विद्या सर्वार्थि साधिका

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PERIODIC TEST -3

Class: XI

Subject: Chemistry MM : 40

Date : 13-01-2025 Time: 1 Hr. 30 min.

General Instructions:

(1) There are 20 questions in all. All questions are compulsory.

(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.

(3) Section A consists of twelve MCQs of 1 mark each, Section B consists of two questions of 2 marks each, Section C consists of two questions of 3 marks each, Section D consists of two long questions of 5 marks each and Section E consists two case study-based questions of 4 marks each.

(4) There is no overall choice. However, an internal choice has been provided in section D and E. You have to attempt only one of the choices in such questions.

(5) Use of calculators is not allowed.

SECTION A

1. Two substances, A and B, which are of equal mass but at different temperatures, come into thermal contact. The specific heat capacity of substance A is twice the specific heat capacity of substance B. Which statement is true of the temperature of the two substances when they reach thermal equilibrium? (Assume no other heat loss other than the thermal transfer between the substances.) (1)

   (A) The final temperature of both substances is closer to the initial temperature of substance A than to the initial temperature of substance B.

   (B) The final temperature of both substances is closer to the initial temperature of substance B than to the initial temperature of substance A.

   (C) The final temperature of both substances is exactly midway between the initial temperatures of substance A and substance B.

   (D) The final temperature of substance B is greater than the final temperature of substance A.

2. A cylinder with a moving piston expands from an initial volume of 0.250 L against an external pressure of 2.00 atm. The expansion does 288 J of work on the surroundings. What is the final volume of the cylinder? (1)

   (A) 1.42 L (B) 1.17 L (C) 144 L (D) 1.67 L

3. Which statement is true for the freezing of liquid water below 0 °C? (1)

   (A) ΔH is positive; ΔS is negative; ΔG is negative

   (B) ΔH is negative; ΔS is negative; ΔG is negative

   (C) ΔH is positive; ΔS is positive; ΔG is positive

   (D) ΔH is positive; ΔS is negative; ΔG is positive

4. For a certain reaction $\Delta H°_{rxn} = -255$ kJ and $\Delta S°_{rxn} = 211$ J/K. Calculate $\Delta G°_{rxn}$ at 55 °C. (1)

   (A) 11.9×10^3 kJ (B) 69.5×10^3 kJ (C) – 267 kJ (D) –324 kJ

5. Under which set of conditions is ΔG_{rxn} for the reaction $A(g) \rightleftharpoons B(g)$ most likely to be negative? (1)

   (A) $P_A = 10.0$ atm; $P_B = 10.0$ atm

   (B) $P_A = 10.0$ atm; $P_B = 0.010$ atm

   (C) $P_A = 0.010$ atm; $P_B = 10.0$ atm

   (D) $P_A = 0.010$ atm; $P_B = 0.010$ atm

6. The decomposition of NH_4HS is endothermic: $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$. Which change to an equilibrium mixture of this reaction results in the formation of more H_2S? (1)
(A) a decrease in the volume of the reaction vessel (at constant temperature)
(B) an increase in the amount of NH_4HS in the reaction vessel
(C) an increase in temperature (D) all of the above

7. For the reaction $2A(g) \rightleftharpoons B(g)$, the equilibrium constant is Kp = 0.76. A reaction mixture initially contains 2.0 atm of each gas (P_A = 2.0 atm and P_B = 2.0 atm). Which statement is true of the reaction mixture? (1)
(A) The reaction mixture is at equilibrium.
(B) The reaction mixture will proceed toward products.
(C) The reaction mixture will proceed toward reactants.
(D) It is not possible to determine from the information given the future direction of the reaction mixture.

8. Which compound will form an acidic solution when dissolved in water? (1)
(A) NH_4Cl (B) NaCl (C) KNO_2 (D) $Ca(NO_3)_2$

9. The solubility of BaSO4 in water is 2.42×10^{-3} gL^{-1} at 298 K. The value of its solubility product (Ksp) will be (Given molar mass of $BaSO_4$ = 233 g mol^{-1}) (1)
(A) 1.08×10^{-10} mol^2L^{-2} (B) 1.08×10^{-12} mol^2 L^{-2}
(C) 1.08×10^{-14} mol^2 L^{-2} (D) 1.08×10^{-8} mol^2 L^{-2}

10. Conjugate bases for Bronsted acids H_2O and HF are _____ respectively. (1)
(A) OH^- and F^- (B) H_3O^+ and H_2F^+ (C) OH^- and H_2F^+ (D) H_3O^+ and F^-

For question numbers 11 and 12, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.
(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion
(B) Both Assertion and Reason are true but Reason is NOT the correct explanation of Assertion.
(C) Assertion is true but Reason is false
(D) Assertion is false but Reason is true.

11. **(A):** Heat of neutralization of HCl and NaOH is same as that of H_2SO_4 with NaOH. (1)
(R): HCl, H_2SO_4 and NaOH are all strong electrolytes.

12. **(A):** For any chemical reaction at a particular temperature, the equilibrium constant is fixed and is a characteristic property. (1)
(R): Equilibrium constant is independent of temperature.

SECTION B

13. Assign proper sign to q and w in the following cases: (2)
(i) A system transfers 10 kJ of energy to the surroundings.
(ii) Surroundings transfer 25 kJ of energy to the system.
(iii) 15 kJ of energy is transferred to the system by doing work on it.
(iv) 30 kJ of energy is lost by the system on account of the work done by the system on the surroundings.

