

Answers to Ch. 13 Problems, P. 435

- ① S: definite shape & volume, particles close to one another, particles vibrate
 L: indefinite shape but definite volume, particles close to one another, particles flow
 G: neither defin. shape nor defin. volume, particles far apart, particles shoot about freely

④ (a) $105.2 \text{ kPa} \times \frac{1 \text{ atm}}{101.3 \text{ kPa}} = \underline{1.038 \text{ atm}}$

(c) $752 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = \underline{0.9895 \text{ atm}}$

⑤ (a) $0.9975 \text{ atm} \times \frac{760 \text{ mm Hg}}{1 \text{ atm}} = \underline{758.1 \text{ mm Hg}}$

(c) $99.7 \text{ kPa} \times \frac{760 \text{ mm Hg}}{101.3 \text{ kPa}} = \underline{748 \text{ mm Hg}}$

⑥ (a) $774 \text{ torr} \times \frac{101.3 \text{ kPa}}{760 \text{ torr}} \times \frac{1000 \text{ Pa}}{1 \text{ kPa}} = \underline{1.03 \times 10^5 \text{ Pa}}$

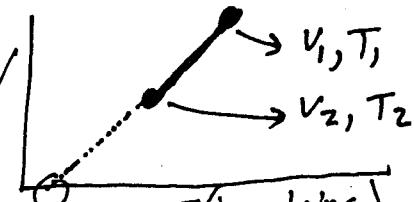
(c) $112.5 \text{ kPa} \times \frac{1000 \text{ Pa}}{1 \text{ kPa}} = \underline{1.125 \times 10^5 \text{ Pa}}$

⑦ (a) $V_1 = 53.2 \text{ mL}$ $V_2 = ?$ $P_1 V_1 = P_2 V_2$
 $P_1 = 785 \text{ mm Hg}$ $P_2 = 700 \text{ mm Hg}$ $V_2 = \frac{P_1 V_1}{P_2} = \frac{(785)(53.2)}{700}$
 $= 59.7 \text{ mL}$

⑧ (a) $V_1 = 291 \text{ mL}$ $V_2 = ?$ $P_1 V_1 = P_2 V_2$
 $P_1 = 1.07 \text{ atm}$ $P_2 = 2.14 \text{ atm}$ $V_2 = \frac{P_1 V_1}{P_2} = \frac{(1.07)(291)}{2.14} = \underline{146 \text{ mL}}$

⑩ $P_2 = ?$ $V_1 = 100 \text{ L}$ $P_1 V_1 = P_2 V_2$
 $P_1 = 760 \text{ mm Hg}$
 $V_2 = \frac{50.0 \text{ mL}}{15,200 \text{ mm Hg}} = 0.0500 \text{ L}$ $(760)(100) = P_2(0.0500)$
 $P_2 = 1.52 \times 10^4 \text{ mm Hg}$

(12) Charles's Law: V & T are directly related.
 Find the ~~V~~ V of a gas at a certain temp. Then, find the V of this same sample of gas at a lower temperature. Plot the results, draw a line between the data points, and extrapolate the line to find what the T would be if you could achieve a volume of zero.



$\rightarrow T$ (in kelvins)
 \rightarrow this temp will be \approx absolute zero

(13) $V_1 = 45.0 \text{ ml}$
 $T_1 = 26.5 + 273 = 299.5 \text{ K}$
 $V_2 = ?$
 $T_2 = 55.2 + 273 = 328.2 \text{ K}$

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

$$\frac{45.0 \text{ ml}}{299.5 \text{ K}} = \frac{V_2}{328.2 \text{ K}}$$

$$(V_2)(328.2 \text{ K}) = (45.0 \text{ ml})(328.2 \text{ K})$$

$$V_2 = 49.3 \text{ ml}$$

(14) (a) $V_1 = 25.0 \text{ L } T_1 = 273 \text{ K}$
 $V_2 = 50.0 \text{ L } T_2 = ?$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{25.0 \text{ L}}{273 \text{ K}} = \frac{50.0 \text{ L}}{T_2}$$

$$(T_2)(25 \text{ L}) = (273 \text{ K})(50 \text{ L})$$

$$T_2 = \frac{(273 \text{ K})(50)}{25 \text{ L}} \\ = 546 \text{ K} \\ = 273^\circ \text{C}$$

