# analysis

May 13, 2023

## 1 Modules

[ ]:
```
import pandas as pd
```

## 2 Data

[ ]:
```
calorimeter = pd.read_csv("calorimeter.txt")
neutralization = pd.read_csv("neutralization-reaction.txt")
solution = pd.read_csv("solution.txt")
m_water_cold = 20 #g
m_water_hot = 10 #g
c_water = 4.18/1000 # kJ/gC
m_NaOH = 20 #g
m_HCl = 20 #g
mols_U = 1 / 60
mols_HCl = 20 * (10**-3)
m_water_solution = 40 #g
```

[ ]:
```
calorimeter
```

[ ]:

| | Tc(C) | Th(C) | deltaT(C) |
|---|---|---|---|
| 0 | 16.1 | 45.5 | 7.4 |
| 1 | 18.5 | 50.0 | 7.8 |

[ ]:
```
neutralization
```

[ ]:

| | Ti(C) | Tf(C) | deltaT(C) |
|---|---|---|---|
| 0 | 17.2 | 22.8 | 5.9 |
| 1 | 16.9 | 23.1 | 6.2 |

[ ]:
```
solution
```

[ ]:

| | Ti(C) | Tf(C) | deltaT(C) |
|---|---|---|---|
| 0 | 17.2 | 16.5 | -0.7 |
| 1 | 17.5 | 17.0 | -0.5 |

## 3 Calorimeter

The heat capacity of the water is $4.182\frac{J}{g\cdot°C}$

$C_{calorimeter} = -\frac{c_{water}}{\Delta T_{water\ cold}}(m_{water\ hot}\Delta T_{water\ hot} + m_{watercold}\Delta T_{water\ cold})$

[ ]:
```
delta_water_cold = calorimeter["deltaT(C)"]
delta_water_hot = calorimeter["Tc(C)"] + delta_water_cold - calorimeter["Th(C)"]

c_calorimeter =-(  c_water / delta_water_cold     )*(
  ↪m_water_hot*delta_water_hot + m_water_cold*delta_water_cold  )
mean_c_calorimeter = c_calorimeter.mean().round(2)  #kJ
std_c_calorimeter = round( c_calorimeter.std(),3 )  #kJ

"C calorimeter = "+str(mean_c_calorimeter)+" +- "+str(std_c_calorimeter)+" KJ/
  ↪°C"
```

[ ]:
```
'C calorimeter = 0.04 +- 0.002 KJ/°C'
```

## 4 Heat of reaction of neutralization

$NaOH + HCl \rightarrow H_2O + NaCl$

$E = -\Delta T(c_{calorimeter} + m_{solution}c_{water})$

In standard conditions ( 1 bar of pressure and 298K ) the enthalpy of neutralization is $60kJ/molHCl$,however, in the laboratory these conditions are not met, since Bogota has a pressure lower than atmospheric pressure and a temperature lower than 298K.

[ ]:
```
enthalpy = -neutralization["deltaT(C)"] * (c_calorimeter + (m_HCl+m_NaOH)*
  ↪c_water)
mean_enthalpy = round( enthalpy.mean() , 1 )
std_enthalpy =  round( enthalpy.std() ,2 )

mol_enthalpy = mean_enthalpy / mols_HCl
std_mol_enthalpy = std_enthalpy / mols_HCl

"enthalpy reaction " + str(mean_enthalpy) + " +- " + str(std_enthalpy) + " kJ, 
  ↪ " +  "enthalpy reaction per mol HCl " + str(mol_enthalpy) + " +- " +
  ↪str(std_mol_enthalpy) + " kJ/mol HCl "
```

[ ]:
```
'enthalpy reaction -1.3 +- 0.06 kJ,   enthalpy reaction per mol HCl -65.0 +- 3.0
kJ/mol HCl '
```

## 5 Enthalpy of solution of $CON_2H_4$

[ ]:
```python
enthalpy = -solution["deltaT(C)"] * (c_calorimeter + m_water_solution * c_water)
mean_enthalpy = round( enthalpy.mean(),2)
std_enthalpy =  round( enthalpy.std() ,2)

mol_enthalpy = round( mean_enthalpy / mols_U)
std_mol_enthalpy = round(std_enthalpy / mols_U)

"enthalpy solution " + str(mean_enthalpy) + " +- " + str(std_enthalpy) + " kJ, ␣
↪ " +  "enthalpy solution per mol of Urea " + str(mol_enthalpy) + " +- " +␣
↪str(std_mol_enthalpy) + " kJ/mol Urea "
```

[ ]:
```
'enthalpy solution 0.13 +- 0.03 kJ,   enthalpy solution per mol of Urea 8 +- 2
kJ/mol Urea '
```