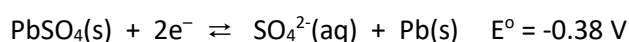
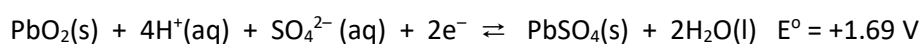


Friday Worksheet

Name:

Galvanic cells worksheet 4



- 1) The equations above are written as they would appear on the electrochemical series. The lead-acid battery is one form of energy storage cell. What substance is used for the following aspects of the battery?

The anode - **Lead**

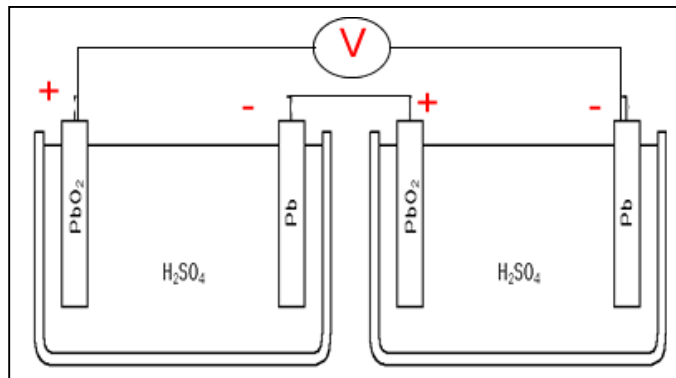
The cathode - **Lead impregnated with PbO₂**. A number of students stated PbO₂, however, students should be aware that a solid ionic compound does not conduct.

The electrolyte - **H₂SO₄ (aq)**



- (a) What happens to the pH of the electrolyte as the battery is:
- discharging
H⁺ ions are being used at the cathode to form water. The pH will increase.
 - recharging
The reaction at the cathode will be reversed so that the following reaction takes place.
$$\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{PbO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{e}^-$$
pH will decrease as the [H⁺] increases
- (b) Write the anode half-equation for when the battery is discharging.
$$\text{SO}_4^{2-}(\text{aq}) + \text{Pb}(\text{s}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$$
- (c) Write the cathode half-equation for when the battery is discharging.
$$\text{PbO}_2(\text{s}) + 4\text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$$
- (d) Knowing that reduction always occurs at the cathode, regardless of whether the cell is recharging or discharging, write the cathode half-equation for when the battery is recharging.
$$\text{PbSO}_4(\text{s}) + 2\text{e}^- \rightarrow \text{SO}_4^{2-}(\text{aq}) + \text{Pb}(\text{s})$$
- (e) What is the equation for the overall reaction taking place in the lead acid battery during discharge?
- (f) Why is it that the life of a battery is severely shortened if frequently knocked about? Explain
It can be recharged. Products remain in contact with the electrodes and hence reaction can be reversed. As it is knocked about products (PbSO₄) fall off the electrodes and hence unable to be converted back to the original reactants.
- (g) A car battery can deliver 12.0 volts and yet the cell above can deliver much less.
- Explain how this is possible.
Cells can be connected in series and hence deliver a voltage that is equivalent to the sum of the voltage of each battery.

ii. Below is a diagram showing two cells connected in series under standard conditions. What is the voltage measured at "V"? **4.14 volts.**



iii. Will the anode increase or decrease in mass as the two cells discharge. Explain

As PbSO₄ is deposited it will increase in mass.

iv. Will the cathode increase or decrease in mass as the two cells discharge. Explain

As PbSO₄ is deposited it will increase in mass