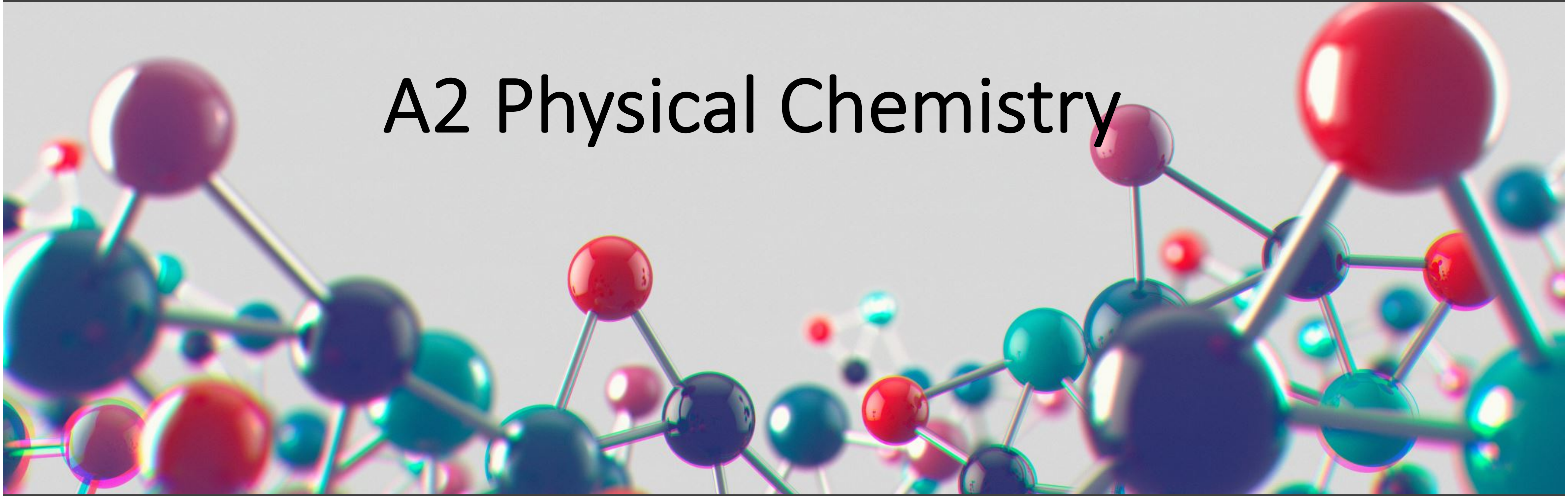

A2 Physical Chemistry

Measuring Electrode Potentials

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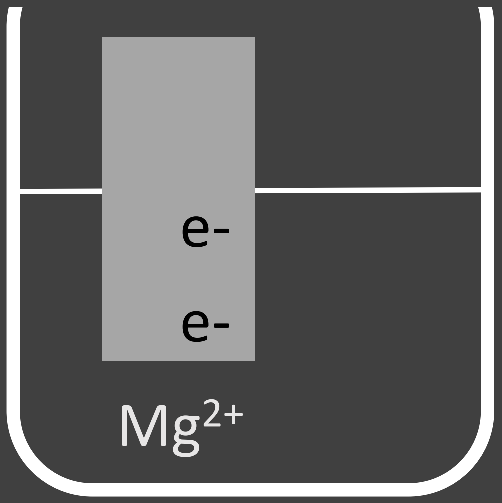
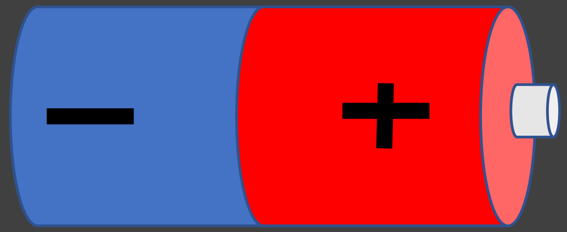
Measuring Electrode Potentials

We charge that collects on the electrode is known as the electrode potential and the Mg^{2+}/Mg equilibrium is known as a half cell.



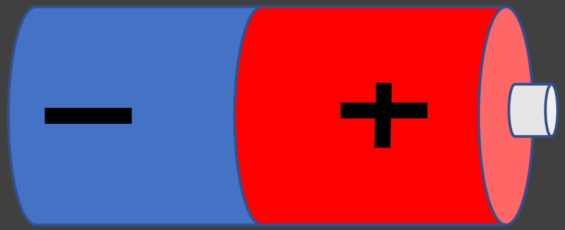
However in order to measure the electrode potential for Mg you need to form a complete circuit.

Measuring Electrode Potentials



We can compare our situation with a battery. A battery has a negative and positive end.

Measuring Electrode Potentials

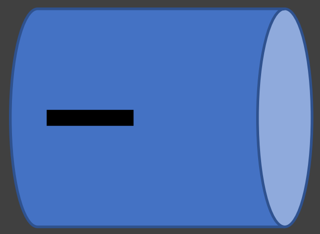


We can compare our situation with a battery. A battery has a negative and positive end. The voltage is the difference in electrical potential between the two ends.

Measuring Electrode Potentials

$Mg^{2+}_{(aq)} + 2e- \rightrightarrows Mg_{(s)}$

Electrode Potential A



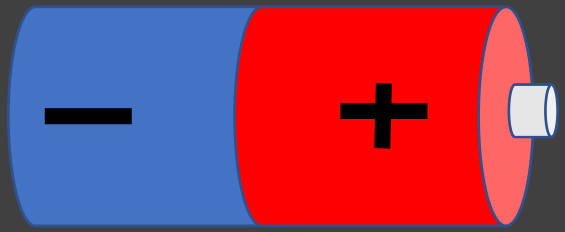
We can compare our situation with a battery. A battery has a negative and positive end. The voltage is the difference in electrical potential between the two ends.
Currently with our Mg^{2+}/Mg system we only have one end.

Therefore we have to have another half cell in order to measure the electrode potential of the Mg^{2+}/Mg half cell.

