RADIANT 2026

Physics

Heat and Energy

Lecture – 02

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Topics *to be covered*

1. ENERGY FLOW IN AN ECOSYSTEM
2. FOOD CHAIN
3. ENERGY FLOW
4. Questions

5) Ecosystem

Recap *of previous lecture*

1. CONCEPT OF HEAT (HEAT AS ENERGY)
2. CONCEPT OF TEMPERATURE
3. ANOMALOUS EXPANSION OF WATER


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Heat

(A) J

(B) cal

(C) kcal

(D) all

Temp

A → K

B → °C

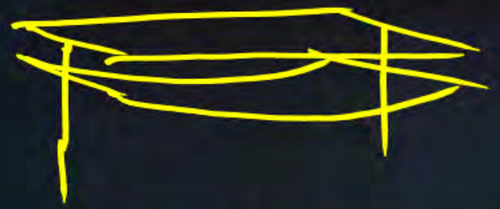
C → °R

D → °F

Difference Between Heat and Temperature

Heat	Temperature
1. Heat is a form of energy obtained due to random motion of molecules in a substance.	1. Temperature is a quantity which determines the direction of flow of heat on keeping the two bodies at different temperatures in contact.
2. The S.I. unit of heat is joule (J)	2. The S.I. unit of temperature is kelvin (K).
3. The amount of heat contained in a body depends on mass, temperature and material of body.	3. The temperature of a body depends on the average kinetic energy of its molecules due to their random motion.
4. Heat is measured by the principle of calorimetry.	4. Temperature is measured by a thermometer.
5. Two bodies having same quantity of heat may differ in their temperature.	5. Two bodies at same temperature may differ in the quantities of heat contained in them.
6. When two bodies are placed in contact, the total amount of heat is equal to the sum of heat of the individual bodies.	6. When two bodies at different temperatures are placed in contact, the resultant temperature is a temperature in between the two temperatures

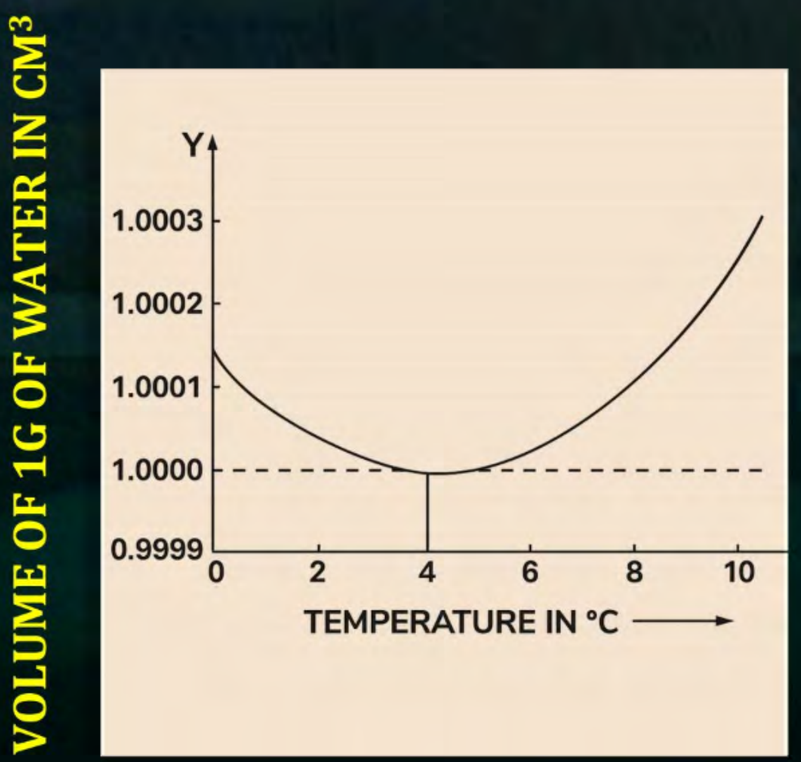
THERMAL EXPANSION



- Almost all substances (solids, liquids and gases) expand on heating and contract on cooling.
- **The expansion of a substance on heating is called the thermal expansion of that substance.**
- A solid has a definite shape, so when a solid is heated, it expands in all directions i.e., the length, area and volume, all increase on heating. The increase in length is called the linear expansion, the increase in area is called the superficial expansion and the increase in volume is called the cubical expansion. The liquids and gases do not have a definite shape, so they have only the cubical (or volume) expansion. On heating, liquids expand more than the solids, and gases expand much more than the liquids.

