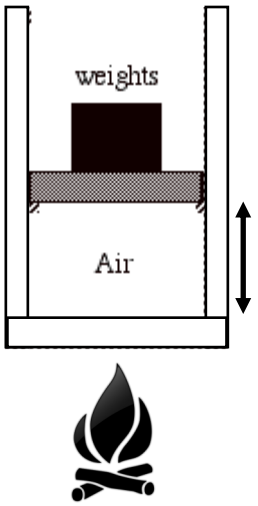
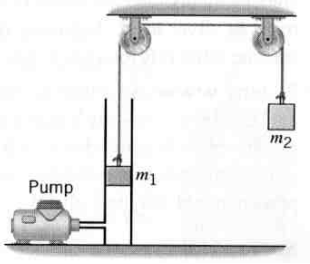
KC's Quantitative Problems
Ideal Gas

- *Thermodynamics.Ideal-Gas*.**QP.KC.1:** The Jaguar XK8 sports-car has eight cylindrical pistons in its engine. Right before a compression stage of the engine's cycle one of the piston's cylinders has 500 cm3 of air at atmospheric pressure (1.01 x 10^5 Pa) and a temperature of 26.0°C. The piston compresses this air during this stage and at the end of this compression the volume has been reduced to 46.1 cm3 and the gauge pressure has increased to 2.71 x 10^6 Pa. Assuming ideal, what is the final temperature of the air?

- *Thermodynamics.Ideal-Gas*.**QP.KC.2:** A frictionless piston that carries some weights, sits atop a pocket of air that's considered ideal. The cylinder containing the air is a poor insulator. At room temperature, 293 K, the height **h** of the piston is 0.120 m. (a) As the temperature of the gas is slowly increased by a heating source, which state variable(s) remain constant? (b) If the temperature is raised to 320 K, what is the new value of **h**? (c) During this process what is the sign of the change in internal energy, the transfer of heat, and the work on the gas?



- *Thermodynamics.Ideal-Gas*.**QP.KC.3:** A cylinder has a frictionless piston of mass $\mathbf{m_1}$ = 0.50 kg and radius 2.5 cm fitted inside it. This mass is then attached via a light rope that passes over two massless, frictionless pulleys to another block $\mathbf{m_2}$ = 9.5 kg, as shown in the figure. The piston is open at the top and has a pump creating a reduced but constant pressure below $\mathbf{m_1}$. If the block ($\mathbf{m_1}$) falls from rest a distance of 1.25 m in 3.30 s, what is the pressure beneath the piston?



- *Thermodymaics.Ideal.Gas*.**QP.KC.4:** Are the S.I. units for the universal gas constant (J/mol)·(K) or (J)/(mol·K)? I.e. is the Kelvin unit in the numerator or the denominator? Show your work.