11
CBSE

Practical Skills in

PHYSICS

SUPPLEMENTARY MATERIAL

(AS PER THE REVISED CBSE SYLLABUS 2019-20)

Full Circle Education Pvt Ltd
(Progressive Educational Publishers)
Formerly
Full Marks Pvt Ltd
New Delhi-110002

As per the Circular – Curriculum dt. 29/3/2019 The following changes have been made in Practical Skills in Physics by the CBSE

EXPERIMENTS ADDED

1. **Elasticity**

   1.2 To find the force constant of a helical spring by plotting a graph between load and extension

2. **Atmospheric Pressure**

   2.1 To study the variation in volume (V) with pressure (P) for a sample of air at constant temperature by plotting graphs between P and V and between P and 1/V

5. **Thermal Radiation and Heat**

   5.1 To study the relationship between the temperature of hot body and time by plotting a cooling curve

1.2 TO FIND THE FORCE CONSTANT OF A HELICAL SPRING BY PLOTTING A GRAPH BETWEEN LOAD AND EXTENSION

The force constant of a spring is also known as the spring constant. It is the ratio of restoring force and extension. A spring works on the principle of Hooke's law.

Aim

To find the force constant of a helical spring by plotting a graph between load and extension.

Materials Required

● Helical spring ● Slotted weights ● Weight pan ● Pointer ● Vertical metre scale ● A stand with rigid support

Theory

If a load F is suspended from a helical spring it increases the length of the spring. If change in length is Δl, then

$$F \propto \Delta l$$

or,

$$F = k\Delta l$$

where, k is the spring constant.

Spring constant,

$$k = \frac{\text{Restoring force, (F)}}{\text{Extension } (\Delta l)}$$

If m is the mass of the load, then

$$mg = k\Delta l$$

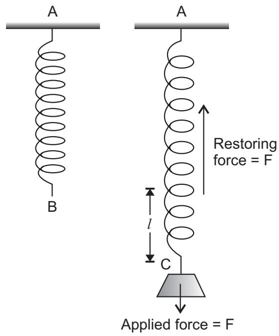
$$\Delta l = \frac{mg}{k}$$

If

$$\Delta l = 1$$

Then,

$$k = mg = F$$



Elasticity of Helical Spring

So, spring constant can be defined as the force required to produce a unit extension in the spring.

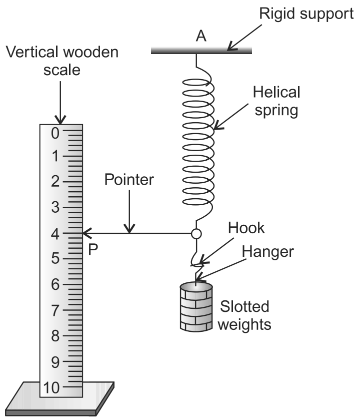
Procedure

Setting up the Apparatus

- Suspend a helical spring from a rigid support.
- Attach a pointer and a hanger to free end of the helical spring.
- Check for free movement of pointer over divisions of the vertical scale.
- Ensure that the tip of the pointer does not touch the vertical scale.

Measurement of Extension in Length

- Note down the initial position of the pointer.
- Add a suitable weight (e.g. 50 g) to the hanger. The tip of pointer moves down.
- Allow the tip of the pointer to come to rest.
- Note down the position of the pointer.
- Add weights in incremental steps and repeat the above steps.
- Similarly remove weights in incremental steps and note the position of the tip of the pointer each time.



Extension of Spring

Observations

Least count of vertical scale = ____cm.

Mass of hanger = ____g.

Mass of each slotted weight = ____g.
Mean extension in length, Δl = ____ cm.