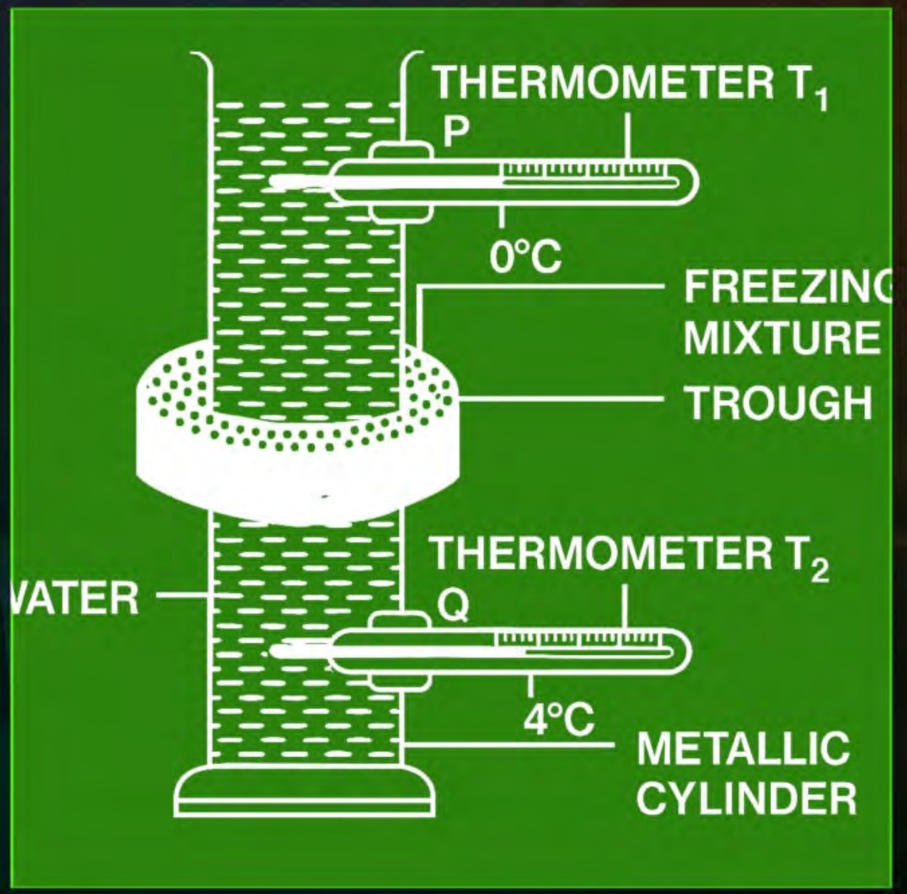
ANOMALOUS EXPANSION OF WATER

The expansion of water when it is cooled from 4°C to 0°C, is known as anomalous expansion of water.



