

PROJECT 10

A_{IM}

To study the effect of nature of surface on emission and absorption of radiation.

A_{PPARATUS AND MATERIAL REQUIRED}

Two identical calorimeters with wooden lids having holes for thermometers, two thermometers, clamp stands for holding thermometer, arrangement to coat one calorimeter black and the other shining white, stop-clock, ice.

P_{RINCIPLE}

Black surfaces are good emitters and good absorbers of heat radiation. Bright surfaces are poor emitters and poor absorbers of heat radiation.

P_{ROCEDURE}

A. For emission of radiation

1. Note the range and least count of both the thermometers.
2. Record the room temperature.
3. Paint one of the calorimeters with black paint or lamp black as shown in Fig. P 10.1(a) and the other calorimeter white with aluminium paint or by wrapping shining silver foil around the calorimeter as shown in Fig. P 10.1(b).
4. Fill hot water in each calorimeter and insert a thermometer in each. Let them stand 30 cm apart.
5. Start the stop-clock and keep it in the middle.
6. Record the temperatures of both the calorimeters at intervals of $\frac{1}{2}$ a minute for first 10 minutes and next 10 minutes at intervals of one minute.

B. For absorption of radiation

1. Use the two calorimeters used for Activity (A) above.
2. Fill them with cold water taken from the refrigerator or made by adding ice to tap water.
3. Insert thermometers in the calorimeters and place them in front of an electric heater so that they receive the same amount of heat.

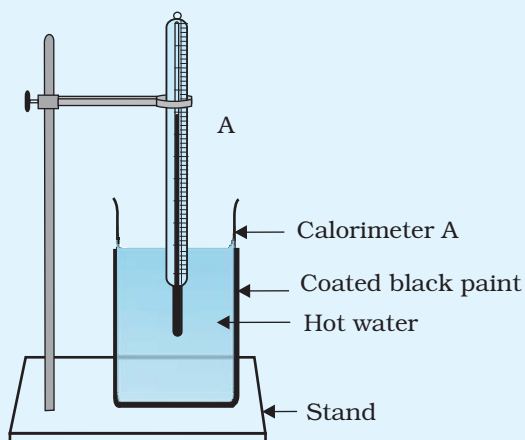


Fig. P 10.1(a): Experimental setup for studying emission of heat radiation from black surface

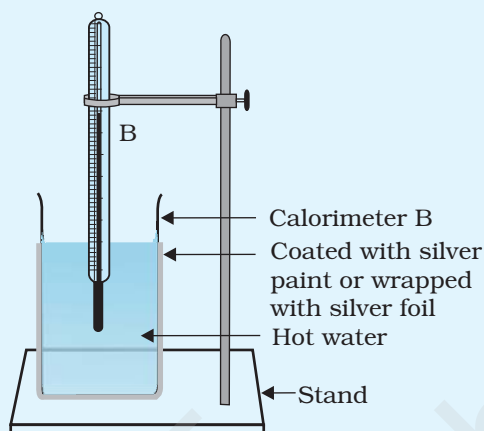


Fig. P 10.1(b): Experimental setup for studying emission of heat radiation from shining surface

Alternatively, place them in the sun, if there is bright sunlight coming from a window.

- With the help of a stop-clock, take temperature vs. time data as in Activity (A).

OBSERVATIONS AND CALCULATIONS

Range of thermometer A = ... °C

Least count of thermometer A = ... °C

Range of thermometer B = ... °C

Least count of thermometer B = ... °C

Table P 10.1(a) : For emission of radiation

S. No.	Black coated calorimeter			
	Time (t) (minutes)	Temperature of water (°C)	Time (t) (minutes)	Temperature of water (°C)
1				
2				
3				

Table P 10.1(b) : For absorption of radiation

S. No.	Black coated calorimeter		White painted calorimeter	
	Time (t) (minutes)	Temperature of water (°C)	Time (t) (minutes)	Temperature of water (°C)
1				
2				
3				

GRAPH

Plot a graph between time (on x-axis) and temperature (on y-axis) for both the calorimeters and for both, emission and absorption, as shown in Fig. P 10.2 (a) and (b).

