

**Selina Solutions For Class 9 Physics**  
**Chapter 6 – Heat and Energy**

Exercise-6(A)

1. **What is heat? Write its S.I unit.**

**Solution:**

Heat is the internal energy of molecules constituting the body. It flows from a hot body to a cold body. The S.I. unit of heat is joule (J).

2. **Two bodies at different temperatures are placed in contact. State the direction in which heat will flow.**

**Solution:**

Heat flows from the body having higher temperature to a body with low temperature.

3. **Name the S.I. unit of heat. How is it related to the unit calorie?**

**Solution:**

The S.I. unit of heat is joule (J).

Joule is related to unit calorie in the following way:

$1\text{J} = 0.24\text{cal}$  (approximately)

4. **Define temperature and write its S.I unit.**

**Solution:**

Temperature is a quantity which conveys the thermal state of a body (i.e., the degree of hotness or coolness of the body). It determines the direction of flow of heat when two bodies at different temperatures are placed in contact.

The S.I. unit of temperature is Kelvin (K)

5. **Why does a piece of ice when touched with hand, appear cool? Explain.**

**Solution:**

It appears cool because when ice is touched, heat passes from our hand to the ice.

6. **Distinguish between heat and temperature.**

**Solution:**

The differences are as follows:

<b>Heat</b>	<b>Temperature</b>
Form of energy obtained as a result of random motion of molecules in a substance	Quantity that indicates the thermal state of a body, determines direction of heat flow when two bodies are kept in contact having different temperatures
S.I. unit - Joule (J)	S.I. unit - Kelvin (K)
Measured using - Principle of calorimetry	Measured using - Thermometer
Amount of heat contained in a body depends on mass, temperature, material of the body	Temperature depends on the average kinetic energy of its molecules as a result of their random motion

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**7. What do you understand by thermal expansion of a substance?**

**Solution:**

Thermal expansion of a substance is its expansion when it is heated.

**8. Name two substances which expand on heating.**

**Solution:**

The two substances that expand on heating are:

- Brass
- Iron

**9. Name two substances which contract on heating.**

**Solution:**

The two substances that contract on heating are:

- Silver iodide from  $80^{\circ}\text{C}$  to  $141^{\circ}\text{C}$
- Water from  $0^{\circ}\text{C}$  to  $4^{\circ}\text{C}$

**10. What do you mean by anomalous expansion of water?**

**Solution:**

It is the expansion of water when it is cooled from  $4^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ .

**11. At what temperature the density of water is maximum? State its value.**

**Solution:**

The density of water is maximum at  $4^{\circ}\text{C}$ , its value is  $1000\text{ kg m}^{-3}$ .

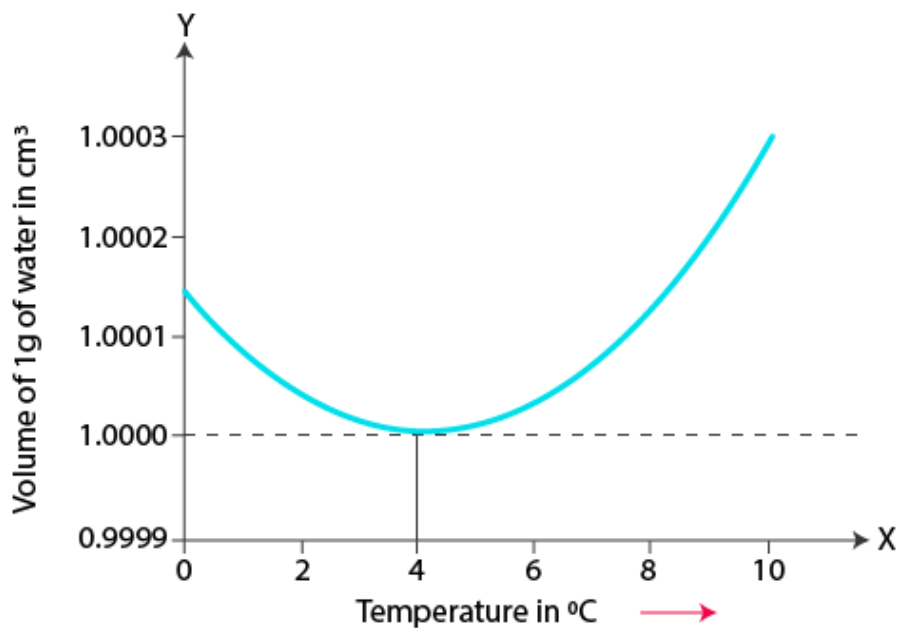
**12. State the volume changes observed when a given mass of water is heated from  $0^{\circ}\text{C}$  to  $10^{\circ}\text{C}$ . Sketch a temperature-volume graph to show the behavior.**

**Solution:**

The volume change, it decreases when a given mass of water is heated from  $0^{\circ}\text{C}$  to  $4^{\circ}\text{C}$ , i.e., it contracts. The volume increases when it is heated from  $4^{\circ}\text{C}$  to  $10^{\circ}\text{C}$ . i.e., it expands.

