CHEMISTRY 2021

Unit 3
Key Topic Test 6 – Electrolysis

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

SOLUTIONS

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

Question 1

Answer: A

Explanation:

Reduction of water occurs at the cathode. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
Therefore, the pH would increase.

Question 2

Answer: A

Explanation:

Q = It = 1 x 60 x 10 = 600 C
n = Q/96500 = 600/96500=0.00622 mol
n(Cr) = n(e-)/3= 0.00207 mol
m = n x M = 0.00207 x 52.0 = 0.1078 g

Question 3

Answer: C

Explanation:

Overall equation is; $2H_2 + O_2 \rightarrow 2H_2O$, so the ratio of H_2: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.

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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 $2I^- \rightarrow I_2 + 2e^-$
reduction $2e^- \rightarrow H_2 + 2OH^-$
Full equation $2I^- + H_2O \rightarrow I_2 + H_2 + 2OH^-$
So, $n(H_2) = ½n(I^-)$

Question 8

Answer: B

Explanation:

$n = m / M = 100\ 000/27=3703$
$n(CO_2) = 3/4n(Al) = 2777$
$m(CO_2) = n \times M = 2777x44 = 122\ 000g = 122\ kg$

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+})

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SECTION B: Short-answer questions

Question 1

a. **i.** $Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2e^-$
ii. $Pb^{2+}_{(aq)} + 2e^- \rightarrow Pb_{(s)}$

2 marks

b. **i.** $H_2O_{(l)} \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$
ii. $Pb^{2+}_{(aq)} + 2e^- \rightarrow Pb_{(s)}$

2 marks

c. **i.** $2Cl^-_{(l)} \rightarrow Cl_{2(g)} + 2e^-$
ii. $Li^+_{(l)} + e^- \rightarrow Li_{(s)}$

2 marks

Total 6 marks

Question 2

a. **i.** $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$
ii. $2Cl^-_{(aq)} \rightarrow Cl_{2(g)} + 2e^-$

1 + 1 = 2 marks

b. **i.** Positive
a. H_2

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. $n(NaOH) = 10^6/40 = 25\ 000$ mol *
$n(e^-) = n(NaOH) \times 2 = 50\ 000$ mol *
$Q = n \times 96\ 500 = 50\ 000 \times 96\ 500 = 4825\ 000\ 000$ C *
$I = Q/t = 4825000000/(60*60*24) = 55\ 800$ A *

4 marks

Total 10 marks

Question 3

a. i. $Ni_{(s)} \rightarrow Ni^{2+}_{(aq)} + 2e^-$
ii. $Ni^{2+}_{(aq)} + 2e^- \rightarrow Ni_{(s)}$

1 + 1 = 2 marks

b. $n = 15\ 000 / 96500 = 0.1554$ mol
$n(Ni) = n(e-) / 2 = 0.1554 / 2 = 0.0777$ mol
$m = n \times M = 0.0777 \times 58.7 = 4.56$g

3 marks

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

1 mark

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

2 marks

Total 8 marks

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Question 4

a. Pb

1 mark

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

ii. $Pb^{2+}_{(aq)} \rightarrow 2e^- \rightarrow Pb_{(s)}$

$Fe^{2+}_{(aq)} + 2e^- \rightarrow Fe_{(s)}$

$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

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

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