Free Response Practice (~~1991 Form~~ 2000 B)

1. Answer the following questions about BeC_2O_4 and its hydrate.
   a. Calculate the mass percent of carbon in the hydrated solid with the formula $BeC_2O_4 \cdot 3\ H_2O$. (2 points)
   b. When heated to 220.°C, $BeC_2O_4 \cdot 3\ H_2O$ dehydrates completely as represented below:

$$BeC_2O_4 \cdot 3\ H_2O(s) \rightarrow BeC_2O_4(s) + 3\ H_2O(g)$$

   If 3.21 g of $BeC_2O_4 \cdot 3\ H_2O$ is heated to 220.°C, calculate each of the following:
      i. The mass of BeC_2O_4 formed. (1 point)
      ii. The volume of $H_2O(g)$ released, measured at 220.°C and 735 mmHg. (2 points)

A student repeats the dehydration from part (b) in an attempt to experimentally determine the number of moles of water in one mole of $BeC_2O_4 \cdot 3\ H_2O$. The student collects the data shown in the table below.

Mass of empty crucible	36.48 g
Initial mass of sample and crucible	39.69 g
Mass of sample and crucible after first heating	38.82 g

   c. Use the data above to:
      i. Calculate the total number of moles of water lost when the sample was heated. (1 point)
      ii. Determine the formula of the hydrated compound. (2 points)
   d. Is the student's experimentally determined waters of hydration greater than, less than, or equal to the waters of hydration in the accepted formula? Provide a reasonable explanation for error and how this error affected the student's results. (2 points)

(a) $\% C = \frac{2(12.01)}{151.078} \times 100 = \boxed{15.90\%}$

(b) (i) $3.21\ g\ BeC_2O_4 \cdot 3H_2O \times \frac{1\ mol\ BeC_2O_4 \cdot 3H_2O}{151.078\ g} \times \frac{1\ mol\ BeC_2O_4}{1\ mol\ BeC_2O_4 \cdot 3H_2O}$

$= 0.0212\ mol\ BeC_2O_4 \times \frac{97.03\ g}{1\ mol} = \boxed{2.06\ g\ BeC_2O_4}$

(ii) $0.0212\ mol\ BeC_2O_4 \cdot 3H_2O \times \frac{3\ mol\ H_2O}{1\ mol\ BeC_2O_4 \cdot 3H_2O} = 0.0636\ mol\ H_2O$

$V = \frac{nRT}{P} = \frac{(0.0636\ mol)(62.36\ \frac{L \cdot mmHg}{mol \cdot K})(220.°C + 273)}{735\ mmHg} = \boxed{2.66\ L\ H_2O}$

(c)(i) $39.69 - 38.82 = 0.87\ g\ H_2O \times \frac{1\ mol}{18.016} = \boxed{0.048\ mol\ H_2O}$

(ii) $38.82 - 36.48 = 2.34\ g\ BeC_2O_4 \times \frac{1\ mol}{97.03\ g} = 0.0241\ mol\ BeC_2O_4$

BeC_2O_4: 0.0241 mol ⎤ ÷ 0.0241 = 1
H_2O : 0.048 mol ⎦ = 2 } $\boxed{BeC_2O_4 \cdot 2H_2O}$

(d) next page

(d) Less than! (experimental = $BeC_2O_4 \cdot 2H_2O$,
accepted = $BeC_2O_4 \cdot 3H_2O$)

It is unlikely that all H_2O was driven off after 1 heating, so the measured mass of anhydrate will be too high (b/c it still contains H_2O) and the calculated mass of H_2O will be too low. Thus, the mole ratio as shown in the experimentally determined hydrate formula will show less waters of hydration than in the accepted formula.