	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department: SCIENCE 2025 – 26** **SUBJECT: PHYSICS**	**Date: 13/01/2026**
Worksheet No: 10 **WITH ANSWERS**	**CHAPTER / UNIT: THERMAL PROPERTIES OF MATTER**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SEC:**	**ROLL NO.:**

<u>OBJECTIVE TYPE OF QUESTIONS (1 MARK):</u>

1) Which of the following processes of transmission of heat will not work in a space station?
   a) conduction
   b) convection
   c) radiation
   d) both conduction and convection
2) At atmospheric pressure, water boils at 100°C. If pressure is reduced, then it,
   a) still boils at the same temperature
   b) now boils at a lower temperature
   c) now boils at a higher temperature
   d) does not boil at all
3) Two spheres are made of the same substance and have diameters in the ratio of 1:2. Their thermal capacities are in the ratio of
   a) 1:2
   b) 1:4
   c) 1:8
   d) 2:1
4) 80 gm of water at 30°C is poured on a large block of ice at 0°C. The mass of ice that melts is
   a) 30 gm
   b) 80 gm
   c) 1600 gm
   d) 150 gm
5) As the temperature increases, the period of a pendulum
   a) increases as its effective length increases, even though its centre of mass remains at the centre of the bob
   b) decreases as its effective length increases, even though its centre of mass remains at the centre of the bob
   c) increases as its effective length increases due to shifting to the center of mass below the centre of the bob
   d) decreases as its effective length remains the same, but the center of mass shifts above the center of the bob

6) The triple point of neon is 24.57 K. Express this temperature on the Celsius and Fahrenheit scales.

a) –208.58°C = – 355.44°F
b) –238.58°C = – 315.44°F
c) –248.58°C = – 415.44°F
d) –218.58°C = – 335.44°F

7) An aluminium sphere is dipped into water. Which of the following is true?

a) Buoyancy will be less in water at 0°C than in water at 4°C
b) Buoyancy will be greater in water at 0°C than in water at 4°C
c) Buoyancy in water at 0°C will be the same as in water at 4°C
d) Buoyancy may be more or less in water at 4°C, depending on the radius of the sphere.

8) The excess temperature of a body falls from 12°C to 6°C in 5 minutes, the temperature of the surroundings is 0°C, then the time to fall the excess temperature from 6°C to 3°C is (assume Newton's cooling is valid)

a) 10 minutes
b) 7.5 minutes
c) 5 minutes
d) 2.5 minutes

9) A brass spring has a spring constant k. When the spring is heated, the spring constant will

a) remain the same
b) increase
c) increase, then decrease
d) decrease

10) Two ends of a metal rod are maintained at temperatures of 200°C and 210°C. The rate of heat flow was found to be 10 J/s. If the ends of the rod are maintained at 400°C and 410°C, the rate of heat flow will be

a) 10 J/s
b) 20 J/s
c) 15 J/s
d) 30 J/s

ASSERTION AND REASONING TYPE OF QUESTIONS (1 MARK):

DIRECTIONS: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) Both A and R are true, and R is the correct explanation of A.
b) Both A and R are true, and R is not the correct explanation of A.
c) A is true, but R is false.
d) A is false, but R is true

11) **Assertion**: A calorimeter is made of a metal with low specific heat capacity.
Reason: A low specific heat capacity ensures minimum heat exchange between the calorimeter and its contents.

12) **Assertion:** If a hot liquid is mixed with a cold liquid, the final temperature of the liquid is always the average of their initial temperatures.
Reason: Heat loss by the hot liquid is equal to the heat gained by the cold liquid.

13) **Assertion:** It is hotter over the top of a fire than at the same distance on the sides.

Reason: The Air surrounding the fire conducts more heat upwards.

14)**Assertion:** Water kept in an open vessel will quickly evaporate on the surface of the Moon.
Reason: The temperature at the surface of the moon is much higher than the boiling point of water.

15)**Assertion:** The radiation from the sun's surface varies as the fourth power of its absolute temperature.
Reason: The Sun is not a blackbody.

VERY SHORT ANSWER TYPE OF QUESTIONS: (2 MARK)

16) Each side of a cube increases by 0.01% on heating. How much is the area of its faces and the Volume increased?

17) Calculate the temperature that has the same numerical value on the Celsius and Fahrenheit scales.

18) Why do pendulum clocks generally go faster in winter and slower in Summer?

19) In an experiment on the specific heat of a metal, a 0.20 kg block of the metal at 150°C is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing 150 cm^3 of water at 27°C. The final temperature is 40°C. Compute the specific heat of the metal.

