Problem Set 1

Thermodynamics

1. Assuming Ideal Behaviour, Claculate the work done when 1.6 mole of Water evaporates at 373 K against Atmospheric Pressure.

2. 5 L cylinder contains 10 M of N_2 Gas at 27°C. If the whole gas escapes into the atmosphere, how much work done by the gas?

3. A gas expands by 0.5 L against constant external pressure of 1 Atm. Calculate the work done in J and cal.

4. What is the work done on the gas when 10 m^3 of it is compressed to 5m3 under constant pressure of 10^3 kPa.

5. A system gives out 20 J of Heat and also does 40 J of work. What is the internal energy change?

6. 200 J work is done on the system and at the same time 140 J heat is given out. What is the change of Internal Energy.

7. A gas absorbs 125 J of heat and expands against the external pressure of 1.2 atm from a volume of 0.5 L to 1 L. What is the internal energy change.

8. 3 mole of ideal gas is heated at constant pressure from 27°C to 127°C. i) Calculate the work of expansion. ii) If the gas is expands isothermally in a reversible manner at 27oC from 1 atm to 0.7 atm, calculate the work done.

9. Camculate w, q, ▲U when 0.75 mole of ideal gas is expanded isothermally and reversibly, at 300 K from 18 L to 30 L.

10. The enthalpy Change for a reaction

    $CH_4+Cl_2= CH_3Cl+HCl$ ▲H= -115 kJ/mol

What is the amount of heat evolve/absorb when 2.525 kg of CH_3Cl is produced? How many moles of Cl_2 will be consumed?

11. A piece of Metal weighing 1 g requires 6.8 J of Heat to raise the temperature by 1°C. Calculate the heat needed for 200 g metal to be heated from 20°C to 30°C.

12. 5.6 dm^3 of an unknown gas at STP requires 52.25 J of heat to raise its temperature by 10oC at constant volume. Calculate C_p, C_v.

13. 0.25 g Diamond is burnt is a bomb caloriemeter in excess of O_2. If the heat capacity is 6.52 kJ/K, then what is the heat of the reaction? Given, The temperature rise of the system is from 20°C to 21.26°C.

14. 0.08 g of Glucose ($C_6H_{12}O_6$) is burnt in a bomb caloriemeter to find out that the teperature has been changed from 25.11°C to 27.21°C. If the heat of reaction is -2803 kJ/mol, calculate the C_v of the bomb Caloriemeter.

15. 20 g of NH4NO3 is dissolved in 250 g of H2O in a coffee cup caloriemeter where no heat is absorbed by the caloriemeter. The temperature fall is recorded from 303.1 K to 298 K. Calculate the heat absorbed/released when heat capacity of water is 4.2 J/K-g.

16. 1.922 g of Methanol (CH_3OH) was burnt in a constant volume bomb caloriemeter immeresed in 2 kg of Water. After the reaction, the temperature of Water is rose by 4.2 K. If the heat capacity of Caloriemeter is 2.02 kJ/K and specific heat capacity of water is 4.2 J/K-g, calculate the enthalpy of the reaction.

17. Find out which one is the heat of Formation of $CaCO_3$.

i) $Ca^{++}(l) + CO_3^=(l) = CaCO_3$ ▲H= -x kJ/mol

ii) $Ca + C + 3/2O_2 = CaCO_3$ ▲H= -y kJ/mol

iii) $CaO(s) + CO_2(g) = CaCO_3$ ▲H= -z kJ/mol

18. Calculate the heat of Reaction of the following equation: $2H_2S + 3O_2 = 2H_2O + 2SO_2$

Given heat of formation of H_2S, H_2O & SO_2 are -20.17, -286 and -296.9 kJ/mol respectively.

19. Entropy change of Vaporization of Acetone is 93 J/K-mol. If the boiling point of Acetone is 56°C then find out the heat required for vaporization of 1g of Acetone. Molecular Formula of Acetone is CH_3COCH_3.

20. Fusion of 0°C ice is having latent heat 334.72 J/g. Find out the entropy of the change. MW of ice is 18.

21. Vaporization of Water at 373 K, Latent heat is 2.52 kJ/g. Find out the Entropy change.

22. 1 mole of water is formed under standard condition of 298 K. If the heat of formation is -286 kJ/mol what is the change of Entropy?

23. 150 J of heat flows out of a large reservoir of water having 500 liter of water at 35°C, while surrounding is having temperature 25°C. If the transfer results no significant changes in temperature the calculate entropy change for the system, surrounding and the total.

24. Find out whether of not Carbon reduction is possible for MgO from given Data, at 298 K.

    H_r= +491.18 kJ/mol and S_r= 197.67 J/K-mol.

Above or below what temperature this would have been possible?

25. Calculate the change of free energy for dissolution of KNO_3 at RT (298 K). Heat of reaction= 34 kJ/mol, Entropy change= 0.116 kJ/mol-K.

26. Find out equilibrium temperature for the reaction $Ag_2O=2Ag+1/2\ O_2$. Given dH=30.56 kJ/mol and dS=0.066 kJ/mol-K. What happens if We keep the reaction below the equilibrium temperature?

27. At 25°C, dH of Fusion of a certain ice is 6.97 kJ/mol and dS= 25.4 J/mol-K. Calculate the free energy of the system for melting and predict if the ice will melt at that temperature?

28. Calculate the tem kJ/mol above which Carbon reduction of lead Oxide is spontaneous.

PbO+C=Pb+CO, dH=108.4 kJ/mol, dS=190 J/mol-K.

29. For a hypothetical reaction, nX=mP. dH=-113.kJ/mol, dS=190 J/mol-K.

Find out dG at 700 K and value of dS_{total} & dS_{Surr}.

30. Calculate the dG for the reaction given as $4NH_3+5O_2=4NO+6H_2O$

Given, dG for NH3, H2O and NO are -16.3, -237 and 86.5 kJ/mol.

31. dH of combustion of Methanol is -726 kJ/mol. Calculate the dG of the Combustion and efficiency of the reaction if given dG of formation of Methanol, CO_2 and Water are -166.2, -394.4 and -237.2 kJ/mol respectively.

$CH_3OH+3/2O_2=CO_2+2H_2O$.