



# AWARE – notes to teachers

**Raising public awareness on electronic waste as a source of valuable materials**

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## Introduction

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The educational content created in AWARE project includes material on e-waste and circular economy and the aim is to raise interest in these topics among schoolchildren. This document contains ideas on how to utilize AWARE content and include these topics into different lessons. Suggestions for learning targets for different school levels are presented below. Answers to some of the exercises presented in AWARE exercise sheets are presented in the end of this document. The topics introduced here may be brought into different classes including chemistry, geography and other science classes but also for example English classes

## Suggestions for learning targets for schoolchildren of different ages

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Primary school (7-12 years old):

- The student understands what is electrical and electronic equipment (EEE), recognizes different types of EEE and understands when they become waste
- The student understands that e-waste consists of different materials, some of which are valuable.
- The student understands that e-waste should be recycled

Secondary school (13-15 years old):

- The student is aware of the large variety of different electrical and electronic equipment (EEE)
- Student understands the consumer's role in the generation of e-waste
- The student understands that e-waste consists of different materials (e.g. metals, plastics...), some of which are valuable and/or rare.
- The life cycle of electronics
- The student understands the benefits of e-waste recycling and knows how to recycle e-waste

Upper secondary school (16-18 years old):

- Student understands the consumer's role in the generation of e-waste
- The student understands that e-waste consists of different materials (e.g. metals, plastics...), some of which are valuable and/or rare.
- The value chain of electronics
- The student understands the benefits of e-waste recycling and knows how to recycle e-waste
- The student understands the environmental and social sustainability aspects of the production and recycling of electronics.

## Some ideas for lessons

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### Short introduction to the topic:

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Watch the AWARE video ([https://www.youtube.com/watch?v=KBPde\\_fk6sU&feature=youtu.be](https://www.youtube.com/watch?v=KBPde_fk6sU&feature=youtu.be)) on e-waste and the valuable materials it contains. Based on the video, answer the following questions:

- Why is it important to recycle e-waste?
- How much e-waste is there in an average household?
- How many different metals are there in an old mobile phone?
- Was this new or familiar information to you?

Advanced exercise: E-waste vocabulary (page 4).

### Circular economy

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Introduce the circular economy concept shortly to the class. Some video options available online:

[Repair, re-use and recycle!](#) Short video by European Parliament, length 1:13 min, English, subtitles available in several languages. (easy)

[Re-thinking Progress: The Circular Economy video](#) by Ellen MacArthur Foundation, length 3:48 min. In English, also available in Spanish, French, German and other languages. (more advanced)

Questions to be answered based on the video: What is the difference between circular and linear economy? What better options are there to disposing waste to landfills? What benefits are there in transforming to circular economy?

Topics to be discussed in class:

- Consumer habits and extending product lifetime. Think about your mobile phone. When was the last time you bought a new phone? Why did you buy a new one? How many phones have you had in your life? Do you use your phone until it is broken, or do you get a newer model even when the old one is still working?

### Materials in electronics:

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Various materials are used in electronic devices. Especially in complicated devices, numerous metals can be found.

- Infographic on important elements used in smartphone: [Elements of a smartphone](#) in Compound Interest
- Task: Some of the materials contained in a smartphone and their other uses in Medium exercises (page 4)
- Task: select an element or material used in electronics, and find out where they originate from and what purpose they are used for. This can be realized for example as a presentation, a group work or a poster.

- Video [Strange day](#) by the AWARD project: Copper is a metal with very good electrical and thermal conducting properties. For that reason, it is used in numerous applications. What would happen if all copper would disappear?
- Many of the elements that are needed for electronic devices are scarce. Introduce the periodic table on scarce elements and their use in mobile phones: <https://www.euchems.eu/euchems-periodic-table/> (available in multiple languages). Discuss our dependence on raw materials in class/small groups. For example indium (In) is an important element in touch screens and cobalt (Co) is needed for lithium ion batteries. How would we cope if we ran out of these important elements?

Advanced level: Introduce the concept of critical raw materials (CRM). These are raw materials that are economically important and used in many high tech applications, but are also associated with high risk in their supply. For example 95 % of rare earth elements are produced in China, and their recycling rates are very low (typically <1 %)

- Task: Exercise on Critical Raw Materials (in advanced exercises, page 5): select one CRM used in electronics and fill in the information card. Information on critical raw materials and their use in different applications can be found for example in <http://criticalrawmaterials.org/critical-raw-materials/> (in English)

Urban mining means the recovery of metals from used electronics and other waste streams. For example, 1 ton of old mobile phones can contain up to 300-400 grams of gold, which is 100 times the concentration of gold in ores.

- Task: Urban mining calculation example in medium exercises (page 6)
- [Your old phone is a veritable gold mine](#) by Verge Science, length 5:08 min, English

## Electronics at home and recycling

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Topics to be discussed in class:

- Variety of electronic products: What kind of electronic products do you use every day? Which of these products are necessary? Are there some products you could live without?

