Refrigerators and heat pumps

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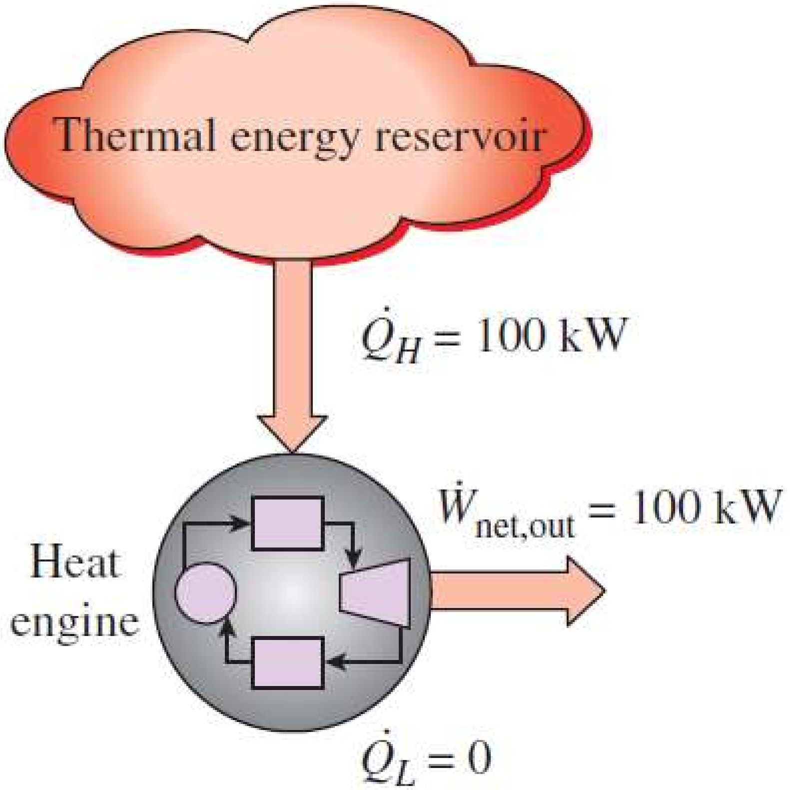
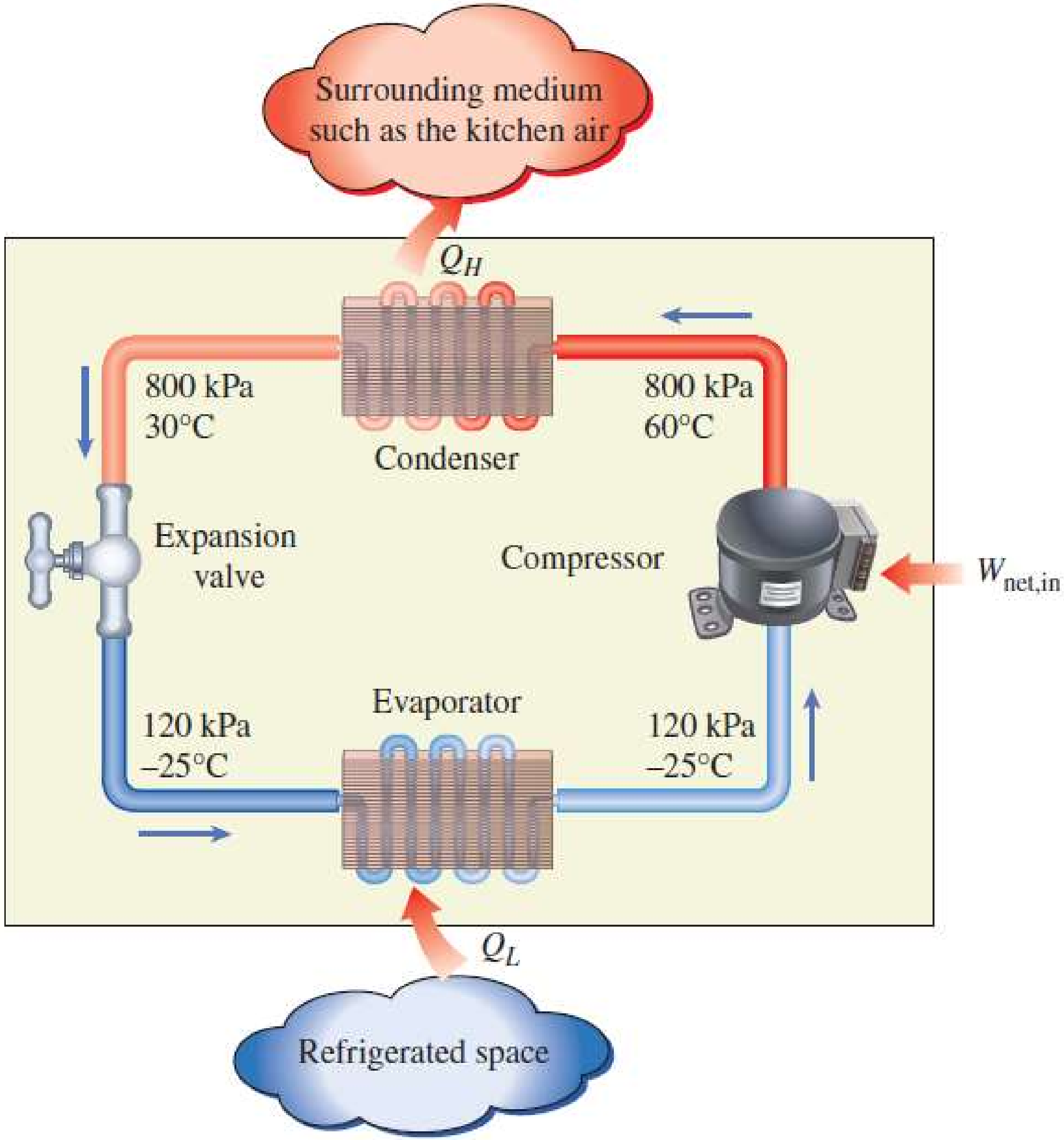
Previous Lecture: Kelvin-Planck statement of 2nd law of TD

