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

Discussion answers sheets

Where should recycling appear in the hierarchy of possible actions? Rank the following actions from most to least preferable and explain your ranking: recycling, repair, reuse, resale, refurbish

Recycling is important, but it should normally come after continued use, repair and reuse. Recycling recovers only some materials, whereas extending a phone's life preserves the complete product.

What might prevent people from returning their old phones for reuse or recycling?

Students might suggest:

- concerns about personal data
- keeping an old phone as a spare
- lack of knowledge about collection points
- collection points being inconvenient or far away
- uncertainty about whether the phone still has value
- lack of financial incentives

What could encourage more people to return their phones?

Possible solutions include:

- convenient collection points
- services that delete safely personal data
- receiving compensations (e.g., vouchers, discounts) for handing in unused phones
- public-information campaigns through e.g., social media or school projects
- clearer disposal instructions

What are possible bottlenecks of recycling smartphones?

Students might suggest:

- an effective collection system
- design for repair and recycling ("end-of-life design"): Smartphones are often difficult to dismantle because components are glued, sealed or tightly integrated. Modular designs, replaceable parts and mechanical fasteners instead of permanent adhesives would make phones easier to repair, disassemble and recycle
- trained workers and technical knowledge
- sorting and automated machinery
- specialist recycling facilities
- safety and environmental concerns (safe transport, storage, handling of chemicals, battery removal etc.)
- treatment of hazardous waste

This allows students to recognize that a successful recycling system involves much more than the chemical extraction demonstrated in the experiment.

Gold recovery from circuit boards still requires energy, equipment and chemicals. Why can it nevertheless be environmentally preferable to mining new gold?

Possible discussion points include:

- less rock must be excavated and processed
- less land and habitat may be disturbed
- less mining waste is produced
- existing resources remain in circulation
- formal recycling facilities can control emissions and hazardous waste
- dependence on mining, which is often associated with dangerous working conditions, labour exploitation, and conflict, can be reduced

What information would a recycling company need before deciding whether recovering metals from smartphones is economically viable?

Students do not need to calculate these values. The objective is to understand that only because gold is valuable does not automatically make a process profitable.

They could identify the following factors:

- the number of phones available
- the amount and value of recoverable materials

- recovery efficiency
- labour and equipment costs
- energy and chemical use
- transport and collection costs
- safety measures
- treatment of hazardous waste
- market prices for recovered materials

The experiment focuses on gold, but what other components or materials might be reused or recovered from a smartphone?

e.g., batteries, screens, cameras, speakers, magnets, circuit-board components, copper, aluminium, steel, cobalt, nickel, lithium, silver and palladium