(15) $V_1 = 201 \text{ L } T_1 = 1150 + 273 = 1423 \text{ K}$
 $V_2 = 5.00 \text{ L } T_2 = ?$

$$\frac{201 \text{ L}}{1423 \text{ K}} = \frac{5.00 \text{ L}}{T_2}$$

$$T_2 = 35.4 \text{ K}$$

$$35.4 - 273 = -238^\circ \text{C}$$

(17) To get that sample to be $1/2$ as big (to reduce V by a factor of two), you would need to cut the temp in half. $25.2^\circ \text{C} + 273 = 298.2 \text{ K}$ $298.2 \text{ K} \div 2 = 149.1 \text{ K}$, or ~~-124~~ -124°C . Alternatively use $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

(B) You would have to double temp to $(298.2 \times 2) = 596.4 \text{ K} = 323.4^\circ \text{C}$

Or, you could use $\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow V_1 = 266, V_2 = 532, T_1 = 298.2 \text{ K}$, etc.

(20) ~~46.2 g O₂~~ = mass of sample
~~V = 100. L~~ = V of sample
 5.00 g is less than original sample.

$\frac{46.2}{5} = 9.24$ ~~times~~ times less oxygen, which will take up ~~9.24~~ ^{less space.}
 $100 \div 9.24 = \underline{\underline{10.8 \text{ liters}}}$ OR, do it like this:

$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2} \Rightarrow P \text{ and } T \text{ do not change, so...}$

$$\cancel{\frac{P_1 V_1}{n_1 T_1} = \cancel{P_2 V_2}} \cancel{\frac{n_1 T_1}{n_2 T_2}} \Rightarrow \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$46.2 \text{ g O}_2 \times \frac{1 \text{ mol}}{32 \text{ g}} = \underline{1.444 \text{ mol}}$$

$$5 \text{ g O}_2 \times \frac{1 \text{ mol}}{32 \text{ g}} = \underline{.1563 \text{ mol}}$$

$$\frac{100 \text{ L}}{1.444 \text{ mol}} = \frac{x \text{ L}}{0.1563 \text{ mol}} \quad x \text{ L} = 10.8 \text{ L}$$

(21) High T, low P (conditions which keep particles far apart)

$$P = 782 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = \underline{1.029 \text{ atm}}$$

$$V = ?$$

$$n = 0.210 \text{ mol}$$

$$T = 27 + 273 = 300. \text{ K}$$

$$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}}$$

$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(0.210 \text{ mol})(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}})(298 \text{ K})}{1.029 \text{ atm}}$$

$$= 5.03 \text{ L}$$

$$(24) P = 1.01 \text{ atm} \quad T = 298 \text{ K}$$

$$V = \cancel{\cancel{\cancel{?}}} \quad R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}}$$

$$n = \cancel{\cancel{\cancel{?}}} \text{ mol}$$

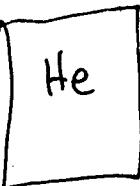
$$0.00831$$

$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(0.00831 \text{ mol})(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{K} \cdot \text{mol}})(298 \text{ K})}{1.01 \text{ atm}}$$

$$= 0.0201 \text{ L}$$

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$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(135)(200)}{(0.0821)(297)} = 1107.3 \text{ mol}$$

