Worksheet: Heat Pumps

Q1: A refrigerator connects reservoirs with temperatures of 260 K and 320 K. What is the change in the temperature of the low-temperature reservoir that results in the work required to cool the low-temperature reservoir being halved? Give your answer to three significant figures.

A 27.0 K

B −41.0 K

C 52.0 K

D −60.0 K

E 30.0 K

Q2: A refrigerator connects reservoirs with temperatures of 270 K and 360 K. What is the change in temperature of the high-temperature reservoir that results in the work required to cool the low-temperature reservoir being halved? Answer to three significant figures.

A 30.0 K

B 90.0 K

C 180 K

D 22.5 K

E 45.0 K

Q3: A heat pump heats a high-temperature reservoir with a temperature of 35°C by 7.5 J for each joule of workthat it does. The pump connects the reservoir to a low-temperature reservoir.What is the temperature of the low-temperature reservoir? Answer in degrees Celsius to three significant figures.

A −3.62°C

B −2.35°C

C −6.07°C

D –1.24°C

E −5.24°C

Q4: Heat pumps and refrigerators are very similar to each other, consisting of the same basic components. However, they are not modeled in exactly the same way as each other.

Which of the following statements correctly explains the similarities between a heat pump and a refrigerator?

A A heat pump and a refrigerator both have the same efficiencywhen transferring internal energy between two reservoirs with the same two temperatures, T_1 and T_2.

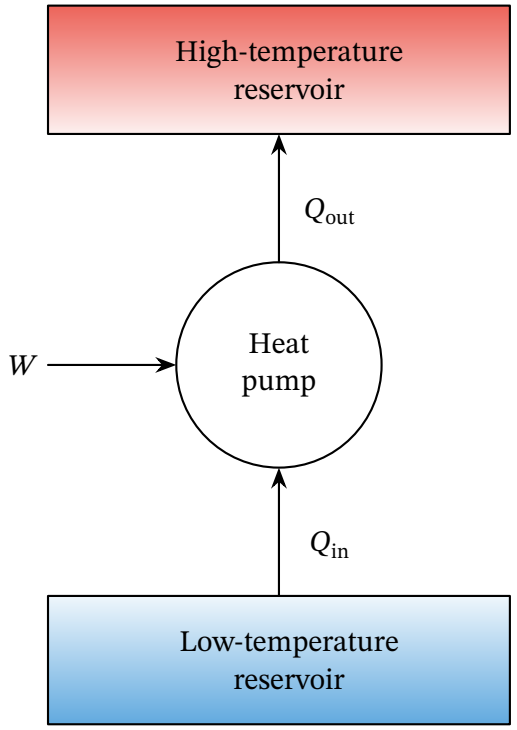
B A heat pump and a refrigerator both transfer internal energyfrom a low-temperature reservoir to a high-temperature reservoir.

Which of the following statements correctly explains the differences between a heat pump and a refrigerator?

A A heat pump transfers internal energy from a high-temperature reservoir to a low-temperature reservoir, whereas a refrigerator transfers internal energy from a low-temperature reservoir to a high-temperature reservoir.

B The efficiency of a heat pump depends on how much work itdoes to add internal energy to a high-temperature reservoir, whereas theefficiency of a refrigerator depends on how much work it does to removeinternal energy from a low-temperature reservoir.

Q5: A heat pump is represented in the diagram, showing thequantities associated with its operation. If the value of W, the work done by the pump, is zero, what is the relationshipbetween the magnitudes of Q_{in} and Q_{out}? Assume that the reservoirs are not at the same temperature as each other.



A $Q_{in} < Q_{out}$

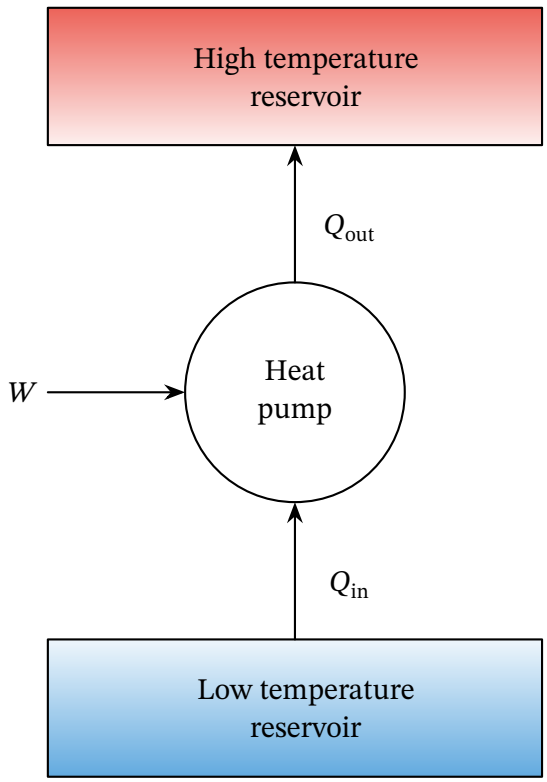
B $Q_{out} \times Q_{in} = 1$

C $Q_{in} > Q_{out}$

D $Q_{in} = Q_{out}$

E $\frac{Q_{out}}{Q_{in}} = 1$

Q6: A heat pump is represented in the diagram, showing thequantities associated with its operation. Which of the following formulas mostcorrectly represents the relationship between Q_{in}, Q_{out}, and W?



A $Q_{\text{in}} - Q_{\text{out}} = W$

B $Q_{\text{in}} + Q_{\text{out}} = W$

C $Q_{\text{out}} - Q_{\text{in}} = W$

D $\frac{Q_{\text{in}}}{Q_{\text{out}}} = W$

E $\frac{Q_{\text{out}}}{Q_{\text{in}}} = W$