Measuring Electrode Potentials

$Mg^{2+}_{(aq)} + 2e^- \rightrightarrows Mg_{(s)}$

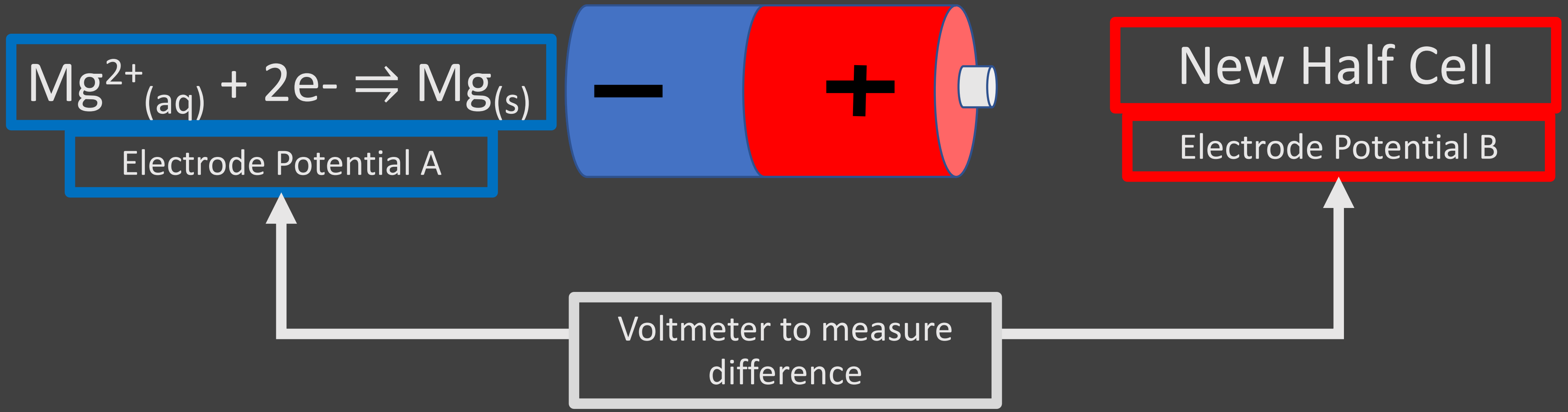
Electrode Potential A



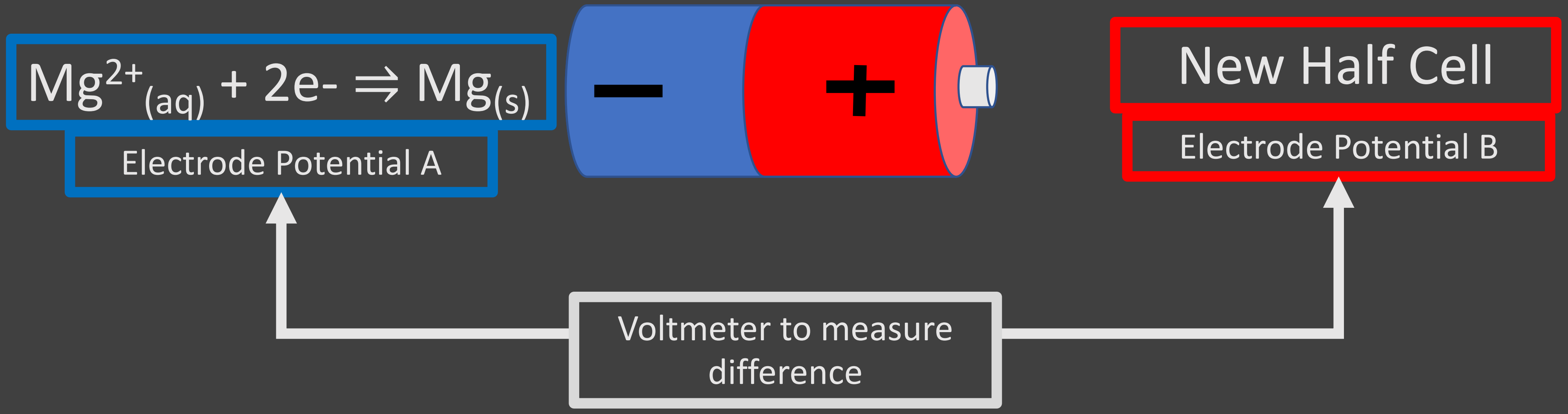
New Half Cell

Electrode Potential B

Measuring Electrode Potentials

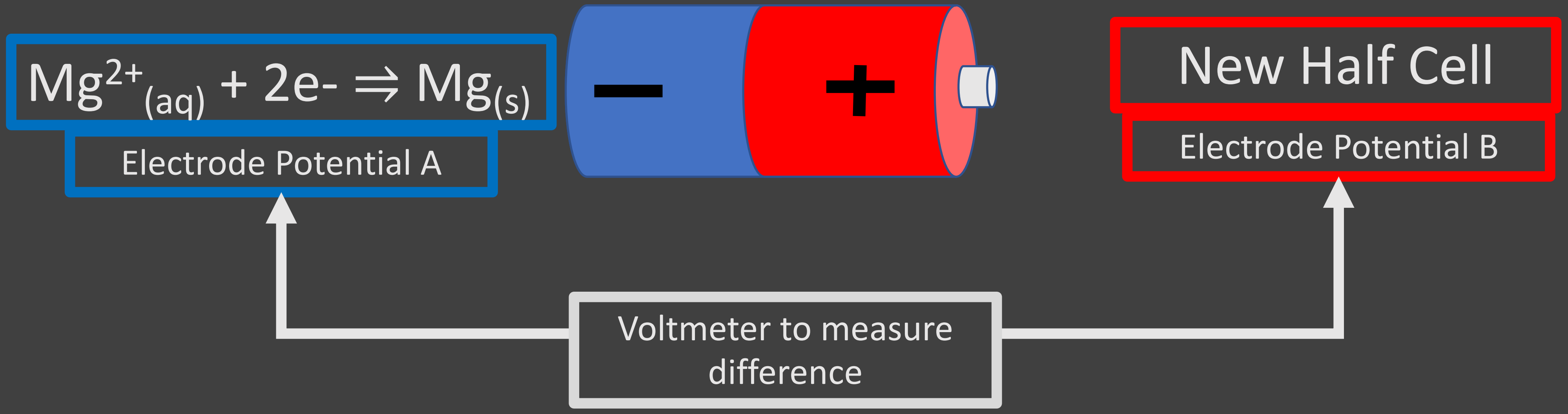


Measuring Electrode Potentials



Electrode Potential A = Voltage – Electrode Potential B

Measuring Electrode Potentials



Electrode Potential A = Voltage – Electrode Potential B

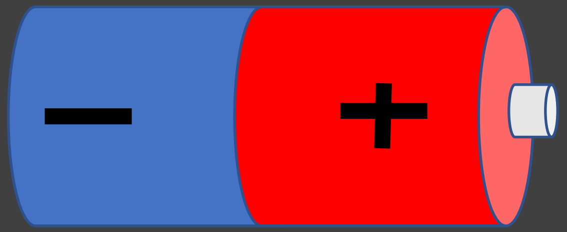
However how we will know the electrode potential of the Mg^{2+}/Mg electrode as the other half cell?

If we don't know Electrode Potential B, we cannot find Electrode Potential A.

