BRIEFCASE

Learning the uses of minerals through non-conventional teaching tools

D.3.3_ BRIEFCASE PEDAGOGIC GUIDE_ Vfinal

PROJECT DOCUMENTATION SHEET

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Content

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1. OVERVIEW OF THE DELIVERABLE

The aim of this document is to provide a pedagogic guide **for the teachers** and it is configured in order to provide a tool that can be used in an autonomous way during their standard daily lessons.

The pedagogic guide takes a tour of the Thematic Briefcase contents, game stories, game rules and educative goals of each one in order to provide a complete view for the teachers.

The Briefcase Games provide an opportunity to teach the pupils about minerals through an educative game, a competition which motivates them to know more about the mining activities. The Briefcase games are not only the physical version located at the project partners sites to be borrow to the schools and educative centres, but also the Virtual Briefcase Game offered for free from the IGME server[1], as it is presented in the following figure.

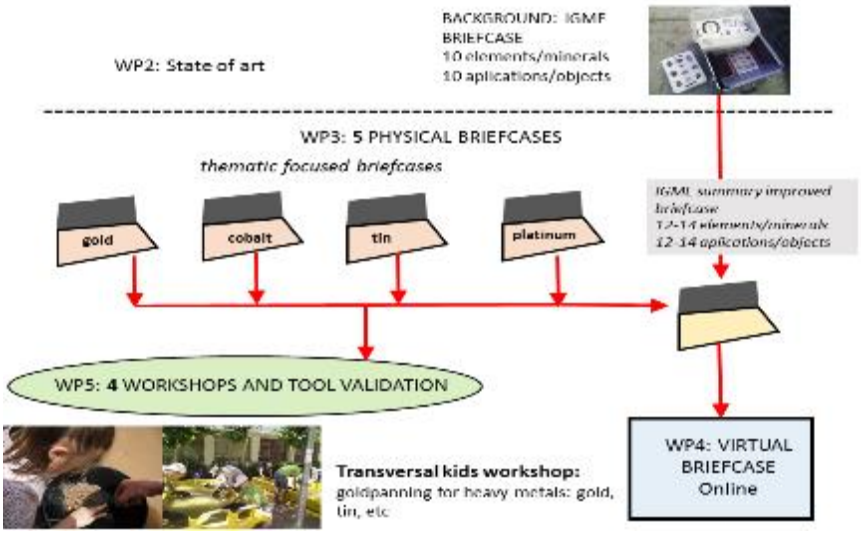

Figure 1: WP3 General scheme of the briefcase toolkit

These didactic guidelines are based on the general ideas of the previous deliverables *D.3.1 Briefcase toolkit* which gave us a general overview of the contents and idea of each of the briefcases, and *D.3.2 Briefcase user's guide*, which provides the basic operation rules for the Briefcase Games. It will be translated to all partners' languages.

Any comment or suggestion will be welcome by the game developers. The contact address for this purpose is direccion.tecnica@fgomezpardo.es

1 http://www.igme.es/museo/didactica/maletasDid.htm

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2. IGME - ORIGINAL BRIEFCASE GEENERALISTIC.

The BRIEFCASE is a mature and consolidated workshop, which has been applied for more than 10 years by the Geomining Museum2, in Madrid (Spain) focused on the diffusion of minerals knowledge among children during their visits to the Museum.

The workshop is aimed at identifying minerals and the ore elements that compose them and some everyday objects made with them. In this way, students guided by teachers, realize that many minerals are used in daily life. This workshop is a complementary activity to the curriculum of primary and secondary students. The problem that arises is that not all schools can include these workshops and that they are designated for a period of time. Therefore, one of the lines of work is that this type of teaching of the uses of the general subjects and objects that they compose are compulsory incorporated to the official and regulated subjects. The Geomining toolkit is the basis of the BRIEFCASE (physical and virtual) concept, but our Project covers much more fields and raise awareness about the mining sector, a concept that is new in this kind of workshops.

I. The materials in the Mineral's daily uses Briefcase

The original Briefcase (IGME consolidated workshop) consists of 10 minerals-elements and 10 objects-uses: things made with the ore elements of each mineral. In the version for the Briefcase, it be added the 4 elements of the new briefcases.

Mineral (box #1)	**Element (search and find using clues)**	**Object (box #2)**
Cinnabar	Mercury	Thermometer
Kyanite	Aluminium	Soda can
Sphalerite	Zinc	Galvanized steel
Fluorite	Fluor	Toothpaste
Galena	Lead	Plumb bob
Lepidolite	Lithium	Mobile phone battery
Magnetite	Iron	Horseshoe
Malachite	Copper	Wire
Orthoclase	Aluminium/potassium-Porcelain	Plate
Wolframite	Tungsten	Light bulb
Gold	Gold	Gold ring
Platinum	Platinum	Catalysator
Skutterudite	Cobalt	Cobalt blue

2 http://www.igme.es/museo/didactica/maletasDid.htm

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Cassiterite	Tin	Car toy

Figure 2: Elements inside IGME Briefcase.

The set includes a box of 10 minerals, a box of 1 object, 4 pieces of clues to guess each element and a sheet of answers and scores

Figure 3: Summary photo of the minerals included in the workshop.

Figure 4: Summary photo of the products manufactured from the minerals in previous figure 3.

II. The Daily Products Briefcase game

Two teams of students and two instructors are established (they can be two teachers or two students). The material is presented in two trays: one with the minerals and another with the objects. The group chooses one of the ten minerals, the one they prefer, and the monitor tells them what mineral it is (in case the students do not know the mineral).

Each team receives a set of the game

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Figure 5: Student and instructor playing with minerals, objects and the clues

The minerals are chosen at random one by one. If the students had studied mineralogy in high school they had to guess the mineral, but if it is not the case, the teacher told them the name of the mineral, from there, with a maximum of 4 clues-tracks they had to find the element that contains the mineral ore, and the use or object in the other part of the box. They took both, mineral and object guessed and separated it

If, for example, the group chooses malachite, the instructor will tell them to try to relate that mineral to the object that has been made from it. In this case it is the cable, since malachite is a carbonate of copper and the cables are made of this metal.

In the previous figure 5, we can see the student on the left, who is the moderator and is reading a clue. The student on the right side has the malachite on the left hand and is finding out the solution: she is going to pick the copper wire. If the team is able to relate the object to the mineral in the first try, you will get a direct hit that is valued with 5 points. This score will be noted by the instructor in the attached table.

The way to score is to guess the element that contains the mineral and the object made with it. If it is successful without clues, 5 points are received, which we point to in the sheet next to the element. If students do not know directly, students will ask for clues that the teacher, assistant or moderator will read to that group. For each track that is requested, one less point is received until they guess the element and object. If you find out the right answer with only one clue you obtain 4 points, if you'll need the 4 clues that would be 1 point. The maximum score would be 50 points that would be correct the 10 minerals-elements and objects without any clue or help

Following with the example of the malachite:

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Figure 6: Image: a student of one of the 2 teams is writing the scores and correct replies in the table

The team may risk relating an object to the mineral in question. In this case, if they fail, 0 points will be noted. The instructor should recommend that they should always use the clues, because this way you can make sure that you have some points. - If the team is not able to relate the mineral to the object, you can request the first clue to the monitor. In this case, the clue says: "The metal that forms this mineral is soft and red. Its generalized use gave name to the Chalcolithic period, established from the year 5000 B.C."

If, with this clue, the team finds out that the cable is the object related to the malachite, they will score 4 points (success with clue 1). If this is not the case, they will have to ask for clues until they finish them. Clue 4 equals 1 point and is always immediate. That is using that clue the correct reply is assured.

This procedure should be used with all pieces, removing the ore and the object from the trays once they have been successfully linked. This way difficulty decreases as the game progresses, as fewer and fewer objects and minerals remain.

Once the relationship between objects and minerals has been established, all the points will be added up and one of the two teams will be the winner.

Here is shown an example of a scoreboard as it would be at the end of the game:

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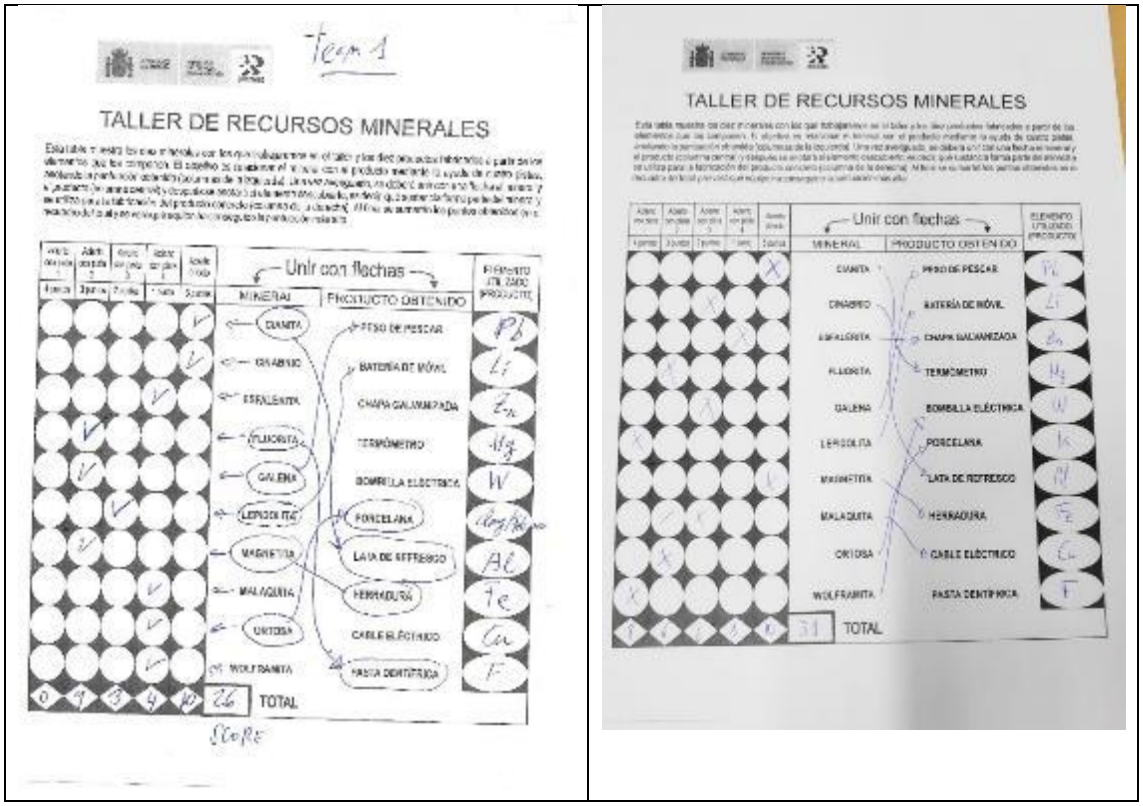

Figure 7: Scoring cards (left team 26 score and right team 31)

The game version for younger students is described as following:

First of all, you have to make two teams with the help of your teachers. They will be the instructors in this game.

