www.scienceinschool.org

Gold mining in the classroom: a lab activity to teach sustainability

Teacher guide: activities to accompany gold recovery from mobile phones

This teacher sheet suggests additional activities to accompany the gold-recovery activity. They help students explore the components, materials and elements found inside a smartphone as well as geographic origins and supply chains.

1) Dismantle an old mobile phone

Guided by the teacher, students dismantle the device into base components and immediately become aware of the large number of parts that are included. We can summarise them into four main sections:

screen, electronics, **battery, casing.**

Depending on the expertise of the school and teachers, individual components can be identified and recognised, looking into their specific functions within the phone.



Example components of a phone
Image: Fukami et al./Digital Investigation

2) Classify the materials of the components

Students can now classify the materials of each component based on observable physical properties, such as colour and magnetism, to distinguish between metals, electronic circuits, and plastics:

- **Ferrous Metals**: Steel casings, screws (tested with magnets)
- **Non-Ferrous Metals**: Copper wiring, aluminium heat sinks
- **Composite materials:** RAM sticks, motherboards (the primary source of precious metals like gold and silver)
- **Plastics**: Outer shells, fan blades
- **Glass:** screen/display

www.scienceinschool.org



Separating and sorting different components of a phone
Image courtesy of the authors

3) Explore the elements inside a smartphone

At this point, it can be useful to ask them to estimate how many chemical elements they think are in a mobile phone and then read the student sheet together in class.

Divided into groups, students can search online to find out which chemical elements are most abundant in each component of the phone and what their specific function is.

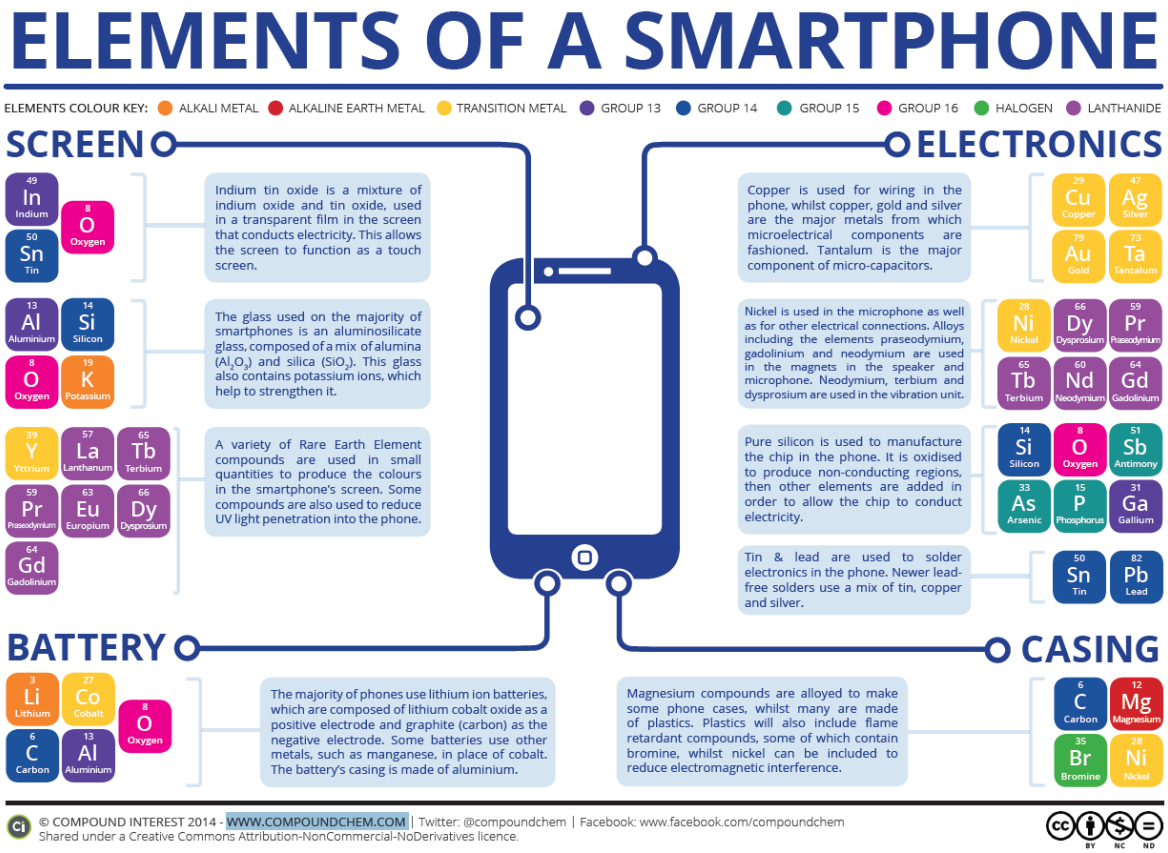
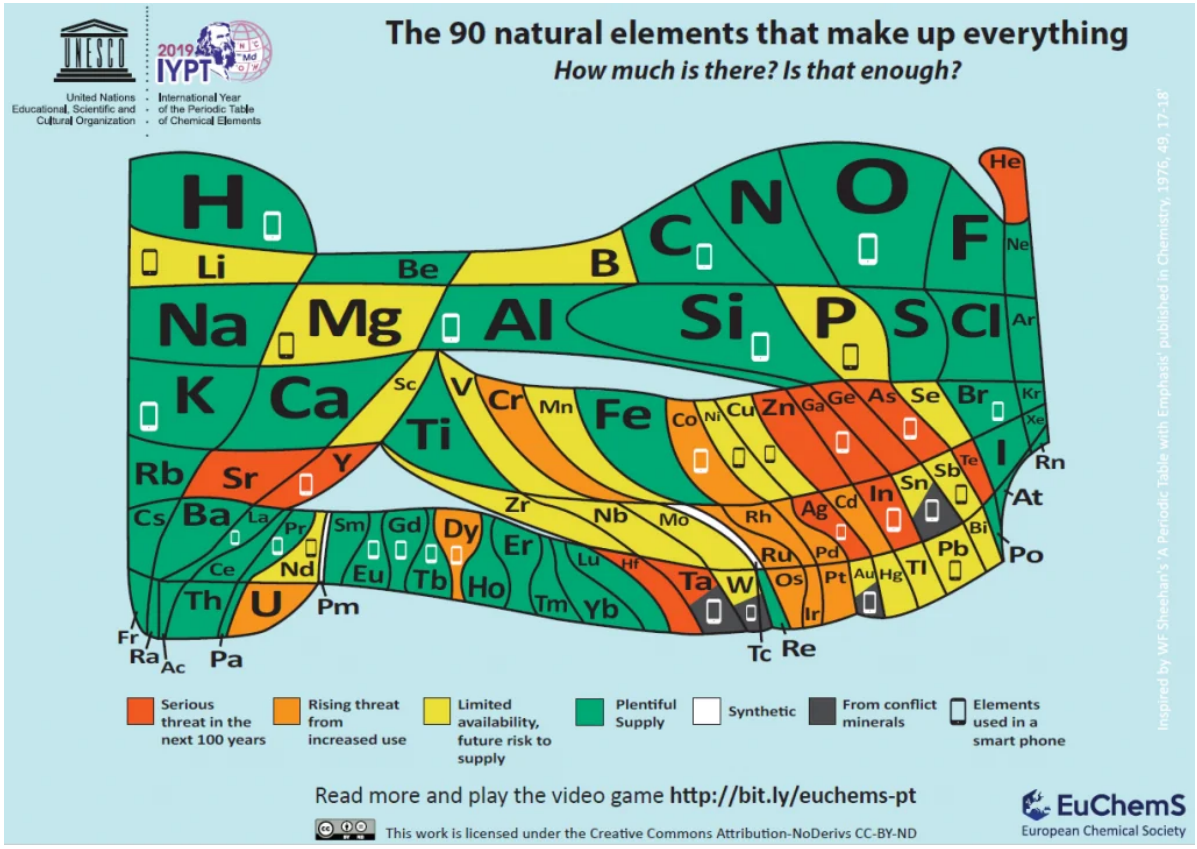


