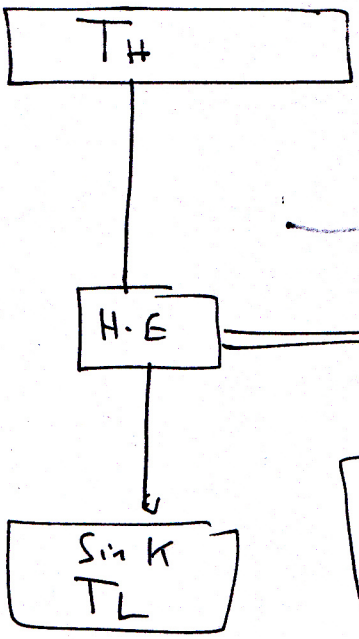
1 Heat engines :-

Car Motor

Gives us work.

محرك السيارة
محرك ميكانيكي



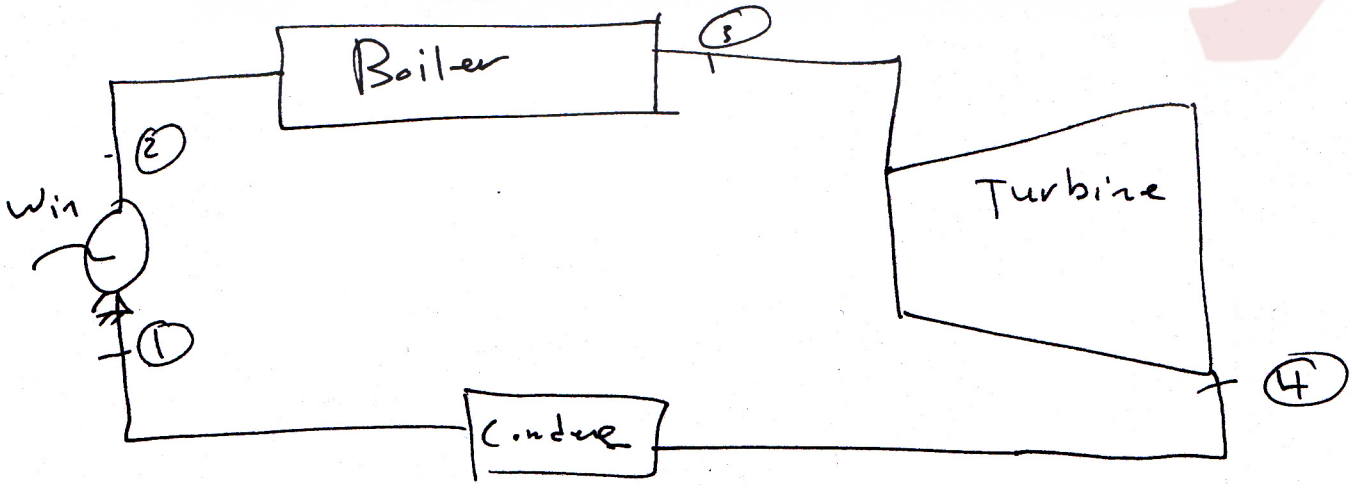
1 hp = 745.7 W

* $W_{net} = W_{out} - W_{in}$

$Q_{net} = Q_{in} - Q_{out}$

* thermal $\eta_{th} = \frac{\dot{W}_{net,out}}{\dot{Q}_{in}}$ or $\eta_{th} = 1 - \frac{\dot{Q}_{out}}{\dot{Q}_{in}}$

$W_{net,} = Q_H - Q_L$



Example: An automobile engine consumes fuel at a Rate of 28 (L/h) and delivers 60 (KW) of power to the wheels. if the fuel has a heating Value of 44000 (KJ/kg) and a density of 0.8 kg/cm³

Determine (a) the efficiency of this engine.

