

	INDIAN SCHOOL AL WADI AL KABIR		
CLASS: XI	DEPARTMENT: SCIENCE 2024 – 25 SUBJECT: PHYSICS	DATE: 20/01/2025	
WORKSHEET NO: 10 WITH ANSWERS	CHAPTER / UNIT: THERMAL PROPERTIES OF MATTER	NOTE: A4 FILE FORMAT	
NAME OF THE STUDENT:	CLASS & SEC:	ROLL NO.:	

OBJECTIVE TYPE OF QUESTIONS (1 MARK):

- On a new scale of temperature (which is linear) and called the Z scale, the freezing and boiling points of water are 39°Z and 239°Z respectively. What will be the temperature on the new scale, corresponding to a temperature of 39°C on the Celsius scale?
 - 200°Z
 - 139°Z
 - 78°Z
 - 117°Z
- A copper rod of 88 cm and an aluminum rod of unknown length have their increase in length independent of increase in temperature. The length of aluminum rod is ($\alpha_{\text{Cu}} = 1.7 \times 10^{-5} \text{ K}^{-1}$ and $\alpha_{\text{Al}} = 2.2 \times 10^{-5} \text{ K}^{-1}$)
 - 68 cm
 - 6.8 cm
 - 113.9 cm
 - 88 cm
- The temperature which has same numerical value on Celsius and Fahrenheit scale
 - -40°
 - 0°
 - -20°
 - 100°
- When the state is being changes from gas to liquid through the process of condensation, the temperature
 - Increases
 - Decreases
 - Remains constant
 - May increase or decrease
- Coefficient of linear expansion of brass and steel rods are α_1 and α_2 . Lengths of brass and steel rods

are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good?

- a) $\alpha_1 l_2 = \alpha_2 l_1$
- b) $\alpha_1 l_1 = \alpha_2 l_2$
- c) $\alpha_1 l_2 = \alpha_2 / l_1$
- d) $\alpha_1 / l_1 = \alpha_2 / l_2$

6) Thermal energy is transferred to a solid. First it melts and then it boils to produce a gas. Which statement about the temperature is correct?

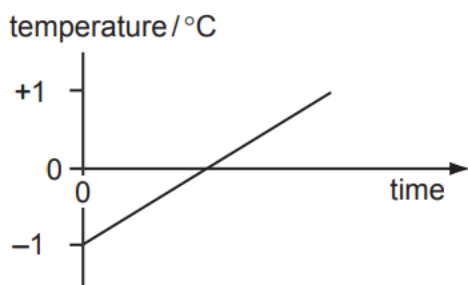
- a) When melting and boiling the temperature does not change.
- b) When melting and boiling the temperature increases.
- c) When melting the temperature increases but when boiling the temperature stays the same.
- d) When melting the temperature stays the same but when boiling the temperature increases.

7) Different amounts of energy are supplied to copper blocks of different masses. Which block experiences the greatest temperature change?

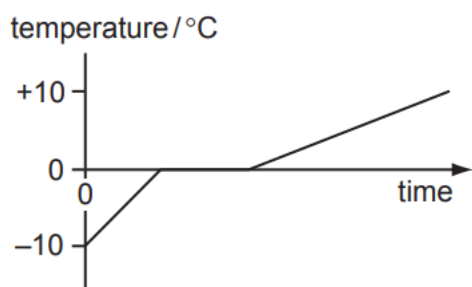
	mass of block / kg	energy supplied / J
A	0.1	200
B	0.2	200
C	0.4	600
D	0.8	400

- a) A
- b) B
- c) C
- d) D

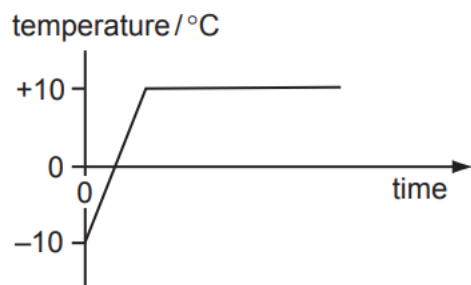
8) Ice at -10°C is heated until it is water at $+10^\circ\text{C}$. Which graph shows how the temperature changes with time?