The following temperature-volume graph shows the behavior:

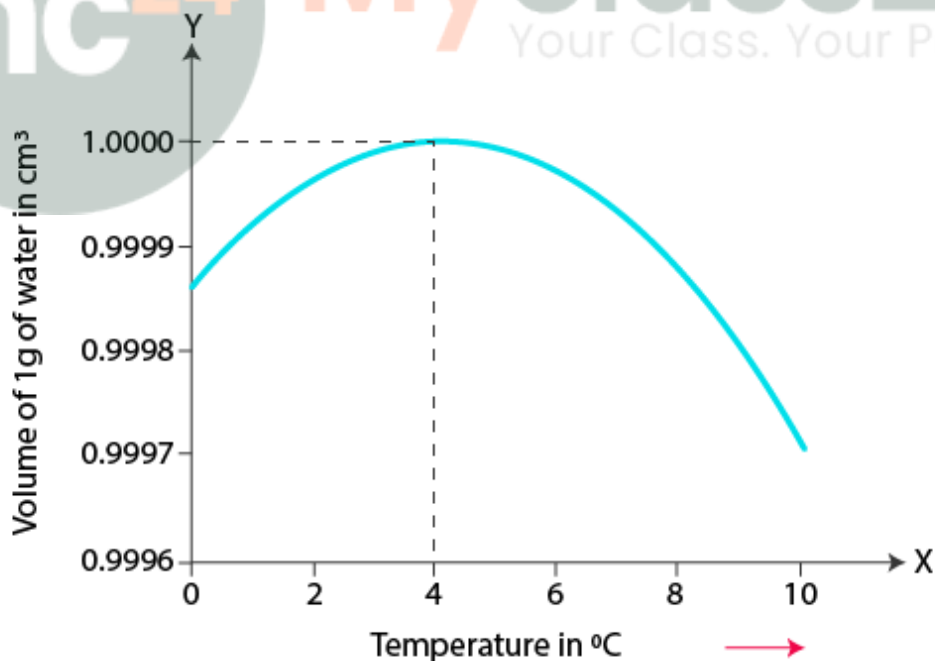
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13. Draw a graph to show the variation in density of water with temperature in the temperature range from 0°C to 10°C.

Solution:

The following graph shows the variation in density of water with temperature in the range of 0°C to 10°C.

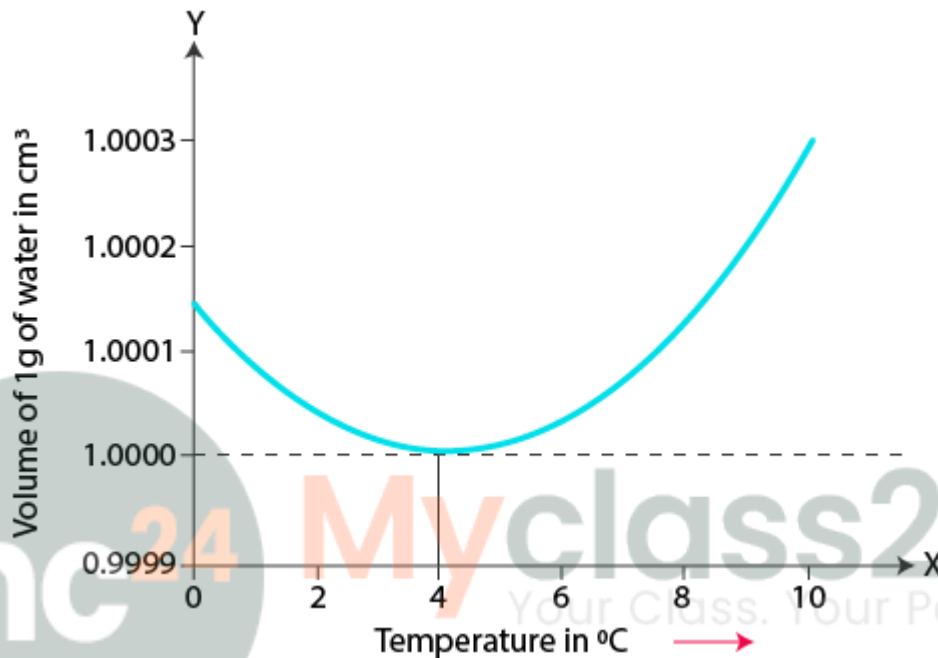


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14. A given mass of water is cooled from  $10^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ . State the volume changes observed. Represent these changes on a temperature-volume graph.

