B13 · Extra practice

Worked solutions | Items 1-2

Extra practice for this lesson. Original questions, not released diploma items. Select one option for multiple choice; other tasks state the required response.

Use the givens and conditions in each prompt. Enter the requested count, coefficient, oxidation number or potential with the stated unit and precision.

B13-D01 · Numerical response

A lead-acid cell uses PbO_2 (+1.69 V) as the cathode and $PbSO_4$/Pb (−0.36 V) as the anode. What is E°cell, in volts to two decimal places?

1. E°cell = 1.69 − (−0.36) = +2.05 V.

2. Cathode value minus anode value.

B13-D02 · Numerical response

A battery is made of lead-acid cells of 2.05 V each, joined in a row. How many cells give 12.3 V? Enter an integer.

1. The voltages add, so 12.3 ÷ 2.05 = 6 cells.

2. Divide the voltage needed by the voltage of one cell.

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Worked solutions | Items 3-4

B13-D03 · Numerical response

A hydrogen fuel cell uses $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ (+1.23 V) and $2H^+ + 2e^- \rightarrow H_2$ (0.00 V). What is E°cell, in volts to two decimal places?

1. E°cell = 1.23 − 0.00 = +1.23 V.

2. Oxygen is reduced at the cathode and hydrogen is oxidized at the anode.

B13-D04 · Multiple choice

A battery is recharged. What kind of cell is it during recharging?

A. A voltaic cell
B. An electrolytic cell
C. A fuel cell
D. Neither

1. A power supply forces the reaction backward, so the battery is an electrolytic cell.

2. Recall which kind of cell needs a power supply.

B13 · Extra practice

Worked solutions | Items 5-6

B13-D05 · Select all that apply

Select every correct statement about a discharging lead-acid battery.

A. Pb is oxidized at the anode
B. Solid $PbSO_4$ forms on both electrodes
C. The acid becomes more concentrated
D. Each electrode gains mass

1. Lead is oxidized at the anode and $PbSO_4$ forms on both electrodes, so both gain mass. The acid is used up and gets weaker.

2. Sulfate and hydrogen ions are used up as $PbSO_4$ and water form.

B13-D06 · Multiple choice

What is the difference between a fuel cell and a battery?

A. A fuel cell is fed its reactants, but a battery stores a fixed amount
B. A fuel cell is an electrolytic cell
C. A battery needs no electrolyte
D. A fuel cell stores all of its fuel inside

1. A fuel cell keeps running while it is fed fuel and oxygen. A battery runs down when its reactants are used up.

2. Ask where the reactants come from in each case.

B13 · Extra practice

Worked solutions | Items 7-8

B13-D07 · Multiple choice

In $Zn + 2OH^- \rightarrow ZnO + H_2O + 2e^-$ in an alkaline cell, which electrode is zinc?

A. The anode, because zinc is oxidized
B. The cathode, because zinc is oxidized
C. The anode, because zinc is reduced
D. The cathode, because zinc is reduced

1. Zinc loses electrons, so it is oxidized, and oxidation always happens at the anode.

2. Oxidation happens at the anode.

B13-D08 · Numerical response

How many moles of electrons are transferred for each mole of Zn in $Zn + 2OH^- \rightarrow ZnO + H_2O + 2e^-$? Enter an integer.

1. The half-reaction shows $2e^-$ for each zinc atom.

2. Read the coefficient of e^-.

B13 · Extra practice

Worked solutions | Items 9-10

B13-D09 · Multiple choice

Copper oxide is heated with charcoal: $2CuO + C \rightarrow 2Cu + CO_2$. Which statement is correct?

A. Carbon is the reducing agent

B. Carbon is the oxidizing agent

C. Copper is oxidized

D. Nothing changes oxidation number

1. Copper goes from +2 to 0 and is reduced. Carbon goes from 0 to +4 and is oxidized, so carbon is the reducing agent.

2. Find what gives electrons.

B13-D10 · Matching

Match each item to its description.

Items to match:

1. Primary cell
2. Secondary cell
3. Fuel cell
4. Salt-water pool system

Targets:

A. Rechargeable

B. Used once

C. Fed fuel all the time

D. Makes chlorine by electrolysis

1. A primary cell is used once, a secondary cell is rechargeable, a fuel cell is fed fuel, and a pool system electrolyses salt water.

2. Name how each type of cell or system is used in practice.

B13 · Extra practice

Worked solutions | Items 11-12

B13-D11 · Multiple choice

In $Cl_2 + 2OH^- \rightarrow Cl^- + OCl^- + H_2O$, what are the oxidation numbers of chlorine in Cl_2, Cl^- and OCl^-?

A. 0, −1 and +1

B. 0, +1 and −1

C. −1, 0 and +1

D. 0, −1 and −1

1. Cl_2 is an element, so 0. Cl^- is −1. In OCl^- the sum is −1 and oxygen is −2, so chlorine is +1.

2. Use the oxidation-number rules from B2.

B13-D12 · Written response

A company says that a battery is the best choice because it has the highest voltage. Explain what other evidence is needed to judge it for a purpose.

1. A higher voltage does not prove a longer life, lower cost or lower impact. The job decides which evidence matters.

2. Compare mass, lifetime, recharging, cost and disposal.