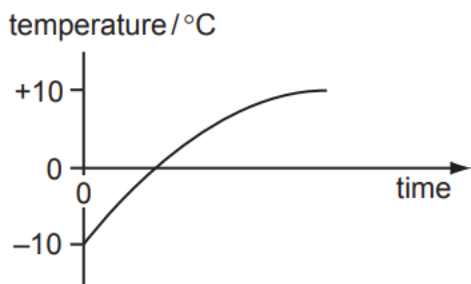
a)



b)



c)



d)

9) Less heat is needed to raise the temperature of 1kg of copper by 1°C than is needed to raise the temperature of 1kg of water by 1°C . Which statement explains this?

- a) Copper has a higher melting point.
- b) Copper has a lower specific heat capacity.
- c) Copper has a smaller specific latent heat.
- d) Copper is a better conductor of heat

10) A 2 kg mass of copper is heated for 40 s by a heater that produces 100 J/s . The specific heat capacity of copper is 400 J/(kg K) . What is the rise in temperature?

- a) 50 K
- b) 10 K
- c) 20 K
- d) 5 K

ASSERTION AND REASONING TYPE OF QUESTIONS (1 MARK):

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

- a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

- b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- c) If Assertion is true but Reason is false.
- d) If both Assertion and Reason are false.

11) **Assertion:** A brass disc is just fitted in a hole in a steel plate. The system must be cooled to loosen the disc from the hole.

Reason: The coefficient of linear expansion for brass is greater than the coefficient of linear expansion for steel.

12) **Assertion:** A hotter body has more heat content than a colder body.

Reason: Temperature is the measure of degree of hotness of a body only.

13) **Assertion:** Thermal expansion in solids is generally very small.

Reason: Solids have strong intermolecular forces that resist significant expansion.

VERY SHORT ANSWER TYPE OF QUESTIONS: (2 MARK)

14) A Celsius and Fahrenheit thermometer are put in a hot bath. The reading of Fahrenheit thermometer is $\frac{3}{2}$ times the reading of Celsius thermometer. What is the temperature of bath on Celsius, Fahrenheit and Kelvin's scales?

15) A piece of metal has a length 30 cm at 15°C . At 90°C its length increases by 0.027 cm. Find the coefficient of cubical expansion of the metal?

16) The length of a steel pan of a river bridge is 50 m and the bridge has to withstand temperature ranging from 4°C to 52°C . What allowance should be kept for its change in length with temperature? Given $\alpha = 1.1 \times 10^{-5} \text{ }^{\circ}\text{C}^{-1}$

17) What is meant by regelation? Also state why skating is possible on snow?

SHORT ANSWER TYPE OF QUESTIONS (3 MARK):

18) A metallic ball has a radius of 9 cm at 0°C . calculate the change in its volume when it is heated to 90°C . Given that coefficient of linear expansion of metal of ball is $1.2 \times 10^{-5} \text{ K}^{-1}$

19) How much should the temperature of a brass rod be increased so as to increase its length by 1%? Given for brass is $0.00002 \text{ }^{\circ}\text{C}^{-1}$

20) A person weighing 60 kg takes in 2000 kcal diet in a day. If this energy were to be used in heating the person without any losses, what would be his rise in temperature? Given specific heat of human body is $0.83 \text{ cal g}^{-1}\text{ }^{\circ}\text{C}^{-1}$

21) A 50 g block of copper at 80°C is dropped into 200 g of water at 20°C . Calculate the final temperature of the system, assuming no heat is lost to the surroundings. Given specific heat capacity of water is $4.186 \text{ J g}^{-1}\text{ }^{\circ}\text{C}^{-1}$ and that of copper is $0.39 \text{ J g}^{-1}\text{ }^{\circ}\text{C}^{-1}$.

LONG ANSWER TYPE OF QUESTIONS (5 MARK):

22) A mixture of 200 g of ice at 0°C and 300 g of water at 50°C is kept in an insulated container. Calculate the final temperature of the system and the mass of ice left, if any.

Latent heat of fusion of ice: 334 J/g

Specific heat capacity of water: $4.18 \text{ J g}^{-1}\text{ }^{\circ}\text{C}^{-1}$

23) Calculate the total heat required to convert 2 kg of ice at -10°C to water at 30°C .

Latent heat of fusion of ice: 334 kJ/kg

Specific heat capacity of ice: $2.1 \text{ kJ kg}^{-1}\text{C}^{-1}$

Specific heat capacity of water: $4.18 \text{ kJ kg}^{-1}\text{C}^{-1}$

24) Find the total heat required to convert 3 kg of ice at -5°C to steam at 110°C .

