11.11 The coefficient of volume expansion of glycerine is $49 \times 10^{-5}\ K^{-1}$. What is the fractional change in its density for a 30 °C rise in temperature?

11.12 A 10 kW drilling machine is used to drill a bore in a small aluminium block of mass 8.0 kg. How much is the rise in temperature of the block in 2.5 minutes, assuming 50% of power is used up in heating the machine itself or lost to the surroundings. Specific heat of aluminium = 0.91 J g^{-1} K^{-1}.

11.13 A copper block of mass 2.5 kg is heated in a furnace to a temperature of 500 °C and then placed on a large ice block. What is the maximum amount of ice that can melt? (Specific heat of copper = 0.39 J g^{-1} K^{-1}; heat of fusion of water = 335 J g^{-1}).

11.14 In an experiment on the specific heat of a metal, a 0.20 kg block of the metal at 150 °C is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing 150 cm^3 of water at 27 °C. The final temperature is 40 °C. Compute the specific heat of the metal. If heat losses to the surroundings are not negligible, is your answer greater or smaller than the actual value for specific heat of the metal?

11.15 Given below are observations on molar specific heats at room temperature of some common gases.

Gas	Molar specific heat (C_v) (cal mol^{-1} K^{-1})
Hydrogen	4.87
Nitrogen	4.97
Oxygen	5.02
Nitric oxide	4.99
Carbon monoxide	5.01
Chlorine	6.17

The measured molar specific heats of these gases are markedly different from those for monatomic gases. Typically, molar specific heat of a monatomic gas is 2.92 cal/mol K. Explain this difference. What can you infer from the somewhat larger (than the rest) value for chlorine?

11.16 A child running a temperature of 101°F is given an antipyrin (i.e. a medicine that lowers fever) which causes an increase in the rate of evaporation of sweat from his body. If the fever is brought down to 98 °F in 20 minutes, what is the average rate of extra evaporation caused, by the drug. Assume the evaporation mechanism to be the only way by which heat is lost. The mass of the child is 30 kg. The specific heat of human body is approximately the same as that of water, and latent heat of evaporation of water at that temperature is about 580 cal g^{-1}.

11.17 A 'thermacole' icebox is a cheap and an efficient method for storing small quantities of cooked food in summer in particular. A cubical icebox of side 30 cm has a thickness of 5.0 cm. If 4.0 kg of ice is put in the box, estimate the amount of ice remaining after 6 h. The outside temperature is 45 °C, and co-efficient of thermal conductivity of thermacole is 0.01 J s^{-1} m^{-1} K^{-1}. [Heat of fusion of water = 335×10^3 J kg^{-1}]

11.18 A brass boiler has a base area of 0.15 m^2 and thickness 1.0 cm. It boils water at the rate of 6.0 kg/min when placed on a gas stove. Estimate the temperature of the part of the flame in contact with the boiler. Thermal conductivity of brass = 109 J s^{-1} m^{-1} K^{-1}; Heat of vaporisation of water = 2256×10^3 J kg^{-1}.

11.19 Explain why :

(a) a body with large reflectivity is a poor emitter

(b) a brass tumbler feels much colder than a wooden tray on a chilly day

(c) an optical pyrometer (for measuring high temperatures) calibrated for an ideal black body radiation gives too low a value for the temperature of a red hot iron piece in the open, but gives a correct value for the temperature when the same piece is in the furnace

(d) the earth without its atmosphere would be inhospitably cold

(e) heating systems based on circulation of steam are more efficient in warming a building than those based on circulation of hot water

11.20 A body cools from 80 °C to 50 °C in 5 minutes. Calculate the time it takes to cool from 60 °C to 30 °C. The temperature of the surroundings is 20 °C.

16) Initial temp $(\theta_1) = 101°F = (101-32)° \times \frac{5}{9}\ °C$

final " $(\theta_2) = 98°F = (98-32) \times \frac{5}{9}\ °C$

$\therefore$ change in temp., $|\Delta\theta| = \theta_1 - \theta_2$

$= [101-98] \times \frac{5}{9}\ °C$

$= \frac{5}{3}\ °C.$

time taken $(t) = 20$ min $= 20 \times 60'$

$= 1200$ s.

mass of the child $(m) = 30$ kg

$= 30{,}000$ g.

Specific Heat (S) = Specific Heat of water

$= 1$ cal/g/°C.

So, the total amount of Heat lost $= ms\Delta\theta$

$Q = ms\Delta\theta$

$Q = 30000 \times 1 \times \frac{5}{3}$

$= 50{,}000$ cal.

Now, the total Heat is lost by the evaporation of Sweat.

Now, the Latent Heat of evaporation $(L) = 580$ cal/g.