14. Write four characteristics of equilibrium constant (Kc). (2)

SECTION C

15. Consider the reaction for the decomposition of carbon tetrachloride gas: (3)

$$CCl_4(g) \rightarrow C\ (s,\ graphite) + 2\ Cl_2(\ g)\quad \Delta H = +95.7\ kJ;\ \Delta S = +142.2\ J/K$$

(a) Calculate ΔG at 25 °C and determine whether the reaction is spontaneous.

(b) If the reaction is not spontaneous at 25 °C, determine at what temperature (if any) the reaction becomes spontaneous.

16. (i) Arrange the following in increasing order of pH: (3)
KNO_3 (aq), CH_3COONa (aq), NH_4Cl (aq), $C_6H_5COONH_4$ (aq)
(ii) The value of Kc for the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ is 1×10^{-4} At a given time, the composition of reaction mixture is [HI] = 2×10^{-5} mol, [H_2] = 1×10^{-5} mol and [I_2] = 1×10^{-5} mol. In which direction will the reaction proceed?

SECTION D

17. Use the following data to calculate $\triangle_{lattice}H^\circ$ for NaBr. $\triangle_{sub}H^\circ$ for sodium metal = 108.4 kJ mol^{-1}, Ionization enthalpy of sodium = 496 kJ mol^{-1}, Electron gain enthalpy of bromine = –325 kJ mol^{-1}, Bond dissociation enthalpy of bromine = 192 kJ mol^{-1} $\triangle_fH\circ$for NaBr(s) = – 360.1 kJ mol–1 (5)

OR

Calculate the enthalpy of formation of carbon disulfide given that the enthalpy of combustion of it is 110.2 kJ mol^{-1} and those of sulphur and carbon are 297.4 kJ and 394.5 kJ/g atoms respectively.

18. At 473 K, equilibrium constant Kc for decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3}. If decomposition is depicted as, (5)

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2 \quad \Delta_rH = 124.0 \text{ kJ mol}^{-1}$$

(i) Write an expression for Kc for the reaction.
(ii) What is the value of Kc for the reverse reaction at the same temperature?
(iii) What would be the effect on Kc if:
(a) more PCl_5 is added (b) pressure is increased (c) the temperature is increased?
(iv) What is common ion effect? Illustrate with an example.

SECTION E

Questions 19 and 20 are Case Study Based questions and are compulsory. Each question carries 4 marks.

19. Read the passage given below and answer the following questions.
The solubility Product Theory: In the traditional theory, it is supposed that in any solution of an electrolyte there is an equilibrium between dissolved but undissociated electrolyte and the free ions:

$$MA \rightleftharpoons M^+ + A^-$$

and hence by the Mass Action Law, in its simple form,

$$[M^+]\,[A^-] = K[MA]$$

where [M+] and [A–] are the concentrations of the ions and [MA] is the concentration of the undissociated molecules. In a saturated solution at fixed temperature and pressure, the quantity [MA], is assumed to be a constant, the subscript "s" denoting the condition of saturation. This quantity is called the molecular solubility and its constancy is assumed to hold independently of the presence of any other electrolyte (referred to below as the added electrolyte). It follows that the product $[M^+][A^-]$ is also a constant and is called the solubility product:

$$[M^+] \,.\, [A^-] = s \quad ...(i)$$

There are thus three assumptions in the derivation: (1) that the equilibrium between ions and undissociated molecules in solution actually occurs; (2) that the simple Mass Action Law in terms of concentrations can be applied to this equilibrium; and (3) that the concentration [MA], of the undissociated part of the solute in a saturated solution is unchanged by the addition of other electrolytes.
(i) Write the correct representation for the solubility product of SnS_2. (1)
(ii) Write the expression for the solubility product of Hg_2Cl_2 in terms of its molar solubility, S. (1)

(iii) What will be the correct condition of precipitation formed when solutions of $BaCl_2$ and Na_2SO_4 are mixed? (2)

OR

(iii) Why is group 2 of qualitative analysis, solution is acidified with HCl before passing H_2S gas?

20. Gibbs free energy (G) is a measure of the maximum available work that can be derived from any system under conditions of constant temperature (T) and pressure (P). G is a thermodynamic "state function", i.e., an equilibrium property that depends only upon the conditions—such as T, P and electrical, magnetic and gravitational fields—imposed on the system being considered, and not on that system's past history. Since absolute G values cannot be determined, changes in G as a system goes from one state to another become the main focus of attention. These ΔG ("delta-G") values are highly informative. If ΔG = G (final state) − G (initial state) is negative, the process observed liberates energy: it will occur spontaneously and can be harnessed to do useful work. For chemical changes, tabulated standard free energy values can be used to predict the direction and energy yield of a particular reaction. For example, it's easy to calculate that if one burns a mole (114 g) of isooctane to carbon dioxide and water, a total of 5226 kJ (kilojoules) of Gibbs free energy will be released, i.e., $\Delta G = -5226$ kJ/mol. This large negative value predicts a spontaneous process that proceeds completely to products. Performed in an internal combustion engine, about one-third of the ΔG will be recovered. A substantially larger fraction could be extracted by a fuel cell.

(i) Write the correct representation of Gibbs Helmholtz equation. (1)

(ii) What will be the value of ΔG at equilibrium? (1)

(iii) Why G is a thermodynamic state function? (2)

OR

(iii) The enthalpy and entropy changes for the equation $C(s)\ \text{diamond} + O_2(g) \rightarrow CO_2(g)$ at 25°C and 1 atm, are $-393.4\ kJmol^{-1}$ and $0.006\ kJmol^{-1}$ respectively. Is the conversion of diamond to CO_2 at room temperature a spontaneous process?