1. Sulfuric acid reacts with sodium chloride to form aqueous sodium sulfate and hydrogen chloride gas. How many mL of gas form at STP when 0.117 kg of sodium chloride reacts with excess sulfuric acid? (5.11)

STP conditions

→ 0°C (273 K)

→ 1 atm

→ 1 mol of gas takes up 22.4 L

$$H_2SO_{4(aq)} + 2NaCl_{(s)} \rightarrow Na_2SO_{4(aq)} + 2HCl_{(g)}$$

$$\frac{.117\ \cancel{kg\ NaCl}}{} \Big| \frac{10^3\ \cancel{g\ NaCl}}{1\ \cancel{kg\ NaCl}} \Big| \frac{1\ \cancel{mol\ NaCl}}{58.44\ \cancel{g\ NaCl}} \Big| \frac{2\ \cancel{mol\ HCl}}{2\ \cancel{mol\ NaCl}} \Big| \frac{22.4\ \cancel{L}}{1\ \cancel{mol}} \Big| \frac{10^3\ mL\ HCl}{1\ \cancel{L\ HCl}}$$

$$= 4.48 \times 10^4\ mL$$

2. Ammonia and hydrogen chloride gases react to form solid ammonium chloride. A 10.0 L reaction flask contains ammonia at 0.452 atm and 22 *C, and 155 mL of hydrogen chloride gas at 7.50 atm. 271 K is introduced. After the reaction occurs and the temperature returns to 22 *C, what is the pressure inside the flask? (5.12)

→ K!

$$NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$$

$$P = \frac{nRT}{V}$$

$$n_{NH_3} = \frac{PV}{RT} = \frac{(.452)(10)}{(.0821)(295)} = 0.187 \text{ mol } NH_3$$

$$n_{HCl} = \frac{PV}{RT} = \frac{(7.5)(.155)}{(.0821)(271)} = 0.052 \text{ mol } HCl$$

$$n_{NH_3 \text{ remaining}} = 0.187 - \left(0.052 \text{ mol } HCl \times \frac{1 \text{ mol } NH_3}{1 \text{ mol } HCl}\right)$$

$$= 0.135 \text{ mol } NH_3$$

$$P = \frac{nRT}{V} = \frac{(0.135)(.0821)(295)}{10}$$

$$\boxed{P = 0.327 \text{ atm}}$$

↳ from excess NH_3

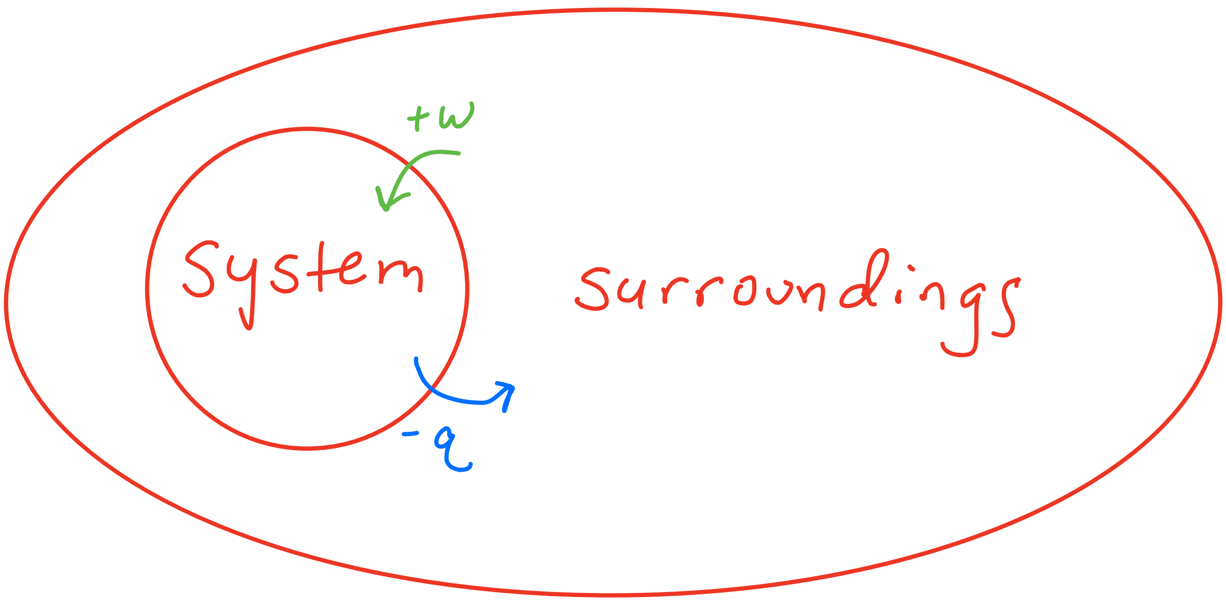
3. If it takes 1.25 minutes for 0.010 mol of He to effuse, how long will it take for the same amount of C_2H_6 to effuse? (5.13)

