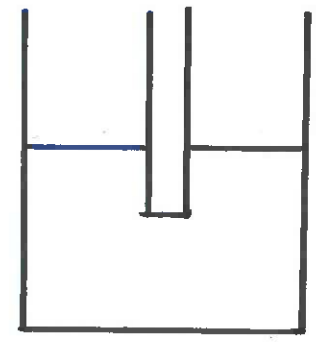




Half Cells & Half Equations

• A half cell is (usually) made up of:

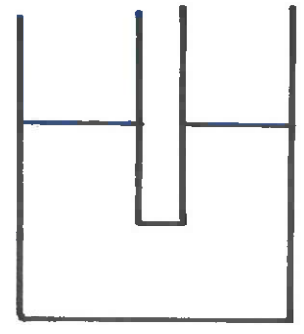


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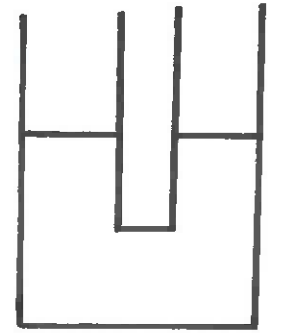


Equilibrium can Shift

Forward Reaction



Reverse Reaction





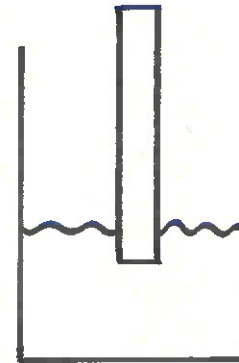
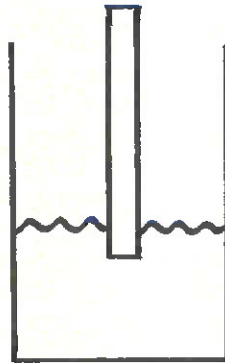
Combining Half-Cells: Conventions

- 1
- 2
- 3
- 4
- 5

e.g.



LHS
O
A
N



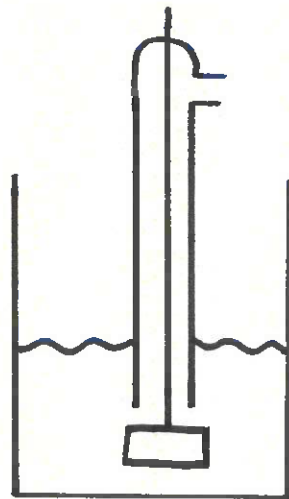
RHS
R
C
P

Short Hand



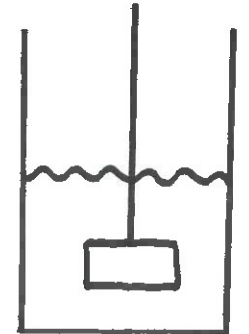
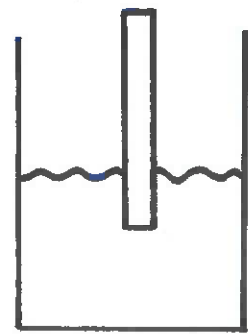
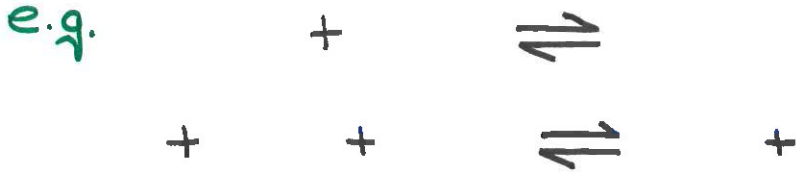
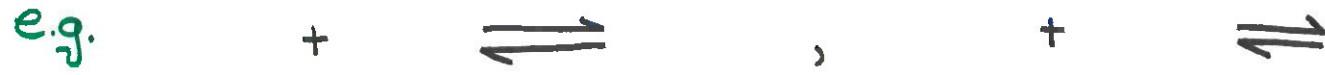
The Standard Hydrogen Electrode (___) 1 2 3 4 5

e.g.





Half Cells on Ions in Solution





The Electrochemical Series

HALF-EQUATION	ELECTRODE POTENTIAL / E ⁰ (V)
$\text{Li}^+_{(\text{aq})} + \text{e}^- \rightleftharpoons \text{Li}_{(\text{s})}$	-3.03
$\text{Ca}^{2+}_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Ca}_{(\text{s})}$	-2.87
$\text{Mg}^{2+}_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Mg}_{(\text{s})}$	-2.37
$\text{Al}^{3+}_{(\text{aq})} + 3\text{e}^- \rightleftharpoons \text{Al}_{(\text{s})}$	-1.66
$\text{Fe}^{2+}_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Fe}_{(\text{s})}$	-0.44
$2\text{H}^+_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{H}_{2(\text{s})}$	0.00
$\text{Cu}^{2+}_{(\text{aq})} + 2\text{e}^- \rightleftharpoons \text{Cu}_{(\text{s})}$	+0.34
$\text{Ag}^+_{(\text{aq})} + \text{e}^- \rightleftharpoons \text{Ag}_{(\text{s})}$	+0.80



Calculating EMF

- 1
- 2
- 3
- 4
- 5

HALF-EQUATION	ELECTRODE POTENTIAL / E° (V)
$\text{Li}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Li}(\text{s})$	-3.03
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ca}(\text{s})$	-2.87
$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mg}(\text{s})$	-2.37
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Al}(\text{s})$	-1.66
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80



=

-

AKA

=

-

e.g.

Greatest EMF Value?

Smallest EMF Value?



