PHYSICS

The following questions given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q.1 **Assertion :** Melting point of ice decrease upon increase in pressure.

Reason : Volume of water is smaller than volume of ice. **[A]**

Sol. Upon increasing pressure ice melts as to decrease the volume and thereby pressure. To freeze the melted ice one need to decrease the temperature down and hence melting point decreases.

Q.2 **Assertion :** In lake or ocean water does not freeze completely.

Reason : Water has minimum volume at 4°C. **[A]**

Q.3 **Assertion :** The melting point of substances must rise with increase in pressure.

Reason : To melt a substance at its melting point heat is given to it. **[D]**

Q.4 **Assertion** : Amount of heat required to raise the temperature of 1 kg of water through 1ºC is 1 kilocalorie.

Reason : By definition, 1 calorie is the amount of heat required to raise the temperature of 1 gram of water through 1ºC. **[A]**

Q.5 **Assertion** : Specific heat of a substance during change of state is infinite.

Reason : During change of state $\Delta Q = mL$, specific heat does not come in. **[B]**

Q.6 **Assertion** : Work required to produce 1 calorie of heat is 4.2 joule.

Reason : This is the standard value of Joule's mechanical equivalent of heat. **[A]**

Q.7 **Statement I :** Water equivalent of a body is depends upon the mass of body.

Statement II : Heat capacity of body is directly proportional to mass. **[A]**

Q.8 **Statement I :** If heat is given to a body then its temperature always increases.

Statement II : When heat is given to a solid body then its internal energy increases. **[D]**

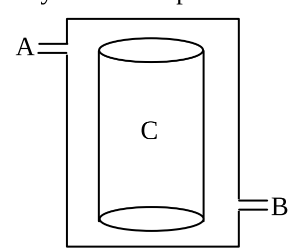
Q.9 **Statement I :** If same amount of ice at 0ºC and water is taken, then total ice will only melt if the temp. of water is greater than 80ºC.

Statement II : From principle of calorimetry, when two substance at different temp. are mixed then heat given by hot substance is equal to heat taken by cold substance. **[A]**

Q.10 **Assertion :** During phase transformation internal energy of material doesn't changes.

Reason : Temperature of material remains same during phase-transformation. **[D]**

Q.11 **Assertion :** Figure shows an arrangement of heating cylinder 'C'. Cylinder is heated more efficiently if steam is passed from A to B.



Reason : Steam tends to stay more time in passed from A to B. **[A]**

Q.12 **Assertion:** Melting of solid at its given melting point will increase the internal kinetic energy.

Reason: Latent heat is the heat required to melt a unit mass of solid at its melting point. **[D]**

Q.13 **Statement-1:** Temperature of the body is lowered considerably if we put wet clothes.
Statement -2: Specific heat of water is high.

(A) Both statement -1 and statement -2 are true and statement -2 is a correct explanation of the statement -1
(B) Both statement -1 and statement -2 are true but statement -2 is not a correct explanation of the statement -1
(C) Both statement -1 and statement -2 are false
(D) statement -1 is false but the statement -2 is true. **[A]**

Q.14 **Assertion :** During phase change temperature of the substance remains constant i.e. during solid $\rightarrow$ liquid and liquid $\rightarrow$ gas.
Reason : Internal energy of the substance during change of phase remains constant. **[C]**

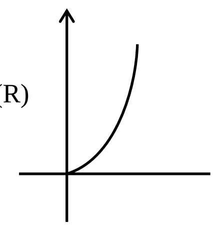
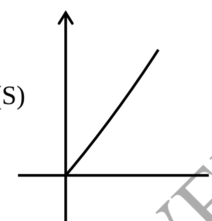
Q.15 **Statement-1 :** The specific heat of a gas in an adiabatic process is zero but it is infinite in an isothermal process.
Statement-2 : Specific heat of a gas directly proportional to heat exchanged with the system and inversely proportional to change in temperature

Sol **[A]**

Q.16 **Assertion (A) :** Melting of solid causes no change in internal energy
Reason (R) : Specific latent heat is the heat required to melt a unit mass of solid.

Sol. **[D]**

Q.1 The specific heat capacity of a material is given as C = AT, where A is a constant, T is temperature. The substance is heated from 27ºC to 127ºC. Unit of A is $J/kg.K^2$. Then match quantities in column I to that in column II.

Column-I	**Column-II**
(A) Mean specific heat in the range 27ºC to 127ºC is	(P) 400 A
(B) Actual specific heat at 127ºC is	(Q) 350 A
(C) Graph of specific heat versus temperature is	(R) 
(D) Graph of amount of heat transferred versus temperature is	(S) 

(A) → Q **(B)** → P **(C)** → S **(D)** → R

Q.2 Column–I contains temperature-range and column–II contains type of thermometer that can be used to measure temperature in that range.

Column I	**Column II**
(A) – 60°C to 140°C	(P) Radiation thermometer
(B) – 260°C to 1200°C	(Q) Thermoelectric thermometer
(C) – 200°C to 1600°C	(R) Mercury thermometer
(D) – 4000°C to 5000°C	(S) Platinum thermometer

Sol. **A → Q,R,S; B → S ; C → Q ; D → P**

Q.3

Column-I	**Column-II**
(A) Final mixture contain only water	(P) 1 kg of ice at –50ºC is mixed with 1×10^{-2}kg of water at 0ºC
(B) Final mixture contain only ice	(Q) 1 kg of ice at 0º with $\frac{1}{3}$ kg of steam at 100ºC
(C) Final mixture contain only steam	(R) $\frac{1}{3}$ kg of water at 100ºC with 1.8 kg of steam of 200ºC
(D) Final temperature is 100ºC	(S) 1 kg of ice at 0ºC with 1 kg of water at 100ºC

Ans. **A → Q,S; B → P; C → R; D → Q,R**

Q.4 Three liquids A, B and C are in three separate containers. Temperature at A, B and C are 10ºC, 15ºC and 20ºC. Mass of each liquid is same. Relation among specific heat capacity of A, B and C are $S_A = 2S_B = 4S_C$

Column-I	**Column-II**
(A) Thermal energy of A changes	(P) When liquid A and B are mixed
(B) Thermal energy of B changes	(Q) When liquid A and C are mixed
(C) Final temperature is $\frac{35}{3}$ ºC	(R) When liquid B and C are mixed
(D) Final temperature is $\frac{90}{7}$ ºC	(S) When all three liquids are mixed

Ans. **A → P,Q,S; B → P,R,S; C → P; D → S**

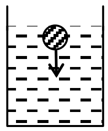
Q.5 Match the column

Column-I	**Column-II**
(A) $0ºC \le T_{mix} < 10ºC$	(P) 10 gm water at 90ºC + 5 gm water at 0ºC
(B) $T_{mix} \le 100ºC$	(Q) 1 gm steam at 100ºC + 6 gm ice at 0ºC
(C) $20ºC \le T_{mix} < 30ºC$	(R) 100 gm water at 10ºC + 3 gm steam at 100ºC
(D) $30ºC \le T_{mix}$	(S) 5 gm water at 70ºC + 5 gm ice at 0ºC
	(T) 1gm water at 0ºC + 1 gm steam at 100ºC

