B15 · Investigation: analyze and explain

Completed notes | Notes 1/2

Put together given evidence, compare predictions with observations, explain differences, identify products and judge a battery design.

1. Evidence and comparison

Put together the evidence

In B14 we predicted each voltage. Now we look at results. This lesson uses a **supplied** sample set that we did not measure.

Pairs are predicted/measured: Zn 1.10/1.07 V, Fe 0.79/0.76 V, Ni 0.60/0.57 V, Ag 0.46/0.43 V. Each row is one cell.

A good table has a title, **units** in the headings, the predicted column and the measured column. Note the controlled conditions too.

The measured column holds **observations**, because those numbers came from a voltmeter. The predicted column holds values from the reduction table.

On the diploma: a common wrong choice mixes up observation and prediction. Ask which column came from a measurement.

Compare

Difference = predicted − **measured**. Each cell here is **0.03** V lower than the prediction. That is a pattern with a direction and a size.

The order also matches, with zinc highest and silver lowest. So the data **support** the table. We say support, not prove.

A percent difference compares the gap with the prediction. For zinc, 0.03 ÷ 1.10 × 100 = **2.7** %. A small gap means close agreement.

On the diploma: describe a pattern with its direction and size, with the unit. Do not just say the numbers are close.

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Completed notes | Notes 2/2

2. Explain, identify and evaluate

Explain a difference

Three possible causes fit a constant gap: the salt bridge adds **resistance**, the strips have **oxide** coatings, or the concentration is not exactly 1.0 mol/L.

Temperature is another, because the table assumes 25 °C. A good report records the room temperature and the concentration.

To test a cause, change **one** thing and measure again. For example, sand the strips and see if the voltage rises toward the prediction.

Until the test is done, the cause is **possible**, not proven. On the diploma: never claim a cause that was not tested.

Identify products

In the Zn/Cu cell, the zinc strip loses mass, so zinc is oxidized. The copper strip gains a **reddish-brown** coating, so copper ions are reduced.

An observation is what we see or measure. An inference is a conclusion drawn from it. Zn^{2+} is colourless, so it is an **inference**.

In the Ag/Cu cell, copper is the anode. The copper strip loses mass, and the copper solution is already blue, so it gets **deeper** blue as Cu^{2+} forms.

A conclusion has a **claim**, the evidence and an explanation. Name a limitation and an **improvement**, such as three trials averaged.

On the diploma: to identify a product, name the observation that supports it.

Battery design and disposal

Three cells of 1.07 V give $3 \times 1.07 =$ **3.21 V**. Judge voltage, mass, cost, lifetime and **leaks**, because voltage is only one part of the evidence.

Used batteries contain metals that can harm soil and water, so they are collected for **recycling**. Recycling has benefits and costs, like the energy it needs.

A hydrogen fuel cell gives about 1.23 V per cell. A fair presentation gives purpose, reactions, benefits and **limits**, and states the source of its evidence.

On the diploma: to evaluate a technology, name evidence that supports it and a limit that remains.

B15 · Worked 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.

B15-P01 · Easy · Name three things that a good data table includes.

1. A title, headings with units, and the predicted values beside the measured values.

2. The controlled conditions should also be noted so that a reader can judge the test.

B15-P02 · Easy · Which column of the table holds observations and which holds predictions? Explain.

1. The measured column holds observations, because they come from measuring.

2. The predicted column holds values from the reduction table.

B15 · Worked practice

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B15-P03 · Easy · Given a given result for zinc and copper: predicted 1.10 V, measured 1.07 V. Find the difference.

1. The difference is predicted minus measured.

2. 1.10 − 1.07 = 0.03 V, so the measured value is 0.03 V lower.

B15-P04 · Easy · All four given cells are 0.03 V below the prediction and the order matches. Does the data support the table? Give a reason.

1. Yes. The order of the voltages is the same as predicted.

2. Each value is within 0.03 V of the prediction, so the table predicts the order and the size well.

B15 · Worked practice

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B15-P05 · Medium · Give two possible explanations for a small constant gap and say how to test one of them.

1. The salt bridge adds resistance, and the strips may have an oxide coating.

2. Sand the strips, measure again and see if the voltage moves closer to the prediction. Change only one thing.

B15-P06 · Medium · Explain why a possible cause should not be stated as proven before a test.

1. A possible cause fits the evidence but has not been tested.

2. Only a test that changes one thing shows if that thing causes the gap.

B15 · Worked practice

Investigation: analyze and explain | Questions 7-8 of 12

B15-P07 · Medium · In a zinc and copper cell the zinc strip loses mass and the copper strip gains a reddish-brown coating. State two observations and the half-reactions they support.

1. Observations: the zinc loses mass and the copper gains a coating.

2. $Zn \rightarrow Zn^{2+} + 2e^{-}$ and $Cu^{2+} + 2e^{-} \rightarrow Cu$.

B15-P08 · Medium · $Zn^{2+}(aq)$ is colourless. Is its formation an observation or an inference? Explain.

1. It is an inference, not an observation.

2. You cannot see the ions. You reason that they form because the zinc strip loses mass.

B15 · Worked practice

Investigation: analyze and explain | Questions 9-10 of 12

B15-P09 · Challenging · Given a given nickel and copper result: predicted 0.60 V, measured 0.57 V. Write a short conclusion with a claim, evidence and one possible explanation.

1. Claim: the result agrees with the table. Evidence: 0.57 V against 0.60 V and the strip changes.

2. Explanation: the salt bridge or an oxide coating could lower the voltage a little.

B15-P10 · Challenging · A design uses one trial for each cell. Give one limitation and one improvement.

1. One trial cannot show how much the measurement varies.

2. Repeat three trials and take the average, and clean the strips before each trial.

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Investigation: analyze and explain | Questions 11-12 of 12

B15-P11 · Challenging · Four cells of 1.07 V are joined in a row. Find the battery voltage and name one disposal step for the used battery.

1. The voltages add: 4 × 1.07 = 4.28 V.

2. Collect the used battery for recycling. Do not put it in the garbage, because it contains metals that can harm soil and water.

B15-P12 · Challenging · Name two parts that a short fuel cell presentation must include, and say why the source of evidence should be stated.

1. Include any two of the purpose, the half-reactions, the benefits and the limits.

2. The source lets a reader check the claims. A claim without evidence cannot be judged.