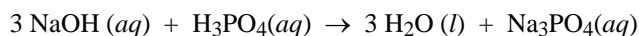


Name (PRINT) KEY

(28 points total)

1. In the CHM 151 lab, you are given a NaOH solution of unknown concentration, and you are asked to find its molar concentration (molarity). You start with 25.00 mL of the NaOH solution and titrate it with 1.500 M H₃PO₄. It takes 15.53 mL of H₃PO₄ to reach the equivalence point of the titration. What is the **molarity** of the NaOH solution? [5 pts]

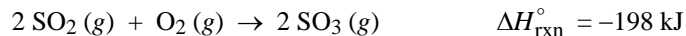


$$\text{mol H}_3\text{PO}_4 = \frac{1.500 \text{ mol}}{1 \text{ L}} \times (15.53 \times 10^{-3} \text{ L}) = 0.02330 \text{ mol H}_3\text{PO}_4$$

$$\text{mol NaOH} = 0.02330 \text{ mol H}_3\text{PO}_4 \times \frac{3 \text{ mol NaOH}}{1 \text{ mol H}_3\text{PO}_4} = 0.06990 \text{ mol NaOH}$$

$$M (\text{NaOH}) = \frac{\text{mol}}{\text{L}} = \frac{0.06990 \text{ mol NaOH}}{25.00 \times 10^{-3} \text{ L}} = \mathbf{2.796 \text{ M}}$$

2. In an endothermic process, heat is transferred from the **surroundings** to the **system**. [2 pts]
3. Which of the following is **exothermic**? [3 pts]
- a) **Water condenses on a cold pipe** * b) Dry ice (CO₂) sublimates (solid → gas)
c) An icicle melts d) Liquid nitrogen boils
e) All of these are exothermic
4. Given the three statements below, which answer is **correct**? [3 pts]
- (1) The sign of ΔH for an endothermic reaction is positive.
(2) In an exothermic reaction, heat is transferred from the system to the surroundings.
(3) An endothermic reaction releases heat.
- a) **1 and 2 are true, 3 is false** * b) 2 and 3 are true, 1 is false c) 1 and 3 are true, 2 is false
d) 1, 2, and 3 are false e) 1, 2, and 3 are true
5. Given the thermochemical equation:

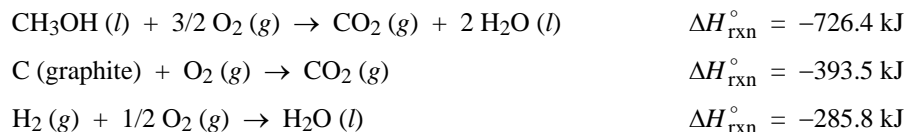


What is the **enthalpy change** (ΔH°) for the decomposition of six moles of SO₃? [3 pts]

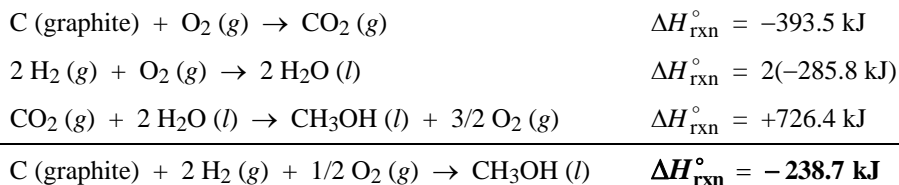
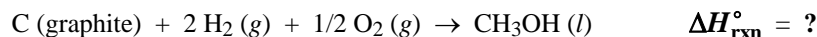


$$\frac{+198 \text{ kJ}}{2 \text{ mol SO}_3} \times 6.00 \text{ mol SO}_3 = \mathbf{+594 \text{ kJ}}$$

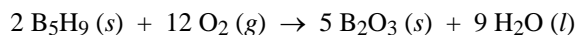
6. From the following heats of combustion,
[4 pts]



calculate the enthalpy of formation of methanol (CH₃OH) from its elements:



7. Use the data given below to calculate the **standard enthalpy change**, $\Delta H_{\text{rxn}}^{\circ}$, for the following reaction:
[4 pts]



$$\Delta H_f^{\circ} [\text{B}_2\text{O}_3 (s)] = -1,273.5 \text{ kJ/mol}, \Delta H_f^{\circ} [\text{B}_5\text{H}_9 (s)] = 73.2 \text{ kJ/mol}, \Delta H_f^{\circ} [\text{H}_2\text{O} (l)] = -285.8 \text{ kJ/mol}$$

Circle the correct answer.

- a) $-2.55 \times 10^3 \text{ kJ}$ b) $-9.09 \times 10^3 \text{ kJ}$ c) $-3.63 \times 10^4 \text{ kJ}$
d) $-1.82 \times 10^4 \text{ kJ}$ e) $-1.69 \times 10^4 \text{ kJ}$

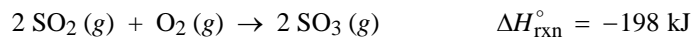
$$\Delta H_{\text{rxn}}^{\circ} = \sum n \Delta H_f^{\circ} (\text{prod.}) - \sum m \Delta H_f^{\circ} (\text{reac.})$$

$$\Delta H_{\text{rxn}}^{\circ} = (5 \text{ mol}) \Delta H_{\text{rxn}}^{\circ} (\text{B}_2\text{O}_3) + (9 \text{ mol}) \Delta H_{\text{rxn}}^{\circ} (\text{H}_2\text{O}) - [(2 \text{ mol}) \Delta H_{\text{rxn}}^{\circ} (\text{B}_5\text{H}_9) + (12 \text{ mol}) \Delta H_{\text{rxn}}^{\circ} (\text{O}_2)]$$

$$\Delta H_{\text{rxn}}^{\circ} = (5 \text{ mol})(-1273.5 \text{ kJ/mol}) + (9 \text{ mol})(-285.8 \text{ kJ/mol}) - [(2 \text{ mol})(73.2 \text{ kJ/mol}) + (12 \text{ mol})(0)]$$

$$\Delta H_{\text{rxn}}^{\circ} = -9.09 \times 10^3 \text{ kJ}$$

8. Given the thermochemical equation:



What is the **enthalpy change** (ΔH°) for the combustion of 640.7 g of SO₂? [4 pts]

$$640.7 \text{ g SO}_2 \times \frac{1 \text{ mol SO}_2}{64.07 \text{ g SO}_2} = 10.00 \text{ mol SO}_2$$

$$\frac{-198 \text{ kJ}}{2 \text{ mol SO}_2} \times 10.00 \text{ mol SO}_2 = -990 \text{ kJ}$$

Potentially Useful Information

$$\text{Molarity} = \frac{\text{moles solute}}{\text{L of solution}}$$

$$\Delta H_{\text{rxn}}^{\circ} = \sum n \Delta H_f^{\circ} (\text{prod.}) - \sum m \Delta H_f^{\circ} (\text{reac.})$$

molar masses: Na (22.99 g/mol), O (16.00 g/mol), H (1.008 g/mol), S (32.07 g/mol), P (30.97 g/mol)