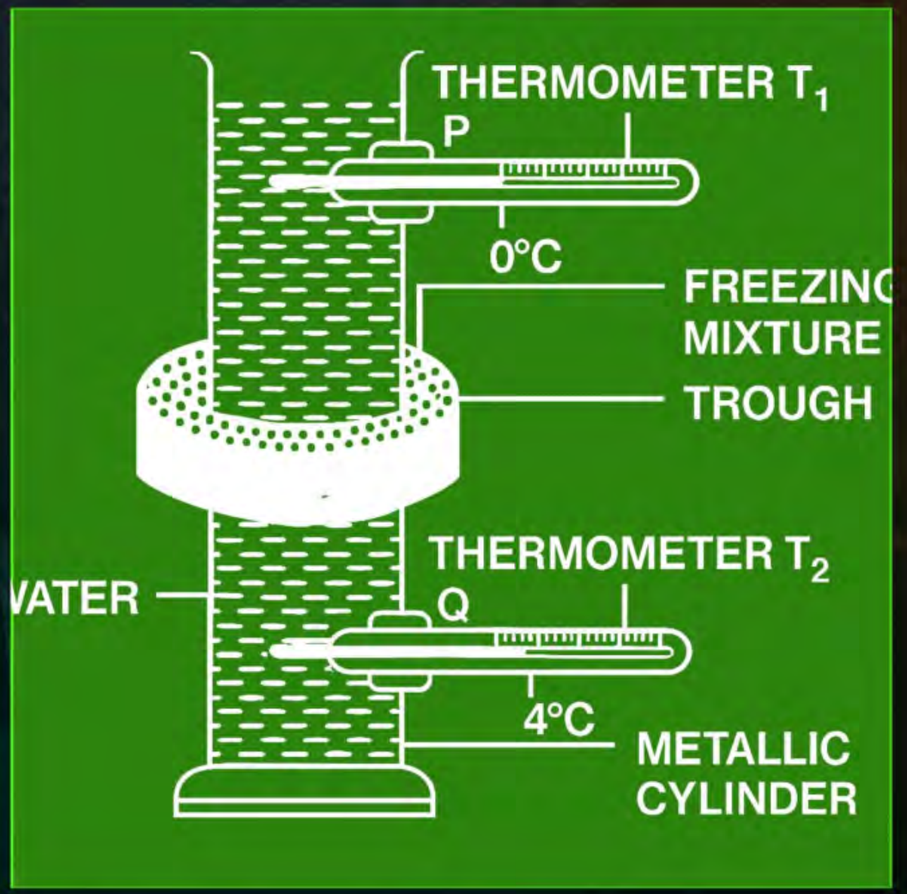
HOPE'S EXPERIMENT TO DEMONSTRATE THE ANOMAOUS EXPANSION OF WATER

In 1805, the scientist T.C. Hope devised a simple arrangement, known as Hope's apparatus for demonstrating the anomalous expansion of water. Figure shows the Hope's apparatus.



HOPE'S EXPERIMENT TO DEMONSTRATE THE ANOMAOUS EXPANSION OF WATER

The apparatus consists of a tall metallic cylinder provided with two side openings P near the top and Q near the bottom, fitted with thermometers T_1 and T_2 respectively. The central part of the cylinder is surrounded by a cylindrical trough containing a freezing mixture of ice and salt. The cylinder is filled with pure water at room temperature. The temperature recorded by both the thermometers is observed at a regular interval of time.



CONSEQUENCES OF ANOMALOUS EXPANSION OF WATER

(i) The anomalous expansion of water helps in preserving the aquatic life during the very cold weather.

CONSEQUENCES OF ANOMALOUS EXPANSION OF WATER

(ii) The anomalous expansion of water is responsible for the burst of water pipe lines, and destruction of crop during the very cold nights.

