

Instructions: You have a total of 55 minutes to complete this test. Answer each of the following questions completely providing details and correct SI units.

Time Start _____ Time finish _____ pledged _____

[1] An ideal 3 dimensional **diatomic** gas (with rotational and vibrational modes realized) has the equation of state $PV=nRT$ where n is the number of moles and $R=8.314 \text{ J/(K mol)}$. Suppose that 1 mole of this ideal gas goes through an **isovolumeric** ($V=\text{constant}$) process. If the change in pressure is $\Delta P=1 \times 10^5 \text{ Pa}$, and the change in temperature is $\Delta T=300\text{K}$, answer the following using correct SI units.

(a) What is the volume of the gas when the pressure is $P=1 \times 10^5 \text{ Pa}$ and the temperature is $T=300\text{K}$?

(b) What are the values of c_v and c_p for this gas?

$c_v =$ _____ $c_p =$ _____
(c) What is the change in internal energy of the gas?

$\Delta U =$ _____
(d) How much heat was supplied (or evolved) from the gas?

$Q =$ _____

[2] A copper cube with a density of 8960 kg/m^3 has a coefficient of linear expansion of $16.6 \times 10^{-6} / ^\circ\text{C}$ and a specific heat of $385 \text{ J/(kg } ^\circ\text{C)}$. Suppose a 1 Kg block of copper is heated from a temperature of 0°C to a temperature of 100°C .

(a) if the cube is isotropic, what is the coefficient of volume expansion?

$$\gamma = \underline{\hspace{2cm}}$$

(b) How much heat is added to the system?

$$Q = \underline{\hspace{2cm}}$$

(c) What is the change in volume of the cube?

$$\Delta V = \underline{\hspace{2cm}}$$

(d) If this expansion was in the presence of a pressure of $1 \times 10^5 \text{ Pa}$, how much work was done by the cube?

$$W = \underline{\hspace{2cm}}$$

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

$$\Delta U = \underline{\hspace{2cm}}$$

[3] A heat engine is observed to operate with 55% efficiency when a heat input of $Q_H=100\text{J}$ is provided.

(a) What is the work that was measured from this engine?

(b) Suppose the engine went through a Carnot cycle with heat input was from a source which has a temperature of $T_H=100^\circ\text{C}$. What is the temperature (in K) of the colder reservoir?

[4] For water, $L_f = 3.33 \times 10^5 \text{ J/kg}$ and $c = 4186 \text{ J/Kg } ^\circ\text{C}$.

(a) If a 1 kg mass of ice at 0°C melts to become water at 0°C , calculate the change in entropy of the system.

$\Delta S =$ _____

(b) If 1 kg of water at 0°C is mixed with 1 kg of water at 50°C , calculate the final equilibrium temperature of the mixture.

$T_f =$ _____

(c) Calculate the change in entropy of the water as a result of the mixing described in part b.

$\Delta S =$ _____