Redox Reactions

Standard difficulty · 20 questions · 40 marks · Time: 37 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. In terms of electrons, oxidation is the:

(a) gain of protons **(b)** loss of neutrons

(c) gain of electrons **(d)** loss of electrons

2. The oxidation number of iron in Fe_3O_4 is:

(a) +8/3 **(b)** −8/3 **(c)** +11/3 **(d)** +5/3

3. In the reaction $2CuO + C \rightarrow 2Cu + CO_2$, the reducing agent is:

(a) CuO **(b)** Cu **(c)** C **(d)** CO_2

4. The redox reaction $4KClO_3 \rightarrow 3KClO_4 + KCl$ is an example of:

(a) non-metal displacement **(b)** decomposition

(c) combination **(d)** disproportionation

5. When Cl_2 changes to Cl^-, each Cl_2:

(a) gains 1 electron **(b)** loses 2 electrons

(c) gains 2 electrons **(d)** gains 3 electrons

6. In Stock notation, Hg_2Cl_2 is named:

(a) mercury(I) chloride **(b)** mercury(IV) chloride

(c) mercury(II) chloride **(d)** mercury(III) chloride

7. Using standard reduction potentials (Zn^{2+}/Zn −0.76 V, K^+/K −2.93 V, Au^{3+}/Au +1.4 V, H^+/H_2 0 V), the strongest reducing agent is:

(a) H_2 **(b)** Zn **(c)** Au **(d)** K

8. Assertion (A): Tin cannot displace chromium from a solution of its salt.
Reason (R): Oxidation is the loss of electrons.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. Define oxidation and reduction in terms of oxidation number.

10. Find the oxidation number of each element in NO_3^-.

11. Balance by the ion-electron method (acidic medium): $Zn + NO_3^- \rightarrow Zn^{2+} + NH_4^+$

12. How many moles of electrons are gained when 3 mol of MnO_4^- changes to Mn^{2+}? How many coulombs is this? (1 mol of electrons = 96,500 C)

13. Write the formula of chromium(III) chloride, and the oxidation number of chromium in it.

14. A cell is made from the couples Cr^{3+}/Cr ($E° = -0.74$ V) and Fe^{2+}/Fe ($E° = -0.44$ V). Which electrode is the anode, which the cathode, and what is $E°_{cell}$?

15. In $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$, which element is oxidised and which is reduced? Show the change in oxidation number.

16. Will iron displace aluminium from a solution of its salt? Give a reason. ($E°$: Fe^{2+}/Fe −0.44 V, Al^{3+}/Al −1.66 V)

Section C — Word problems — 4 × 4 = 16 marks

17. Write the rules for finding the oxidation number of an element in a compound or ion.

18. Balance the reaction between permanganate and manganese(II) in acidic medium by the ion-electron method, showing both half reactions: $MnO_4^- + Mn^{2+} \rightarrow MnO_2$

19. Find the oxidation number of nitrogen in N_2H_4, NO_2, NH_2OH, NO, and arrange them in increasing order of it. Nitrogen ranges from −3 to +5: which of these can act only as an oxidising agent, and which only as a reducing agent?

20. A galvanic cell is made from Zn in a 1 M solution of Zn^{2+} and Fe in a 1 M solution of Fe^{2+}. ($E°$: Zn^{2+}/Zn −0.76 V, Fe^{2+}/Fe −0.44 V) (a) Write the cell notation. (b) Write the half reactions and the cell reaction. (c) Find $E°_{cell}$. (d) In which direction do electrons flow in the wire?

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Answer key

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Q	Answer	Working
1	**(d) loss of electrons**	—
2	**(a) +8/3**	the oxidation numbers add up to the charge on the species
3	**(c) C**	C is oxidised: C 0 → +4
4	**(d) disproportionation**	one element is both oxidised and reduced
5	**(c) gains 2 electrons**	Cl: 0 → −1, for 2 atoms
6	**(a) mercury(I) chloride**	Hg is +1
7	**(d) K**	the lowest E°: its reduced form is most easily oxidised
8	**(b) Both A and R are true, but R is not the correct explanation of A.**	A is true: E°: Sn −0.14 V, Cr −0.74 V. R is true but does not explain A.
9	**Oxidation is an increase in the oxidation number of an element; reduction is a decrease.**	—
10	**N +5, O −2**	the sum is the charge, −1
11	**$4Zn + NO_3^- + 10H^+ \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$**	oxidation: $Zn \rightarrow Zn^{2+} + 2e^-$; reduction: $NO_3^- + 10H^+ + 8e^- \rightarrow NH_4^+ + 3H_2O$
12	**15 mol; 1,447,500 C**	each MnO_4^- gains 5 electrons
13	**$CrCl_3$; +3**	the Roman numeral is the oxidation number
14	**Anode Cr, cathode Fe; E°cell = +0.3 V**	the lower E° is oxidised (anode); E°cell = E°cathode − E°anode
15	**Oxidised: C +2 → +4; reduced: Fe +3 → 0**	an increase in oxidation number is oxidation
16	**No: Fe has the higher E°, so it cannot reduce Al^{3+}.**	the metal with the lower E° is the stronger reducing agent
17	**An element in the free state has 0. A monatomic ion has its charge. Oxygen is −2 (−1 in peroxides, +2 in OF_2). Hydrogen is +1 (−1 in metal hydrides). Fluorine is always −1; alkali metals +1; alkaline earth metals +2. The sum of oxidation numbers is zero for a neutral compound and equals the charge for an ion.**	—
18	**Oxidation: $Mn^{2+} + 2H_2O \rightarrow MnO_2 + 4H^+ + 2e^-$. Reduction: $MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O$. Overall: $2MnO_4^- + 3Mn^{2+} + 2H_2O \rightarrow 5MnO_2 + 4H^+$.**	balance O with H_2O and H with H^+ (in basic medium then add OH^-), then electrons; multiply so the electrons cancel
19	**N_2H_4 −2 < NH_2OH −1 < NO +2 < NO_2 +4. Only an oxidising agent (highest state, can only be reduced): none of them.**	charge balance with O −2 and H +1

Q	Answer	Working
	Only a reducing agent (lowest state, can only be oxidised): none of them.	
20	**(a) Zn | Zn^{2+} || Fe^{2+} | Fe. (b) Anode: Zn → Zn^{2+} + $2e^-$; cathode: Fe^{2+} + $2e^-$ → Fe; cell: Zn + Fe^{2+} → Zn^{2+} + Fe. (c) +0.32 V. (d) From Zn to Fe.**	lower E° is the anode; E°cell = E°cathode − E°anode

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