Important Questions for Class 11 Physics Chapter 10: Chapter 10 of Class 11 Physics, Thermal Properties of Matter, deals with the concepts of heat, temperature, and the behavior of matter under thermal conditions. Key topics include the laws of thermodynamics, specific heat capacity, and calorimetry. The chapter explores how heat affects different substances, the concept of latent heat, and the mechanisms of heat transfer (conduction, convection, and radiation).

Understanding the ideal gas laws and applying concepts like thermal expansion and specific heat are essential for analyzing real-world thermal processes. This chapter also covers the importance of thermal properties in practical applications like engines and refrigerators.

Important Questions for Class 11 Physics Chapter 10 Overview

Chapter 10, "Thermal Properties of Matter," in Class 11 Physics covers essential concepts like temperature, heat, specific heat, thermal expansion, and the laws of thermodynamics. Important questions from this chapter typically focus on calculating heat transfer, understanding specific heat capacities, and applying concepts of thermal expansion in practical scenarios.

Mastery of these topics is crucial as they lay the foundation for advanced studies in thermodynamics and material science. These concepts also have real-world applications in engineering, climate science, and everyday technology, making this chapter fundamental for both academic progress and practical understanding of the physical world.

Important Questions for Class 11 Physics Chapter 10 Thermal Properties of Matter

Below is the Important Questions for Class 11 Physics Chapter 10 Thermal Properties of Matter -

1. A copper block of mass $2.5 \mathrm{~kg}$ is heated in a furnace to a temperature of $500^{0} \mathrm{C}$ and then placed on a large ice block. What is the maximum amount of ice that can melt? (Specific heat of copper $=0.39 \mathrm{Jg}^{-1} \mathrm{~K}^{-1}$; heat of fusion of water $=335 \mathrm{Jg}^{-1}$

Ans: The copper block's mass, $m=2.5 \mathrm{~kg}=2500 \mathrm{~g}$

The temperature of the copper block has risen, $\Delta \theta=500^{0} \mathrm{C}$

Copper's specific heat ${ }_{u} C=0.39 \mathrm{Jg}^{-1} \mathrm{C}^{-1}$

The heat of water fusion, $L=335 \mathrm{Jg}^{-1}$

The greatest amount of heat that a copper block may lose in a given amount of time, $=m C \Delta \theta$

$=2500 \times 0.39 \times 500$

$=487500 \mathrm{~J}$

Let $m_{1} g$ be the amount of ice that melts when the copper block is put on the ice block,

The heat that the melting ice has acquired, $=m_{1} L$

$$\therefore m_{1}=\frac{Q}{L}=\frac{487500}{335}=1455.22 \mathrm{~g}$$

As a result, the total amount of ice that can melt is $1.45 \mathrm{~kg}$.

2. A 'thermocol' icebox is a cheap and efficient method for storing small quantities of cooked food in summer in particular. A cubical icebox of side $30 \mathrm{~cm}$ has a thickness of $5.0 \mathrm{~cm}$. If $4.0 \mathrm{~kg}$ of ice is put in the box, estimate the amount of ice remaining after $6 \mathrm{~h}$.

The outside temperature is $45^{0} \mathrm{C}$, and co-efficient of thermal conductivity of thecmacole is $0.01 \mathrm{Js}^{-1} \mathrm{~m}^{-1} \mathrm{~K}^{-1}$. [Heat of fusion of water $ = 335 \times {10^3}\;{\text{J}}\;{\text{k}}{{\text{g}}^{ - 1}}{\text{l}}$

Ans: The provided cubical ice box's side, $s=30 \mathrm{~cm}=0.3 \mathrm{~m}$

The ice box's thickness, $l=5.0 \mathrm{~cm}=0.05 \mathrm{~m}$

In the ice because of ice kept, $m=4 \mathrm{~kg}$

Time gap, $t=6 \mathrm{~h}=6 \times 60 \times 60 \mathrm{~s}$

the temperature outside, $T=45^{0} \mathrm{C}$

Thermacele's heat conductivity coefficient, $K=0.01 \mathrm{Js}^{-1} \mathrm{~m}^{-1} \mathrm{~K}^{-1}$

The heat of water fusion, $L=335 \times 10^{3} \mathrm{~J} \mathrm{~kg}^{-1}$

Let's call m be the total amount of ice that melts in $6 \mathrm{~h}$.

