

- A 100.0-g rock is heated to 78.24°C. The rock is then placed in 100.0 g of water at 25.00°C. The final temperature of the mixture is 33.43°C. The specific heat of water is 4.184 J/g °C. What is the specific heat of the rock? (5%)
- Determine the enthalpy change that would result from the incomplete combustion (combustion with insufficient oxygen) of coal to give carbon monoxide:

$$2 \text{C(s)} + \text{O}_2(\text{g}) \rightarrow 2 \text{CO(g)}$$
 The following thermochemical equations are known:

$$\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \quad \Delta H = -393.7 \text{ kJ}$$

$$2 \text{CO(g)} + \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g}) \quad \Delta H = -566.0 \text{ kJ} \quad (5\%)$$
- The hydration of sulfur trioxide occurs by the reaction

$$\text{SO}_3(\text{g}) + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4(\text{aq})$$
 Here $\Delta H = -227 \text{ kJ/mol}$ and $\Delta S = -309 \text{ J/mol K}$. Is the reaction spontaneous at 1450 K? (10%)
- At an initial concentration of 0.250 M, the concentration of O_3 decreased by 0.0313 M in 100.0 s. Calculate the initial rate of the reaction

$$2 \text{O}_3 \rightarrow 3 \text{O}_2 \quad (10\%)$$
- What is the rate law for the following mechanism?

$$\text{Cr}^{2+} + \text{UO}_2^{2+} \rightleftharpoons \text{CrUO}_2^{4+} \quad (\text{fast})$$

$$\text{CrUO}_2^{4+} + \text{Cr}^{2+} \rightarrow 2 \text{Cr}^{3+} + \text{UO}_2 \quad (\text{slow})$$

$$\text{UO}_2 + 4 \text{H}^+ \rightarrow \text{U}^{4+} + 2 \text{H}_2\text{O} \quad (\text{fast}) \quad (5\%)$$
- A 0.500 M solution of pyridine contains $2.6 \times 10^{-5} \text{ M OH}^-$. What is the base-ionization constant of pyridine? (10%)
- Calculate the half-reaction potential at 25.0°C for the reaction

$$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn(s)}$$
 The concentration of Zn^{2+} is 0.0120 M. (10%)
- Cadmium hydroxide is a colorless solid used in the electrodes of NiCad batteries. What concentration of Cd^{2+} can exist in a solution of pH 8.00? The K_{sp} of Cd(OH)_2 is 1.2×10^{-14} . (10%)

9. Calculate the solubility of AgI in 2.00 M aqueous NH_3 . The value of K_{sp} for AgI is 8.5×10^{-17} , and the value of K_f for $\text{Ag}(\text{NH}_3)_2^+$ is 1.7×10^7 . (10%)
10. Decide which of the following four nuclides are radioactive: $^{124}_{50}\text{Sn}$, $^{125}_{50}\text{Sn}$, $^{76}_{31}\text{Ga}$ and $^{45}_{21}\text{Sc}$. (5%)
11. Identify the repeating unit in each of the following polymers.
a. polystyrene
b. polypropylene
c. polybutadiene
d. polytetrafluoroethylene (10%)
12. The equilibrium constant for the formation of hydrazine is $K_c = 5.00 \times 10^{-3}$.
$$\text{N}_2(\text{g}) + 2 \text{H}_2(\text{g}) \rightleftharpoons \text{N}_2\text{H}_4(\text{g})$$

Suppose 2.00 mol H_2 and 1.00 mol N_2 are placed in a 1.00-L container. Calculate (a) the equilibrium concentration of each substance and (b) the equilibrium constant for the reverse reaction. (10%)