Measuring Electrode Potentials

$Mg^{2+}_{(aq)} + 2e^- \Rightarrow Mg_{(s)}$

Electrode Potential A



New Half Cell

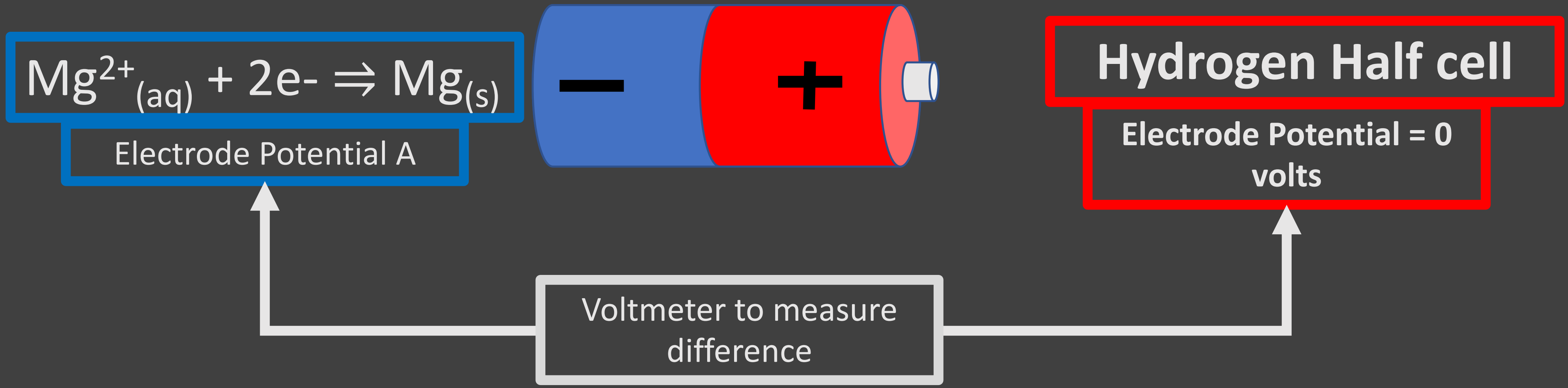
Electrode Potential B

Voltmeter to measure difference

Electrode Potential A = Voltage – Electrode Potential B

We deal with this by setting the defining the electrode potential of the $2H^+/H_2$ half cell as 0 volts. Electrode potentials of all other half cells are then quoted compared to the hydrogen half cell.

Measuring Electrode Potentials



Electrode Potential A = Voltage – Electrode Potential B

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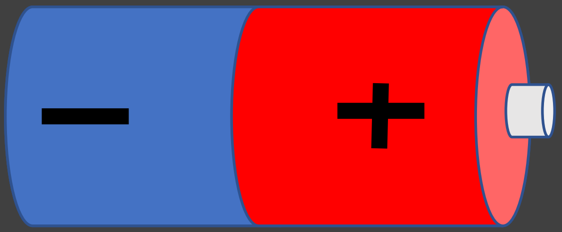
Measuring Electrode Potentials

$Mg^{2+}_{(aq)} + 2e^- \Rightarrow Mg_{(s)}$

Electrode Potential A



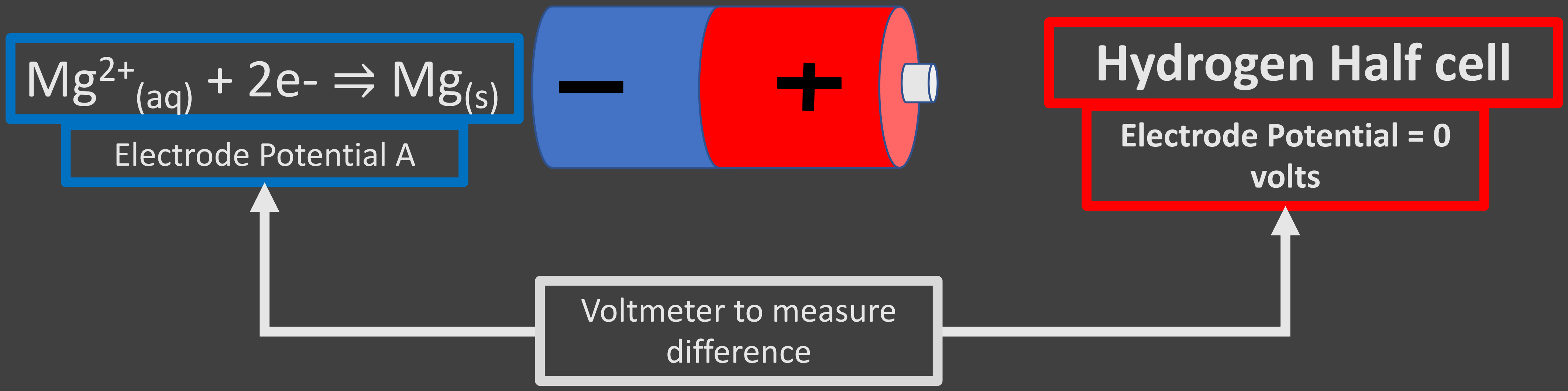
Hydrogen Half cell

Electrode Potential = 0 volts

Voltmeter to measure difference

Electrode Potential A = Voltage – 0

Measuring Electrode Potentials



Electrode Potential A = Voltage

Hydrogen Half Cell

$2H^+_{(aq)} + 2e^- \rightrightarrows H_{2(g)}$

Hydrogen Half Cell

$2H^+_{(aq)} + 2e^- \rightleftarrows H_{2(g)}$

No metal to form a circuit?

How do we deal with gases?

What concentration of $H^+_{(aq)}$ to use?

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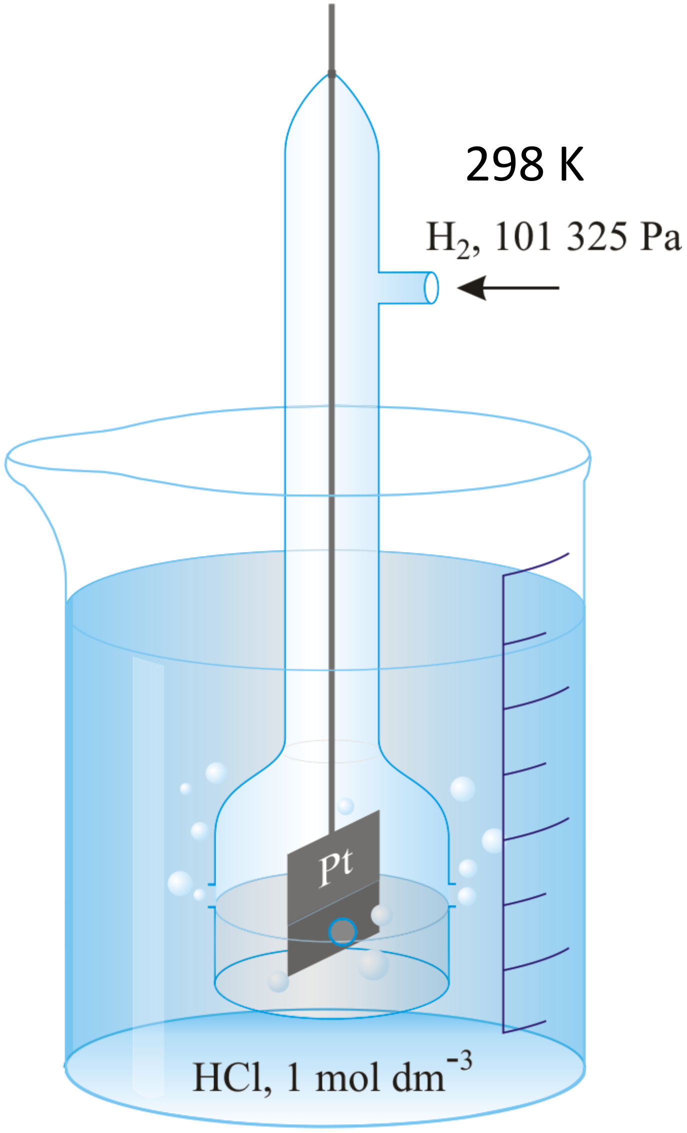
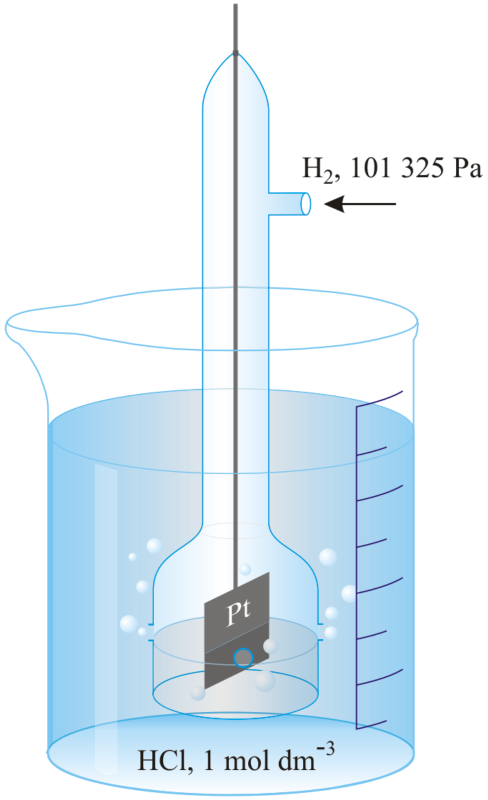
What concentration of $H^+_{(aq)}$ to use?