The briefcase has two trays, one with the minerals and one with products that are made with those minerals.

Now, you (both teams) have to choose a mineral from the box, the want you prefer. Don't worry if each one you like different minerals; you are going to play with all of them!

Once you have chosen a mineral, your teachers will tell you its name, (in case you don't know it) so don't be afraid if you don't know any of the minerals in the box, at the end of the game, you will know them all!

Now that you know the minerals name, it's time to guess which object is made with that mineral. This is the funny part, because the instructors will give you some clues to help you. If you guess the object without any clue, your team will score 5 points, the maximum score! But be careful, because if you fail will making the guess, you won't get any points! It is safer to use all the clues you need, even if that means wining fewer points.

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If you get to guess the object using only 1 clue, you will get 4 points, but If you use 2 clues, you get 3 points, so if you use more clues, you will get less points.

When both teams finish playing with one mineral, you remove it from the game and take another one. Repeat this until you have played with all minerals.

Once you have figured out all the relationships between objects and minerals, it's time to add up all the points of your team and compare the result with the other team score. The team with the higher score is the winner!

There are 4 clues for each element and object. Finding out without clues is 5 points, but finding out with 1 clue is 4 points, etc

1. CINNABAR HgS

1. The metal that this mineral is made of is a toxic element, but is very useful when used in measuring tools.
2. Its vapors are toxic and its leakages pollute. In the Roman Ages, when they still didn't know the toxicity of this metal, some women dyed their lips and chicks with the red of its oxides.
3. It amalgamates easily with gold and silver.
4. It is the only common metal that appears liquid in Nature at room temperature.

2. KYANITE Al_2SiO_5

1. The name of this mineral comes from the Greek term "kianos", meaning "blue".
2. It contains a metal which is light colored, very light weighed, cheap to obtain, easily recyclable and has many industrial applications.
3. The metal is used in the manufacturing of deodorants, since it inhibits the action of the sweat glands and the development of bacteria that cause bad smell.
4. Given that this is a metal very resistant to corrosion, it is used to make car tires and window frames as well as in the famous "silver foil" used to wrap sandwiches. It is also used to manufacture beer cans.

3. SPHALERITE OR BLENDE (Zn,Fe)S

1. One of the names of this mineral comes from the German word "blende", which means cheat, because sometimes it can be confused with galena. The metal that makes up this mineral has a bluish white color.
2. It is an essential element of our diet because it favors the growth of our body. It is present in meat, fish, bird meat, egg yolk, liver, sea food, legumes, mushrooms, whole grains…
3. The automobile industry is its main consumer. It is also used in the manufacturing of antidandruff shampoo thanks to the properties of zincpiritione. One of the greatest producers worldwide of this metal was the Reocín deposit in Cantabria.

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4. It is mostly used to galvanize, that is, to coat iron and steel to protect them against corrosion.

4. FLUORITE CaF_2

1. One of this mineral's element is frequently used in blast furnaces to lower the melting point of steel.
2. When mixed with silica, a high-quality glass is obtained, which can be used to glace ceramics or to produce fiberglass.
3. Besides in fluorite, the element is present in dissolved sea water salts.
4. One of its better-known uses is in toothpastes manufacturing.

5. GALENA PbS

1. The metal that makes up this mineral is very, very heavy. It is used in car batteries because when plates of this element are bathed in sulfuric acid, they produce electricity. Its presence makes batteries very heavy.
2. The romans made water tubing of this metal. However, it is toxic, and when it enters the human body, it produces lead poisoning or saturnism.
3. This last name comes from the name the alchemist gave to this metal, "Saturn". Beethoven suffered this illness, and it is probable that it caused his deafness.
4. Thanks to this metal we can fish, since it is used in the plumb bobs.

6. LEPIDOLITE $K(Li,Al)_3(F,OH)_2AlSi_4O_{10}$

1. This mineral's name comes from a Greek word that means "scale" because it is a silicate with flaky structure. From that word also comes the scientific name of butterflies "Lepidoptera" given because of the scales they have in their wings.
2. One of the most curious uses of the metal which this mineral is made of, is in psychiatry to treat bipolar disorder, which is related to the lack of this element in the organism.
3. It is an alkaline element and its name comes from the Greek "lithos", which means "stone". The reason for that is that it was the only alkaline element discovered in a mineral. The rest of the alkaline elements (sodium, potassium, rubidium, cesium and francium) were found in plant tissues.
4. Is the lightest known element. Its density is half of the density water. It is used in electric batteries (for example in mobile phones) and in heat conducting alloys.

7. MAGNETITE $Fe^{2+}Fe^{3+}{}_2O_4$

1. This mineral is formed by a well-known metal which represent more than the 95% of all metals used. It is considered the metal by excellence. It is very abundant in the crust and also in the meteorites.
2. To provide higher hardness and resistance to corrosion, it is alloyed with nickel, chrome, tungsten, vanadium, cobalt and more.
3. It has magnetic properties and it is mostly used in the manufacturing of steel.
4. It is, after aluminum, the most abundant metal on Earth.

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8. MALACHITE $Cu_2(OH)_2(CO_3)$

1. The metal that makes up this mineral is soft ant red. Its widespread use gave its name to de Chalcolithic archeological period which developed from 5000 B.C.
2. It is often used in alloys such as bronze and brass. It is the third most used metal in the world, behind aluminum and iron.
3. The 1, 2 and 5 cents coins coating are made of this metal. It is one of the few materials that doesn't degrade or lose its physical and chemical properties in the recycling process.
4. Electricity owns a lot to this metal, since electric wires are made from it.

9. ORTHOCLASE $K(AlSi_3O_8)$

1. It is a very common mineral in the terrestrial crust andenvase
is part of granites and gneisses. It contains silicon (Si), aluminium (Al) and potassium (K).
2. It is used in the manufacturing of glass, mostly for containers. Aluminium provides the glass strength and toughness, and potassium lowers the melting temperature of the material.
3. With this mineral we can produce our crockery or the tiles that cover the bathrooms in most of our homes.
4. With the products made from this mineral you can have breakfast or a tea comfortably, since it's from the orthoclase that porcelain is produced.

10. WOLFRAMITE $(Mn,Fe)WO_4$

1. During World War I the metal that makes up the wolframite reached a great importance as a strategical metal because it was used to make the shielding plates of war machines.
2. It was discovered in 1783 by the Spanish Elhúyar brothers. Its properties were not developed until mid-XX century, when its ability to improve the steel properties was discovered. It can be cut with a saw, forged or stretched in threads.
3. It is also known as tungsten, that means "heavy stone" in Swedish. It is used in the manufacturing of metals which are almost as hard as diamond.
4. Edison, one of the most famous inventors of all times, has a lot to thank to this metal, since bulbs filaments are made of it.

11. CASSITERITE (SnO_2)

1 This is one of the earliest minerals' humans used. It was alloyed with copper to form bronze for making tools and weapons. These items have been found in the Middle East and Egypt from around 3000 BCE.

2: It is used widely because of its capacity to prevent corrosion, combine with other materials and coat other metals.

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3: Because of its resistance to corrosion and the ability to maintain purity in water and drinks, it is often used to coat food and drink cans. (If the object is food can, please make this Clue 4)

4 Because of its ability to combine with other materials and low-melting-point, it is increasingly used in solders to join metals, especially for making electrical connections in the electrical and electronics industries, such as electronic circuit boards.

12. PLATINUM (Pt)

1: It is used because it is resistant to scratching and damage. There is a code written on it. After a long time, its colour will remain the same. It is very expensive.

2: The surface of the hard disk is distinguished, where this mineral is internally deposited. Theoretical Approach to Data Storage Capacity on a Hard Disk Drive. The importance of using platinum in data storage capacity.

3: It is used as catalyst in cars in order to oxidize carbon monoxide (CO) and hydrocarbons (HC), reducing in this way the pollutant exhaust gases emitted to the atmosphere.

4: It has various uses in a mobile phone. Its role is in the durability and resistance of the LCD screen to avoid breakage. Moreover, the use of it in the brightness of the LCD screen is quite important.

13. GOLD (Au)

1.It is extremely inactive. It is unalterable by air, heat, humidity and most chemical agents, although it dissolves in mixtures containing chlorides, bromides or iodide.

2. It has been known and appreciated since ancient times, not only for its beauty and corrosion resistance, but also for being easier to work than other metals and less expensive to extract. Due to its relative rarity, it began to be used as a currency and as a reference in international monetary transactions.

3.At present it has been given some therapeutic uses: some thiolates (or similar)) are used as anti-inflammatories in the treatment of rheumatoid arthritis and other rheumatic diseases. The use of this mineral in medicine is known as chrysotherapy.

4. It performs critical functions in communications, spacecraft, jet aircraft engines and many other products.

Its high electrical conductivity and oxidation resistance has allowed wide use as thin electrodeposited layers on the surface of electrical connections to ensure a good, low resistance connection.