Ans. **A → R,S** **B → P,Q,R,S,T**
C → Q, T **D → P**

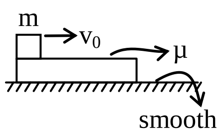
Q.6 **Column-I** **Column-II**

(A) A steel ball is moving down in a viscous liquid — (P) Internal energy of system must increase



(B) When a solid is given some amount of heat — (Q) Temperature of system may increase

(C) During melting of a substance — (R) Temperature of system is constant

(D) 

Upper block is given a velocity v_0 & lower block initially at rest — (S) Temperature of system must increase

(T) No change will occur

Sol. **A → P, S ; B → P, Q ; C → P, R ; D → P, S**

Q.7 Match the column :

Column -I	**Column-II**
(A) specific heat capacity	(P) depends on mass
(B) Latent heat	(Q) Property of substance alone
(C) Heat capacity	(R) Independent of mass
(D) Water equivalent	(S) Property of object alone

Sol. **A→ Q, R ; B → Q, R ; C → P, S; D → P, S**
Conceptual

Q.8 Three liquids A, B and C having same specific heat and mass m, 2m and 3m have temperatures 20ºC, 40ºC and 60ºC respectively. Temperature of the mixture when :

Column-I	**Column-II**
(A) A and B are mixed	(P) 35ºC
(B) A and C are mixed	(Q) 52ºC
(C) B and C are mixed	(R) 50ºC
(D) A, B and C all three are mixed	(S) 45ºC
	(T) None

Sol. **A→ T ; B → R ; C → Q ; D → T**

Q.9

Column I	***Column II***
(a) Final temperature is 2.5ºC	(p) *10 gm water at 30º is mixed with 10 gm of water at 70ºC*
(b) Final mixture contain ice & water	(q) *10 gm of ice at 0ºC is mixed with 10 gm of water at 85ºC*
(c) Final mixture contains water & steam	(r) *10 gm of ice at 0ºC is mixed with 10 gm of water at 50ºC*
(d) Final temperature is 50ºC	*(s) 10 gm of ice at 0ºC is mixed with 10 gm of steam at 100ºC*

(A) a → q, b → r, c → s, d → p
(B) a → p, b → s, c → r, d → q
(C) a → p, b → q, c → r, d → s
(D) a → s, b → p, c → r, d → q

Sol. **[A]**

Q.10 Three liquids A, B and C are in three separate containers. Temperature at A, B and C are 10ºC, 15ºC and 20ºC. Mass of each liquid is same. Relation among specific heat capacity of A, B and C are $S_A = 2S_B = 4S_C$

Column-I	**Column-II**
(A) Thermal energy of A changes	(P) When liquid A and B are mixed
(B) Thermal energy of B changes	(Q) When liquid A and C are mixed
(C) Final temperature is $\frac{35}{3}$ ºC	(R) When liquid B and C are mixed
(D) Final temperature is $\frac{90}{7}$ ºC	(S) When all three liquids are mixed
	(T) When half the sample of A & B are mixed

with complete sample of C

Sol. (A) → P,Q,S,T; (B) → P,R,S,T;
(C) → P; (D) → S

Q.11 Match the column :

Column-I	**Column-II**
(A) Final mixture contains water only	(P) 5gm of ice at –20ºC is mixed with 25gm of water at 30ºC
(B) Final mixture contains both ice and water	(Q) 5gm of ice at –20ºC is mixed with 18gm of water at 25ºC
(C) Final mixture's temperature is 0ºC	(R) 5gm of ice at –20ºC is mixed with 10gm of water at 25ºC
(D) Final temperature is of mixture is 10ºC	(S) 50gm of ice at –20ºC mixed with 5gm of water at 20ºC
	(T) 5 gm of water at 0ºC is mixed with 2.5 gm of water at 30ºC

Sol. (A) → P,Q,T; (B) → R;
(C) → Q,R,S; (D) → P,T

PHYSICS

Q. 1 In three experiments, a material A at a particular low temperature T_C and a material B at a particular high temperature T_H are placed in an isolated and insulated container. When they reach thermal equilibrium with each other (No phase change occurs), their final temperature T_f is measured. The masses m_A & m_B and specific heats C_A & C_B of the materials are given in the table. Assume that heat transferred is Q in the experiment.

Experiment	**m_A**	**C_A**	**m_B**	**C_B**
1	m	c	m	c
2	m	c	2m	c
3	m	2c	m	c

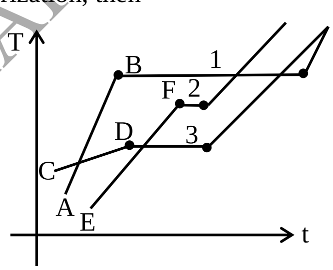
Then which of the following is correct

(A) $(T_f)_1 > (T_f)_2 > (T_f)_3$ (B) $Q_2 > Q_1 > Q_3$

(C) $Q_1 > Q_2 > Q_3$ (D) $(T_f)_2 > (T_f)_1 > (T_f)_3$

[A,B]

Q. 2 Three different materials of identical masses are placed in turn, in a special oven where material absorbs energy at a constant rate. During the heating process, each material begins in liquid state and ends in gaseous state. Figure gives the temperature T versus time t for three materials. Then if T_b be the boiling temperature, C the specific heat of liquid, L the latent heat of vaporization, then –

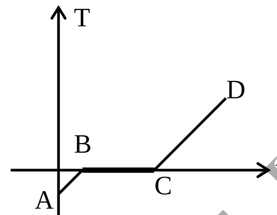


(A) $(T_b)_2 > (T_b)_1 > (T_b)_3$ (B) $C_3 > C_2 > C_1$

(C) $L_1 > L_3 > L_2$ (D) $C_1 > C_2 > C_3$

[B,C]

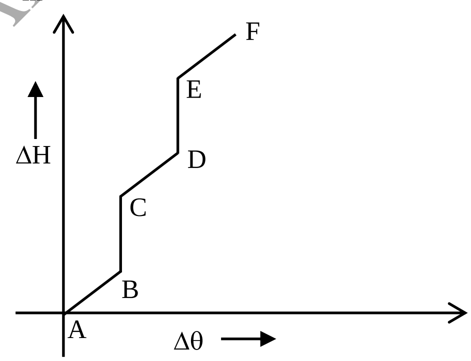
Q. 3 Heat is supplied to a ice at a constant rate Temperature variation with time is as shown in figure. Then –



(A) During AB volume of substance increases
(B) During BC volume of substance decreases
(C) Specific heat of substance in liquid phase is proportional to reciprocal of slope of portion AB, of graph
(D) Latent heat of fusion of substance is independent of portion AB of graph

[B,D]

Q.4 A solid is heated up and ΔH vs $\Delta\theta$ (ΔH : Heat given, $\Delta\theta$: change in temperature) is plotted as shown in figure. Material exist in only one phase in –



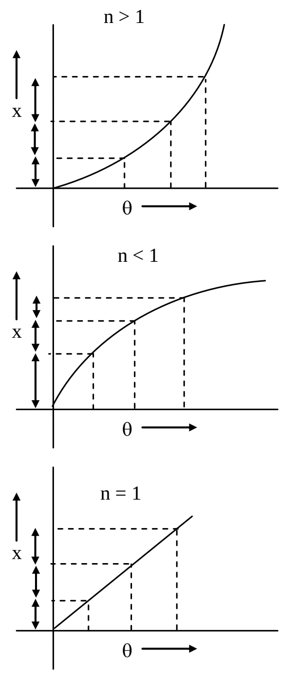
(A) AB (B) BC
(C) CD (D) EF **[A,C,D]**

Sol. If material exist in single phase, temperature always increases with heat supplied.

