INDIAN SCHOOL AL WADI AL KABIR

Class: XI	**Department: SCIENCE 2020 -21** **SUBJECT: PHYSICS**	**Date of submission: 11.01.2021**
Worksheet No:10 WITH ANSWERS	**Topic: THERMAL PROPERTIES OF MATTER**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT-	**CLASS & SECTION**	**ROLL NO.**

Multiple choice questions:

1. The density of a substance at 0°Cis 10 g/cc and at 100°C its density is 9.7 g/cc. The coefficient of linear expansion of the substance is

(a) 10^{-4} °C^{-1} (b) 10^{-2} °C^{-1} (c) 10^{-3} °C^{-1} (d) 10^{-5} °C^{-1}

use the formula of volumetric thermal expansion ,
$V = V_o(1 + 3\alpha \times \Delta T)$ [because , Y = 3α

we know, density = mass/Volume ,
because mass can't be change if temperature change .
so, formula of thermal expansion for density,
$d = d_o((1 + 3\alpha \times \Delta T)$
9.7 = 10/[1 + 3α × (100 - 0)]
9.7 = 10/[1 + 300α]
9.7 + 2910α = 10
2910α = 0.3 => α = 0.00010309
α = 1.0309 × 10^-4 /°C

2. A copper wire of length L increases in length by 0.2% on heating from 20°C to 40°C. Then percentage change in area of a copper plate of dimensions 3L x 2L on heating from 20°C to 40°C is

(a) 0.15% (6) 0.3% (c) 0.4% (d) 0.6%

solution : using formula, $\Delta l = l\alpha\Delta T$
as it is given that , Δl = 0.2 % of l = 0.002l
so, 0.002l = lα × (40°C - 20°C)
$\Rightarrow 2 \times 10^{-3} = \alpha \times 20$
$\Rightarrow \alpha = 1 \times 10^{-4}$ /°C
now change in area is given by, ΔA = AβΔT
we know, β = 2α
so, ΔA = A2αΔT
$\Rightarrow \Delta A/A = 2\alpha\Delta T = 2 \times 10^{-4}$/°C × 20°C
$= 4 \times 10^{-3}$
percentage change in area = ΔA/A × 100
$= 4 \times 10^{-3} \times 100$
= 0.4 %

3. The ratio of densities of iron at 10°C and 30°C is (α of iron = 10 x 10^{-6} °C^{-1})

(a) 1.003 (6) 1.0003 (c) 1.006 (d) 1.0006

α - Coefficient of linear expansion $= 10 \times 10^{-6}\ °C^{-1}$

$$V' = V + \Delta V = V + \gamma V \times \Delta T = V(1 + \gamma \Delta T)$$

$$\text{density} = \frac{\text{mass}}{\text{Volume}} = \frac{M}{V(1+\gamma\Delta T)} = \frac{d_1}{(1+\gamma\Delta T)}$$

$$\frac{d_{10°C}}{d_{30°C}} = \frac{\left(\frac{d_1}{1+3\alpha(10-25)}\right)}{\frac{d_1}{1+3\alpha(30-25)}} = \frac{1+3\times10\times10^{-6}\times15}{1+3\times10\times10^{-6}\times5} = 1.006$$

4. pendulum clock shows correct time at certain temperature. At a higher temperature the clock

(a) loses time (b) gains time

(c) neither gains nor loses time (d) firstly gains and then loses

The time period pendulum is,

$T = 2\pi\sqrt{(L/g)}$ (where, T is the period , g=9.81 m/s/s)

Since the length(L) of the pendulum changes with temperature so the period will also change.

For higher temperature the length will increase and the period will also extend which shows the time of the ticks. So the clock will lose the time.