14. SKUTTERUDITE ($(Co,Ni,Fe)As_{2-3}$)

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1.The name of this mineral is because it was discovered in 1845 in Skuterud (Norway). It contains a very valuable metal that often appears associated with nickel. In fact, its properties are similar.

2.It is one of the so-called blood minerals, because it finances conflicts in third world countries and also economizes through serious human rights violations, such as the employment of children in mines in inhuman conditions.

3.Its high resistance makes it very useful in the manufacture of superalloys, it is resistant to corrosion and cutting tools. This metal has several radioactive isotopes that are used in radiotherapy for the treatment of cancer, replacing the radio, more expensive.

4.The metal containing skutterudite is an important oligoelemnte for humans, since it is present in vitamin B12. It is also used in the ceramic industry to give the characteristic blue color.

III. Specific questions addressed to the behaviour education

At the end of the game the teacher will propose to reflect on the minerals that we use every day. Students will point out what objects and what minerals from the briefcase they use frequently and which are mined in Europe. Also to reflect which ones they use every day but they did not know that they were composed of certain minerals in the suitcase.

The following ideas will intend the students review their daily behaviour regarding with, for example, recycling and origin of ores:

- Some of the toxic objects are not recycled but sold relatively cheap to Third World countries where they are often buried in non-appropriate places (depending the country and the element)
- Many of the minerals from the briefcase are mined in non-adequate conditions in countries with no- appropriate environmental laws and social conditions, non-gender opportunities, etc.
- Highlight that many of these minerals use to be mined in Europe in the 19th century and until the 1970's (beginning of big scale mine shutdown and major crisis in European mining industry). There are deposits in Europe that can be mined in environmentally friendly and social adequate conditions but nobody wants a mine near their town or Village

Questions, do you know that?

- Which of the elements/minerals of the briefcase do you use every day? The reply is all. In today's society with technology and specific alloys and objects, we need much more elements from the periodic table than in the 60's.
- Which of the objects can be recycled with the usual recipients we have at home: yellow, green etc

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- Which of the objects need to be recycled in a specific point nearby
- Which of the objects need to be recycled in very specific places and are stored in the recycling plant to be sent outside
- Do you know what means “Not in My Backyards”? It means that you don’t want for example a mine, a factory or a waste plant near your house, but you and modern society needs those things, and you don’t mind if they are mined or worked outside your country where laws and rules and not as strict as in Europe.
- Select which minerals from the briefcase are actually being mined in Europe (even with small production). Surprisingly there are some of them. Reply: fluorite (Spain), magnetite (Kiruna mine in Artic Sweden), wolframite (tungsten) in Spain, Portugal and Austria
- Select which minerals were extensively mined in Europe and now come mainly from outside. There are now very few mines of this minerals: Reply: blende (zinc), galena (Pb), malachite (copper)

3. GOLD AND CONFLICT MINERALS THEMATIC BRIEFCASE

The Gold Briefcase Game targets at children 6-14 years old and it is based on a virtual journey to know more on the social-but-hidden life of Gold. The workshop is divided into three main parts: an opening activity, the journey composed by 4 parts, and a final activity.

About the gold

Gold mining in Europe is governed by the strict regulatory framework (Directive 2006/21/EC). Although discussions about gold recovery processes are often controversial, this production process is considered by the EU as the Best Available Technique. In addition, the United Nations Environmental Program (UNEP) has developed the International Cyanide Management Code for the manufacture, transport, and use of cyanide in the production of gold in the mining industry. All EU gold mines today apply cyanide destruction technology and are currently in the process of adopting the code.

In case of artisanal mining and under current socio-economic and political conditions in developing countries, such as Suriname, Guiana, Indonesia, Philippines, Mongolia and part of the Western Africa (e.g. Ghana, Burkina Faso, Mali), mercury-based gold mining is the easiest and the cheapest way of obtaining this metal, mostly used in illegal exploitations. These mercury-based methods are usually practiced without any safety precautions. Mercury is highly toxic. Artisanal gold mining comprises about 50% of total mercury emissions to the environment.

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Regarding with the conflict zones, the conflict gold trade starts at mines controlled by armed groups, where approximately 40% of the miners are children.

I. Gold Briefcase contents

- Gold dust kids
- Story of the pirate searching a gold treasure
- Map of gold extraction sites
- A golden medal, a calculator, a coin, red pigment and a memory card
- Visual aids, photos and videos, showing the ornamental and decorative use of gold (for younger pupils)
- visual aids, photos and videos, showing some artisanal and small-scale mining (for older pupils)
- Gold ore

II. The Gold Briefcase game

Opening Activity. Students will be divided in two teams. The workshop plays on the change of perspective, therefore it will start with a stimulus question to test the knowledge on this topic. The teacher will ask to the students: Which is the first object (product) that you image when you think to gold? Each group will draw the object.

(10-14 students) The teacher will ask as well: Which are the sayings that you know associated to gold? Each group will have to find the largest number as possible of sayings in about 3 minutes.

Journey. Later, the teacher will inform the students that they are beginning a journey with a new friend, the pirate Goldie, a detective with a magnifying lens, a map and a briefcase (teacher will show the briefcase without showing the content). This pirate searching a treasure, has a question in his mind: What is the history of Gold?

The teacher will anticipate to the students that at the end of the journey, the winner group will be awarded with something “very beauty” and “of value”. The award will be the golden metal contained in the Briefcase but students will know it only at the end. It will be the starting point object for the last activity. The virtual journey starts. The teacher will prepare the four plasticised cards with the pirate on it next page drawing.

Firstly, the teacher will read the first question of the pirate in the plasticised card : **Where does the Gold come from?**

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Secondly, he/she will take the minerals ores from the briefcase showing them to the classroom. In this part the students could touch the minerals in order to discover the materiality of Gold.

Game: each group should describe the minerals and the difference between the two gold samples. It will win who will have done the most accurate description. The goal is to familiarised students with the concept of toughness and flacking, while the concepts of colour and brightness should be more intuitive. Each group then will paste the Gold kids dust on their drawing-object.

At the end the teacher will read out what the pirate has discovered on the history of gold in the backside of the first plasticised card.

Where does the Gold come from?

Example. In the fourth millennium B.C., gold was recovered as nuggets and flakes from streambed gravels in Asia Minor and Central Asia. Possibly a little later, the Egyptians recovered gold along the Nile. Gold is a chemical element whit symbol Au, from Latin aurum. Its atomic number is 79. In its purest form, it is bright, slightly reddish yellow, dense, soft, malleable, and ductile metal. Gold often occurs in free elemental (native) form, as nuggets or grains, in rock, in veins, and in alluvial deposits. It occurs in a solid solution series with the native element silver (as electrum) and also with copper, nickel, platinum and palladium. Then, each group will receive two worldwide maps of countries where gold is mostly extracted (Europe mines are included). Through the medium of photos the teacher will show the difference between artisanal or small-scale mining and large-scale or corporate

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mining, as well as the different work conditions.

The teacher will read the second question of the pirate: **What can I do with it?**

Figure 8: Example of products made of the mineral

The goals are to understand: the difference between native ore and final product and the presence of gold in our daily life. Cost, chemical inertness, workability, and appearance are the most important determinants of how and where gold is used.

Game: the teacher will show a calculator, a coin, a red pigment and a memory card.

(6-10 students). Each group will have to guess which products contain gold or is made by it (actually in all of these). Groups will received one point for each correct answer and they will lost one point for each wrong ones.

(10-14 students). Each group will receive a set of four plasticised cards with the gold concentration in each of these four objects and the reason why it is present on it. Students have to relate the card to the right object. One point to each correct match. Next step: if they find out almost two objects more where gold is present (mobil phones, computers, jewellery, glass), the group will gained two points more.

The teacher will read the third question of the pirate: **How does gold arrive in our countries?** The main goal is to understand the gold business and the overexploitation of rich countries on poor ones. She/he will explain the flows of ore from the extraction sites to countries where is mined and countries where is sold.

(10-14 students). Each group will have to drawn on their worldwide map previously delivered some arrows representing these flows. They will receive one point to each correct arrow. Then teacher will reflect with students on the directions of the arrows. In this part there will be a focus on conflict minerals. Through the medium of photos the teacher will explain the hidden side of the gold chain: the gold treatment in the poor countries, the environmental consequences of mining, the power of big companies, the presence of children in the mining sites. Together with the teacher students will think and discuss the complexity of conflicts and their possible solutions (international certificates, new extractive technologies,…).

The teacher will read the fourth and last question of the pirate: **How can we give another life to gold when we dismiss the object in which is contained?**

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The teacher will explain that recycling could be one solution to the mineral conflicts. She/he will encourage the reflection on the importance of recycling for climate change and for improving conditions of whom is working in the mines. The teacher will show the green or recycling points in the area (she/he will have already done previously). All together students will create a paper box for the school where they will collect recycling gold objects.

Final activity. The teacher will announce the end of the virtual journey. The pirate is satisfied with their job and now his briefcase is full of information.

The group that will have scored more points during the games will be awarded with a golden metal contained in the briefcase.

Why a golden metal? In this last phase the teacher will encourage the students to reflect upon the symbolic representations of this mineral. Through the medium of photos

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Figure 9: Examples of photos (source: Google images)

she/he will explain the culturally and historically associations between gold and the concept of "beauty", "value" and "power".

III. Specific questions addressed to the behaviour education

At the end of the game, the teacher will propose reflect about how our daily activities can help to improve the lives of the people living in areas where mining is operating, and how can work together against climate change. The following ideas will intend the students review their daily behaviour regarding with, for example, recycling.