Let, the total mass of sweat that

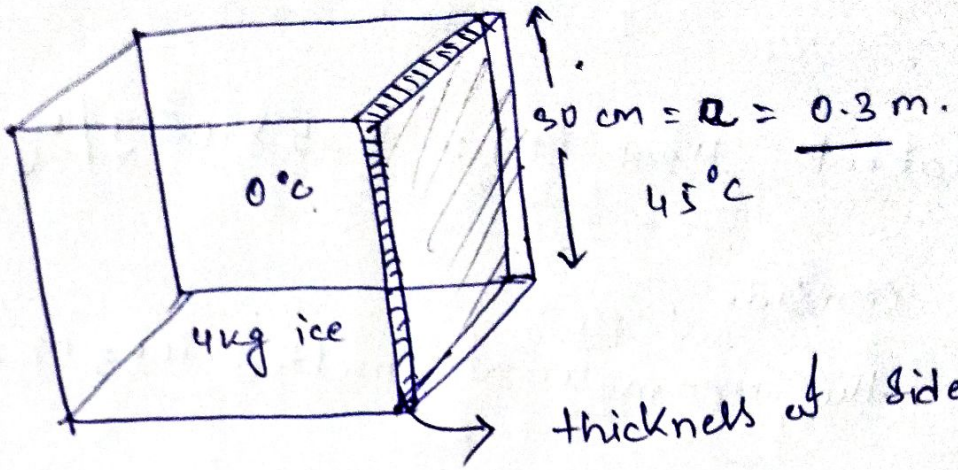
$\therefore$ evaporated be $= m'$

So, $Q = m'L$

$\therefore m' = \frac{Q}{L} = \frac{50{,}000}{580}$ g.

$\therefore$ the rate of evaporation $= \frac{m'}{t} = \frac{50{,}000/580}{1200}$ g/s.

17)



given,

total surface area of the cubical box (A) = $6 \times a^2$

$= [6 \times (0.3)^2]\ m^2$.

In this case thickness of the wall (l) = 0.05 m is the length in this formula.

$$\Rightarrow \boxed{Q = \frac{KA(T_2 - T_1)t}{l}} \rightarrow 6\ h.$$

T_2 = outside temp (T_2) = 45°C $\therefore (T_2 - T_1) = 45\ °C$

inside temp (T_1) = 0°C. $= 45\ K$.

Time (t) = 6 hr = (6 × 3600) s.

co-efficient of thermal conductivity of the material of the box (K) = $0.01\ J s^{-1} m^{-1} K^{-1}$

So, the Heat flowing inside from outside.

$$Q = \frac{KA(T_2 - T_1)t}{l} = \frac{0.01 \times 6 \times (0.3)^2 \times 45 \times 6 \times 3600}{0.05}\ \text{Joule}$$

(1)

and, this Heat will melt the ice inside the box.

Given, Latent Heat (L) = 335×10^3 J/kg.

Let us conside,

the mass of melted ice; m

$\therefore$ $Q = mL$

$\Rightarrow$ $m = \frac{Q}{L}$ → Derive Q from eq^n (1)

So, the mass of Remaining ice

= (4 - m) kg.

80) Suppose, A body of mass m, Specific Heat s. (at temp = θ_0 °c) is placed in a place with temp. θ_0 °c. $[\theta > \theta_0]$

According to Newton's law of cooling,

the Rate of Heat loss, $-\frac{dQ}{dt} \propto (\theta - \theta_0)$

$$\therefore -\frac{dQ}{dt} = K(\theta - \theta_0)$$

$\Delta\theta = 80°c - 50°c$

$$\Rightarrow \frac{ms\,d\theta}{dt} = K(\theta - \theta_0) \qquad [dQ = ms\,d\theta]$$

$$\Rightarrow \frac{d\theta}{(\theta - \theta_0)} = -\frac{K}{ms} \cdot dt$$

$$\Rightarrow \frac{d\theta}{(\theta - \theta_0)} = -c\,dt.$$

If the temp. of the body is falling from θ_1 to θ_2 °c in time t.

$\theta_1 > \theta_2$

then,

$$\int_{\theta_1}^{\theta_2} \frac{d\theta}{(\theta - \theta_0)} = -c\int_0^t dt$$

$$\Rightarrow \left[\log_e (\theta - \theta_0)\right]_{\theta_1}^{\theta_2} = -c\,[t]_0^t$$

$$\Rightarrow \log_e \frac{\theta_2 - \theta_0}{\theta_1 - \theta_0} = -ct$$

$$\Rightarrow \boxed{\log_e \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0} = ct}$$

where, $c = \frac{K}{ms}$.

$\theta_1 = 80^\circ C$, $\theta_2 = 50^\circ C$

$t = 5$ minutes $= 300$ sec.

