Chemistry Worksheets Class 11 on Chapter 8 Redox Reactions with Answers- Set 3

Q-1: Choose the correct statement for the galvanic cell.
a) Oxidation: cathode
b) Positive electrode: cathode
c) Flow of electron: cathode to anode
d) All are correct

Answer: b) Positive electrode: cathode

Q-2: The flow of electrons in an electrochemical cell is from
a) Anode to the cathode through an internal circuit
b) Cathode to the anode through an external circuit
c) Cathode to the anode through an internal circuit
d) Anode to the cathode through an external circuit

Answer: a) Anode to the cathode through an internal circuit

Q-3: Which of the following is not a reducing agent?
a) SO_2
b) H_2O_2
c) CO_2
d) NO_2

Answer: c) CO_2
Explanation: Since carbon cannot increase its oxidation state further in CO_2 and is already at its maximum oxidation state of +4, it cannot function as a reducing agent.

Q-4: A metal ion, M^{2+} loses 2 electrons; its oxidation number will be
a) +4
b) zero
c) -4
d) +1

Answer: a) +4
Explanation: When a substance loses electrons, its oxidation state increases. In this case, the substance has lost 2 electrons and thus will have an oxidation number of +4.

Q-5: $Cr_2O_7^{2-}$ + Y → Cr^{3+}+ H_2O + oxidised product of Y, Y in this reaction cannot be
a) $C_2O_4^{2-}$
b) Fe^{2+}
c) S^{2-}
d) $SO_4^{2-.}$

Answer: d) $SO_4^{2-.}$
Explanation: SO_4^{2-} is not a reducing agent and hence does not reduce $Cr_2O_7^{2-}$.

Q-6: Given the standard electrode potentials.
i) K^+/K = -2.93 V
ii) Ag^+/Ag = 0.80 V
iii) Hg^{2+}/Hg = 0.79 V
iv) Zn^{2+}/Zn = -0.76 V
v) Na^+/Na = -2.71 V
Arrange these metals in their increasing order of reducing power.

Answer: Reducing power is the ability of the substance to reduce others but itself to undergo oxidation. If the oxidation potential is higher, the reducing power will also be higher, or alternatively, if the reduction potential is lower, the reducing power will be higher. It is accurate in both directions.
The reduction potentials of the various electrodes are provided in the question. According to the discussion above, the correct sequence is i) < iii < iv < v) < i).

Q-7: Consider the elements:
K, Ar, F, Br
a) Determine the element that only has a negative oxidation state.
b) Determine the element that only has a positive oxidation state.
c) Determine which element has both positive and negative oxidation states.
d) Determine the element with neither a negative nor a positive oxidation state.

Answer:
a) F is the most electronegative element. It only displays a negative oxidation state as a result.
b) K is the metal and has a tendency to lose electrons, thus will show only a positive oxidation state.
c) Br is the element that exhibits both positive and negative oxidation states.
d) Ar is a noble gas, which by definition, is an inert substance. They exhibit neither the negative nor the positive oxidation state as a result of not either losing or gaining electrons.

Q-8: Can a solution of 1M $ZnSO_4$ be stored in a vessel made of copper? Given that
$E^o(Zn^{2+}/Zn)$= -0.76 V and $E^o(Cu^{2+}/Cu)$= 0.34 V

Answer: Yes

Explanation: Since the reduction potential of Zn is lower than that of Cu, we can store the $ZnSO_4$ solution in a copper vessel.

Q-9: What are the limitations of the concept of oxidation number?
Answer: The idea of the redox process has evolved over time. Oxidation, according to the concept of oxidation number, is an increase in oxidation number caused by the loss of electrons. Simultaneously, reduction implies a decrease in oxidation number due to electron gain. It was previously assumed that there is a decrease in electron density around the oxidising atom. At the same time, the electron density around the atom undergoing reduction increased. This could be considered a limitation of the concept of oxidation number.

Q-10: Calculate the oxidation number of N in the $(NH_4)_2SO_4$ molecule.
Answer: Let the oxidation number of N in the $(NH_4)_2SO_4$ molecule is x.
Now,
$2x + (+1\times8) + 6 + (-2\times4) = 0$
$2x + 8 + 6 - 8 = 0$
$x = -3$

Q-11: How can you say that formation of sodium chloride from gaseous sodium and gaseous chlorine is a redox reaction?
Answer: The reaction for the formation of sodium chloride from gaseous sodium and gaseous chlorine is given below:
$Na\ (g) + Cl_2\ (g) \rightarrow NaCl(s)$

In this reaction, sodium changes its oxidation state from zero to +1 in NaCl, while chlorine changes its oxidation state from zero to -1. It is a redox reaction because both oxidation and reduction occur simultaneously.

Q-12: Copper dissolves in dilute nitric acid but not in dilute HCl. Explain.
Answer: The E^O of the Cu^{2+}/Cu electrode (0.34 V) is higher than that of the H^+/H_2 electrode (0.0 V). Therefore, H^+ ions cannot oxidise Cu to Cu^{2+} ions, so Cu does not dissolve in dilute HCl. In contrast, the electrode potential of NO_3^- ion, that is, NO_3^-/NO, electrode (+ 0.97 V), is higher than that of the copper electrode, and hence it can oxidise Cu to Cu^{2+} ions, and hence Cu dissolves in dilute HNO_3. Thus, Cu dissolves in dilute HNO_3 due to the oxidation of Cu by NO_3^- ions and not by H^+ ions.

