Balancing Redox Reactions Practice

Name Answer Key

Please write answers on a separate sheet of paper.

1) a) Write balanced half-equations for each of the following oxidation or reduction processes.

i) Br^- to Br_2
ii) N_2 to NO_3^-
iii) V^{3+} to VO^{2+}
iv) H_2SO_4 to S
v) NO_3^- to NH_4^+
vi) BrO_3^- to Br_2

(6)

b) Write a redox equation for the reaction of H_2SO_4 with Br^- ions, producing S and Br_2, using the half-equations from (a). Also state which species is oxidised, which is reduced, and the oxidising and reducing agents.

c) When concentrated nitric acid is added to copper metal, the copper is oxidised to oxidation state +2 and the nitric acid is reduced to nitrogen (IV) oxide. Derive half-equations and then write an equation for the reaction.

(Total 12)

2) State whether the following three reactions are redox reactions or not. For those that are redox reactions, clearly indicate any changes in oxidation state.

a) $Zn + 2\,HCl \rightarrow ZnCl_2 + H_2$

b) $CuO + 2\,HCl \rightarrow CuCl_2 + H_2O$

c) $MnO_2 + 4\,HCl \rightarrow MnCl_2 + Cl_2 + 2\,H_2O$

d) $Cl_2 + H_2O \rightarrow HCl + HOCl$

(7)

(Total 7)

3) a) Explain, in terms of electrons, what happens to oxidising and reducing agents in reactions. (1)

b) Using these definitions, explain which species is oxidised and which is reduced, and the oxidising and reducing agent in reaction below. (2)

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

c) What is the oxidation state of each element in the following species:

Na_2SO_4 $Na_2S_2O_3$ Na_2SO_3 S_8 $KClO_3$ $KClO$ KH Na_2O_2 Na_2O (9)

(Total 12)

4) a) For each of the following reduction or oxidation processes write a half equation.

i) conversion of H^+ to H_2
ii) conversion of SO_4^{2-} to SO_3^{2-}
iii) conversion of H_2O_2 to O_2
iv) conversion of IO_3^- to I_2
v) conversion of I^- to I_2

(5)

b) Use your half-equations to write a redox equation for the reaction of IO_3^- with I^- to form I_2. (1)

(Total 6)

5) Write redox equations for the following reactions using the half-equations provided.

$MnO_4^- + 8\,H^+ + 5\,e^- \rightarrow Mn^{2+} + 4\,H_2O$
$2\,Cl^- \rightarrow Cl_2 + 2\,e^-$
$2\,Cr^{3+} + 7\,H_2O \rightarrow Cr_2O_7^{2-} + 14\,H^+ + 6\,e^-$

a) Reaction of acidified MnO_4^- and Cl^-. (1)

b) Reaction of acidified MnO_4^- and Cr^{3+}. (1)

(Total 2)

Balancing Redox Rxns Answer Key

1. a) i. $2Br^- \rightarrow Br_2 + 2e^-$

ii $N_2 \rightarrow 2NO_3^- + 10e^-$

$6H_2O + N_2 \rightarrow 2NO_3^- + 10e^- + 12H^+$

iii $V^{3+} \rightarrow VO^{2+} + e^-$

$H_2O + V^{3+} \rightarrow VO^{2+} + e^- + 2H^+$

iv $\overset{+1\ +6\ -2}{H_2SO_4} + 6e^- \rightarrow S + 4H_2O$
$+ 6H^+$

v $\overset{+5\ -2}{NO_3^-} + 8e^- \rightarrow \overset{-3\ +1}{NH_4^+}$

$4H^+ + NO_3^- + 8e^- \rightarrow NH_4^+$

vi $\overset{+5\ -2}{BrO_3^-} + 5e^- \rightarrow Br_2 + 3H_2O$
$+ 6H^+$

b) $2Br^-_{(aq)} \rightleftharpoons Br_2(l) + 2e^-$ oxidation $2Br^-$ oxidized/reducing agent

$6H^+_{(aq)} + \overset{+2\ +6\ -2}{H_2SO_4}_{(aq)} + 6e^- \rightarrow \overset{0}{S}_{(s)} + 4H_2O(l)$ reduction H_2SO_4 reduced/oxidizing agent

balanced redox rxn:

