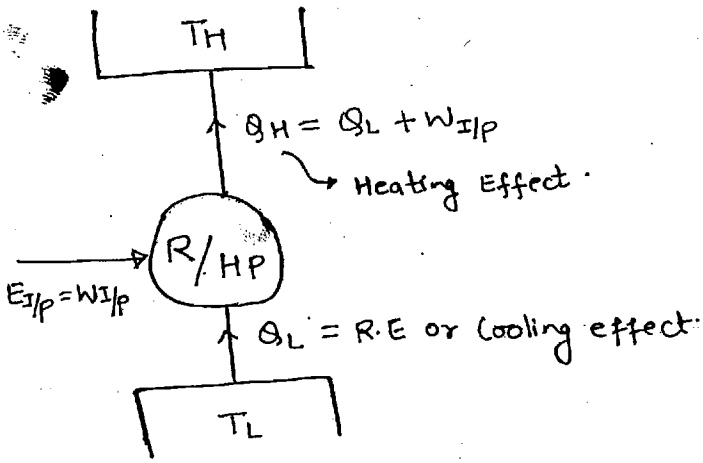
REFRIGERATION & AIR-CONDITIONING...

* REFRIGERATION :-

* Refrigeration is the process of maintaining the place at a lower temp. Compare to the Surroundings.
* Refrigerant is the working fluid which helps in providing refrigeration.
* The heat absorbed from lower temp is called refrigeration effect or cooling effect. Heat Rejected at highere temp is called Heating effect.
* Refrigeration effect and heating effect per unit time is called refrigeration Capacity & heating Capacity resp.



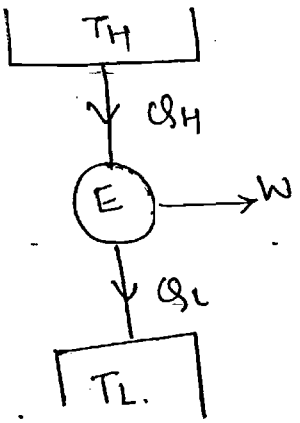
$$COP_{Ref.} = \frac{D.E}{E_{I/P}}$$

$$COP_{Ref} = \frac{R.E}{W_{I/P}}$$

$$COP_{HP} = \frac{H.E}{W_{I/P}}.$$

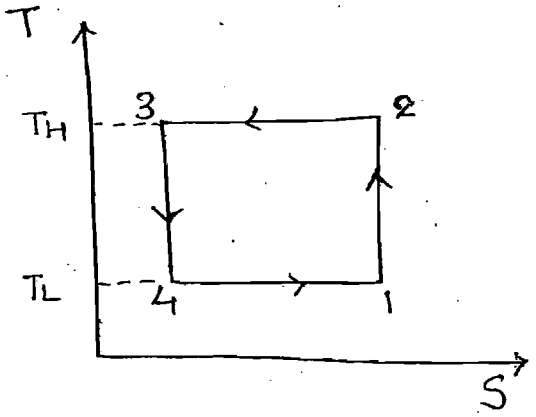
$$COP_{HP} - COP_{Ref} = \frac{HE - R.E}{W_{I/P}}.$$

$$\boxed{COP_{HP} - COP_{REF} = 1}$$



$$\eta = \frac{D.E}{E_{I/P}} = \frac{W}{Q_H}.$$

* The ideal cycle for Refrigeration is "Reversed Carnot Cycle".



$$COP_{Ref} = \frac{T_L}{T_H - T_L}$$

$$COP_{HP} = \frac{T_H}{T_H - T_L}$$

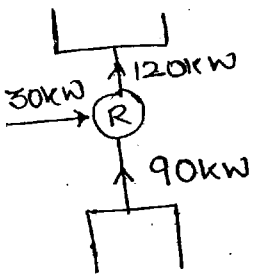
Process 1-2 :- Isentropic Compression

Process 2-3 :- Isothermal Heat Rejection.

Process 3-4 :- Isentropic expansion

Process 4-1 :- Isothermal Heat addition.

Q-6 (W.B).

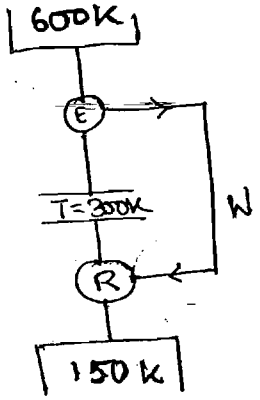


$$COP = \frac{R.E}{W}$$

$$= \frac{90}{30}$$

$$\boxed{COP = 3}$$

Q.2 (W.B)



