# Short Answer Type Questions – II

**Q.1. A cannot heat engine whose sink is at 200 K, has an efficiency 30%. By how much the temperature of the source be increased to have its efficiency equal to 50%. Keeping sink temperature constant.**

**Ans.** From the relation

$$\eta = 1 - \frac{T_2}{T_1}$$

or $$\frac{T_2}{T_1} = 1 - \frac{30}{100} = \frac{7}{10}$$

or $$T_1 = \frac{10T_2}{7} = \frac{10 \times 200}{7} = 285.71 \text{ K}$$

new efficiency is now 50%

$$\eta' = 1 - \frac{T_2}{T_1}$$

$$\frac{T_2}{T_1} = 1 - \eta'$$

$$\frac{T_2}{T_1} = 1 - \frac{50}{100} \text{ or } \frac{1}{2}$$

$$2T_2 = T_1$$

or $$T_1 = 2 \times 200 \text{ K}$$

$$T_1 = 400 \text{ K}$$

Now increase in temperature of source

= 400 K – 285.71 K

= 114.3 K

**Q.2. A refrigerator has to transfer an average of 263 J of heat per second from temperature $-10^{o}$C to $25^{o}$C. Calculate the average ideal reversible cycle and no other losses.**

**Ans.** Given: $$T_2 = 25 + 273 = 298 \text{ K}$$

$$T_1 = -10 + 273 = 263 \text{ K}$$

From relation

$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$$

Or $$Q_1 = \frac{T_2}{T_1} \times Q_2 = \frac{298}{263} \times 263$$

$$= 298 \text{ Js}^{-1}$$

∴ Average power consumed = $Q_1 - Q_2$

= (298 – 263) $Js^{-1}$

= 35 W.

**Q.3. Assuming the domestic refrigerator as reversible engine working between melting point of ice and the room temperature of 27$^o$C, calculate the energy in Joule that must be supplied to freeze one kg of water. (Given melting point of ice = 0$^o$C L = 80 cal $g^{-1}$)**

**Ans.** Given: $T_1 = 27 + 273 = 300$ K

$T_2 = 0 + 273 = 273$ K

$m$ = 1 kg = 1000 g; L = 80 cal $g^{-1}$

Heat to be removed,

$$Q_2 = mL$$

$$= 1000 \times 80 \text{ cal}$$

$$= 8 \times 10^4 \text{ cal}$$

From the relation

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2},$$

$$Q_1 = \frac{T_1}{T_2} \times Q_2 = \frac{300}{273} \times 8 \times 10^4$$

$$= 87912.1 \text{ cal}$$

Energy required to be supplied,

W = $Q_1 - Q_2$

= (87912.1 – 80,000) cal

= 7912.1 cal = 7912.1 × 4.2 J

= 33230.8 J