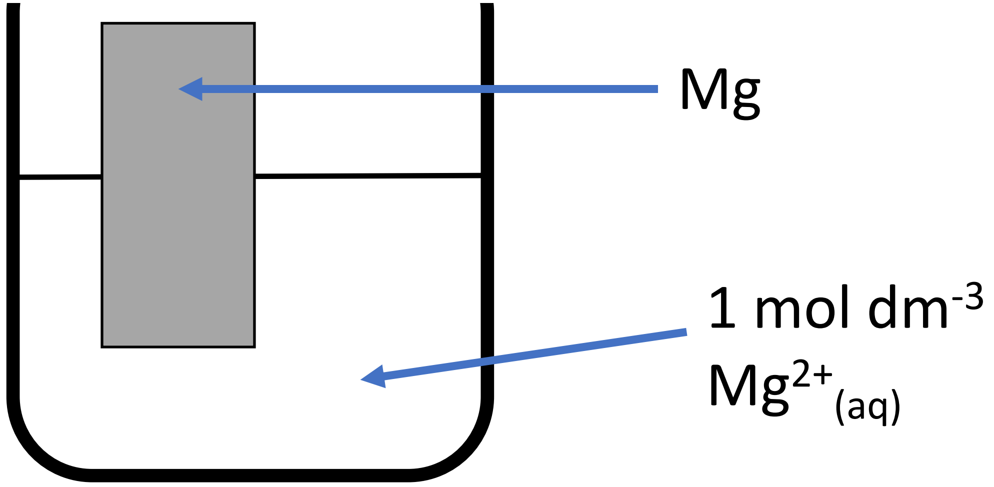
Hydrogen Half Cell

$$2H^+_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$$

Standard Electrode Potential = 0 volts



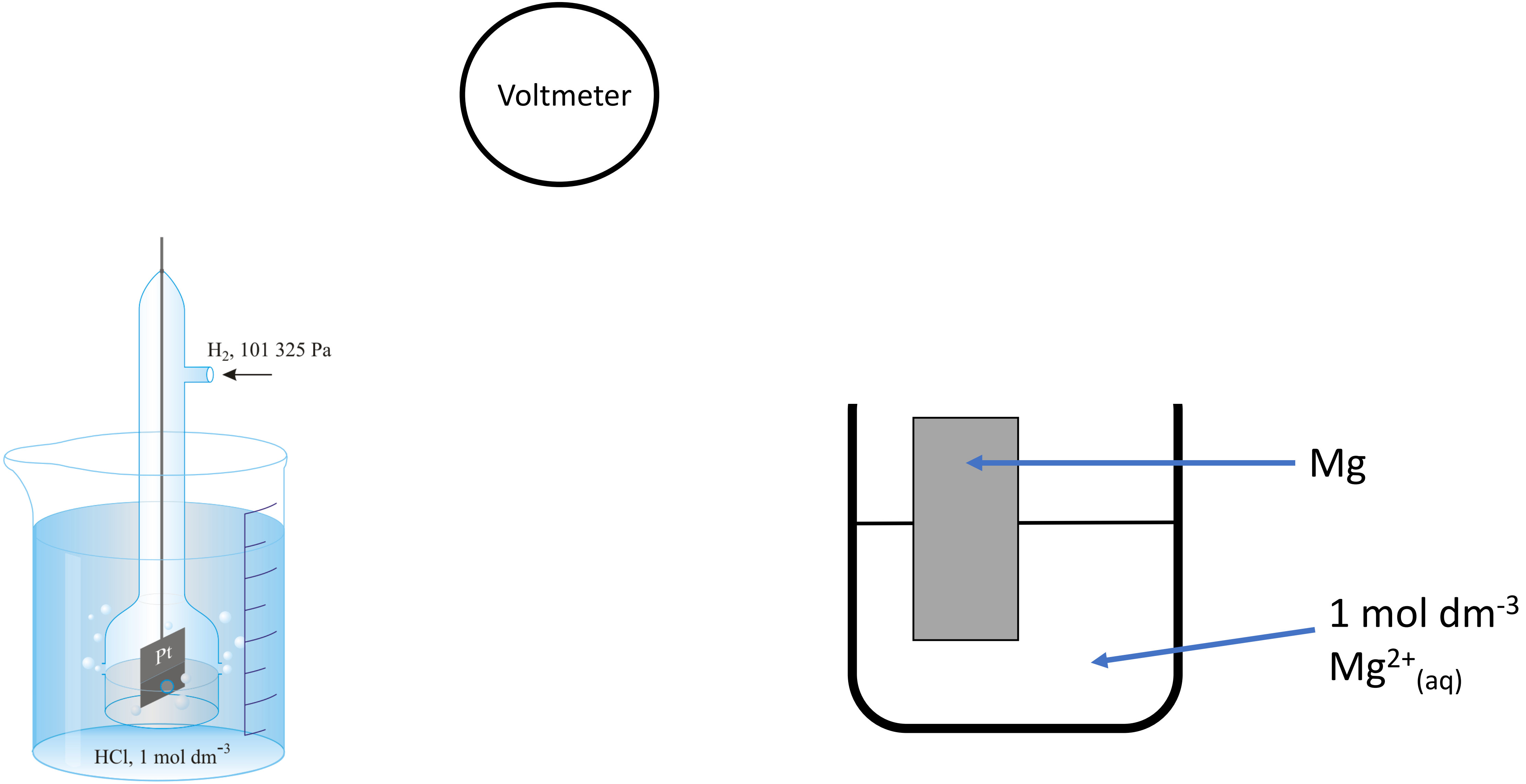




$$2H^+_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$$

Standard Electrode Potential = 0 volts

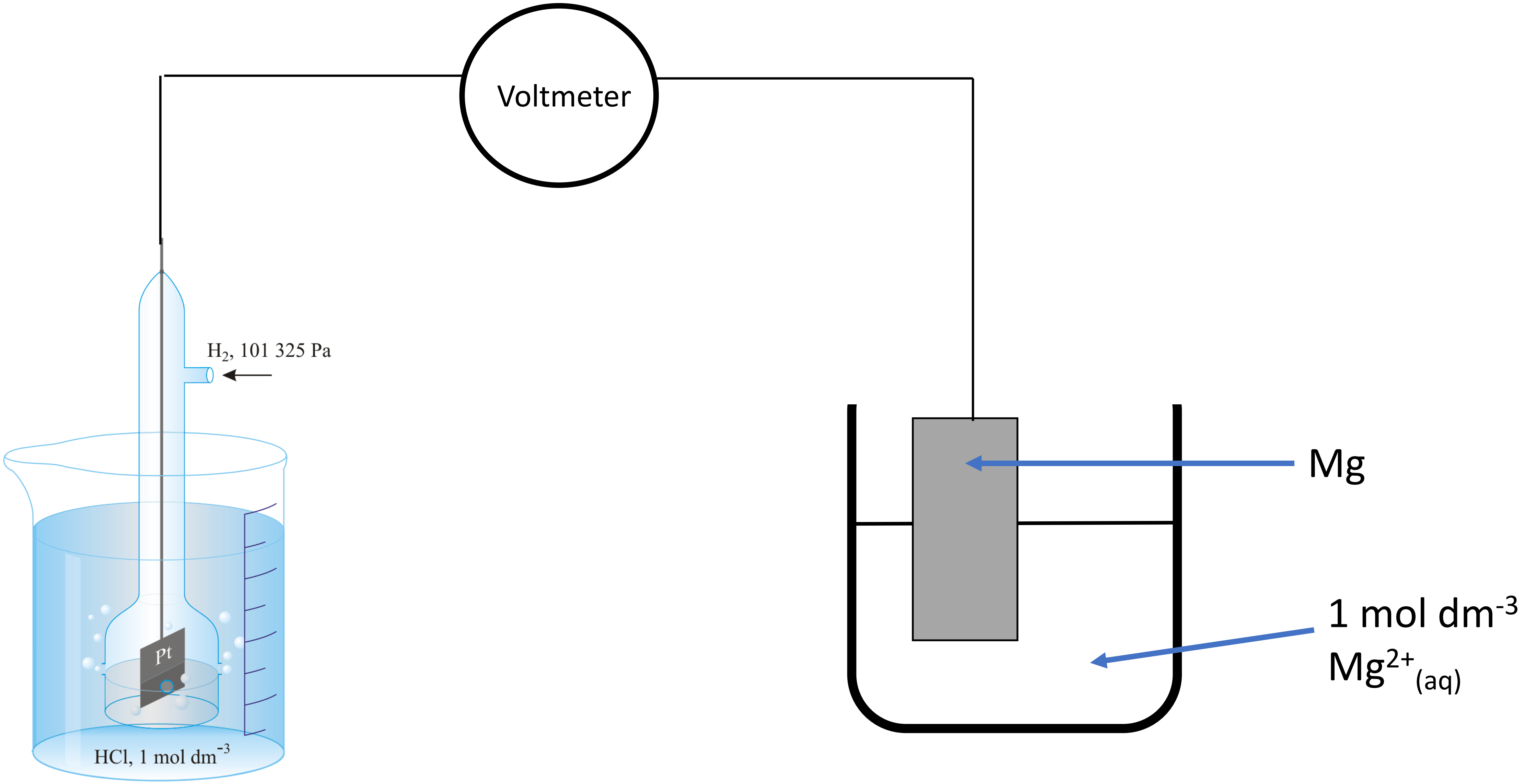
