1. Q1
   a. Since the temperature of the solution dropped, the reaction absorbed energy, so the process is **endothermic**.
   b. $q_{rxn} = -q_{sol} = -mc\Delta t$

      $= -(36.5)(4.184\ J/g{\cdot}K)(19.4-22.7)K$

      $= 503.96\ J$

      This is for $1.50\ g\ NH_4NO_3 \cdot \frac{1\ mol}{20.06\ g} = 0.0187\ mol\ NH_4NO_3$

      Setting up proportions, we have:

      $$\frac{503.96\ J}{0.0187\ mol\ NH_4NO_3} = \frac{x\ \ J}{1\ mol\ NH_4NO_3}$$

      x = **26.9 kJ/mol**

2. We use:

   $\Delta H_{rxn} = \Sigma H_{products} - \Sigma H_{reactants}$

   $-2091.4\ kJ = [3\Delta H_f(H_2O\ (l)) - 3\Delta H_f(CO_2\ (g))] - [\Delta H_f((CH_2)_3\ (g) + 9/2\ \Delta H_f(O_2\ (g))]$

   $-2091.4\ kJ = [(3\ mol)(-285.83\ kJ/mol) + (3\ mol)(-393.5\ kJ/mol)] - [(1\ mol)(\Delta H_f(CH_2)_3) + 9/2\ mol)(0\ kJ/mol)]$

   $-2091.4\ kJ = [-857.49 - 1180.5] - [\Delta H_f((CH_2)_3\ (g)) + 0]$

   $\Delta H_f(CH_2)_3\ (g) = -53.41\ kJ/mol$

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

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

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

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

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

   $\lambda = \frac{c}{\nu} = \frac{3 \cdot 10^8\ m/s}{6.615 \cdot 10^{14}\ 1/s} = 4.866 \cdot 10^{-7}\ m$

   = **486.6 nm**

4.
   a. Ag: $[Kr]5s^1 4d^{10}$

      Ag^+: $[Kr]4d^{10}$
   b. Ag: [Kr] |↑ | |↑↓| |↑↓| |↑↓| |↑↓| |↑↓|

      5s 4d

      Ag^+: [Kr] | | |↑↓| |↑↓| |↑↓| |↑↓| |↑↓|

      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 $J\ g^{-1}\ °C^{-1}$ or $J\ g^{-1}\ K^{-1}$ (calories or kilograms acceptable alternatives)
T has units of °C or K

b. - Volume or mass of the HCl or NaOH <u>solutions</u>
- 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 <u>and</u> the reaction has 1:1 stoichiometry, moles of H_2O = moles of HCl = moles NaOH. To determine the number of moles of HCl:

(volume HCl) (mol HCl/ 1L)(1 mol H_2O/ 1 mol HCl) = mol H_2O

OR

(volume HCl) (1.0 mol NaOH/ 1L)(1 mol H_2O/ 1 mol NaOH) = X mol H_2O

OR

$n_{H20} = n_{HCl} = n_{NaOH} = V_{HCl} \times 1\ M = V_{NaOH} \times 1\ M$

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

$\Delta H_{neut} = (-q)/\ (\text{mol } H_2O)$ **OR** $(q)/\ (\text{mol } H_2O)$

(mol reactant can substitute for mol H_2O)

d.

i) The ΔT will be greater, so *q* increases. There are more <u>moles</u> 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 <u>per mole</u> 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

$\Delta H_{neut} = (-q)/ (\text{mol } H_2O)$

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) $M_1V_1 = M_2V_2$

(0.129M)(33.19mL) x 2 = M_2(25mL)

M_2 = **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 x 100 = **70%**

b. avg atomic mass = 0.7x44 + 0.2x45 + 0.1x46 = **44.9 amu**

c. **Sc**