20)100 g of water is supercooled to –10°C. At this point, due to some disturbance, mechanized or otherwise, some of it suddenly freezes to ice. What will be the temperature of the resultant mixture, and how much mass would freeze?

21) A brass rod of length 50 cm and diameter 3.0 mm is joined to a steel rod of the same length and diameter. What is the change in length of the combined rod at 250 °C, if the original lengths are at 40.0 °C? The ends of the rod are free to expand (Coefficient of linear expansion of brass = 2.0×10^{-5} K^{-1}, steel = 1.2×10^{-5} K^{-1}).

SHORT ANSWER TYPE OF QUESTIONS (3 MARK):

22) A 10 kW drilling machine is used to drill a bore in a small aluminium block of mass 8.0 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 J g^{-1} K^{-1}.

23)Show that the coefficient of volume expansion for a solid is three times its coefficient of volume expansion.

24) A copper block of mass 2.5 kg is heated in a furnace to a temperature of 500 °C and then passed on a large ice block. What is the maximum amount of ice that can melt?

25) 10 kg of hot water at 70 °C is mixed with 20 kg of cold water at 10 °C for bathing. What is the final temperature of the mixture? (Neglect the thermal capacity of the bucket.)

LONG ANSWER TYPE OF QUESTIONS (5 MARKS):

26) A thin rod having length L_0 at 0 °C and coefficient of linear expansion α has two ends maintained at temperatures θ_1 and θ_2, respectively. Find its new length.

27) Explain why:

i. A body with large reflectivity is a poor emitter
ii. The Earth without its atmosphere would be inhospitably cold.
iii. Heating systems based on the circulation of steam are more efficient in warming a building than those based on the circulation of hot water.

28) A thermocol icebox is a cheap and efficient method for storing small quantities of cooked food, in particular. A cubic icebox with a side length of 30 cm has a thickness of 5 cm. If 4 kg of ice is put in the box, estimate the amount of ice remaining after 6 h. The outside temperature is 45° C, and the coefficient of thermal conductivity of thermocol is 0.01 $Js^{-1}m^{-1}K^{-1}$. [Heat of fusion of water = 33×10^3]

CASE STUDY TYPE OF QUESTIONS (4 MARKS):

29)The process by which heat is transferred directly from one body to another body without affecting the intervening medium is called radiation. In this mode of heat transfer, all bodies are continuously emitting radiant energy or thermal radiation by virtue of their temperature. It travels in the form of an electromagnetic wave. The total radiant energy emitted by a black body at temperature T is $E = \sigma T^4$, where σ is a constant, c, and A is the surface area of the body. The radiant energy emitted by other bodies is $Q = \varepsilon E$, where ε is the emissivity of the body.

i. What is the mode of heat transfer from the sun to Earth?

ii. What is the speed of radiant energy that transfers from one body to another?

iii. Which type of body completely absorbs all the radiation falling on its surface?

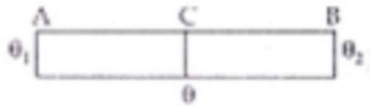
iv. If the temperature of a black body is increased by two times, then how will its radiant energy change?

ANSWER KEY	
1	d) both conduction and convection
2	b) now boils at a lower temperature
3	c) 1:8
4	a) 30 gm
5	a) increases as its effective length increases, even though its centre of mass remains at the centre of the bob
6	c) –248.58° C = – 415.44° F
7	a) Buoyancy will be less in water at 0°C than in water at 4°C
8	c) 5 minutes
9	d) decrease
10	a) 10 J/s
11	a) Both A and R are true, and R is the correct explanation of A.
12	d) A is false, but R is true.