Q-13: What is the maximum and minimum oxidation state of S, N and Cl?
Answer:
i) The highest oxidation number of N is +5 since it has five electrons in the valence shell ($2s^2 2p^3$), and its minimum oxidation number is -3 since it can accept three more electrons to acquire the nearest inert gas configuration.

ii) Similarly, the highest oxidation number of S is +6 since it has 6 electrons in the valence shell, and its minimum oxidation number is -2 since it needs two more electrons to acquire the nearest inert gas configuration.

iii) Likewise, the maximum oxidation number of chlorine is +7 since it has seven electrons in the valence shell, and its minimum oxidation number is -1 since it needs only one more electron to acquire the nearest noble gas(Ar) configuration.

Q-14: To create a cell, an iron rod is dipped in 1M $FeSO_4$ solution and a chromium rod in 1M $Cr_2(SO_4)_3$ solution. Iron and chromium electrodes have standard reduction potentials of -0.45 V and -0.75 V, respectively.
a) What will be the cell reaction?
b) What will be the standard EMF of the cell?
c) Which electrode will act as an anode?
d) Which electrode will act as a cathode?

Answer:
a) The two half-cell reduction reactions are:
i) $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$; $E^o = -0.45$ V
ii) $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$; $E^o = -0.75$ V
Multiply equations i) and ii) by 3 and 2 respectively, then subtract eqn ii) from i) to get the overall cell reaction, that is, $3Fe^{2+} + 2Cr \rightarrow 3Fe + 2Cr^{3+}$
b) $E^o_{cell} = -0.45 - (-0.75\ V) = +0.30$ V
c) Since Cr^{3+}/Cr electrode has lower reduction potential, it acts as the anode
d) Since Fe^{2+}/Fe electrode has higher reduction potential, it acts as the cathode.

Q-15: How many millimoles of potassium dichromate are required to oxidise 24 cm^3 of acidic 0.5 M Mohr's salt solution?

Answer: Number of millimoles of $K_2Cr_2O_7$ present in 24 cm^3 of 0.5 M solution = 24 × 0.5 = 12
The balanced chemical equation for the reaction is:
$K_2Cr_2O_7 + 6\ (NH_4)_2SO_4.FeSO_4.6H_2O + 7H_2SO_4 \rightarrow K_2SO_4 + 6(NH_4)_2SO_4 + 3Fe_2(SO_4)_3 + Cr_2(SO_4)_3 + 43H_2O$
From the balanced equation,
6 moles of Mohr's salt are oxidised by $K_2Cr_2O_7$ = 1 mole,
Therefore, 12 millimoles of Mohr's salt will be oxidised by $K_2Cr_2O_7$ = (⅙) × 12 = 2 millimoles

Q-16: The half cell reactions with their oxidation potentials are
$Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$; $E^o_{oxidation} = +0.13$ V
$Ag(s) \rightarrow Ag(aq) + e^-$; $E^o_{oxidation} = -0.80$ V
Write the cell reaction and calculate its EMF.

Answer: Rewrite the two equations in the reduction form. Thus,
i) $Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$; $E^o_{reduction} = -0.13$ V
ii) $Ag(aq) + e^- \rightarrow Ag(s)$; $E^o_{reduction} = +0.80$ V
To obtain the equation for the cell reaction, multiply equation (ii) by 2 and subtract from equation (i); we have
$Pb(s) + 2Ag^+(aq) \rightarrow Pb^{2+}(aq) + 2Ag(s)$

$E^o_{cell} = +0.80 - (-0.13) = +0.93$ V.

Q-17: State whether the following statements are True or False.
a) Metals with lower electrode potentials than standard hydrogen electrodes react with aqueous mineral acids to produce H_2 gas.
b) Cl_2 can oxidise Br^- ion to Br_2.
c) A copper sulphate solution can be placed in a zinc vessel.

Answer:
a) True
b) True
c) False. Zinc is more reactive than copper, hence can displace copper from copper sulphate. This shows a reaction will occur. So it is not recommendable to store copper sulphate solution in a vessel made of zinc.

Q-18: What is the oxidation state of sodium in sodium amalgam?
Answer: Sodium amalgam is a homogeneous mixture of Na and Hg, and because Na is elemental, its oxidation number is zero.

Q-19: Why nitrous acid acts as an oxidising and a reducing agent?
Answer: The chemical formula for nitrous acid is HNO_2.
The oxidation number of N in HNO_2 = +3
The maximum oxidation number of N = +5
The minimum oxidation number of N = -3
Thus, the oxidation number of N can increase by losing electrons or decrease by accepting electrons. Therefore, HNO_3 acts both as an oxidising as well as a reducing agent.

Q-20: Calculate the volume of 0.05 M $KMnO_4$ solution required to oxidise completely 3.80 g of oxalic acid ($H_2C_2O_4$) in an acidic medium.

Answer: The balanced equation for the redox reaction is:
$2KMnO_4 + 5(COOH)_2 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$
Number of moles of oxalic acid = 3.80/90 = 0.042 mole.

From the balanced equation,
5 moles of $(COOH)_2$ = 2 moles of $KMnO_4$
Therefore, 0.042 mole of $(COOH)_2$ = ⅖ ×0.042 = 0.017 mole of $KMnO_4$
Now 0.05 mole of $KMnO_4$ is present in the solution = 1000 cm^3
Therefore, 0.017 mole of $KMnO_4$ is present in solution = (1000 × 0.017/0.05) = 340 cm^3