Homework: Fill in the e-waste study form. The results can be used, for example, to calculate the average amount of electronic devices in households. Furthermore, the results of the class can be used to estimate the value of selected precious metals (Au, Ag, Pt, Cu) in discarded electronics (smart phones, tablets, laptops). The information given in the urban mining task can be used in this (in medium exercises, page 6).

- Additional: Interview your parents - do they know how to recycle e-waste and do they know why e-waste should be recycled?

For recovering the valuable materials from electronics, collection of the discarded devices is the first step.

- Infographic on [Recycling rates of smartphone metals](#) in Compound Interest. Discuss in class what kinds of materials in e-waste are typically recycled. Many of the base metals (such as copper, aluminium etc.) are recycled, but it is more difficult to recover elements that are present in tiny amounts. Also devices are getting more complex and components smaller which makes the recycling and also repairing more complicated.
- Task: Find out how to recycle e-waste in your area. Which are the benefits of sorting and recycling electronic waste? How could the collection of e-waste be improved?
- Task: Plan and organize a motivational campaign for your school on why and how to recycle e-waste: what benefits are there in recycling e-waste? Include also information on how to recycle e-waste in your region.

## Sustainability:

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Watch a video on sustainability and the life cycle of electronics: [The Story of Electronics](#) by The Story of Stuff Project, length 7:46 min, English.

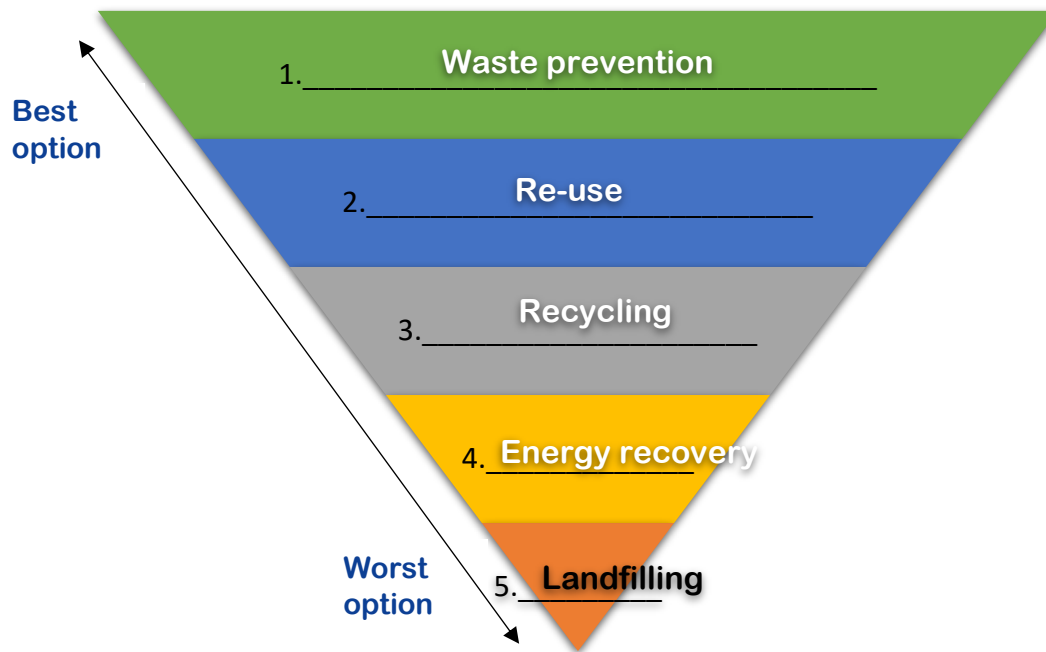
Topics to be discussed in class:

- Sustainability of electronics:
  - Which materials are used in the manufacturing of electronic products?
  - Where do these materials come from?
  - What kind of problems are there related to the mining of raw materials for electronic products?
  - What kinds of problems are there related to the recycling of e-waste?
  - What does the term “sustainable electronics” mean?

## Answers: Basic

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Fill in the waste hierarchy in the right order



