THE FARADAY INSTITUTION FutureCat

NEXT GENERATION LI-ION CATHODE MATERIALS

"Build a Battery" CLASSROOM CARD GAME - TEACHER'S DOCUMENT

This is a GCSE resource on electrochemistry. It builds on the GCSE specification with further information on electrochemical cells, batteries and materials. The resource covers aspects of electrochemistry, materials science and careers within the battery sector.

The educational resource is created by FutureCat, which is part of the Faraday Institution research community. The Faraday Institution is an independent institute for research into electrochemical energy storage.
For more information, you can visit the groups websites.
The Faraday Institution : https://www.faraday.ac.uk/
FutureCat: https://futurecat.ac.uk/

OVERVIEW OF RESOURCE CONTENTS

This is an educational card game that can be used with the whole class to support the learning of electrochemistry and include enrichment knowledge about battery technology and careers linked to batteries. There are two presentations that can be used

1) Build a Battery Card game session presentation
2) Electric Car presentation – this includes the game and an additional activity of designing an electric car. This is a longer activity that aims to take up a whole lesson or to be used during lunchtime or after school STEM club.

Multiple Group Session Set up

There are **8** application cards in total (1 Electric Car, 1 Tablet, 1 Phone, 1 Green Battery, 1 Sodium Battery, 1 Children's Toy, 1 Cobalt Free Battery, 1 Affordable Battery)

You will need to keep the application cards separate to the main deck.

As a teacher, you can either

1) Display the application cards 3 face up, 3 face down
2) Give an application card to each group for them to match their cards against.
3) Let groups play the small group version (then they will need 1 deck per group)

Example

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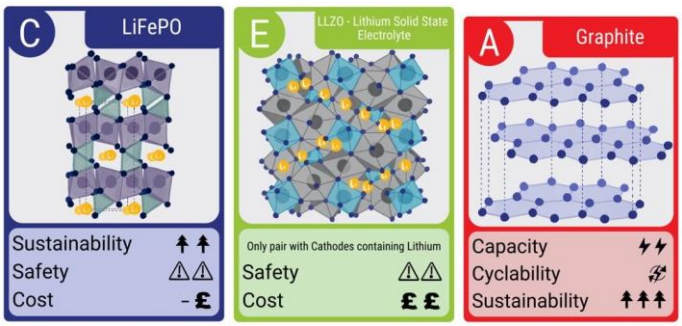
Cards in the Build a Battery Card Game

These are the cards in the pack that are to be dealt out among the groups in a random way.
You may wish to have 2 packs printed to play with if you have a larger class. There are 42 cards in a single deck **not** including the job cards.

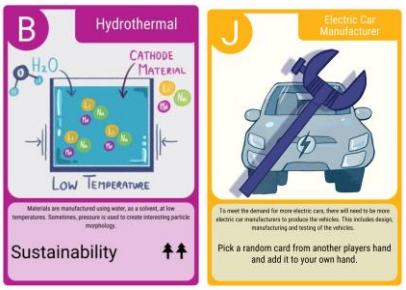
- 12 Cathodes (1 LiNixMnyCo1-x-y O, 1 NaNm02, 2 of NaFePo4, 2 of Li2NiMnO3, 2 of LiFePO4, 2 of LiMn2O4, 2 of LiCoO2)
- 10 Anodes (2 Silicon, 2 Graphene, 3 Graphite, 1 Hard Carbon, 1 LiTiO, 1 Soft Carbon)
- 12 Electrolyte (2 Lithium Solid Electrolyte, 2 Lithium Polymer Electrolyte, Lithium Organic Electrolyte , Sodium Organic Electrolyte, 2 Sodium Polymer Electrolyte, 2 NASICON Sodium Solid Electrolyte)
- 8 Bonus Cards (2 Solid State synthesis, 2 Sol-gel method, 2 Hydrothermal, 2 Bio-templating)

- 10 Job Cards (2 Battery Researcher, 2 Crystallographer, 2 Battery Trend Analysis, Electric Car Manufacturer, 2 Investor)

A battery is made up of an **anode (red)**, a **cathode (blue)**, and an **electrolyte (green)**. These three cards must be compatible with each other. Guidance is given on the cards if they need to be paired with another specific card.



Other cards



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Bonus Cards (purple/pink): Up to one bonus card can be played with each battery to improve its characteristics.

Job Cards (yellow) – are used in the **small group version** rather than the classroom version of the game so you do not have to print these out.

Slides included in the presentation

Slide 2 - Introduction to the parts of a chemical cell.
Slide 3 - Cathode and reduction.
Slide 4 - Anode and oxidation.
Slide 5 - image of electron and ion flow in a chemical cell
Slide 6 - redox reaction definition
Slide 7- battery compared to a chemical cell, highlighting the similar components to both, so GCSE student can see the link visually
Slide 8 - Visual of the battery discharging, electrons powering a tablet
Slides 9 to 14 - introduction to the game and the types of battery building cards
Slides 15 to 19- introduction to the battery characteristics on the playing cards. It explains capacity, cyclability, sustainability, safety and cost.
Slide 20 - making the batteries with the playing cards.

Slide 21 - **How to win**. This explains how teams will compete to make the best battery for a certain characteristic.

Once each round has been played (depending on how many rounds you choose to play – see below) , each group will show their cards to win an application card, with the group who matches an application card winning that card (if they have it, or if it is displayed) If they win the application card, another application card on display is turned face up/group is given another application card.

They put their 'winning hand' to one side, and can pick up 4 more cards from the pile of unused cards.

Rounds of the Game

Slides 23 to 25 - listed a variety of different rounds for the students to distribute the cards around the classroom. **As the teacher, you can decide which rounds you want to include**. In a larger class it may be more appropriate to focus more on the rotation round. But a small class may find the opportunity to discuss card trading more enjoyable and would be faster with less groups.

Round 1 – Rotation -

- A type of Card is selected (cathode, electrolyte anode or bonus)
- each team has to give one of their card of that type **to the group on their left**
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Round 2 – Selection

- Each group nominates one person to swap cards with another group.
- The cards swapped must be the same type of card, so at the end of the round, each team has the same distribution of cards. So if it is cathodes, just cathodes are swapped.
- **This is done with the group on the right.**
- For example, group 1 nominates Ann and she goes to group 2 and selects one of their cathode cards and swaps it with a group 1 card.
- Each team can just show the cards they have (e.g. cathode) in that category.

Round 3 – Trading - This is an OPTIONAL round for teachers, depending on their class.

- Groups have an opportunity to trade cards.
- Any type of card can be traded for another, but groups should remember they still need 1 Cathode, 1 Electrolyte and 1 Anode to build their battery and win.
- A group member is nominated to address the class. They state the card they want to trade (ie. electrolyte card with ++ safety) and the card they want to receive (ie anode with one + or more for sustainability).
- No one is forced to trade, but each group is given an opportunity to (Again, this round upto teacher discretion, depending on your class size and characteristics of the class)

The winning group is the group with most application cards.
If there is a draw between teams, you can draw a random application card and the team with the best matching characteristics to the application card will win the card. This may have to be played as a 'knock out' if there are several teams drawing.

If you have any feedback on the game and want to get in touch please Contact us on our website form