Calculation

The spring constant k can be calculated by using following formula:

$$k = \frac{mg}{\Delta l}$$

Example: Suppose a weight of 200 g wt. produces an extension of 2 mm in the spring. Then

$$k = \frac{200\text{g} \times 9.8\ \text{ms}^{-2}}{2\ \text{mm}} = \frac{0.2\ \text{kg} \times 9.8\ \text{N}}{2 \times 10^{-3}} = 980\ \text{N/m}$$

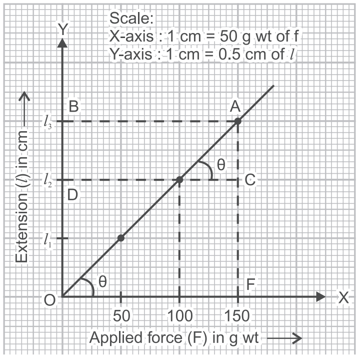
Plotting of Graph

Plot a graph between load, mg (or restoring force, F) and extension, Δl. Take load on X-axis and extension along Y-axis. The graph is a straight line.

$$\text{Slope of straight line} = k = \frac{F}{\Delta l}$$

$$\tan\theta = \frac{AC}{GC} = \frac{BD}{EF}$$

So, $k = \tan\theta =$ ____Nm^{-1}



Load-extension graph for helical spring

Reults

- The force constant of the given spring = ____ Nm^{-1} (from graph)
  = ____ Nm^{-1} (from formula)
- The graph between load and extension is a straight line.

Precautions

- Allow the pointer to come to rest before taking reading.
- Weight should be increased in small increments.
- Loading should not be done beyond elastic limits of the spring.
- Motion in the loaded spring should not be jerky.
- Be gentle while adding or removing weights.
- Tip of pointer should not touch the vertical scale.
- Vertical scale should be parallel to vertical spring.

Sources of Error

- Slotted weights may not show correct weight.
- Pointer may not be horizontal.
- The support may not be rigid.
- Too much load may end up stretching the spring permanently.

Suggested Experiments

1. Repeat this experiment with a stiff spring.
2. Repeat this experiment with a least stiff spring.

VIVA VOCE

Q1. Define force constant or spring constant of a spring.

Ans. The force required to produce unit extension in a spring is called the force constant or spring constant of that spring.

Q2. What is the SI unit of force constant?

Ans. Newton per metre (Nm^{-1})

Q3. What is the effect of thickness of wire on spring constant?

Ans. The value of spring constant increases with thickness of wire.

Q4. It is ensured that the tip of pointer should not touch the vertical scale. Why?

Ans. This is done to nullify the effect of friction between pointer and vertical scale. If friction is there, it will give errors in reading.

Q5. Define Spring constant.

Ans. Spring constant is defined as the force required to produce a unit extension.

Q6. Which devices use Helical spring?

Ans. Spring balance.

NCERT LAB MANUAL QUESTIONS

Q1. If the length of the wire used is reduced what will be its effect on
(*a*) extension on the wire and (*b*) stress on the wire

Ans. (*a*) If the length of the wire used is reduced then the extension on the wire is reduced.
(*b*) If the length of the wire used is reduced then there will be no change in the stress on the wire.

Q2. Use wire of different radii (r_1, r_2, r_3) but of same material in the above experimental set up. Is there any change in the value of Young's modulus of elasticity of the material? Discuss your result.

Ans. No, since Young's modulus of elasticity of a material is constant and it doesn't change with radius of the wire of the same material.

❑❑❑

2.1 TO STUDY THE VARIATION IN VOLUME (V) WITH PRESSURE (P) FOR A SAMPLE OF AIR AT CONSTANT TEMPERATURE BY PLOTTING GRAPHS BETWEEN P AND V AND BETWEEN P AND 1/V

Boyle's law gives the relationship between pressure and volume, at constant temperature. According to Boyle's law pressure is inversely proportional to the volume of the gas at constant pressure.

Aim

To study the variation in volume (V) with pressure (P) for a sample of air at constant temperature by plotting graphs between P and V and between P and 1/V.

