Name_____ Date_____

Key

Practice IB Exam: Topics 9

138

1. What are the oxidation numbers of the elements in sulfuric acid, H_2SO_4?

	Hydrogen	Sulfur	Oxygen
A.	+1	+6	–2
B.	+1	+4	–2
C.	+2	+1	+4
D.	+2	+6	–8

(1)

2. Consider the following reaction:

$$H_2SO_3(aq) + Sn^{4+}(aq) + H_2O(l) \rightarrow Sn^{2+}(aq) + HSO_4^-(aq) + 3H^+(aq)$$

Which statement is correct?

A. H_2SO_3 is the reducing agent because it undergoes reduction.

B. H_2SO_3 is the reducing agent because it undergoes oxidation.

C. Sn^{4+} is the oxidizing agent because it undergoes oxidation.

D. Sn^{4+} is the reducing agent because it undergoes oxidation.

(1)

3. What occurs during the operation of a voltaic cell based on the following reaction?

$$Ni(s) + Pb^{2+}(aq) \rightarrow Ni^{2+}(aq) + Pb(s)$$

	External circuit	Ion movement in solution
A.	electrons move from Ni to Pb	$Pb^{2+}(aq)$ move away from Pb(s)
B.	electrons move from Ni to Pb	$Pb^{2+}(aq)$ move toward Pb(s)
C.	electrons move from Pb to Ni	$Ni^{2+}(aq)$ move away from Ni(s)
D.	electrons move from Pb to Ni	$Ni^{2+}(aq)$ move toward Ni(s)

(1)

4. A voltaic cell is made from copper and zinc half-cells. The equation for the reaction is

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

Which statement is correct when the cell produces electricity?

A. Electrons are lost from zinc atoms.

B. The mass of the copper electrode decreases.

C. Electrons flow from the copper half-cell to the zinc half-cell.

D. Negative ions flow through the salt bridge from the zinc half-cell to the copper half-cell.

(1)

5. Which processes occur during the electrolysis of molten sodium chloride?

I. Sodium and chloride ions move through the electrolyte.
II. Electrons move through the external circuit.
III. Oxidation takes place at the anode.

A. I and II only
C. II and III only
B. I and III only
D. I, II and III

(1)

6. Which is the strongest reducing agent according to the spontaneous reactions below?

$$2Cr(s) + 3Fe^{2+}(aq) \rightarrow 2Cr^{3+}(aq) + 3Fe(s)$$
$$Fe(s) + Pb^{2+}(aq) \rightarrow Fe^{2+}(aq) + Pb(s)$$

A. $Cr(s)$
C. $Pb^{2+}(aq)$
B. $Cr^{3+}(aq)$
D. $Pb(s)$

(1)

7. The oxidation number of chromium is the same in all the following compounds **except**

A. $Cr(OH)_3$
C. $Cr_2(SO_4)_3$
B. Cr_2O_3
D. CrO_3

(1)

8. Magnesium is a more reactive metal than copper. Which is the strongest oxidizing agent?

A. Mg

B. Mg^{2+}

C. Cu

D. Cu^{2+}

(1)

9. Which statement is correct?

A. Spontaneous redox reactions produce electricity in an electrolytic cell.

B. Electricity is used to carry out a non-spontaneous redox reaction in a voltaic cell.

C. Oxidation takes place at the negative electrode in a voltaic cell and the positive electrode in an electrolytic cell.

D. Oxidation takes place at the negative electrode in a voltaic cell and reduction takes place at the positive electrode in an electrolytic cell.

(1)

10. Which processes occur during the electrolysis of molten sodium chloride?

I. Sodium and chloride ions move through the electrolyte.

II. Electrons move through the external circuit.

III. Oxidation takes place at the positive electrode (anode).

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1)

11. What happens to the $Cr^{3+}(aq)$ ion when it is converted to $CrO_4^{2-}(aq)$?

A. Its oxidation number decreases and it undergoes reduction.

B. Its oxidation number decreases and it undergoes oxidation.

C. Its oxidation number increases and it undergoes reduction.

D. Its oxidation number increases and it undergoes oxidation.

(1)

12. What species are produced at the positive and negative electrodes during the electrolysis of molten sodium chloride?

	Positive electrode	**Negative electrode**
A.	$Na^+(l)$	$Cl_2(g)$
B.	$Cl^-(l)$	$Na^+(l)$
C.	$Na(l)$	$Cl_2(g)$
D.	$Cl_2(g)$	$Na(l)$

(1)

13. The following reactions are spontaneous as written.

$Fe(s) + Cd^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cd(s)$

$Cd(s) + Sn^{2+}(aq) \rightarrow Cd^{2+}(aq) + Sn(s)$

$Sn(s) + Pb^{2+}(aq) \rightarrow Sn^{2+}(aq) + Pb(s)$

Which of the following pairs will react spontaneously?

