To Study the Factors Affecting the Rate of Loss of Heat of a Liquid

Aim
To study the factors affecting the rate of loss of heat of a liquid.

Apparatus
Two calorimeters A and B of different areas, two thermometers, two stands, stopwatch, wooden lids, burner and liquid (water).

Theory
According to Newton's Law of cooling, rate of cooling (i.e., heat lost per sec) of a body is directly proportional to the difference of temperature of the body and the surrounding.

$$\frac{dQ}{dt} = K(T - T_0)$$

where, T = temperature of hot liquid.

T_0 = temperature of surrounding (air).

K = constant, it value depends upon.

(i) Nature of surface.
(ii) Area of surface.
(iii) Nature of material of body.

Then, for same difference of temperature, rate of cooling also depends upon :
(i) Area of the surface of the body.
(ii) Nature of the surface of the body.
(iii) Material of the surface of the body (material effects conductivity through walls of the body).

Diagram

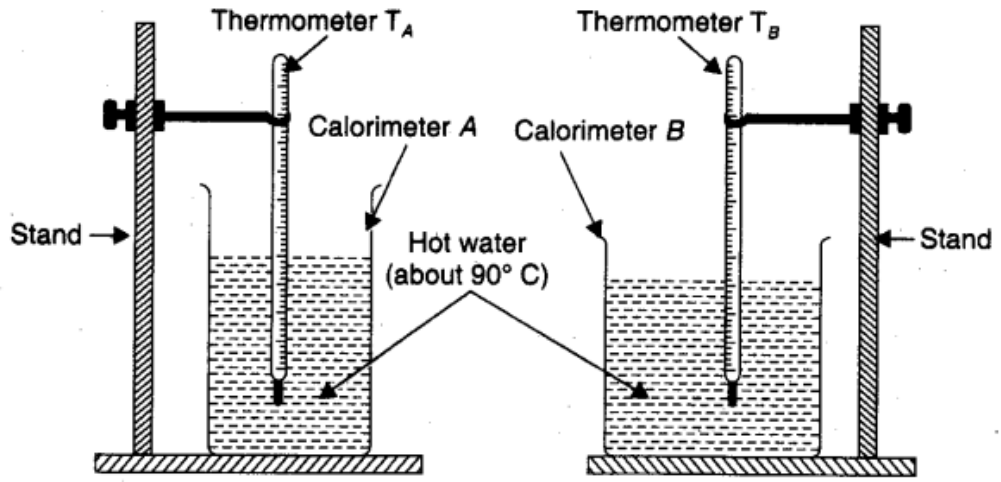


Fig. Studying the effect of area of surface losing heat.

Procedure

1.Fill the space between double wall of the enclosure with water and put the enclosure on a laboratory table.
2.Fill the calorimeter two-third with water heated to about 80°C.
3.Suspend the calorimeter inside the enclosure along with a stirrer in it. Cover it with a wooden lid having a hole in its middle.
4.Suspend from clamp and stand, one thermometer in enclosure water and the other in calorimeter water.
5.Note least count of the thermometers.
6. Set the stop clock/watch at zero and note its least count.
7. Note temperature (T0) of water in enclosure.
8. Start stirring the water in calorimeter to make it cool uniformly.
9. Just when calorimeter water has some convenient temperature reading (say 70°C), note it and start the stop clock/watch.
10. Continue stirring and note temperature after every one minute. The temperature falls quickly in the beginning.
11. Note enclosure water temperature after every five minutes.
12. When fall of temperature becomes slow note temperature at interval of two minutes for 10 minutes and then at interval of 5 minutes.
13. Stop when fall of temperature becomes very slow.
14. Record your observations as given ahead.

Case I. Take same volume of same liquid in calorimeters of small and large cross¬section (nature and material of surface same).

Case II. Take same volume of same liquid in similar calorimeters having black painted and polished outer surface (area and material of surface same).

Case III. Take same volume of same liquid in similar calorimeters of different materials (area and nature of surface same).

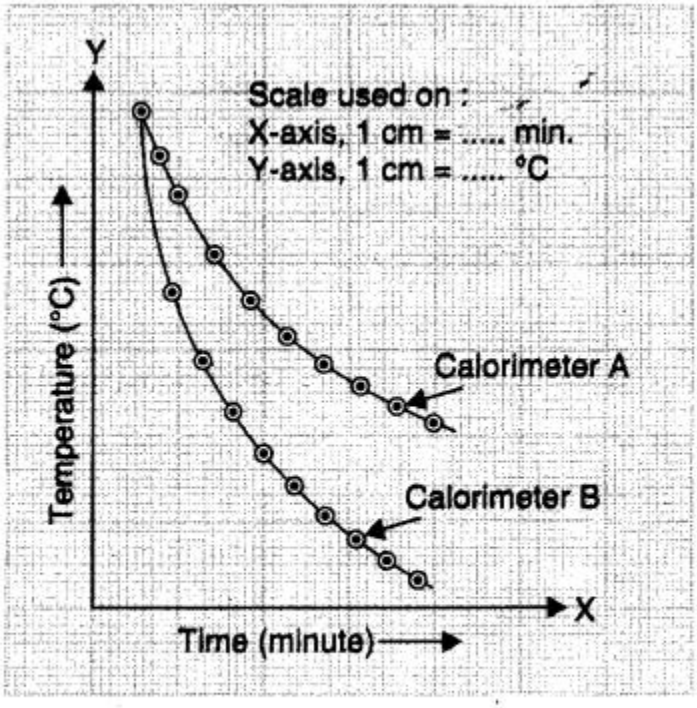
Observations

Least count of enclosure water thermometer =……..°C.
Least count of calorimeter water thermometer = ……..°C.
Least count of stop clock/watch = …….s.
Table for time and temperature

Serial No. of Obs.	Time for cooling t(mt)	Temperature of water in calorimeter T (°C)	Temperature of water in enclosure T_0 (°C)	Difference of temperature $T - T_0$ (°C)
1.	0	70	30	40
2.	1	68		38
3.	2	66		36
4.	3	64		34
5.	4	62		32
6.	5	61	30	31
7.	6	60		30
8.	7	59		29
9.	8	58		28
10.	9	56		26
11.	10	54	30	24
12.	12	53		23
13.	14	51		21
14.	16	49		19
15.	18	46		16
16.	20	44	30	14
17.	25	42	30	12
18.	30	38	30	8
19.	35	36	30	6
20.	40	35	30	5
21.	45	34	30	4

(Note. The ideal observations given above are as sample.)

Graph



Temperature and time for calorimeter A, having small surface area and calorimeter B having large surface area.

Comparison of graphs

Case I. Cooling is fast from more surface area.
Cooling is slow from less surface area.

Case II. Cooling is fast from black painted surface and slow from polished surface of the calorimeter.

Case III. Cooling is fast from calorimeter having more conducting material and slow from calorimeter having less conducting material.

Result

Case I. Rate of cooling depends upon the area of the surface through which heat is lost. More area of surface causes higher rate of cooling.

Case II. Rate of cooling depends upon the nature of the surface through which heat is lost. Black painted surface causes higher rate of cooling.

Case III. Rate of cooling depends upon the material of the surface. More conducting surface causes higher rate of cooling.

Precautions

1. Double-walled enclosure should be used to maintain surrounding at a constant temperature.
2. Stirring should remain continuous for uniform cooling.
3. Same volume of same liquid should be taken in all cases.
4. Graphs of one case should be plotted on same graph paper on same scale.