Student Name: _____

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CHEMISTRY 2021

Unit 3
Key Topic Test 7 – Electrolysis

Recommended writing time*: 45 minutes
Total number of marks available: 50 marks

QUESTION BOOK

* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions

- Students are permitted to bring into the room for this test: scientific calculator, pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 10 pages.

Instructions

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions.
Choose the response that is **correct** for the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks are **not** deducted for incorrect answers.
If more than one answer is completed for any question, no mark will be given.

Question 1

During the electrolysis of 1M NaI, the pH at the cathode will;

A. increase

B. decrease

C. stay the same

D. increase initially and then decrease as the products of the reaction mix together

Question 2

The mass of chromium deposited onto an object during an electroplating process when 1.00 A is passed through a 1.0 M $CrCl_3$ solution for 10 minutes is;

A. 0.108 g

B. 0.323 g

C. 0.972g

D. 1.942 g

Question 3

When a 1M solution of $MgSO_4$ solution undergoes electrolysis the ratio of hydrogen gas to oxygen gas is:

A. 1:1

B. 1:2

C. 2:1

D. 1:3

Question 4

1.2 moles of a solid is deposited at the cathode of a cell when 2.4 Faradays of electricity is passed through a cell. The solid formed is most likely to be;

A. lithium

B. magnesium

C. aluminium

D. silver

Question 5

In a galvanic cell, the two half equations need to take place in separate half cells. In an electrolytic cell,

A. there also needs to be two half cells to prevent mixing of the reactants and products

B. the reactants and products are free to mix as there is no spontaneous reaction between the reactants

C. the reactants are free to mix but the products may need to be separated as they can often react with each other

D. the reactants must be separated but the products can be allowed to mix as they don't spontaneously react.

Question 6

The lead acid battery is often used in cars. During discharging it acts as a galvanic cell and during recharging it acts as an electrolytic cell. The half equations are;

$$Pb_{(s)} + H_2SO_{4(aq)} \rightarrow PbSO_{4(s)} + 2H^+_{(aq)} + 2e^-$$

$$\text{and } PbO_{2(s)} + H_2SO_{4(aq)} + 2H^+_{(aq)} + 2e^- \rightarrow PbSO_{4(s)} + 2H_2O_{(l)}$$

During discharging and recharging;

A. the cathode is negative

B. the electrons move from the negative to the positive electrode

C. oxidation occurs at the lead electrode

D. the lead electrode is negative

Question 7

A 1M solution of NaI undergoes electrolysis. For each mole of I^- that reacts, the mol of H_2 produced is;

A. 0.5

B. 1

C. 2

D. 4

The following information refers to the next 3 questions.

Aluminium is produced by the electrolysis of aluminium oxide or alumina (Al_2O_3). The half equations are;

$$Al^{3+}_{(aq)} + 3e^- \rightarrow Al(s)$$
$$C_{(s)} + 2O^{2-}_{(aq)} \rightarrow CO_{2(g)} + 4e^-$$

Question 8

If 100kg of aluminium is produced, the mass of carbon dioxide produced (in kg) is;

A. 75

B. 122

C. 163

D. 217

Question 9

The cell needs to be shut down from time to time as

A. The aluminium metal needs to be removed

B. More aluminium oxide needs to be added

C. A crust forms that needs to be removed

D. The carbon anode needs to be replaced

Question 10

A molten electrolyte is chosen because;

A. Water is a stronger reductant than aluminium metal so will react in preference to it

B. Aluminium ions are a weaker oxidant than water so will not be reduced

C. A faster rate of reaction will occur

D. This will reduce the amount of electricity required

SECTION B- Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.
To obtain full marks for your responses you should:

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.

Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s).

