SCIENCE OLYMPIAD 2011/2012 ST. JOE'S INVITE

THERMODYNAMICS

Team:_____ Team Number:_____

Team Member Names: 1. _____

2. _____

Instructions: This test contains two parts. Part I contains 10 questions and Part II contains 5 questions. Answer all questions on the test paper. If you need more room, you may attach extra paper.

Each question in Part I is worth 1.5 points. Each question in Part II is worth 7 points. The test is worth a total of 50 points. Show all work for Part II. Partial credit will be given. Answers without accompanying work will receive little credit.

An appendix is attached to this test. This information may be required to answer some of the questions on this test.

You may not finish the test in the allotted time. Therefore, you are encouraged to complete the questions in any order that you choose.

Part I

1. The state of a pure, compressible system is completely satisfied by how many independent, intensive properties?

2. In a thermodynamic system, where does energy transfer occur?

3. At the _____ the saturated liquid and saturated vapor states are identical.

4. What type of energy is associated with intermolecular forces and is influenced by the spacing between molecules (gas vs. liquid vs. solid)?

5. The state of a system depends on the path taken to reach that state. (True/False)

6. A turbine extracts work out through having a _____ pressure fluid at the inlet convert to a _____ pressure fluid at the outlet.

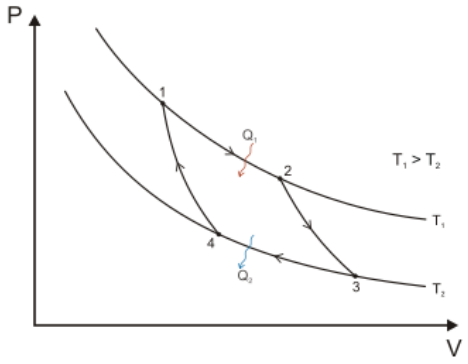
7. Label the 4 processes for a Carnot cycle:

   1-2: _____

   2-3: _____

   3-4: _____

   4-1: _____



8. The ideal gas equation of state is valid under _____ pressures and _____ temperatures relative to critical point properties.

9. A reversible process will always have a _____ efficiency than an irreversible one.

10. Which of the following is not a law of thermodynamics?
    a. If two systems are in thermal equilibrium with a third system, they are also in thermal equilibrium with each other.
    b. Energy can be transformed, but not created nor destroyed.
    c. Mass can be neither created nor destroyed.
    d. Energy has a natural tendency to become more disordered.

Part II

1. Both a gage and a manometer are attached to a gas tank to measure its pressure. If the reading on the pressure gage is 80 kPa, determine the distance between the two fluid levels of the manometer if the fluid is mercury (density ρ=13,600 kg/m^3).

2. A vessel having a volume of 0.4 m^3 contains 2.0 kg of a liquid and water vapor mixture in equilibrium at a pressure of 600 kPa. Find the volume and mass of both the liquid and the vapor.

3. A piston-cylinder device initially contains 0.25 kg of nitrogen gas at 130 kPa and 180ºC. The nitrogen is now expanded isothermally to a pressure of 80 kPa. Determine the boundary work done during the process.

4. Helium is to be compressed from 120 kPa and 310 K to 700 kPa and 430 K using a compressor. A heat loss of 20 kJ/kg occurs during the compression process. Neglecting kinetic energy changes, determine the power input required for a mass flow rate of 90 kg/min.

5. A heat engine is operating on a Carnot cycle and has a thermal efficiency of 75%. The waste heat from this engine is rejected to a nearby lake at 15ºC at a rate of 14 kW. Determine the power output of the engine and the temperature of the source, in ºC.