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

2. Inside a house where the room temperature is **25 °C**, a child is handed a **2 L** birthday balloon containing helium – this, of course, makes little Bobby really happy! When Bobby walks outside to the frigid Siberian winter day, the balloon **loses 10% 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 phosphorus pentachloride is produced.
    a. Calculate the mass of product that is formed.
    b. Assuming that the volume and temperature do 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 are 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. 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) $P = 4$ atm
$V = 1$ L
$T = ?$
$n = ?$

n can be determined from mass:

$$\frac{1\text{ g } CH_4 \mid \text{mol}}{\mid 16.05\text{ g}} = 0.0623 \text{ mol}$$

$PV = nRT$

$$T = \frac{PV}{nR} = \frac{(4\text{ atm})(1\text{L})}{(0.0623\text{ mol})(0.08206\ \frac{\text{L atm}}{\text{mol}\cdot\text{K}})} = 782.4\text{ K}$$

(2) Gas Law: P + n are constant (and R, of course)

$PV = nRT$ $\quad \frac{V}{T} = \frac{nR}{P} = \text{constant}$ $\quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$

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

$V_1 = 2L$
$T_1 = 25°C + 273.15 = 298.15$ K

$V_2 \rightarrow$ 10% of V_1 lost $\rightarrow$ $0.1(2L) = 0.2L$ lost
$V_2 = 2L - 0.2L = 1.8L$

$$T_2 = \frac{V_2 T_1}{V_1} = \frac{(1.8L)(298.15K)}{2L} = 268.3\text{ K}$$

$°C = 268.3 - 273.15 = -4.82\ °C$

(3) $MW = \frac{g}{mol} = \frac{100\text{ g}}{n}$ ← find from $PV = nRT$

$$n = \frac{PV}{RT} = \frac{(10\text{ L})(2.94\text{ atm})}{(0.08206\ \frac{\text{L atm}}{\text{mol}\cdot\text{K}})(300\text{K})} = 1.19\text{ mol}$$

$$MW = \frac{100\text{ g}}{1.19\text{ mol}} = 83.7\text{ g/mol}$$ ⟹ Krypton

④ $N_2O_4(g) \rightarrow N_2(g) + 2O_2(g)$

need V_{tot}

$V_{tot} = V_{N_2} + V_{O_2}$

$V = 4L$
$P = 1atm$
$T = 273.15K$

constant: P & T

$PV = nRT$

$\frac{V}{n} =$ constant $\frac{V_1}{n_1} = \frac{V_2}{n_2}$

$n_1 \uparrow N_2O_4$, $n_2 \uparrow N_2 + O_2$

$n = \frac{PV}{RT} = \frac{(4L)(1atm)}{(0.08206)(273.15K)} = 0.178$ mol N_2O_4

$0.178 \text{ mol } N_2O_4 \times \frac{1 \text{ mol } N_2}{1 \text{ mol } N_2O_4} = 0.178 \text{ mol } N_2$

$n_2 = 0.178 + 0.356 = 0.534$ mol

$0.178 \text{ mol } N_2O_4 \times \frac{2 \text{ mol } O_2}{1 \text{ mol } N_2O_4} = 0.356 \text{ mol } O_2$

$V_2 = \frac{V_1 n_2}{n_1} = \frac{4L(0.534 mol)}{0.178 mol} = 12 L$

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

PCl_3: 5g; Cl_2: 4L @ STP $\rightarrow n = \frac{4L(1atm)}{(0.08206)(273.15K)} = 0.178$ mol Cl_2

$5g\ PCl_3 \times \frac{mol}{137.32g} \times \frac{1 \text{ mol } PCl_5}{1 \text{ mol } PCl_3} \times \frac{208.02g}{mol} = 7.574$ g PCl_5

$0.178 \text{ mol } Cl_2 \times \frac{1 \text{ mol } PCl_5}{1 \text{ mol } Cl_2} \times \frac{208.02g}{mol} = 37.12$ g PCl_5

b) Pressure after: need moles of Cl_2 left the reaction

Start: 0.178 mol Cl_2 (from above)

Used: $7.574 \text{ g } PCl_5 \text{ made} \times \frac{mol}{208.02g} \times \frac{1 \text{ mol } Cl_2}{1 \text{ mol } PCl_5} = 0.0364$ mol

left: $0.178 - 0.0364 = 0.142$ mol

$P = \frac{nRT}{V} = \frac{0.142(0.08206)(273.15K)}{4L} = 0.79atm$

6. $C_5H_{12}(g) + 8\,O_2(g) \longrightarrow 5\,CO_2(g) + 6\,H_2O(g)$

a) $\dfrac{1\,g\;C_5H_{12}}{} \left| \dfrac{mol}{72.17\,g} \right| \dfrac{8\,mol\;O_2}{1\,mol\;C_5H_{12}} = 0.1108\,mol\;O_2$ needed

b) $P = \dfrac{nRT}{V} = \dfrac{0.1108\,mol\,(0.08206)(400\,K)}{2.5\,L} = 1.455\,atm$

c) i) All O_2 is consumed, so $n = \varnothing$ + $P = \varnothing$

ii) CO_2: need moles to calculate pressure

$\dfrac{0.1108\,mol\;O_2}{} \left| \dfrac{5\,mol\;CO_2}{8\,mol\;O_2} \right. = 0.06925\,mol\;CO_2$

$P = \dfrac{nRT}{V} = \dfrac{(0.06925)(0.08206)(400\,K)}{2.5\,L} = 0.909\,atm$

iii) H_2O: $\dfrac{0.1108\,mol\;O_2}{} \left| \dfrac{6\,mol\;H_2O}{8\,mol\;O_2} \right. = 0.0831\,mol\;H_2O$

$P = \dfrac{nRT}{V} = \dfrac{(0.0831\,mol)(0.08206)(400\,K)}{2.5\,L} = 1.091\,atm$

iv) $P_{Tot} = P_{O_2} + P_{CO_2} + P_{H_2O} = 1.091 + 0.909 = 2\,atm$

7. $C_6H_{12}O_6(s) + 6\,O_2(g) \longrightarrow 6\,CO_2(g) + 6\,H_2O(g)$

1.8 g

2.6 L
3 atm
400 K $\rightarrow n = \dfrac{PV}{RT} = \dfrac{0.2376\,mol\;O_2}{} \left| \dfrac{6\,mol\;CO_2}{6\,mol\;O_2} \right. = 0.2376\,mol\;CO_2$

$\dfrac{1.8\,g}{} \left| \dfrac{mol}{180.18\,g} \right. = \dfrac{0.01\,mol\;C_6H_{12}O_6}{} \left| \dfrac{6\,mol\;CO_2}{1\,mol\;C_6H_{12}O_6} \right. = \boxed{0.06\,mol\;CO_2}$

$C_6H_{12}O_6$ = L.R.

$\dfrac{0.01\,mol\;C_6H_{12}O_6}{} \left| \dfrac{6\,mol\;H_2O}{1\,mol} \right. = \boxed{0.06\,mol\;H_2O}$

O_2 used: $\dfrac{0.06\,mol\;H_2O}{} \left| \dfrac{6\,mol\;O_2}{6\,mol\;H_2O} \right. = 0.06\,mol\;O_2$ used

left: $0.2376 - 0.06$

$\boxed{0.1777\,mol\;O_2}$

$n_{tot} = 0.06 + 0.06 + 0.1777 = 0.298\,mol$

$P = \dfrac{nRT}{V} = \dfrac{0.298\,(0.08206)(400\,K)}{2.6\,L} = 3.76\,atm$