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Class XI	Department of Science 2021-2022 SUBJECT : CHEMISTRY	Date of Submission: 13.12.2021
Work sheet No.: 10 WS WITH ANSWERS	Chapter: Thermodynamics	Note: A4 File format
Name of the student:	Class & Section:	Roll No.

Objective type Questions (1 mark)

1. For the reaction $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$ which of the following is valid?
   (a) $\Delta H = \Delta U$
   (b) $\Delta H > \Delta U$
   (c) $\Delta H < \Delta U$
   (d) None of the above

2. Predict the sign of ΔS^0 for the following reaction:
$$2H_2S_g + 3O_{2_g} \rightarrow 2H_2O_g + 2SO_{2_g}$$

3. Which of the following equations represents enthalpy of formation of H_2O ?
   (a) $2H_2(g) + O_{2\,(g)} \longrightarrow 2H_2O_{(l)};\ \Delta H = -ve$
   (b) $2H_2O_{2(g)} \longrightarrow 2\ H_2O_{(l)} + O_{2(g)};\ \Delta H = +ve$
   (c) $H_{2(g)} + \frac{1}{2}\ O_{2(g)} \longrightarrow H_2O_{(l)}\quad \Delta H = +ve$
   (a) $2H_2O_{(g)} \longrightarrow 2H_{2(g)} + O_{2(g)}\ ;\ \Delta H = +ve$

4. The equation representing the combustion of Carbon and Carbon monoxide are
   $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}\ \Delta H = -394$ kJ/mol
   $CO_{(g)} + \frac{1}{2}\ O_2(g) \longrightarrow CO_{2(g)}\ \Delta H = -284.5$ kJ/mol
   The heat of formation of 1 mol of $CO_{(g)}$ is:
   (a) -109.5 kJ/mol
   (b) +109.5 kJ/mol
   (c) +180 kJ/mol
   (d) +100 kJ/mol

5. ΔH for the combustion of the compound is
   (a) Positive
   (b) Zero
   (c) Negative
   (d) May be positive or negative

Assertion – Reason type Questions (1 mark)

(A) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(B) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
(C) Assertion is correct, but reason is wrong statement.
(D) Assertion is wrong, but reason is correct statement.

6. Assertion: Enthalpy of combustion is always negative.
   Reason: Combustion reaction proceeds with evolution of heat

7. Assertion: Both internal energy and enthalpy are state functions
   Reason: Internal energy and enthalpy are extensive properties

8. Assertion: Many endothermic reactions which are non-spontaneous at room temperature become spontaneous on increasing the temperature
   Reason: Endothermic reactions become spontaneous at high temperatures if ΔS is +ve and $T\Delta S > \Delta H$

   Paragraph -based Questions

   .
9. The enthalpy change of reaction remains the same irrespective of the number of steps is Hess's law. It helps to calculate the enthalpy of formation, combustion, and other enthalpy changes. Enthalpy change can also be calculated by using bond enthalpies. The first law gives the law of conservation of energy but does not give the direction of the reaction. The second law states, the entropy of the universe is continuously increasing due to spontaneous processes taking place in it. ΔH and ΔS (entropy change) cannot decide the spontaneity of the process. We need ΔG (free energy change) which is –ve for spontaneous, +ve for non-spontaneous. $\Delta G = 0$ for the process in equilibrium. ΔG is related to the equilibrium constant. If $\Delta G = $ –ve, 'K' is +ve and vice versa. The third law of thermodynamics states the entropy of a perfectly crystalline substance is zero at zero kelvin

   I Born Haber cycle helps in calculating -------------------

   II ΔH_f° of O_3, CaO, NH_3, and HI are +142.2, – 643.9, –46, +25.95 kJ mol^{-1}. Arrange

   these in increasing order of stability.

   III What are the signs of ΔH and ΔS for the process to be always spontaneous?

   IV Give the mathematical expression for the second law of thermodynamics.
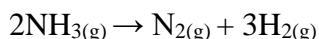
Short Answer Type – 1 Questions

10. a) For the reaction,

N_2 (g) + 3H$_2$ (g) →2NH$_3$ (g) ΔH = -95kJ and ΔS = -200JK^{-1}

Calculate the temperature at which Gibbs energy change is equal to zero.

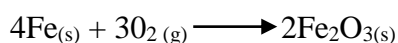11. Change in internal energy is a state function while work is not, why?

