Order of Half equations in the Electrochemical Series
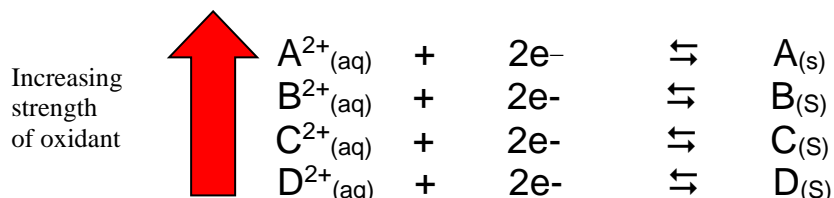
Before conducting this investigation complete the virtual experiment in this link.

Aim
To perform an experiment to determine the order of four half equations and hence create a mini "electrochemical series".

Each half –equation can be represented in the form:

Increasing strength of oxidant →

$$A^{2+}_{(aq)} + 2e^- \rightleftharpoons A_{(s)}$$
$$B^{2+}_{(aq)} + 2e^- \rightleftharpoons B_{(S)}$$
$$C^{2+}_{(aq)} + 2e^- \rightleftharpoons C_{(S)}$$
$$D^{2+}_{(aq)} + 2e^- \rightleftharpoons D_{(S)}$$

Materials
- 4 x unidentified half cells, labelled 'A' to 'D'
- 50 mL of 0.1 M potassium nitrate solution
- 100 mL beaker
- voltmeter
- 2 x wire leads with alligator clips
- filter paper for salt bridges
- safety glasses

Safety
Wear safety glasses and a laboratory coat for this experiment.
Solutions in some of the half cells are corrosive and toxic.
Handle the half cells with care.

Method
1. A number of half cells have been prepared and labelled A to D. Six stations around the room have been set up to allow you to compare all the various combinations of half-cells by creating a number of electrochemical cells.

2. At each station, use the filter paper and KNO_3 solution Salt bridge) to connect the half cells. Then connect the cell to the voltmeter so that a positive reading is achieved. Use the voltmeter to determine the polarity of the electrodes and the voltage output of the cell. Keep in mind:

   - *The negative electrode is the anode where the reductant is oxidised.*
   - *The positive electrode is where the oxidant is reduced.*

   Disconnect the cell once you have the information you require.

3. Use this information to fill in the table in the results section. Determine the reaction (oxidation or reduction) occurring in each half cell and hence identify the stronger oxidant in each combination.

Results

Complete a results table shown below.

Half cell setup	Half cell forming the posative electrode	Half cell forming the negative electrode	Voltage	Oxidation half equation	Reduction half equation	Oxidant	Reductant
$A^+/A \; \| \; B^{2+}/B$							
$A^+/A \; \| \; C^+/C$							
$A^+/A \; \| \; D^+/D$							
$B^{2+}/B \; \| \; C^+/C$							

Table 1

Use the information you gathered to develop a mini electrochemical series for the half equations for the half-cells A^+ / A to D^+ / D showing the strongest oxidant at the top of your series (you do not need to assign voltage values).

List the four reduction half equations, in the form X^{2+} (aq) + e → X^+(aq), in order of increasing strength of oxidant in the table below
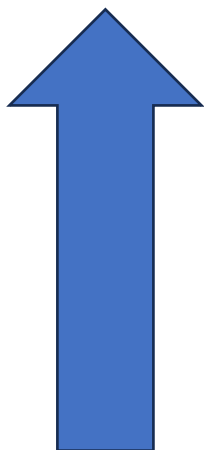
Increasing Strength of oxidant

Discussion

1. Include a BRIEF explanation of how you used the experimental data to establish order of oxidant strength.

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_____

2. Find the cell voltage of each of the galvanic cells listed below using the data collected from the prac.

   $B^{2+}/B \ || \ D^+/D$

   $C^+/C \ || \ D^{2+}/D$

3. Results of the $B^{2+}/B \ || \ D^+/D$ cell from two groups conducting this experiment, under the same conditions, are given table 2.

Group	Trial 1 (V)	Trial 2(V)	Trial 3 (V)
1	0.26	0.25	0.26
2	0.20	0.19	0.20

Table 2

Figure 1

   a. Are the results in table 2 :
      i.   repeatable? Explain

_____
_____
_____
_____

      ii.   reproducible? Explain.

_____
_____
_____
_____

b. Suggest two possible errors one with the equipment and one with the method. Explain how this contributed to results shown in table 1.

   i.   Equipment

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   ii.   Method

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c. Are the results obtained during this investigation valid for the laboratory conditions at which the experiment was conducted? Explain the reasoning for your answer.

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Conclusion
Write an appropriate conclusion for this experiment.

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