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- Recycle your electric and electronic devices in the supply shops, NGO or in green points (younger)
- Check if they are recycling all appropriate elements at home in this specific container (older)
- Identification of the waste classification system implemented in the area (older)
- Check providers transparency in the supply chain (older)
- Check green points close to their homes (older)
- Preliminary identification of green or recycling points in the area (teacher)

Questions:

- Is any place around the area to recycle electronic devices? Where? What kind of devices can be deposit there? What's happen with this refused devices? (younger)
- Do pupils put the devices in the urban containers? Why? What's happen with this refused devices? (younger)
- How can older students know about their device's suppliers and about their practises? Can they check in internet about some of them? (older)
- Which advantage is provided by the appropriate recycling practises regarding with the electronic devices? (older)
- Is there any green point around the area? What kind of residues can the pupils deposit there? (older)

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4. THEMATIC BRIEFCASE: TIN and Daily Life

The Tin Thematic Briefcase highlights the prevalence of tin in our life: tin is found in various locations worldwide; tin is added to many products and materials to improve the quality of our life; and tin has been used for a very long time in human history. The Tin Thematic Briefcase introduces the significant historical mining activities in the UK (Cornwall) where pupils live. The existence of tin in their country shows pupils the relevance of tin mining and the socioeconomic rationales behind mining activity. The Tin Thematic Briefcase also encourages pupils to think about consequences of careless mining, including 'conflict minerals' from artisanal and small-scale mining in the Democratic Republic of Congo, and sustainable ways to source tin, including the use of modern technologies and recycling. Additionally, it provides some creative element, in the form of car themed rubber stamps and miniature car construction model, to be used at any time if children desire some artistic engagement. Therefore, it links to several subject areas such as geography, science, history, design and technology and citizenship.

Properties and applications of Tin

Tin applications in car manufacturing below[3] will be used for the main activity to learn the properties and capacities of tin as well as the wide applications of tin in contemporary world. It demonstrates the usefulness and prevalence of tin in our daily life.

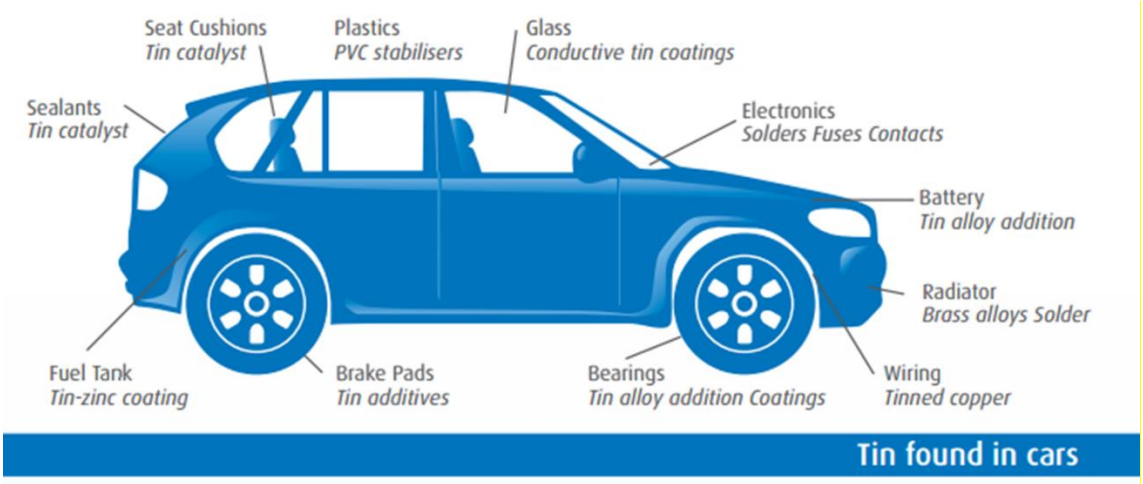

Figure 10: Tin found in car

[3] ITRI (2013) 'Use of Tin today ' http://www.csdtin.com.au/?attachment_id=591

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I. Tin Briefcase contents:

- Cassiterite, sphalerite, orthoclase, and fluorite
- Tin ingot
- Food tin, tooth paste, cup, and Sudocrem (antiseptic healing cream)
- Visual aids - chemical elements
- Poster - elements of a smartphone
- Poster - tin found in car
- Transparent flip flap book - car parts
- Visual aid - tin producing countries
- Inflatable globes
- Map and picture – tin mining in Cornwall (UK)
- Sets of Jigsaw Puzzles
- Jigsaw Puzzles Instruction for teachers
- Sets of Bingo Cards for students and Call Out Card for teachers
- Bingo Instruction for teachers
- A set of car themed rubber stamps and ink pads
- Sets of miniature car construction model
- Posters - artisanal and small-scale mining in the Democratic Republic of Congo
- Posters - modern industrial mining operations
- Guide sheet - minerals
- Teacher's guide

II. The Tin Briefcase Game

The Tin Briefcase Game consists of six parts and starts with an introduction game to discover which daily objects (food tin, toothpaste, cup and Sudocrem/ supplement) are made of the four minerals (cassiterite, sphalerite, orthoclase, and fluorite) in the Briefcase. Teacher shows the minerals, explains which countries they are from (some are from the UK), and allows children to touch the minerals. Teacher prompts children to guess the objects and emphasises the prevalence of minerals in our life in general as well as the presence of minerals in where children live. Focusing on Tin, Teacher also shows the tin ingot made of Cornish cassiterite. For older children (above Year 9), various elements extracted from these minerals can be explained, using the posters of chemical elements.

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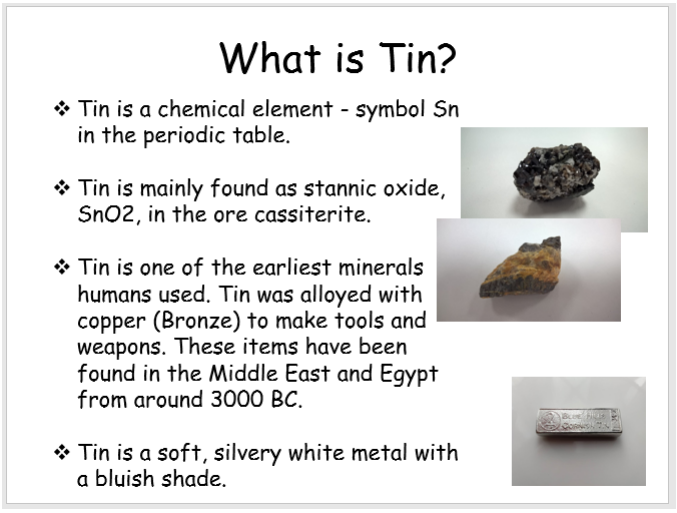
In the second part, Teacher explains the focus on Tin as one of the most prevalent minerals, followed by:

- What Tin is
- Tin's properties and their applications in different objects, including food tin, solder in electrical circuit board, and smartphone screen
- Tin found in cars, shown in the transparent flip flap book
- Significant Tin producing countries shown in the graph and finding these countries on the inflatable globes
- Tin mining activities in the UK (Cornwall)



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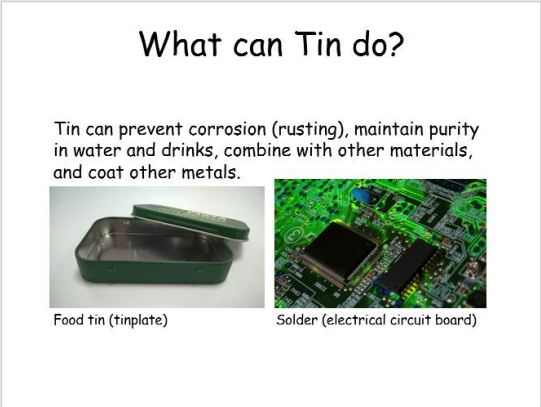

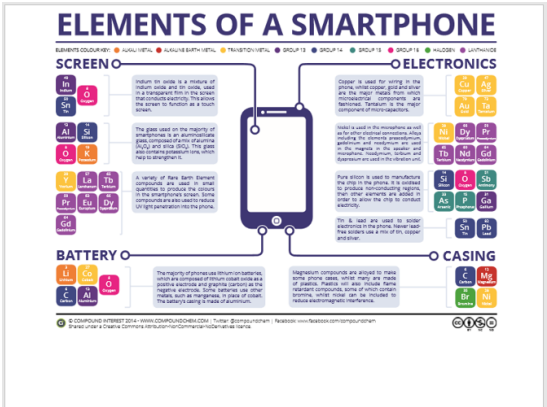

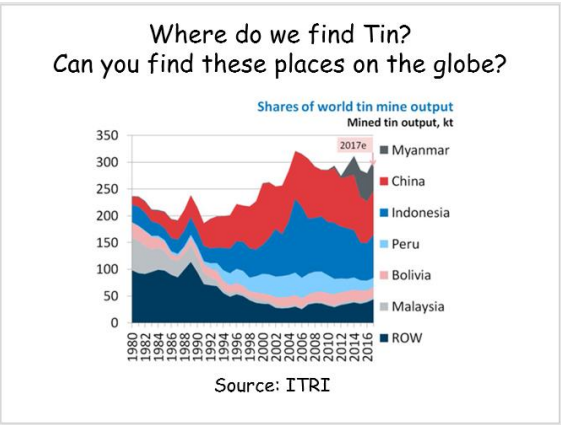

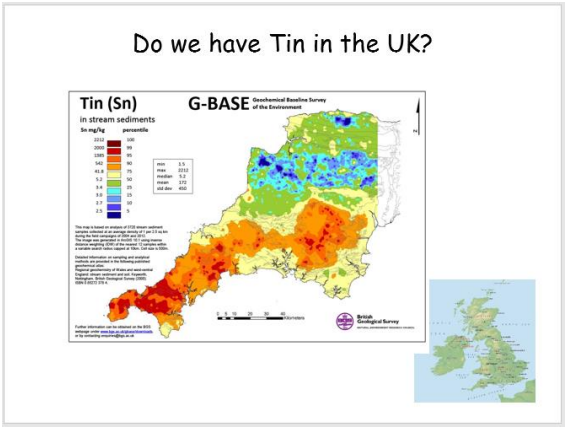

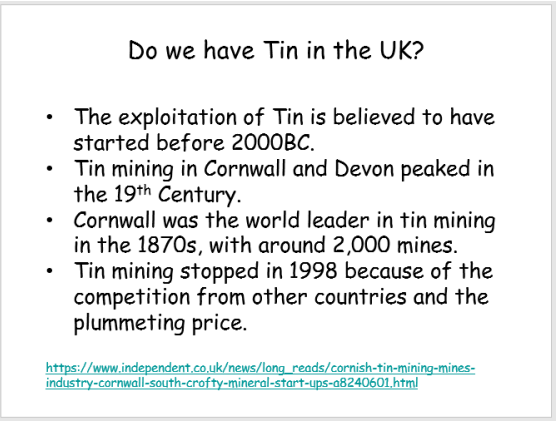

The third part uses the jigsaw puzzles. Teacher hands out four sets of jigsaws, each contain four pieces to complete (16 pieces in total), to groups of children. Each jigsaw set contains mineral, property, element/ material, and object to match. The groups of children compete which group can complete the below sets of jigsaws first. Additional Jigsaw Puzzles for daily electronic goods like smartphone and laptop computer, using the conflict minerals, can be introduced to older children (above Year 9). The additional Jigsaw Puzzles will provide teacher the opportunity to discuss the impact of conflict mineral extraction (artisanal and small-scale mining) and processing in the mining communities. The conflict minerals will show the linkage between the use of these

