



CHEMISTRY 2021

Unit 3

Key Topic Test 4 – Commercial and Rechargeable Cells

Recommended writing time*: 45 minutes

Total number of marks available: 50 marks

SOLUTIONS

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

Question 1

Answer: C

Explanation:

Reduction occurs at the cathode and the electrolyte is alkaline.

Question 2

Answer: C

Explanation:

Sulphuric acid is reacting so the density decreasing. Electrons flow from the Pb to PbO₂ electrode. The anode has a negative polarity and the mass of lead oxide decreases.

Question 3

Answer: B

Explanation:

The products of the electrode must remain in contact with the electrodes if the reaction is to be reversed. The electrons travel from the lead oxide to lead electrodes. The concentration of sulphuric acid will increase and the lead electrode has a negative polarity.

Question 4

Answer: B

Explanation:

Fuels cells are much more energy efficient than an internal combustion engine. Often around twice as efficient.

Question 5

Answer: C

Explanation:

Water is a product of the oxidation reaction.

Question 6

Answer: C

Explanation:

The difference in E^0 values in a hydrogen fuel cell is 1.23V

Question 7

Answer: D

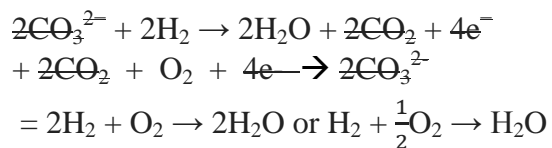
Explanation:

The arrow is in the internal circuit so electrons are not involved. Hydroxide ions are produced at the cathode and consumed at the anode.

Question 8

Answer: C

Explanation:



Question 9

Answer: D

Explanation:

The main difference between a primary and secondary cell is that secondary cells can be recharged by applying an external current.

Question 10

Answer: B

Explanation:

Self-discharge of a battery involves side reactions reducing the amount of active material. A and D occur but do not result in self-discharge.

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

- a. i. +4 to +3
ii. reduction

1 + 2 = 3 marks

- b. i. $\text{Zn}_{(s)} + 2\text{OH}^-_{(s)} \rightarrow \text{Zn}(\text{OH})_{2(s)} + 2e^-$
ii. $2\text{MnO}_{2(s)} + \text{H}_2\text{O}_{(l)} + 2e^- \rightarrow \text{Mn}_2\text{O}_{3(s)} + 2\text{OH}^-_{(s)}$

1 + 1 = 2 marks

- c. primary

1 marks

Total 6 marks

Question 2

- a. i. Cd
ii. NiO(OH)

1 + 1 = 2 marks

- b. the separator allows movement of ions between the two half cells* but prevents direct mixing of the reactants.*

2 marks

- c. the products must stay in contact with the electrodes* in a convertible form.*

2 marks

- d. $\text{Cd}(\text{OH})_{2(s)} + 2e^- \rightarrow \text{Cd}_{(s)} + 2\text{OH}^-_{(aq)}$
 $2\text{Ni}(\text{OH})_{2(s)} + 2\text{OH}^-_{(aq)} \rightarrow 2\text{NiO}(\text{OH})_{(s)} + 2\text{H}_2\text{O}_{(l)} + 2e^-$
 $\text{Cd}(\text{OH})_{2(s)} + 2\text{Ni}(\text{OH})_{2(s)} \rightarrow 2\text{NiO}(\text{OH})_{(s)} + 2\text{H}_2\text{O}_{(l)} + \text{Cd}_{(s)}$

3 marks

- e. Negative

1 mark

- f. An external power source is provided and a potential difference of greater than 1.3 V is applied in the reverse direction.

2 marks

- g. e.g. KOH. (anything with OH⁻ ions)

1 mark

Total 13 marks

Question 3

- a. Hydrogen could be stored as a metal hydride.

1 mark

- b. i. $\text{H}_{2(g)} \rightarrow 2\text{H}^+_{(aq)} + 2e^-$
ii. $\text{O}_{2(g)} + 4\text{H}^+_{(aq)} + 4e^- \rightarrow 2\text{H}_2\text{O}_{(l)}$

1 + 1 = 2 marks

- c. Potentially hydrogen gas could be obtained from renewable resources but natural gas is not renewable*. However fuel cells are much more energy efficient than internal combustion engines which reduces the amount of fuel consumed.*

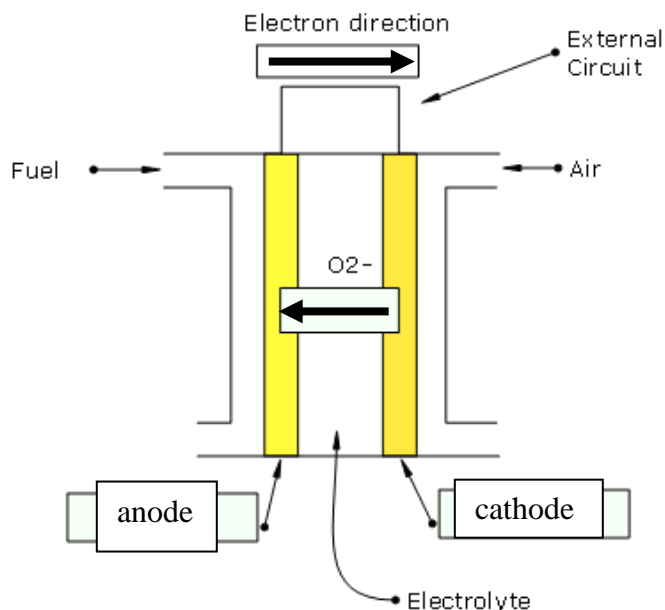
2 marks

- d. The power output of a fuel cell can be increased by using porous electrodes which increases their surface area* and using a material that acts as a catalyst for the reaction.*
2 marks
- e. Fuel cells are much more energy efficient than internal combustion engines.
1 mark

Total 8 marks

Question 4

- a.
b.



- c. $2\text{H}_{2(\text{g})} + \text{O}_{2(\text{g})} \rightarrow 2\text{H}_2\text{O}_{(\text{l})}$
- d. $\text{CH}_4 + 4\text{O}^{2-} \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 8\text{e}^-$
- e. (1 mark for using O^{2-} and 1 mark for balancing)

1 mark

2 marks
Total 7 marks

Question 5

- a. i. positive
ii. $\text{O}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})} + 4\text{e}^- \rightarrow 4\text{OH}^-_{(\text{aq})}$

1 + 1 = 2 marks

- b. Aluminium is lighter than lead* and oxygen from the air does not need to be stored.*
2 marks
- c. Aluminium is acting as a fuel* at the anode and oxygen reacts at the cathode*.
2 marks

Total 6 marks