$$\frac{\text{Rate } X}{\text{Rate } Y} = \sqrt{\frac{\mathcal{M}_Y}{\mathcal{M}_X}}$$

$$\frac{\text{Rate He}}{\text{Rate } C_2H_6} = \sqrt{\frac{\mathcal{M}_{C_2H_6}}{\mathcal{M}_{He}}} = \sqrt{\frac{30.07 \text{ g/mol}}{4.003 \text{ g/mol}}} = 2.74$$

$$\frac{1.25 \text{ mins He} \mid 2.74 \text{ mins } C_2H_6}{\mid 1 \text{ min He}} = \boxed{3.43 \text{ mins}}$$

4. In a reaction, gaseous reactants form a liquid product. The heat absorbed by the surroundings is 26.0 kcal, and the work done on the system is 15.0 Btu. Given that 1 kcal = 4.184 kJ and 1 Btu = 1.055 kJ, calculate ΔE in kJ. (6.1)



General Formula:

$$\Delta E = q + w$$

Here:

$$\Delta E = (-q) + (+w)$$

$$\Delta E = \left(\frac{-26 \text{ kcal}}{} \Big| \frac{4.184 \text{ kJ}}{1 \text{ kcal}}\right) + \left(\frac{15 \text{ Btu}}{} \Big| \frac{1.055 \text{ kJ}}{1 \text{ Btu}}\right)$$

$$\Delta E = (-26 \times 4.184 \text{ kJ}) + (15 \times 1.055 \text{ kJ})$$

$$\boxed{\Delta E = -93 \text{ kJ}}$$

5. Find the heat released in kJ when 5.50 L of ethylene glycol (d = 1.11 g/mL) in a car radiator cools from 37.0 *C to 25.0 *C. (6.3)

$$q = mc\Delta T$$

$$d = \frac{m}{V}$$

$$m = dV$$

$$m = \frac{1.11\ \text{g}}{\text{mL}} \cdot \frac{1000\ \text{mL}}{1\ \text{L}} \cdot 5.5\ \text{L} = 6.10 \times 10^3\ \text{g}$$

$$c = \frac{2.42\ \text{J}}{\text{g}\cdot\text{K}} \cdot \frac{1\ \text{kJ}}{1000\ \text{J}} = 0.00242\ \frac{\text{kJ}}{\text{g}\cdot\text{K}}$$

