6. (10 Points) Which of the following is NOT a state variable: (HRK 26-30)
   a. work
   b. internal energy
   c. entropy
   d. temperature
   e. pressure

   Q and W are NOT state variables— they are ways to transfer energy. BUT a system does NOT have either Q or W.

   Show work on problems 7-12. A correct answer with no work is worth 0 points.

7. (15 points) A heat engine operates between 200°C and 20°C. Its maximum possible efficiency is: (HRK 26-21)
   a. 90%
   b. 100%
   c. 38%
   d. 72%
   e. 24%

   \[ \eta = 1 - \frac{T_L}{T_H} = 1 - \frac{273 + 20}{273 + 200} = 1 - \frac{293}{473} = 0.38 \]

   Convert °C to K!!

8. (15 points) The coefficient of linear expansion of steel is \( 11 \times 10^{-6} \) per K. A steel ball has a volume of 100 cm\(^3\) (exactly) at 0°C. When heated to 100°C, its volume becomes? (HRK 22-32)
   a. 100.33 cm\(^3\)
   b. 100.0011 cm\(^3\)
   c. 100.0033 cm\(^3\)
   d. 100.000011 cm\(^3\)
   e. none of the above

   \[ \Delta V = 3 \alpha V \Delta T \]
   \[ = 3 \left( 1.1 \times 10^{-5} \text{ K}^{-1} \right) (100 \text{ cm}^3) (100 \text{ K}) \]
   \[ = 0.33 \text{ cm}^3 \]

   \[ V_f = V + \Delta V = 100.33 \text{ cm}^3 \]