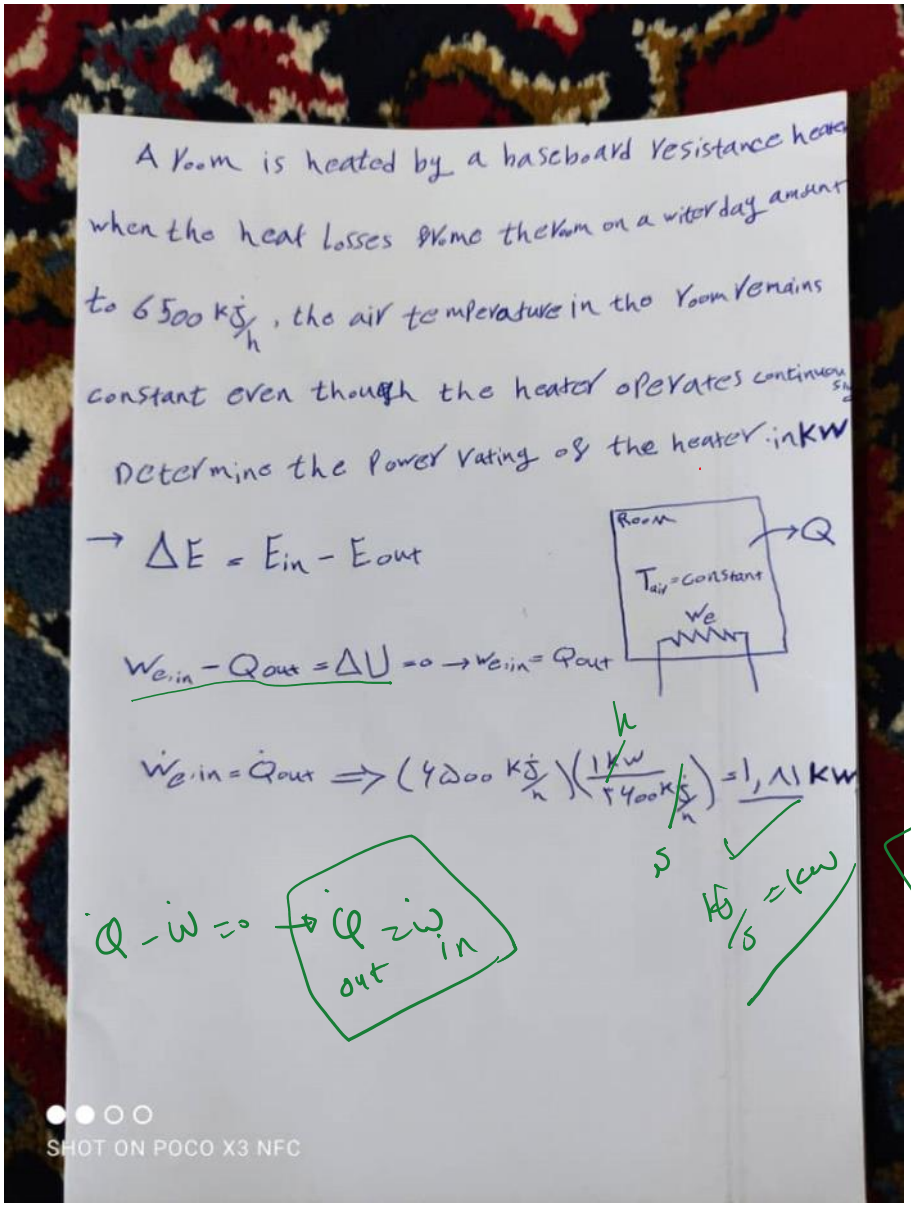
Meeting_006

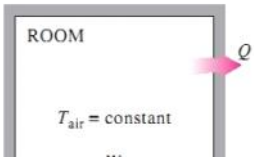
Tuesday, March 16, 2021 8:03 AM

فاتحي_002



WhatsApp Image 2021-03-09 at 9.11.35 AM

4–69 A room is heated by a baseboard resistance heater. When the heat losses from the room on a winter day amount to 6500 kJ/h, the air temperature in the room remains constant even though the heater operates continuously. Determine the power rating of the heater, in kW.