Q.5 Thermometric property of a substance used to make thermometer varies with temperature as $x = A\theta^n$ where θ is temperature, A is positive constant and n is positive rational number. The distance between two consecutive calibration on temperature scale –
(A) Increase with increase in temperature if $n > 1$
(B) Remains constant with change in temperature if $n = 1$
(C) Increase with increase in temperature if $n = 1/3$
(D) Decrease with increase in temperature if $n < 1$

[A,B,D]

Sol. x versus θ graph :



For same temperature difference change in 'x' increase, with increase in temperature if n > 1, decrease with increase in temperature if n < 1, remains same if n = 1.

Q.6 The heat capacity of a body depends on–

(A) the heat given

(B) the temperature raised

(C) the mass of the body

(D) the material of the body **[C,D]**

Q.7 If heat is supplied to a solid, its temperature–

(A) must increase (B) may increase

(C) may remain constant (D) may decrease

[B,C]

Q.8 The temperature of a solid object is observed to be constant during a period. In this period–

(A) heat may have been supplied to the body

(B) heat may have been extracted from the body

(C) no heat is supplied to the body

(D) no heat is extracted from the body **[A,B]**

Q.9 The temperature of an object is observed to rise in a period. In this period–

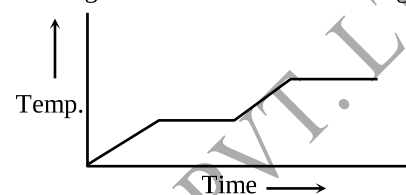
(A) heat is certainly supplied to it

(B) heat is certainly not supplied to it

(C) heat may have been supplied to it

(D) work may have been done on it **[C,D]**

Q.10 Heat is supplied to a certain homogeneous sample of matter at a uniform rate. Its temperature is plotted against time as shown in the figure



Which of the following conclusions can be drawn -

(A) its specific heat capacity is greater in the solid state than in the liquid state

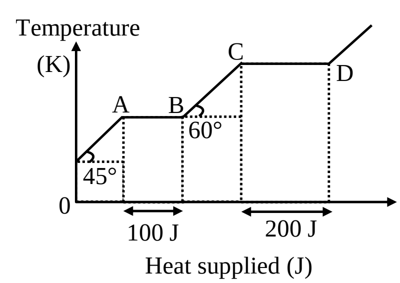
(B) its specific heat capacity is greater in the liquid state in the solid state

(C) its latent heat of vaporization is greater than its latent heat of fusion

(D) its latent heat of vaporization is smaller than its latent heat of fusion **[A,C]**

Sol. Slope of graph is greater in the solid state i.e. temperature is rising faster, hence lower heat capacity. The transition from solid to liquid state takes lesser time, hence latent heat is smaller.

Q.11 The temperature change versus heat supplied curve is given for 1 kg of a solid block. Then, which of the following statements(s) is/are correct ?



(A) Specific heat capacity of the solid is 1 J/kg K

(B) Specific heat capacity of liquid phase is $\sqrt{3}$ J/kg K

(C) Latent heat of vaporization is 100 J/kg

(D) Latent heat of vaporization is 200 J/kg

[A, D]

Q.12 During the melting of a slab of ice at 273 K at atmospheric pressure, **[IIT–98]**

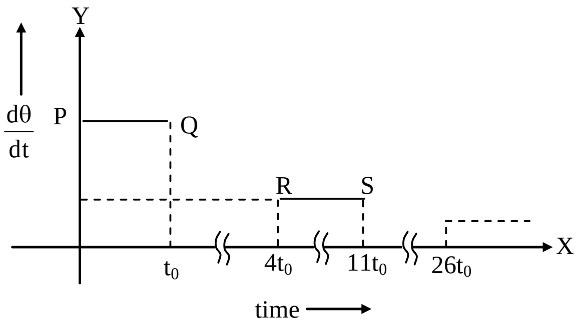
(A) positive work is done by the ice-water system on the atmosphere

(B) positive work is done on the ice-water system by the atmosphere

(C) the internal energy of the ice-water system increases

(D) the internal energy of the ice-water system decreases **[B,C]**

Q.13 A material is heated up at constant rate and graph between rate of increment of temperature versus time is drawn –



Choose the correct option –

(A) Melting starts at 'P'

(B) Boiling starts at 'S'

(C) Specific heat of material in solid state is more than that in liquid state

(D) Latent heat of fusion is less than latent heat of vaporization **[B,D]**

Sol. During phase transition temperature remains constant and hence $\frac{d\theta}{dt} = 0$

Time during melting ($3t_0$) is less than time during vaporization ($15t_0$)

Q.14 Choose the correct options -

(A) Specific heat is the property of substance alone

(B) Heat capacity is the property of substance alone

(C) Water equivalent is the property of substance alone

(D) Latent heat is the property of substance alone

Sol. conceptual

Q.15 Three different liquids with equal masses (m), specific heat as s_A, s_B and s_C & initial temperature as T_A, T_B & T_C are kept closed in a isolated container, then -

(A) final temperature of mixture will be $\frac{1}{3}(T_A + T_B + T_C)$ if $s_A = s_B = s_C$

(B) heat given by liquid A to liquid B & C will be $\frac{ms_A}{3}(2T_A - T_B - T_C)$ if $s_A = s_B = s_C$

(C) heat absorbed by liquid C will be $\frac{ms_C}{s_A + s_B + s_C}[s_A(T_A - T_C) + s_B(T_B - T_C)]$

(D) heat absorbed by liquid A is $\frac{ms_A}{3}(T_B + T_C - 2T_A)$ if $s_A = s_B = s_C$

[A,B,C,D]

Sol. $T_{final} = \frac{m_A s_A T_A + m_B s_B T_B + m_C s_C T_C}{m_A s_A + m_B s_B + m_C s_C}$

Q.16 m_1 gm ice at 0ºC, m_2 gm water at 50ºC and m_3 gm steam at 100ºC are mixed together then the correct alternative is -

(A) Temperature of mixture is 0ºC if $m_1 \geq \frac{5}{8} m_2 + 8 m_3$.

(B) Temperature of mixture is 100ºC if $m_3 \geq \frac{5}{54} m_2 + \frac{m_1}{3}$

(C) Temperature of mixture is 50ºC if $23 m_1 = 59 m_3$

(D) Temperature of mixture is 50ºC if $18 m_1 = 59 m_3$ **[A,B,C]**

Sol. Heat taken by (ice + water) = Heat given by steam if temp of mixture is 100ºC.

