Activity Description

This is a worksheet containing a variety of activities to reinforce the content delivered in the ‘Hydrogen: Properties, Thermodynamics and Electrochemistry’ presentation. The content is aimed for student aged 15-18.

It consists of:

- Activities aimed at consolidating knowledge from the presentation
- An answer sheet for the activities

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Hydrogen Properties – Worksheet

What are some key properties of hydrogen?

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What are the key energy properties of gaseous hydrogen?

How does the energy density differ in liquid hydrogen? Why?

What is Hess's Law?

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Draw a Hess Cycle to calculate the missing enthalpy...

$H_2(l) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ ΔH = -284.93kJ/mol

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ ΔH = ?

$H_2(l) \rightarrow H_2(g)$ ΔH = +0.80kJ/mol

What is a spontaneous reaction?

How can you make a non-spontaneous reaction occur? Can you relate this to an electrolyser?

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Hydrogen Properties - Worksheet Answers

What are some key properties of hydrogen?

- Colourless
- Tasteless
- Odourless
- Low density
- Low solubility
- Highly reactive
- Highly flammable in air
- Lightest element

What are the key energy properties of gaseous hydrogen?

- Low boiling point of -253°C (20K)
- Low melting point of -259°C (14K)

- Hydrogen as a fuel has:
  - A low energy density per unit volume
  - A high energy density per unit weight

How does the energy density differ in liquid hydrogen? Why?

- Liquid hydrogen has a much greater energy density per unit volume than gaseous hydrogen
- This is because the particles in a liquid are much closer together than the particles in a gas (they are more densely packed together), hence the energy density of liquid hydrogen is much greater per unit volume

What is Hess's Law?

Hess's Law - the enthalpy change for a chemical reaction is independent of the route taken

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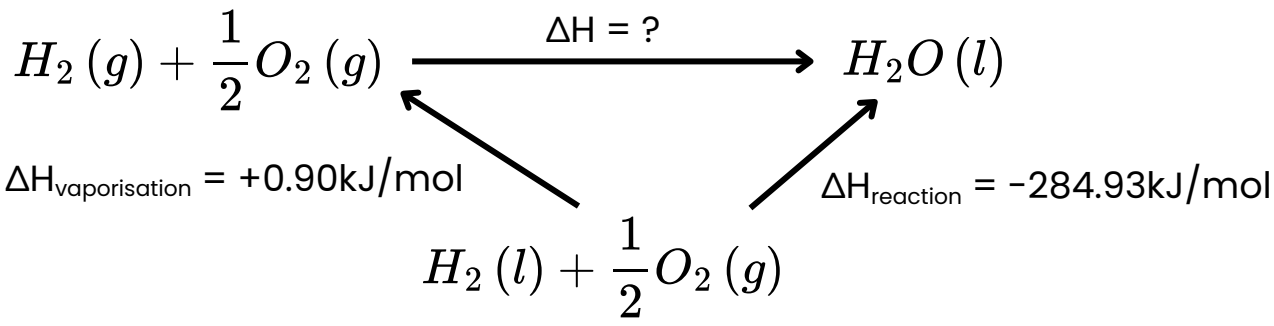
Define these fuel cell components...



ΔH = -(ΔH$_{vaporisation}$) + ΔH$_{reaction}$ = -(+0.90) + (-284.93) = -285.83kJ/mol

- The reaction enthalpy is therefore -285.83kJ/mol, so it is exothermic

What is a spontaneous reaction?

- A spontaneous reaction is a reaction that occurs on its own
- No continuous outside energy source is required
- The more negative the Gibbs Free Energy for the reaction is, the more spontaneous
- Gibbs Free Energy is temperature dependent, so a change in temperature can force a reaction to occur spontaneously

How can you make a non-spontaneous reaction occur? Can you relate this to an electrolyser?

- Provide a continuous outside energy source
- Gibbs Free Energy is temperature dependent, so a change in temperature can force a reaction to occur spontaneously

- In an electrolyser, a continuous current is applied
- This allows a non-spontaneous reaction to occur, such as splitting water into hydrogen and oxygen

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