$\dot{m}_{fuel} = \rho \dot{V} = 0.8\ kg/L * 28\ \frac{L}{h}$

we know that

$cm^3 = L$

$1\ m^3 = 1000\ cm^3 = 1000\ L$

$\boxed{\dot{m}_{fuel} = 22.4\ kg/h}$

$\dot{Q}_H = \dot{m}\ q_H$

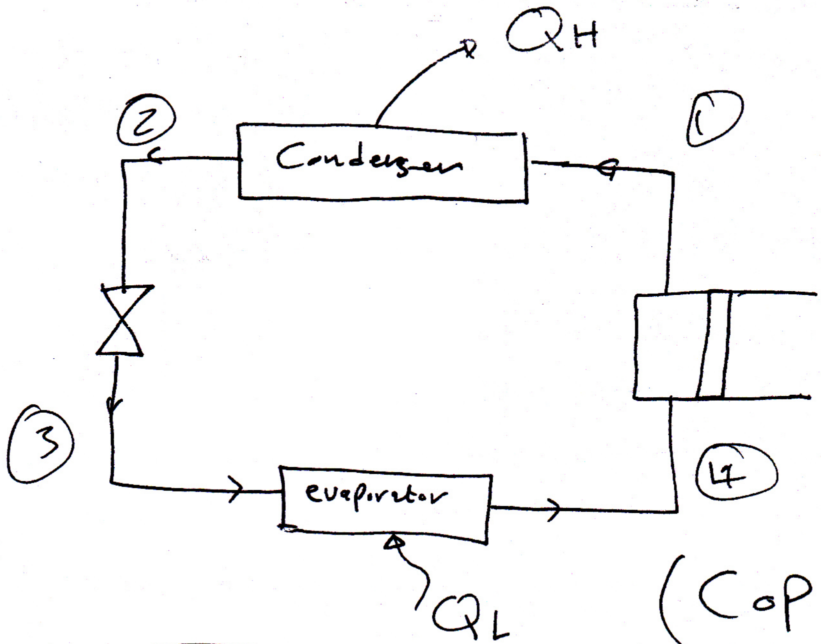
$= 22.4\ kg/h * 44000\ KJ/kg$

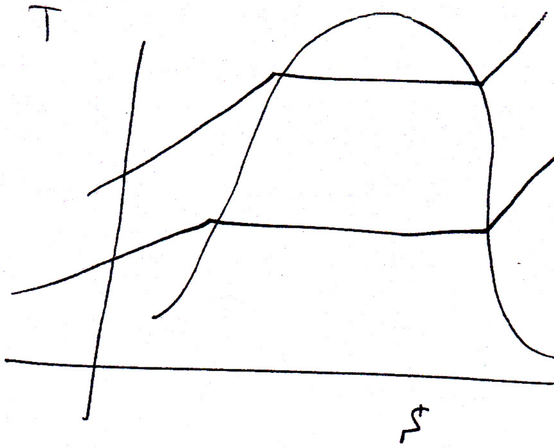
$= 985600\ KJ/h = 273.78\ (KW)$

$\eta_{th} = \frac{\dot{W}_{net}}{\dot{Q}_H} = \frac{60\ KW}{273.78\ KW} = 0.219$

$= 21.9\ \%$

Refrigerator and HP





$$(COP)_R = \frac{\dot{Q}_L}{\dot{W}_{net}}$$

$$\dot{W}_{net} = \dot{Q}_H - \dot{Q}_L$$

$$(COP)_R = \frac{\dot{Q}_L}{\dot{Q}_H - \dot{Q}_L}$$

* في حال استخدمت في القوانين Q وليس T نحن
في حالة ال Ideal cycle أما إذا استخدمت T فأنت في
(Carnot cycle) وهو ال Maximum.

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Heat pump is the Reversed Cycle of the Ref. cycle.

$$(COP)_{HP} = \frac{\dot{Q}_H}{\dot{Q}_H - \dot{Q}_L} = \frac{\dot{Q}_H}{\dot{W}_{net}}$$

$$(COP)_{HP} = (COP_R) + 1$$

Example :- When a Man Returns to his well-sealed house on a summer day, he finds that the house is at 32 °C. He turns on the air conditioner, which cools the entire house to 20 °C in 15 min. If the COP of the air conditioner is 2.5. Determine (a) the power drawn by the a.c. assume the entire mass within the house is equivalent to 800 kg of air for which $C_v = 0.72$ kJ/kg·°C and $C_p = 1.0$ kJ/kg·°C. (4)

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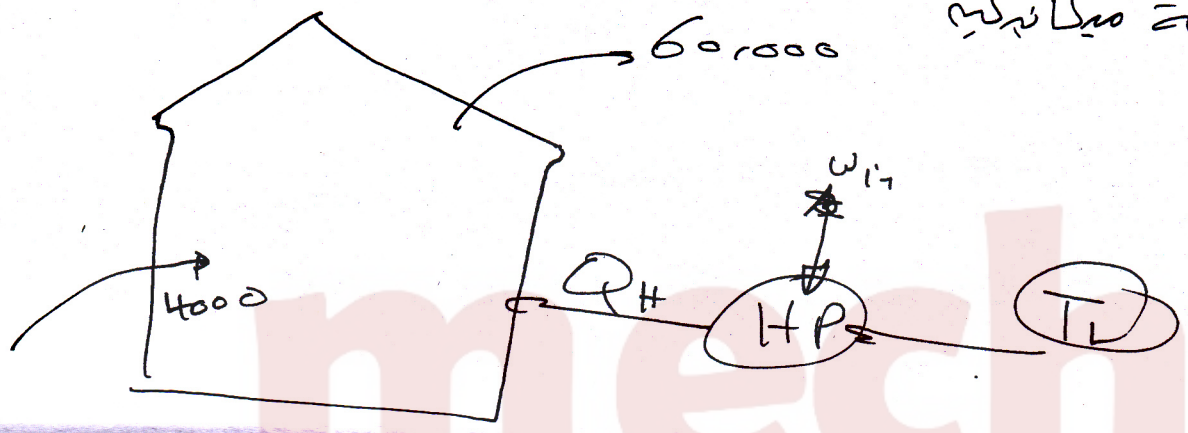
Example :- A heat pump is used to maintain a house at a constant temperature of 23°C. the house is losing heat to the outside air through the walls and the window at Rate of 60,000 KJ/h while the energy generated within the house From people, light, and appliances amount to 4000 KJ/h For a CoP of 2.5.

Determine, the Required power input to the Heat pump.



$$\dot{Q}_H = 60000 - 4000 = 56000 \text{ KJ/h}$$

$$\dot{W}_{net} = \frac{\dot{Q}_H}{COP_{HP}} = \frac{56000}{2.5} * \frac{1 \text{ kw}}{3600}$$

$$= 6.22 \text{ (kw)}$$

⊛ Example: Refrigerant 134a enters the evaporator Important.

Coils placed at the back of the Freezer section of a household Refrigerator at 120 kPa with $X = 20\%$ and leaves at 120 kPa and $-20^{\circ}C$.

If the compressor consumes 450 (W) of Power and the CP is 1.2. Determine:-

(a) the Mass flow Rate of the Refr.

(b) the Rate of heat Rejected to the kitchen air. معدل الحرارة المرفوضة للهواء في المطبخ