$$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$$



$2H^{+}_{(aq)} + 2e^{-} \rightleftharpoons H_{2(g)}$

$Mg^{2+}_{(aq)} + 2e^{-} \rightleftharpoons Mg_{(s)}$

Standard Electrode Potential = 0 volts



$$2H^+_{(aq)} + 2e- \rightleftharpoons H_{2(g)}$$

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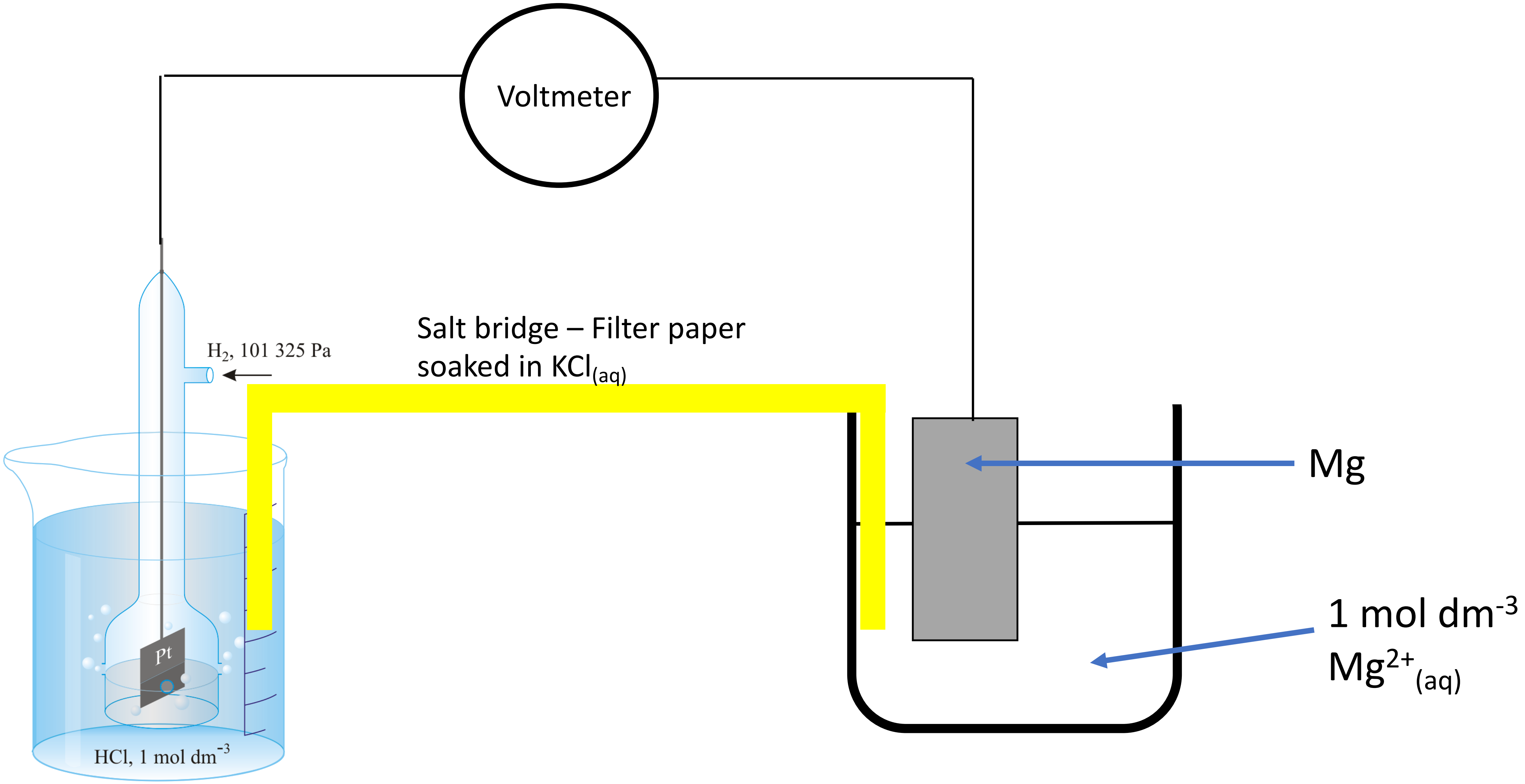
Standard Electrode Potential = 0 volts