5. Certain amount of heat is given to 100g of copper to increase its temperature by 21°C. If the same amount of heat is given to 50 g of water, then the rise in its temperature is (specific heat capacity of copper = 400 J kg^{-1} K^{-1} and that for water = 4200 J kg^{-1} K^{-1})

(a) 4 ºC (b) 5.25 ºC (c) 8 ºC (d) 10.5 ºC

The amount of heat supplied is given by the

relation $Q = mc\Delta T$

Here , m = 100g = 0. 1 kg,c = 400J/ kg -K

$\Delta T = 21K$ *for copper*

Thus, $Q = 0.1 \times 400 \times 21 = 840J$

Hence , $840 = 0.05 \times 4200 \times \Delta T$

$\Rightarrow \quad \Delta T = 4°C$

6. Specific heat of a substance at the melting point becomes

(a) low (b) high (c) remains unchanged (d) infinite

Amount of heat required to raise the temp. of 1 kg of substance to 1°C

$$Q = mC\Delta T$$

$$\frac{Q}{0} = C \Rightarrow C = \infty$$

7. Person weighing 60 kg takes in 2000 kcal diet in a day. If this energy was to be used in heating the person without any losses, his rise in temperature would be nearly (Given sp. heat of human body is 0.83 cal g^{-1} $°C^{-1}$)

(a) 30°C (b) 40°C (c) 35°C (d) 45°C

$m = 60\text{ kg} = 60{,}000\text{ g}$, $\Delta Q = 2000\text{ k cal} = 2000 \times 10^3\text{ cal}$

$S = 0.83\text{ cal g}^{-1}\,°C^{-1}$

$$\Delta Q = m S \Delta T$$

$$\Delta T = \frac{\Delta Q}{mS} = \frac{2000 \times 10^3}{6 \times 10^3 \times 0.83} \simeq 40°C$$

Fill in the blanks,

1. Heat is a form of……. which produces in us the……....
2. Amount of heat required to raise the temperature of 1 gram of water through 1°C is called …………
3. Amount of heat required to raise the temperature of unit mass of the substance through unit degree is called .... of the substance.
4. A boiling point of a substance ………. with increase in pressure.
5. The change from solid state to vapour state without passing through the liquid state is called …………
6. The phenomenon of refreezing of ice on reducing the pressure from ice is called ....

ANSWERS OF MCQs; -1. (a),2. (d), 3. (d), 4. (a), 5. (a), 6. (d), 7. (b),

Answers; Fill in the blanks, .1. energy, sensation of warmth 2. 1 cal, 3. Sp.ht.cap. 4. Increases, 5. Sublimation, 6. Relegation.

CONCEPTUAL TYPE QUESTIONS: -

1. Can water be boiled without heating?

Ans: - Yes. At low pressure. Below the room temperature, when the pressure is made low, the water starts boiling without supplying any heat.

2. Why water is preferred to any other liquid in the hot water bottles?
Ans: - Water is preferred to any other liquid in the hot water bottles because the specific heat of water is high. It does not cool fast.
3. The ice at 0°C is converted into steam at 100°C. State the isothermal changes in the process.
Ans: - Isothermal changes are (i) conversion of ice at 0°C into water at 0°C (ii) conversion of water at 100°C into steam at 100°C.

4. What is relegation?
Ans. It is a phenomenon of refreezing the water into ice (on the surface of ice formed due to increase in pressure) on removing the increased pressure.
5. What is sublimation?
Ans. On heating a substance, the change from solid state to vapour state without passing through the liquid state is called sublimation.
6. What is specific heat of a gas in an isothermal process?
Ans- Infinite, because $\Delta T = 0$, $c = Q/m\Delta T$.
7. What is the basic condition for Newton's law of cooling to be obeyed?
Ans. Newton's law of cooling will be obeyed if the temperature difference between body and surroundings is small, i.e., not more than 40°C.

