

SCIENCE OLYMPIAD 2011/2012 ST. JOE'S INVITE

THERMODYNAMICS

Team: Key

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
2. In a thermodynamic system, where does energy transfer occur?
Boundaries
3. At the Critical Point 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)?
Latent
5. The state of a system depends on the path taken to reach that state. (True/False) False
6. A turbine extracts work out through having a high pressure fluid at the inlet convert to a low pressure fluid at the outlet.

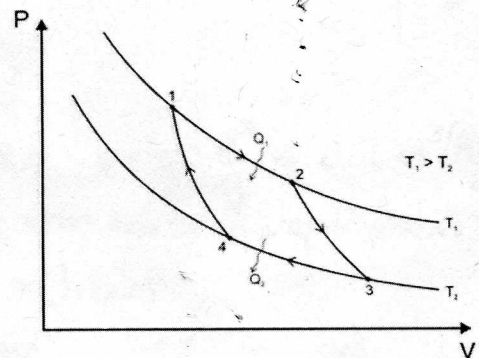
7. Label the 4 processes for a Carnot cycle:

1-2: Isothermal Heating (Expansion)

2-3: Adiabatic Expansion

3-4: Isothermal cooling (compression)

4-1: Adiabatic Compression



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

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

10. Which of the following is not a law of thermodynamics?

- If two systems are in thermal equilibrium with a third system, they are also in thermal equilibrium with each other.
- Energy can be transformed, but not created nor destroyed.
- Mass can be neither created nor destroyed.
- 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 $\rho = 13,600 \text{ kg/m}^3$).

Manometer fluid in equilibrium \Rightarrow pressure on gas by liquid = pressure of liquid on gas
Hydrostatic pressure: $P = \rho gh$

$$\text{So } P_g = \rho gh.$$

$$P_g = 80 \text{ kPa} = 80,000 \text{ Pa}$$

$$80,000 \text{ Pa} = 13,600 \frac{\text{kg}}{\text{m}^3} \cdot 9.81 \text{ m/s}^2 \cdot h$$

$$h = 0.600 \text{ m}$$