Latent heat of fusion of ice: 334 kJ/kg

Latent heat of vaporization of steam: 2260 kJ/kg

Specific heat capacities:

Ice: $2.1 \text{ kJ kg}^{-1}\text{C}^{-1}$

Water: $4.18 \text{ kJ kg}^{-1}\text{C}^{-1}$

Steam: $2.0 \text{ kJ kg}^{-1}\text{C}^{-1}$

CASE STUDY TYPE OF QUESTIONS (4 MARK):

25) Thermal expansion is a critical factor engineers consider while designing structures like bridges, pipelines, and buildings. When the temperature changes, materials expand or contract, potentially causing stress or deformation if not accommodated. Steel, commonly used in construction, has a linear coefficient of expansion of $\alpha = 1.2 \times 10^{-5} \text{ }^{\circ}\text{C}^{-1}$.

Consider a steel bridge with a total length of 1.5 km. The bridge is designed to withstand temperature variations from -10°C in winter to 40°C in summer. Engineers have installed expansion joints at regular intervals to prevent structural damage due to thermal expansion.

During extreme weather, the temperature variation causes the steel bridge to expand or contract. If expansion joints were not provided, the resulting stress could damage the bridge structure or compromise its integrity. Expansion joints allow controlled movement of bridge sections, maintaining safety and functionality. Without proper design, thermal stresses could lead to cracks or deformation, affecting the bridge's longevity and safety.

The below figure shows: a) Thermal expansion joints like these in the (b) Auckland Harbour Bridge in New Zealand allow bridges to change length without buckling.



(a)



(b)

- i. What is the the total expansion of the steel bridge when the temperature increases from -10°C to 40°C .
 - a) 90 cm
 - b) 9 cm
 - c) 0.9 cm
 - d) 900 cm
- ii. If no expansion joints are provided, calculate the stress produced in the bridge due to thermal expansion.
 - a) $1.2 \times 10^8 \text{ Pa}$
 - b) $1.12 \times 10^8 \text{ Pa}$
 - c) $1.2 \times 10^8 \text{ Pa}$
 - d) $2.2 \times 10^8 \text{ Pa}$
- iii. Which of the following is a practical solution to manage thermal expansion in long pipelines?
 - a) Painting the pipelines
 - b) Using stronger materials
 - c) Installing expansion loops
 - d) Decreasing the diameter of the pipes
- iv. The linear expansion of a material is directly proportional to:
 - a) Its density
 - b) The change in temperature
 - c) Its specific heat capacity
 - d) The square of its temperature

ANSWER KEY	
1	d) 117°Z
2	a) 68 cm
3	a) -40°
4	c) Remains constant
5	b) $\alpha_1 l_1 = \alpha_2 l_2$
6	a) When melting and boiling the temperature does not change.
7	a) A
8	b)
9	b) Copper has a lower specific heat capacity.
10	d) 5 K
11	a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

12	d) If both Assertion and Reason are false
13	a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
14	Reading on $T_f = \frac{3}{2}\theta$ As $\frac{\theta}{100} = \frac{T_f - 32}{180}$ $\frac{\theta}{5} = \frac{\frac{3}{2}\theta - 32}{9}$ On solving, we get $\theta = -106.67^\circ\text{C}$ Temperature on kelvin's scale $T_k = -106.67 + 273.15$ $= 166.48\text{ K}$
15	Here $L_{15} = 30\text{cm}$, $L_{90} - L_{15} = 0.027\text{cm}$ Coefficient of linear expansion of steel piece $\alpha = \frac{L_{90} - L_{15}}{L_{15} \times (90 - 15)} = \frac{0.027}{30 \times 75} = 12 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$ Coefficient of cubical expansion of steel piece $\gamma = 3\alpha = 3 \times 12 \times 10^{-6} = 36 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$
16	$\Delta L = L \cdot \alpha \cdot \Delta T$ $\Delta L = 50\text{ m} \times (1.1 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}) \times 48 \text{ } ^\circ\text{C}$ $\Delta L = 50 \times 1.1 \times 10^{-5} \times 48$ $\Delta L = 50 \times 5.28 \times 10^{-4}$ $\Delta L = 2.64 \times 10^{-2}\text{ m} = 2.64\text{ cm}$
17	Regelation is the process in which a material, typically ice or snow, melts under pressure and then refreezes when the pressure is reduced. This phenomenon occurs because the melting point of ice decreases as pressure increases. When a person skates on ice, the pressure exerted by the skate blade on the ice causes a thin layer of ice beneath the blade to melt because the melting point of ice decreases with pressure. The thin layer of water beneath the skate blade provides lubrication, making it easier for the blade to glide over the ice. As the pressure is relieved (as the skate moves forward), the melted water refreezes, creating a smooth surface again, and the cycle continues. Thus, the pressure from the skate blade causes melting, and the removal of pressure allows the water to refreeze, which is why skating is possible even on snow or ice.

