Redox:

(1) Basic Theories

-2008 I(1)

(1) The oxidation number of the nitrogen atom in NH_4Cl is

1) -5 2) -4 3) -3 4) -2

5) 2 6) 3 7) 4 8) 5

-2008 I(6)

(6) As written, the following reactions A and B proceed to the right :

A : $2H^+ + Sn(s) \rightleftharpoons H_2(g) + Sn^{2+}$

B : $Sn^{4+} + H_2(g) \rightleftharpoons Sn^{2+} + 2H^+$

The order of oxidizing strength is

1) $H^+ > Sn^{2+} > Sn^{4+}$ 2) $H^- > Sn^{4+} > Sn^{2+}$ 3) $Sn^{2+} > H^+ > Sn^{4+}$

4) $Sn^{2+} > Sn^{4+} > H^+$ 5) $Sn^{4+} > H^+ > Sn^{2+}$ 6) $Sn^{4+} > Sn^{2+} > H^+$

-2009 I(7)

(7) There are three metals A, B, and C. Read a) and b), and arrange A, B, and C in order of decreasing ionization tendency.

a) A dissolves in dilute nitric acid, but B does not.

b) C reacts with water at room temperature, but A and B do not.

1) A > B > C 2) A > C > B 3) B > A > C

4) B > C > A 5) C > A > B 6) C > B > A

-2010 Q9

Q9 Sulfur dioxide (SO_2) is formed when copper (Cu) is dissolved in a hot, concentrated sulfuric acid (conc. H_2SO_4). From ①–⑤ below, choose the one that is the correct value for the change in the oxidation number of sulfur in this reaction. **9**

① 2 ② 3 ③ 4 ④ 5 ⑤ 6

-2010 Q14

Q14 From ①–④ below choose the metal that **does not deposit** silver (Ag) on the surface when immersed in aqueous silver nitrate ($AgNO_3$ *aq*). **14**

① Cu ② Fe ③ Pt ④ Zn

-2012 I(6)

(6) In which of the reactions 1) to 4) the underlined element is oxidized?

1) $CuSO_4 + H_2\underline{S} \rightarrow Cu\underline{S} + H_2SO_4$
2) $Cl_2 + \underline{S}O_2 + 2H_2O \rightarrow 2HCl + H_2\underline{S}O_4$
3) $\underline{S}O_2 + 2H_2S \rightarrow 2H_2O + 3\underline{S}$
4) $10KCl + 2K\underline{Mn}O_4 + 8H_2SO_4 \rightarrow 5Cl_2 + 2\underline{Mn}SO_4 + 6K_2SO_4 + 8H_2O$

-2013 I(6)

(6) In which of the reactions 1) to 4) is the underlined element oxidized?

1) $\underline{Cl}_2 + SO_2 + 2H_2O \rightarrow 2H\underline{Cl} + H_2SO_4$
2) $\underline{S}O_2 + 2H_2S \rightarrow 2H_2O + 3\underline{S}$
3) $CuSO_4 + H_2\underline{S} \rightarrow CuS + H_2\underline{S}O_4$
4) $10KCl + 2K\underline{Mn}O_4 + 8H_2SO_4 \rightarrow 5Cl_2 + 2\underline{Mn}SO_4 + 6K_2SO_4 + 8H_2O$

-2016 IV(1)

(1) Sodium is an electropositive element, while chlorine is an electronegative element. Sodium is ionized by taking an electron away from a neutral atom, of which process is (a). On the other hand, addition of an electron to chlorine atom, of which process is (b), produces chloride ion.

-2018 II(a)-(c)

Sulfur dioxide reacts with oxygen to form sulfur trioxide. Further reaction of sulfur trioxide with water leads to the formation of sulfuric acid. The oxidation number of the sulfur atom is (a) for sulfur dioxide, (b) for sulfur trioxide, and (c) for sulfuric acid. Sulfur dioxide also reacts with hydrogen sulfide to form sulfur, the chemical equation of which is expressed as (d).

-2018 I(6)

(6) Which of reactions described in 1) to 4) is an oxidation-reduction reaction?

1) $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
2) $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$
3) $Al(OH)_3 + NaOH \rightarrow Na[Al(OH)_4]$
4) $I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$

-2019 II(a)(b)

Dissolution of metallic silver Ag(0) into dilute and concentrated nitric acid solutions generates (a) and (b) gases, respectively. Addition of aqueous ammonia into an aqueous solution

(2) Redox Reactions

-2006 II(1)

Find the coefficients (a)-(d) of the following 2 reactions.

$MnO_4^- + (a)H^+ + (b)e^- \rightarrow Mn^{2+} + (c)H_2O$

$H_2C_2O_4 \rightarrow 2CO_2 + (d)H^+ + (d)e^-$

-2007 I(9)

(9) In the electrolysis of an aqueous solution of sodium hydroxide using platinum electrodes, the reactions that occur at the anode and the cathode are respectively

1) $Na^+ + e^- \rightarrow Na$
2) $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
3) $Na \rightarrow Na^+ + e^-$
4) $2OH^- \rightarrow H_2 + O_2 + 2e^-$
5) $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

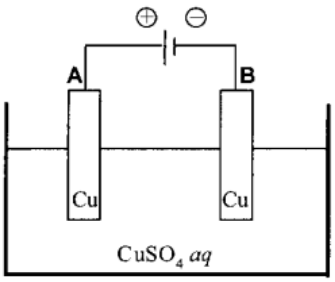
-2009 I(2)

(2) Give the name of the gas formed by adding concentrated hydrochloric acid to manganese(IV) oxide and heating.

