CHAPTER – 25

CALORIMETRY

Ans 1. Mass of aluminium = 0.5 kg,

Mass of water = 0.2 kg

Mass of iron = 0.2 kg

Temp. Of aluminium ans water = 20 °C = 297 K

Temp. of iron = 100°C = 373 k

Sp heat of aluminium = 910 J/Kg-K

Sp heat of iron = 470 J/kg-k

Sp heat of water = 4200J/kg-k

Heat again = 0.5 x 910(T-293) + 0.2 x 4200 x (343 – T)

= (T- 292)(0.5 x 910 + 0.2 x 4200) = 0.2 x 470 x (373 –T)

Heat lost = 0.2 x 470 x (373 –T)

Heat gain = Heat lost

(T -292)(0.5x 910 + 0.2 x 4200) = 0.2 x 470 x (373 –T)

T =298 k

T = 298 – 273 = 25 °C Answer

Ans 2. Mass of Iron = 100 gm = 0.1 kg

Water eq of calorimeter = 10 gm

Mass of water = 240 gm

Let the Temp. Of surface = 0°C

S_{iron} = 470 J/kg-k

Total heat gained = Total heat lost.

So, 0.1 x 470 x (θ – 60) = 0.24 x 4200 x (60-20)

θ = 4200 + (2820/47) = 917.61 °C   Answer

Ans 3. Temp. Of A = 12°C; B= 19°C; C= 28°C

Temp of (A+B) = 16°C; Temp. of (B+C) = 23°C

In accordance with the principle of calorimetry when A & B are mixed

M_{CA} (16-12) = M_{CB} (19-16)

CA4=CB3; CA= ¾ CB   ---(1)

And when B & C are mixed

M_{CA} (23-19) = M_{CC} (28 -23)

4CB = 5CC; CC = 4/5 CB ---(2)

When A & C are mixed, if T is the common temperature of mixture

M_{CA} (T - 12) = M_{CC} (28 – T)

(3/4) CB (T - 12) = (4/5) CB (28 - T)

15T- 180 = 448 -16T

T = 628/31 = 20.258 =20.3 °C Answer

Ans4. Part a)

Heat released when temperature of 200 ml changes to 0 ^oC

(Heat $_{water}$) = $200x10^{-6}x1000x4200x10$ = 8400 J

Heat required to change 4x8 cm^3 ice into water (Heat $_{ice}$) = $32x10^{-6}x900x3.4x10^5$ = 97920 J

As, Heat $_{ice}$ > Heat $_{water}$. Some ice will be left unmelted and there will be equilibrium between ice and water and of course equilibrium temperature will be 0^oC. Answer

Part b) mass of ice melted = m

$mx3.4x10^5 = 8400$

m = 0.0247 Kg = 25 g Answer

Ans 5. Total heat released when temperature drops by 5°C(Q) = mcθ = 10x4200x5 = 210000 J

Rate of heat taken away when water evaporates = $.0002x.27x10^6$ = 454 J/s

Time = Q/454 = 210000/454 = 462.555 seconds = 7.70 min Answer

Ans 6. Let initial temperature = T

Let volume of cube = V m^3

Mass of cube(m_c) = 8000V Kg

Volume of ice melted = V

Mass of ice melted(m_w) = 900V Kg

Heat liberated by cube = $m_c x C_c x(T-0)$ = 8000Vx470xT = 3760000VT

Heat taken by ice to melt = $900Vx3.36x10^5$ = 302400000V J

Equating both heats, we get T = 80.42 ^oC Answer

Ans7. We can see that latent heat of fusion is smaller that latent heat of vaporization. So, ice will

Change into water first because less heat is required for this and most possibly there will be equilibrium between steam and water

Heat released when ice changed (H_1) = 1x3.36x10^5 J

Heat when temperature of water changes from 0^oC to 100^oC (H_2) = 1x4200x100 = 420000 J

Total Heat taken by ice to change into water at 100^oC = H_1+H_2 = 420000+336000 = 756000 J