Predicting Reactions AKA "The Anticlockwise Rule"

1 2 3 4 5

HALF-EQUATION	ELECTRODE POTENTIAL / E° (V)
$\text{Li}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Li}(\text{s})$	-3.03
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ca}(\text{s})$	-2.87
$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mg}(\text{s})$	-2.37
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Al}(\text{s})$	-1.66
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80

①

②

Making Predictions

Q! Will $\text{Al}(\text{s})$ displace Ca^{2+} in $\text{CaCl}_2(\text{aq})$?

Overall



Predicting The Feasibility of Reactions

e.g. Will Calcium react with dil. H_2SO_4 ?



e.g. Will Copper react with dil. H_2SO_4 ?



Limitations

e.g.

NB, Kinetics (rate) of the reaction may be slow that no real reaction is seen!!



E°_{cell} : Changing Conditions

e.g.

+

\rightleftharpoons

+

\rightleftharpoons

Overall :

+

\rightleftharpoons

+

Concentration

Temperature

$\therefore \uparrow$ Temp

\downarrow Temp



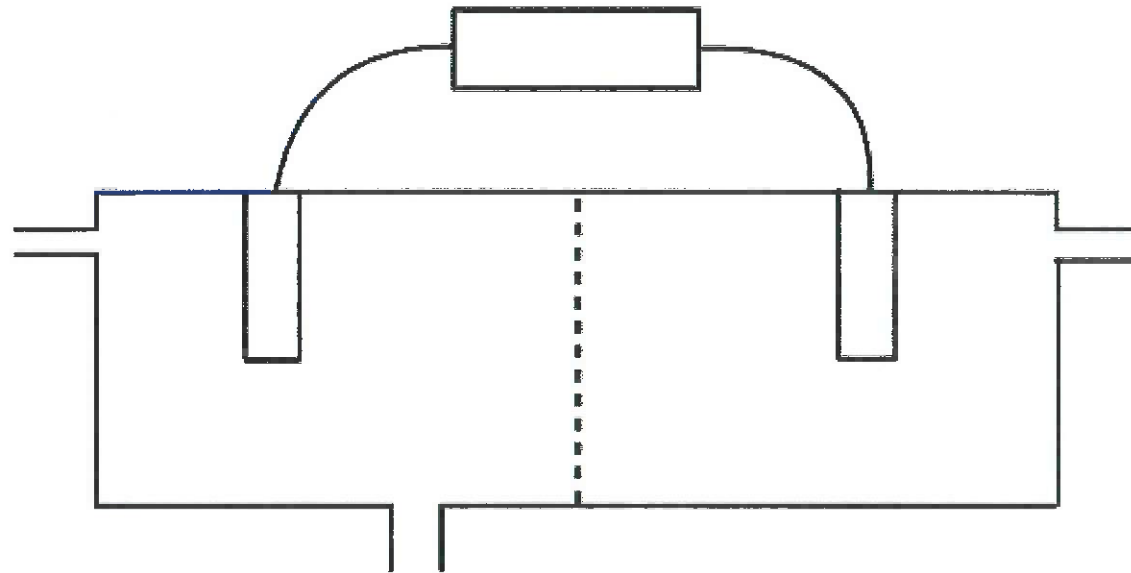
Storage Cells: Lithium Ion Batteries

- 1
- 2
- 3
- 4
- 5

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Fuel Cells



(A)

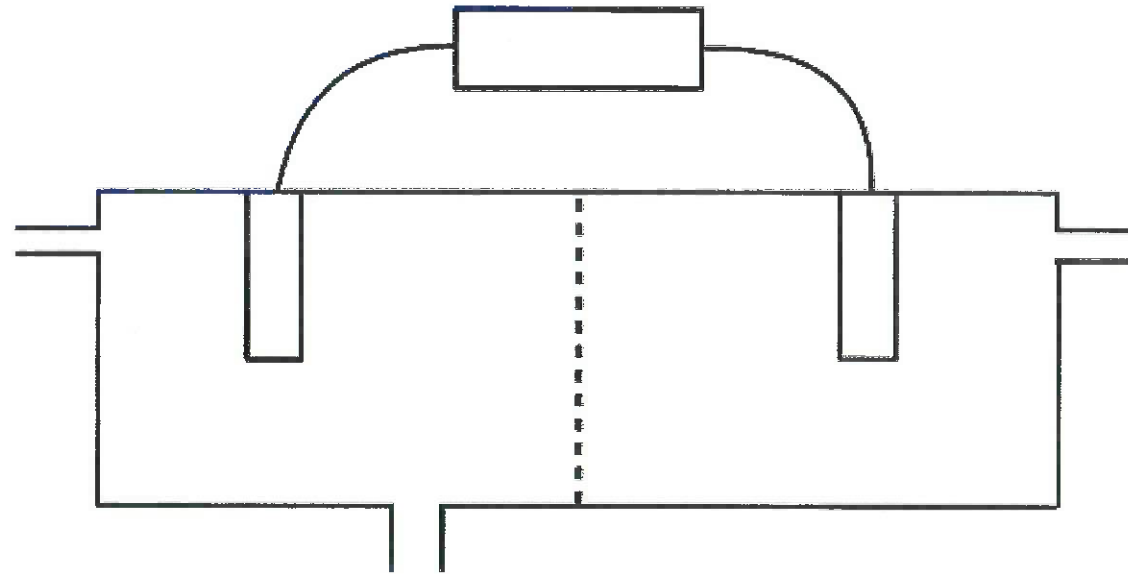
(B)

Overall :



Hydrogen Fuel Cells

1 2 3 4 5



Overall:



Hydrogen Fuel Cells: Pros & Cons

1 2 3 4 5

PROS	CONS
<ul style="list-style-type: none">••••••••••	<ul style="list-style-type: none">••••••