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minerals in our daily life and the impact on the mining communities in the world. The jigsaw puzzles are shown below.

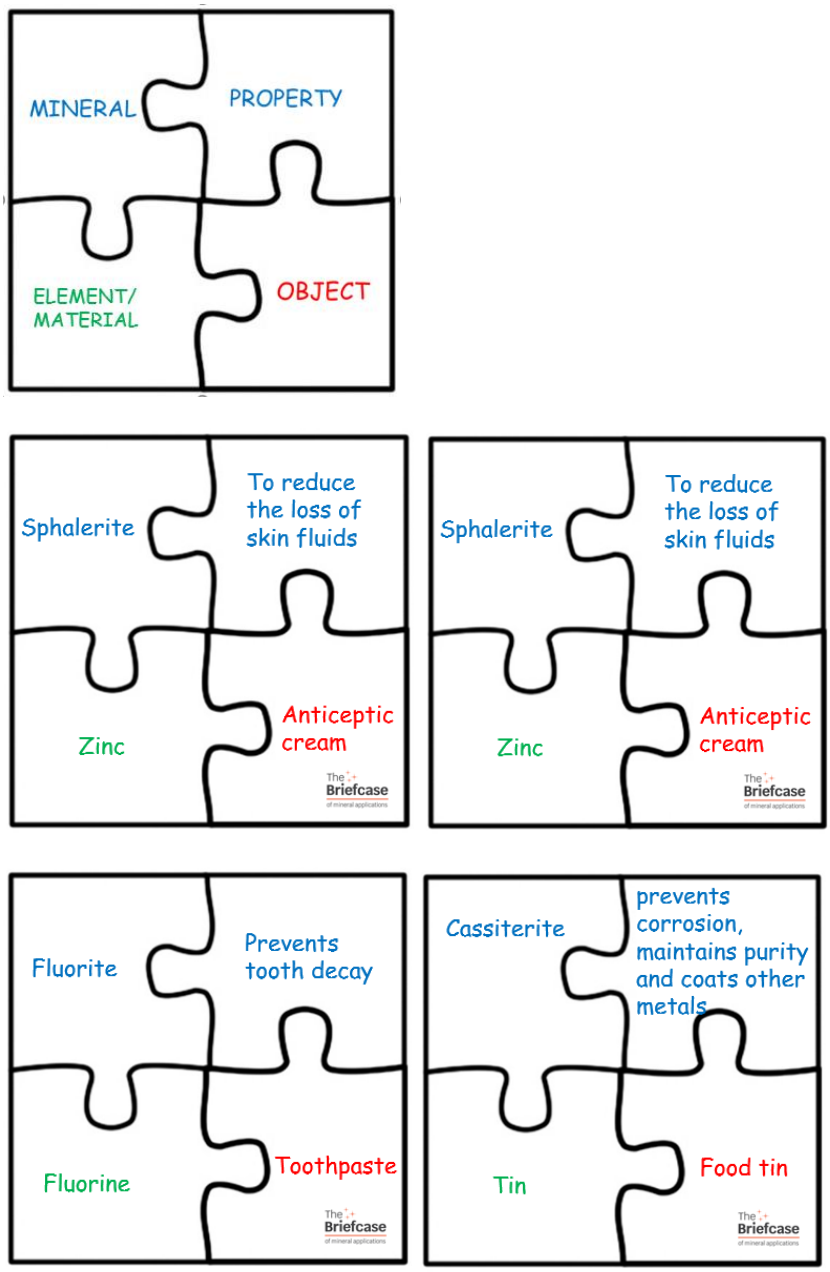

Figure 11: Jigsaw Puzzles

The fourth part uses the Bingo game. Teacher hands out Bingo Cards and pens to groups of children (ideally above Year 6) and calls out the questions, including definition, word, phrase or object. Children have to find the answer on their Bingo Card and mark it with the pen. They have to shout 'Bingo!' when they have all the answers covered diagonally, across a row or vertically in a column. The first group of students who have 'Bingo' wins the game. Different sets of Bingo Cards on the locations, properties and applications of

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Tin can be used to suit the level of students. The Bingo Cards and Call Out Card are shown below.

Alloy	Silver	Cornwall
Solder	Peru	PVC
Break pads	Corrosion	Tinplate

Tools and weapons	Touch screen	Cornwall
Solder	Myanmar	Bronze
Glass	Corrosion	Electronic circuit board

China	Sn	Silver
Food tin	Cassiterite	Electronic circuit board
Glass	Tools and weapons	Alloy

Sn	Bolivia	Tinplate
Food tin	Cassiterite	Break pads
Glass	Touch screen	PVC

Bingo Questions

Q1: This is a mixture of different metals - Alloy
Q2: Tin solder is often used for making electrical connections in this - Electronic circuit board
Q3: This is a country where Tin is mined - China/Peru/Bolivia/Myanmar
Q4: Tin is mixed with Indium to make this part of smart phones conduct electricity - Touch screen
Q5: Tin is extracted from this mineral - Cassiterite
Q6: This is a metal (steel) sheet coated with Tin - Tinplate
Q7: Tin is alloyed with copper to make this - Bronze
Q8: This place was the world leader in Tin mining in 1870s - Cornwall
Q9: Tin is used to add resistance in this car parts - Break pads
Q10: One of the capacities of Tin can prevent this - Corrosion
Q11: This is the symbol of Tin in the periodic table - Sn
Q12: We keep food in this because Tin prevents corrosion - Food tin
Q13: This is the colour of pure Tin - Silver
Q14: This is made of Tin because of the low melting point of Tin - Solder
Q15: In the Bronze age, humans used Tin to make these - Tools and weapons
Q16: Tin is used to make this flat - Glass
Q17: Tin chemical is added to make it stop degrading in heat and sunlight - PVC (Polyvinyl Chloride)

Figure 12: Bingo Cards and Call Out Card

The fifth part discusses the impact of our life from using minerals, focusing on some negative consequences from mining. Teacher can show pictures (and videos) of 'conflict minerals' from artisanal and small-scale mining in the Democratic Republic of

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Congo as an example. The activity can be extended for older children (above Year 9) to include research.