Materials Required

- Boyle's law apparatus
- Plumb line
- Fortin's Barometer
- Thermometer
- A pair of set-squares

Theory

Boyle's law

For an enclosed gas, at constant temperature (T)

$$P \propto \frac{1}{V}$$

or

$$PV = \text{constant}$$

A graph between P and 1/V is a straight line.

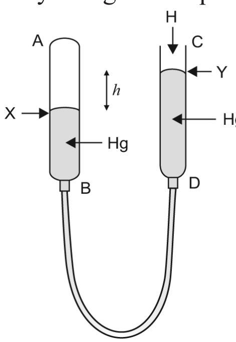
Pressure and volume can be determined using Boyle's law apparatus.

Procedure

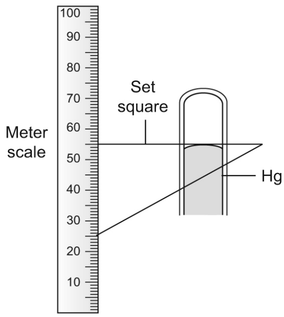
- Set the apparatus with wooden board vertically with the help of levelling screws.

Measurement of Pressure

- The pressure of enclosed air in tube AB is measured by noting the difference (h) in mercury levels in two tubes.
- This is done by using a set square; as shown in figure.



Pressure of air in tube



Measuring the level of mercury by using set-square

$$h = Y - X$$

$\Rightarrow$ P (pressure of enclosed air) = $Z \pm h$ (where, Z is atmospheric pressure)

Measurement of Volume of Trapped Air

- When the closed tube is not graduated the volume can be found as follows:
  Volume of air in tube = Volume of air in Length PR – Volume of air in curved portion PQ.
- The radius (r) of the tube can be found with the help of a Vernier calliper.

$$\text{Volume of curved portion} = \text{Volume of hemisphere of radius } r.$$

$$= \frac{1}{2} \times \frac{4}{3}\pi r^3 = \frac{2}{3}\pi r^3$$

$$\text{Volume of PQ} = \pi r^2 \times r = \pi r^3$$

$$\text{Error in volume} = \text{Volume of PQ} - \text{Volume of curved portion}$$

$$= \pi r^3 - \frac{2}{3}\pi r^3 = \frac{1}{3}\pi r^3$$

$$\text{Correction in length} = -\frac{1}{3}r = \frac{1}{3}\text{PQ}$$

Required correction in length needs to be subtracted from measured length.

Measurement of Volume of Air at Given Pressure

- Set up the plank of Boyle's law apparatus vertically by adjusting levelling screws and spirit level.
- Using a thermometer, note down room temperature.
- Using Fortin's Barometer note down atmospheric pressure.
- Adjust the height of tube CD so that mercury level in both the tubes become same.
- After that, note down the volume of air in tube AB.

Raising the tube CD

- Raise the tube CD by about 2 cm.
- Note down the higher level of mercury in tube AB.
- Note down the reduced volume of air in AB.
- Note down the mercury level in CD.
- Further raise the tube CD by about 2 cm and repeat above steps.
- Repeat the previous steps a few more times.

Lowering the tube CD

- Now lower the tube CD by about 2 cm.
- Note down the increased volume of air in AB.
- Note down the mercury level in CD.
- Lower down CD further by about 2 cm and repeat above steps.
- Repeat the previous steps a few more times.