18	As radius of ball, $r_0 = 9.0 \text{ cm} = 0.090 \text{ m}$ at 0°C, hence its volume, $V_0 = \frac{4}{3}\pi r_0^3 = \frac{4}{3} \times 3.14 \times (0.090)^3$ $= 3.05 \times 10^{-3} \text{ m}^3$ Again as, $\alpha = 1.2 \times 10^{-5} \text{ K}^{-1}$, $\therefore \gamma = 3\alpha = 3 \times 1.2 \times 10^{-5} = 3.6 \times 10^{-5} \text{ K}^{-1}$ Moreover rise in temperature $\Delta T = 90^\circ\text{C} - 0^\circ\text{C} = 90^\circ\text{C} = 90 \text{ K}$ $\therefore$ Increase in volume, $\Delta V = V\gamma\Delta T$ $= 3.05 \times 10^{-3} \times 3.6 \times 10^{-5} \times 90$ $= 9.88 \times 10^{-8} \text{ m}^3 = 9.88 \text{ cm}^3$
19	Here, $\Delta T = ?$, $\frac{\Delta L}{L} = \frac{1}{100}$, $\alpha = 0.00002^\circ\text{C}^{-1}$ As, $\Delta L = \alpha L \Delta T$ $\therefore \alpha \Delta T = \frac{\Delta L}{L}$ or $\Delta T = \frac{\Delta L}{L\alpha} = \frac{1}{100 \times 0.00002}$ $\Delta T = \frac{10^5}{2 \times 10^2} = 500^\circ\text{C}$
20	$Q = 200 \text{ kcal} = 2 \times 10^5 \text{ cal}$ Amount of heat required for a person, $\therefore Q = mc\Delta T$ $\Rightarrow \Delta T = \frac{Q}{mc} = \frac{2 \times 10^5}{60 \times 10^3 \times 0.83} = 4.016^\circ\text{C}$
21	Heat lost by copper = heat gained by water $50(0.39)(80 - T) = 200(4.186)(T - 20)$ $T = 21.37^\circ\text{C}$
22	Energy required to completely melt 200 g of ice $Q = mL$ $Q = 200(334)$ $Q = 66800 \text{ J}$ Energy lost by water as it cools $Q = ms\Delta T$ $Q = 300(4.18)(50 - T)$ Heat lost = heat gained $66800 = 300(4.18)(50 - T)$ $T = 4100/1254 = 3.27^\circ\text{C}$ No mass of ice is left.
23	Heat required to heat ice from -10°C to 0°C $Q_1 = ms\Delta T = 2(2.1 \times 10^3)(10) = 42 \text{ kJ}$ Heat required to melt the ice at 0°C $Q_2 = mL = 2(334 \times 10^3) = 668 \text{ kJ}$ Heat required to heat water from 0°C to 30°C

	$Q_3 = ms\Delta T = 2(4.18 \times 10^3)(30) = 250.8 \text{ kJ}$ Total heat, $Q = 960.8 \text{ kJ}$
24	Heat required to heat ice from -5°C to 0°C $Q_1 = ms\Delta T = 3(2.1 \times 10^3)(5) = 31.5 \text{ kJ}$ Heat required to melt the ice at 0°C $Q_2 = mL = 3(334 \times 10^3) = 1002 \text{ kJ}$ Heat required to heat water from 0°C to 100°C $Q_3 = ms\Delta T = 3(4.18 \times 10^3)(100) = 1254 \text{ kJ}$ Heat required to convert water at 0°C to steam $Q_4 = mL = 3(2260 \times 10^3) = 6780 \text{ kJ}$ Heat required to heat steam from 100°C to 110°C $Q_5 = ms\Delta T = 3(2.0 \times 10^3)(10) = 60 \text{ kJ}$ Total heat, $Q = 9127.5 \text{ kJ}$
25	i) a) 90 cm ii) a) $1.2 \times 10^8 \text{ Pa}$ iii) c) Installing expansion loops iv) b) The change in temperature

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