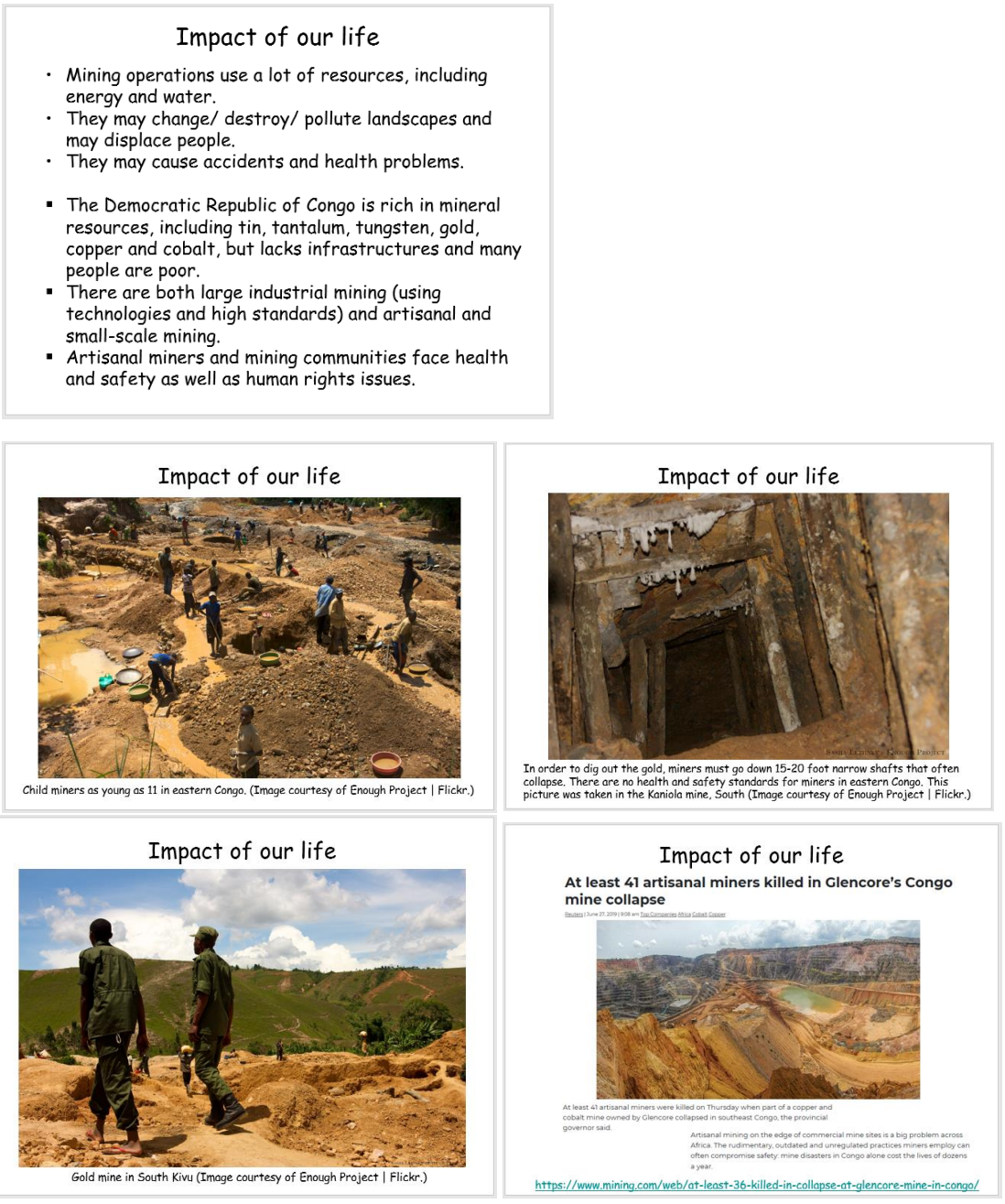

Figure 13: Pictures of artisanal and small-scale mining in the DRC

The last part discusses sustainable ways to source tin, including the use of modern technologies and recycling. Teacher shows pictures of good practice industrial mining operation using modern technologies. For older children (above Year 9), Tin mining in Europe – Cornwall in the UK - can be considered why the mines were closed, if they should be re-opened, and if so, how they should operate. Also, Teacher explains the state of Tin recycling and discusses how we can contribute to more sustainable use of minerals including recycling.

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Figure 14: Photos of a modern Mine.

III. Specific questions addressed to the behaviour education

At the end of the game, Teacher proposes to reflect about how our daily activities can help to protect the environment, working together for a sustainable world.

- Drink and food cans recycling in the specific container at home (younger)
- Check if they are recycling all appropriate elements at home in this specific container (older)
- Identification of the waste classification system implemented in the area (teacher)

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Questions:

- Do participants usually recycle drink and food cans? In which container? Why? (younger)
- Are there Plastic Caps Recycling Projects around us? Can the pupils recycle caps for humanitarian or social purposes? (younger and older)
- What kind of materials should we recycle and where can we find a recycling station? (older)
- How many recycling containers can the pupils find around the area? (older)
- Where can pupils recycle electronic waste like a smartphone?
- Is it a good idea to reopen mines in Europe (older)? Why? If so, how should mining in Europe operate?
- Should we avoid buying products using 'conflict minerals' (older)? Why? What can we do to improve the negative consequences?

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5. RECYCLING AND PLATINUM THEMATIC BRIEFCASE:

The platinum briefcase toolkit aims to provide the essential knowledge to students related to the effect of platinum in everyday life and its recycling processes. Moreover, MONOLITHOS' products as well as the recycling and recovery processes which are used during the treatment of spent automotive-catalysts will help children to get a broader understanding on the characteristics and properties of platinum and its recycling importance as well.

Platinum is a very expensive and relatively rare precious metal.

There are many fields in which platinum is present:

- ✓ Jewelries, ornaments and artifacts
- ✓ Dental implants and in some surgical tools *(defibrillators, cardiac pacemakers)*
- ✓ Laboratory utensils
- ✓ Hard disks
- ✓ Special silicones for kitchen utensils
- ✓ Electrical resistance wires
- ✓ Aircraft and sport car industries
- ✓ Liquid glass displays in laptops, in LCD TV, in mobile phones
- ✓ Optical fibers

However, its most widely known application is as a catalyst in catalytic converters of vehicles, which are used in order to remove harmful pollutants from exhaust gases (flue gases). Catalyst is a substance which increases the rate of a chemical reaction, without itself participating or undergoing any chemical change. It is considered to be the key player in clean energy technologies.

I. How is platinum extracted from its mineral ore?

An ore is any mineral which contains one or more useful minerals in an exploitable amount and is created by geological processes in the earth's crust or on its surface**. A mineral** is determined as any chemical element which exists naturally either in soil or in the form of a solution, in water and is a constitution of the rocks that make up the solid crust of the earth. Some of the minerals containing platinum are *sperrylite ($PtAs_2$), tellurides ($PtTe_2$), platinum sulfides*: *Braggite (Pt, Pd) S, Cooperite-PtS* and *Laurite*. Platinum extraction from these ores is a long-lasting procedure which can take up to 6 months and up to 12 tons of ores to produce an industry troy ounce. Platinum deposits can be found all around the world with more than 70 percent of the world's platinum supply coming from South Africa. Russia, Canada and Zimbabwe follow. There are two

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methods platinum material is produced, either from recycling of scrap and spent automotive catalysts or from mines.

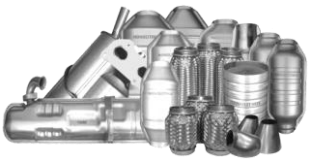
II. Metals which are included in platinum group and their impact on people's life and environment

The elements which are included in platinum metals group *(Pt, Pd, Rh, Ir, Os, Ru)* cause serious problems in people's health and pollute the environment. They are usually detected in airborne particulate matter (PM), roadside dust, soil, sludge, water and finally, the food chain. As a result, they accumulate in living organisms and tissues causing serious problems like asthma, nausea, increased hair loss, increased spontaneous abortion, dermatitis and others. Their metallic form is considered inert related to biological reactions.

III. Recycling and recovery of precious metals in MONOLITHOS company

MONOLITHOS' products (*catalytic converters, exhaust systems and particle filters*) and its Research & Innovation Department, contribute to the protection of public health and environment from vehicle emissions.

Platinum group metals *(Pt, Pd and Rh)* are the state-of the-art noble metals used as catalysts in catalytic converters for the control of the emissions from exhaust gases. Spent catalysts are recycled in order to recover the above precious elements.



MONOLITHOS is not only recycling spent auto-catalysts, but also make new catalysts, using recycled critical raw materials namely PGMs, rare earths and cobalt, tungsten and vanadium by implementing cost-effective recycling processes.

IV. Learning goals: "Learning by Playing"

During this learning experience, children will gain essential knowledge on:

- ✓ Wide range of objects containing platinum.
- ✓ Negative effects of not recycling on people's life and environment
- ✓ Understanding the importance of recycling spent auto-catalysts and waste materials (used daily objects which contain PGMs) in order to mitigate the contamination caused by them.
- ✓ Platinum group mining in Europe and all over the world.
- ✓ Learning the recycling and recovery processes of platinum.

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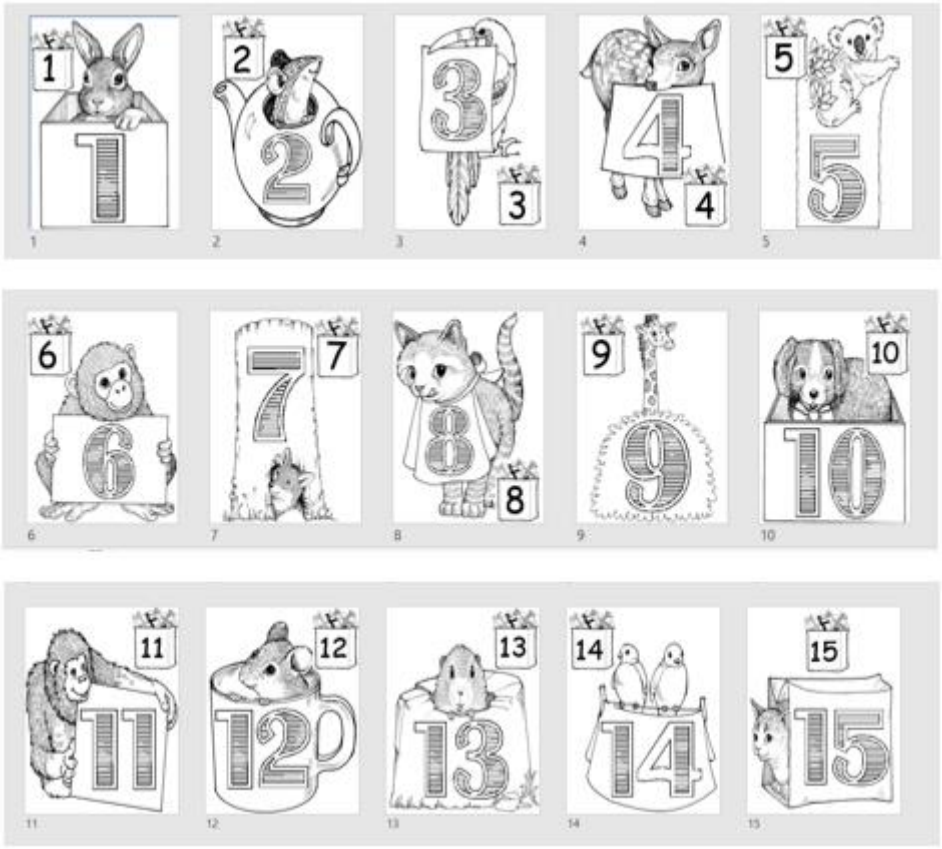
✓ Young students will be aware of global environmental protection benefits.

V. Platinum briefcase game

Platinum briefcase game aims at children ages between 6 to 14 years old and it consists of three parts. The number of participating children can be a whole class which numbers 25-30 students. The class which will be chosen to play the game will be divided into two (2) teams.

During all game steps, the class is divided into two groups and they both participate in all game steps. Each team will have colored numbered cards for each child *(yellow cards for the first team and green cards for the second).* Then, children can give a name to their team.



