



CHEMISTRY 2021

Unit 3

Key Topic Test 6 – Electrolysis

Recommended writing time*: 45 minutes

Total number of marks available: 50 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: A

Explanation:

Reduction of water occurs at the cathode. $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$
Therefore, the pH would increase.

Question 2

Answer: A

Explanation:

$Q = It = 1 \times 60 \times 10 = 600 \text{ C}$
 $n = Q/96500 = 600/96500 = 0.00622 \text{ mol}$
 $n(\text{Cr}) = n(\text{e}^-)/3 = 0.00207 \text{ mol}$
 $m = n \times M = 0.00207 \times 52.0 = 0.1078 \text{ g}$

Question 3

Answer: C

Explanation:

Overall equation is; $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, so the ratio of $\text{H}_2:\text{O}_2$ is 2:1

Question 4

Answer: B

Explanation:

The ratio of the mole of solid to the mole of electrons is 1:2. So the solid must form +2 ions, which must be magnesium.

Question 5

Answer: C

Explanation:

In an electrolytic cell, the reactants can mix as they do not spontaneously react with each other. However, the products must be separated as they often react with each other.

Question 6

Answer: D

Explanation:

The Pb electrode remains negative during both discharging and charging. Responses A, B and C are correct for only charging or discharging.

Question 7

Answer: A

Explanation:

oxidation $2\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$

reduction $2\text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$

Full equation $2\text{I}^- + \text{H}_2\text{O} \rightarrow \text{I}_2 + \text{H}_2 + 2\text{OH}^-$

So, $n(\text{H}_2) = \frac{1}{2}n(\text{I}^-)$

Question 8

Answer: B

Explanation:

$$n = m / M = 100\,000 / 27 = 3703$$

$$n(\text{CO}_2) = 3/4n(\text{Al}) = 2777$$

$$m(\text{CO}_2) = n \times M = 2777 \times 44 = 122\,000\text{g} = 122\text{ kg}$$

Question 9

Answer: D

Explanation:

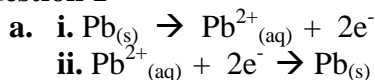
As carbon is involved in the reaction at the anode, the carbon anode needs to be replaced. The cell would need to be shut down for this to happen.

Question 10

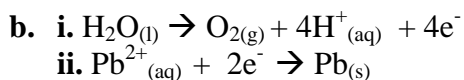
Answer: B

Explanation:

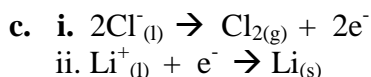
A molten electrolyte would be required as water will react in preference to aluminium ions. (Water is a stronger oxidant than Al^{3+})

SECTION B: Short-answer questions**Question 1**

2 marks

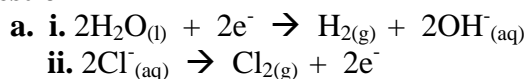


2 marks

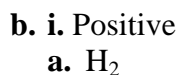


2 marks

Total 6 marks

Question 2

1 + 1 = 2 marks



1 + 1 = 2 marks

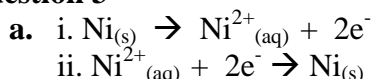
c. The membrane allows movement of ions* such as Na^{+*} and prevents the products from mixing.* (any 2 *)

2 marks

d. $n(\text{NaOH}) = 10^6/40 = 25\,000 \text{ mol} *$
 $n(e^{-}) = n(\text{NaOH}) \times 2 = 50\,000 \text{ mol} *$
 $Q = n \times 96\,500 = 50\,000 \times 96\,500 = 4\,825\,000\,000 \text{ C} *$
 $I = Q/t = 4\,825\,000\,000 / (60 \times 60 \times 24) = 55\,800 \text{ A} *$

4 marks

Total 10 marks

Question 3

1 + 1 = 2 marks

b. $n = 15\,000 / 96\,500 = 0.1554 \text{ mol}$
 $n(\text{Ni}) = n(e^{-}) / 2 = 0.1554 / 2 = 0.0777 \text{ mol}$
 $m = n \times M = 0.0777 \times 58.7 = 4.56\text{g}$

3 marks

c. 1.00M (Ni^{2+} is produced at the anode and consumed at the cathode)

1 mark

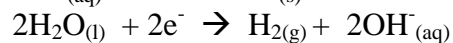
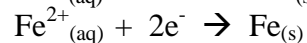
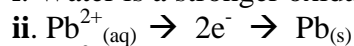
d. $n(\text{Ni}^{2+}) = 0.0777 \text{ mol}$
 $c = n/V = 0.0777 / 0.100 = 0.777 \text{ M} *$
 Change in concentration = $1.00 - 0.777 = 0.223 \text{ M} *$

2 marks

Total 8 marks

Question 4**a. Pb**

1 mark

b. i. Water is a stronger oxidant than Al^{3+} .

1 + 3 = 4 marks

Total 5 marks

Question 5**a.**

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

5 marks

You need a porous rather than a solid barrier* so ions can move between the two half cells and maintain electrical neutrality.*

Magnesium is not produced as water reacts* in preference to the Mg^{2+} as water is a stronger oxidant.*

Iron cannot be used as iron reacts* instead of Cl^- as iron is a stronger oxidant than Cl^- .*

6 marks

Total 11 marks