

EX:- 5). A Carnot Engine whose heat sink is at  $27^{\circ}\text{C}$  has an efficiency of 40%. By how many degrees should the temperature of source be changed to increase the efficiency by 10% of the original efficiency?

Solution :- Here,

$$T_2 = 27^{\circ}\text{C} = 27 + 273 = 300\text{K}$$

$$\eta = 40\%, \quad T_1 = ?$$

From,

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

$$\frac{T_2}{T_1} = 1 - \eta = 1 - \frac{40}{100} = \frac{60}{100} = \frac{3}{5}$$

$$T_1 = \frac{5}{3} T_2 = \frac{5}{3} \times 300 = 500\text{K}$$

Increase in efficiency = 10% of 40% = 4%

$\therefore$  New efficiency  $\eta' = 40 + 4 = 44\%$

Let  $T_1'$  be the new temperature of the source.

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

$$\therefore \frac{T_2}{T_1} = 1 - \eta' = 1 - \frac{44}{100} = \frac{56}{100}$$

$$T_1 = \frac{100}{56} T_2 = \frac{100}{56} \times 300 = 535.7\text{K}$$

$\therefore$  Increase in temp. of source  
=  $535.7 - 500 = 35.7\text{K}$

Thank you