0.0599 = 0.2975\text{ mol gas}$$

$$P_{TOT} = \frac{0.2975(0.08206)(400)}{2.6} = 3.76\text{ atm}$$