$6Br^-(aq) + 6H^+(aq) + H_2SO_4(aq) \rightarrow 3Br_2(l) + S(s) + 4H_2O(l)$

c) $\overset{+1\ +5\ -2}{HNO_3}_{(aq)} + H^+(aq) + e^- \rightarrow \overset{+4\ -2}{NO_2}_{(g)} + H_2O(l)$ reduction

$Cu(s) \rightarrow Cu^{2+} + 2e^-$ oxidation

balanced redox rxn:

$2H^+(aq) + 2HNO_3(aq) + Cu(s) \rightarrow 2NO_2(g) + 2H_2O(l) + Cu^{2+}(aq)$

a) $\overset{0}{Zn} + 2\overset{+1\ -1}{HCl} \rightarrow \overset{+2\ -1}{ZnCl_2} + \overset{0}{H_2}$

redox!

b) $\overset{+2\ -2}{CuO} + 2\overset{+1\ -1}{HCl} \rightarrow \overset{+2\ -1}{CuCl_2} + \overset{+1\ -2}{H_2O}$

not redox!

c) $\overset{+4\ -2}{MnO_2} + 4\overset{+1\ -1}{HCl} \rightarrow \overset{+2\ -1}{MnCl_2} + \overset{0}{Cl_2} + 2\overset{+1\ -2}{H_2O}$

redox!

d) $\overset{0}{Cl_2} + \overset{+1\ -2}{H_2O} \rightarrow \overset{+1\ -1}{HCl} + \overset{+1\ -2\ +1}{HOCl}$

redox!
disproportionation rxn ☺

3) oxidizing agents get reduced = accept e⁻
a) reducing agents get oxidized = donate e⁻

oxidizing agent reduced

b) $\overset{0}{Mg} + \overset{+1\ +6\ -2}{H_2SO_4} \rightarrow \overset{+2\ +6\ -2}{MgSO_4} + \overset{0}{H_2}$

reducing agent oxidized

c) $\overset{+1\ +6\ -2}{Na_2SO_4}$ $\overset{+1\ +5\ -2}{KClO_3}$ $\overset{+1\ -2}{Na_2O}$

$\overset{+1\ +2\ -2}{Na_2S_2O_3}$ $\overset{+1\ +1\ -2}{KClO}$

$\overset{+1\ +4\ -2}{Na_2SO_3}$ $\overset{+1\ -1}{KH}$

$\overset{0}{S_8}$ $\overset{+1\ -1}{Na_2O_2}$

a) i. $2H^+ + 2e^- \rightarrow H_2$

ii $\overset{+6}{S}O_4^{2-} + 2e^- \rightarrow \overset{+4}{S}O_3^{2-}$

iii $\overset{+1}{H_2}\overset{-1}{O_2} \rightarrow \overset{0}{O_2} + 2e^- + 2H^+$

iv $2\overset{+5}{I}O_3^- + 10e^- \rightarrow \overset{0}{I_2} + 6H_2O$

$+ 12H^+$

v. $2I^- \rightarrow I_2 + 2e^-$

b) ~~$6IO_3^- + 5e^- \rightarrow I_2 + 10e^-$~~

~~$2(12H^+ + 2IO_3^- + 5e^- \rightarrow I_2 + 6H_2O)$~~

$5(2I^- \rightarrow I_2 + 2e^-)$

$12H^+ + 2IO_3^- + 10I^- \rightarrow 6I_2 + 5I_2 + 6H_2O$

$12H^+ + 2IO_3^- + 10I^- \rightarrow 6I_2 + 6H_2O$

reduce! $6H^+_{(aq)} + 2IO_3^-(aq) + 5I^-_{(aq)} \rightarrow 3I_2(aq) + 3H_2O(l)$

5. a) $2(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O)$

$5(2Cl^- \rightarrow Cl_2 + 2e^-)$

$2MnO_4^- + 16H^+ + 10Cl^- \rightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$

b) $5(2Cr^{3+} + 7H_2O \rightarrow Cr_2O_7^{2-} + 14H^+ + 6e^-)$

$6(5e^- + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O)$

$10Cr^{3+} + 35H_2O + 6MnO_4^- + 48H^+ \rightarrow 5Cr_2O_7^{2-} + 70H^+ + 6Mn^{2+} + 24H_2O$

$\Rightarrow 10Cr^{3+} + 11H_2O + 6MnO_4^- \rightarrow 5Cr_2O_7^{2-} + 22H^+ + 6Mn^{2+}$