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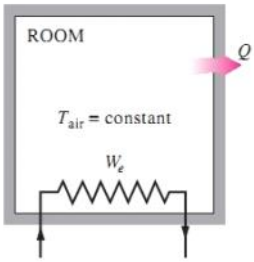
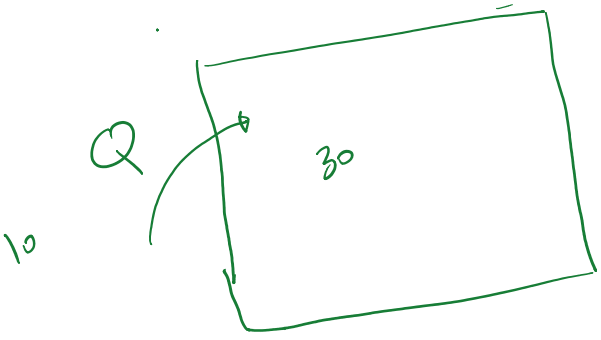


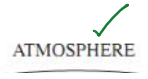
FIGURE P4–69

Chapter 6

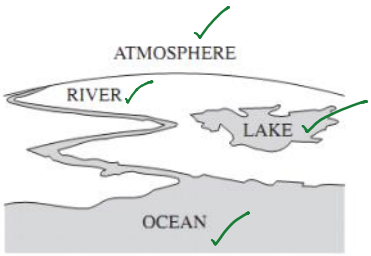
THE SECOND LAW OF THERMODYNAMICS



6–2 ▪ THERMAL ENERGY RESERVOIRS



۷ دما هر منبع گرمایی بالاتر از دمای محیط است.



۱- خورشید ۲- دالکترهای هسته ای

۳- مشعل های گازی

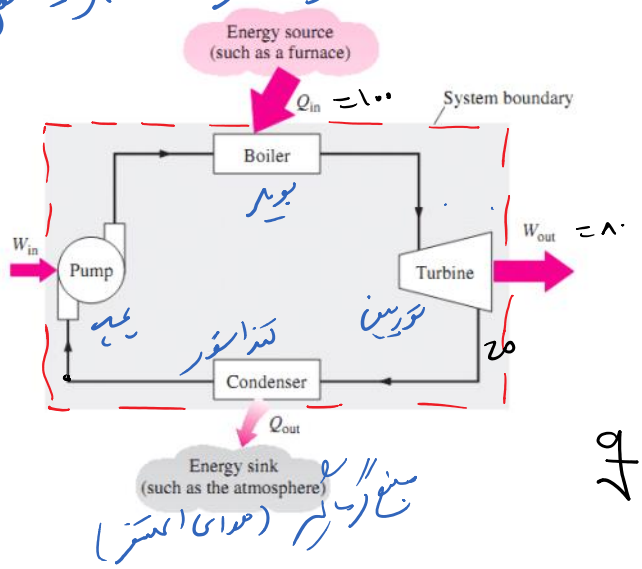
منابع گرمایی ← گرمادهی
← گرمگیری

گرمادهی (دالکترهای هسته ای - مشعل گازی)

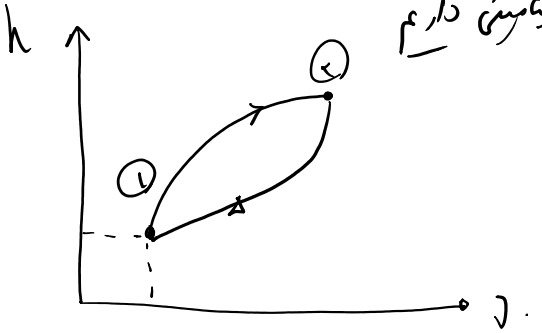
ماشین گرمایی:

۱- در سیکل ترمودینامیکی کار می کند

۲- سیال عامل H2O است.



$$q - w = h_2 - h_1$$

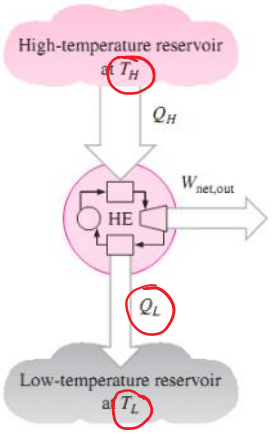


سیکل ترمودینامیکی داریم ⟶ $\oint dh = 0$

$q - w = 0 \longrightarrow q = w$

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

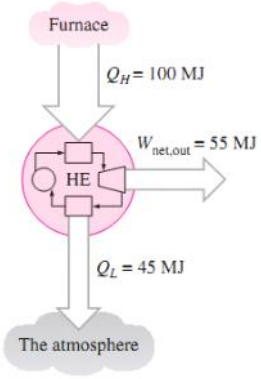
$$Q_H - Q_L = W_T - W_p = W_{net}$$



$$\text{Thermal efficiency} = \frac{\text{Net work output}}{\text{Total heat input}}$$