NUMERICAL TYPE QUESTIONS: -

1. A brass disc has a hole of diameter 2.5 cm at 27°C. Find the change in the diameter of the hole of the disc when heated to 327°C. Given coefficient of linear expansion of brass is 1.9×10^{-5} °C^{-1}

Solution. Here, $D_{27} = 2{\cdot}5$ cm ;

$$\Delta T = 327 - 27 = 300°C$$

$$\alpha = 1{\cdot}9 \times 10^{-5}\ °C^{-1}\ ; \quad D_{327} - D_{27} = ?$$

$$D_{327} = D_{27}\,[1 + \alpha\,\Delta T] = D_{27} + D_{27}\,\alpha\,\Delta T$$

Change in diameter $= D_{327} - D_{27} = D_{27}\,\alpha\,\Delta T$

$$= 2{\cdot}5 \times (1{\cdot}9 \times 10^{-5}) \times 300$$

$$= \mathbf{0{\cdot}014\ cm.}$$

2. How much should the temperature of a brass rod be increased so as to increase its length by 1%? Given α for brass is 0.00002 °C^{-1}

Solution. Here, $\Delta T = ?$; $\frac{\Delta L}{L} = \frac{1}{100}$

$$\alpha = 0{\cdot}00002\ ^\circ C^{-1}$$

As, $$\Delta L = \alpha\, L\, \Delta T$$

$$\therefore \quad \Delta T = \frac{\Delta L}{L\alpha} = \frac{1}{100 \times 0{\cdot}00002}$$

$$= \frac{10^5}{2 \times 10^2} = \mathbf{500^\circ\ C}$$

3. Railway lines are laid with gaps to allow for expansion. If the gap between steel rails 60 m long be 3.60 cm at 10°C, then at what temperature will the lines just touch? Co-efficient of linear expansion of rail = 11 x 10^{-6} °C^{-1}

Here, $l = 60$ m ; $\Delta l = 3{\cdot}60$ cm $= 3{\cdot}6 \times 10^{-2}$ m ;

$\theta_1 = 10^\circ C$, $\theta_2 = ?$; $\alpha = 11 \times 10^{-6}\ ^\circ C^{-1}$

$$\alpha = \frac{\Delta l}{l(\theta_2 - \theta_1)} \quad \text{or} \quad \theta_2 - \theta_1 = \frac{\Delta l}{l\alpha}$$

$$\text{or} \quad \theta_2 = \theta_1 + \frac{\Delta l}{l\alpha} = 10 + \frac{3{\cdot}60 \times 10^{-2}}{60 \times 11 \times 10^{-6}}$$

$$= 10 + 54{\cdot}54 = \mathbf{64{\cdot}54^\circ C}$$

4. A blacksmith fixes iron ring on the rim of the wooden wheel of a bullock cart. The diameter of the rim and the ring are 5.243 m and 5.231 m respectively at 27°C. To what temperature should the ring be heated so as to fit the rim of the wheel? Coefficient of linear expansion of iron is 1.20 x 10^{-5} K^{-1}.

Solution. Here, $L_{T_1} = 5{\cdot}231$ m ;

$L_{T_2} = 5{\cdot}243$ m ; $T_1 = 27^\circ C$, $T_2 = ?$

$$\text{As,} \quad \alpha = \frac{L_{T_2} - L_{T_1}}{L_{T_1}(T_2 - T_1)} \quad \therefore \ T_2 - T_1 = \frac{L_{T_2} - L_{T_1}}{L_{T_1} \times \alpha}$$

$$\text{or} \quad T_2 = \frac{L_{T_2} - L_{T_1}}{L_{T_1} \times \alpha} + T_1$$

$$= \frac{5{\cdot}243 - 5{\cdot}231}{5{\cdot}231 \times 1{\cdot}2 \times 10^{-5}} + 27$$

$$= 191{\cdot}1 + 27 = 218{\cdot}1 \approx \mathbf{218^\circ C}$$

5. The water of mass 75 g at 100°C is added to ice of mass 20g at-15°C. What is the resulting temperature. (Latent heat of ice = 80 cal/g and specific heat of ice = 0.5 cal g^{-1} °C^{-1})

Solution. Let the resulting temperature be T_0°C

Sp. heat of water, $s_1 = 1$ cal/g/°C

Heat lost by water $= m_1\, s_1\, \Delta T_1$

$= 75 \times 1 \times (100 - T_0)$ cal.