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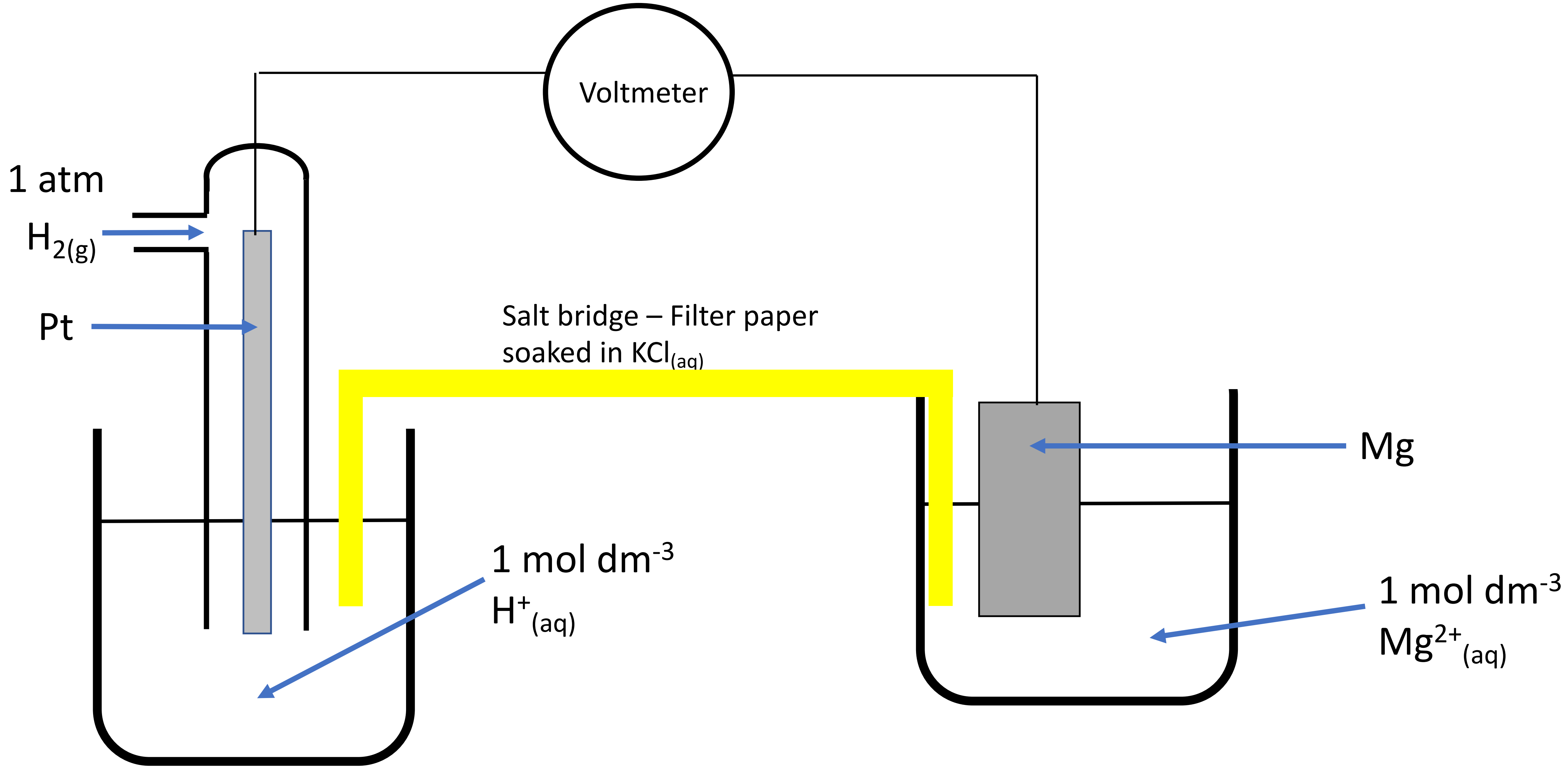

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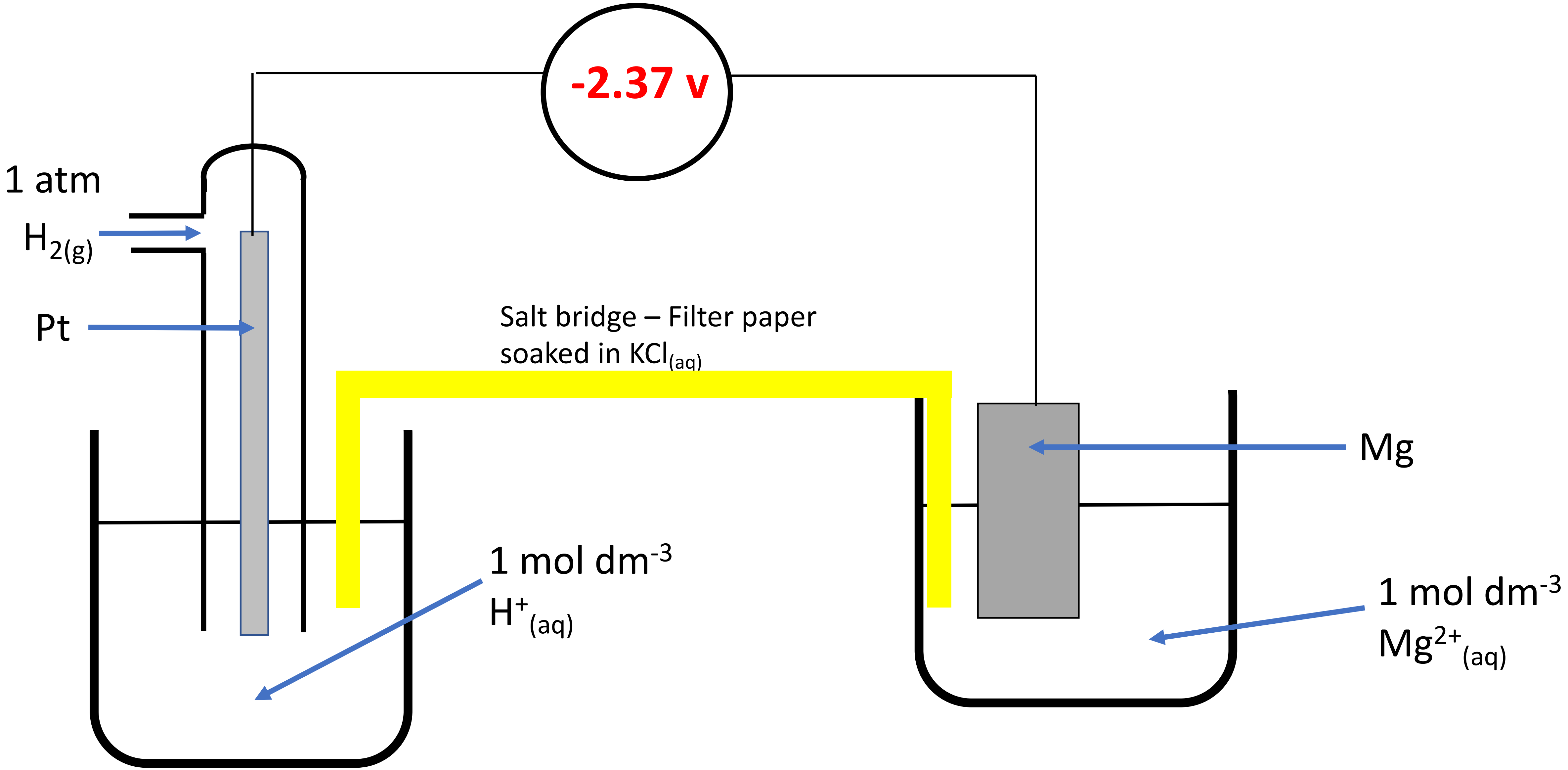

