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 × 1 × 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. $2 \times 400 \times 500 = m \times 3.5 \times 10^5$

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

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?

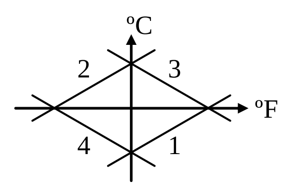
(A) $\frac{Pm}{t}$ (B) $\frac{Pt}{m}$ (C) $\frac{m}{Pt}$ (D) $\frac{t}{Pm}$

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] $\frac{c_1}{c_2} = \frac{m_1S_1}{m_2S_2} = \frac{p_1vS_1}{p_2vS_2} = \frac{2}{3} \times \frac{3}{4} = \frac{1}{2}$

Q.24 The absolute zero temperature in Fahrenheit is -

(A) – 273ºF (B) –32ºF

(C) –460ºF (D) –132ºF

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

$\Rightarrow F = -459.4ºF = -460ºF$

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. $\frac{C_1}{C_2} = \frac{P_1 V s_1}{P_2 V s_2} = \frac{1}{3} \times \frac{3}{1} = 1 : 1$

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

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

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

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

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

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

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

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 × 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 λ × 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] $-\frac{dT}{dt} = \frac{K}{100 \times S_w}(T - T_0)$

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

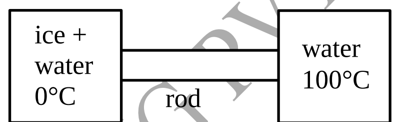
$$\int_{40}^{35} \frac{-dT}{(T - T_0)} = \int_0^2 \frac{dt}{100 \times \rho_\ell s_\ell}$$

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

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

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

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