The quantity of heat lost by the meal is calculated as follows:

$$\theta=\frac{K A(T-0) t}{l}$$

Where, In such case, the surface area

$$A = \text{ Surface area of the } b0x = 6s^2 = 6 \times (0.3)^2 = 0.54 \text{ m}^3$$

$$\theta = \frac{0.01 \times 0.54 \times (45) \times 6 \times 60 \times 60}{0.05} = 104976 J$$

But $\theta = mL$

$$\therefore m' = \frac{\theta}{L}$$

$$= \frac{104976}{335 \times 10^3} = 0.313 \text{ kg}$$

Mass of ice left $= 4 - 0.313 = 3.687 \text{ kg}$

As a result, the amount of ice left after is. 6 h is 3.687 kg.

3 Mark Questions

1. The triple points of neon and carbon dioxide are 24.57 K and 216.55 K respectively. Express these temperatures on the Celsius and Fahrenheit scales.

Ans: The following is a relation between the Kelvin and Celsius scales:

\$$T_c = T_k - 273.15 \ldots \text{ (j) }$ \$

The temperature scales in Celsius and Fahrenheit are linked in the following way:

\$$T_F = \frac{9}{5} T_c + 32 \ldots$ \$

If you want to use neon, you need use the following formula.

$T_{\text{k}} = 24.57 \text{ K}$

$\therefore T_{\text{c}} = 24.57 - 273.15 = -248.58 \text{C}$

$$T_F = \frac{9}{5} T_c + 32$$

$$= \frac{9}{5}(-248.58) + 32$$

$$= 415.44^2 \text{ F}$$

In case of carbon dioxide:

$T_{\text{K}} = 216.55 \text{ K}$

In case of carbon dioxide:

$$T_{\mathrm{K}} = 216.55\ \mathrm{K}$$

$$\therefore T_c = 216.55 - 273.15 = -56.60^0\mathrm{C}$$

$$T_F = \frac{9}{5}(T_6) + 32$$

$$= \frac{9}{5}(-56.60) + 32$$

$$= -69.88\mathrm{C}$$

2. Two absolute scales A and B have triple points of water defined to be $200\ \mathrm{A}$ and $350\ \mathrm{B}$. What i the relation between T_A and T_B ?

Ans: Water's triple point on the absolute scale $A, T_1 = 200\ \mathrm{A}$

Water's triple point on the absolute scale $\mathrm{B}_2 T_2 = 350\ \mathrm{B}$

Water's triple point on the Kelvin scale, $T_X = 273.15\ \mathrm{K}$

The temperature $273.15\ \mathrm{K}$ on Kelvin scale is equal to $200\ \mathrm{A}$ on absolute scale A.

$$T_1 = T_K$$

$$200\ \mathrm{A} = 273.15\ \mathrm{K}$$

$$\therefore A = \frac{273.15}{200}$$

The temperature $273.15\ \mathrm{K}$ on Kelvin scale is equal to $350\ \mathrm{B}$ on absolute scale B.

$$T_2 = T_K$$

$$350\ \mathrm{B} = 273.15$$

$$\therefore B = \frac{273.15}{350}$$

On a scale A, T_A is triple point of water.

On a scale B, T_B is triple point of water.

$$\therefore = \frac{273.15}{200} \times T_A = \frac{273.15}{350} \times \bar{T}_B$$

$$T_A = \frac{200}{350} T_B$$

Hence, the ratio $T_A : T_B$ is given as 4.7.

