Black Body – Class 11 Physics (CBSE)

1. What is a Black Body?

A **black body** is an ideal body that absorbs all the radiations incident on its surface, irrespective of their wavelength, frequency and direction.

It neither reflects nor transmits any radiation falling on it.

A black body is also called a **perfect absorber** of radiation.

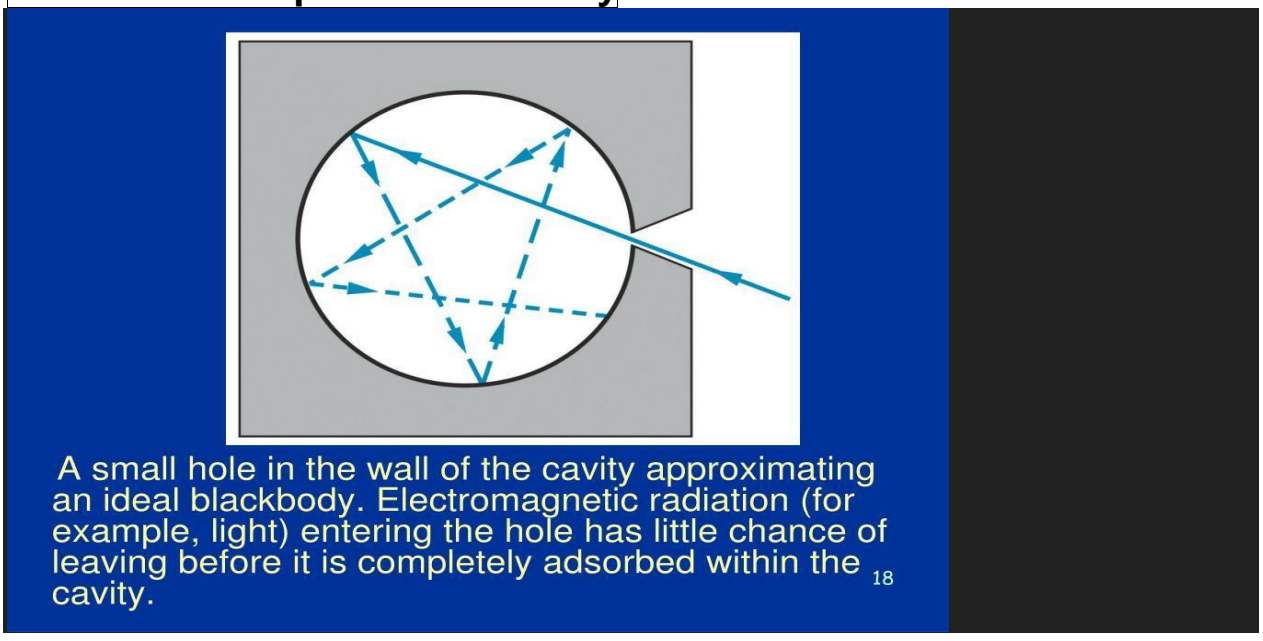
Definition for CBSE examination:

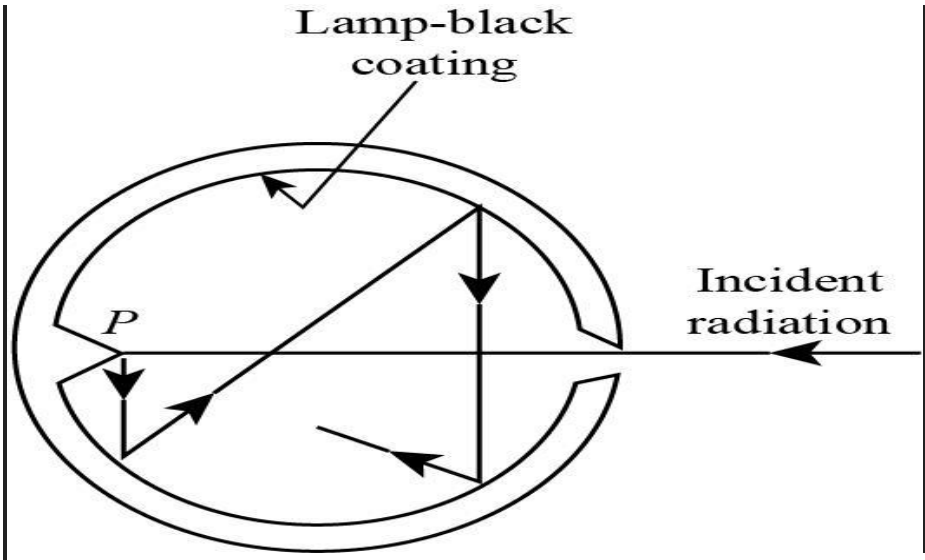
A black body is an ideal body that absorbs completely all the radiations incident upon it, without reflecting or transmitting any part of them.