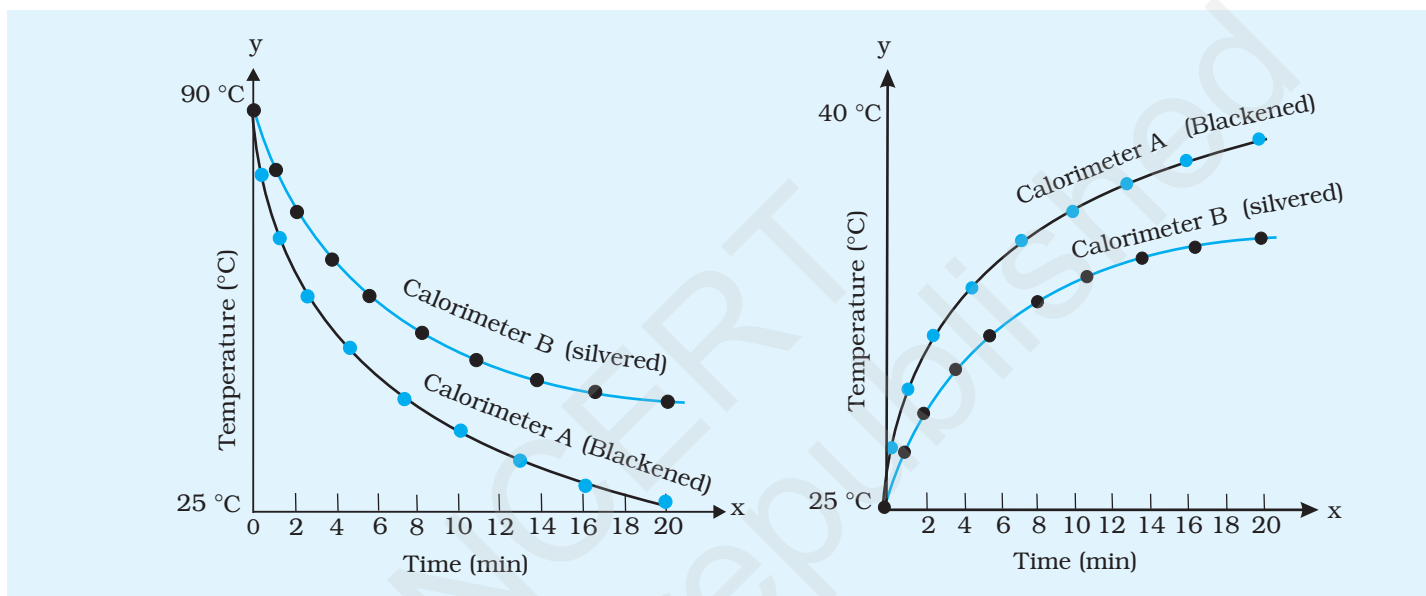


Fig. P 10.2(a): Temperature vs. time graph for emission of heat radiation

Fig. P 10.2(b): Temperature vs. time graph for absorption of heat radiation

CONCLUSION

1. Compare the rates of cooling in Activity (A) in both cases for the same temperature range. It is found that the (blackened/silvered) calorimeter is a better emitter of heat.
2. Compare the rise in temperatures of the two calorimeters in Activity (B). It is found that the ... calorimeter is a better absorber of radiation.

SOURCES OF ERROR

1. Perfectly black and perfectly shining surfaces may not be available.
2. Variations in surrounding temperature during the period of Activity may take place.

PROJECT 11

A_{IM}

To study conservation of energy with a 0.2 pendulum.

A_{PPARATUS AND MATERIAL REQUIRED}

A heavy spherical bob with a hook, thread, metre scale, a peg (a pencil or a 15 cm scale), a rigid support and a stand with a clamp.

