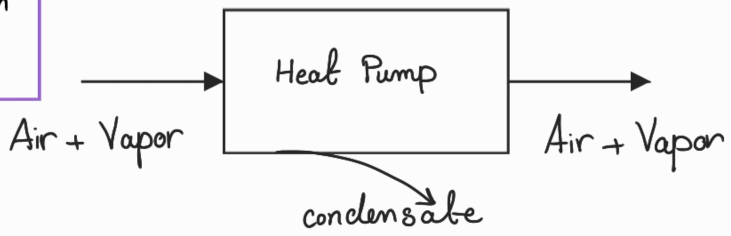
# Experiment 1

## Experimental Heat Pump and air cooler

vapor compression cycle/ Refrigeration cycle



## Calculations

$$P_a = \frac{RT}{P_a}$$

Density

ambient pressure

$$\gamma = \frac{\phi P_w}{P_a}$$

Humidity ratio

specific Humidity

Heat:

$Q_1 = m_1 C_p T_1$ Energy dry air has at inlet

$Q_2 = \gamma m_1 h_v$ Energy of water vapor entering

$Q_3 = m_1 C_p T_2$ Energy dry air has at outlet

$Q_4 = (\gamma m_1 - m_2) h_v$ Energy of water vapor leaving

$Q_5 = m_2 h_w$ Energy of condensate

$Q_6 = m_3 T_3 c_w$ Energy of water entering

$Q_7 = m_3 T_4 C_w$ Energy of water entering

$Q_8$ = Radiation and stray losses

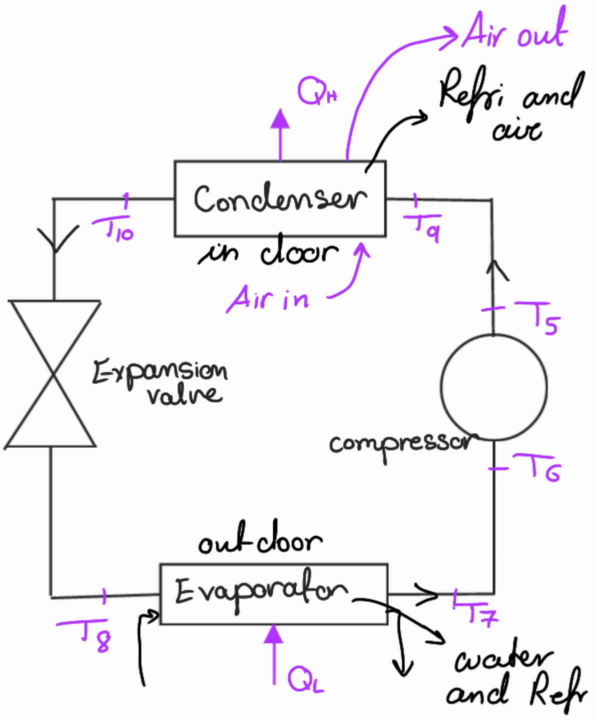
**Note**

$$\gamma m_1 = \frac{\text{Kg vapor}}{\text{Kg dry air}} \times \text{Kg dry air}$$

## To calculate $Q_8$

$$(Q_6 - Q_7) + (E_c + E_p) = (Q_3 + Q_4 + Q_5) - (Q_1 + Q_2) + Q_8$$

$$\underbrace{\text{Energy of condensate} + \text{Energy of compressor and fan}}_{\text{Energy needed}} = \underbrace{\text{Energy out} - \text{Energy Entering}}_{\text{Energy Added}} + Q_8$$



## To calculate coefficient of performance

Real: $(CP_H)_E = \frac{(Q_3+Q_4+Q_5)}{E_c+E_F} = \frac{\text{Energy Added}}{\text{Energy needed}}$

Ideal: $(CP_H)_{max} = \frac{\overset{\text{energy obtaned}}{(T_1+T_2)/2}}{\underset{\text{energy used}}{(T_1+T_2)/2-(T_3+T_4)/2}}$

## To calculate internal coefficient of performance

Real: $(CP_H)_I = \frac{(Q_3+Q_4+Q_5)-E_f-(Q_1+Q_2)}{E_c}$

Ideal: $(CP_H)_{max} = \frac{\overset{\text{Ref. out of condenser}}{T_{10}}}{\underset{\text{Air to Refrigerant}}{T_{10}-T_8}}$

**Note**

$T_1$ constant : Air in

$T_2$ increase : Air out

$T_3$ constant : water in

$T_4$ Decreases : water out

$T_{10}$ increase } Refrigerent

$T_7$ Decreases }

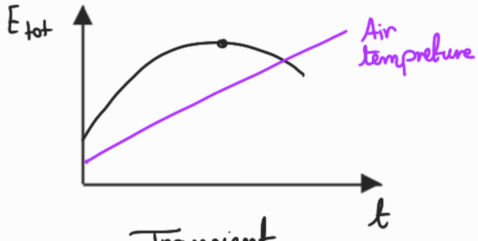
$T_5, T_6, T_8, T_9$ :

## What are the conditions of the experiment?

1 constant flow rate (transient)

2 various flow rate (steady state)

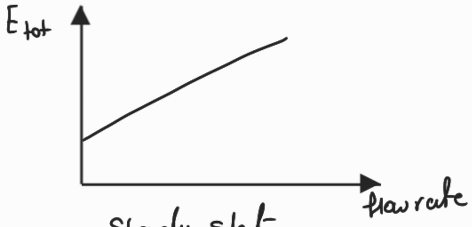
## What are the results of the experiment?



Transient

constant water flow rate
time is changing

Power increases until it reaches maximum point then it decreases why? because $T_{air}$ in the room increases as time passes so less power is needed to heat the air



Steady state

changing flow rate & constant time

when flow rate of water increases more Power is needed since heat transfer increases

## Apparatus

- water flow meter in the condenser → Rotameter
- manometer → connected with static tube → air flow rate
- Air properties are : T dry Bulb , T wet Bulb