$$\Delta T = T_F - T_I$$

$$\Delta T = 25°\text{C} - 37°\text{C}$$

$$\Delta T = -12°\text{C} = -12\ \text{K}$$

$$q = mc\Delta T$$

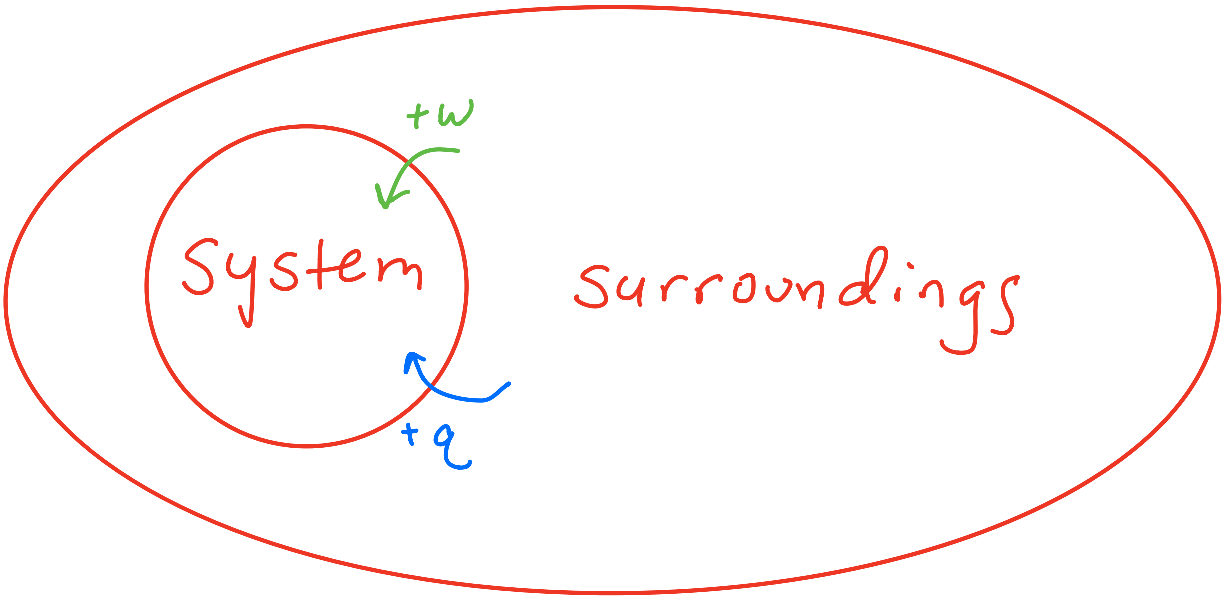
$$q = (6.10 \times 10^3\ \text{g})(0.00242\ \frac{\text{kJ}}{\text{g}\cdot\text{K}})(-12\ \text{K})$$