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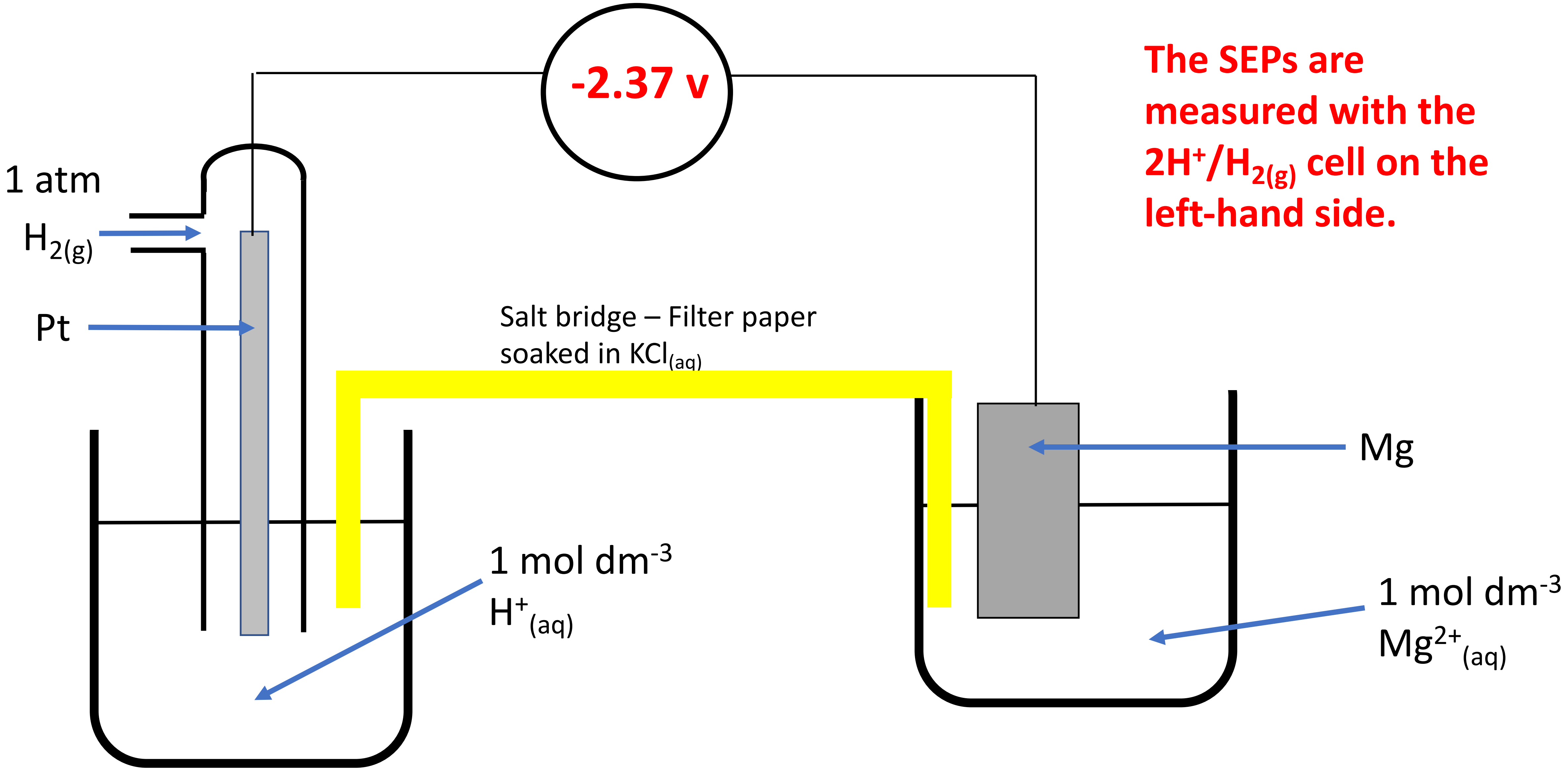
Standard Electrode Potential = ?



The SEPs are measured with the $2H^+/H_{2(g)}$ cell on the left-hand side.

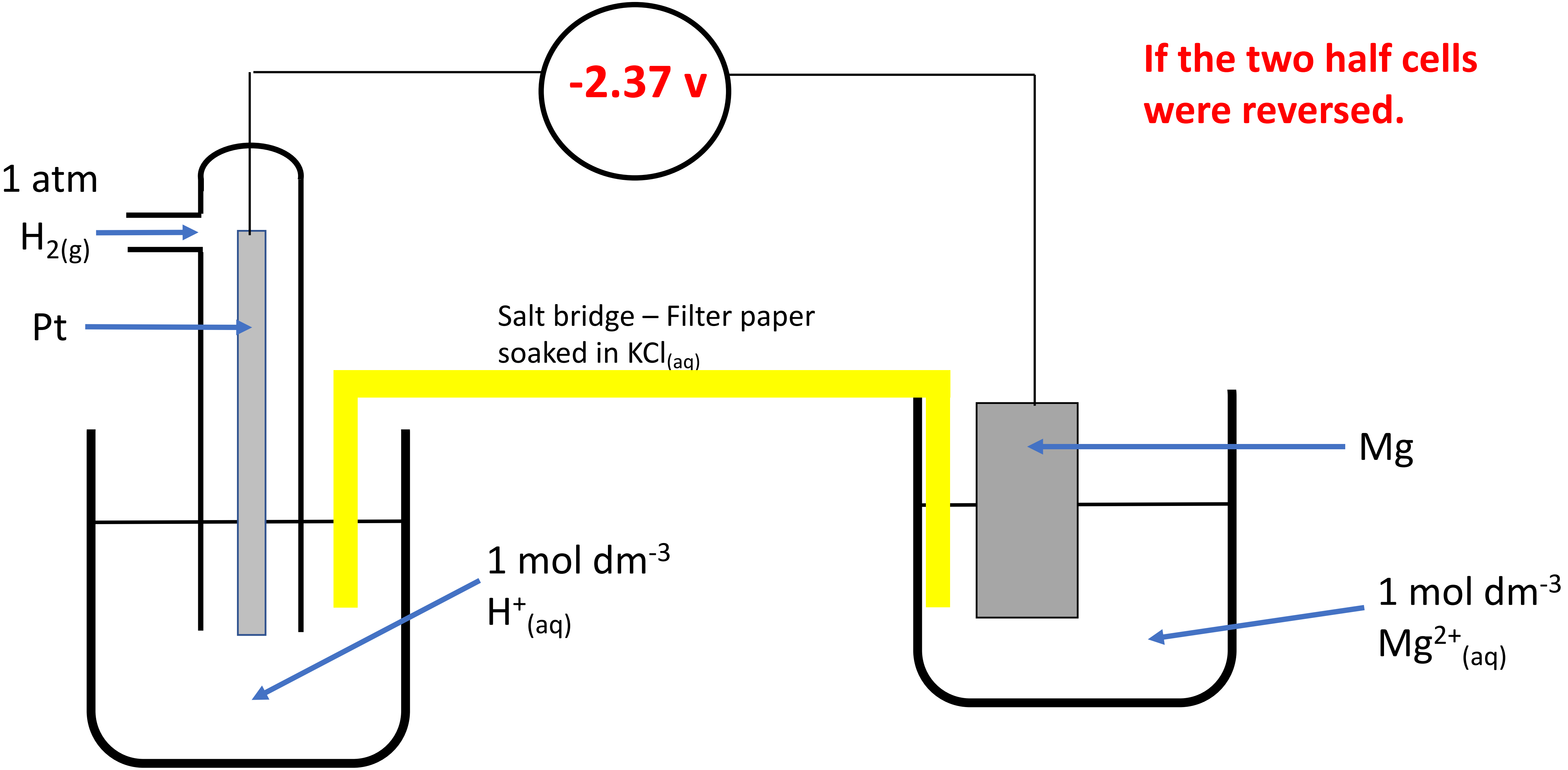
$$2H^+_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$$