$$V = 200 \text{ L}$$

$$P = 135 \text{ atm}$$

$$T = 24 + 273 = 297 \text{ K}$$

$$R = 0.0821 \frac{\text{Latm}}{\text{Kmol}}$$

$$n = ?$$

$$= 1107.3 \text{ mol}$$

$$1107.3 \text{ mol} \times \frac{4.00 \text{ g}}{1 \text{ mol}} =$$

$$\boxed{4430 \text{ g of He}}$$

$$V = 200 \text{ L}$$

$$P = 135 \text{ atm}$$

$$T = 297 \text{ K}$$

$$R = 0.0821 \frac{\text{Latm}}{\text{Kmol}}$$

$$n = ?$$

$$= 1107.3 \text{ mol}$$

$$1107.3 \text{ mol} \times \frac{2.02 \text{ g}}{1 \text{ mol}} =$$

$$\boxed{2240 \text{ g H}_2}$$

$$27) 16.3 \text{ g of N}_2 \times \frac{1 \text{ mol}}{28.0 \text{ g}} = \frac{0.582 \text{ mol}}{1 \text{ mol}} N_2 = n$$

$$P = 1.25 \text{ atm}$$

$$V = 25.0 \text{ L}$$

$$T = ?$$

$$R = 0.0821 \frac{\text{Latm}}{\text{Kmol}}$$

$$PV = nRT$$

$$T = \frac{PV}{nR} = \frac{(1.25 \text{ atm})(25.0 \text{ L})}{(0.582 \text{ mol})(0.0821 \frac{\text{Latm}}{\text{K.mol}})}$$

$$\approx 654 \text{ K}$$

$$\approx 381^\circ \text{ C}$$

30)

$$V_1 = 459 \text{ mL} \quad V_2 = ?$$

$$T_1 = 27^\circ \text{ C} = 300 \text{ K} \quad T_2 = 15 + 273 = 288 \text{ K}$$

$$P_1 = 1.05 \text{ atm} \quad P_2 = 0.997 \text{ atm}$$

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

$$\frac{(1.05)(459)}{300} = \frac{(0.997)V_2}{288}$$

$$464 \text{ mL} = V_2$$

32) Gas becomes saturated w/ water vapor

because water tends to evaporate. The water vapor is taken into account by subtracting the vapor pressure of water from the total gas pressure before doing any further calculations on the gas.

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$$\boxed{P_{TOT} = 10.0 \text{ atm}}$$

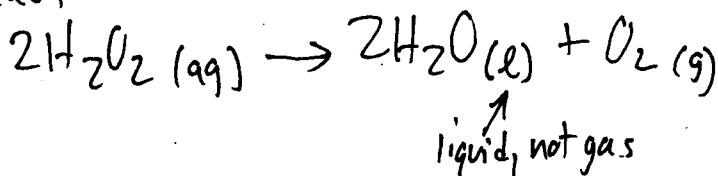
Moles of gas = $3 + 2 + 1 = 6 \text{ moles}$

$$P_{N_2} = \frac{3}{6} \times \text{total} = \left(\frac{1}{2}\right)(10) = \cancel{5.00} \text{ atm}$$

