



ACTIVITY

AIM

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

MATERIAL REQUIRED

Two identical calorimeters (A and B) along with their lids and stirrers, one another calorimeter C with internal diameter about twice of the diameter of calorimeters (A and B), two thermometers of least count 0.1°C each.

Two stands each with a clamp for holding thermometer, 500 ml beaker to heat the water, a stopwatch, a cylinder and plastic mug and two tumblers of same size.

THEORY

The rate of loss of heat by a body is given by,

$$\frac{dQ}{dt} = m \times S \times \frac{d\theta}{dt}$$

Where,

$\frac{d\theta}{dt}$ is the rate of fall of temperature which is also called as rate of cooling.

m is the mass and so are the specific heat capacity of the material of the body.

The rate of loss of heat and the rate of fall of temperature are two different concepts. To be practical here, we would our confine our investigations to study of the factor on which the rate of cooling i.e.,

$\frac{d\theta}{dt}$ depends.

The rate of loss of heat of a body depends upon the:

1. Area of the exposed surface.
2. Nature of the radiating surface.
3. Difference between the temperature of the hot body and that of its surrounding.

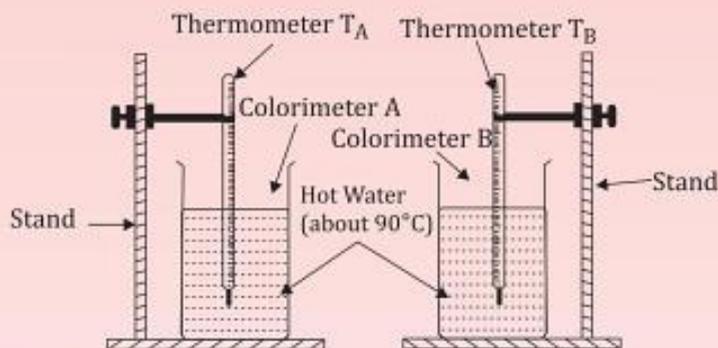
PROCEDURE

A. EFFECT OF SURFACE AREA:

1. Take two calorimeters A and B of much different diameter and arrange them with thermometers as shown in figure.
2. Label the thermometers as T_A and T_B and note their least count.
3. Take hot water up to 90°C and pour 200 ml of it in each calorimeter.

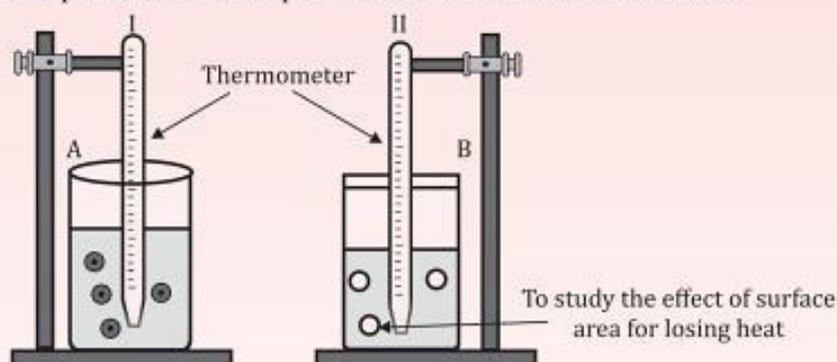
Note: the temperature of water in both the calorimeters initially after an interval of 1 minute and then after 2 minutes in the observation table.





B. EFFECT OF THE NATURE OF SURFACE:

4. Take two identical calorimeters A and B. Blacken the outer surface of one of them with the help of flame of a candle keeping the surface of other shining.
5. Pour 200 ml of boiling water in each calorimeter and suspend thermometer in each calorimeter.
6. Note the reading of fall of temperature with respect to time in the observation table.



C. EFFECT OF TEMPERATURE DIFFERENCE BETWEEN THE LIQUID AND THE SURROUNDING:

7. Clean the surface of two identical calorimeters as shown in the figure.
8. Note the least count of the thermometers.
9. Take hot water up to 85 °C and pour 200 ml water in one calorimeter and pour 200 ml water at a
10. lower temperature (say 65 °C) to another calorimeter.
11. Suspend thermometer in each calorimeter with the stand.
12. Note the fall of temperature of water in each calorimeter with respect to time.
13. Tabulate the observations and plot a graph between the temperature and time elapsed.

