Friday Worksheet **Name: ……………….**

Electrolytic cells worksheet 6

1) Fill in the gaps of the following

a) A lead-acid battery is made up of 6 lead-acid galvanic (voltaic) cells connected up in series each delivering 2 volts to give a total of 12 volt output.

b) When a lead-acid battery cell is producing electricity (discharging) it is converting chemical energy into electrical energy. This involves a spontaneous redox reaction.

c) Lead-acid cells are rechargeable because the reaction products adhere to the electrodes.

d) A galvanic cell, such as the lead-acid car battery, can be recharged by connecting the negative terminal of a battery charger to the negative terminal of the galvanic cell and the positive terminal of a battery charger to the positive terminal of the galvanic cell.

e) Recharging a lead-acid cell is a non-spontaneous electrolytic process because it requires the input of energy

f) Galvanic cells which can be recharged are known as secondary cells

2) The overall reaction that takes place as the battery discharges is given below.
$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4(aq) \Rightarrow 2PbSO_4(s) + 2H_2O(l)$

i. What is the half reaction taking place at the anode?
$Pb(s) + SO_4^{2-}(aq) \Rightarrow PbSO_4(s) + 2e$

ii. What is the half reaction taking place at the cathode?
$PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e \Rightarrow PbSO_4(s) + 2H_2O(l)$

iii. What happens to the pH of the electrolyte as the battery is discharging?
Increases as H^+ ions are being used.

iv. What is the composition of the electrode at the:
- anode Lead metal

- cathode Lead metal impregnated with PbO_2

v. Why can this cell be recharged?
Products ($PbSO_4$) remain in contact with the electrodes.

3) A lead acid battery is connected to a recharger as shown on the right.

a) Identify the anode and cathode for each image shown on the right.

b) As the battery is recharging, what is the half equation for the reaction that occurs at the

i. positive electrode.

$PbSO_4(s) + 2H_2O(l) => PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e$

ii. negative electrode

$PbSO_4(s) + 2e => Pb(s) + SO_4^{2-}(aq$

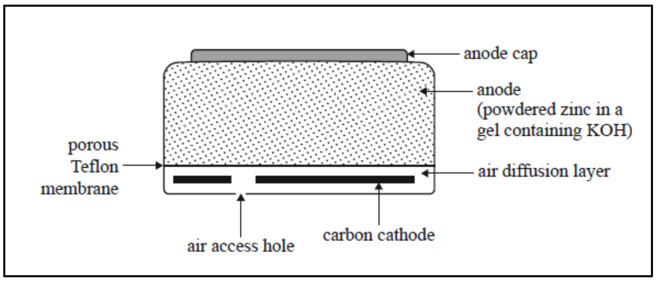
c) What is happening to the pH of the electrolyte during recharging?

$[H^+]$ increases hence pH decreases.

4) A zinc-air button cell is used in hearing aids and a simplified diagram is shown below. The anode is in the form of powdered zinc dispersed in gel that contains KOH as the electrolyte. The cathode is composed of a carbon disc.

The overall reaction is shown on the right.

$2Zn(s) + O_2(g) + 2H_2O(l) => 2Zn(OH)_2(s)$



a) Write the half reaction that occurs at the anode

The question clearly stated that KOH is the electrolyte. We write the half equations as if they occur in an alkaline environment. Click to refresh yourself with how to write half equations in an alkaline environment.

Oxidation occurs at the anode.

$Zn(s) + 2OH^-(aq) => Zn(OH)_2 + 2e$

b) Write the half reaction that occurs at the cathode

Reduction occurs at the cathode.

$4e + 2H_2O(l) + O_2(g) => 4OH^-(aq)$

c) What is the purpose of the KOH in the battery?

Correct responses included any response that identified the KOH as the medium through which ions move throughout the cell to form the internal circuit.

KOH is the electrolyte. The electrolyte allows for the movement of ions and as such any response should convey this understanding. Example are given below.

- allow for electrolytic conduction between the electrodes

- provide K+ ions (cations) to move towards the cathode and OH– (anions) to move towards the anode and balance the charges around the electrodes
- provide the internal circuit in the cell.

d) This zinc-air button cell is run for 5.0 hours at a steady current of 2.45 mA.

What mass of zinc hydroxide is formed?

$Q = 2.45 \times 10^{-3} \times 5 \times 60 \times 60$

$= 44.1$ C

$n(e^{-}) = 44.1/96500$

$= 4.57 \times 10^{-4}$ mol

$n(Zn(OH)_2)$ formed $= ½ \times 4.57 \times 10^{-4}$

$= 2.3 \times 10^{-4}$ mol

$m(Zn(OH)_2)$ formed $= 2.3 \times 10^{-4} \times 99.4 =$

$= 0.023$ g