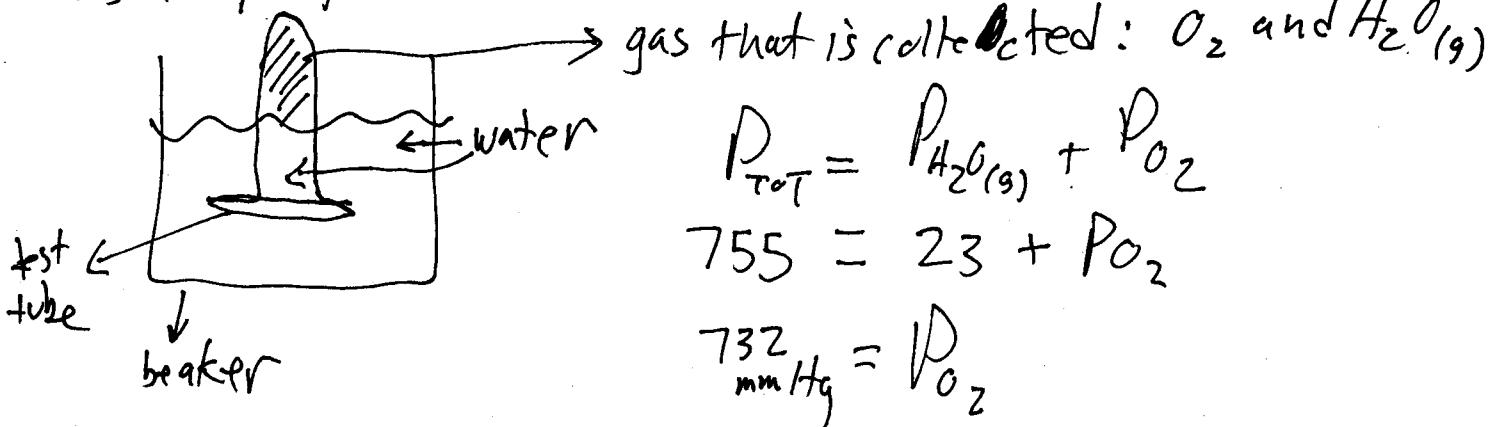
$$P_{O_2} = \frac{2}{6} \times \text{total} = \left(\frac{1}{3}\right)(10) = \cancel{3.33} \text{ atm}$$

$$P_{CO_2} = \frac{1}{6} \times \text{total} = \left(\frac{1}{6}\right)(10) = 1.67 \text{ atm}$$

(36) Mistake in equation, as far as I can tell! We did this reaction instead:



The gaseous H_2O is produced only due to the evaporation of the solvent H_2O that was originally present. I just don't see how steam (gaseous H_2O) could be produced by the decomposition reaction if it takes place in 24°C solution, which is mostly water & therefore has a very high specific heat capacity. Anyway....



$$732 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.963 \text{ atm}$$

$$P = 732 \text{ mm Hg} \times \cancel{0.963} = 0.963 \text{ atm}$$

$$T = 24 + 273 = 297 \text{ K}$$

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{(0.963)(0.500)}{(0.0821)(297)} = 0.0197 \text{ mol}$$