Prior to beginning of the game, the teacher will show to children the pure platinum nugget and its mineral ore, both accompanied by colored plasticized cards in which details about the characteristics and physicochemical properties of platinum will be contained and further discussed with students (i.e. origin and formation of platinum etc.). Among the cards, a world map demonstrating platinum deposits will also be presented, so that children being familiarized with Platinum deposits and demand all over the world. The teacher will also refer to some of the platinum's applications in daily life.

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At first, the teacher will explain to children the what a mine is and will then describe the differences between the two different categories of mines.

Subsequently, the trainer will describe step by step the extraction process, while at the same time there will be a continuous interaction and assistance between the teacher and the children for any questions they might have.

Steps of the extraction process are described below:

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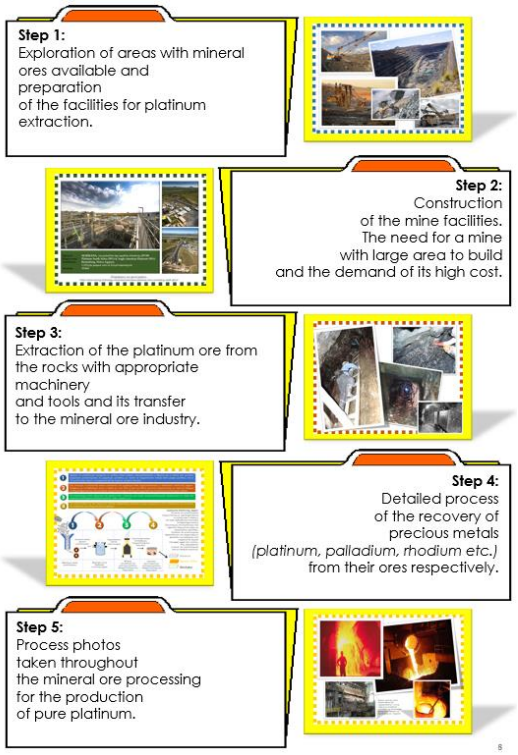

VI. 2nd Part of the game

The second stage of the game begins with the narration of a story of an 8 years old boy called **Platonas**, who lives with his family in Athens. Platonas is invited by his classmate, **Rhodoula** at her house for her birthday party. The teacher narrates the story, asking questions to children regarding information/details about the party *(time of the party, location of the house, mean of transportation etc.).* Only when a child raises his numbered card, the teacher will allow him to speak and answer the question, otherwise the answers won't count.

The correct answers to these questions count for (1) grade or (2) grades if they are the answer to an intermediate question (grades are clarified for each question during the game). Out of the total number of answers, only five specific answers will be the "**key**" ones and will count for (5) grades. The team with the greater number of grades will be the winner!

Every time that a "key" answer regarding an object which is included in the platinum briefcase, comes of, the teacher will open the briefcase and show to children the related object. Each object is accompanied by illustrative cards which contain details about its applications and the role of platinum in that.

The objects which have been chosen, except apart from platinum ore are five:

1. **Platinum catalyst (catalyst powder and cordierite)**
2. **Watch**
3. **Hard disk**
4. **Mobile phone with LCD screen**

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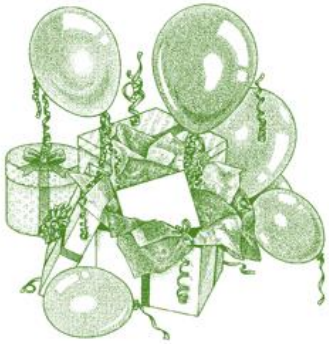
5. **Denture with platinum implant**

Rhodoula's invitation for her classmate, Platonas!



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1st Question

For the platinum briefcase object Watch
with the "key" word: Time

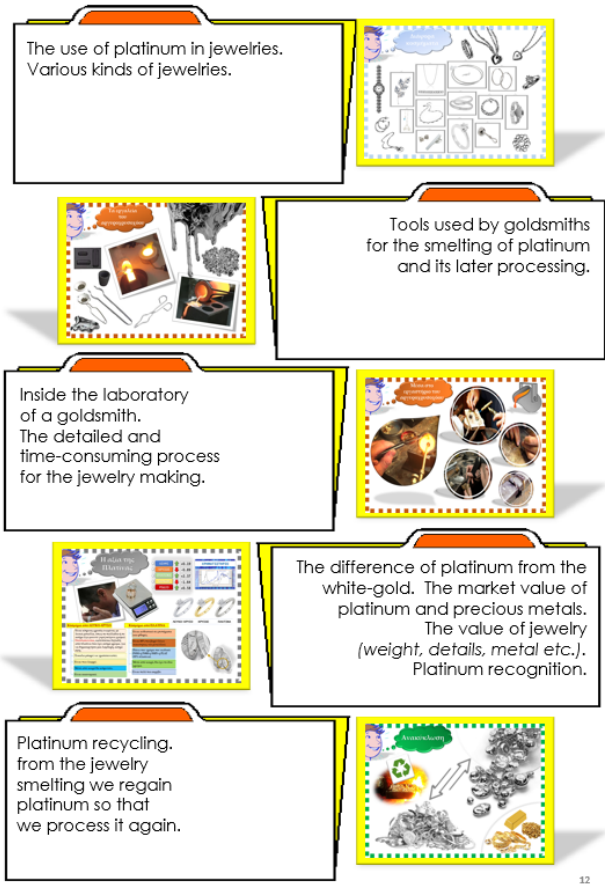
POSSIBLE ANSWERS:

1. Home address
2. **Time of the party**
3. Date
4. Dress code
5. Confirmation of attendance
6. Contact number
7. Name of the host

To the correct answer:
Time of the party, the teacher shows to children the **watch** from the briefcase.

The **five** cards below follow.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: Time of the party, the students assert (5) grades.



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Intermediate Question:

For the platinum briefcase object Hard disk with the "key" word: Internet

POSSIBLE ANSWERS:

1. On a map
2. **On internet,** on PC
3. With the help of labels at the street
4. Oral instructions by a taxi driver
5. On GPS

To the correct answer:
On internet, on PC the teacher proceeds to the second question.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: On internet, on PC, the students assert (2) grades.

2nd Question

For the platinum briefcase object Hard disk with the "key" words: Hard disk

POSSIBLE ANSWERS:

1. Keyboard
2. **Hard disk**
3. Mouse
4. Screen
5. Memory card
6. Graphics card
7. Processing card
8. Speakers

To the correct answer:
Hard disk, the teacher shows the **hard disk** from the briefcase.

The **five** cards follow below.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: Hard disk, the students assert (5) grades.

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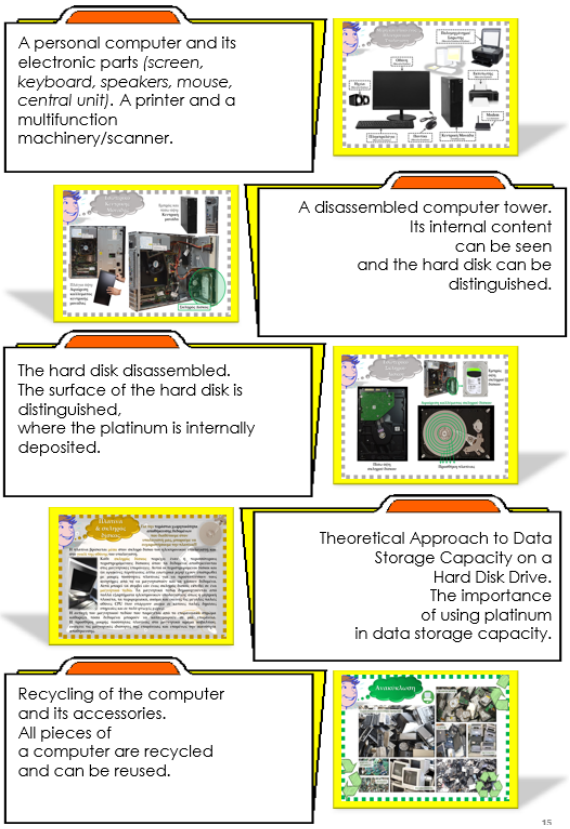

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3rd Question

For the platinum briefcase object Denture

with the "key" words: We brush our teeth

POSSIBLE ANSWERS:

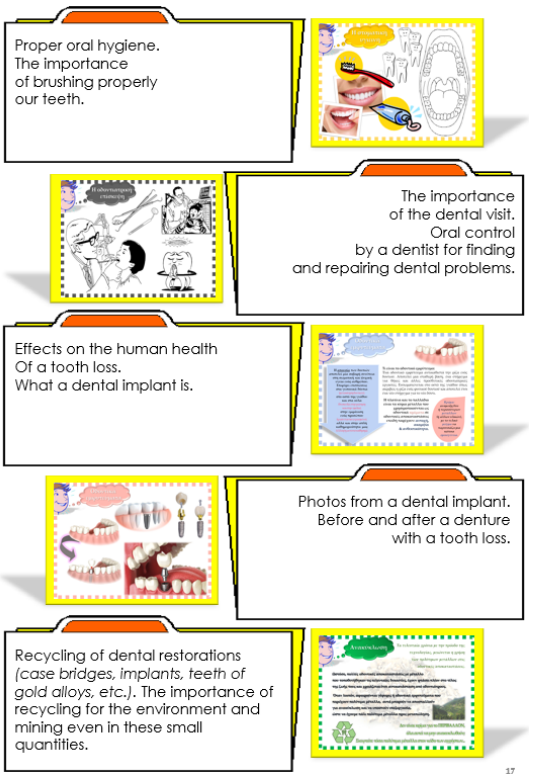
1. We get dressed
2. **We brush our teeth**
3. We clean our face
4. We wear our shoes
5. We have a bath
6. We wear out jewelry
7. We groom our hair

To the correct answer:

We brush our teeth, the teacher shows the **denture** from the briefcase.

