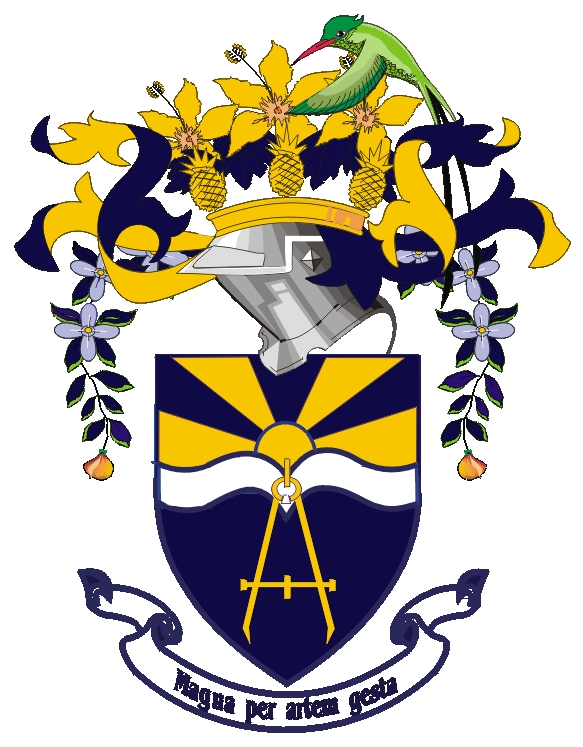
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**UNIVERSITY OF TECHNOLOGY, JAMAICA**

**COLLEGE/ FACULTY: Engineering and Computing**

**SCHOOL/ DEPARTMENT: SOE/Chemical Engineering**

**Final/ Redo Examination, Semester 1**

Module Name: Chemical Engineering Thermodynamics 1

Module Code: CHE3003

Date: December, 2011

Theory/ Practical: Theory

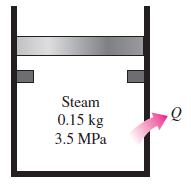
Groups: B.Eng.3C

Duration: 2 hours

**Instructions**

1. **ANSWER ALL QUESTIONS**
2. **EACH QUESTION MUST BEGIN ON A NEW PAGE**
3. **LEAVE TWO LINES BETWEEN PARTS OF A QUESTION**
4. **READ EACH QUESTION CAREFULLY BEFORE ANSWERING**
5. **SHOW CLEARLY ALL EQUATIONS USED FOR CALCULATIONS**
6. **THE INTENDED MARK IS INDICATED AT THE BEGINNING OF EACH QUESTION**
7. **ANSWER MUST BE NUMBERED IDENTICAL TO THE QUESTION BEING ANSWERED**
8. **A FORMULA SHEET AND UNIT CONVERSION ARE ATTACHED.**

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO**

**QUESTION 1 (30 Marks)**

A piston–cylinder device initially contains 0.15 kg steam at 3.5 MPa, superheated by 5°C. Now the steam loses heat to the surroundings and the piston moves down, hitting a set of stops at which point the cylinder contains saturated liquid water. The cooling continues until the cylinder contains water at 200°C. Determine:

1. the final pressure and the quality (if mixture). **[14]**
2. the boundary work. **[6]**
3. the amount of heat transfer when the piston first hits the stops. **[5]**
4. and the total heat transfer. **[5]**

**QUESTION 2 (20 marks)**

1. Consider two Carnot heat engines operating in series. The first engine receives heat from the reservoir at 1800 K and rejects the waste heat to another reservoir at temperature *T*. The second engine receives this energy rejected by the first one, converts some of it to work, and rejects the rest to a reservoir at 300 K. If the thermal efficiencies of both engines are the same, determine the temperature *T*. **[8]**
2. A 25-kg iron block initially at 350°C is quenched in an insulated tank that contains 100 kg of water at 18°C. Assuming the water that vaporizes during the process condenses back in the tank, determine the total entropy change during this process. The specific heat of water at 25°C is cp = 4.18 kJ/kg.°C. The specific heat of iron at room temperature is cp = 0.45 kJ/kg.°C **[12]**

**QUESTION 3 (25 marks)**

Using the virial equations of state, calculate the volume occupied by 23.2 g of *n*-butane at 258.3oC and 30.0 bar.