$$\text{راندمان حرارتی} = \frac{\text{کار خالص تولیدی}}{\text{گرمای کل مصرفی}} = \frac{W_{net}}{Q_H}$$

$$\Rightarrow \eta = \frac{W_{net}}{Q_H} = \frac{W_T - W_p}{Q_H} = \frac{Q_H - Q_L}{Q_H} = 1 - \frac{Q_L}{Q_H}$$



$$\eta = \frac{55}{100} = \frac{Q_H - Q_L}{Q_H} = \frac{100 - 45}{100} = \frac{55}{100}$$

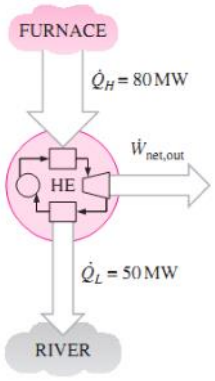
چرخه‌ای راندمان حرارتی ۱۰۰٪ دارد. $\Leftarrow Q_L = 0$

Can We Save Q_{out}?

آیا می‌توان Q_L را کاملا صفر کرد.

EXAMPLE 6–1 Net Power Production of a Heat Engine

Heat is transferred to a heat engine from a furnace at a rate of 80 MW. If the rate of waste heat rejection to a nearby river is 50 MW, determine the net power output and the thermal efficiency for this heat engine.

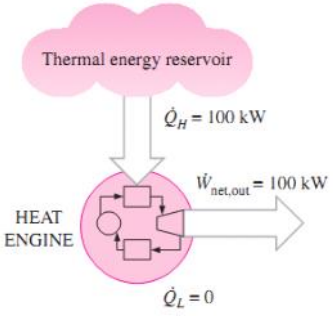


$$\dot{W}_{net} = \dot{Q}_H - \dot{Q}_L = 80 - 50 = 30\ \text{MW}$$

$$\eta = \frac{\dot{W}_{net}}{\dot{Q}_H} = \frac{W_{net}}{Q_H} = \frac{30}{80} \times 100 = \frac{3}{8} \times 100 =$$

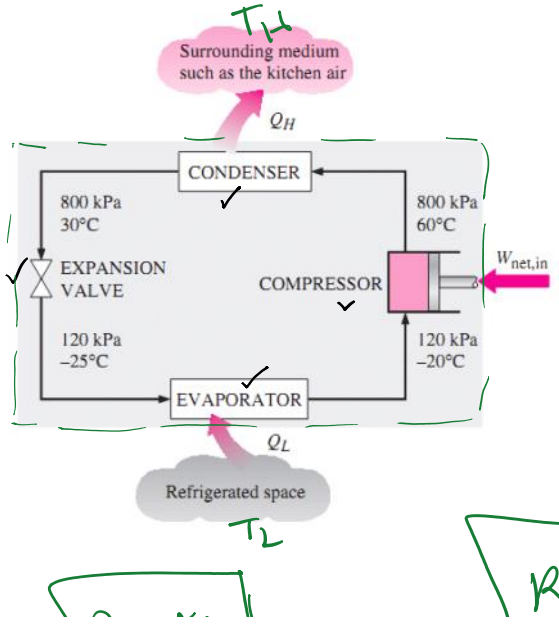
The Second Law of Thermodynamics: Kelvin–Planck Statement

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.



6–4 • REFRIGERATORS AND HEAT PUMPS

سیکل تبرید و پمپ های گرمایی



① اجزاء: کمپرسور - کندانسور - شیر فشار شکن و اواپراتور

② در سیکل کار می‌کند

③ در آن، دو ضیغ گرمایی است.