Observations

Mean of Atmospheric Pressure

Atmospheric pressure at the beginning of experiment, Z_1 = _____cm of Hg

Atmospheric pressure at the end of experiment, Z_2 = _____cm of Hg

Mean Atmospheric Pressure, $Z = \frac{Z_1 + Z_2}{2}$ = _____cm of Hg

Room Temperature

Room temperature at the beginning of experiment, t_1 = _____°C

Room temperature at the end of experiment, $t_2 = \frac{t_1 + t_2}{2}$ = _____°C

Mean temperature, T = $t_1 + t_2/2$ = _____°C

Correction in Level of Mercury due to curved portion of tube AB

Reading at the top end of tube, AB = x_1 = _____cm

Reading at the beginning of curved portion of tube AB = x_2 = ____cm

Correction = $\frac{1}{3}(x_1 - x_2)$ = ____cm

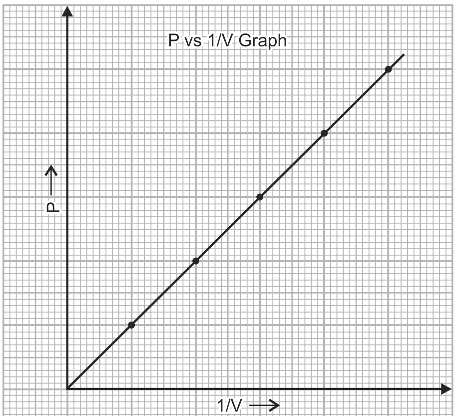
Alternately, correction can also be calculated by using

$$l = \frac{1}{3}r \quad \text{where, } r = \text{radius of tube}$$

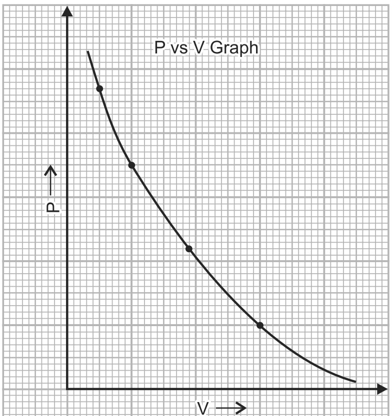
Position of Hg level		Pressure Difference (p) (cm) Tube AB – Tube CD	Pressure of Air $P = Z_0 + p$ (cm of Hg)	Volume of air V (cm^3)	$\frac{1}{V}$ (cm^{-3})	PV
In Tube AB (cm)	In Tube CD (cm)					
20	20	0	75.0	20	0.050	1500
19.5	15.6	+ 3.9	78.9	19	0.053	1499.1
18.5	5.3	+ 13.2	88.2	17	0.059	1499.54
20.5	24.1	– 3.6	71.4	21	0.048	1499.4
21.5	27.8	– 6.8	68.2	22	0.045	1500.4
21.5	31.3	– 9.8	65.2	23	0.043	1499.6

Plotting of graph

- Draw a graph between P(on y-axis) and V(on x-axis). The graph is a hyperbola.
- Draw a graph between P(y-axis) and 1/V(x-axis). The graph is a straight line.



Graph between P and 1/V



Graph between P and V

Results

- The graph of P vs 1/V shows an upward slanting line. This means that as per Boyle's law volume of a given mass of gas is inversely proportional to pressure at constant temperature.
- The graph of P vs V shows a downward sloping curve. This means that as per Boyle's law volume of a given mass of gas is inversely proportional to pressure at constant temperature.

Precautions

- The apparatus should be set in perfectly vertical and horizontal position.
- The open tube should be moved gradually.
- Set square should be positioned at the upper meniscus level while taking the reading.
- Calculate the correction for curved portion of closed tube and use this while measuring the volume of air.
- Plug the open tube with cotton; when it is not in use.
- Mercury should be clean, without traces of glass.

Sources of Error

- Possible charges in atmospheric pressure and room temperature during the experiment.
- Presence of moisture in air in closed tube.
- Error while taking the reading.
- Chances of oxidization of mercury during exposure to air.

Suggested Experiments

1. Determine the values of 1/V for different values of h.
2. Analyse the significance of atmospheric pressure in this experiment.

VIVA VOCE

Q1. What is Boyle's Law?

Ans. Boyle's Law explains the relation between pressure and volume of a given mass of gas at constant temperature. It states that at constant temperature, the volume of given mass of gas varies in indirect proportion to the pressure.

$$P \propto \frac{1}{V}$$

Where, P is pressure and V is volume of the given mass of gas.

Q2. What happens to the volume of air when it is released from an inflated tube?

Ans. The volume of air released from an inflated tube experiences less pressure once it is outside the tube. So, by following Boyle's law its volume increases.