Standard Electrode Potential = 0 volts

$$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$$

Standard Electrode Potential = ?

If the two half cells were reversed.



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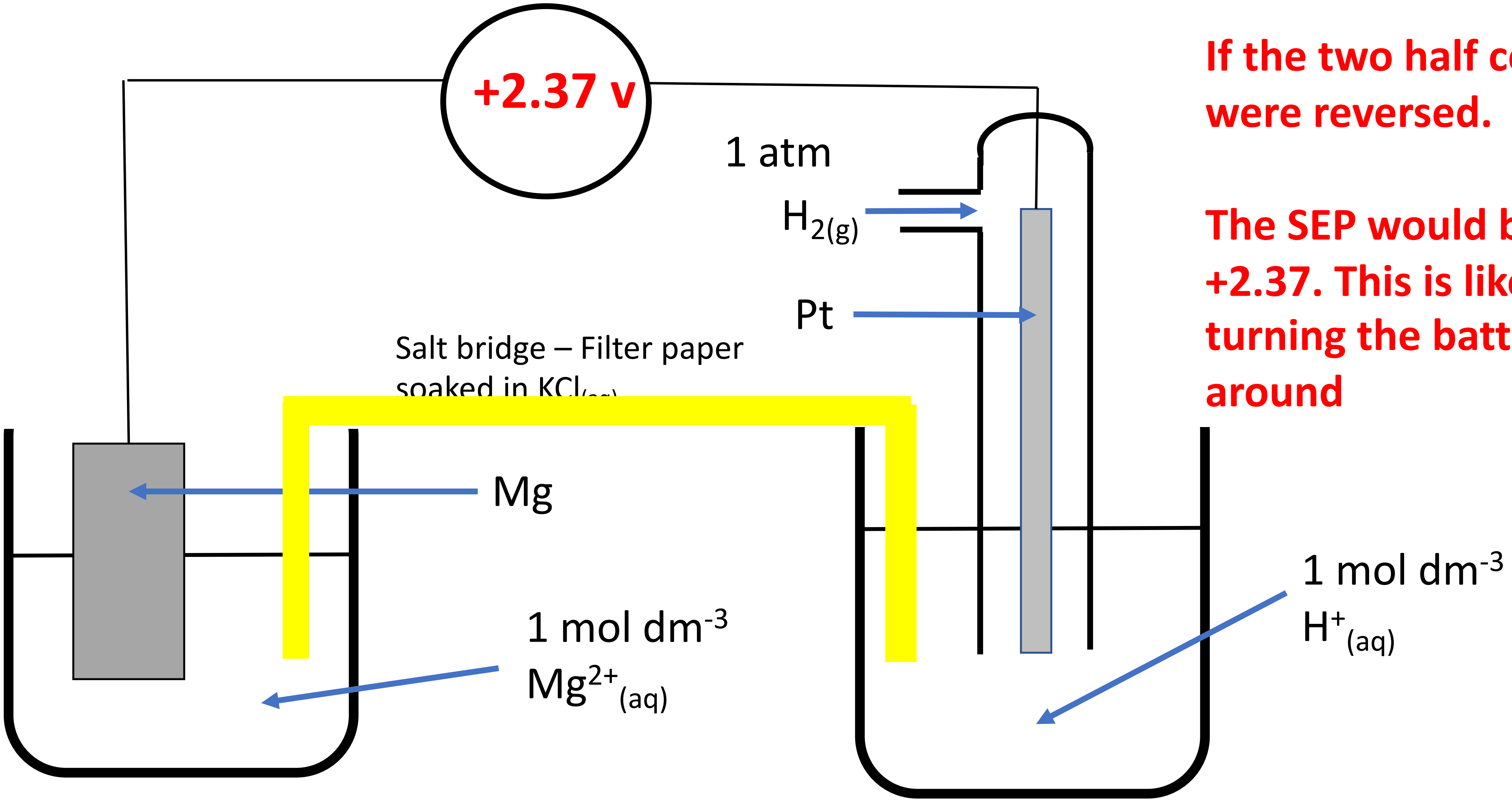

If the two half cells were reversed.

The SEP would be +2.37. This is like turning the battery around

$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$

$2H^{+}_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$

Standard Electrode Potential = 0 volts

Standard Electrode Potentials

Always written as a reduction half equation – i.e. electrons on the left hand side

Half equation		SEP/V
$K^+(aq) + e^-$	$\rightarrow K(s)$	-2.93
$Ca^{2+}(aq) + 2e^-$	$\rightarrow Ca(s)$	-2.87
$Na^+(aq) + e^-$	$\rightarrow Na(s)$	-2.71
$Mg^{2+}(aq) + 2e^-$	$\rightarrow Mg(s)$	-2.37
$Al^{3+}(aq) + 3e^-$	$\rightarrow Al(s)$	-1.66
$Zn^{2+}(aq) + 2e^-$	$\rightarrow Zn(s)$	-0.76
$Fe^{2+}(aq) + 2e^-$	$\rightarrow Fe(s)$	-0.44
$Pb^{2+}(aq) + 2e^-$	$\rightarrow Pb(s)$	-0.13
$2H^+(aq) + 2e^-$	$\rightarrow H_2(g)$	0.00
$Cu^{2+}(aq) + e^-$	$\rightarrow Cu^+(aq)$	0.15
$Ag^+(aq) + e^-$	$\rightarrow Ag(s)$	0.80
$Au^{3+}(aq) + 3e^-$	$\rightarrow Au(s)$	1.50

Compared to $2H^+_{(aq)}/H_{2(g)}$

Less easily reduced – less likely to gain electrons

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