1) chlorine 2) hydrogen 3) oxygen 4) ozone

-2010 Q10

Q10 An electric current is made to flow through an aqueous copper sulfate ($CuSO_4$ *aq*) as shown below. From ①-⑥ below choose the pair that includes correct statements describing the change that takes place at the electrodes **A** and **B**, respectively. **10**



	A	B
①	The mass increases.	The mass decreases.
②	The mass increases.	A gas is generated.
③	The mass decreases.	The mass increases.
④	The mass decreases.	A gas is generated.
⑤	A gas is generated.	The mass increases.
⑥	A gas is generated.	The mass decreases.

-2014 I(6)

(6) Which combination of the substances 1) to 4) produces chlorine when they react to evolve gases?

1) calcium hydroxide and ammonium chloride
2) manganese dioxide and hydrochloric acid
3) sodium chloride and sulfuric acid
4) zinc and hydrochloric acid

-2014 III

III Give the appropriate name of the compounds or ions for (a) to (d) below using chemical formulas. The e^- denotes an electron.

The overall reaction in a fuel cell that uses KOH as electrolyte is written as follows;

$2\,H_2 + O_2 \rightarrow 2\,H_2O$.

At the anode, (a) is oxidized by the reaction;

(a) + 2 (b) → 2 (c) + 2 e^-.

At the cathode, (d) is reduced by the reaction;

(d) + 2 (c) + 4e^- → 4 (b).

-2015 II

II

(1) Under acidic conditions, manganese peroxide reacts with hydrogen peroxide as shown below.

$$2MnO_4^- + \boxed{a}\,H_2O_2 + \boxed{b}\,H^+ \rightarrow 2Mn^{2+} + \boxed{c}\,O_2 + \boxed{d}\,H_2O$$

Give the appropriate values for [a] to [d] in this reaction.

(2) Write a chemical reaction formula where Mn^{2+} is oxidized by H_2O_2 to produce MnO_2 under basic conditions.

-2016 I(6)

(6) Which combination of the substances 1) to 4) will not produce hydrogen when reactions are conducted under appropriate temperature and pressure?

1) copper and concentrated nitric acid
2) calcium hydride and water
3) sodium metal and water
4) zinc and hydrochloric acid

-2017 II(1)

II Aqueous solution of sodium hydroxide was electrochemically decomposed by using platinum electrodes. Answer the following questions.

(1) Write the chemical formula of the substance formed at the cathode during the electrolysis.

-2018 II(d)

Sulfur dioxide reacts with oxygen to form sulfur trioxide. Further reaction of sulfur trioxide with water leads to the formation of sulfuric acid. The oxidation number of the sulfur atom is (a) for sulfur dioxide, (b) for sulfur trioxide, and (c) for sulfuric acid. Sulfur dioxide also reacts with hydrogen sulfide to form sulfur, the chemical equation of which is expressed as (d).

-2020 II(1)

(1) Ammonia reacts with oxygen to form nitric oxide and water. The chemical reaction equation is as follows:

$4NH_3 + (\ a\ )\ O_2 \rightarrow (\ b\ )\ NO + (\ c\ )\ H_2O$.

(3) Calculations with Redox

-2006 II(2)

0.320g of calcium oxalate CaC_2O_2 is dissolved in dilute sulfuric acid. When free acid formed $H_2C_2O_2$ is titrated against a standard $KMnO_4$ solution, 20.0ml of titrate is required. What is the concentration of the $KMnO_4$ solution? (Mass numbers are given as: H=1.0, C=12.0, O=16.0, K=39.1, Ca=40.0 and Mn=54.9.)

-2008 III

Ⅲ In the electrolysis of 200ml of 0.15mol/l $CuSO_4$ solution using platinum electrodes, 0.16g of oxygen gas evolved at the anode. Answer the following questions (1) and (2). (Atomic weights : H : 1.0, O : 16.0, S : 32.0, and Cu : 63.5)

(1) How many faradays of charge was passed through the solution?

(2) What should be the molarity of the $CuSO_4$ solution after the electrolysis?

(1)	F	(2)	mol/l

-2009 I(5)

(5) In the electrolysis of an aqueous solution of sodium nitrate using platinum electrodes, 0.50 faradays of electrical charge was passed through the solution. How many grams of gas evolved at the anode?

1) 1.0 2) 2.0 3) 4.0 4) 8.0

5) 16 6) 23 7) 32 8) 46

-2017 II(2)

II Aqueous solution of sodium hydroxide was electrochemically decomposed by using platinum electrodes. Answer the following questions.

(2) An electric current of 9.65 A flowed for 2 hours during the electrolysis. Calculate the total amount of substance formed at the anode after the electrolysis to two significant figures. The Faraday constant is 96500 C mol^{-1}.