

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 ($\text{C}_6\text{H}_{12}\text{O}_6$) 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 $P = 4 \text{ atm}$

$V = 1 \text{ L}$

$T = ?$

$n = ?$

n can be determined from mass:

$$\frac{1 \text{ g CH}_4}{16.05 \text{ g}} = 0.0623 \text{ mol}$$

$$PV = nRT$$

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

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

$$PV = nRT$$

$$\frac{V}{T} = \frac{nR}{P} = \text{constant}$$

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

$$V_1 = 2 \text{ L}$$

$$T_1 = 25^\circ\text{C} + 273.15 = 298.15 \text{ K}$$

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

$$V_2 \rightarrow 10\% \text{ of } V_1 \text{ lost} \rightarrow 0.1(2 \text{ L}) = 0.2 \text{ L lost}$$

$$V_2 = 2 \text{ L} - 0.2 \text{ L} = 1.8 \text{ L}$$

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

$$^\circ\text{C} = 268.3 - 273.15 = -4.82^\circ\text{C}$$

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

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

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



$V = 4L$
 $P = 1 \text{ atm}$
 $T = 273.15K$

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

need V_{tot}

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

constant: $P+T$

$PV = nRT$

$\frac{V}{n} = \text{constant}$

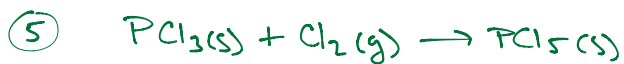
$\frac{V_1}{n_1} = \frac{V_2}{n_2}$
 $\uparrow \quad \quad \uparrow$
 $N_2O_4 \quad N_2 + O_2$

$0.178 \text{ mol } N_2O_4 \left| \frac{1 \text{ mol } N_2}{1 \text{ mol } N_2O_4} \right. = 0.178 \text{ mol } N_2$

$0.178 \text{ mol } N_2O_4 \left| \frac{2 \text{ mol } O_2}{1 \text{ mol } N_2O_4} \right. = 0.356 \text{ mol } O_2$

$n_2 = 0.178 + 0.356 = 0.534 \text{ mol}$

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



\downarrow
5g

\downarrow
4L @ STP

$\rightarrow n = \frac{4L(1 \text{ atm})}{(0.08206)(273.15K)} = 0.178 \text{ mol } Cl_2$

$5g \text{ PCl}_3 \left| \frac{\text{mol}}{137.32g} \right| \frac{1 \text{ mol } PCl_5}{1 \text{ mol } PCl_3} \left| \frac{208.02g}{\text{mol}} \right. = 7.574g \text{ PCl}_5$

$0.178 \text{ mol } Cl_2 \left| \frac{1 \text{ mol } PCl_5}{1 \text{ mol } Cl_2} \right| \frac{208.02g}{\text{mol}} = 37.12g \text{ PCl}_5$

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

Start: 0.178 mol Cl_2 (from above)

used: $7.574g \text{ PCl}_5 \text{ made} \left| \frac{\text{mol}}{208.02g} \right| \frac{1 \text{ mol } Cl_2}{1 \text{ mol } PCl_5} = 0.0364 \text{ mol}$

left: $0.178 - 0.0364 = 0.142 \text{ mol}$

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



a) $\frac{1g C_5H_{12}}{72.17g} \frac{8 mol O_2}{1 mol C_5H_{12}} = 0.1108 mol O_2 \text{ needed}$

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

c) i) All O_2 is consumed, so $n = 0 + P = 0$

ii) CO_2 : need moles to calculate pressure

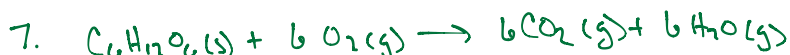
$\frac{0.1108 mol O_2}{8 mol O_2} \frac{5 mol CO_2}{1 mol O_2} = 0.06925 mol CO_2$

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

iii) H_2O : $\frac{0.1108 mol O_2}{8 mol O_2} \frac{6 mol H_2O}{1 mol O_2} = 0.0831 mol H_2O$

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

iv) $P_{tot} = P_{O_2} + P_{CO_2} + P_{H_2O} = 1.091 + 0.909 = 2 atm$



$\frac{1.8g}{180.18g} \frac{6 mol CO_2}{1 mol C_6H_{12}O_6} = 0.06 mol CO_2$

$\frac{1.8g}{180.18g} = 0.01 mol C_6H_{12}O_6 \frac{6 mol CO_2}{1 mol C_6H_{12}O_6} = 0.06 mol CO_2$

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

$\frac{0.01 mol C_6H_{12}O_6}{1 mol} \frac{6 mol H_2O}{1 mol} = 0.06 mol H_2O$

$O_2 \text{ used: } \frac{0.06 mol H_2O}{6 mol H_2O} \frac{6 mol O_2}{1 mol H_2O} = 0.06 mol O_2 \text{ used}$

left: $0.2376 - 0.06$

$0.1777 mol O_2$

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

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