$$\eta = 1 - \frac{T_L}{T_H}$$

$$= 1 - \frac{300}{600}$$

$$= 0.5$$

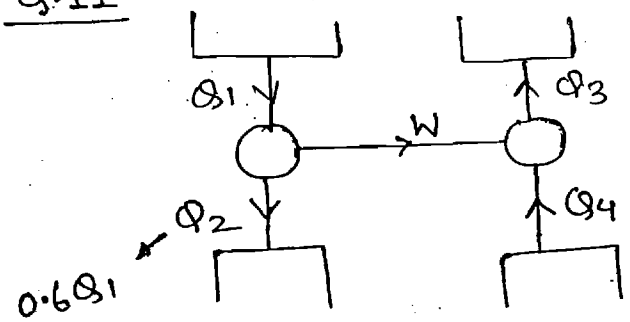
$$\eta = \frac{1}{COP}$$

$$\boxed{COP = 2}$$

$$COP_{HP} = \frac{300}{300 - 150}$$

$$\boxed{COP_{HP} = 2}$$

Q.11



$\eta_{H.E} = 0.4$

$\eta_E = \frac{W}{Q_1}$

$0.4 = \frac{W}{Q_1}$

$\boxed{W = 0.4Q_1}$

$Q_2 + Q_4 = 3Q_1$

$0.6Q_1$

$\boxed{Q_4 = 2.4Q_1}$

$COP_{Ref} = \frac{Q_4}{W}$

$= \frac{2.4Q_1}{0.4Q_1}$

$\boxed{COP_{Ref} = 6}$

TON OF REFRIGERATION :-

ONE TON OF REFRIGERATION REPRESENTS THE RATE OF HEAT TRANSFER REQUIRED TO CONVERT ONE U.S TON [907kg] OF WATER AT 0°C INTO ICE AT 0°C IN 24 hrs.

1 US TON ($\approx$ 907 kg)

1 TR = 3.5167 KW

$\approx$ 211 KJ/min

$\approx$ 50.4 kCal/min.

NOTE:- * The COP for ice making comes out be lower than that for comfort Colling, because the Lower temp for ice making is much Lower than that for Comfort Cooling.

* The electricity bill for Air Conditioner is much higher Compared to domestic refrigerator because the Refrigeration Capacity for air-conditioner is 10 times more than the domestic Refrigerator.

A/c

55°C → ——————

+5°C → ——————

$$COP_{A/c} = \frac{R.C}{\dot{W}} \quad (R.C: 5\,KW)$$

$COP_{A/c} = 3$

$\dot{W} = 1.667\,KW$

ICE MAKING

—————— +55°C

—————— −25°C

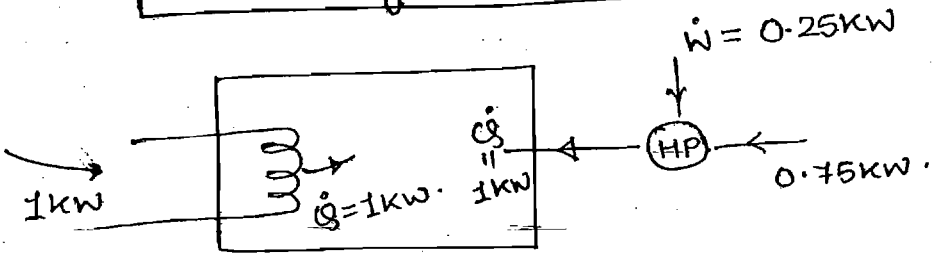
$$COP_{Ref} = \frac{R.C}{\dot{W}} \quad (R.C: 0.5\,KW)$$

$COP_{Ref} = 1.5$

$\dot{W} = 0.33\,KW$

* Electric Heating is Very less efficient Compared to the use of H.P.

$$(COP)_{\text{electric Heating}} = \frac{1\,KW}{1\,KW} = 1.$$

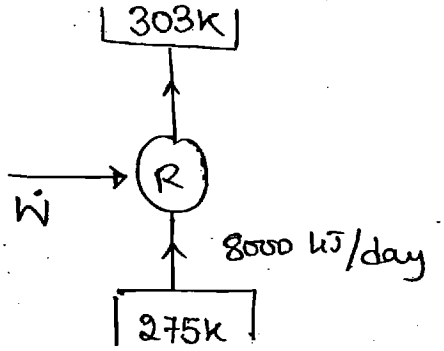


$$(COP)_{HP} = \frac{1\,kW}{\dot{W}_{I/p}}$$

$(COP)_{HP} = 4$

$\dot{W}_{I/p} = 0.25\,kW$

CH·1

① 

$$COP = 0.15\left[\frac{275}{303-275}\right]$$

$$(COP)_R = 1.47.$$

$$COP = \frac{R.C}{W_{I/P}.}$$

$$1.47 = \frac{8000}{W_{I/P}.}$$

$$W_{I/P} = 5430.3 \text{ kJ/day}$$

$$W_{I/P} = \frac{5430.3}{3600}$$

$$= \underline{1.51 \text{ kWh/day}}.$$

1 kWh = 3600 kJ

$\frac{1 kJ}{sec} \times 3600$ sec.

$(2 \times 40W + 150W) \times 10^{-3} \times 12 \times 30$

kW. Hrs.

82.8 kWh

⑧

$$R.C = \dot{m} c (T_H - T_L)$$

$$3.5167 = \dot{m} \times 4.18 (35-20)$$

$$\dot{m} = 200 \text{ kg/hr} \approx \underline{200 \text{ l/hr}}.$$

$\rho_w = 1 kg/ltr$

$= 1000 kg/m^3.$

⑯

$$Q = \overset{3600}{\dot{m}} \left[\overset{c}{2} \times (30) \overset{dT}{,} + \overset{(230)}{LH} + 0.5 \times 20\right]$$

$27^\circ C \longrightarrow -3^\circ C \longrightarrow -3^\circ C \longrightarrow -23^\circ C$

$$Q = \underline{10,80000}.$$

$$\text{Ref. Capa.} = \frac{Q.}{10 \times 3600} = \boxed{30 kW.}$$