ActivPhysics simulation 8.14

Q1 A 2nd
B 3rd
C 1st
D 4th

Q2 $P = nRT/V$

Q3 A: $\Delta U = 0$, $W = Q$

$W = \int p\,dV = \int \frac{nRT}{V}\,dV = nRT \ln V_f/V_0 = 2.67\ \text{KJ}$

$= 1.0\ 8.3145\ 500\ \ln 19/10$

B: $Q = 0$

$W = -\Delta U = -\frac{3}{2} nR\Delta T = 2.49\ \text{kJ}$

C: $\Delta U = 0$

$Q = W = nRT \ln V_f/V_0 = 1.0\ 8.3145 \ln \frac{21}{40} = -1.61\ \text{kJ}$

D: $Q = 0$

$W = -\Delta U = -\frac{3}{2} nR\Delta T = -2.49\ \text{kJ}$

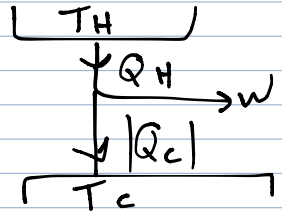
Q4 $e = \frac{W}{|Q_H|} = \frac{2.67\text{kJ} + 2.49\text{kJ} - 1.61\text{kJ} - 2.49\text{kJ}}{2.67\text{kJ}} = 0.397$

Q5 $e = 1 - \frac{T_c}{T_H} = 1 - \frac{300}{500} = 0.4$

Q7 $e_{max} = 1 - T_{coldest}/T_{hottest} = 1 - 270\text{k}/600\text{k} = 0.55$

$e_{min} = 1 - T_{warmest\ cold}/T_{coolest\ hot} = 1 - \frac{350\text{k}}{400\text{k}} = 0.13$

Heat engine



$W = Q_H + Q_c$

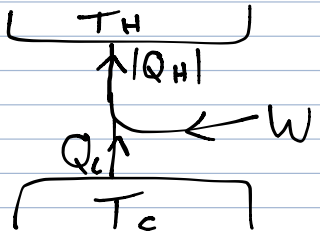
$= |Q_H| - |Q_c|$

$Q_H > 0$ $Q_c < 0$

$W > 0$

efficiency = $\frac{\text{output work}}{\text{input heat}} = \frac{W}{Q_H}$

Refrigerator



$W = Q_H + Q_c$

$|W| = |Q_H| - |Q_c|$

$Q_H < 0$ $Q_c > 0$

$W < 0$

coeff. of performance = $\frac{\text{heat removed}}{\text{work required}} = \frac{|Q_c|}{|W|} = K$

example A freezer has $K = 2.40$ and brings $1.80\,kg$ of H_2O at $25.0°C$ down to $-5.0°C$ in 60 min.

a) How much heat is removed?

$Q_c = Q_{cool\ H_2O} + Q_{convert\ to\ ice} + Q_{cool\ ice}$

$= mc\Delta T_{H_2O} - mL_f + mc\Delta T_{ice}$

$= 1.80kg\left(4190\frac{J}{kg\cdot K}(-25\,K) - 3.34\cdot10^5\frac{J}{kg} + 2010\frac{J}{kg\cdot K}(-5K)\right) = -8.08\cdot10^5\,J$

b) How much electrical energy is consumed?

$W = \frac{|Q_c|}{K} = \frac{8.08\cdot10^5\,J}{2.40} = 3.37\cdot10^5\,J$

c) How much heat is delivered to the room?

$|Q_H| = |W| + |Q_c| = 3.37\cdot10^5 + 8.08\cdot10^5\,J = 1.14\cdot10^6\,J$

ch04 s2.html if $|Q_c|$ were 0, then $W = Q_H$ and $e = 1.0$ ← not possible

⇒ "A" works

if Q_H were smaller than W, then $e > 1.0$

⇒ "B" works

→ E: A & B

53.html

refrigerator perspective: no work is needed to cool the house

entropy perspective: going from disordered to more ordered → not allowed

Poll everywher: do the exam prep/review on

A: Friday
B: Wednesday