"It is impossible for any device that operates on a cycle to receive heat from a single reservoir and produce a net amount of work"



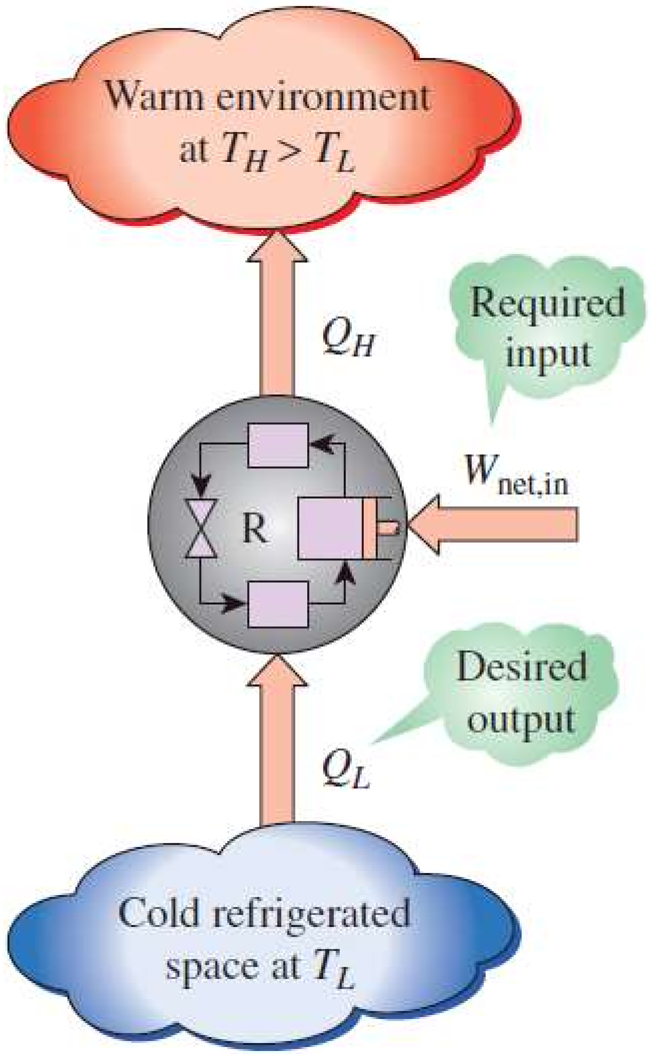
Figs: Cengel & Boles: TD

Refrigeration: Transfer of heat from low to high T



Figs: Cengel & Boles: TD

Refrigeration: "Coefficient of performance" vs. efficiency



$$\text{COP}_\text{R} = \frac{\text{Desired output}}{\text{Required input}} = \frac{Q_L}{W_{\text{net,in}}}$$

