# Virtual Enthalpy Lab

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# 1 Aim

To calculate the enthalpy of a displacement reaction.

# 2 Data Collection

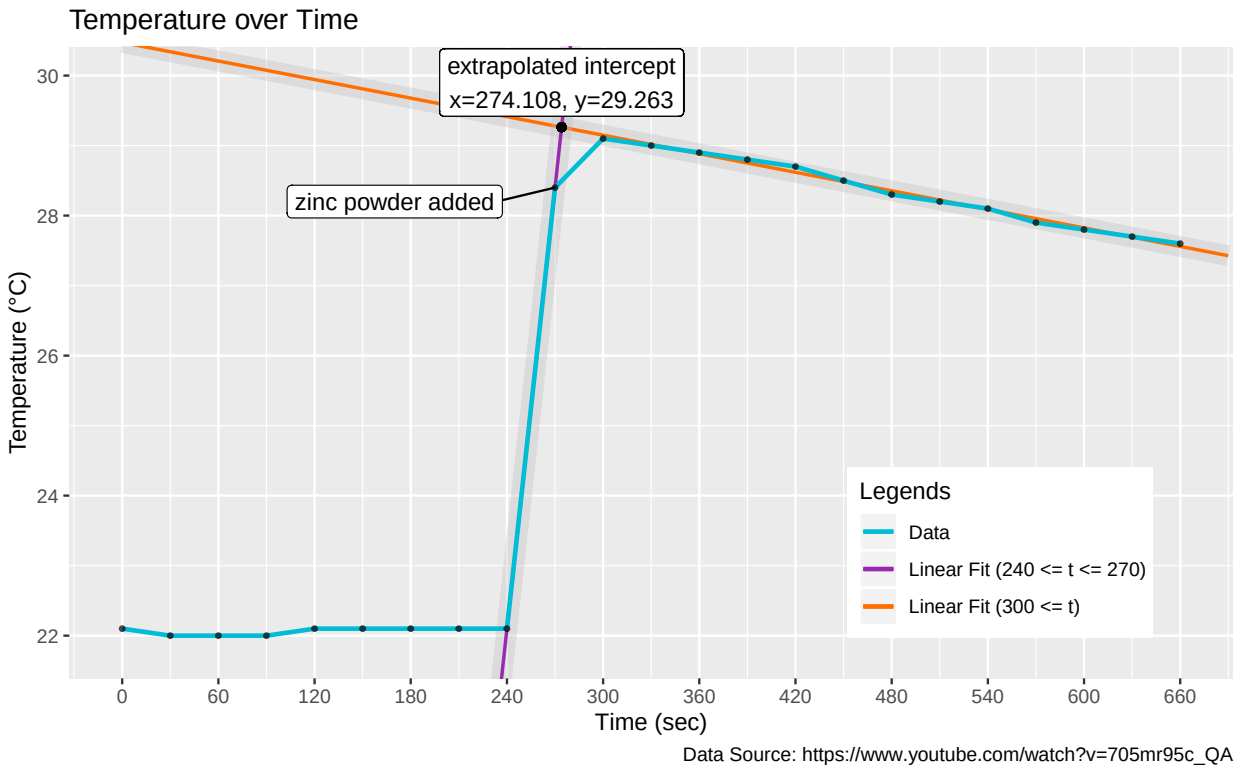


Figure 1: Graph

# 3 Data Analysis

## 3.1 $\max T$ – Maximum Temperature by Extrapolation

By extrapolating the lines, we can observe that the highest $T = 29.3°\text{C}$.

### 3.2 $\triangle T$ – Change of Temperature

The highest $T = 29.3°\text{C}$, and before adding Zn ($t = 240\text{sec}$) to the cup $T = 22.1°\text{C}$. Thus we can calculate that

$$\triangle T = 29.3°\text{C} - 22.1°\text{C} = 7.2°\text{C} \tag{1}$$

### 3.3 $Q$ – Heat

By using the equation of thermaldynamics, which is

$$Q = mC\triangle T \tag{2}$$

we can calculate the heat $Q$ as following:

$$\begin{aligned} Q &= mC\triangle T \\ &= 25\text{g} \cdot 4.18\text{Jg}^{-1}°\text{C}^{-1} \cdot 7.2°\text{C} \\ &= 752.4\text{J} \\ &= 0.7524\text{kJ} \end{aligned}$$

### 3.4 $n_{\text{solute}}$ – Moles of Solute Reacted

$$\begin{aligned} \frac{1000\text{mL}}{1\text{mol}} &= \frac{25\text{mL}}{n_{\text{solute}}} \\ n_{\text{solute}} &= 0.025\text{mol} \end{aligned}$$

### 3.5 $\triangle H$ – Change of Enthalpy

$$\begin{aligned} \frac{0.025\text{mol}}{0.7524\text{kJ}} &= \frac{1\text{mol}}{\triangle Q} \\ \triangle Q &= +30.096\text{kJ} \end{aligned}$$

We know that $\triangle H = -Q$ so that

$$\triangle H = 30.096\text{kJ}\,\text{mol}^{-1}$$

## 4 Error Analysis

1. The researcher have only partially sealed the calorimeter by leaving a hole on top of it in order to let the thermometer go through. Such setup may increase the amount of heat loss during the experiment.

   We could design a special case where there's a small hole (with diameter appximately 1cm) on it. This hole could be sealed with a cap when an insulated environment is needed, and can be opened when need to add Zn powder by using a funnel.

2. During stirring, the thermometer may touched the surface of the cup which can lead to sudden temperature drop and also may effect the proper operation on the thermometer.

   This could be solved by using a very well insulated container (such as a mug that is designed specifically for thermally insulated), where the inner surface of such container is having a relatively same temperature as the solution inside, which shall have a relatively small side effect on measurement.

3. After deploying Zn powder there's going to be a short period of time where the powder has already reacting with the liquid but the cap is not closed yet, and may release some amount of energy during this. This may cause the heat loss in the system due to the poor design of the apparatus.

   Same solution in Error 1 could be used.

4. By measuring with a interval of 30sec we could still get small variations on our data due to long interval and the time human may need on capturing the temperature, which may 'shift' the whole graph towards positive X which may lead to a slightly missed dataset comparing to the real values.

   We could utilize the LabQuest equipments that are available in the Physics laboratory where a digital thermometer could be used. Such digital thermometer is capable of sampling data up to a 20times/s rate which is way better than the manually 2times/min sampling rate.

# 5 Conclusion

Through calculations, the change of enthalpy in this reaction is determined as $30.096\text{kJ mol}^{-1}$. This data may have some error because several errors exist in the current system, and could be fixed by implementing and/or using some better apparatuses as listed in Section 4.