P_{RINCIPLE}

A simple pendulum of length l , mass m oscillates due to the restoring force expressed as $F = -mg \sin \theta$ for small displacement (less than 15°)

$$\sin \theta = \theta = \frac{x}{l}$$

The force constant k can be written as $k = \frac{mg}{l}$

and maximum kinetic energy $KE = \frac{1}{2} kx^2$

D_{ESCRIPTION}

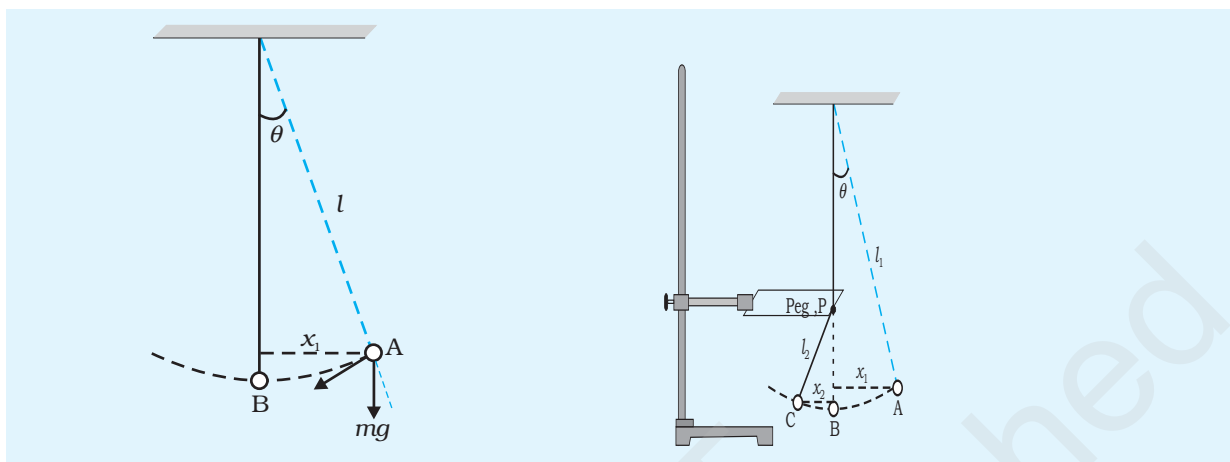
When the oscillation of a simple pendulum is restricted into two parts using a peg P at any point on its string, it becomes a two-length pendulum. During one half of the journey, the bob of mass m , has length l_1 and displacement x_1 at position A and for other half it has a length l_2 and displacement x_2 . At position B, the bob of mass m has the same kinetic energy. Therefore, energy conservation demands that

$$\frac{1}{2} k_1 x_1^2 = \frac{1}{2} k_2 x_2^2$$

$$\text{or } \frac{l_1}{l_2} = \frac{x_1^2}{x_2^2}$$

This relationship (Eq. P 11.1) can be verified for different positions of peg P.

(P 11.1)

**Fig. P 11.1:** A simple pendulum**Fig. P 11.2:** A two-length pendulum

PROCEDURE

1. Setup a simple pendulum using a heavy bob. Release the bob gently from position A and measure the maximum displacement x_1 , using a metre scale (Fig. P 11.1).
2. Fix a peg P (a pencil or a scale will do) horizontally to a clamp stand and bring it in contact with the string of the oscillating pendulum. The peg should obstruct the motion of the pendulum when its string is vertical, that is, along its mean position (Fig. P 11.2).
3. The effective length of the pendulum would get reduced for a part of its oscillation after it is held by the peg (Fig. P 11.2).
4. Measure the maximum displacement x_2 using metre scale, when the bob reaches at position C.
5. Repeat the Steps 2 to 4 for different positions of peg P.
6. Record these observations in a table and calculate $\frac{l_1}{l_2}$ and $\frac{x_1^2}{x_2^2}$ for each case.
7. Establish the equality, $\frac{l_1}{l_2} = \frac{x_1^2}{x_2^2}$.

OBSERVATIONS AND CALCULATIONS

Length of a simple pendulum, $l = \dots$ cm

S. No.	Displacement of bob		Length of the pendulum		$\frac{l_1}{l_2}$	$\frac{x_1^2}{x_2^2}$
	In position A x_1 (cm)	In position B x_2 (cm)	In position A l_1 (cm)	In position B l_2 (cm)		
1						
2						
3						
4						

RESULT

Relationship $\frac{l}{l} = \frac{x}{x}$, based on the conservation of energy is verified.