Heat gained by ice

(*i*) from – 15°C to 0°C $= m_2\, s_2\, \Delta T_2$

$= 20 \times 0{\cdot}5 \times (0 + 15) = 150$ cal

(*ii*) in converting into water at 0°C $= m_2\, L$

$= 20 \times 80 = 1600$ cal

(*iii*) in raising the temperature of water formed from 0°C to T_0°C.

$= m_2\, s_1\, (T_0 - 0) = 20 \times 1 \times T_0 = 20\, T_0$ cal

According to principle of calorimetry,

heat lost = heat gained

$$75\,(100 - T_0) = 150 + 1600 + 20\, T_0$$

$$\text{or} \quad 7500 - 75\, T_0 = 1750 + 20\, T_0$$

$$\text{or} \quad 95\, T_0 = 5750 \quad \text{or} \quad T_0 = \frac{5750}{95} = \mathbf{60{\cdot}5^\circ\ C}$$

6. When 0.15 kg of ice at 0°C is mixed with 0.30 kg of water at 50°Cin a container, the resulting temperature is 6.7°C. Calculate the heat of fusion of ice. (water 4186 J kg^{-1} K^{-1})

Solution. Heat lost by water

$= m_w s_w (T_1 - T_2) = 0{\cdot}30 \times 4186 \times (50 - 6{\cdot}7)$

$= 54376{\cdot}14$ J

Heat taken by ice $= m_i L + m_i s_w (T_2 - T_0)$

$= 0{\cdot}15 \times L + 0{\cdot}15 \times 4186 \times (6{\cdot}7 - 0)$

$= 0{\cdot}15\, L + 4206{\cdot}93$ J

Heat lost = heat gained

∴ $54376{\cdot}14 = 0{\cdot}15\, L + 4206{\cdot}93$

or $\mathbf{L = 3{\cdot}34 \times 10^5\ J\ kg^{-1}}$

7. How many grams of ice at -14°C are needed to cool 200 gram of water form 25°C to 10°C? Take specific heat of ice = 00.5 cal g^{-1} $°C^{-1}$ and Latent heat of ice = 80 cal g^{-1}.

Solution. Here, $m_{ice} = ?\ m_w = 200$ g ;

$s_{ice} = 0{\cdot}5$ cal $g^{-1}\,°C^{-1}$, $L_{ice} = 80$ cal g^{-1}

Heat lost by water in cooling from 25°C to 10°C is

$Q_1 = m_w \times s_w \times \Delta T_1 = 200 \times 1 \times (25 - 10)$

$= 3000$ cal.

Heat gained by ice at – 14°C to change into water at 10°C is

$Q_2 = m_{ice}\, s_{ice}\, \Delta T_2 + m_{ice} L_{ice} + m_{ice} \times s_w \times \Delta T_3$

$= m \times 0{\cdot}5 \times [0 - (-14)] + m \times 80 + m \times 1 \times (10 - 0)$

$= 97$ m cal

As heat lost = heat gained, so $Q_1 = Q_2$

or $3000 = 97$ m or $m = \frac{3000}{97}$ **= 31 g**

8. How much meters can a 50 kg man climbs by using the energy from a slice of a bread which produces 420 kJ heat? Assuming that the human body efficiency working is 30%. Use g = 10 m/s^2.

Sol: - Let h be the height climbed by man. Increase in PE of man = mgh = 50 x 10 x h J

Heat produced; H = 420 kJ = 420 x 1000 J = 4.2 x 10^5 J

efficiency of man = 30%,

So heat energy utilized = $\frac{30}{100}$ x 4.2 x 10^5 = 12.6 x 10^4 J

Now, increase in PE = heat energy utilized

50 x 10 x h = 12.6 x 10^4

h = $\frac{126000}{50 \times 10}$ = 252m.

PREPARED BY: - MR. RANDHIR KUMAR GUPTA	CHECKED BY : HOD - SCIENCE