13	c) A is true, but R is false
14	b) A is true, but R is false.
15	c) A is true, but R is false.
16	As each side of a cube increases by 0.01% on heating. This results in an increase in faces by 0.02% and the volume by 0.03%.
17	(°F-32)/180 =°C/100; Let F=C=T; T= - 40 °C = - 40 ° F
18	In winter, the length of the pendulum becomes shorter, so its time period reduces, i.e., the pendulum takes less time to complete an oscillation, so it goes faster. In summer, the length increases, resulting in an increase in the time period, i.e., the pendulum takes more time for complete oscillation, so the clock goes slower.
19	0.43 J $g^{-1}K^{-1}$ **Explanation:** Heat lost by the metal = Heat gained by the water and calorimeter system $m_1c_1\Delta T_1 = (m_1 + m_2)c_2\Delta T_2$ $200 \times c_1 \times 110 = (150 + 25) \times 4.186 \times 13$ $c_1 = \frac{175\times4.186\times13}{200\times110}$ $c_1 = 0.43Jg^{-1}K^{-1}$
20	Water mass = 100 g At -10°C ice and water mixture exists. Heat required (given out) by - $10^\circ C$ ice to $0^\circ C$ ice = $ms\Delta t$ $= 100 \times 1 \times [0 - (-10)]$ $Q = 1000\text{cal}$ Let gm of ice melted Q = ml $m = \frac{Q}{L} = \frac{1000}{80} = 12.5g$ So, there is m = 12.5 g water and ice in mixture. Hence temperature of mixture remains $0^\circ C$.
21	**Explanation:** For the expansion in the brass rod $\frac{\Delta l_1}{l_1} = \alpha_1\Delta T$ $\Delta l_1 = l_1\alpha_1\Delta T = 50 \times 2.1 \times 10^{-5} \times 210 = 0.2205cm$ For the expansion in the steel rod $\frac{\Delta l_2}{l_2} = \alpha_2\Delta T$ $\Delta l_2 = l_2\alpha_2\Delta T = 50 \times 1.2 \times 10^{-5} \times 210 = 0.126cm$ Total change in the lengths of brass and steel $\Delta l = \Delta l_1 + \Delta l_2 = 0.2205 + 0.126 = 0.346cm$ Total change in the length of the combined rod = 0.346 cm

22	Power of the drilling machine, P = 10 kW = 10×10^3 W =10^4 W Mass of the aluminum block, m= 8.0 kg = 8000 g Time, t = 2.5 min = 2.5 $\times$ 60 = 150 s Specific heat of aluminium, c= 0.91 J $g^{-1}K^{-1}$ Let rise in the temperature of the block after drilling = δT Total energy of the drilling machine = $P \times T$ $= 10 \times 10^3 \times 150 = 1.5 \times 10^6 J$ As only 50% of the energy is useful as per the question so useful energy , $\Delta Q = \frac{50}{100} \times 1.5 \times 10^6 = 7.5 \times 10^5 J$ But $\Delta Q = mc\Delta T$ $\therefore \Delta T = \frac{\Delta Q}{mc}$ $= \frac{7.5 \times 10^5}{8 \times 10^3 \times 0.91}$ = 103°C Therefore, temperature of block increases by 103^0 C in drilling for 2.5 minutes.
23	Consider a solid in the form of a rectangular parallelopiped of sides a, b, and c respectively $\therefore$ its volume $V = abc$. If the solid is heated so that its temperature rises by ΔT, then increase in its sides will be $\Delta a = a \cdot \alpha \cdot \Delta T$, $\Delta b = b \cdot \alpha \cdot \Delta T$ and $\Delta c = c \cdot \alpha \cdot \Delta T$ or $a' = a + \Delta a = a(1 + \alpha \cdot \Delta T), b' = b + \Delta b,\ b(1 + \alpha . \Delta T)$ and c' = c + Δc = c(1 + $\alpha . \Delta T$) $\therefore$ New volume $V' = V + \Delta V$ = a'b'c' = abc (1+ $\alpha . \Delta T)^3$ $\therefore$ Increase in volume $\Delta V = V' - V$ = $\left[abc(1 + \alpha \cdot \Delta T)^3 - abc\right]$ $\therefore$ Coefficient of volume expansion $\gamma = \frac{\Delta V}{V \cdot \Delta T}$ = $\frac{abc(1+\alpha \cdot \Delta T)^3 - abc}{abc \cdot \Delta T}$ $\therefore \gamma = \frac{(1+\alpha \cdot \Delta T)^3 - 1}{\Delta T}$ = $\frac{\left(1+3\alpha \cdot \Delta T + 3\alpha^2 \cdot \Delta T^2 + \alpha^3 \cdot \Delta T^3\right) - 1}{\Delta T}$ = $3\alpha + 3\alpha^2 \Delta T + \alpha^3 \cdot \Delta T^2$ As we know that α has an extremely small value for solids $\therefore \gamma = 3\alpha$ $\Rightarrow$ the coefficient of volume expansion of a solid is three times of its coefficient of linear expansion.

