實驗三 Evaporation Heat of Water

Object：

Determine λ(evaporating heat per gram), and compute the difference between the inner energy of the liquid water and the vapor ΔU.

Theory：

To brief matter from the liquid state into vapor state, we need an energy Λ. This energy Λ is used to increase the internal energy U, and to do the work which is necessary to expand the matter from the volume of the liquid to the volume of the vapor：

$$W = P(V_V - V_L)$$

Where P = the outside pressure.

V_V = the volume of the vapor.

V_L = the volume of the liquid.

With a good approximation we can

1. Neglect V_L compared to V_V.
2. Treat the vapor as an ideal gas.

So we have：$W = PV_V = RT$

(we consider the evaporation heat of one mole liquid)

With the first law of thermodynamics we have：$\Lambda = \Delta U + RT$

In our experiment we use electric energy to evaporate a certain mass of water m. Using the electric-heat equivalent we have：

$$IV_e tr = m\lambda + q$$

Where I = current, in Ampere.

V_e = voltage, in Volt.

r = 0.23 cal/joule.

m = evaporated amount of water. In gram.

λ = evaporating heat per gram, in cal/g.

q = the energy that is lost because of the fact that our system is not completely isolated.

To eliminate the unknown q, we evaporate water twice with different currents I. Then we have：

$$I_1 V_{e1} tr = m_1 \lambda + q \qquad \text{and} \qquad I_2 V_{e2} tr = m_2 \lambda + q$$

From both equation we get：

$$\lambda = \frac{(I_1 V_{e1} - I_2 V_{e2}) tr}{m_1 - m_2}$$

we assume that q is unchanged in both experiments.(why can we do this?)

Procedure：

1. Ask the assistant to check the water level in the dewar vessel and to open the water tap for cooling water.
2. Switch on the transformer and bring the current to I_1=3A.
   Record the current and the voltage.
3. Wait until the condensed water runs uniformly. Then change the vessel to a vessel with some water in it (determine the mass m_a before change it), and start timing with a stop watch.
4. After 10 minutes take away the vessel and determine the mass m_b.

$$m_b - m_a = m_1$$

5. Repeat the procedure with I_2=3.3A

Circuit Diagram：