7 (14)

A single rod of length 54.0 cm is made from a 22.0 cm rod of steel and 32.0 cm of aluminium. If the combined rod is subjected to a 45.0°C temperature difference, then what is the total Increase in Length?

Solution

⇒ For any ~~two~~ linear rod, Change in length under temperature difference $= l \times \alpha \times \Delta\theta$

⇒ Total Change in length = Change in length in steel + that of aluminium.

Therefore,

Change in length $= (22 \times 11e-6 \times 45) + (32 \times 25e-6 \times 45)$

$= (4.699e-4)$ meters.

$= 0.0004689$

8 (14)

What is the change in entropy of 570g of ice as it melts into water.

Solution

The change in entropy of the ice melting into water is

$$\Delta S = \frac{\Delta Q}{T}$$

where: ΔQ is the amount of heat.

T is the temperature in kelvin

$\Delta Q = mL_f$, where L_f is the latent heat of fusion of ice = 333 J/g

$T = 273 + 0 = 273k.$

$$\Delta S = \frac{mL_f}{T} = \frac{333 \times 570}{273}$$

$\Delta S = 695.2747$ J/k

9(1b)

Forty moles of monatomic gas expand isobarically from volume 3.5 m³ to volume 9.5 m³. If the gas has an initial temperature 45°C then,

~~(a) Find the final temperature~~

Summary of question.

N° of moles 40 = n

Initial volume = $3.5 m^3$

final volume = $9.5 m^3$

Initial temperature $T_i = 45°C$

let final temperature be T_f

pressure => P.

$\because PV_i = nRT_i$ } pressure is same since it is isobaric process.

and $PV_f = nRT_f$

a) Find final temperature.

deviding both equation above

$$\frac{PV_i}{PV_f} = \frac{nRT_i}{nRT_f}$$

$$\therefore T_f = \frac{V_f T_i}{V_i} = \frac{9.5 \times (273+45)}{3.5} = \frac{9.5 \times 318}{3.5}$$

$T_f = \cancel{1057.35}$ 863K.

$= 863 - 273 = 590°c$

9 (6)

b) The work done by expanding gas.

$$W = \int_{v_i}^{v_f} P dV \quad \text{since } P \text{ is constant}$$

then $$W = P \int_{V_i}^{V_F} dV$$

$$W = P_{v_f} - P_{v_i}$$

$$W = nRT_f - nRT_i$$

$$W = nR(T_f - T_i)$$

$$W = 40(8.134)\{\cancel{590}\ 863 - 318)$$

$$= 40 \times 8.134 \times 545$$

$$= 177,321.2 \text{ J}$$

c) Heat gained or lost. Q

for constant pressure

$Q = nC_p \Delta T$ where C_p is molar heat capacity at constant pressure.

$$C_p = \left(1 + \frac{f}{2}\right)R \quad f \Rightarrow \text{degree of free atom}$$

for monatomic gas $f = 3$

$$\therefore C_p = \left(1 + \frac{3}{2}\right)R = \frac{5}{2}R$$

Continuation of # 9 (16) part C

$$Q = nC_p\Delta T = 40 \times \frac{5}{2}R(T_f - T_i)$$

$$= 40 \times \frac{5}{2} \times 8.314 \times (863 - 318)$$

$$= 831.4 \times 545$$

$$Q = 453113 \text{ Joule} \cdot (\text{Heat gained})$$

Question # 10 (16)

Copper pellets with total mass of 200g at a temperature 100°C dropped into a container holding 450g of water at 24°C. Find the equilibrium temperature of the system.

Solution:

at equilibrium temperature

Heat lost = Heat gained

$$Q_{lost} = Q_{gained}$$

$Q = mc\Delta\theta$ where $m \Rightarrow$ mass, $c \Rightarrow$ specific heat capacity

$\Delta\theta \Rightarrow$ Change in temperature

specific heat capacity of water is 4200 J/kg/°C

specific heat capacity of copper 385 J/kg/°C

Heat lost by ~~water~~ copper = Heat gained by water

$$Q_{lost} = 200 \times 385 \times (100 - T_f) \qquad (450 \times 4200 \times (T_f - 24))$$

$$7700000 - 77000T_f = 1890000T_f - 45360000$$

$$7700000 + 45360000 = (1890000 + 77000)T_f$$

$$T_f = \frac{50130000}{1967000} = 25.49°C \Rightarrow \text{final temperature.}$$

12. (14)

A hot metal in the shape of cube whose edge has length 12cm is at temperature 600K. at what net rate does it radiate heat when when it is placed in air at temperature 300K?

Solution

Applying Stefan Boltzmann's law, the heat emmited at a temperature T, having emissivity "e" and surface area A is given by

$Q = \sigma e A T^4$ where σ is Stefan boltzmann's Const

$\sigma = 5.67 \times 10^{-8}$

$Area = 6 \times \left(\frac{12}{100}\right)^2 = 0.0864 m^2.$

$e = 1$

$Q = 5.67 \times 10^{-8} \times 1 \times 0.0864 \times 300^4$

$= 39.681 J/Sec$