

1. Q1

a. Since the temperature of the solution dropped, the reaction absorbed energy, so the process is **endothermic**.

$$\begin{aligned} \text{b. } q_{\text{rxn}} &= -q_{\text{sol}} = -mc\Delta t \\ &= -(36.5)(4.184 \text{ J/g}\cdot\text{K})(19.4-22.7)\text{K} \\ &= 503.96 \text{ J} \end{aligned}$$

$$\text{This is for } 1.50 \text{ g NH}_4\text{NO}_3 \cdot \frac{1 \text{ mol}}{20.06 \text{ g}} = 0.0187 \text{ mol NH}_4\text{NO}_3$$

Setting up proportions, we have:

$$\frac{503.96 \text{ J}}{0.0187 \text{ mol NH}_4\text{NO}_3} = \frac{x \text{ J}}{1 \text{ mol NH}_4\text{NO}_3}$$

$$x = \mathbf{26.9 \text{ kJ/mol}}$$

2. We use:

$$\Delta H_{\text{rxn}} = \sum H_{\text{products}} - \sum H_{\text{reactants}}$$

$$- 2091.4 \text{ kJ} = [3\Delta H_f(\text{H}_2\text{O}(\text{l})) - 3\Delta H_f(\text{CO}_2(\text{g}))] - [\Delta H_f((\text{CH}_2)_3(\text{g})) + 9/2 \Delta H_f(\text{O}_2(\text{g}))]$$

$$- 2091.4 \text{ kJ} = [(3 \text{ mol})(-285.83 \text{ kJ/mol}) + (3 \text{ mol})(-393.5 \text{ kJ/mol})] - [(1 \text{ mol})(\Delta H_f(\text{CH}_2)_3) + 9/2 \text{ mol})(0 \text{ kJ/mol})]$$

$$- 2091.4 \text{ kJ} = [-857.49 - 1180.5] - [\Delta H_f((\text{CH}_2)_3(\text{g})) + 0]$$

$$\Delta H_f(\text{CH}_2)_3(\text{g}) = - 53.41 \text{ kJ/mol}$$

$$3. \Delta E = R_H(1/n_i^2 - 1/n_f^2)$$

$$= (2.18 \cdot 10^{-18} \text{ J})(1/4^2 - 1/2^2)$$

$$= -4.088 \cdot 10^{-19} \text{ J}$$

$$v = \frac{\Delta E}{h} = -6.165 \cdot 10^{14} \text{ 1/s}$$

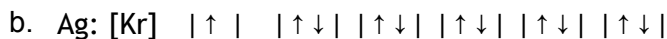
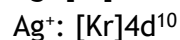
h

The frequency of the photon is $\mathbf{6.165 \cdot 10^{14} \text{ Hz}}$

$$\lambda = \frac{c}{v} = \frac{3 \cdot 10^8 \text{ m/s}}{6.165 \cdot 10^{14} \text{ 1/s}} = 4.866 \cdot 10^{-7} \text{ m}$$

$$= \mathbf{486.6 \text{ nm}}$$

4.



5s

4d



5s

4d

c. Ag: 1 valence electron

Ag⁺: 0 valence electron

5.

- a. q has units of joules (or kilojoules or calories or kilocalories)
 m has units of grams or kilograms
 c has units of $\text{J g}^{-1} \text{ } ^\circ\text{C}^{-1}$ or $\text{J g}^{-1} \text{ K}^{-1}$ (calories or kilograms acceptable alternatives)
 T has units of $^\circ\text{C}$ or K
- b. - Volume or mass of the HCl or NaOH solutions
- initial temperature of HCl or NaOH before mixing
- final (highest) temperature of solution after mixing
- c.

i) Since there is mixing of equal volumes of the same concentration and the reaction has 1:1 stoichiometry, moles of H_2O = moles of HCl = moles NaOH. To determine the number of moles of HCl:

$$(\text{volume HCl}) (\text{mol HCl} / 1\text{L}) (1 \text{ mol H}_2\text{O} / 1 \text{ mol HCl}) = \text{mol H}_2\text{O}$$

OR

$$(\text{volume HCl}) (1.0 \text{ mol NaOH} / 1\text{L}) (1 \text{ mol H}_2\text{O} / 1 \text{ mol NaOH}) = \text{mol H}_2\text{O}$$

OR

$$n_{\text{H}_2\text{O}} = n_{\text{HCl}} = n_{\text{NaOH}} = V_{\text{HCl}} \times 1 \text{ M} = V_{\text{NaOH}} \times 1 \text{ M}$$

ii) Determine the quantity of the heat produced, q , from $q = mc\Delta T$, where m = total mass of solution; divide q by mol H_2O determined in part (c) (i) to determine ΔH_{neut} :

$$\Delta H_{\text{neut}} = (-q) / (\text{mol H}_2\text{O}) \text{ OR } (q) / (\text{mol H}_2\text{O})$$

(mol reactant can substitute for mol H_2O)

d.

i) The ΔT will be greater, so q increases. There are more moles of HCl and NaOH reacting so the final temperature of the mixture will be higher.

ii) Both q and mol H_2O increase proportionately. However, when the quotient is determined, there is no change in ΔH_{neut}
Molar enthalpy is defined as per mole of reaction, therefore it will not change when the number of moles is doubled.

- e. Heat is lost to the air will produce a smaller ΔT . In the equation $q = mc\Delta T$ a smaller ΔT will produce a smaller value for q (heat released) than it should. in the equation

$$\Delta H_{\text{neut}} = (-q) / (\text{mol H}_2\text{O})$$

the smaller magnitude of a and the constant mol H_2O means that ΔH_{neut} will be less negative (more positive).

6.

a.

56.87kJ

b.

0.118mol ethane

c.

**2 mol used in equation

963.9kJ

7.

i) $M_1V_1 = M_2V_2$
 $(0.129\text{M})(33.19\text{mL}) = M_2(25\text{mL})$
 $M_2 = \mathbf{0.171M}$ 0.34 M

0,34 is the correct answer since mole ratio of KOH to H2SO4 is 2:1.

ii) molarity would be **lower**

8.

a. $0.7 \times 100 = \mathbf{70\%}$

b. avg atomic mass = $0.7 \times 44 + 0.2 \times 45 + 0.1 \times 46 = \mathbf{44.9 \text{ amu}}$

c. **Sc**