The efficiency of a Carnot engine is 30%. Its efficiency is to be raised to 60%. By how much must the temperature of the source be increased if the sink is at 27°C?

Find: ΔT – ?

Given:

$\eta_1 = 0.3$

$\eta_2 = 0.6$

$T_2 = 300$ K

Solution:

Efficiency of Carnot engine:

$\eta = \frac{T_1 - T_2}{T_1}$ (1),

where T_1 – the absolute temperature of the heater,

T_2 – the absolute temperature of the fridge

Of (1) $\Rightarrow \eta T_1 = T_1 - T_2$ (2)

Of (2) $\Rightarrow T_1(1 - \eta) = T_2$ (3)

Of (3) $\Rightarrow T_1 = \frac{T_2}{1 - \eta}$ (4)

Of (4) $\Rightarrow T_1' = \frac{T_2}{1 - \eta_1}$ (5)

Of (5) $\Rightarrow T_1' = 429$ K (6)

Of (4) $\Rightarrow T_1'' = \frac{T_2}{1 - \eta_2}$ (7)

Of (7) $\Rightarrow T_1'' = 750$ K (8)

$\Delta T = T_1'' - T_1'$ (9)

(6) and (8) in (9): $\Delta T = 321$ K

Answer:

321 K (321 °C)