30.3.2016

DOON UNIVERSITY, DEHRADUN

Mid Semester Examination, Second Semester, 2015-16

Department of Physics, School of Physical Sciences

M.Sc. Physics 2 Years programme

Course: PHC-451: Thermodynamics & Statistical Mechanics

Time Allowed: 2Hours *Maximum Marks: 30*

Note: Attempt All Questions from Sections A,B,C.

SECTION: A

Attempt All Questions. *(Marks:1 X 6 =6)*

1. Which of the following is an extensive property?
   (i) Pressure (ii) Volume (iii) Gibbs Free energy (iv) Temperature
   (a) (i) and (iii) (b) (i) and (ii)
   (c) (ii) and (iii) (d) (i) and (iv)
2. If P is the pressure of an ideal gas and v is the root mean square velocity then the pressure is proportional to:
   (a) v (b) $v^{1/2}$ (c) v^2 (d) v^{-2}
3. If v is the specific volume and b is the correction in the volume term for a real gas equation then, the specific volume of the real gas at the critical condition (v_c) will be:
   (a) b/3 (b) a/b (c) 3b (d) b^3
4. Which of the following have the units of work:
   (i) TdS (ii) SdT (iii) PdV (iv) VdP (v) PdS (vi) PdT
   (a) (i), (ii), (iii) and (iv) (b) (i), (iii), (v) and (vi)
   (c) (iii), (v) and (vi) (d) (v) and (vi)
5. In a "free" adiabatic expansion the work done by the gas is:
   (a) R ln ($T_{final}/T_{initial}$) (b) R ln($T_{initial}/T_{final}$)
   (c) R ln ($V_{final}/V_{initial}$) (d) Zero
6. Which one is true of the following?
   (a) Entropy of universe always remains constant
   (b) Entropy of universe always increases
   (c) Entropy of the universe always decreases
   (d) Entropy of any part of an arbitrary system always increases.

SECTION: B

Attempt All Questions. *(Marks: 3 X 4=12)*

7. Obtain the entity RT_c/P_cv_c where, R is gas constant, T_c, P_c and v_c are critical temperature, pressure and specific volume respectively, for a real gas with the following gas equation: $(P+\frac{a}{v^2})(v-b)=RT$

8. Obtain the process equation for an ideal gas following an adiabatic process. If in a process, the Pressure is lowered by half of its initial pressure, what will be the final Volume and temperatures respectively?
9. An idea gas has P_1 and v_1 initial pressure and specific volumes, respectively. It undergoes two processes in separate experiments. The first process is adiabatic and the second one is isothermal. In both the processes, the final volume is v_2 whereas, the final pressures are P_{2s} and P_{2T}, respectively. If $v_2 > v_1$ then,
   (a) Draw the P-v diagrams for both the processes on the same graph.
   (b) Express the final pressure and temperatures using the state equation.
   (c) Calculate the work done in both the processes if γ is the ratio of the isobaric and isochoric specific heat ratios.
10. Explain the Carnote engine cycle. Hence, obtain the expression for the efficiency of the engine.

SECTION: C Attempt All Questions. ***(Marks: 6X 2=12)***

11. Using the T and v as independent variables, derive the expression for the term c_p-c_v where, c_p and c_v are specific isobaric and isochoric heats, respectively. Derive the same using the T and P independent variables. Using the above relations and the ideal gas equation, derive the Mayer's law.
12. **(a)** Show the four thermodynamic potentials as a function of two basic properties. From these relations, show all the properties as a partial derivative of the thermodynamic potentials. Also, derive the Maxwell's thermodynamic relations from this.

    (b) If decrease in the pressure at equilibrium in two phases of a component is ΔP then what will be the decrease in the transition temperature if the latent heat is L and the specific volumes are v_1 and v_2 for the two phases. Consider the phase transition is of first order.