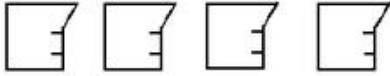


1 l Beaker x 1



250 ml Beaker x 4



100 ml Measuring Cylinder x 1



Bowl x 1



Ice container x 3



1 l Bottle of ethanol



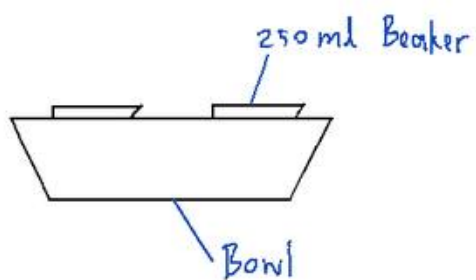
120 ml Bottle



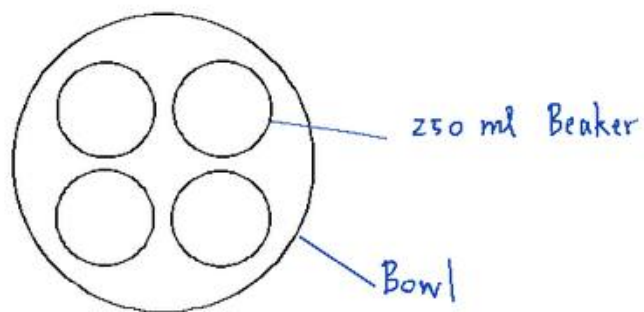
Calorimeter



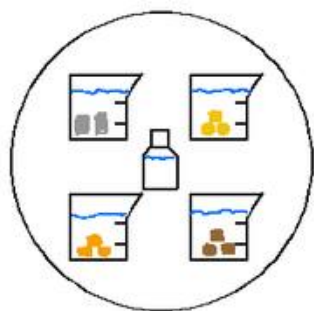
Digital Thermometer



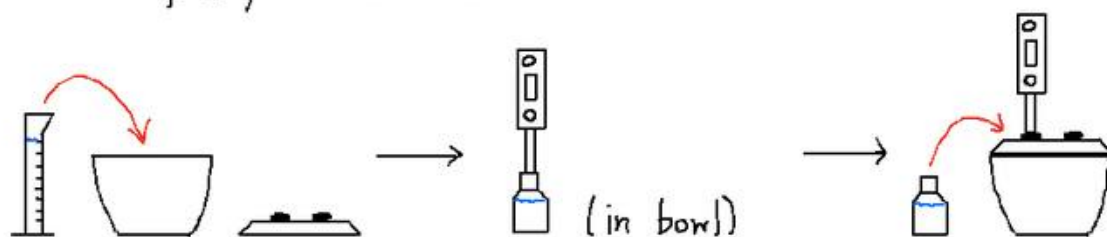
Side View



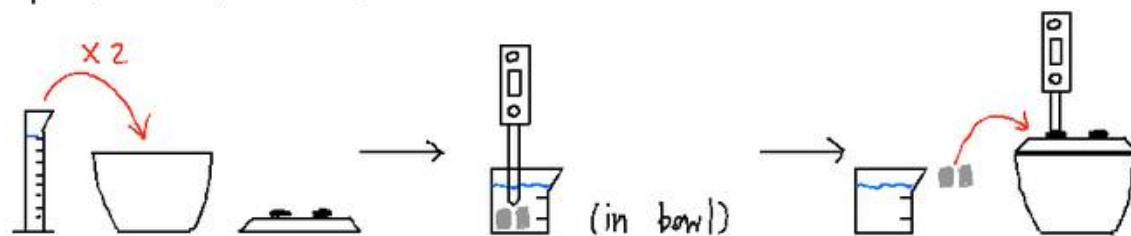
Top View



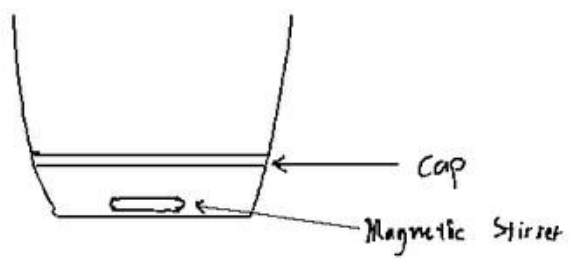
Heat Capacity of Calorimeter



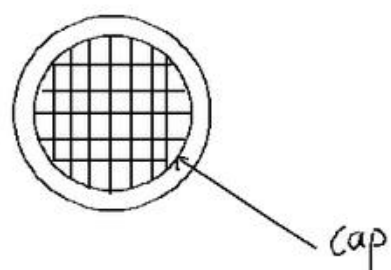
Specific Heat of Metals



Side View



Top View



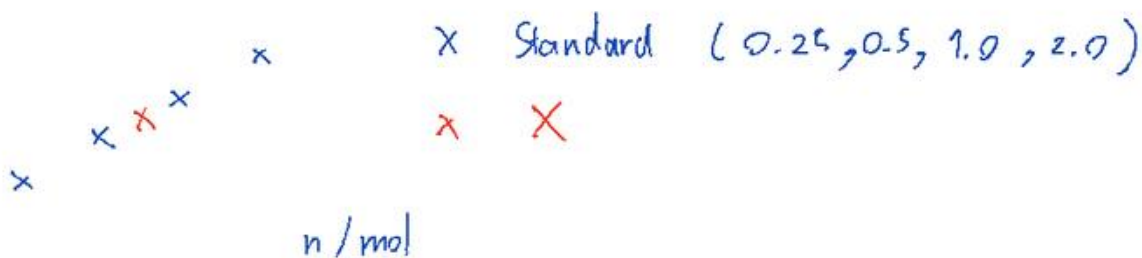
Unknown Unknown - limiting $\rightarrow$ Dilute
 Battery > Calorimeter > Titration
 - Error
 - Precision
 - Accuracy

Goal - find unknown concentration of H_2SO_4 Battery X M

X M of H_2SO_4 react with 1 M of NaOH
 excess ($0.25 < X < 2$)

Standard (0.25, 0.5, 1, 2) M of H_2SO_4
 With 2 M of NaOH

q / kcal



Prediction

$$\text{slope} = \text{kcal mol}^{-1}$$

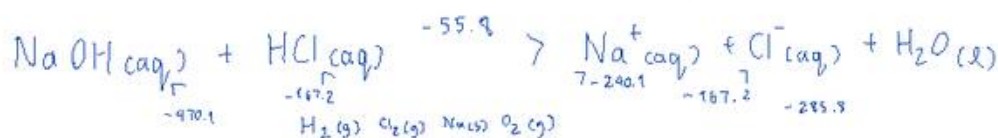
NaOH 10.17 M $\rightarrow$ 105 ml

DI_{water} 895 ml

Unknown HCl $\frac{0.25 \times 100 + 2 \times 35}{135} = 0.7\text{M}$

ess' law
used on
halpy of
formation

enthalpy



~0.25 50.0 ~25.0

~0.50 50.0 ~25.0

~1.00 50.0 ~25.0

~2.00 50.0 ~25.0

(approx room temp)

~25.0 26.0

~25.0 28.0

~25.0 30.0

~25.0 32.0

(approx room temp) (sample)

ΔH_n (a.s) NaOH

ΔH_n (a.s) NaOH

ΔH_n (a.s) HCl/NaOH

