B14 · Investigation: plan and predict

Student notes - complete the underlined spaces | Notes 1/2

Write a testable question, draw a labelled cell design, predict the anode and voltage from the table, plan safe handling and plan a battery.

Name: _____ Date: _____

1. Question, variables and design

A testable question

We have used the table to predict voltages. Now we test the predictions. A testable question links one thing we change to one thing we measure.

The variable you change is the _____ variable. The variable you measure is the _____ variable. Here we change the metal and measure the voltage.

A fair test keeps everything else the same. These are the controlled variables: the _____, temperature, electrode size and salt bridge.

The table values assume _____ solutions at standard conditions. If a control changed, we could not tell what caused a change in voltage.

On the diploma: the independent variable is what you change, and the dependent variable is what you measure.

A labelled design

A half-cell is a metal strip, called an electrode, in a solution of its _____. The second half-cell is always copper in copper(II) sulfate.

A _____ lets ions move between the half-cells. This keeps the charge balanced and completes the circuit. A voltmeter joins the strips through wires.

Label the _____, the cathode, the direction of electron flow and the concentrations. Electrons flow in the wire from the anode to the cathode.

On the diploma: a labelled diagram needs the salt bridge, the solutions with concentrations, the wires and the meter.

Zn/Cu cell, 0.500 A for 30.0 min. q = _____

$n(e^-) = 900 \div (9.65 \times 10^4)$ = _____

$Zn \rightarrow Zn^{2+} + 2e^-$, so zinc lost = _____

$Cu^{2+} + 2e^- \rightarrow Cu$, so copper gained = _____

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Student notes - complete the underlined spaces | Notes 2/2

2. Predict, stay safe and plan a battery

Predict before measuring

The metal with the _____ reduction value is the anode, because that metal is oxidized. The higher value is the cathode.

Zn/Cu: zinc (−0.76 V) is lower, so zinc is the anode. E°cell = cathode − anode = 0.34 − (−0.76) = _____. Dropping the minus sign gives a classic wrong answer.

Ag/Cu: silver (+0.80 V) has the higher value, so copper is the _____. E°cell = 0.80 − 0.34 = _____. Copper is not always the cathode.

When you double a half-reaction to balance electrons, you do not _____ its table value. The voltage does not depend on the number of copies.

A prediction is not an _____. Only a measurement shows what the cell does. Ask where a number came from: the table or a meter.

Safety and disposal

Read the _____ and the safety data sheet first. They are part of _____, the system for labelling hazardous materials in workplaces.

Wear goggles, gloves and an apron. Silver nitrate stains skin. Copper(II) compounds harm life in water.

Collect solutions that contain metal _____. Do not pour them down the drain, because they can harm water life.

On the diploma: name the hazard from the label, then a matching precaution, and give a reason for each step.

Plan a battery

Cells in a row _____ their voltages. A device needs at least 3.0 V, and one Zn/Cu cell gives 1.10 V.

So 3.0 ÷ 1.10 = 2.7. We cannot use part of a cell, so round up and use _____ cells. They give 3 × 1.10 = 3.30 V. Two cells give only 2.20 V.

The voltage _____ as the cell works, because the reactants get used up. So the plan must include a test over time.

A bigger table voltage does not always make a better battery. Magnesium gives 2.71 V with copper but reacts with water. On the diploma: name a practical fact such as safety, cost or lifetime.

B14 · Practice

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State symbols: (s) solid, (aq) dissolved in water, (l) liquid, (g) gas. Use the supplied reaction and conditions. B4 values name the Alberta Chemistry 30 Data Booklet table where used.

B14-P01 · Easy · Given the question "How does the metal in one half-cell change the cell voltage?" Name the independent variable and the dependent variable.

B14-P02 · Easy · Name two variables that must be controlled when you compare metals joined to copper, and explain why.

B14-P03 · Easy · List the parts that a labelled diagram of a zinc and copper cell must show.

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B14-P04 · Easy · Explain what the salt bridge does in your design.

B14-P05 · Medium · Given Fe^{2+}/Fe −0.45 V and Cu^{2+}/Cu +0.34 V. Predict the anode, the cell reaction and the voltage.

B14-P06 · Medium · Given Ag^{+}/Ag +0.80 V and Cu^{2+}/Cu +0.34 V. Which metal is the anode and what is the voltage?

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B14-P07 · Medium · Given Ni^{2+}/Ni −0.26 V and Ag^{+}/Ag +0.80 V. Write the cell reaction and find the voltage. Explain why the silver table value is not doubled.

B14-P08 · Medium · A student predicts +0.79 V and says this proves the measured voltage will be 0.79 V. Explain what is wrong.

B14-P09 · Challenging · Name two hazards or precautions for a plan that uses silver nitrate solution, and one disposal step.

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B14-P10 · Challenging · A device needs at least 3.0 V. Using 1.10 V cells in a row, find how many cells are needed and the voltage of the battery.

B14-P11 · Challenging · Explain why a metal with a large cell voltage can still be a poor choice for a battery. Use magnesium as an example.

B14-P12 · Challenging · Given a plan and a prediction only. State what they can show and what they cannot show, and why a real measurement may differ.