I. $Sn(s) + Fe^{2+}(aq)$

II. $Cd(s) + Pb^{2+}(aq)$

III. $Fe(s) + Pb^{2+}(aq)$

A. I only

B. II only

C. III only

(D.) II and III only

(1)

14. In which reaction does chromium undergo a change in oxidation number?

A. $Cr_2O_3 + 3H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3H_2O$

B. $Cr_2(SO_4)_3 + 6NaOH \rightarrow 2Cr(OH)_3 + 3Na_2SO_4$

(C.) $K_2Cr_2O_7 + 4H_2SO_4 + 6HCl \rightarrow Cr_2(SO_4)_3 + K_2SO_4 + 7H_2O + 3Cl_2$

D. $2K_2CrO_4 + H_2SO_4 \rightarrow K_2Cr_2O_7 + K_2SO_4 + H_2O$

i.e., "in acidic solution"

(1)

15. Tin(II) ions can be oxidized to tin(IV) ions by acidified potassium permanganate(VII) solution according to the following unbalanced equation.

$$\underline{5}\ Sn^{2+} + \underline{2}\ MnO_4^- + \underline{16}\ H^+ \rightarrow \underline{5}\ Sn^{4+} + \underline{2}\ Mn^{2+} + \underline{8}\ H_2O$$

(a) Identify the oxidizing agent and the reducing agent.

Oxidizing agent ..... MnO_4^- .....

Reducing agent ..... Sn^{2+} .....

(1)

(b) Balance the equation above.

add [$2(5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + H_2O)$ / $5(Sn^{2+} \rightarrow Sn^{4+} + 2e^-)$]

$5Sn^{2+} + 2MnO_4^- + 16H^+ \rightarrow 5Sn^{4+} + 2Mn^{2+} + 8H_2O$

(1)

16. Deduce the **change** in oxidation number of chromium in the below reaction. State with a reason whether the chromium has been oxidized or reduced.

$$CrO_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

+6 +3

oxidation number reduced by 3.

The change is reduction because the oxidation number decreases. **(2)**

17. A part of the reactivity series of metals, in order of decreasing reactivity, is shown below.

magnesium
zinc
iron
lead
copper
silver

If a piece of copper metal were placed in separate solutions of silver nitrate and zinc nitrate

(i) determine which solution would undergo reaction.

silver nitrate **(1)**

(ii) identify the type of chemical change taking place in the copper and write the half-equation for this change.

Oxidation;

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

(iii) State, giving a reason, what visible change would take place in the solutions.

The formation of aqueous $Cu(NO_3)_2$ would turn the solution *blue as solid silver is deposited (forms). **(2)**

* just one of those things you need to remember: copper solutions are blue!

Electrolytic cell (not an electrochemical (or voltaic) cell)

18. Electrolysis can be used to obtain chlorine from molten sodium chloride. Write an equation for the reaction occurring at each electrode (the anode and the cathode). **(4)**

Anode (positive electrode; site of oxidation)

$2Cl^- \rightarrow Cl_2 + 2e^-$

Cathode (negative electrode; site of reduction)

$Na^+ + e^- \rightarrow Na$

20. Consider the following redox equation.

$$5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow 5Fe^{3+}(aq) + Mn^{2+}(aq) + 4H_2O(l)$$

(i) Determine the oxidation numbers for Fe and Mn in the reactants and in the products. **(2)**

Reactants	Products
Fe +2	Fe +3
Mn +7	Mn +2

(ii) Based on your answer to (i), deduce which substance is oxidized. **(1)**

Fe^{2+}

↖ No credit if just "Fe" or "iron"!