ΔH_n (a.s) HCl

If NaOH starts ~2.5 M
HCl if HCl sample < 1 M
NaOH if HCl sample > 1 M

calculate
 ΔH_n for
each
experiment
and
find
mean

(More space for Q3)

$$\Delta H_n = -1 \times \Delta T \times 100 \times \frac{C_p}{1000} \times \frac{1000}{C_r} \times \frac{1}{100}$$

$$\Delta T = t_f - \left(\frac{t_i + t_{cal}}{2} \right)$$

$$C_p = 4.184 \text{ J K}^{-1} \text{ g}^{-1}$$

C_r = molar concentration of the mixed solution (obtained base on calculation from titration experiment)

$$C_r = \frac{-1 \times \Delta T \times C_p}{\Delta H_n} <$$

$$\text{Conc of HCl} = C_r \times 2 <$$

Use data that has NaOH as limiting agent

The final concentration is half of the original because it has both water content of NaOH and HCl solution



/ml	6.10	21.60	15.90
/ml	21.60	37.10	30.65
/ml	15.50	15.50	14.75
	0.3080	0.3160	0.3096

pale pink pale pink pale pink pale pink pale pink pale pink

$$n = \frac{m}{M_r} \quad C = \frac{n}{V} \quad C_1V_1 = C_2V_2$$

$$\frac{m \text{ of KHP}}{M_r \text{ of KHP}} \times \frac{1}{\text{Total Volume of NaOH}} = \text{concentration of titrant NaOH}$$

$$\text{Conc of Stock NaOH} = \frac{\text{conc of titrant NaOH} \times 250 \text{ ml}}{10 \text{ ml}}$$

$$\frac{\text{conc of titrant NaOH} \times \text{Total Volume of NaOH}}{\text{Volume of Analyte}} = \text{conc of HCl}$$

$$\text{Volume of Analyte} = 10.00 \text{ ml}$$

$$\text{Conc of Stock HCl} = \frac{\text{conc of analyte HCl} \times 50 \text{ ml}}{5 \text{ ml}}$$