ACTIVITY 12

AIM

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

APPARATUS AND MATERIAL REQUIRED

Two copper calorimeters of different sizes (one small and another big); two copper calorimeters of same size (one painted black and the other highly polished), two tumblers of same size (one metallic and another plastic); two thermometers having a range of - 10° C to 110° C and least count 0.5 °C, stop watch/clock, cardboard lids for calorimeters, two laboratory stands, a pan to heat water; a measuring cylinder, a plastic mug.

PRINCIPLE

Hot bodies cool whenever placed in a cooler surrounding.

Rate of loss of heat is given by $\frac{dQ}{ds}$

Q = mass × specific heat capacity(s) × temperature (θ) = $ms\theta$

$$\frac{dQ}{dt} = ms\frac{d\theta}{dt}$$

hence rate of loss of heat is proportional to rate of change of temperature.

The rate of loss of heat of a body depends upon (a) the difference in temperature of the hot body and its surroundings, (b) area of the surface losing heat, (c) nature of the surface losing heat and (d) material of the container.

PROCEDURE

(A). Effect of area of surface on rate of loss of heat.

1. Note the room temperature, least count of the two thermometers (T_A and T_B).

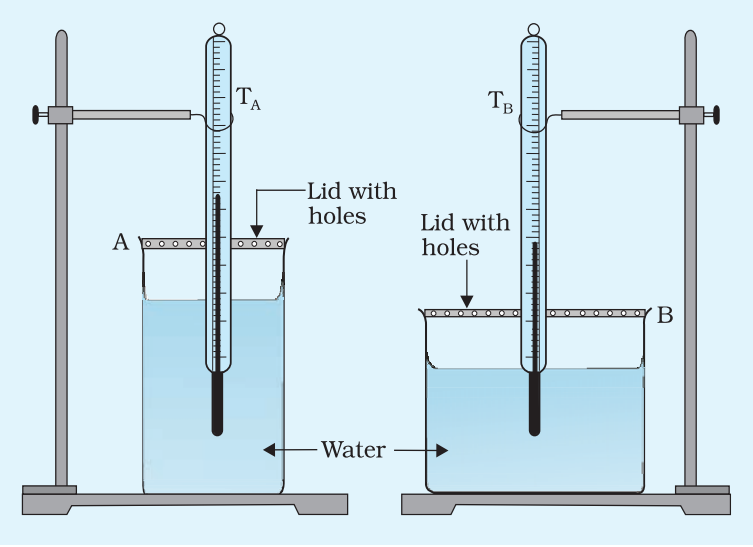

Fig. A 12.1: *Experimental set up for studying the effect of surface area on cooling*

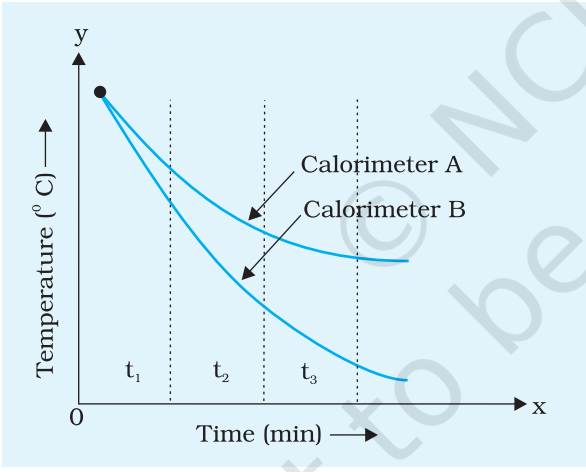

Fig. A 12.2: *Cooling curve for water cooled in calorimeters A and B. Surface area of water is more for calorimeter B than for the calorimeter A*

2. Take the big (A) and small (B) calorimeters.

3. Heat water in the pan up to nearly 80°C (no need to boil the water).

4. Pour 100 mL of hot water in calorimeter (A) and also in calorimeter (B). This should be done carefully and with least time loss. One can use a plastic mug to pour 100 mL of hot water in a measuring cylinder.

5. Insert a thermometer in each of the two calorimeters. Use stands to keep the thermometers vertical. Also ensure that the thermometer bulb is well inside the hot water in the calorimeters (Fig. A 12.1).

6. Note the temperature of the water in the two calorimeters initially at an interval of 1 minute till the temperature of water in the calorimeter is about 40-30°C above the room temperature and thereafter at intervals of 2 minutes when the temperature of hot water is about 20-10°C above room temperature.

7. Record your observation in Table A 12.1. Plot graphs between θ_A versus time and θ_B versus time for both the calorimeters on the same graph paper (Fig. A 12.2).

8. Determine the slope of θ versus t graph after 5 minute interval.

OBSERVATIONS

Least count of thermometer = ... °C

Room temperature = ... °C

Table A 12.1: Effect of area of surface on rate of cooling

	Calorimeter A (Big)			Calorimeter B (Small)	
S. No.	Time	Temp θ_A	S. No.	Time	Temp θ_B

B. Effect of nature of surface of container on rate of cooling of a liquid

1. Use the two identical small calorimeters; one with black (A) and the other with highly polished (B) surfaces.
2. Repeat Steps 3 to 8 as in part A.

Table A 12.2: Effect of nature of surface on rate of cooling

	Calorimeter Black (A)			Calorimeter White (B)	
S. No.	Time	Temp θ_A	S. No.	Time	Temp θ_B

C. Effect of material of container on rate of cooling of a liquid

1. Use the metallic tumbler (A) and the plastic tumbler (B) instead of calorimeters.
2. Repeat Steps 3 to 8 as in part A. Record your observations in a table similar to Table A 12.1.

RESULT

From the six graphs plotted on 3 graph sheets complete the following:

1. The rate of cooling is ... °C/min in the larger calorimeter as compared to the smaller calorimeter.

2. Least rate of cooling is ... °C/min observed in calorimeter ... part A/B/C.
3. Black surfaces radiate ... heat as compared to white or polished surface in the same time when heated to the same temperature.
4. Plastic mugs are preferred for drinking tea, as the rate of cooling of a liquid in them is ...

PRECAUTIONS

1. θ_A, θ_B and time recordings are to be done simultaneously so a set-up that allows both thermometers could be read quickly and at the same time should be planned.
2. The lid of the calorimeter should be covered with insultating material to make sure that the heat is lost (cooling takes place) only from the calorimeter surface.
3. All three activities should be performed under similar conditions of wind and temperature of the surrounding to reduce their effect on the rate of cooling.

DISCUSSION

1. The rate of cooling in summers is lower than in winters. Give a reason for your answer.
2. Surface of metallic kettles are often polished to keep the tea warm for a long time.
3. Why does the rate of cooling decrease when the temperature of liquid is closer to the room temperature?

SUGGESTED ADDITIONAL EXPERIMENTS/ACTIVITIES

1. Compare the effectiveness of disposable thermocole tumblers with that of glass for taking tea.
2. Study the rate of cooling of tea contained in a stainless steel (metallic) teapot and a ceremic teapot.
3. Compare the rate of cooling of tea in a cup and in a saucer.