24	Mass of copper block, m = 2.5 kg = 2.5 = 2.5×1000 = 2500 g Increase in the temperature , $\Delta\theta = 500^\circ C$ Specific heat of copper, C = 0.39 J g^{-1} C^{-1} Latent heat of fusion for water, L = 335 J g^{-1} Heat lost by the copper block = Q = $mC\Delta\theta$ = $2500 \times 0.39 \times 500$ = 487500 J Let m_1 is the amount of ice that melts on absorbing heat by copper block. heat gained by melting of m_1 gram of ice, Q = m_1L $\therefore m_1 = \frac{Q}{L} = \frac{487500}{335} = 1455.22g$ Hence, 1.45 Kg of maximum ice can get melt on placing the copper block on ice cube.
25	For hot water m_1 = 10 kg, T_1 = 70 ° C For cold water m_2 = 20 kg, T_2 =10 °C Let the final temperature of the mixture be T Then, heat is lost by the hot water $Q_1 = m_1c_1(T_1\text{-}T) = 10\times c_1 \times (70 - T)$ Heat gained by cold water, $Q_2 = m_2c_2(T\text{-}T_2) = 20\times c_2 \times (T -70)$ From the principle of calorimetry, Heat lost = Heat gained $10\times c_1 \times (70 - T) = 20\times c_2 \times (T -70)$ The specific heat of hot and cold water is equal ie, $c_1=c_2$ Therefore , 10(70 -T) = 20(T - 10) Or 700 – 10 T = 20 T – 200 30 T =900 T=900/30=30 ° C

26	As the temperature of rod varies from θ_1 to θ_2 from one end to another. So mean temperature of rod, $\theta = \frac{(\theta_1+\theta_2)}{2}$  So rate of flow of heat from A to C to B are equal $\because \theta_1 > \theta > \theta_2$ From defination of thermal conductivity we get, $\therefore \quad \frac{d\theta}{dt} = \frac{KA(\theta_1-\theta)}{L_0/2}$ (A = area of cross-section of the rod, L_0 = length of the rod) $again,\ \frac{d\theta}{dt} = \frac{KA(\theta-\theta_2)}{L_0/2}$ (since same amount of heat flows from A to B via C in unit time) K is coefficient of thermal conductivity of the material of the rod. $\therefore \theta_1 - \theta = \theta - \theta_2$ $\therefore \theta = \frac{\theta_1+\theta_2}{2}$ Hence the final length of the rod, $L = L_0(1+\alpha\theta) = L_0\left[1+\alpha\left(\frac{\theta_1+\theta_2}{2}\right)\right]$
27	i. A body that has large reflectivity is a poor absorber of heat. It is also a poor emitter of heat. ii. The atmosphere traps the heat reaching the Earth from the sun. In the absence of an atmosphere, almost the total heat reaching Earth will be reflected. So, the earth will be inhospitably cold. iii. Steam at 100 °C contains 2.27×10^6 J of heat (as latent heat) per kg more than water at 100 °C. So, steam is more efficient in warming than water.
28	Side of the given cubical ice box, s = 30 cm = 0.3m Area of each surface of the box = $s^2 = (0.3)^2\ m^3$ Thickness of the icebox, l = 5.0 cm = 0.05 m Mass of ice kept in the icebox, m = 4kg Time gap, t = 6 h = 6 $\times$ 60 $\times$ 60s Outside temperature, θ_1 = 45°C Inside temperature, θ_2 = 0°C Coefficient of thermal conductivity of thermacole, K = 0.01 J s-1 $m^{-1}K^{-1}$ Heat of fusion of water, L = 335×10^3 J kg^{-1} Let 'm' be the total amount of ice that melts in 6h. The amount of heat lost by the food, kept in the thermacole in 6 hrs(using the equation from defination of thermal conductivity): $Q = \frac{KA(\theta_1-\theta_2)t}{l}$ Where, A = Total surface area of the box = 6 × area of each surface = 6 $\times(0.3)^2$ = 0.54 m^3 $\therefore Q = \frac{0.01\times0.54\times(45)\times6\times60\times60}{0.05} = 104976J$ Now, if m' be the mass of melted ice, then $Q = m'L$ $\therefore m' = \frac{Q}{L}$ $= \frac{104976}{335\times10^3} = 0.313\text{kg}$ Mass of ice left = 4 - 0.313 = 3.687 kg

29	i.	The heat from the sun reaches Earth by radiation.
	ii.	As the radiant energy from a body is emitted in the form of electromagnetic radiation, it travels at the speed of light. Hence, the speed of radiant energy will be equal to the speed of light.
	iii.	A perfectly black body completely absorbs all the radiation falling on its surface.
	iv.	The radiant energy emitted by a black body is given by $E = \sigma T^4$; $E \propto T^4$ $E_1/E_2 = (T_2/T_1)^4$ Given, $T_2 = 2T_1$ Therefore $E_2 = (2T_1/T_1)^4 E_1 = 16E_1$ Hence, the new radiant energy is increased by 16 times the original value

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