

Instructions: You have a total of 55 minutes to complete this test.

Answer each of the following questions completely.

Time Start \_\_\_\_\_ Time finish \_\_\_\_\_ Pledged \_\_\_\_\_

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

Do not discuss any aspect of this test with anyone until I return the test.

$273.15 + T[C] = T[K]$ ;  $R = 8.31 \text{ J/(mole K)}$ ; Water:  $c = 4186 \text{ J/kg}$ ,  $L_f = 3.34 \times 10^5 \text{ J/kg}$

[1] 1 mole of an ideal monatomic three-dimensional gas with  $c_v = 3/2 R$  is allowed to go through several processes. Calculate the required quantities. Assume that any initial pressure is  $1 \times 10^5 \text{ pa}$ .

1a: Calculate  $c_p$  for this gas.

$c_p =$  \_\_\_\_\_

1b: If the gas goes through an isovolumeric ( $V = \text{constant}$ ) process, calculate  $\Delta U$  if the temperature increased from 300K to 500K.

$\Delta U =$  \_\_\_\_\_

1c: If the gas goes through an isothermal process, calculate  $\Delta U$ .

$\Delta U =$  \_\_\_\_\_

1d: If the gas goes through an isobaric process, calculate the heat added if the temperature increased from 300K to 500K.

$Q =$  \_\_\_\_\_

[2] 2a. If 5kg of water at 80 C is mixed with 2 kg of water at 10 C, what is the final equilibrium temperature of the mixture?

$T_f =$  \_\_\_\_\_

2b. Suppose 7 kg of ice at 0C melts and becomes 7 kg of water at 0C. Assuming no volume change, what is the change in internal energy of the ice?

$\Delta U =$  \_\_\_\_\_

2c. What is the change in entropy of the ice when it melts as in part (b)?

$\Delta S =$  \_\_\_\_\_

[3] A heat engine produces 55 Joules of work for a heat input of 200 J.

3a. Calculate the efficiency of this engine.

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

3b. How much heat does this engine reject?

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

3c. Suppose this engine operates with a lower temperature of  $T_c = 100^\circ\text{C}$ . If the engine has an efficiency equal to the Carnot efficiency, what is the temperature of the hotter reservoir?

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

[4] A cube of metal of mass 10kg has a specific heat of 2300 J/kg and a volume of  $0.1 \text{ m}^3$  at  $T = 300\text{K}$  and a coefficient of volume expansion given by  $70 \times 10^{-6} / ^\circ\text{K}$ . You may assume that the cube is surrounded by the atmosphere with a pressure of  $1 \times 10^5 \text{ pa}$ . If the metal experiences a temperature change of 400K, answer the following questions.

4a: What is the final volume of the cube?

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

4b: If the metal experiences a temperature change of 400K, what is the work done by the metal.

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

4c: How much heat was added to the system?

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

4d: What was the change in internal energy of the cube?

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