3. A steel tape $1 \mathrm{~m}$ long is correctly calibrated for a temperature of $27.0^0 \mathrm{C}$. The length of a steel rod measured by this tape is found to be $63.0 \mathrm{~cm}$ on a hot day when the temperature is $45.0^0 \mathrm{C}$. What is the actual length of the steel rod on that day? What is the length of the same steel rod on a day when the temperature is $27.0^0 \mathrm{C}$? Coefficient of linear expansion of steel $= 1.20 \times 10^{-6} \mathrm{~K}^{-1}$

Ans: Temperature-dependent length of steel tape $T = 27^0 \mathrm{C}, l = 1 \mathrm{~m} = 100 \mathrm{~cm}$ At temperature $T_1 = 45^0 \mathrm{C}$, the length of the steel rod, $l_1 = 63 \mathrm{~cm}$

Let, l be the real length of the steel rod and l be the length of the steel tape at $45^0 \mathrm{C}$

$$l' = l + al\left(T_1 - T\right)$$

$$\therefore l' = 100 + 1.20 \times 10^{-5} \times 100(45 - 27)$$

$$= 100.0216 \mathrm{~cm}$$

Therefore, As a result, the actual length of the steel rod $45^0 \mathrm{C}$ can be computed as follows:

$$l_2 = \frac{100.0216}{100} \times 63$$

$$= 63.0136 \mathrm{~cm}$$

As a result, the rod's real length is at

$45.0^0 \mathrm{C}$ is $63.0136 \mathrm{~cm}$. Its total length at $27.0^0 \mathrm{C}$ is $63.0 \mathrm{~cm}$.

4. A $10 \mathrm{~kW}$ drilling machine is used to drill a bore in a small aluminium block of mass $8.0 \mathrm{~kg}$. How much is the rise in temperature of the block in 2.5 minutes, assuming 50% of power is used up in heating the machine itself or lost to the surroundings. Specific heat of aluminium $= 0.91 \mathrm{~Jg}^{-1} \mathrm{~K}^{-1}$

Ans: Drilling machine's power $P = 10 \mathrm{~kW} = 10 \times 10^3 \mathrm{~W}$

The length of time that the machine is in use, $t = 2.5 \text{ min} = 2.5 \times 60 = 150 \text{ s}$

Aluminum's specific heat, $c = 0.91 \text{Jg}^{-1} \text{ K}^{-1}$

After drilling, the block's temperature rises $= \delta T$

Drilling machine's total energy $= P_t$

$= 10 \times 10^3 \times 150$

$= 1.5 \times 10^6 \text{ J}$

Only a 50% portion of the power is usable.

However, it is useful energy $\Delta = \frac{50}{100} \times 1.5 \times 10^5 = 7.5 \times 10^5 \text{ J}$

$\text{But} \Delta = mc_{\Delta} T$

$\therefore A = \frac{\Delta Q}{mc}$

$= \frac{7.5 \times 10^5}{8 \times 10^3 \times 0.91}$

$= 103^0 \text{C}$

As a result, the temperature of the block rises by 103^0C in 2.5 minutes of drilling.

5. In an experiment on the specific heat of a metal, a $0.20 \mathrm{~kg}$ block of the metal at $150^{0} \mathrm{C}$ is dropped in a copper calorimeter (of water equivalent $0.025 \mathrm{~kg}$) containing $150 \mathrm{~cm}^{3}$ of water at $27^{0} \mathrm{C}$. The final temperature is $40^{0} \mathrm{C}$. Compute the specific heat of the metal. If heat losses to the surroundings are not negligible, is your answer greater or smaller than the actual value for specific heat of the metal?

Ans: The metallic mass, $m=0.20 \mathrm{~kg}=200 \mathrm{~g}$

The metal's initial temperature, $T_{1}=150^{0} \mathrm{C}$

The metal's final temperature, $T_{2}=40^{0} \mathrm{C}$

The mass of a calorimeter is equal to the mass of water, $m^{\prime}=0.025 \mathrm{~kg}=25 \mathrm{~g}$

Volume of water, $V=150 \mathrm{~cm}^{3}$

Water mass (M) at given temperature $T=27^{0} \mathrm{C}$:

$150 \times 1=150 \mathrm{~g}$

The temperature of the metal has dropped:

$\$ \Delta T=T_{1}-T_{2}=150-40=110^{0} \mathrm{C} \$$

Water's specific heat, $C_{w}=4.186 \mathrm{~J} / \mathrm{g} /^{1} \mathrm{~K}$

Metal's specific heat, $=C$

Metal dissipates heat, $\theta=m C \Delta T \ldots$ (i)