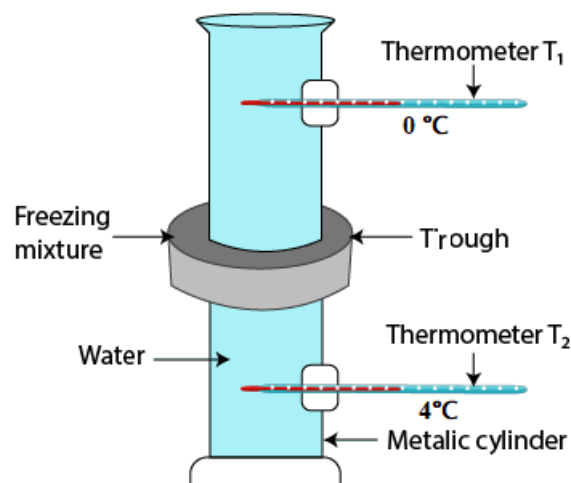
**Solution:**

When water is cooled from  $10^{\circ}\text{C}$ , the density of water first increases up to  $4^{\circ}\text{C}$  and then decreases on cooling further below  $4^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ . Hence, the density of water is maximum at  $4^{\circ}\text{C}$  which is equal to  $1\text{ g cm}^{-3}$



15. Describe an experiment to show that water has maximum density at  $4^{\circ}\text{C}$ . What important consequences follow from this peculiar property of water? Discuss the importance of this phenomenon in nature.

**Solution:**



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T.C. Hope devised a simple arrangement known as Hope's apparatus for demonstrating the anomalous expansion of water.

**Experimental Setup:** The apparatus consists of a tall metallic cylinder with two side openings P (near the top) and Q (near the bottom), fixed with thermometers  $T_1$  and  $T_2$ . The center part of the cylinder is girdled with a cylindrical trough which contains the mixture of ice and salt. The cylinder is filled with pure water that is at room temperature.

**Observation:**

- Both thermometers  $T_1$  (upper thermometer) and  $T_2$  (lower thermometer), initially are at the same room temperature
- Initially, the temperature noted at  $T_2$  starts decreasing, becomes steady at  $4^\circ\text{C}$ , while temperature at  $T_1$  remains unchanged at this time.
- Temperature recorded at  $T_2$  is steady and constant at  $4^\circ\text{C}$  and at  $T_1$  records a continuous fall in the temperature up till  $0^\circ\text{C}$  which then becomes steady.
- Lastly, the temperature at  $T_1$  is  $0^\circ\text{C}$  and the temperature at  $T_2$  is  $4^\circ\text{C}$ .

The density of water increases and it contracts when the freezing mixture cools water in the central portion of the cylinder, causing it to sink to the base, for the reading of  $T_2$  to rapidly fall.

No changes are observed at  $T_1$  because the temperature of water in the upper part remains unchanged which continues until the intact water located below the central portion touches  $4^\circ\text{C}$ .

Due to anomalous expansion, on cooling further below  $4^\circ\text{C}$ , water of the central portion expands causing the density to decrease, consequently it rises upwards. This results in the readings of  $T_1$  to fall rapidly at  $0^\circ\text{C}$ , thereby causing water to freeze to form ice at  $0^\circ\text{C}$  at the top, proving water has the maximum density at  $4^\circ\text{C}$ .

**Importance:**

Helps to preserve the aquatic life during cold weathers, as temperature falls in winter, the uppermost layer of ponds contract, causing it to become denser, hence sinking. Thereby, a circulation is setup, till the whole of water in the pond reaches its maximum density at  $4^\circ\text{C}$ . A further drop in the temperature causes the top layer to expand and remain intact at the top until it freezes. This is why, though the layers at the top freeze, the water at the base is at  $4^\circ\text{C}$ , where fishes can thrive easily.