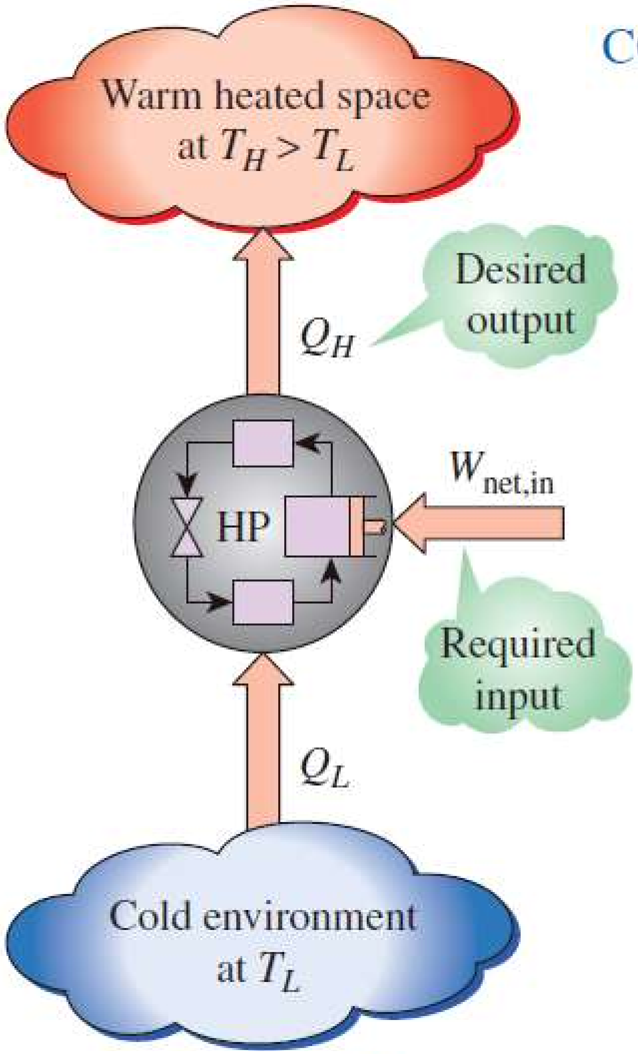
$$W_{\text{net,in}} = Q_H - Q_L \qquad (\text{kJ})$$

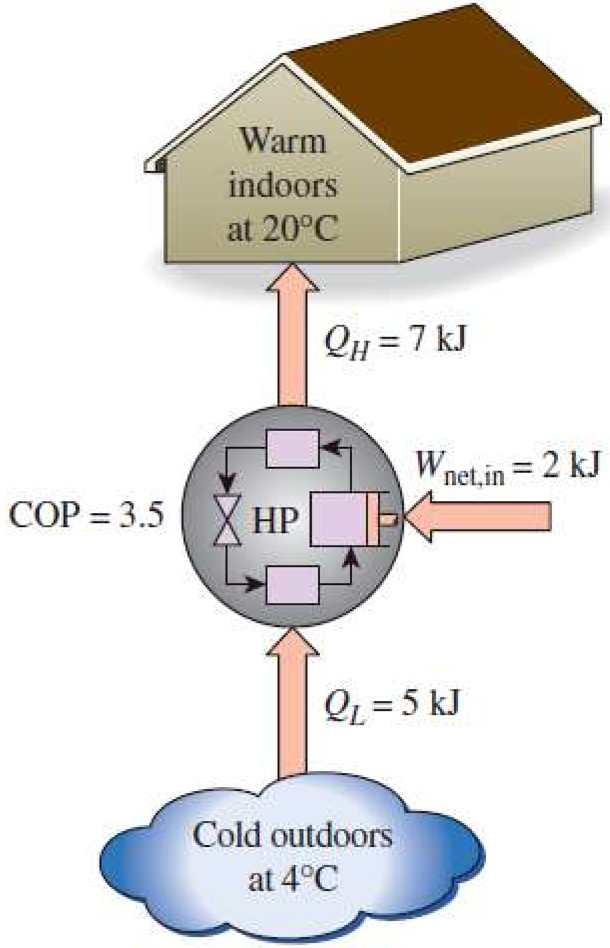
$$\text{COP}_\text{R} = \frac{Q_L}{Q_H - Q_L} = \frac{1}{Q_H/Q_L - 1}$$

Figs: Cengel & Boles: TD

Heat Pump: Coefficient of performance

$$\text{COP}_{\text{HP}} = \frac{\text{Desired output}}{\text{Required input}} = \frac{Q_H}{W_{\text{net,in}}}$$





$$\text{COP}_{\text{HP}} = \frac{Q_H}{Q_H - Q_L} = \frac{1}{1 - Q_L/Q_H}$$

$$\text{COP}_{\text{HP}} = \text{COP}_{\text{R}} + 1$$

Figs: Cengel & Boles: TD

What's next?

- Clausius statement of 2^{nd} law of TD, its equivalence to the Kelvin-Planck statement and perpetual motion of the 2^{nd} kind!