Q3. What is an ideal gas?

Ans. The gas which obeys Charles' law, Boyle's law and Avogadro's law of gases is called an ideal gas.

Q4. What do you understand by LPG or Liquefied Petroleum Gas?

Ans. The cooking gas supplied in cylinders is called LPG or Liquefied Petroleum Gas. This is because the gas is filled in cylinders by applying very high pressure and the high pressure turns the gas into liquid form.

Q5. Why do tubes of vehicles burst during summers?

Ans. According to Charles' Law, the volume of a given mass of gas varies directly with temperature. During summers the air in the inflated tube increases in volume because of rise in temperature. The pressure on tube increases because of this, which finally leads to bursting of the tube.

Q6. What do you understand by atmospheric pressure?

Ans. Amount of force per unit area exerted by the atmosphere is called atmospheric pressure.

Q7. What is the SI unit of atmospheric pressure?

Ans. SI unit of atmospheric pressure is bar.

$$1 \text{ bar} = 10^5 \text{ Nm}^{-2}$$

Another unit for atmospheric pressure is one standard atmosphere. It is abbreviated as 'atm'. 1 atm is the pressure exerted by a mercury column of height 76 cm.

Q8. Which instrument is used for measuring atmospheric pressure?

Ans. Barometer.

Q9. What is the reason for mercury being used in barometer?

Ans. Any liquid can be used for making a barometer. Mercury has the highest density among liquids. As a result the height of barometer can be conveniently small. Hence, mercury is used in barometer.

Q10. What is Aneroid barometer?

Ans. Aneroid barometer is used in aeroplanes to measure the attained height. It does not contain a liquid.

Q11. How would you use a barometer to forecast a storm?

Ans. A sudden fall in the level of mercury shows reduced air pressure, which is an indication of an upcoming storm.

Q12. Which law gives the relationship between pressure and volume of a gas? Define Boyle's law?

Ans. According to Boyle's law; pressure varies inversely as volume of a gas; if temperature and mass are constant.

Q13. Which device is used for measuring pressure of gas?

Ans. Barometer is a device to measure pressure of gas.

Q14. What happens to the volume of gas inside a bicycle tube when temperature increases?

Ans. Bicycle tube's burst due to increase in volume. This is in accordance to Charles' law.

Q15. Which two laws give the ideal gas equation?

Ans. Combination of Boyle's law, pressure law and Charles' law gives ideal gas equation.

NCERT LAB MANUAL QUESTIONS

Q1. Plot $\frac{1}{V}$ versus 'h' graph and determine the value of $\frac{1}{V}$ when $h = 0$. Compare this to the value of atmospheric pressure. Give a suitable explanation for your result.

Ans. We know that pressure $p = H \pm h$. We also know that graph between $\frac{1}{V}$ and p is a straight line. Hence, the graph between $\frac{1}{V}$ and h would also be a straight line. This shows that pressure of a given mass of gas is inversely proportional to its volume.

Q2. Comment on the two methods used for estimation of the volume of the curved portion of the closed tube. What are the assumptions made for the two methods?

Ans. One of the methods assumes the curved portion as a hemisphere, while another method assumes the curved portion to be a cylinder with same radius and height. Both the methods show some difference in final calculation.

Q3. If the diameter of tube AB is large, why would the estimation of the curved portion be unreliable?

Ans. If diameter of the tube AB is large then radius will not be equal to height. Hence, there will be unreliable estimation of the curved portion.

Q4. The apparatus when not in use should be kept covered to avoid contamination of mercury in the open tube. How will oxidation of mercury affect the experiment?

Ans. Oxidation of mercury will reduce the amount of mercury in the tube and will thus lead to incorrect measurement of pressure.

❑❑❑

5.1 TO STUDY THE RELATIONSHIP BETWEEN THE TEMPERATURE OF HOT BODY AND TIME BY PLOTTING A COOLING CURVE

According to the Newton's law of cooling, the rate of cooling is directly proportional to the temperature of the object above its surroundings, provided that the difference between the temperature of the object and its surrounding is not very large.