2. Important Characteristics of a Black Body

1. It absorbs 100% of the radiation falling on it.
2. It is a perfect absorber and a perfect emitter of radiation.
3. It does not reflect or transmit any incident radiation.
4. The radiation emitted by a black body depends only on its temperature.
5. At a given temperature, it emits the maximum possible thermal radiation.

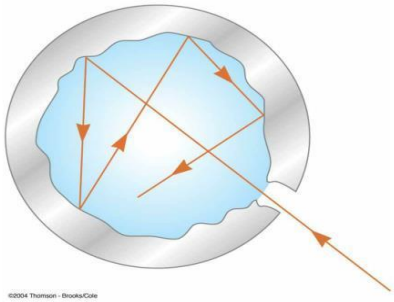
3. Practical Example of a Black Body





Blackbody Approximation

- A good approximation of a black body is a small hole leading to the inside of a hollow object
- The nature of the radiation leaving the cavity through the hole depends only on the temperature of the cavity walls



A hollow enclosure with a small hole is considered a good practical approximation of a black body.

Working:

- When radiation enters through the small hole, it undergoes multiple reflections inside the cavity.
- At each reflection, some energy is absorbed by the inner walls.
- After several reflections, almost all the radiation gets absorbed.
- Therefore, the small hole behaves approximately like a perfect black body.

Important: A small hole in a hollow cavity is considered a practical example of a black body.

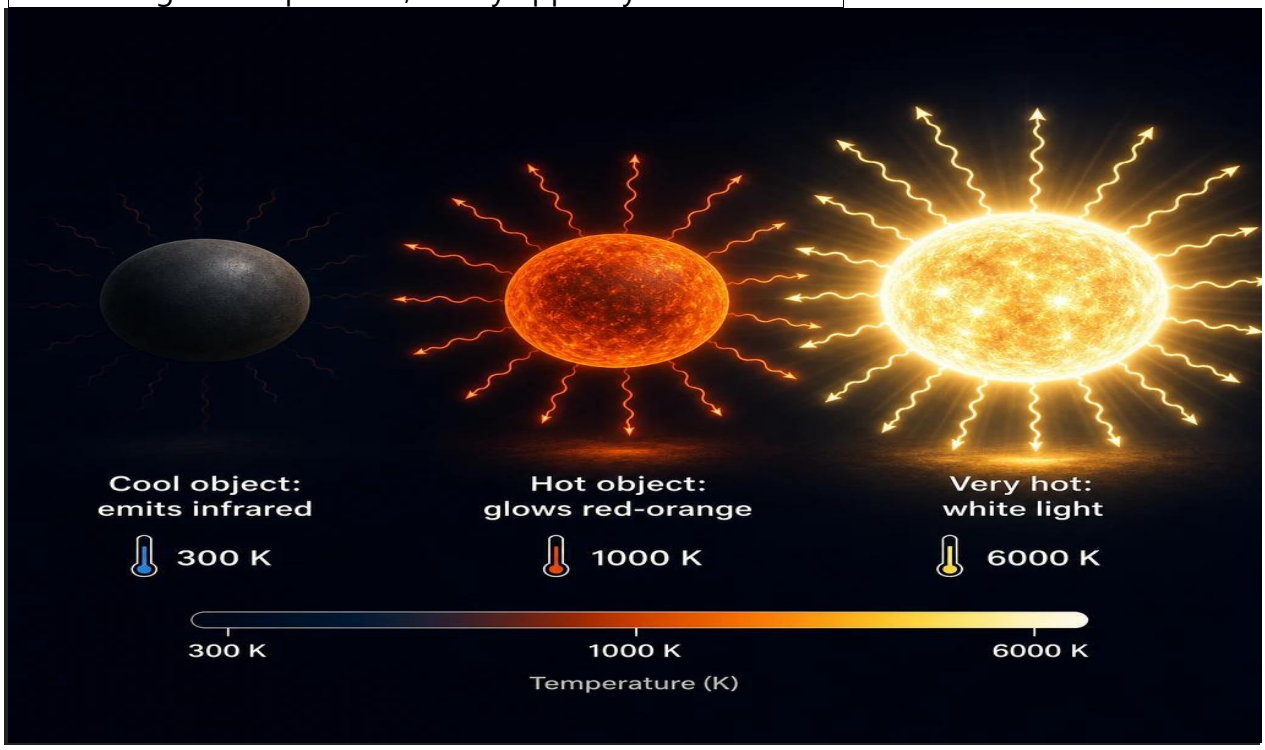
4. Black Body Radiation

The radiation emitted by a black body due to its temperature is called **black body radiation**.