Q.17 1 kg of ice at 0ºC is mixed with 1.5 kg of water at 45ºC [latent heat of fusion = 80 cal/g]. Then-

(A) the temperature of the mixture of 0ºC

(B) mixture contains 156.25 g of ice

(C) mixture contains 843.75 g of ice

(D) the temperature of the mixture is 15ºC

Sol. **[A,B]**

Use principle of calorimetery.

Q. 18 It takes 15 minutes to raise a certain amount of water 0ºC to boiling point using an electric heater. After this one hour and twenty minutes are required in the same conditions to convert all the water into vapour -

[A, D]

(A) latent heat of vaporization is 530 cal

(B) latent heat of vaporization is 533 cal

(C) mass of water is 1 kg

(D) latent heat of vaporization is 540 cal **.[B]**

Sol. $L = \frac{t_2}{t_1} \times 100$

Q.19 Select the correct statements -

(A) When state of substance changes, heat is always absorbed by substance

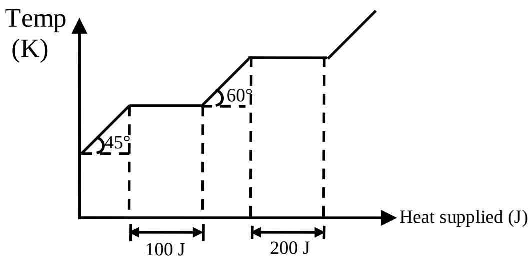
(B) When substance changes its state its temperature during this period remains constant

(C) Internal energy changes

(D) None of these

Sol.[B,C]

Q.20 The temperature change versus heat supplied curve is given for of a solid block. Then which of the following statement (s) is/are correct -



(A) Specific Heat of the solid is 1 J/kg–k

(B) Specific Heat of the liquid is $\sqrt{3}$ J/(kg–k)]

(C) Latent heat of vaporization is 100 J/kg

(D) Latent Heat of vaporization is 200 J/kg

Sol.[A, D]

Q.1 On an X temperature scale, water freezes at –125ºX and boils at 375ºX. On a Y temperature scale water freezes at –70ºY and boils at –30ºY The value of temperature on X-scale equal to the temperature of 50ºY on Y-scale is ....ºX.

Sol. **1375**

$$\frac{X-(-125)}{500} = \frac{Y-(-70)}{40}$$

if Y = 50

X = 1375ºX

Q.2 Heat required to convert 1 kg of water at 80ºC to vapour at 100ºC and 2 atm pressure (1 atm = 10^5 Pa) (in kJ) is (L_v = 580 cal/gm and specific heat of water = 1 cal/gm/ºC). **[2606]**

Sol. The process would be

$$\text{1 kg water at 80ºC} \xrightarrow{\Delta H_1} \text{1 kg water at 100ºC}$$

$$\downarrow \Delta H_2$$

1 kg vapour at 100ºC and 2 atm pressure

$\Delta H_1 = ms\Delta\theta = 1 \times 4.2 \times 10^3 \times 20$

$= 8.4 \times 10^4$ J

$\Delta H_2 = mL_v + P\Delta V$

$= 1 \times 580 \times 10^3 \times 4.2 + 2 \times 10^5 \times 850.14 \times 10^{-3}$

$= 26.06 \times 10^5$ J = 2606 kJ

Q.3 A thermometer of mass 50 gm and specific heat 0.4 cal/gm/ºC reads 10ºC. It is then inserted into 1 kg of water and reads 40ºC in thermal equilibrium. The temperature of water before insertion of thermometer in 10 ºC is (Neglect other heat losses). **[0041]**

Sol. Neglecting other heat losses

Heat lost by water = Heat gained by thermometer

$\therefore m_1 s_1 (\theta_1 - 40º) = m_2 s_2 (40º - 10º)$

m_1 = mass of water

m_2 = mass of thermometer

s_1 = specific heat of water

s_2 = specific heat of thermometer

$\Rightarrow \theta_1 = 40.6$ ºC

≈ 41ºC

Q.4 Temperature of a body while measuring with a centigrade scale was found to be 30ºC and was increasing at a rate $\frac{5}{3}$ ºC/sec. What will be rate of increase if we are measuring it with a Fahrenheit scale at the same instant ? (Ans in ºF/sec) **[3]**

Sol. Rate of increase in Fahrenheit = 1.8 × Rate of increase in Celsius scale

Ans. 3º F/sec

Q.5 A cube of iron (density = 8000 kg/m^3, s_{iron} = 470 J/kg–K) is heated to a high temperature and is placed on a large block of ice at 0ºC. The cube melts the ice below it, displaces the water and sinks. In the final equilibrium position, its upper surface just goes inside the ice. If initial temperature of block is 10 λ, then find the value of λ.

d_{ice} = 900 kg/m^3, $L_f = 3.34 \times 10^5$ J/kg. **[8]**

Sol. Cube will melt ice of equal volume.

Q.6 Specific heat of a substance varies with absolute temperature as s = BT^2 J/kg – K where $B = \frac{3J}{kg - K^3}$. The amount of heat required to raise the temperature of 3 kg substance from 0 K to 10 K can be written as $\lambda \times 10^n$ J. Find the value of λ, where λ and n are integers. **[3]**

Sol. $H = \int_0^T msdT = 3000$ J

Q.7 A certain bullet of mass 6 gm melts at 300ºC and has specific heat as 0.20 Kcal/kg ºC and a heat fusion of $\frac{15kcal}{kg}$. The heat needed to melt the bullet if it was originally at 0ºC, can be written as λ kJ. Then the value of λ is. (J = 4)

Sol.[9] $Q = ms\Delta T + mL$

= 450 cal

Ans. 450 × 4 = 9000 J

Q.8 A piece of iron of mass m = 325 g is placed in a calorimeter filled with thawing ice. The amount of ice that will melt by the time thermal equilibrium is reached is (n.4) × 10^1 g where n is a single digit number. If the volume of the piece of iron being lowered into the calorimeter is $V = 48\ cm^3$. The density of iron at 0ºC is $d_0 = 6.8\ g/cm^3$, its thermal capacity C = 0.12 cal/g ºC and the coefficient of volume expansion of iron is $\gamma = 3.3 \times 10^{-5}$/ ºC. Find the value of n.