**16. Deep pond of water has its top layer frozen during winter. State the expected temperature of water layer (i) just in contact with ice, (ii) at the bottom of pond.**

**Solution:**

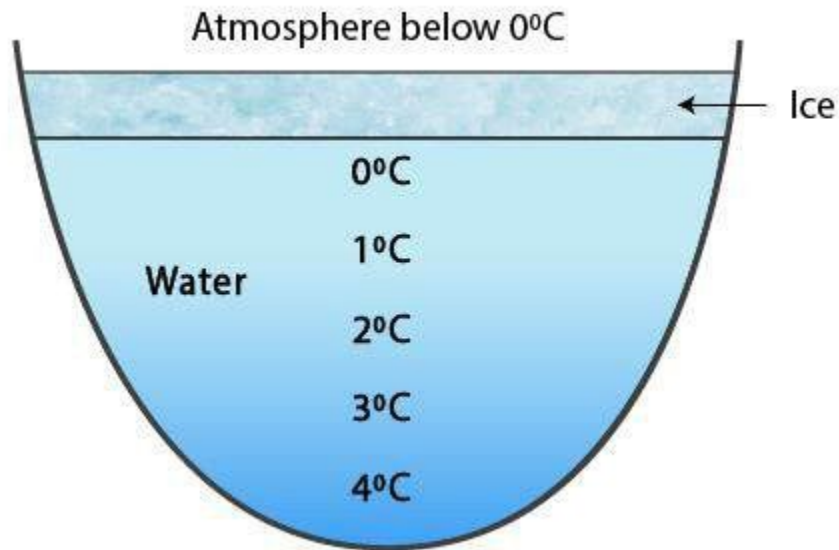
- (i) Just in contact with ice -  $0^\circ\text{C}$
- (ii) At the bottom of pond -  $4^\circ\text{C}$

**17. Draw a labelled diagram showing the temperature of various layers of water in an ice covered pond.**

**Solution:**

The following diagram shows the temperature of various water layers in an ice covered pond.

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**18. Explain the following:**

- (a) Water pipes in colder countries often burst in winter.
- (b) In winter, water tank (or ocean) starts freezing from the surface and not from the bottom
- (c) Fishes survive in ponds even when the atmospheric temperature is below  $0^{\circ}\text{C}$
- (d) A hollow glass sphere which floats with its entire volume submerged in water at  $4^{\circ}\text{C}$ , sinks when water is heated above  $4^{\circ}\text{C}$ .
- (e) A glass bottle completely filled with water and tightly closed at room temperature, is likely to burst when kept in the freezer of a refrigerator.

**Solution:**

- (a) The atmospheric pressure on winter nights drops below  $4^{\circ}\text{C}$  causing the water enclosed in the pipe lines to expand and exert a huge pressure on the pipe, hence the bursting
- (b) The temperature drops in winters causing the surface of the tank to contract and become dense and sink to the base. A circulation is hence set up till the intact water in the tank touches the maximum density at  $4^{\circ}\text{C}$ . Further fall in temperature causes the upper most layer to expand and remains there until it is frozen. Consequently, water in the tank freezes from the top and not from the base.
- (c) During colder weathers, the aquatic life is preserved by the anomalous expansion of water. The topmost layer in the pond contracts when the temperature drops, hence becomes denser and sinks to the bottom. Until the water touches maximum density at  $4^{\circ}\text{C}$ , the circulation is set up. Drop in temperature causes the top layer to expand and remain at the top until it freezes. Hence, though the upper layer is frozen, the water at the base is at  $4^{\circ}\text{C}$ , hence the fishes can easily survive.
- (d) The density of water decreases on heating water above  $4^{\circ}\text{C}$ . Consequently, the upthrust or the upward force that acts on the water as a result of the water upon the hollow glass sphere decreases, causing it to sink.
- (e) When the temperature of the water falls below  $4^{\circ}\text{C}$  inside the freezer, the water inside the bottle starts expanding. In case the bottle is filled completely and secured tightly, water cannot expand, hence it may burst.

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**Multiple choice type:**

**1. Calorie is the unit of:**

- (a) Heat
- (b) Work
- (c) Temperature
- (d) Food

**Solution:**

- (a) Heat

Heat is measured in calorie.  $1 \text{ cal} = 4.186 \text{ J}$

**2. 1 J equals to:**

- (a) 0.24 cal
- (b) 4.28 cal
- (c) 1 cal
- (d) 1 kcal

**Solution:**

- (a) 0.24 cal

**3. S.I. unit of temperature is:**

- (a) cal
- (b) joule
- (c) celsius
- (d) kelvin

**Solution:**

- (d) kelvin

Though temperature is usually measured in Celsius, kelvin is the S.I. unit.

**4. Water is cooled from  $4^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ . It:**

- (a) Contracts
- (b) Expands
- (c) First contracts, then expands
- (d) First expands, then contracts

**Solution:**

- (b) Expands

Expansion of water occurs when water is cooled from  $4^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ .

**5. Density of water is maximum at:**

- (a)  $0^{\circ}\text{C}$
- (b)  $100^{\circ}\text{C}$
- (c)  $4^{\circ}\text{C}$
- (d)  $15^{\circ}\text{C}$

**Solution:**

- (c)  $4^{\circ}\text{C}$