ACTIVITY # 1 | PSC 320 | L. REED, G. BULLEN, H. Holy | 1/2

CALORIMETER

great

1. ENERGY CONVERSION FLOW CHART

(CANDLE) PARAFFIN WAX COMBUSTION U_c ⟹ IGNITION ⟹ HEATING WATER (Q_{H_2O}) + HEAT LOST TO ENVIRONMENT (Q_{LOSS})

↑ BUTANE COMBUSTION U_c (LIGHTER)

2. MEASURE INPUT ENERGY & OUTPUT ENERGY

HEAT TRANSFER

HEATING UP THE WATER:

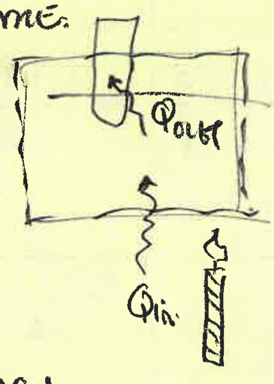
$$Q_{H_2O} = m_{H_2O} C_{p\,H_2O} (T_2 - T_1)_{H_2O}$$

CALORIMETER

COMBUSTION OF AIR

$$Q_{FUEL} = HHV_{FUEL} \cdot m_{FUEL}$$

CONTROL VOLUME:



$$Q_{in} = Q_{out}$$

$$\underset{WAX}{m \Delta H_c} = \underset{H_2O}{m c \Delta T}$$

↑ heat of combustion ↑ spec. heat capacity

PARAFFIN WAX

$\Delta H_c = 42 \frac{MJ}{kg}$

WATER

$c_p = 4.186 \frac{J}{g^\circ C}$

$\rho = 1 \frac{g}{mL}$

INPUT ENERGY

$$Q_{in} = m_{WAX} \Delta H_c$$

$$m_{WAX} = m_{INITIAL}^{WAX} - m_{WAX\,FINAL}$$

$m_{WAX\,i} = 0.94\ g$

$m_{WAX\,f} =$

ENERGY BALANCE:

$$E_{in} = E_{out}$$

$$(m_i - m_f)_{WAX}\,\Delta H_{c_{WAX}} = m_{H2O}\, c_{p_{H2O}} (T_f - T_i) + Q_{LOSS}$$

$$(m_i - m_f)\,\Delta H_{c_{WAX}} = \rho_{H2O} V_{H2O}\, c_{p_{H2O}} (T_f - T_i) + Q_{LOSS}$$

INITIAL MEAS

$V_{H2O} = 6.0$ mL

$T_i = 21.5°C$

$$m_{H2O} = \frac{1\,g}{mL} \cdot 6.0\,mL = 6.0\,g$$

Pretty small

FINAL MEASUREMENTS:

$\Delta t = 1{:}46$ — TIME TO HEAT

$m_{f_{WAX}} = 0.86\,g$

$T_f = 44.25°C$

$$(0.94 - 0.86\,g)\,42\,\frac{MJ}{1000\,g} = 6.0\,g \cdot 4.186\,\frac{J}{g°C}(44.25 - 21.5°C) + Q_{LOSS}$$

(1×10^6 J = MJ)

$$(0.08\,g)\,42000\,\frac{J}{g} = 571\,J + Q_{LOSS}$$

$$3360\,J - 571\,J = Q_{LOSS}$$

$$Q_{LOSS} = 2789\,J$$

3) POWER

$$P_{FUEL} = \frac{Q_{H2O}}{\Delta t} = \frac{3360\,J}{(60 + 46\,sec)} = 20.2\,W$$

(166 sec)

$$P_{WATER} = \frac{Q_{H2O}}{\Delta t} = \frac{571\,J}{166\,s} = 3.44\,W$$

4)

$$\eta = \frac{Q_{H2O}}{Q_{FUEL}} = \frac{571\,J}{3360\,J} \doteq 17\%$$

5) WOULD INSULATE THE EXPERIMENT!