④ سیال عامل ←

R-134a

T_L

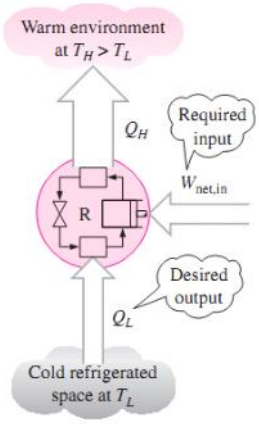
R-۲۲

R-۱۳۴a

سیال کامل ⟵ ②

سیکل یخچال: گرما را از منبع دما پایین می‌گیرد و به منبع دما بالا انتقال می‌دهد. از سیکل یخچال

علت اصلی گرفتن گرما از منبع دما پایین است. (یخچال - سردخانه‌ها)



قانون اول ترمودینامیک ⟵ $q - w = h_2 - h_1 = 0$

$q = w$

$q_L - q_H = -w_c \longrightarrow \boxed{q_H - q_L = w_c}$

Coefficient of Performance (COP)

$$COP = \frac{\text{وظیفه سیکل یخچال}}{\text{کار ورودی}} = \frac{q_L}{w_c}$$

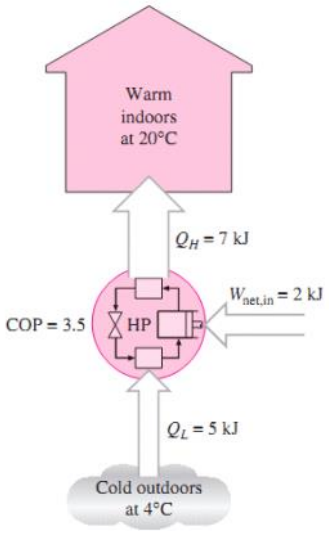
$$COP_R = \frac{\text{Desired output}}{\text{Required input}} = \frac{Q_L}{W_{net,in}} = \frac{q_L}{w_c} = \frac{\text{گرمای گرفته شده از فضای داخل یخچال}}{\text{کار داده شده به کمپرسور}} = \frac{\dot{q}_L}{w_c}$$

$$COP = \frac{q_L}{w_c} = \frac{q_L}{q_H - q_L} = \frac{1}{\frac{q_H}{q_L} - \frac{q_L}{q_L}}$$

$$\Rightarrow COP = \frac{1}{Q_H/Q_L - 1}$$

یخچال گرمایی: هدف انتقال گرما به منبع دما بالاست.

هدف: گرمایش داخل خانه



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

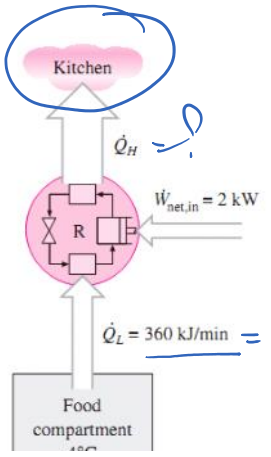
$$COP_{HP} = \frac{\text{گرمای داده شده به فضای داخل خانه (یا محفظه)}}{\text{کار داده به سیستم}} = \frac{Q_H}{W_C}$$

$$COP_{HP} = \frac{Q_H}{Q_H - Q_L} = \frac{1}{1 - Q_L/Q_H}$$

$1 < COP < \infty$

EXAMPLE 6–3 Heat Rejection by a Refrigerator

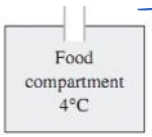
The food compartment of a refrigerator, shown in Fig. 6–24, is maintained at 4°C by removing heat from it at a rate of 360 kJ/min. If the required power input to the refrigerator is 2 kW, determine (*a*) the coefficient of performance of the refrigerator and (*b*) the rate of heat rejection to the room that houses the refrigerator.



$$\dot{Q}_L = 360 \text{ kJ/min} = \frac{360}{60} = 6 \text{ kJ/s}$$

$$COP = \frac{\dot{Q}_L}{\dot{W}} = \frac{6}{2} = 3$$

$$COP = \frac{\dot{Q}_L}{\dot{W}_C} = \frac{6}{2} = 3$$



$$\dot{Q}_H - \dot{Q}_L = \dot{W}_C \longrightarrow \dot{Q}_H = 2 + 6 = 8 \text{ kW}$$

The Second Law of Thermodynamics: Clausius Statement

There are two classical statements of the second law—the Kelvin–Planck statement, which is related to heat engines and discussed in the preceding section, and the Clausius statement, which is related to refrigerators or heat pumps. The Clausius statement is expressed as follows:

> It is impossible to construct a device that operates in a cycle and produces no effect other than the transfer of heat from a lower-temperature body to a higher-temperature body.