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|  | **Constructing a galvanic cell** |

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|  | CAUTION: ALL CHEMICALS ARE IRRITANTS CuS  AND Fe ARE CORROSIVE. Zn AND K ARE FLAMMABLE; KEEP THEM AWAY FROM OPEN FLAMES. DO NOT DISPOSE OF ANY CHEMICALS DOWN THE SINK. WEAR PERSONAL PROTECTIVE EQUIPMENT AT ALL TIMES. IF CHEMICALS COME IN CONTACT WITH YOUR SKIN, FLUSH THE AFFECTED AREA FOR 15\_MINUTES. CONSULT A HEALTHCARE PROFESSIONAL IF ANY CHEMICALS ARE INGESTED. | **Aim**  To determine the order of metals on the electrochemical series by constructing galvanic cells made from various metal / metal ion half-cells.  **Materials**  • 50 mL 1 M CuS  • 50 mL 1 M Fe  • 50 mL 1 M Zn  • 50 mL 1 M Al  • 200 mL 1 M K  • 4 × 100 mL beakers  • One 2 × 10 cm piece of each of copper, iron (or a nail), zinc and aluminium  • Pen for labelling glassware  • 6 strips of filter paper (approx. 3 × 15cm)  • 2 × alligator clips  • Plastic tweezers  • Voltmeter  • Emery paper  • Wash bottle with deionised water  • 200 mL waste beaker  **Method** |
| Construct a galvanic cell using two metal/metal-ion half-cells.  Source:*Chemistry 2019 v1.3 General Senior Syllabus*  © Queensland Curriculum & Assessment Authority  **Context**  Galvanic cells are constructed from two half-cells, a salt bridge, connecting wires and a voltmeter.  The reducing and oxidising ability of each half-cell determines the amount of energy produced by each cell, and can be measured with the voltmeter.  The electrochemical series allows you to predict the outcome of a galvanic cell and the voltage that will result. These half-cells have been measured against the hydrogen half-cell (0.00 V) at 25ºC, 1 M and 1 atm. | |
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| **1** Construct four half-cells by placing 50 mL of the copper sulfate solution in a 100 mL beaker and adding the copper strip, which acts as the electrode. Repeat this for the iron, zinc and aluminium half-cells. Label each beaker as the respective solution. Remember to scour the metal strips with emery paper.  **2** Immerse one piece of the filter paper in the potassium nitrate solution. Using the plastic tweezers, remove it from the solution and place it as a bridge between two of the half-cells (see  Figure 1 on the previous page).  **3** Connect an alligator clip to each of the metal electrodes.  **4** Connect the other end of each electrode to the voltmeter. If the voltmeter has a negative reading, swap the wires that are connected to the terminals.  Note: As soon as the electrodes are connected to the voltmeter, the electrochemical circuit is complete and the voltmeter will immediately measure the voltage of the cell. This must be recorded immediately because it will reduce over time.  You must also record whether each electrode is positive or negative in the galvanic cell. This can be determined by looking at the voltmeter. The negative electrode connects to the negative  terminal and the positive electrode connects to the positive terminal.  **5** Deconstruct the galvanic cell, ensuring that the filter paper is disposed of in the waste beaker and that no solution in the half-cell contaminates another.  **6** Reconstruct the galvanic cell until every pair of half-cells have been connected and the results have been recorded. | | **Results**  Construct a table (such as the one below) that records the voltage produced by each of the six galvanic cells as well as the polarity of the electrodes.   |  |  |  |  | | --- | --- | --- | --- | | Galvanic Cell | Metal Compound Solution | Voltage (V) | Polarity of Electrodes | | 1 |  |  |  | | 2 |  |  |  | | 3 |  |  |  | | 4 |  |  |  | | 5 |  |  |  | | 6 |  |  |  |   **Discussion**  **1** Which electrode is always negative, and which is  always positive? Use this information to list the half-cells in order with the strongest oxidant first.  **2** Does your half-cell order agree with the half-equations on the electrochemical series in the QCAA Chemistry formula and data book?  **3** Use the electrochemical series to draw the six galvanic cells as they are explained in Worked example 7.1B (page 171). You must also add the of each cell, as shown in Worked example 7.2 (page 176).  **4** Do the theoretical and experimental values match? Explain why this is.  **5** What is the salt bridge in the experiment?  Explain why this ionic solution was selected as the salt bridge.  **6** On the electrochemical series, copper is the highest half-equation because copper ions are the strongest oxidant. What materials can be used to construct a copper half-cell if it is connected to a tin half-cell? Explain why you chose these materials.  **Conclusion**  Summarise the outcomes of this practical. |