**QUESTION 4 (25marks)**

Consider a cylinder fitted with a piston that contains 2.0 mol of H2O in a container at 1000 K. Calculate how much work is required to isothermally and reversibly compress this gas from 10.0 L to1.0 L in each of the following cases:

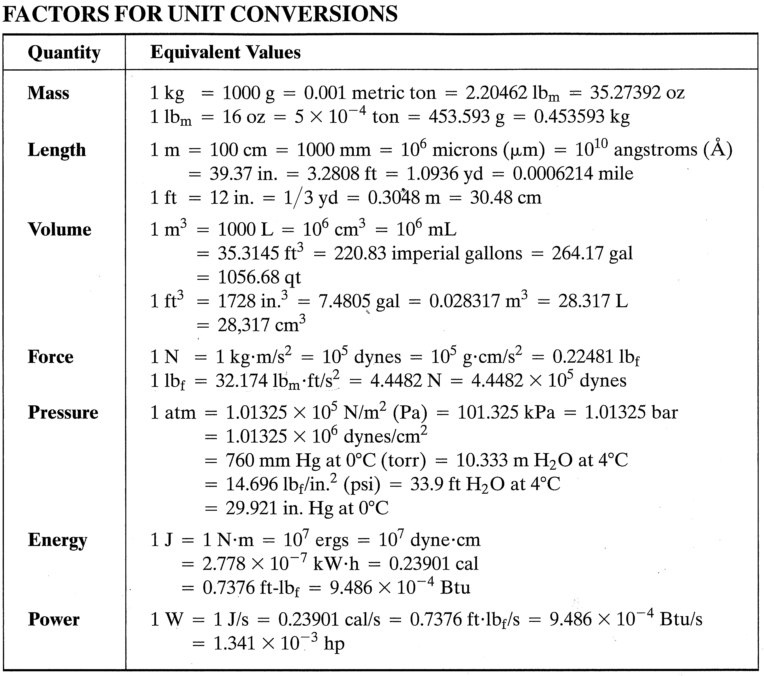
1. Using the ideal gas model for water. **[5]**
2. Using the Redlich-Kwong equation to relate P, *v,* and *T.* where *a* = 14.24 JK1/2m3/mol2 and *b* = 2.11x10-5 m3/mol **[5]**
3. Using steam tables **[15]**

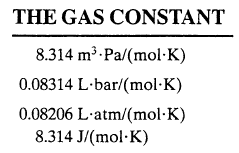
**TOTAL MARKS =100**

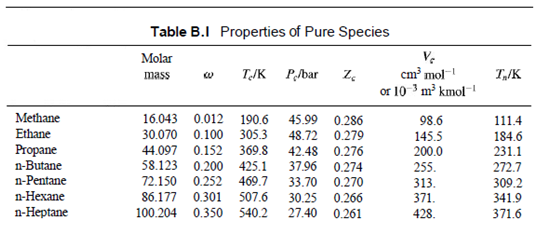
**END OF PAPER**

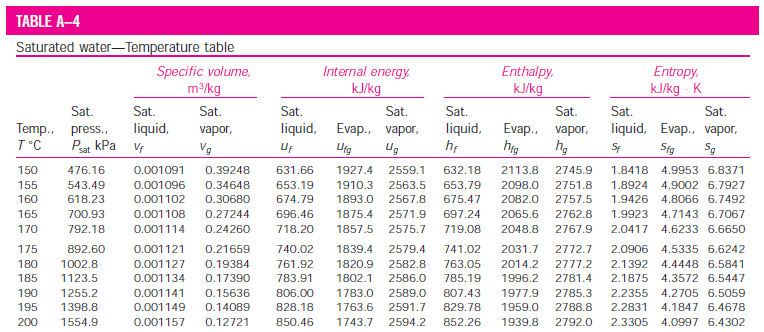
Formula Sheet

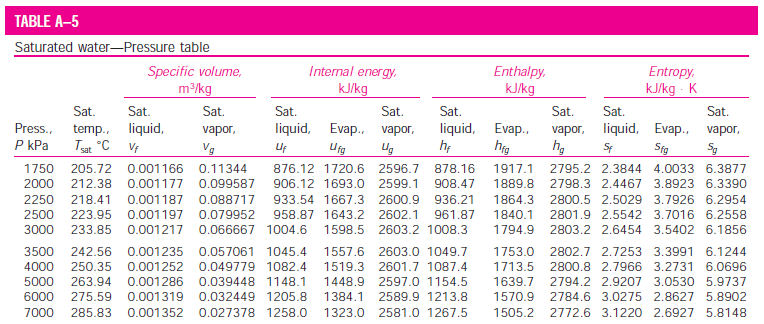
Where, *P****c*** is the critical pressure in bars and *Trn* is the reduced temperature at *Tn*