OBSERVATIONS

Least count of the thermometer $T_A = \text{---} \text{ } ^\circ\text{C}$

Least count of the thermometer $T_B = \text{---} \text{ } ^\circ\text{C}$

TABLE FOR EFFECT OF AREA OF SURFACE

S. No.	Calorimeter A		Calorimeter B	
	Time (min)	Temperature T_A ($^\circ\text{C}$)	Time (min.)	Temperature T_B ($^\circ\text{C}$)
1.				
2.				
3.				

4.				
5.				
6.				
7.				

TABLE FOR EFFECT OF NATURE OF SURFACES (EQUAL SURFACE AREA)

S. No.	Calorimeter A, Natural metal surface		Calorimeter B, Blackened surface	
	Time (min.)	Temperature T_A ($^{\circ}\text{C}$)	Time (min.)	Temperature T_B ($^{\circ}\text{C}$)
1.				
2.				
3.				
4.				

TABLE FOR EFFECT OF TEMPERATURE DIFFERENCE BETWEEN HOT BODY AND ITS SURROUNDING

Room temperature $\theta_0 = \dots\dots\dots^{\circ}\text{C}$

Initial temperature of water in calorimeter, A = 85°C

Initial temperature of water in calorimeter, B = 65°C

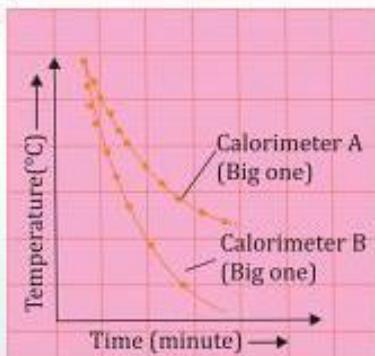
S. No.	Calorimeter A, Time (min)	Initial temperature = 85°C Temperature ($^{\circ}\text{C}$)	Calorimeter B Time (min.)	Initial temperature = 65°C Temperature ($^{\circ}\text{C}$)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

GRAPH

Plot a graph between the time (t) (along X – axis) and temperature (along Y – axis) after taking a suitable scale.

Scale used on X-axis, 1 cm = min

Scale used on Y-axis, 1 cm = $^{\circ}\text{C}$



Graph showing the effect of area of surface on rate of cooling.



RESULT

The rate of loss of heat from a liquid (water):

1. Increases with the increase in the surface area.
2. Increases when the heat is radiated from the black surface.
3. Increases with the temperature difference between the liquid and the surroundings.

PRECAUTIONS

1. Take equal volume of hot water in each case.
2. Do not place two calorimeters very close to each other.
3. Water should be kept stirring slowly.
4. Outer surface of the calorimeter should be kept exposed to air.

SOURCES OF ERROR

1. The condition of the surroundings may change during the experiment.
2. The liquid may be disturbed while taking observations.

VIVA VOCE

Q1. State Newton's law of cooling.

Ans. It states that for small temperature difference between a body and its surroundings, the rate of loss of heat by the body is directly proportional to its excess temperature over the surroundings.

$$E \propto (T - T^{\circ})$$

Q2. Why should water in calorimeters be constantly stirred?

Ans. The stirring ensures that the temperature of whole water in the container remains constant.

Q3. Why do animals tend to fold their bodies when they feel cold?

Ans. To minimize the surface area and hence, to minimize heat loss.

Q4. If the calorimeters are made of different materials but identical in all other respects, how will the:

(i) rate of cooling, and

(ii) rate of loss of heat

Will be affected?

Ans. According to Newton's law of cooling, the rate of cooling depends upon temperature difference of body and its surroundings, so, rate of cooling will not be affected but rate of loss of heat will be different.

Q5. What is the effect of surface area of container on rate of loss of heat of water?

Ans. The rate of loss of heat increases with increase in surface area.

Q6. If the surface of the container is coated with black colour, what will be its effect on the rate of loss of heat?

Ans. Increases.