$$= 0.0197 \text{ mol}$$

$$R = 0.0821 \frac{\text{Latm}}{\text{Kmol}}$$

$$V = 0.500 \text{ L}$$

$$n = ? = 0.0197 \text{ mol}$$

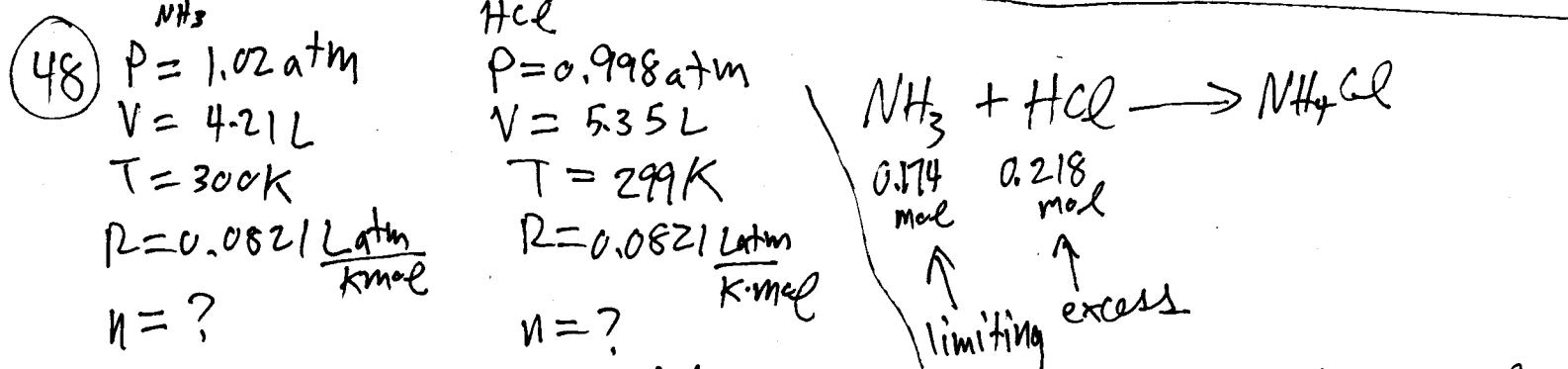
38) SKIP this

40) Each molecule is moving. If moving object hits a barrier, it exerts a force on that barrier. Pressure is force exerted ÷ surface area on which it is exerted. The walls of the container experience pressure because molecules of gas are hitting them.

43) Higher temp = faster moving molecules. faster speed = more force exerted when the molecule of gas hits something. You can experience this by throwing a baseball at a window at a slow speed and then at a high speed. Be careful; I'm just kidding.

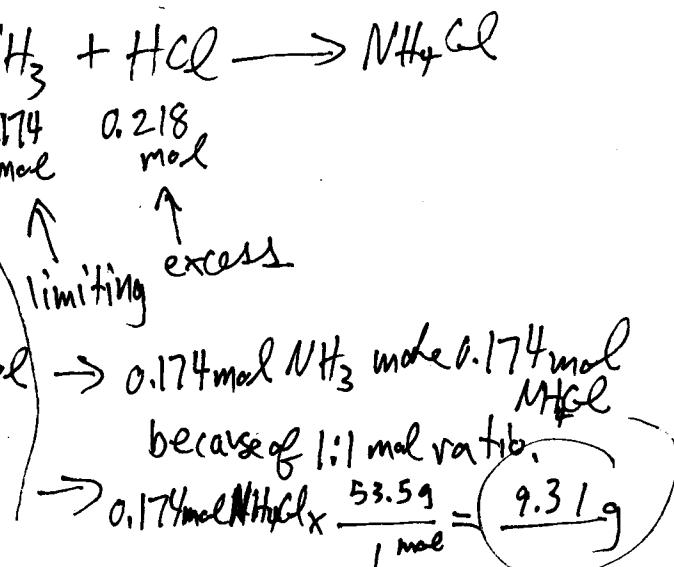
45) Smaller volume means molecules get closer; the closer the molecules, the greater the intermolecular interactions. In other words, if you get the molecules too close to one another, the molecules will start to attract or repel, which is not a part of the ideal gas model.

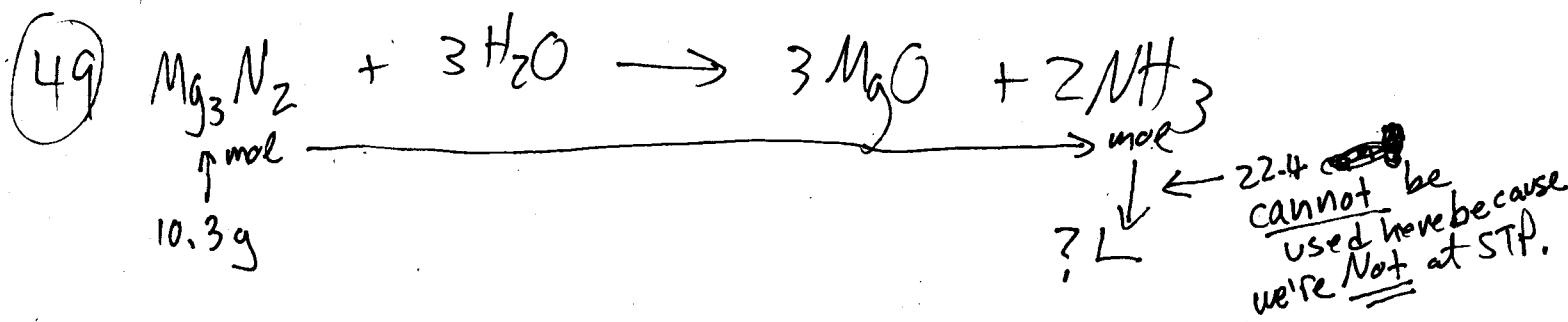
46) ~~15.2 g CaCO₃~~ × $\frac{1 \text{ mol CaCO}_3}{100.08 \text{ g CaCO}_3} \times \frac{1 \text{ mol CO}_2}{1 \text{ mol CaCO}_3} \times \frac{22.4 \text{ L CO}_2}{1 \text{ mol CO}_2} = 3.40 \text{ L}$



