

## Review of the Calculation of Absolute Uncertainty - Lab #1

To evaluate the absolute uncertainty,  $e_{M_{\text{HCl}}}$ , for the final measured quantity,  $M_{\text{HCl}}$ , include all uncertainties associated with the measurements used to arrive at  $M_{\text{HCl}}$ :

$$M_{\text{HCl}} = M_{\text{THAM}} V_{\text{THAM}} / V_{\text{HCl}} \rightarrow \text{measure: } M_{\text{THAM}}, V_{\text{THAM}}, \text{ and } V_{\text{HCl}}$$

$$\%e_{M_{\text{HCl}}} = \sqrt{(\%e_{M_{\text{THAM}}})^2 + (\%e_{V_{\text{THAM}}})^2 + (\%e_{V_{\text{HCl}}})^2} \quad (1)$$

We need  $\%e_{M_{\text{THAM}}}$ ,  $\%e_{V_{\text{THAM}}}$ , and  $\%e_{V_{\text{HCl}}}$  to solve for  $\%e_{M_{\text{HCl}}}$  in (1):

1. Determination of  $\%e_{M_{\text{THAM}}}$ :

$$M_{\text{THAM}} = \text{moles of THAM} / \text{Liter of de-ionized water} = n_{\text{THAM}} / V_{\text{H}_2\text{O}}$$

Since the determination of  $M_{\text{THAM}}$  requires a division, we determine  $\%e_{M_{\text{THAM}}}$  in order to calculate the uncertainty in  $M_{\text{THAM}}$ :

$$\%e_{M_{\text{THAM}}} = \sqrt{(\%e_{n_{\text{THAM}}})^2 + (\%e_{V_{\text{H}_2\text{O}}})^2}$$

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$$\%e_{V_{\text{H}_2\text{O}}} = (e_{V_{\text{H}_2\text{O}}} / V_{\text{H}_2\text{O}}) \times 100$$

$$\boxed{\pm 0.12 \text{ mL}} \quad 250 \text{ mL}$$

Harris, Table 2-3, p. 27

$$n_{\text{THAM}} = g_{\text{THAM}} / \text{molecular mass}_{\text{THAM}}$$

$$\%e_{n_{\text{THAM}}} = \sqrt{(\%e_{g_{\text{THAM}}})^2 + (\%e_{\text{molec. mass}})^2}$$

$$\%e_{g_{\text{THAM}}} = (e_{g_{\text{THAM}}} / g_{\text{THAM}}) \times 100$$

$$\boxed{\pm 0.0002 \text{ g}} \quad \text{mass of THAM}$$

See Harris, page 49, he calculates absolute uncertainty for the molecular mass of  $\text{C}_2\text{H}_4$ . Look up molecular formula of THAM and calculate  $\%e_{\text{molec. mass}}$  for THAM.

## 2. Determination of $\%e_{V_{\text{THAM}}}$ :

$$\%e_{V_{\text{THAM}}} = (e_{V_{\text{THAM}}} / V_{\text{THAM}}) \times 100$$

$$\boxed{\pm 0.05 \text{ mL}} \quad 50 \text{ mL}$$

Harris, Table 2-4, p. 27

## 3. Determination of $\%e_{V_{\text{HCl}}}$ :

$$V_{\text{HCl}} = V_{\text{final}} - V_{\text{initial}}$$

$$e_{V_{\text{HCl}}} = \sqrt{(e_{V_{\text{final}}})^2 + (e_{V_{\text{initial}}})^2} \longrightarrow \%e_{V_{\text{HCl}}} = (e_{V_{\text{HCl}}} / V_{\text{HCl}}) \times 100$$

$$\boxed{\pm 0.05 \text{ mL for a 50 mL buret}}$$

Harris, Table 2-2, p. 26

4. Determination of  $e_{\text{M}_{\text{HCl}}}$ : Substitute  $\%e_{\text{M}_{\text{THAM}}}$ ,  $\%e_{\text{V}_{\text{THAM}}}$ , and  $\%e_{\text{V}_{\text{HCl}}}$  into (1)

$$\%e_{\text{M}_{\text{HCl}}} = \sqrt{(\%e_{\text{M}_{\text{THAM}}})^2 + (\%e_{\text{V}_{\text{THAM}}})^2 + (\%e_{\text{V}_{\text{HCl}}})^2} \quad (1)$$

$$\%e_{\text{M}_{\text{HCl}}} = (e_{\text{M}_{\text{HCl}}} / M_{\text{HCl}}) \times 100 \quad (2)$$

Re-arrange (2) give  $e_{\text{M}_{\text{HCl}}}$ :

$$e_{\text{M}_{\text{HCl}}} = (\%e_{\text{M}_{\text{HCl}}}) (M_{\text{HCl}}) / 100$$

5. Final Answer (whew!!):

$$M_{\text{HCl}} \pm e_{\text{M}_{\text{HCl}}}$$

\* Remember to hold at least extra significant figure through the calculations and round off the Final Answer to obtain the correct number of significant figures.