Previous HSE Questions from the chapter "THERMODYNAMICS"

1. Differentiate state functions from path functions and give one example for each. (2)
2. First law of thermodynamics can be stated as $\Delta U = q + w$. How can this equation be expressed for :
   a) An isothermal reversible change?
   b) A process carried out at constant volume? (2)
3. Enthalpies of formation of some compounds are given below :

Compound	CO	CO_2	N_2O	N_2O_4
Enthalpy of formation (kJ/mol)	-110.0	-393.0	81.0	9.7

   Using these data, calculate the enthalpy of reaction for

   $N_2O_4(g) + 3CO(g) \longrightarrow N_2O(g) + 3CO_2(g)$ (3) [August 2018]
4. What is meant by entropy of a system? What happens to the entropy during the following changes?
   a) A gas condenses into liquid.
   b) $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$ (2)

5. Write the thermochemical equation corresponding to the standard enthalpy of formation of benzene.
   [Hint; $\Delta_f H^0$ of benzene = + 49.0 $kJmol^{-1}$) (2)
6. The reaction of cyanamide (NH_2CN) with dioxygen was carried out in a bomb calorimeter and ΔU was found to be -7 42.7 kJ mol^{-1}, at 298K. Calculate enthalpy change for the reaction at 298 K.

   $$NH_2CN_{(g)} + \frac{3}{2} O_{2(g)} \rightarrow N_{2(g)} + CO_{2(g)} + H_2O_{(l)}$$ (3) [March 2018]
7. a) i) State Hess's law.
   ii) Calculate $\Delta_f H^0$ when diamond is formed from graphite.
   C(diamond) + $O_2 \longrightarrow CO_2(g)$; $\Delta_C H^0$ = -395 kJ
   C(graphite) + $O_2 \longrightarrow$ CO2(g); $\Delta_C H^0$ = -393.5 kJ (3)
   b) An extensive property is.....
   i) density ii) pressure iii) temperature iv) mass (1) [July 2017]
8. a) Some macroscopic properties are given below. Help Reena to classify them into two groups under suitable titles.
   [Heat capacity, Entropy, Refractive index, Surface tension] (2)
   b) For the reaction $2A(g) + B(g) \longrightarrow 2D(g)$, ΔU^0 = -10.5 kJ/mol, ΔS^0 = -44.1 J/K/mol at 298K. Calculate ΔG^0 for the reaction. (2) [March 2017]
9. a) Which of the following is a process taking place with increase in entropy?
   i) Freezing of water ii) Condensation of steam iii) Cooling of a liquid iv) Dissolution of a solute (1)

   b) State and illustrate Hess's law. (3) [September 2016]
10. The enthalpy change in a process is the same, whether the process is carried out in a single step or in several steps.
    a) Identify the law stated here. (1)
    b) Calculate the enthalpy of formation of CH_4 from the following data:
    i) $C(s) + O_2(g) \rightarrow CO_2(g)$; ΔH = -393.7 kJ/mol
    ii) $H_2(g) + ½ O_2(g) \rightarrow H_2O(l)$; ΔH = -285.8 kJ/mol
    iii) $CH_4(g) + 2 O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; ΔH = -890.4 kJ/mol (3) [March 2016]
11. Expansion of a gas in vacuum is called free expansion.
    a) Which one of the following represents free expansion of an ideal gas under adiabatic conditions?

i) $q = 0, \Delta T \neq 0, w = 0$ ii) $q \neq 0, \Delta T = 0, w = 0$ iii) $q = 0, \Delta T = 0, w = 0$ iv) $q = 0, \Delta T < 0, w \neq 0$ (1)

b) The enthalpy change for the reaction $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$ is -91.8 kJ at 298 K. Calculate the value of internal energy change. ($R = 8.314\ JK^{-1}\ mol^{-1}$) (3) [Oct. 2015]

12. a) Classify the following into intensive and extensive properties.
    i) Internal energy ii) Density iii) Heat capacity iv) Temperature (2)

    b) Calculate the standard free energy (ΔG^0) for the conversion of oxygen to ozone $3/2\ O_2(g) \rightarrow O_3(g)$ at 298K, if the equilibrium constant for the conversion is 2.47×10^{-29}. (Given $R = 8.314\ JK^{-1}mol^{-1}$). (2) [March 2015]

