Thermodynamics & Heat Engines Worksheet

In this worksheet we will be evaluating two different heat engines—the Otto and Carnot cycles. Before getting into the specifics of the problems at hand, begin by recapping what you have learned about thermodynamics and the four different thermodynamic processes. What are the main thermodynamic equations that you anticipate using in solving analyzing these heat cycles?

In addition to these useful equations, fill in the table below for the four thermodynamic processes. Be sure you know what the conditions are for each process, and use that information to help you fill in the table. If there are additional equations or relationships, use the *adtl.* column for such information.

	ΔU	**ΔQ**	**ΔW**	**adtl.**
Isochoric				
Adiabatic				
Isobaric				
Isothermal				

Using the above information, determine the efficiency of the following Otto Cycle (Figure 1). One mole of an ideal gas expands adiabatically from an initial volume of 100 cm^3 and an initial pressure of 100 kPa (point a) to one third of the initial volume and five times the initial pressure (point b). Next, the gas is ignited at a constant volume, causing the pressure to double (point c). As a result, the cylinder undergoes an adiabatic expansion back to the initial volume. Lastly, heat is rejected from the system in an isochoric process, until the initial pressure is reached.

What is the total work done by the engine?

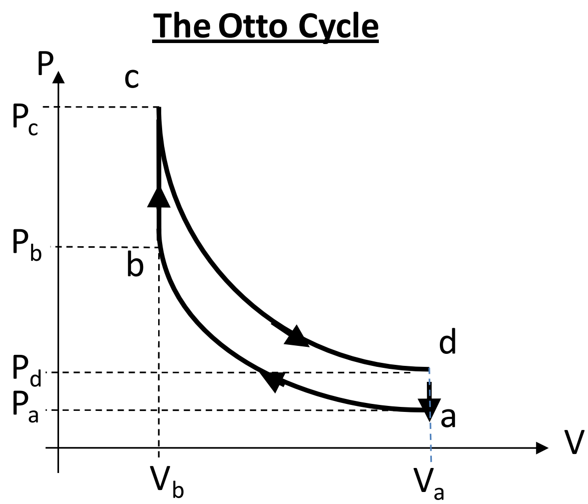

Figure 1

How much heat is put into the system?

What is the efficiency of this Otto Cycle?

In a similar fashion to the previous analysis, determine the efficiency of the following Carnot Cycle (Figure 2). One mole of an ideal gas expands along an isotherm at temperature 300 K from an initial volume of 100 cm^3 (point a) to twice the initial volume (point b). Next, the gas expands adiabatically, causing the pressure to drop to one-third of its previous value (point c). The gas then compresses isothermally until the pressure is doubled (point d). Lastly, the gas is compressed adiabatically back to its initial state (point a).

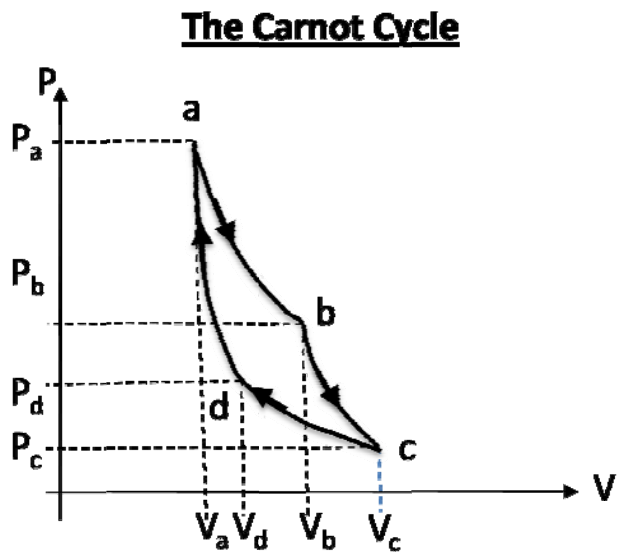

Figure 2

What is the total work done by the engine?

How much heat is put into the system?

What is the efficiency of this Carnot Cycle?

Prove that the efficiency for this Carnot engine is greatest obtainable efficiency for any type of heat engine operating between the same two temperatures.