ENERGY FLOW IN AN ECOSYSTEM

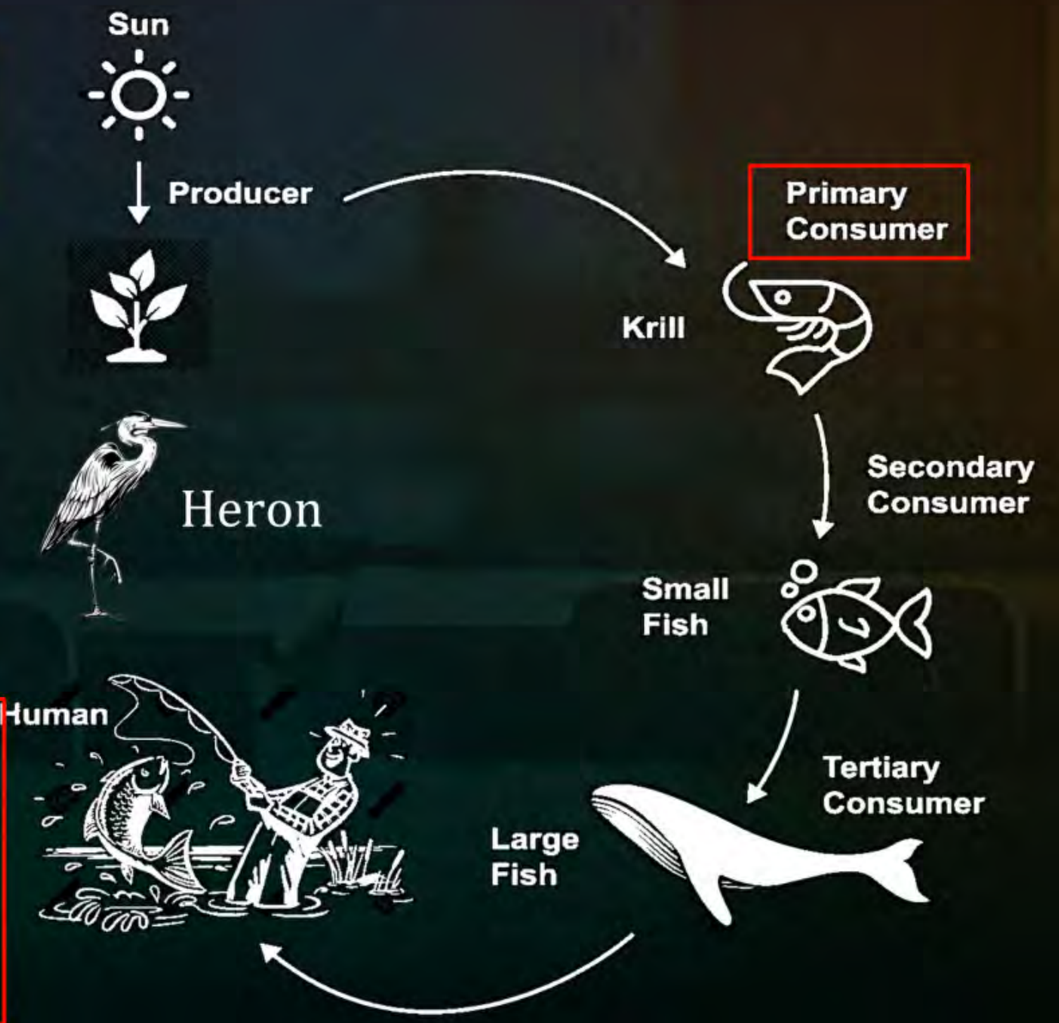
- A unit composed of biotic components **(i.e., producers, consumers and decomposers)** and abiotic components **(i.e., light, heat, rain, humidity, inorganic and organic substances)** is called an ecosystem.
- The existence of living beings such as plants and animals depends on the flow of energy in them. Energy is needed for all the biotic activities. The most significant source of energy for all ecosystems is the sun.

ENERGY FLOW IN AN ECOSYSTEM

- The energy received on the earth from the sun is utilized in different ways. Nearly 56-60% part of the incident energy is absorbed by the atmosphere, nearly 10% is utilized in heating of water and land, and only 8% falls on plants.
- Plants absorb most of the energy falling on them. Out of the absorbed energy, plants use only 0.02% in photosynthesis for producing their food. They are called the producers.

FOOD CHAIN

- In ecosystem, photosynthetic plants and bacteria act as producers.
- The food synthesized by producers is utilised by primary consumers (such as krill).
- The primary consumers are eaten by the secondary consumers (such as small fish) and in turn they are consumed by the tertiary consumers (such as large fish).
- The tertiary consumers may be eaten by man. The man may be the last consumer in this chain of energy transfer when he eats the fish. This simple food chain is shown in Figure.



ENERGY FLOW

- The producers (photosynthetic plants) synthesize organic substances by the process of photosynthesis (i.e., they bind the simple compounds with the help of solar energy into the complex organic substances).
- The chemical energy so stored in plants is called the gross primary production.
- The producers themselves first use the synthesized organic substances in the process of respiration in which some energy is used in oxidation of organic substances.

ENERGY FLOW

- The rest of the energy, called the net primary production, is stored for the growth, development and important metabolic processes.
- In Fig., the gross primary production by the producers is 20,810 cal energy, out of which 11,977 cal energy is used in the respiration and the net primary production is 8,833 cal energy.


Thank You