Instructions: You have a total of 55 minutes to complete this test. Answer each question completely.

Time Start_____ Time finish _____pledged _____

You must supply all details that led to your answer and correct SI units where required.

(1) An ideal 3 dimensional **monoatomic** gas with $C_v = \frac{3}{2}R$ has the equation of state $PV = nRT$ where n is the number of moles and R=8.314 J/(K mol). Suppose that n=1 mole of this ideal gas goes through an **isovolumeric** (V=constant) process. If the change is pressure is $\Delta P=1x10^5$ Pa, and the change in temperature is $\Delta T=300K$, answer the following using correct SI units.

(a) what is the initial volume of the gas if the initial pressure is $P=1x10^5$ Pa and the initial temperature is T=500K?

(b) what is the change in internal energy of the gas?

(c) how much heat was supplied (or evolved) from the gas?

(d) If the gas went through an isobaric process (P=constant=$1x10^5$ Pa) instead with the change in temperature still being $\Delta T=300K$, what would be the change in internal energy of the gas?

(2) An ideal diatomic 3 dimensional gas with an initial volume of $1m^3$ is initially at a temperature of T=300K. You may assume that $C_v = \frac{7}{2}R$, which you will need in order to calculate γ.

(a) Calculate γ for this gas.

(b) If the gas increases its temperature **adiabatically** to a temperature of 600K, what was the final volume of the gas?

(3) A heat engine is observed to operate with 35% efficiency when a heat input of Q_H=100J is provided.
(a) What is the work that was measured from this engine?

(b) Suppose the engine went through a Carnot cycle with a rejected source which has a temperature of T_c=300 ^{0}C. What is the temperature of the input reservoir?

(c) Suppose an inventor wants you to loan money for an engine which he says is up to 84% efficient between the temperature extremes of 500 ^{0}C and 75 ^{0}C. Should you invest in this project? Note: saying just yes or no here is not sufficient; your answer needs to be based upon physics with your work shown.

(4) A metal cube with a density of 7000 kg/m^3 has a coefficient of linear expansion of 4.5x10^{-6} /^{0}C and a specific heat of 200 J/(kg ^{0}C). Suppose a 1 Kg block of the metal is heated from a temperature of 0^{0}C to a temperature of 100^{0}C.
(a) What is the change in volume of the cube?

(b) How much heat is added to the system if this expansion was in the presence of an atmosphere of P=1x10^5 Pa?

(c) If this expansion was in the presence of a pressure of 1x10^{5}Pa, how much work was done by the cube?

(d) What was the change in internal energy of the cube?