Question 1

Determine half equations when the following chemicals are electrolysed;

a. $PbSO_{4(aq)}$ with Pb electrodes;

i. oxidation half equation

_____

ii. reduction half equation

_____

1 + 1 = 2 marks

b. $PbSO_{4(aq)}$ with inert electrodes;

i. oxidation half equation

_____

ii. reduction half equation

_____

1 + 1 = 2 marks

c. $LiCl_{(l)}$ with inert electrodes;

i. oxidation half equation

_____

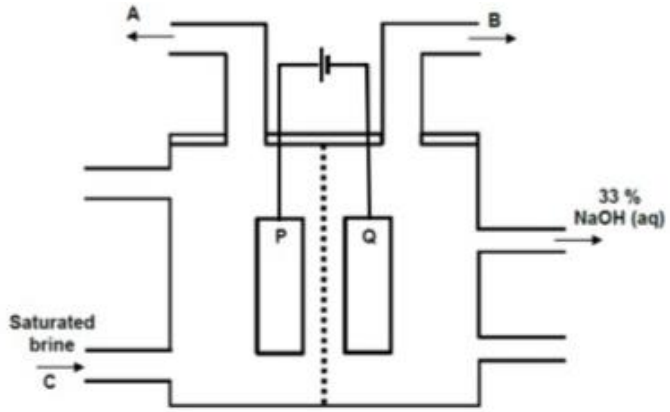
ii. reduction half equation

_____

1 + 1 = 2 marks
Total 6 marks

Question 2

The membrane cell is used to produce chlorine gas, hydrogen gas and sodium hydroxide from a concentrated brine solution (4M NaCl).



a. The brine is introduced into the cell (labelled C) and 33% sodium hydroxide is produced at electrode Q. Write half equations for the reactions occurring at;

i. Electrode Q _____

ii. Electrode P _____

2 marks

b. Determine;

i. The polarity of electrode Q _____

ii. The formula of chemical B _____

2 x 1 = 2 marks

c. Describe the function of the membrane as shown by the dotted line between the two electrodes.

_____

_____

_____

2 marks

d. A membrane cell operates continuously with a potential difference of 4V and produces 1 tonne of sodium hydroxide each day. Determine the current used by the cell.

_____

_____

_____

_____

4 marks

Total 10 marks

Question 3

15 000 Faradays of electricity is passed through a cell containing two nickel electrodes and 100mL of 1.00 M nickel nitrate solution.

a. Determine the half equation at the;

i. Anode _____

ii. Cathode _____

1 + 1 = 2 marks

b. What mass of metal would be deposited at the cathode?

_____

_____

3 marks

c. Determine the final concentration of nickel nitrate.

_____

1 mark

d. The nickel electrodes are replaced by inert carbon electrodes. Determine the final concentration of nickel ions.

_____

_____

_____

_____

2 marks

Total 8 marks

Question 4

A student places a copper electrode in an electrolytic cell containing 1M solutions of $Pb(NO_3)_2$, $Fe(NO_3)_2$ and $Al(NO_3)_3$. A current is run through the cell for a long period of time and the copper becomes plated with more than one metal.

a. Determine the first metal that will be coated onto the copper.

_____

1 mark

b. A second metal is coated onto the copper once the first solution is depleted.

i. Why won't a third metal be coated onto the copper?

_____

_____

ii. Write half equations to show the three reduction reactions that will occur.

_____

_____

_____

1 + 3 = 4 marks

Total 5 marks

Question 5

A student designs a cell for the production of magnesium and chlorine. The cell consists of 2 compartments separated by a solid barrier. The electrolyte used is a concentrated (4M) $MgCl_2$ solution to produce Cl_2 gas at the anode and magnesium metal at the cathode. A power source in the circuit provides a potential difference of 6.0V. Iron electrodes are used to reduce costs.

a. The design aspects are listed below. For each of these indicate if the design aspect is workable or not workable.

Design aspect	Workable or not workable
2 compartments separated by a solid barrier	
4M $MgCl_2$ electrolyte to produce Cl_2 gas at the anode	
4M $MgCl_2$ electrolyte to produce magnesium metal at the cathode	
Power source producing 6 volts	
Iron electrodes	

5 marks

b. For each of the design aspects that is not workable, explain why by referring specifically to the relevant Chemistry.

_____

_____

_____

_____

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_____

_____

_____

_____

6 marks
Total 11 marks

END OF KEY TOPIC TEST