Sol. **[6]** $M = \frac{ms(V\rho_0 - m)}{L\ \gamma m} = 64$

Q.9 To find C_x the specific heat capacity of material X, Ram places 75 g of it in a 30 g copper calorimeter that contains 65 g of water, all initially at 20ºC. When Ram adds 100 g of water at 80ºC, the final temperature is 49 ºC. What is C_x ?
[Specific heat capacity of copper = 410 J $kg^{-1}\ K^{-1}$,
Specific heat capacity of water C_w = 4200 J $kg^{-1}K^{-1}$]

Sol. **[2180]**

$C_x = 2180\ \frac{J}{kg.K}$

$(m_xC_x + m_{Cu}\ C_{Cu} + m_wC_w)\ \Delta\theta$
$= m_{hw}\ C_{hw}\ \Delta\theta_{hw}$

Q.10 A calorimeter of negligible heat capacity contains 100 gm water at 40°C. The water cools to 35°C in 5 min.. If water is now replaced by a liquid of same volume as that of water at same initial temperature it cools to 35°C in 2 min. Given sp. heats of water and liquid are 4200 J/kg-°C and 2100 J/kg-°C respectively. Find the density of liquid give answer in….× 100 kg/m^3. [Assume Newton law of cooling is applicable]

Sol.[8] $-\frac{dT}{dt} = \frac{K}{100 \times S_w}(T - T_0)$

$$\int_{40}^{35} \frac{-dT}{T - T_0} = \int_0^5 \frac{K}{100 \times S_w}\ dt$$

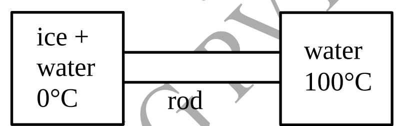
$$\int_{40}^{35} \frac{-dT}{(T - T_0)} = \int_0^2 \frac{dt}{100 \times \rho_\ell s_\ell}$$

$$\frac{5K`}{100S_w} = \frac{2K}{100 \times \rho_\ell S_\ell}$$

$$\rho_\ell = \frac{4}{5}\ g/cm^3 = \frac{4 \times 10^{-3} kg}{5 \times 10^{-6} m^3} = \frac{4}{5} \times 10^3$$

$$= \frac{40}{5} \times 10^2 = 800 kg/m^3$$

Q.11 An insulated container is filled with mixture of water & ice at 0°C. Another container is filled with water that is continuous boiling at 100°C. In a series of experiments, the containers are connected by various thick rods that pass through the walls of the containers. The rod is insulated in such a way that there is no heat loss to surroundings. In experiment 1, a copper rod is used and the ice melts in 20 min. In experiment 2, a stell rod is used and ice melts in 60 min. How long would it take to melt the ice if the two rods are used in series given ans in …..× 10 min.



Sol. [8]

When Cu rod is used

$\frac{100}{R_{Cu}} \times 20 = m \times L$ …..(1)

when stell rod is used

$\frac{100}{R_{stell}} \times 60 = mL$ ….(2)

when both are in series

$R_{eq} = R_{Cu} \times R_{stell}$

$\frac{100}{R_{Cu} \times R_{stell}} \times t = mL$

from (1) & (2)

$R_{Cu} = \frac{2000}{mL}$

$R_{stell} = \frac{6000}{mL}$

$\frac{100 \times mL \times t}{8000} = mL$

t = 80 minutes

Q.12 A steel drill making 180 rpm is used to drill a hole in a block of steel. The mass of steel block and the drill is 180 gm each. The entire mechanical work is used up in producing heat such that the rate of rise of temperature of the system is 0.5 °C/sec. If τ is the couple required to drive the drill then, find its value in SI units.
(C_{steel} = 0.10 cal/gm–°C , J = 4.186)

Sol.. [4] $P = \tau W = \frac{d\theta}{dt} = (2m)\ s\ \frac{(\Delta T)}{\Delta t}$

Q.13 A cylinder containing a gas is closed by a movable piston. The cylinder is submerged in an ice-bath at 0°C. The piston is quickly pushed down to compress the gas. Now it is held in this position for some time until gas again reaches at 0°C and then slowly raised back to initial position. If 100 gm ice melted during the whole process, then how much work is done on the gas (in kcal) ? (L_f = 80 cal/gm)

Sol.[8] $Q_{cycle} = W_{cycle}$

Q.14 A certain bullet of mass 6 gm melts at 300ºC and has specific heat as 0.20 Kcal/kg ºC and a heat fusion of $\frac{15\text{kcal}}{\text{kg}}$. The heat needed to melt the bullet if it was originally at 0ºC, can be written as λ kJ. Then the value of λ is.

(Take mechanical equivalent J = 4)

Sol.[9] $Q = ms\Delta T + mL$

$= 450$ cal

$450 \times 4 = 9000$ J

Q.15 64 gm of steam at 100ºC is kept in a vessel of negligible heat capacity. Amount of ice required at 0ºC so that at equilibrium only water is remaining at 0ºC is m gm. Find m.

Sol.[8] $m = \frac{64}{8} = 8$ gm

Q.16 In two colorimeters we poured 200 gm of water each at temperature of + 30ºC and +40ºC. From the 'hot' calorimeter 50 gm of water, is poured into 'cold' calorimeter and stirred. Then, from 'cold' colorimeter 50 gm of water is poured into 'hot' and again stirred . How many times from starting do you have to poured the same portion of water back and forth so that temperature difference between water in colorimeters becomes less than 3ºC? Heat loss during transfer and heat capacity of calorimeters is neglected.

Sol.[5] $T_{mix} = \frac{m_1sT_1 + m_2sT_2}{(m_1 + m_2)s}$

PHYSICS

Q. 1 A calorimeter contain 20 gm of water at 20 ºC. The water equivalent of Calorimeter is 10 gm. The amount of heat required to raise the temperature of water from 20 ºC to 60 ºC (Sp. heat of water = 1cal/gm-ºC)

(A) 1000 cal (B) 800 cal
(C) 400 cal (D) 1200 cal **[D]**

Sol. $Q = 30 \times 1 \times 40$
$= 1200$ cal.

Q. 2 If two sphere having same radius but the ratio of their specific heat is 2 : 1 and the ratio of their density is 1 : 4 then the ratio of their heat capacity is -

(A) 2 : 1 (B) 1 : 2
(C) 1 : 1 (D) 1 : 4 **[B]**

Sol. $\frac{C_1}{C_2} = \frac{\rho_1 v_1 s_1}{\rho_2 v_2 s_2}$

$= \frac{2}{1} \times \frac{1}{4} = \frac{1}{2}$

Q. 3 Ice at 0ºC is added to 200gm of water initially at 70°C in a vacuum flask. When 50 gm of ice has been added and has all melted, the temperature of flask and contents is 40ºC, When a further 80 gm of ice is added and has all melted, the temperature of whole becomes 10ºC. Neglecting heat lost to surroundings the latent heat of fusion of ice is :

(A) 80 cal/gm (B) 90 cal/gm
(C) 70 cal/gm (D) 540 cal/gm **[B]**

Sol. Accoding to principle of calorimetry,

$ML_F + Ms\,\Delta T = (ms\Delta T)_{water} + (ms\Delta T)_{flask}$

$50L_f + 50 \times 1 \times (40 - 0)$

$= 200 \times 1 \times (70 – 40) + W (70 – 40)$

or $50L_f + 200 = (200 + W)\, 30$

or $5L_f = 400 + 3W$ ....(i)

Now the system contains(200 + 50) gm of water at 40ºC, so when further 80 gm of ice is added.

$80L_f + 80 \times 1 \times (10 – 0)$

$= 250 \times 1 \times (40 – 10) + W (40 – 10)$

or $80L_f + 800 = (250 + W)30$

or $80L_f = 670 + 3W$ ....(ii)

Solving equation (i) and (ii),

$L_f = 90$ cal/gm and $W = \frac{50}{3}$ gm

Q.4 Heat is absorbed by a body but its temperature does not change. Which of the following statements explains the phenomenon ?