12. The value of $\Delta_fH^\ominus$ for NH$_3$ is – 91.8 kJ mol–1. Calculate enthalpy change for the following reaction:

2NH$_{3(g)}$ → N$_{2(g)}$ + 3H$_{2(g)}$

Short Answer Type – 1I Questions

13. a. For a reaction, ΔH is –ve, ΔS is +ve. Is this reaction spontaneous?
    b. The standard heat of formation of Fe$_2$O$_3$ (s) is 824.2kJ mol^{-1} Calculate heat change for the reaction.
       4Fe$_{(s)}$ + 3O$_{2\ (g)}$ ⟶ 2Fe$_2$O$_{3(s)}$
14. An ideal gas is allowed to expand against a constant pressure of 2 bar from 10 L to 50 L in one step. Calculate the amount of work done by the gas.
15. The net enthalpy change of a reaction is the amount of energy required to break all the bonds in reactant molecules minus amount of energy required to form all the bonds in the product molecules. What will be the enthalpy change for the following reaction?
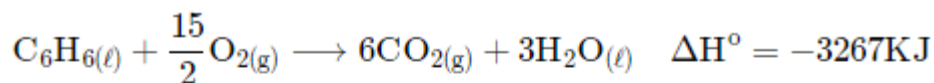   H$_2$(g) + Br$_2$(g) → 2HBr(g)
    Given that Bond energy of H$_2$, Br$_2$ and HBr is 435 kJ mol^{-1} , 192 kJ mol^{-1} and 368 kJ mol^{-1} respectively.
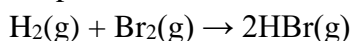
Long Answer Type Questions

16. a. Define standard enthalpy of formation.
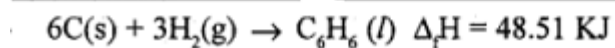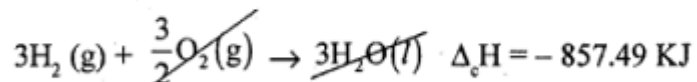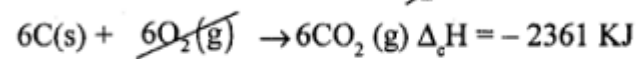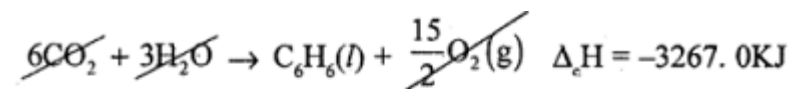   b. Calculate the enthalpy of formation of benzene from data

$$C_6H_{6(\ell)} + \frac{15}{2}O_{2(g)} \longrightarrow 6CO_{2(g)} + 3H_2O_{(\ell)} \quad \Delta H^\circ = -3267KJ$$

$$\Delta_fH^\circ\,(CO_2) = -393.5\,KJ\,mol^{-1}$$

$$\Delta_fH^\circ\,(C_2O) = -285.8\,KJ\,mol^{-1}$$

Answers:

1. c

2. $\Delta S = -ve$

3. (c)

4. (a)

5. (c)

6. (a)

7. (b)

8. (a)

9. I ΔH lattice enthalpy

   II O_3, HI, NH_3, CaO

   III ΔH -ve ΔS +ve

   IV $\Delta S > 0$

10. -475K

11. The change in internal energy during a process depends only upon the initial state and final state while work depends on upon the path followed.

12. 183.6 kJ mol^{-1}

13. a Yes, the reaction is spontaneous

    b $\Delta H° = \Sigma\Delta H°_f$ (products) - $\Sigma\Delta H°_f$(reactants) = [2 x $\Delta H°_f Fe_2O_3$] - [4$\Delta H°_f Fe_{(s)}$ + 3$\Delta H°_f O_{2(g)}$] =

    2 (-824.2 kJ) - [4 x 0 + 3 x 0] = -1648.4 J

14. $w = - p_{ex} (V_f - V_i) = -2 \times 40 = - 80$ L bar

15. $\Delta rH^\ominus = \Sigma$ bond enthalpies reactants $=-\Sigma$ bond enthalpies products

    $=435+192-(2\times368)$kJmol^{-1}

    $\Delta rH^\ominus=-109$KJmol^{-1}

16. a Standard enthalpy of formation of a compound is the change in enthalpy when one mole of the compound is formed from its elements in their standard states under standard conditions i.e, at 298K and 101.3kPa pressure.

    b Required equation $6C(s) + 3H_{2(g)} \rightarrow C_6H_{6\,(l)} \Delta_f H =?$

4

Given Data: $C(s) + O_{2(g)} \rightarrow CO_{2(g)}$ $\Delta cH = -393.5$ KJ

$H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow H_2O_{(l)}$ $\Delta cH = -285.83$ K

$C_6H_{6(l)} + 15/2\ O2_{(g)} \rightarrow 6CO_2 + 3H_2O$ $\Delta cH = -3267$ KJ

$6CO_2 + 3H_2O \rightarrow C_6H_6(l) + \frac{15}{2}O_2(g)$ $\Delta_c H = -3267.0$ KJ

$6C(s) + 6O_2(g) \rightarrow 6CO_2\ (g)$ $\Delta_c H = -2361$ KJ

$3H_2\ (g) + \frac{3}{2}O_2(g) \rightarrow 3H_2O(l)$ $\Delta_c H = -857.49$ KJ

$6C(s) + 3H_2(g) \rightarrow C_6H_6\ (l)$ $\Delta_f H = 48.51$ KJ

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