Problem 1
An ideal compressor is used to fill the Macy’s Thanksgiving Day Parade balloons with hot air. Air enters the compressor at 280 K and 100 kPa and exits at 440 K. Initially the balloon contains 325 kg of air at 280 K and 100 kPa. When it is fully inflated, the Buzz Lightyear balloon is at 400 K, 100 kPa, and a volume of 2600 m$^3$. Determine:

a. the compressor work in kJ require Ans.: -314,094 kJ
b. the boundary work of the inflation process in kJ Ans.: 233,883 kJ

Problem 2
The MSU Simon Power Plant has observed that it burns less coal in the winter when the temperature is 265 K compared to the summer time when the temperature is 305 K. Estimate the percent coal savings assuming:

Combustion temperature of 2500 K
Power production of 10 MW
Coal consumption is directly proportional to the heat transfer rate from the burning coal

Ans.: Cost savings of 1.82%
**Problem 3**
Consider applying our Carnot heat engine approach to a biological system, specifically, a hunting cheetah. The work output may be considered to be the kinetic energy change as the 45 kg cheetah accelerates from rest to 27 m/s. The heat input, \( Q_H \), may be considered to come from the digestion of meat. The outside temperature is 30°C and the cheetah’s internal temperature from which the \( Q_H \) comes from is 42°C. Determine

a. the heat that must be supplied \textbf{Ans.: 430.6 kJ}  
b. the heat that must be rejected \textbf{Ans.: 414.2 kJ}  
c. the kilograms of meat that must be digested if 200 kJ of heat is released for every kilogram of meat digested \textbf{Ans.: 2.15 kJ}  

![Diagram of thermodynamic cycle](image-url)