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SE-6723

B. E. - III (Sem. V) (Chem.) Examination

May / June – 2011

Thermodynamics : Paper - I

Time : **3** Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. - 3 (Sem. 5) (Chem.)**

Name of the Subject :

☛ **Thermodynamics - 1**

☛ Subject Code No. : **6 7 2 3** ☛ Section No. (1, 2,.....) : **Nil**

Seat No. :

Student's Signature

(2) Figures to the right indicate marks.

(3) Assume suitable data if necessary and mention them clearly.

(4) Use of scientific calculator Casio fx 82, fx 83, fx 100 or equivalent of other companies is allowed.

(5) Draw neat and clean figure/diagram wherever necessary.

1 (a) Define the following : **1×6=6**

(i) Entropy

(ii) First law of thermodynamics

(iii) Irreversible process

(iv) Chemical equilibrium

(v) Phase rule

(vi) Carnot's theorem

(b) Attempt following : **2×6=12**

(i) Show that work is a path function and not a property.

(ii) Define enthalpy. Why does the enthalpy of an ideal gas depend only on temperature ?

(iii) Distinguish between "Heat engine" and "Heat pump".

(iv) Explain absolute temperature scale.

(v) Define critical temperature and critical pressure.

(vi) What is Quasi-static process.

2 Attempt any **two** : **8×2=16**

(a) Give comparison of S.F.E.E. with Euler and Bernoulli equation.

(b) P-T diagram for a pure substance

(c) Explain cyclic refrigeration

3 Attempt any **two** : **8×2=16**

(a) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and the network output of the combined engine refrigerator plant is 360 kJ.

(i) Evaluate the heat transfer to the refrigerator and the net heat transfer to the reservoir at 40°C.

(ii) Reconsider (i) given that the efficiency of the heat engine and the COP of refrigerator are each 40% of their maximum possible values.

(b) In a steam power station, steam flows steadily through a 0.2 m diameter pipeline from the boiler to the turbine. At the boiler end, the steam conditions are found to be : $p = 4$ MPa, $t = 400°\,C$, $h = 2313.6$ kJ/kg and $v = 0.073\ m^3/kg$. At the turbine end, the conditions are found to be : $p = 3.5$ MPa, $t = 392°\,C$, $h = 3202.6$ kJ/kg and $v = 0.084\ m^3/kg$. There is a heat loss of 8.5 kJ/kg from the pipeline. Calculate the steam flow rate.

(c) It is required to melt 5 tonnes/h of iron from a charge at 15°C to molten metal at 1650°C. The melting point is 1535°C, and the latent heat is 270 kJ/kg. The specific heat in solid state is 0.502 and in liquid state (29.93/ atomic weight) kJ/kg K. If an electric furnace has 70% efficiency. Find the kW rating needed. If the density in molten state is 6900 kg/m^3, and the both volume is three times the hourly melting rate, find the dimensions, of cylindrical furnace if the length to diameter ratio is 2. The atomic weight of iron is 56.

4 (a) Answer the following questions : **10**

(i) Write down fundamental property relation for a homogeneous fluid of constant composition.

(ii) What is critical point ?

(iii) Briefly explain single stage ejector.

(iv) Define volume expansivity (β). What is value of β at absolute zero temperature.

(v) The principle of refrigerator is based on which law of thermodynamics ? Write down names of at least two refrigarants ?

(b) Write a short note on Maxwell's equation. **8**

5 Answer the following : (any **two**) **16**

(a) Consider the steady state adiabatic, irreversible flow of an incompressible liquid in a horizontal pipe of constant cross sectional area. Show that :

(i) The velocity is constant

(ii) The temperature increases in the direction of flow

(b) A house has a winter heating requirement of 30 kW and a summer cooling requirement of 60 kW. Consider a heat pump installation to maintain the house temperature at 293.15 K in winter and 298.15 K in summer. This requires circulation of the refrigerant through interior exchanger coils at 303.15 K in winter

and 278.15 K in summer. Underground coils provide the heat source in winter and heat sink in summer. For a year round ground temperature of 288.15 K, the heat transfer characteristics of the coils necessitate refrigerant temperatures of 283.15 K in winter and 298.15 K in summer. What are the minimum power requirements for winter heating and summer cooling ?

(c) Write a short note on compression processes.

6 Answer the following : (any **two**) **16**

(a) Derive Clausius-Clapeyron equation.

(b) Write a short note on vapor compression refrigeration cycle.

(c) Write a short note on choice of refrigerant. Briefly explain two stage cascade refrigeration system.