$$\boxed{q = -177\ \text{kJ}}$$

$$\Delta E = q + w$$

$$\Delta E = (+q) + (+w)$$

$$\Delta E = \oplus$$



$$\Delta E = q + w$$

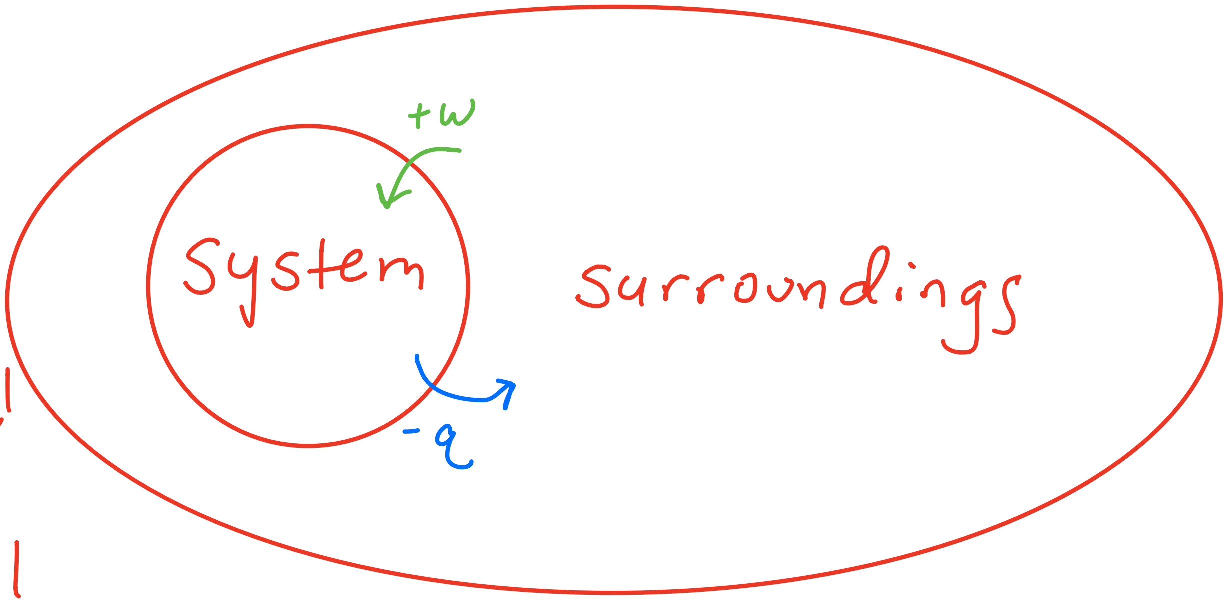
$$\Delta E = (-q) + (+w)$$

$\Delta E = \oplus$ IF

$|w| > |q|$

$\ominus$ IF

$|w| < |q|$



$$\Delta E = q + w$$

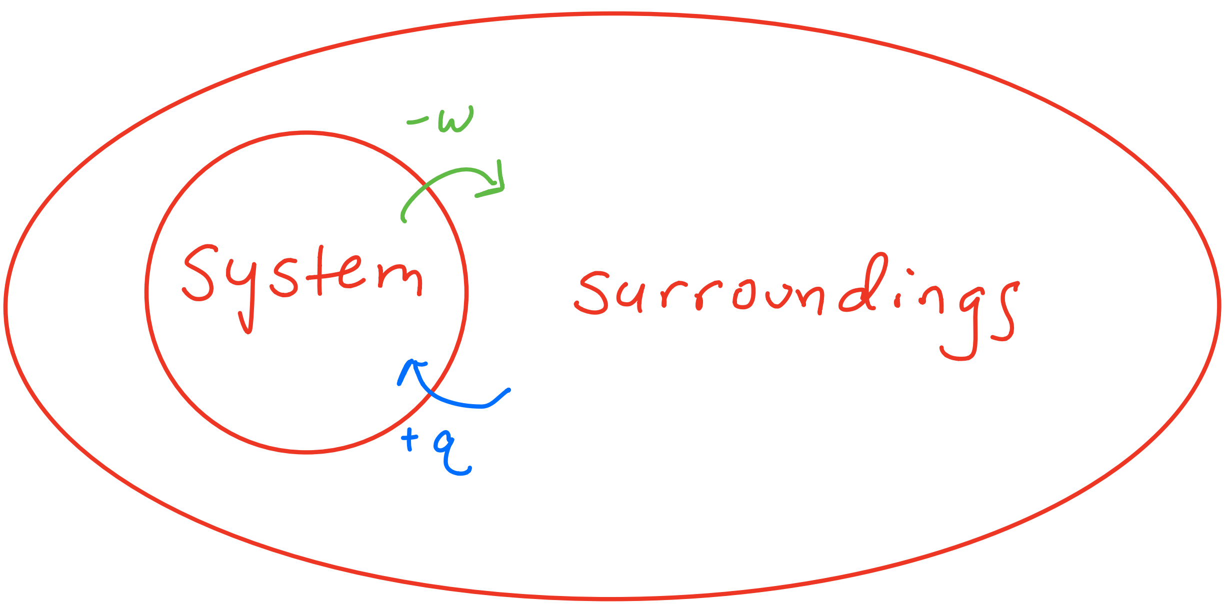
$$\Delta E = (+q) + (-w)$$

$\Delta E = \oplus$ IF

$|q| > |w|$

$\ominus$ IF

$|q| < |w|$



$$\Delta E = q + w$$

$$\Delta E = (-q) + (-w)$$

$$\Delta E = \ominus$$