Aim

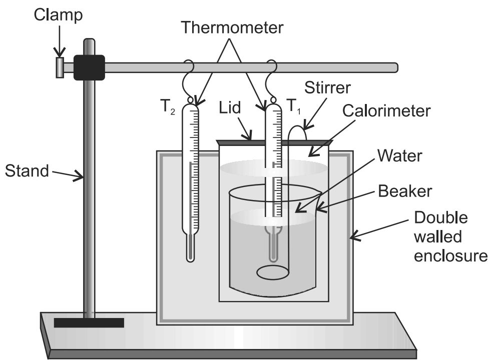
To study the relationship between the temperature of hot body and time by plotting a cooling curve.

Materials Required

- Two thermometers
- Beaker
- Tripod stand
- Thread
- Clamp and stand
- Burner
- Stopwatch
- Newton's law of cooling apparatus
- Wire gauge
- Two rubber stoppers with holes

Theory

The Newton's law of cooling apparatus has a double walled enclosure which is closed by an insulating lid. The calorimeter is suspended inside the double walled enclosure. In between the double walls, water is filled to keep the temperature of surrounding constant. Through the holes of lid thermometers are inserted.



Newton's law of cooling apparatus

According to Newton's law of cooling

$$\frac{dQ}{dt} = -k(T - T') \qquad ...(i)$$

Rate of cooling,

$$\frac{dQ}{dt} = ms\frac{dT}{dt}$$

or

$$-k(T - T') = ms\frac{dT}{dt} \qquad \text{[from eq. } (i)]$$

$$\frac{dT}{dt} = -k'(T - T')$$

On integrating

$$\int \frac{dT}{T - T'} = -k' \int dt$$

$$ln\,(T - T') = -k't + C$$

or

$$2.303 \log (T - T') = -k't + C$$

where, C is integration constant.

A graph between log (T – T′) and t will be a straight line.

Procedure

Calibrate the Thermometer

- Clean the Newton's law of cooling apparatus and keep it on table.
- Determine the least counts of both the thermometers (T_1 and T_2).
- Put the thermometer T_1 in a beaker by using a clamp stand and measure its temperature.
- Put the thermometer T_2 in the double-walled container by using the clamp stand and measure its temperature.
- The difference between the two readings gives the value of required correction.

Measuring the Falling Temperature of Hot liquid

- Find the least count of stop watch.
- Put water (at room temperature) in double-walled container.
- With the help of a clamp stand, fix the thermometer T_2 in the water in double walled container.
- Note the initial reading of thermometer T_2 (*i.e.,* value of Q_1) at the beginning of experiment.
- Heat some water to a temperature of about 40°C above the room temperature. Pour the hot water in calorimeter up to the top.
- Keep the calorimeter along with hot water; in the enclosure and cover the lid.
- Fix the thermometer T_1 and stirrer in the calorimeter through the holes in the lid.
- Put rubber stoppers in the lid to make the apparatus airtight.
- Wait for some time and note the initial temperature of the water between the double walls, with the thermometer T_2.
- When the difference between readings of two thermometers is about 30°C, start the stopwatch.
- Note the reading of thermometer T_1 after every minute. This is T°C.
- Keep on stirring gently and constantly.
- When the temperature drops to about 5°C above that of enclosure, record the reading of thermometer T_2 after every two minutes. This is T'°C.
- Once the fall in temperature becomes very low, stop noting the temperature and stop the stopwatch.

Observations

Calibration in Thermometer

Initial reading of thermometer T_1, a = ____°C.

Initial reading of thermometer T_2, b = ____°C.

Correction needed on thermometer T_2, $(a – b)$ = ____°C.

Cooling curve

Least count of stopwatch = ____S.