When a black body is heated, it emits electromagnetic radiation.

For example:

- At a lower temperature, it emits mainly infrared radiation.
- At a higher temperature, it may appear red.
- At a still higher temperature, it may appear yellow or white.



Thus, the colour and intensity of radiation emitted by a black body depend upon its temperature.

5. Important Laws Related to Black Body Radiation

These laws are useful for understanding thermal radiation and are important for higher-level study.

(a) Stefan-Boltzmann Law

The total energy radiated per unit area per second by a black body is directly proportional to the fourth power of its absolute temperature.

$E=\sigma T_4$

Where:

- E = Energy radiated per unit area per second.

- σ = Stefan's constant.
- T = Absolute temperature in Kelvin.

(b) Wien's Displacement Law

The wavelength corresponding to maximum intensity of radiation is inversely proportional to the absolute temperature.

$\lambda_m T = b$

Where:

λ_m = Wavelength of maximum intensity.

- T = Absolute temperature.
- b = Wien's displacement constant.

Important CBSE-Based Questions on Black Body

The following questions are useful for Class 11 Physics revision and conceptual understanding.

A. Very Short Answer Questions (1 Mark)

1. What is a black body?
2. Why is a black body called a perfect absorber?
3. Does a black body reflect any incident radiation?
4. What is black body radiation?
5. Give one practical example of a black body.
6. What is the nature of radiation emitted by a black body?
7. Does the radiation emitted by a black body depend on its material or temperature?

B. Short Answer Questions (2 Marks)

1. Define a black body. Write any two characteristics of a black body.
2. Why is a small hole in a hollow cavity considered a good approximation of a black body?
3. What happens to the radiation emitted by a black body when its temperature increases?
4. Why is a black body considered both a perfect absorber and a perfect emitter?
5. Differentiate between a perfect reflector and a perfect absorber.

C. Long Answer Questions (3–5 Marks)

1. Explain the concept of a black body with the help of a suitable diagram.
2. Explain the construction and working of a cavity radiator as a practical approximation of a black body.

3. What is black body radiation? Explain how the nature of emitted radiation changes with temperature.
4. State and explain Stefan-Boltzmann law.
5. State Wien's displacement law and explain the relationship between temperature and wavelength of maximum intensity.

D. Important Numerical Questions

Q1. The temperature of a black body is doubled. How many times will its energy radiated per unit area per second increase?

Solution:

According to Stefan-Boltzmann law,

$E = \sigma T^4$

If temperature becomes $2T$,

$E = \sigma(2T)^4$

$E = 16\sigma T^4$

$E' = 16E$

Answer: The energy radiated increases 16 times.

Q2. The wavelength of maximum intensity of a black body is $500\ \text{nm}$ $500nm$. Calculate its temperature using Wien's displacement law.

Given:

$\lambda_m = 500 \times 10^{-9}\ m$

$b = 2.898 \times 10{-}3 mK$

Using,

$\lambda_m T = b$

$T = 2.898 \times 10{-}3500 \times 10{-}9$ $T = 500 \times 10^{-9}\ \ 2.898 \times 10^{-3}$

$T = 5796K$

E. Important MCQs (CBSE Pattern)

Test your understanding

5 MCQs

Q1. A black body is a body which:

A. Reflects all radiation

B. Absorbs all incident radiation

C. Transmits all radiation

D. Emits no radiation

Q2. A small hole in a hollow cavity behaves approximately as:

A. Perfect reflector

B. Perfect absorber

C. Perfect transmitter

D. Perfect insulator

Q3. The energy radiated per unit area per second by a black body is proportional to:

A. T

B. T^2

C. T^3

D. T^4

Q4. Wien's displacement law is:

A. $\lambda m/T$ = constant

B. λmT = constant

C. λmT^2 = constant

D. λm = constant

Q5. The colour of radiation emitted by a heated body changes with:

A. Its shape only

B. Its temperature

C. Its volume only

D. Its mass only