(A) Only kinetic energy of vibration increases
(B) Only potential energy of intermolecular force field increases
(C) No increase in internal energy takes place
(D) Increase in kinetic energy is balanced by decrease in potential energy

Sol. **[B]**

Only potential energy will increase as
U = K.E + P.E

Q.5 If specific heat of a substance is infinite, it means-

(A) Heat is given out
(B) Heat is taken in
(C) No change in temperature takes place whether heat is taken in or given out
(D) All of the above

Sol. [C]

$Q = m.c.\Delta\theta \Rightarrow c = \frac{Q}{m.\Delta\theta}$;when $\Delta\theta = 0 \Rightarrow c = \infty$

Q.6 2 gm ice at 0ºC is mixed with 5 gm steam at 100ºC in a calorimeter of negligible heat capacity. At equilibrium the calorimeter will contain -

(A) $\frac{13}{3}$ gm steam and water at 100ºC

(B) $\frac{1}{3}$ gm ice and water at 0ºC

(C)only water at temperature 67ºC

(D) none of these

Sol. **[A]**

Heat given by steam = Heat taken by ice.

Q.7 A copper block of mass 2 kg is heated to a temperature of 500ºC and then placed in a large block of ice at 0ºC. What is the maximum amount of ice that can melt ? The specific heat of copper is 400 J kg^{-1} $ºC^{-1}$ and latent heat of fusion of ice is
3.5×10^5 J kg^{-1} :

(A) $\frac{4}{3}$ kg (B) $\frac{6}{5}$ kg

(C) $\frac{8}{7}$ kg (D) $\frac{10}{9}$ kg **[C]**

Sol. $2 \times 400 \times 500 = m \times 3.5 \times 10^5$

$4 = m \times 3.36 \Rightarrow m = \frac{4}{3.56}$ kg $= \frac{40}{35} = \frac{8}{7}$ kg

Q.8 Evaporation of perspiration is an important mechanism for temperature control in warm-blooded animals. What mass of water must evaporate from the surface of an 80 kg human body to cool it 1ºC ? The specific heat capacity of the human body is approximately 1 cal $g^{-1}(ºC)^{-1}$, and the latent heat of vaporisation of water at body temperature (37ºC) is 577 cal g^{-1}.

(A) 139 g (B) 128 g

(C) 110 g (D) 109 g

Sol. **[A]**

$80 \times 1000 \times 1 = m \times 577$

$m = \frac{8000}{577} = 139$ gm

Q.9 A stream of photons impinging normally on a completely absorbing screen in vacuum exerts a pressure P. If I is the irradiance then -

(A) $P = \frac{2I}{c}$ (B) P = Ic (C) $P = \frac{I}{c}$ (D) P = 2Ic

Sol.[C] Pressure $= \frac{F}{A} = \frac{P \times n}{At} = \frac{h}{\lambda} \times \frac{n}{At}$

Irradiance = Intensity = $I = \frac{nhc}{\lambda At}$

Q.10 5 g of steam at 100ºC is passed into 6g of ice at 0ºC. If the latent heats of steam and ice are 540 cal/g and 80 cal/g, then the final temperature is :

(A) 0ºC (B) 50ºC

(C) 30ºC (D) 100ºC **[D]**

Sol. 6 < 3

So, temp of mixture is 100ºC

Q.11 The temperatures of equal masses of three different liquids A, B and C are 12ºC, 19ºC and 28ºC respectively. The temperature when A and B are mixed is 16ºC. When B and C are mixed it is 23ºC. The temperature when A and C are mixed will be -

(A) 15ºC (B) 18.2ºC

(C) 20.25ºC (D) 24.5ºC

Sol. **[C]** $ms_A \times 4 = ms_B \times \Rightarrow 4s_A = 3s_B$ ....(i)

$ms_B \times 4 = ms_C \times 5 \Rightarrow 4s_B = 5s_C$ ....(ii)

By (i) & (ii)

$16s_A = 15\, s_C$ ....(iii)

$ms_A (\theta - 12) = ms_C (28 - \theta)$ ....(iv)

By (i) & (iv)

$\theta = 20.25ºC$

Q.12 The temperature of a body on Kelvin scale is found to be x K. When it is measured by a Fahrenheit thermometer, it is found to be xºF. Then x is :

(A) 301.25 (B) 574.25

(C) 313 (D) 40 **[B]**

Sol. $\frac{x - 273}{373 - 273} = \frac{f - 32}{212 - 32}$

$\Rightarrow x - 273 = \frac{5}{9}(x - 32)$

$\Rightarrow 9x - 9 \times 273 = 5x - 160 \Rightarrow x = 574.25$

Q.13 A substance of mass m kg requires a power input of P watts to remains in the molten state at its melting point. When the power is turned off, the sample completely solidifies in time t sec. What is the latent heat of fusion of the substance?

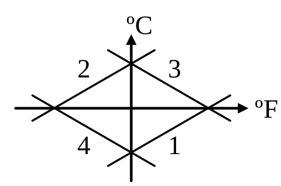
(A) $\frac{Pm}{t}$ (B) $\frac{Pt}{m}$ (C) $\frac{m}{Pt}$ (D) $\frac{t}{Pm}$

Sol. [B] Heat lost in t sec = mL or heat lost per sec = $\frac{mL}{t}$.

This must be the heat supplied for keeping the substance in molten state per sec.

$\therefore \frac{mL}{t} = P$ or $L = \frac{Pt}{m}$

Q.14 Which of the curves in figure represents the relation between Celsius and Fahrenheit temperature-



(A) 1 (B) 2 (C) 3 (D) 4

Sol. [A] $\frac{C}{5} = \frac{F - 32}{9} \Rightarrow C = \left(\frac{5}{9}\right)F - \frac{20}{3}$. Hence graph between ºC and ºF will be a straight line with positive slope and negative intercept.

Q.15 Two liquids A and B are at 32°C and 24°C. When mixed in equal masses the temperature of the mixture is found to be 28°C. Their specific heats are in the ratio of -

(A) 3 : 2 (B) 2 : 3
(C) 1 : 1 (D) 4 : 3

Sol. **[B]**

$$\frac{H_1}{H_2} = \frac{R_1^3}{R_2^3} \times \frac{\rho_1}{\rho_2} \times \frac{s_1}{s_2}$$

Q.16 Boiling water is changing into steam. At this stage the specific heat of water is-

(A) < 1 (B) ∞ (C) 1 (D) 0

Sol. **[B]**

$C = \frac{Q}{m.\Delta\theta}$; as $\Delta\theta = 0$, hence c becomes ∞.**]**

Q.17 A 1 kg cube of ice of volume 1000 ml at temperature 0°C is placed in a cylinder of cross sectional area 200 cm^2 . If ice melts only on top surface by absorbing heat from environment at a rate 80 cal per second. The time when ice lifts from base of cylinder is –

(given density of water 1000 kg/m^3)

(A) 4 min. 10 sec. (B) 8 min. 20 sec.
(C) will never lift (D) more than 10 min.

Sol. [B] Ice will float when completely immersed.