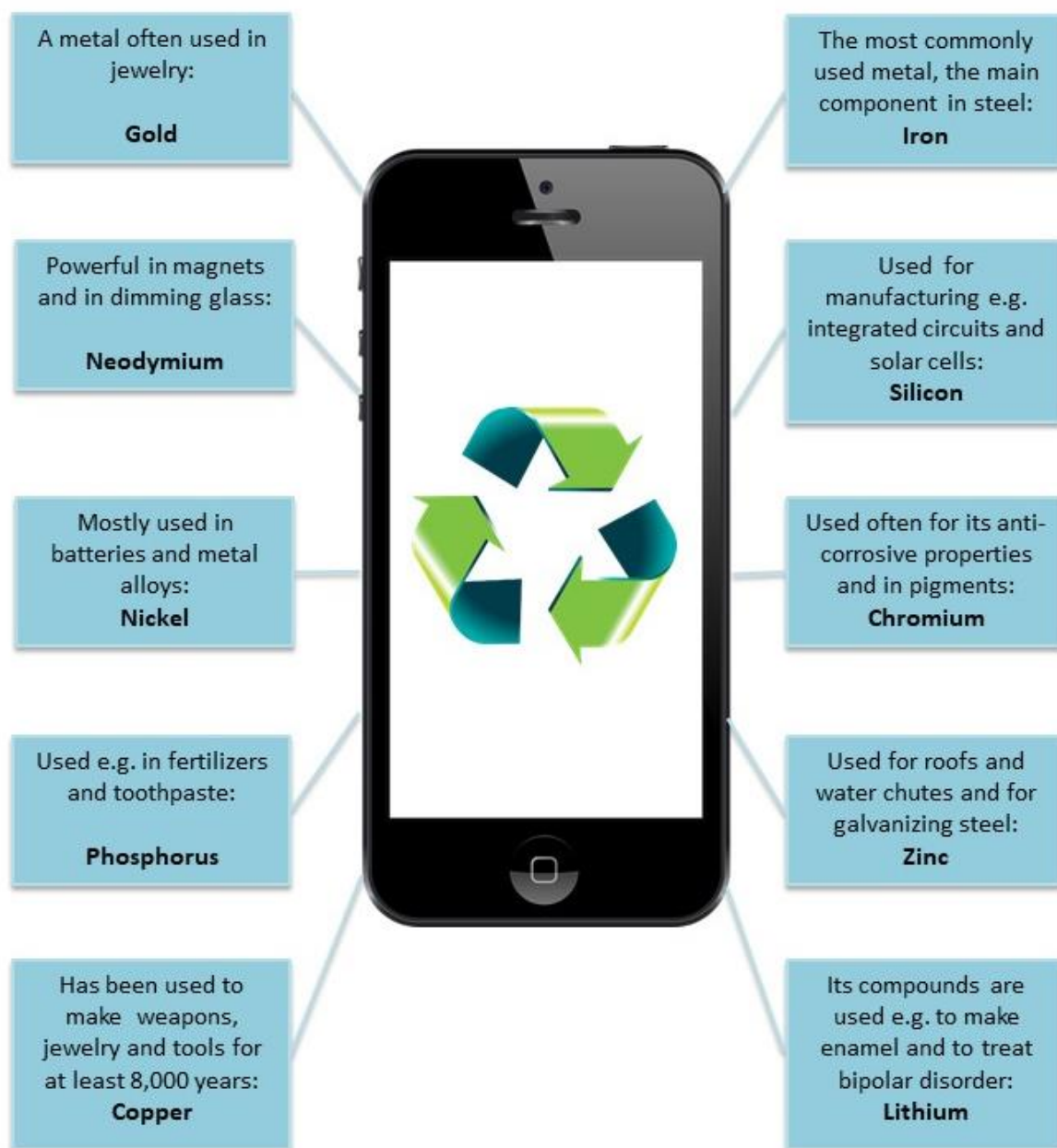
**Which of these products can you put into an e-waste recycling bin?**





## Answers: Medium

### Some of the materials contained in a smartphone and their other uses





## Answers: Advanced

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### E-waste vocabulary

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1. **WEEE or e-waste:** Electronic devices that are broken or otherwise discarded.
2. **Planned obsolescence:** Planning or designing a product with a limited useful life.
3. **Rare earth elements (REEs):** A set of seventeen chemical elements in the periodic table, specifically the fifteen lanthanides plus scandium and yttrium. They are usually used in electronics in very small amounts, but they are vital for many high-tech applications due to their unique properties
4. **Circular economy:** Circular economy is an alternative to a traditional linear economy (make, use, dispose). Circular economy is an economic system aimed at eliminating waste and the continual use of resources. Circular systems employ reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed system, minimising the use of resource input and the creation of waste, pollution and emissions
5. **Conflict minerals:** Conflict minerals are natural resources that are extracted in a conflict zones and their trade can be used to finance armed groups. Most common examples are tin, tungsten, tantalum and gold, which are extracted from the Democratic Republic of the Congo (DRC) and are used in everyday products such as mobile phones.
6. **Critical raw materials (CRM):** Raw materials that are economically important for the European economy but have high-risk in their supply.
7. **Pyrometallurgy:** the branch of science and technology concerned with the use of high temperatures to extract and purify metals
8. **Ore:** a naturally occurring solid material from which a metal or valuable mineral can be extracted profitably
9. **Waste hierarchy:** A method that lists waste management options in an order based on what is best for the environment
10. **Urban mining:** Production of raw materials from waste, spent products or buildings

## About AWARE

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This content has been created as a part of AWARE project. The purpose of the AWARE project is to spread information on e-waste and circular economy among schoolchildren of different ages and teachers. For more information, please visit

<https://aware-eit.eu/>

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