The temperature of the water and the calorimeter system is rising:

$\Delta T^{\prime \prime}=40-27=13^{0} \mathrm{C}$

$$\Delta \theta^{\prime \prime}=m_{1} C_{\mathrm{v}} \Delta T^{\prime}$$

$$=\left(M+m^{\prime}\right) C_{u} \Delta T^{\prime} \ldots \text { (ii) }$$

Heat lost by the metal = Heat gained by the water and colorimeter system.

$$m C \Delta T=\left(M+m^{\prime}\right) C_{\mathrm{V}} \Delta T$$

$$200 \times C \times 110=(150+25) \times 4.186 \times 13$$

$$\therefore C=\frac{175 \times 4.186 \times 13}{110 \times 200}=0.43 \mathrm{Jg}^{-1} K^{-1}$$

If heat is lost to the environment, the value will of C will be lower than the real value.

4 Marks Questions

1. The electrical resistance in ohms of a certain thermometer varies with temperature according to the approximate law:

$$R = R_0 [1 + \alpha (T - T_e)]$$

The resistance is 101.6Ω at the triple-point of water $273.16\ \mathrm{K}$, and 165.5Ω at the normal melting point of lead $(600.5\ \mathrm{K})$. What is the temperature when the resistance is 123.4Ω?

Ans: It is assumed that:

$$R = R = R_0 [1 + \alpha (T - T_\theta)] \ldots (i)$$

Where,

R_0 and T_0 are the starting resistance and temperature respectively R and T are the ultimate resistance and temperature, respectively a is a constant

When water reaches its triple point, $T_0 = 273.15\ \mathrm{K}$

Lead resistance, $R_0 = 101.6\Omega$

When these values are substituted in equation (i), we get:

$$R = R_0 [1 + a (T - T_0)]$$

$$165.5 = 101.6[1 + a(600.5 - 273.15)]$$

$$1.629 = 1 + a(327.35)$$

$$\therefore a = \frac{0.629}{327.35} = 1.92 \times 10^{-3}\ \mathrm{K}^{-1}$$

For resistance, $R_1 = 123.4\Omega$

$$R = R_0 [1 + a (T - T_0)]$$

Where, T is the temperature when the resistance of lead is calculated 123.4Ω

$$123.4 = 101.6 [1 + 1.92 \times 10^{-3}(T - 273.15)]$$

$$1.214 = 1 + 1.92 \times 10^{-3}(T - 273.15)$$

$$\frac{0.214}{1.92 \times 10^{-1}} = T - 273.15$$

$$\therefore T = 384.61\ \mathrm{K}$$

2. A large steel wheel is to be fitted on to a shaft of the same material. At $27^0\mathrm{C}$, the outer diameter of the shaft is $8.70\ \mathrm{cm}$ and the diameter of the central hole in the wheel is $8.69\ \mathrm{cm}$. The shaft is cooled using 'dry ice'. At what temperature of the shaft does the wheel slip on the shaft? Assume coefficient of linear expansion of the steel to be constant over the required temperature range $\alpha_{\text{stel}} = 1.20 \times 10^{-5}\ \mathrm{K}^{-1}$

Ans: The given temperature, $T = 27^0\mathrm{C}$ In Kelvin, the given temperature is expressed as:

$27 + 273 = 300\ \mathrm{K}$

The steel shaft's outside diameter at $T, d_1 = 8.70\ \mathrm{cm}$

The centre hole in the whed has a diameter of $T, d_2 = 8.69\ \mathrm{cm}$

Steel linear expansion coefficient, $a_{\text{tedl}} = 1.20 \times 10^{-5} K^{-1}$

The temperature of the shaft drops when it is cocled with dry ice. T_1

If the diameter of the wheel changes, it will slip on the shaft, $\Delta \mathrm{d} = 8.69 - 8.70 = -0.01\ \mathrm{cm}$

Temperature T_1, can be determined from the relation:

$\Delta d = d_1^d u_{\text{thal}}\ (T_1 - T)$

$0.01 = 8.70 \times 1.20 \times 10^{-5}\ (T_1 - 300)$

$(T_1 - 300) = 95.78$

$\therefore T_1 = 204.21\ \mathrm{K}$

$= 204.21 - 273.16$

$= -68.95^0\mathrm{C}$

3. Given below are observations on molar specific heats at room temperature of some common gases.

Gas	Molar Specific Heat (C_t) $\left(CalMol^{-1}K^{-1}\right)$
Hydrogen	4.87
Nitrogen	4.97
Oxygen	5.02
Nitric oxide	4.99
Carbon monoxide	5.01
Chlorine	6.17

The measured molar specific heats of these gases are markedly different from those for monatomic gases. Typically, molar specific heat of a monatomic gas is $2.92 \mathrm{cal/molK}$. Explain this difference. What can you infer from the somewhat larger (than the rest) value for chlorine?

Ans: The gases indicated in the table are diatomic in nature. They have other degrees of freedom (modes of motion) in addition to translational degrees of freedom. Heat must be supplied to raise the temperature of these gases. The average energy of all modes of motion is increased as a result of this. As a result, diatomic gases have a higher molar specific heat than monatomic gases.

If just rotational motion is taken into account, the molar specific heat of a diatomic is gas $= \frac{5}{2}R$

$= \frac{5}{2} \times 1.98 = 4.95 \mathrm{calmol}^{-1}\ \mathrm{K}^{-1}$

All of the observations in the table agree with, the exception of chlorine $\left(\frac{5}{2}R\right)$. This is because, in addition to rotational and translational modes of motion, chlorine exhibits vibrational modes of motion at ambient temperature.

4.Explain why:

(a) a body with large reflectivity is a poor emitter

(b) a brass tumbler feels much colder than a wooden tray on a chilly day

(c) an optical pyrometer (for measuring high temperatures) calibrated for an ideal black body radiation gives too low a value for the temperature of a red hot iron piece in the open, but gives a correct value for the temperature when the same piece is in the furnace

(d) the earth without its atmosphere would be inhospitably cold

(e) heating systems based on circulation of steam are more efficient in warming a building than those based on circulation of hot water

Ans: (a) A body with a high reflectivity absorbs light radiations poorly. A poor radiation absorber will also be a poor radiation emitter. As a result, a body with a high reflectivity is an inefficient emitter.

(b) Brass is an excellent heat conductor. When a person touches a brass tumbler, heat is easily transferred from the body to the tumbler. As a result, the body's temperature drops to a lower level, and one feels cooler.

Wood is a poor heat conductor. When one touches a wooden tray, just a small amount of heat is transferred from the body to the tray. As a result, there is only a minor reduction in body temperature, and one does not feel cool. On a cool day, a metal tumbler seems colder than a wooden tray.

(c) The temperature of a red hot iron piece maintained in the open is measured incorrectly by an optical pyrometer calibrated for perfect black body radiation. The equation for black-body radiation is:

$$E = \sigma \left(T^4 - T_0^4\right)$$

Where,

$E =$ Energy radiation

$T =$ Temperature of optical pyrometer

$T_0 =$ Temperature of open space

$\sigma =$ Constant

As a result, increasing the temperature of open space lowers the amount of energy radiated. When the same piece of iron is heated in a furnace, the amount of radiation energy produced is the same.

(d) Earth would be inhospitably cold without its atmosphere. There will be no additional heat trapped in the absence of air gases. The heat would be reflected back to the surface of the earth.

(e) A heating system that circulates steam rather than hot water is more efficient in warming a building. This is due to the fact that steam includes latent heat, which is surplus heat.

Benefits of Using Important Questions for Class 11 Physics Chapter 10

Using important questions for Class 11 Physics Chapter 10 Thermal Properties of Matter offers several advantages:

Focused Preparation: It helps students focus on the most frequently asked and important topics, ensuring efficient study time.

Better Understanding: By solving these questions, students can deepen their understanding of key concepts like heat transfer, specific heat, and thermodynamic processes.

Enhanced Problem-Solving Skills: Practicing important questions sharpens analytical and problem-solving abilities, crucial for both exams and practical applications.

Exam Readiness: It boosts confidence by familiarizing students with the exam pattern and types of questions likely to appear.

Self-Assessment: Students can evaluate their grasp of the subject and identify areas that need further attention.