Q.18 In an energy recycling process, X g of steam at 100°C becomes water at 100°C which converts Y g of ice at 0°C into water at 100°C. The ratio of X/Y will be -

(A) 1/3 (B) 2/3 (C) 3 (D) 2

Sol. **[A]**

Sp. heat of vaporization = 22.68×10^5 J/kg

$= X \times 10^{-3} \times 22.68 \times 10^5$

$= Y \times 10^{-3} \times 3.36 \times 10^5 + Y \times 10^{-3} \times 4200 \times 100$

$\therefore \frac{X}{Y} = \frac{1}{3}$

Q.19 If a thermometer reads freezing point of water as 20ºC and boiling point as 150ºC, how much thermometer read when the actual temperature is 60ºC-

(A) 98ºC (B) 110ºC (C) 40ºC (D) 60ºC

Sol. [A] Temperature on any scale can be converted into other scale by $\frac{x - LFP}{UFP - LFP}$ = constant for all scales

$$\frac{x - 20}{150 - 20} = \frac{60}{100} \Rightarrow x = 98ºC$$

Q.20 Liquids A and B are at 30ºC and 20ºC. When mixed in equal masses, the temperature of the mixture is found to be 26ºC. Their specific heats are of ratio -

(A) 3 : 2 (B) 1 : 1 (C) 2 : 3 (D) 4 : 3

Sol. **[A]** $ms_A (30 - 26) = ms_B (26 - 20)$

$4s_A = 6s_B \Rightarrow \frac{s_A}{s_B} = \frac{3}{2}$

Q.21 A body A of mass 0.5 kg and specific heat 0.85 is at a temperature of 60ºC. Another body B of mass 0.3 kg and specific heat 0.9 is at a temperature of 90ºC. When they are connected to a conducting rod, heat will flow from -

(A) A to B
(B) B to A
(C) heat can't flow
(D) first from A to B, then B to A

Sol.[B] Heat flows from a body at higher temperature to a body at tower temperature. So heat will flow from B to A.

Q.22 10 gm of ice at 0ºC is mixed with 10 gm steam at 100ºC in a container of negligible heat capacity. Amount of steam in the mixture after some time will be (S_w = 1 cal/gmºC, L_v = 540 cal/gm, L_f = 80 cal/gm) –

(A) 0 gm (B) $\frac{20}{3}$ gm
(C) $\frac{10}{3}$ gm (D) None of these **[B]**

Sol. Amount of steam required to convert all the ice in water at 100ºC is $\frac{10}{3}$ gm.

Q.23 The ratio of densities of two substance is 2 : 3 and their specific heats are in the ratio 3 : 4. The ratio of their thermal capacities for unit volume is -

(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 8 : 9

Sol.[B] $\frac{c_1}{c_2} = \frac{m_1 S_1}{m_2 S_2} = \frac{p_1 v S_1}{p_2 v S_2} = \frac{2}{3} \times \frac{3}{4} = \frac{1}{2}$

Q.24 The absolute zero temperature in Fahrenheit is -

(A) – 273ºF (B) –32ºF
(C) –460ºF (D) –132ºF

Sol. [C] $\frac{F-32}{9} = \frac{K-273}{5} \Rightarrow \frac{F-32}{9} = \frac{0-273}{5}$

$\Rightarrow F = -459.4^\circ F = -460^\circ F$

Q.25 Latent heat of ice is 80 cal g^{-1} and J = 4.2 J cal^{-1}. A boy can melt 60 gram ice in 1 minute by chewing. His power is –

(A) 4800 W (B) 336 W

(C) 1.33 W (D) 0.75 W **[B]**

Q.26 Heat required to convert one gram of ice at 0°C into steam at 100°C is -

(A) 100 cal (B) 0.01 kcal

(C) 716 cal (D) 1 kcal **[C]**

Q.27 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) 160 gm (B) 80 gm

(C) 40 gm (D) 30 gm

Sol. **[D]**

Heat released by water

$\Delta Q = 80 \times 1 \times 30 = 2400$ cal ……(i)

Mass of Ice melt

$2400 = m \times 80$ $[\Delta Q = mL]$

$\therefore m = \frac{2400}{80} = 30$ gm

Q.28 One gm of ice at 0°C is added to 5gm of water at 10°C. If the latent heat is 80 cal/gm, the final temperature of the mixture is -

(A) 5°C (B) 0°C

(C) –5°C (D) none of these

[B]

Q.29 One gm of ice is mixed with one gm of steam. After thermal equilibrium is reached, the temperature of mixture is -

(A) 100°C (B) 55°C

(C) 75°C (D) 0°C **[A]**

Q.30 Which one of the following would raise the temperature of 20 gm of water at 30ºC most when mixed with :

(A) 20 gm of water at 40ºC

(B) 40 gm of water at 35º

(C) 10 gm of water at 50ºC

(D) 4 gm of water at 80ºC **[D]**

Sol. $T = \frac{m_1 s_1 T_1 + m_2 s_2 T_2}{m_1 s_1 + m_2 s_2}$,

T is maximum, If we take 4 gm of water at 80ºC

Q.31 When 300 J of heat is added to 25 gm of sample of a material its temperature rises from 25°C to 45°C. The thermal capacity of the sample and specific heat of the material are respectively given by -

(A) 15 J/°C, 600 J/kg-°C

(B) 600 J/°C, 15 J/°C-kg

(C) 150 J/°C, 60 J/kg-°C

(D) none of these **[A]**

Q.32 70 calories are required to raise the temperature of 2 moles of an ideal gas at constant pressure from 30°C to 35°C. The amount of heat required (in calories) to raise the temperature of the same gas through the same range (30°C to 35°C) at constant volume is -

(A) 30 (B) 50

(C) 70 (D) 90 **[B]**

Q.33 The heat required to convert one kg of ice to water is -

(A) latent heat of vaporisation (B) specific heat

(C) molar specific heat

(D) latent heat of fusion **[D]**

Q.34 A liquid of mass m and specific heat C is heated to a temperature 2T. Another liquid of mass (m/2) and specific heat 2C is heated to a temperature 2T. If these two liquids are mixed, the resulting temperature of the mixture is -

(A) (2/3)T (B) (8/5)T

(C) (3/5)T (D) (3/2)T **[D]**

Q.35 10 gm of ice at –20ºC is added to 10gm of water at 50ºC. S_{water} = 1 cal/gmºC, S_{ice} = 0.5 cal/gmºC. $L_{f_{ice}}$ = 80 cal/gm. The resulting temperature is -

(A) –20ºC (B) 15ºC

(C) 0ºC (D) 50ºC **[C]**

Sol. Some ice will left in the mixture.

Q.36 Liquids A and B are at 30°C and 20°C. When mixed in equal masses, the temperature of the mixture is found to be 26°C. Their specific heats are in the ratio of -

(A) 3 : 2 (B) 1 : 1

(C) 2 : 3 (D) 4 : 3 **[A]**

Q.37 The densities of two materials X and Y are in the ratio 1 : 3. Their specific heats are in the ratio 3 : 1. If we take same volumes of the two substances, the ratio of their thermal capacities will be :

(A) 1 : 1 (B) 1 : 3

(C) 1 : 6 (D) 1 : 9 **[A]**

Sol. $\frac{C_1}{C_2} = \frac{P_1 Vs_1}{P_2 Vs_2} = \frac{1}{3}\times\frac{3}{1} = 1 : 1$

Q.38 Two tanks A and B contains water at 30ºC and 80ºC respectively, calculate the amount of water that must be taken from each tank to prepare 40kg of water at 50ºC -

(A) 24 kg, 16 kg (B) 16 kg, 24 kg

(C) 20 kg, 20 kg (D) 30 kg, 10 kg **[A]**

Sol. $m_1 \times 1\,(50 - 30) = m_2(80 - 50)$ ....(i)

$m_1 + m_2 = 40$ kg ....(ii)

Q.39 Two liquids are at temperature 20ºC and 40ºC. When same mass of both of them is mixed, the temperature of the mixture is 32ºC. What is the ratio of the their specific heats ?