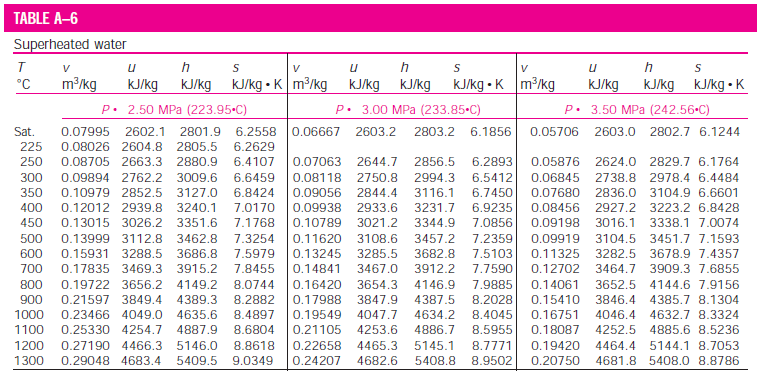
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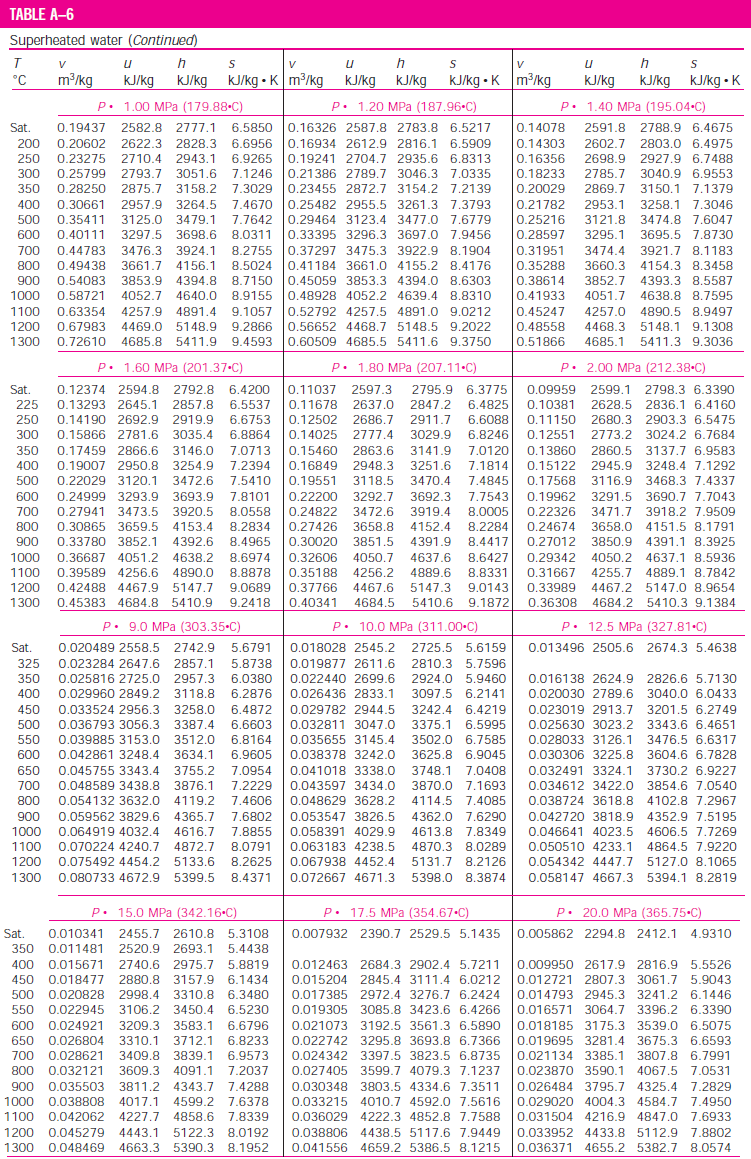
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