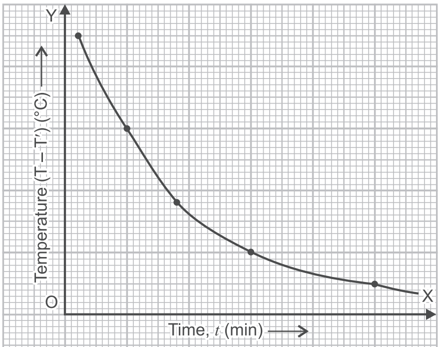
Table for Measuring Change in the Temperature of Water with Time

S. No.	Time for cooling, *t*(s)	Temperature of water in calorimeter, T (°C)	Difference of water temperature, T – T' (°C)	$\log_{10}$ (T – T')
1				
2				
3				
⋮				
20				

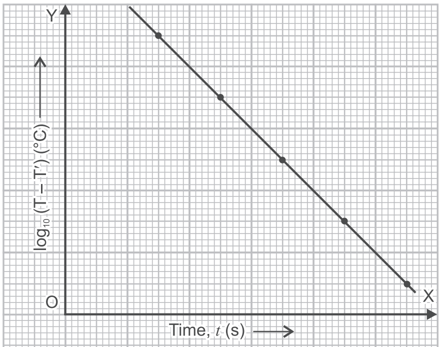
Least count of thermometers = ____°C.
Initial temperature of water in enclosure, Q_1 = ____°C.
Final temperature of water in enclosure, Q_2 = ____°C.
Mean temperature, $T' = \frac{Q_1 - Q_2}{2}$ = ____°C.

Plotting of Graph

- Plot a graph between temperature (T – T′) and time.
- Plot a graph between log (T – T′) along *y*-axis and time along *x*-axis.



Graph between (T – T′) and *t*



Graph between log (T – T′) and *t*

Results

- From graph it is concluded that the temperture decreases quickly in the beginning and then slowly.
- The graph between change in temperature and time is a curved line.

Precautions

- Stirring should be gentle and continuous.
- Holes in the lid should be made airtight.
- Initial temperature of water in calorimeter must be about 30°C above room temperature.
- Always carry out calibration of thermometer before starting this experiment.
- Thermometer should not touch the wall of calorimeter.

Sources of Error

- Possible change in temperature of surrounding.
- Failure to continuously stir the water.
- Faulty operation of stop watch.
- Holes in lid may not be airtight.

Suggested Experiments

1. Plot the graph of temperature difference and time to determine the value of C.
2. Verity Stefan's law with this experiment.

Result

The downward slope of the curve means that at high temperature the rate of cooling is faster compared to the rate of cooling at low temperature.

VIVA VOCE

Q1. What is Newton's law of cooling?

Ans. It states that the rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings.

Q2. White clothes or brighter clothes are more comfortable in summers. By which mode of conduction of heat brighter clothes reflect off heat energy?

Ans. Radiation.

Q3. How is phenomenon of radiation used in cooking utensils?

Ans. Bottoms of some cooking utensils are black coloured to absorb heat due to radiation.

Q4. Which type of heat transfer is mainly responsible for heating up of cooking utensil?

Ans. Conduction.

Q5. Which type of heat transfer mechanism explains the flow of air from coast to sea during daytime?

Ans. Convection.

Q6. Which type of heat transfer mechanism explains the flow of air from sea to coast during night?

Ans. Convection.

Q7. What do you understand by conduction of heat?

Ans. Transfer of heat through solids takes place by conduction.

Q8. What do you understand by convection?

Ans. Convection is responsible for transfer of heat through fluids.

Q9. What do you understand by radiation?

Ans. With the help of radiation heat can be transferred even in the absence of a medium.

Full Circle Education Pvt Ltd
(Progressive Educational Publishers)
Formerly
Full Marks Pvt Ltd
4238A/1, Ansari Road, Daryaganj
New Delhi-110002
Phone: 011-40556600 (100 lines)
Fax: 011-40556688
E-mail: info@fcepl.in
Website: www.fullcircleeducation.in