(A) 1/3 (B) 2/3

(C) 1/5 (D) 2/5 **[B]**

Sol. $ms_A(32 - 20) = ms_B\,(40 - 32)$

$12s_A = 8s_B$

$\frac{s_A}{s_B} = \frac{2}{3}$

Q.40 The minimum mass of ice at 0ºC required to just condense m grams of steam at 100ºC is: (latent heat of steam and ice are 540 cal/g and 80 cal/g respectively)

(A) 5.4 m (B) 7 m

(C) 3 m (D) 6.75 m **[C]**

Sol. Let m_1 is mass of ice required

then, $m_1 \times 80 + m_1 \times 1 \times 100 = 540$ m

$180\, m_1 = 540\, m \Rightarrow m_1 = 3m$

Q.41 Two bodies of specific heats S_1 and S_2 having same heat capacities are combined to form a single composite body. Specific heat of composite body is -

(A) $S_1 + S_2$ (B) $\frac{S_1+S_2}{2}$

(C) $\frac{2S_1S_2}{S_1+S_2}$ (D) $\frac{1}{S_1} + \frac{1}{S_2}$ **[C]**

Sol. $m_1 s_1 = m_2 s_2$ ......(1)

$m_1 s_1 + m_2 s_2 = (m_1 + m_2)\, s$ ....(2)

$s = \frac{m_1s_1 + m_2s_2}{m_1+m_2} = \frac{2m_1s_1}{m_1+m_2}$ $(\because m_1s_1 = m_2s_2)$

$= \frac{2m_1s_1}{m_1 + \frac{m_1s_1}{s_2}} = \frac{2s_1s_2}{s_1+s_2}$

Q.42 The steam point and ice point of a mercury thermometer are marked as 80º and 10º. At what temperature on centigrade scale the reading of this thermometer will be 59º ?

(A) 70º C (B) 60º C

(C) 80º C (D) None of these **[A]**

Sol. $\frac{T'-10}{80-10} = \frac{T_C}{100}$; T' = 59º

Q.43 300 g of water at 25°C is added to 100g of ice at 0°C. The amount of ice melts is -

(A) 6.25 g

(B) 93.75 g

(C) 100 g

(D) none of the above **[B]**

Sol. heat release by water = m s d θ

= 300 × 1 × 25

= 7500 Cal.

amount of Ice melts from this heat

dQ = mL

$$m = \frac{dQ}{L} = \frac{7500}{80} = 93.75 \text{ g}$$

Q.44 A temperature difference of 5°C on Celsius scale corresponding to the following temperature difference in the Fahrenheit scale -

(A) 9° (B) 41°

(C) 2.8° (D) 15° **[A]**

Sol. $\frac{C}{5} = \frac{F-32}{9}$

$\frac{\Delta C}{5} = \frac{\Delta F}{9}$

$\Delta F = 9 \times \frac{5}{5} = 9°$

Q.45 250 gm of water and equal volume of alcohol of mass 200 gm are replaced successively in the same calorimeter and cool from 60ºC to 55ºC in 130 sec and 67 sec respectively. If the water equivalent of calorimeter is 10 gm. The specific heat of alcohol in cal/gmºC is -

(A) 1.30 (B) 0.67
(C) 0.62 (D) None of these **[C]**

Sol. Hint : Rate of heat loss are equal in both case.

Q.46 2 kg ice at – 20ºC is mixed with 5 kg water at 20ºC in an insulating vessel having negligible heat capacity. Calculate the final mass of water remaining in container.

Given sp. heat water = 4.186 kJ K^{-1} kg^{-1}
sp. heat Ice = 2.092 kJ K^{-1} kg^{-1}
Latent heat of fusion of ice = 334.7 kJ Kg^{-1}

(A) 7 kg (B) 6 kg
(C) 4 kg (D) 2 kg **[B]**

Sol. Heat that can be given to ice by water
= 5 kg × 1 × (20 – 0)
Q = 100 k cal.
Energy required to raise temp of ice from – 20ºC to 0ºC
E = 2 kg × 0.5 × (0 – (– 20) = 20 k cal.
Heat available for = Q – E
Melting ice = 100 – 20 = 80 k cal.
L = 80 cal/gram

Ice that can be melted = $\frac{80 \text{ k cal}}{80 \text{ cal}}$ = 1000 gram = 1 kg.

Hence water left in container = 6 kg

Q.47 Water of volume 2 litre in a container is heated with a coil of 1 kW at 27ºC. The lid of the container is open and energy dissipates at rate of 160 J/s. In how much time temperature will rise from 27ºC to 77ºC ?
[Given specific heat of water is 4.2 kJ/kg]

(A) 8 min 20 s (B) 6 min 2 s
(C) 7 min (D) 14 min **[A]**

Sol. Energy gained by water (in 1 s)
= energy supplied – energy lost
= (1000 J – 160 J) = 840 J
Total heat required to raise the temperature of water from 27ºC to 77ºC is $ms\Delta\theta$.
Hence, the required time

$$t = \frac{ms\Delta\theta}{\text{rate by which energy is gained by water}}$$

$$= \frac{2 \times (4.2 \times 10^3) \times 50}{840}$$

= 500 s
= 8 min 20 s

Q.48 One gram of ice is mixed with one gram of steam. After thermal equilibrium, the temperature of the mixture is -

(A) 0°C (B) 100° C
(C) 55°C (D) 80°C **[B]**

Sol. Heat release when 1gm steam convert into water at 100°C is = $mL_{cond.}$
= 1 × 536 cal.
heat required to convert ice into water at 100°C = $mL_{fus.} + mS_w d\theta$
= (1× 80) + 1 × 1 × 100
= 180 cal
Since 536 cal is greater than 180 cal so partial condensation will take place and the final temperature will be 100° C

Q.49 If x grams of steam at 100ºC becomes water at 100ºC which converts y grams of ice at 0ºC into water at 100ºC, then the ratio x/y will be –

(A) $\frac{1}{3}$ (B) $\frac{27}{4}$ (C) 3 (D) $\frac{4}{27}$

Sol. [A] x × 540 = y × 80 + y × 1 × 100

$\Rightarrow$ 540 x = 180 y or $\frac{x}{y} = \frac{1}{3}$

Q.50 Ice point and steam point on a particular scale reads 10º and 80º respectively. The temperature on ºF scale when temperature on new scale is 45º is -

(A) 50º F (B) 112ºF
(C) 122ºF (D) 138ºF **[C]**

Sol. Relation between the two scales

$$\frac{t-10}{80-10} = \frac{F-32}{180}$$

$$F = \frac{18}{7}(t-10) + 32$$