$$\begin{aligned} PV &= nRT \\ \frac{PV}{RT} &= n = \frac{(1.02)(4.21)}{(0.0821)(300)} \\ &= 0.174 \text{ mol} \end{aligned}$$

$$n = \frac{PV}{RT} = 0.218 \text{ mol}$$





$$10.3 \text{ g } Mg_3N_2 \times \frac{1 \text{ mol } Mg_3N_2}{100.93 \text{ g } Mg_3N_2} \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } Mg_3N_2} = 0.204 \text{ mol } NH_3$$

$$P = 752 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.989 \text{ atm}$$

$$T = 24 + 273 = 297 \text{ K}$$

$$V = ?$$

$$n = 0.204 \text{ mol}$$

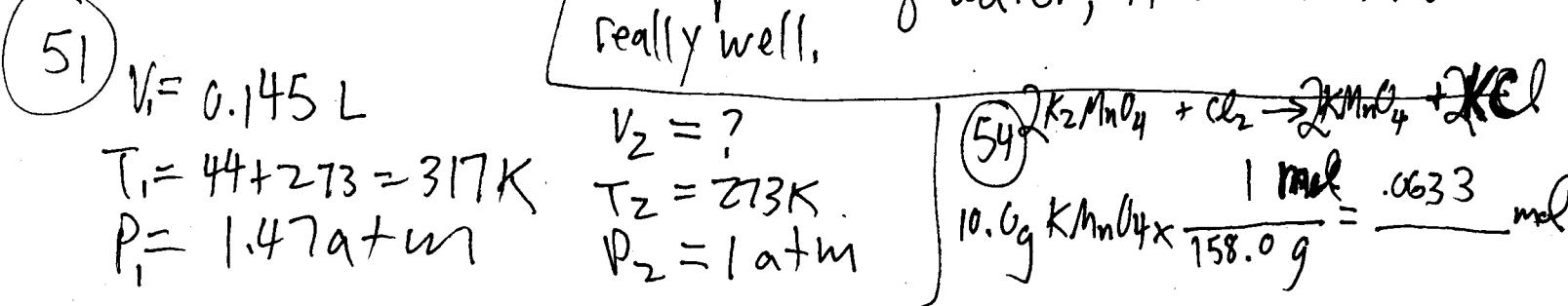
$$R = 0.0821 \frac{\text{Latm}}{\text{K} \cdot \text{mol}}$$

$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(0.204)(0.0821)(297)}{0.989}$$

$$V = 5.03 \text{ Liters}$$

Well, that's how much you would produce. I doubt that you collect all of it in the presence of water; it dissolves in water really well.



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

$$\frac{(1.47)(0.145)}{317} = \frac{(1)V_2}{273}$$

$$V_2 = 0.184 \text{ L or } 184 \text{ mL}$$

$$0.06328 \text{ mol } KMnO_4 \times \frac{1 \text{ mol } Cl_2}{2 \text{ mol } KMnO_4} = 0.03165 \text{ mol } Cl_2$$

~~$$0.03165 \text{ mol } Cl_2 \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.709 \text{ L Cl}_2$$~~

$$0.03165 \text{ mol } Cl_2 \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.709 \text{ L Cl}_2$$