13. a) ΔG gives a criterion for spontaneity of reactions at a constant pressure and temperature. How is ΔG helpful in predicting the spontaneity of the reaction? (2)

    b) State and explain Hess's law of constant heat summation. (2) [August 2014]

14. a) For the oxidation of iron $4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2Fe_2O_{3(s)}$, entropy change ΔS is -549.4 J/K/mol at 298K. Inspite of the negative entropy change of this reaction, why is the reaction spontaneous? ($\Delta_r H^0$ for the reaction is -1648×10^3 $Jmol^{-1}$). (2)

    b) Write the differences between extensive and intensive properties. Give one example of each. (2) [March 2014]

15. a) The enthalpy of combustion of $CH_{4(g)}$, C(graphite) and $H_{2(g)}$ at 298K are -890.3 kJ mol^{-1}, -393.5 kJ mol^{-1} and -285.8 kJ mol^{-1} respectively. Calculate the enthalpy of formation of $CH_{4(g)}$. (2)

    b) Match the following:

1. $W = -\Delta U$	a) Enthalpy change
2. $\Delta U = 0$	b) Universal gas constant
3. $C_p - C_v$	c) Adiabatic process
4. q_P	d) Isothermal process
	e) Cyclic process

(2) [September 2013]

16. Most of the naturally occurring processes are spontaneous.
    a) Give the criteria for spontaneity of a process in terms of free energy change (ΔG). (1)
    b) Exothermic reactions associated with a decrease in entropy are spontaneous at lower temperatures. Justify on the basis of Gibbs equation. (1)
    c) Find the temperature above which the reaction $MgO_{(s)} + C_{(s)} \rightarrow Mg_{(s)} + CO_{(g)}$ becomes spontaneous. (Given $\Delta_r H^0 = 490\ kJ\ mol^{-1}$ and $\Delta_r S^0 = 198\ JKmol^{-1}$). (2) [March 2013]

17. a) Construct an enthalpy diagram for the determination of lattice enthalpy of sodium chloride. (2)

    b) Enthalpy and entropy changes of a reaction are 40.63 kJ/mol and 108.8 J/K/mol. Predict the feasibility of the reaction at 27^0C. (2) [September 2012]

18. a) Explain the Hess's law of constant heat summation, with an example. (2)

    b) Draw the enthalpy diagram for exothermic and endothermic reactions. (2) [September 2012]

19. Thermodynamics deals with energy changes of macroscopic systems.
    a) Consider a chemical reaction taking place in a closed insulated vessel. To which type of thermodynamic system does it belong? (1)
    b) State the first law of thermodynamics. (1)

c) 3 mol of an ideal gas at 1.5 atm and 25^0C expands isothermally in a reversible manner to twice its original volume against an external pressure of 1 atm. Calculate the work done. (R = 8.314 $JK^{-1}mol^{-1}$) (2) [March 2012]

20. A spontaneous process is an irreversible process and may only be reversed by some external agency.
    a) Decrease in entropy is the only criterion for spontaneity. Do you agree? Why? (2)
    b) Calculate the work done for the reversible isothermal expansion of 1 mole of an ideal gas at 27^0C, from a volume of 10 dm^3 to a volume of 20 dm^3. (2) [October 2011]
21. The spontaneity of a process is expressed in terms of a change in Gibbs energy.
    a) What is mean by change in Gibbs energy of a system? (1)
    b) How is it related to the enthalpy and entropy of a system? (1)
    c) How is it useful in predicting the feasibility of a process? (2) [March 2011]
22. Lattice enthalpy of an ionic salt is a factor that determines its stability.
    a) Define the lattice enthalpy. (1)
    b) Draw the Born-Haber cycle for the calculation of lattice enthalpy of the ionic crystal NaCl. (3) [September 2010]
23. A system in thermodynamics refers to that part of the universe in which observations are made.
    a) What do you mean by an isolated system? Give an example. (1)
    b) Distinguish between intensive and extensive properties. Give two examples for each. (3) [March 2010]
24. a) State Hess's law of constant heat summation. (2)
    b) The equilibrium constant for a reaction is 5. What will be the value of ΔG^0? Given that R = 8.314 J/K/mol, T = 300K. (2) [March 2009]
25. Some properties are "state functions".
    a) q and w are not state functions, but (q+w) is a state function. Why? (1)
    b) What do you mean by saying that pressure is an intensive property? (1)
    c) What is the difference in internal energy of a system, if 100 kJ of energy is radiated out without doing any work? (1) [February 2008]

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