So this heat will be released by steam to change into water

Mass of steam changed into water = m

Heat = m x latent heat = 756000

m = 756000/2.26x10^6 = .3345 kg

Total mass of Water = 1+ .3345 = 1.3345 Kg Answer

Mass of steam = 1 - 0.3345 = 0.66548 Kg Answer

Ans8. Power input = 80% of 1000 = .8x1000 = 800 W

Heat taken by water = 20x4200x(35-10) = 2100000

Time = heat/power = 2100000/800 = 2625 seconds = 43.75 min Answer

Ans9. Volume of water = .5 m^3

Density = 1000 kg/m^3

Heat liberated by water = mass x specific heat x θ = 1000x.5x4200x (20-5) = 31500000 J

Heat = mgh = 10x10xh = 31500000 = 315000 m = 315 Km Answer

Ans10. Mass of bullet = 20g = 0.02 kg

Velocity of bullet = 40 m/s

Total energy of bullet = ½ mv^2

= ½ $(0.02)(40)^2$

= 16 J Answer

Ans11. Mass of man = 50 kg velocity = 18 km/hr = 5 m/sec

Change in temperature of water (θ) = 10° C

Total energy = ½ mv^2

= ½ $(50)(5)^2$ = 625 J

We know, Q = mcθ

625= m x 4200 x 10

m = 0.01488 kg

= 14.88 gm Answer

Ans 12. Mass = 4.0 kg

Height = 1m + 2m= 3m

Potential energy = mgh

= 4 x 9.81 x 3 = 117.72 J

Thermal energy produced =117.72 x 80 % = 94.176 J = 94.176/4.187 cal = 22.492 cal. Answer

Ans 13. Mass = 1500 kg Velocity =54 km/hr =15 m/sec

Time to stop = 10 sec

Total energy of the system = ½ $(1500)(15)^2$ = 168750 J = 40303.3198 cal

Energy loss in 10 sec = 40303.3198 cal

Rate of loss of energy = 4030.33198 cal/sec Answer

Ans 14. Mass = 100 gm = 0.1 kg

Change in energy = ½ mv_1^2 – ½ mv_2^2

= ½ $(.1)(10^2 - 5^2)$ = 3.75 J

Ans 15. Energy of 1st block = ½ x 10 x 10^2 = 500 J

Energy of 2nd block = ½ x 20 x 20^2 = 4000 J

Total energy = 4500 J

Conservation of momentum,

$m_1 \times v_1 + m_2 \times v_2 = M \times V$

$10 \times 10 + 20 \times 20 = 30 \times V$

$V = 16.66$ m/sec

Energy of system after collision = $\frac{1}{2} M V^2 = \frac{1}{2} \times 30 \times (16.666)^2$ =4166.66 J

Change in energy = 4500-4166.66 = 333.33 J Answer

Ans16. Initial potential Energy = mgh_1 = 9.8x2m = 19.8m J

Final Potential Energy = mgh_2 = 9.8x1.5m = 14.7m J

Mechanical loss = 19.8 – 14.7 = 5.1 J

40% of mechanical loss = .4x5.1 = 2.04 J

Rise in temperature = 2.04/800 = 2.55×10^{-3} °C

Ans17. Mechanical energy will be lost by friction only.

Here friction force(f) = mg sin θ = 0.2x9.8xsin 37 = 1.17955 N

Work done (energy lost or thermal energy)(H) = 1.17955x0.6 = 0.7077344 J

H = mCθ = 0.2x420xθ = .7077344

$\theta = 8.4 \times 10^{-6}$ °C

Ans18. When spring is broken, block falls from 40cm.

Loss in Energy = mgh = 1.2x9.8x.4 = 4.707 J

This heat will rise temperature of block as well as water and also temperature of both will be same because they are in equilibrium.

$m_{block} \times C_{block} \times \theta + m_{water} \times C_{water} \times \theta = 4.707$

θ(.26x4200 + 1.2x250) = 4.707

$\theta = 3.38 \times 10^{-3}$ °C