$\theta_0 = 20^\circ C$

So, from eqn (1)

$$\log_e \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0} = ct.$$

$$\therefore c = \frac{1}{t} \cdot \log_e \frac{\theta_1 - \theta_0}{\theta_2 - \theta_2}$$

$$= \frac{1}{300} \cdot \log_e \frac{80 - 20}{50 - 20}$$

$$= \frac{1}{300} \log_e 2^2$$

2nd case :

$\theta_1 = 60^\circ C$, $\theta_2 = 30^\circ C$

$t = ??$

& $\theta_0 = 20^\circ C$.

$$\therefore t = \frac{1}{c} \log \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0} \qquad \left[\log_e x^y = y \log_e x \right]$$

$$= \frac{1}{\frac{1}{300} \log_e 2} \cdot \log \frac{60^\circ - 20^\circ}{30^\circ - 20^\circ}$$

$$= \frac{300}{\log_e 2} \times \log_e 4 = \frac{300}{\log_e 2} \cdot \log_e (2)^2$$

$$= \frac{(300 \times 2)}{\log_e 2} \times \log_e 2$$

$$\boxed{t = 600 \text{ sec}}$$

1.The ratio of the lengths of two metallic rods is 2:3 and the ratio of the coefficients of linear expansion of their materials is 4:3. The ratio of their linear expansions for the same rise in temperature is

A .1:2

B. 2:3

C. 3:4

D. 8:9

2. Two copper spheres of the same external radius, one solid but the other hollow, are heated up to a certain temperature and then are allowed to cool under similar conditions. Which sphere will cool faster?

3.why do two pieces of ice stick when pressed together?

4. The temperature of a black body is increased from 27 °C to 927 °C. What is the ratio of the heat radi ated at these two temperatures?

5. A vessel of water equivalent 5 g contains 55 g of water at 20°C. 25 g of ice at 0°C is added to the water. What will be the final nature and temperature of the mixture? Latent heat of fusion of ice = 80 cal.g^{1}.

class test

1. Given, $\frac{l_1}{l_2} = \frac{2}{3}$

and, $\frac{\alpha_1}{\alpha_2} = \frac{4}{3}$

we know,

$$(l - l_0) = l_0 \alpha \Delta t$$

$$\therefore \frac{(l-l_0)_1}{(l-l_0)_2} = \frac{l_1 \alpha_1 \Delta t}{l_2 \alpha_2 \Delta t} \quad [\text{same rise in temp.}]$$

$$= \frac{l_1 \alpha_1}{l_2 \alpha_2} = \frac{2 \times 4}{3 \times 3} = 8 : 9$$

$\therefore$ Ans. → option - (D)

2) we know,

$$Q = ms\theta\Delta\theta$$

$$\Rightarrow \frac{Q}{t} = ms\frac{\Delta\theta}{t}$$

$$\Rightarrow H = ms\left(\frac{\Delta\theta}{t}\right)$$

↓ Rate of change of temp.

Rate of change of Heat (loss or gain)

NOW, $\frac{\Delta\theta}{t} = \frac{H}{ms}$

Both Spheres (copper) have the same Specific Heat (s)

So, $\frac{\Delta\theta}{t} \propto \frac{1}{m}$;

So, the Hollow Sphere (less mass) will cool faster.

3) When two pieces of ice pressed ~~togthi~~ together the melting point at the surface of contact decreases so, there ice melts at the pontion, but ~~bt~~ when the pressured is released the melting Returns to the normal value as a result the liquid water at the surface of contact freezes and two pieces stick together.

4) From Stefan's law.

We know, Heat energy Radiated per unit time, per unit area is directly proportional to the fourth power of absolute temp. of its surface.

i.e $E \propto T^4$

$\Rightarrow E = \sigma T^4$

$\therefore \frac{E_1}{E_2} = \frac{\sigma T_1^4}{\sigma T_2^4} = \frac{T_1^4}{T_2^4}$

Now, $T_1 = 27^\circ C = (27 + 273)\ K$

$= 300\ K$

$T_2 = 927^\circ C = (927 + 273)$

$= 1200\ K$.

$\therefore \frac{E_1}{E_2} = \left(\frac{300}{1200}\right)^4 = \frac{1}{256}$

5) Suppose, To raise the temp. by $\Delta\theta$ amount of a body whose Specific heat is s and mass is m.

then, $Q = ms\Delta\theta$

Now, this amount of Heat (Q) can raise the temp. of water (mass w) by the same amount ($\Delta\theta$)

∴ Then, w is is the water equivalent of that body. [s_w = Specific Heat of water]

$$\therefore Q = ms\Delta\theta = w s_w \Delta\theta$$

$$\therefore \boxed{ms = w s_w}$$

Here, water equivalent of the vessel (w) = 5g.

mass of water (m_1) = 55g.

initial temp. (θ_1) = 20°C

mass of ice (m_2) = 25g. ; temp. (θ_2) = 0°C

s_w = 1 cal g^{-1} $°C^{-1}$ (C.G.S)

Heat Required to melt the total Ice

$Q_1 = 25 \times 80$

$= 2000$ cal

Heat Regeet by the (vessel + water) to come at 0°C.

$= 5 \times 1 \times (20-0) + 55 \times 1 \times (20-0)$

$= 1200$ cal.

So, this heat is not sufficient to melt the 25g ice.

So, amount of Ice that will melt →

$$\Rightarrow 1200 = m \times 80$$

$$\therefore m = 15g.$$

Remaining Ice $= (25 - 15) = 10g$.

So, the mixture will be at $0°C$.

with $(55+15) = 70g$ wate and $10g$ ice at $0°C$.