Image: Andy Brunning/Compound Interest, CC BY-NC-ND 4.0

The students can locate them on the periodic table and compare them with the periodic table of element abundance, where the size of each element is proportional to its presence in the Earth's crust and atmosphere.



The periodic table of abundances
Image: EuChemS, CC BY-ND

Prompt questions:

- Looking at the table of abundances compared to the standard periodic table, which elements appear enlarged and which ones seem to almost have disappeared?
- Your phone contains lithium (Li), cobalt (Co), copper (Cu), gallium (Ga), indium (In), and silicon (Si). Which of these are represented in larger areas and which are representing in smaller areas on the table?
- If an essential element for computer chips is tiny in the periodic table of abundance, what geopolitical, economic, or practical problems do you think this could cause?

4) Let's quantify and locate on Google Earth

To encourage reflection and raise awareness, students can be asked to search online for the quantity (in grams) of some of the chemical elements contained in a phone, for example, the

quantities of rare earth elements, cobalt, tin, tantalum, tungsten and gold (3TG) (find more info in the student information sheet) or elements that are at risk of running out.

Additionally, students could be asked to search for the locations around the world where these raw materials are concentrated.

Here is an example of a summary table:

Symbol	Atomic number	Element	Quantity	Function	Extraction location
Li	3	Lithium	0.4 g	Battery	Australia, Chile, Argentina
Al	13	Aluminium	25 g	Battery, casing, glass of the screen	Australia, China, Brazil
Co	27	Cobalt	8 g	Building lithium-ion battery	DRC
Cu	29	Copper	9 g	Electronics: wiring, microelectrical components	Chile, Perù, China

Prompt questions:

- If we were to open up your phone and trace the origin of every single chemical element, such as lithium from Chile, cobalt from the Congo or indium from China, what would the geographic map of your device look like?
- What would happen if a country suddenly decided to block the export of a critical mineral used in microchip production?
- How many kilometres do you think individual chemical elements travel before being assembled into the final phone you hold in your hand?