

Total Pages—6

(Set-Q<sub>1</sub>)

**B.Tech-3rd (M & M)**

**Metall. Thermodynamics and Kinetics**

*Full Marks : 70*

*Time : 3 hours*

**Q. No. 1 is compulsory and answer any five from the rest**

*The figures in the right-hand margin indicate marks*

All parts of a question should be answered at one place

1. Answer *all* questions : 2 × 10

(a) State Raoult's law of ideal solution.

(b) Calculate the entropy increase when one mole of ice melts water at 0 °C.

Given :  $\Delta H = 6.02 \text{ kJ mol}^{-1}$  (latent heat of fusion of water).

(c) Differentiate between intensive and extensive properties.

(d) State the zeroth law of thermodynamics.

( Turn Over )

- (e) State Gibb's phase rule for metallurgical system for condensed phase.
  - (f) Differentiate between reversible and irreversible process.
  - (g) State the different postulates of statistical thermodynamics.
  - (h) Define activation energy of a reaction.
  - (i) Define state function. Provide two examples of state function.
  - (j) Differentiate among open, closed and isolated system with suitable examples.
2. (a) Prove that :

$$C_p - C_v = R$$

For an ideal gas under isothermal condition and constant pressure

where,

$C_p$  is heat capacity at constant pressure,  
 $C_v$  is heat capacity at constant volume,  $R$  is universal gas constant.

- (b) Prove that for an ideal gas, under isothermal condition. 5

$$q = RT \ln(V_f/V_i)$$

where,

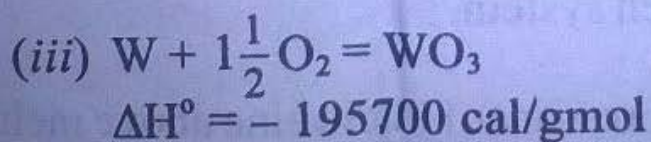
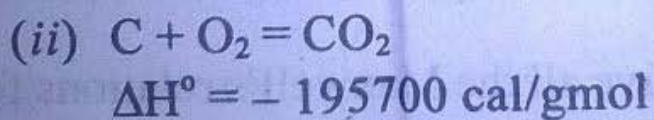
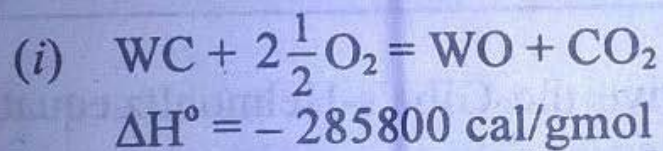
$V_f$  is the final volume of the system,

$V_i$  is the initial volume of the system,

$q$  is the heat supplied to the system

3. (a) State Hess's law. Explain the law with requisite illustration. 5

- (b) Calculate the enthalpy of formation of WC from the following data at 25 °C : 5



4. (a) "The entropy of a system in isolation can never decrease." Give a mathematical explanation to above statement. 6

(b) Calculate the entropy change for the reaction.



At 298 K. Given the standard values of the entropy is at 298 K for various compounds are :

4

Substance	Values of entropy
$\text{Fe}_2\text{O}_3$	21.4 cal/°C/mol
C	49.5 cal/°C/mol
Fe	32.63 cal/°C/mol
CO	47.3 cal/°C/mol

5. (a) (i) Derive the Gibb's-Helmholtz equation for free energy.

4

(ii) Derive all the Maxwell's relations for a given system.

3

(b) Vapour pressure of liquid zinc above melting point of 420 °C is given by :

$$\log(P_{\text{Zn}}) = \frac{6400}{T} + 5.5$$

The heat of fusion of Zn is 1600 cal/g atom for above the melting point and it is 1400 cal/g atom below its melting point. Derive a formula for vapour pressure over solid zinc below its melting point. 3

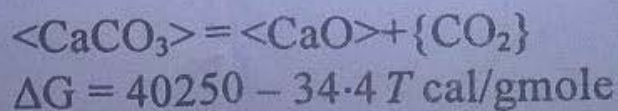
6. (a) (i) State Sievert's law. 2

(ii) Molten alloy steel was found to contain 10 ppm hydrogen when inside the furnace where the ambient partial pressure of hydrogen was 0.2 atm. The steel must contain only 1 ppm before it solidifies. To what vacuum pressure it must be exposed before casting. 3

(b) Prove that  $\delta q$  is not perfectly differentiable but  $(\delta q/T)$  is perfectly differentiable. 5

7. (a) With the help of Ellingham diagram, comment on carbothermic reduction of metal oxide. 5

(b) The free energy of the reaction :



( 6 )

What is the highest temperature at which the reaction will not occur in open atmosphere.

5

8. Write short notes on any *four* :

$2\frac{1}{2} \times 4$

- (i) Activated complex theory
  - (ii) Chemical potential
  - (iii) Nernst equation
  - (iv) Clausius-Clapyeron equation
  - (v) Henry's law.
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