The **five** cards below follow.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: We brush our teeth, the students assert (5) grades.



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4rth Question

For the platinum briefcase object Mobile Phone
with the "key" word: Mobile Phone

POSSIBLE ANSWERS:

1. The gift
2. **The mobile phone**
3. The jacket, the coat (depending on the season)
4. The bag
5. The cap, gloves, scarf (depending on the season)Τα γυαλιά
6. Brother/Sister
7. Money *(depending on the age of the children)*

To the correct answer:
Mobile phone, the teacher shows the **mobile phone** from the briefcase.

The **five** cards below follow.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: Mobile phone, the students assert (5) grades.

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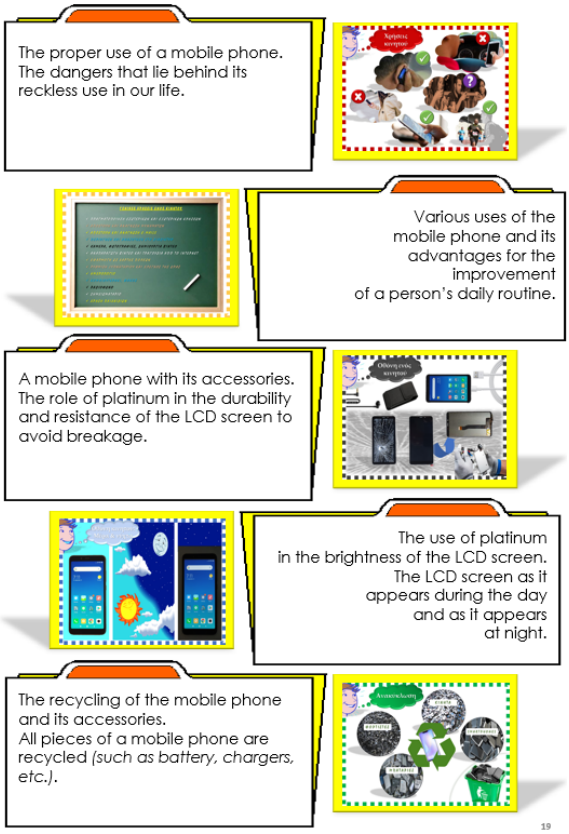

Intermediate question:

For the platinum briefcase object Catalyst with the "key" word: Car

POSSIBLE ANSWERS:

1) The bus
2) **The car**
3) Metro
4) Tram, train
5) Taxi
6) Bike
7) On foot

To the correct answer:

The car, the teacher proceeds to the 5th question.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: The car, the students assert (2) grades.

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5th Question

For the platinum briefcase object Catalyst
with the "key" word: Catalyst

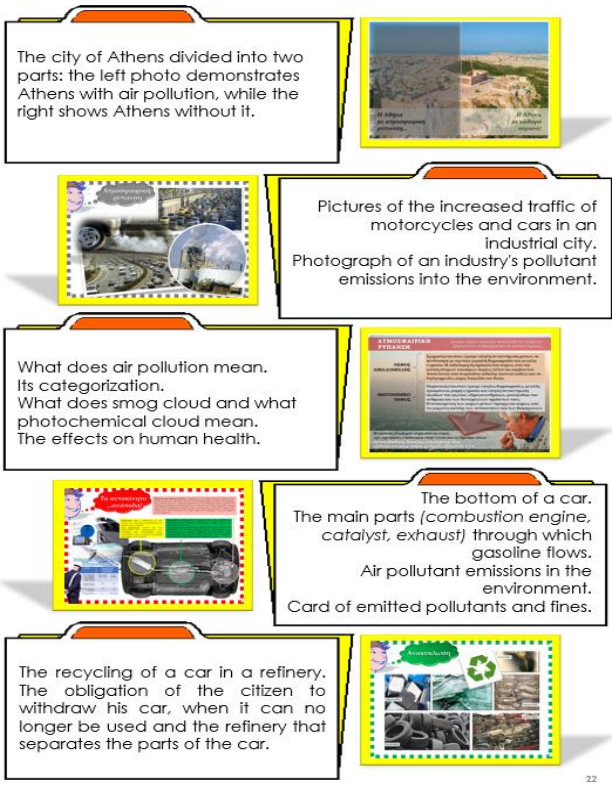
POSSIBLE QUESTIONS:

1. The steering wheel
2. **The catalyst**
3. The exhaust system
4. The wheels
5. The doors, the windows
6. The seats
7. The engine
8. The tank

To the correct answer:
The catalyst, the teacher shows the catalyst from the briefcase.

The **five** cards below follow.

In all possible answers the students can assert (1) grade for their team, while for the "key" answer: The catalyst, the students assert (5) grades.



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3rd Part of the game

At the third part of the game the importance of recycling in our daily life will be presented. The concept of this part is to select an object among the five objects mentioned above and describe its recycling process. In this game, the catalyst in the car has been selected as object.

What is and from which parts is the catalyst in a car consisted of.

In particular, the instructor will theoretically approach along with the students the meaning of the catalyst and the parts which it is consisted of. Each of the five cards following, will illustrate one of the steps required for the catalyst recycling. At each step of the recycling process, children will have the chance to discuss and interact with the teacher further about the recycling process, by asking him/her questions.

Recycling process of a spent auto-catalyst is described as follow:

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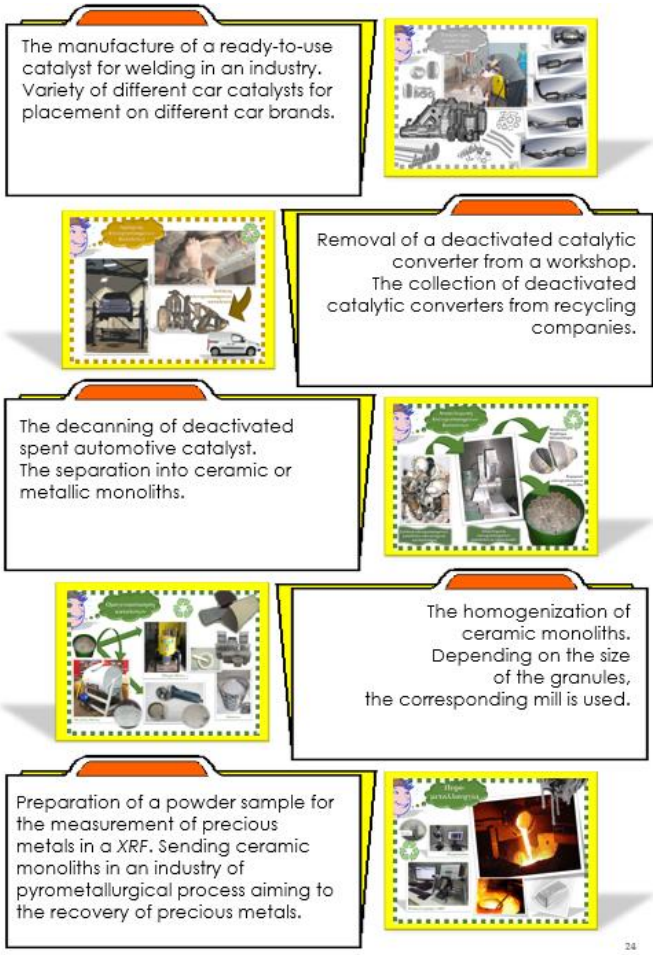

Subsequently, the teacher will discuss with the children the importance of platinum recycling. More specifically, he/she will explain to them the necessity of recycling :

- Due to low availability of platinum ores
- Due to platinum's high cost
- Due to the environmental damage caused by its extraction etc.

The teacher will present to children examples of mines around the world showing them photos with the impact a mine has on the environment. Finally, the teacher will explain that it is very important the company that owns the mine to have a responsible policy. An effort to minimize the environmental footprint on land after the completion of a mine, should be done. Thus, it should ensure that the land and the natural landscape is restored to its original state with the help of the state, the municipalities. It will do so by developing new vegetation, new environmental actions to protect the local ecosystem where a mine belongs.

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Diploma of successful training

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The Platinum briefcase toolkit aims to provide the essential knowledge to the pupils related to the recycling processes of Platinum and other platinum group elements and their applications in everyday life.

Monolithos' products and the recycling and recovery processes which are implemented will help pupils to get a broader understanding on platinum group elements and especially platinum, and the importance of recycling.

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6. COBALT AND BATTERIES THEMATIC BRIEFCASE

The Cobalt Thematic Briefcase is focused on the diffusion of minerals knowledge among students, aiming to teach which minerals are used for the production of two things: a mobile phone and a (lithium-ion) battery. The mobile phone is an ideal object for informing schoolchildren about our resource-intensive consumption habits, because 98 % of young people own a mobile phone and thus have direct experience of this everyday accessory. The teachers who participate in our workshops are shown how to use the Briefcase in class. It's appropriate for teaching in a range of different subjects, from chemistry, geography and physics to social studies and ethics. Cobalt, which is used for the production of lithium-ion batteries, is discussed in particular.

I. Cobalt Briefcase contents

- Disassembled mobile phone
- Primary raw materials
- Model Lithium-Ion battery
- Cobalt Ores (Skutterudite, Heterogenite, Erythrite)
- Visual aids, photos and videos, showing the applications
- Map of cobalt extraction sites

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II. The Cobalt Briefcase game

The Raw Material Starting Game:

Bring:

- 1 cookie
- 1 t-shirt
- 1 plastic bottle
- 1 mobile phone/computer
- 1 piece of jewelry
- 1 nail
- Raw material briefcase

The teacher shows all the items listed above to the students and asks them to identify them. Then he/she asks the students what the items are made of.

- Question: what do you need in order to make a cookie? Answer: food items – flour, eggs, sugar, water etc.
- Q: What do you need in order to make a t-shirt? What is this/your t-shirt made of? Cotton? Wool?

Then ask about the rest of the items? Plastic bottle = plastic, jewelry = some metals? Nail = iron?

The idea is to get children and students to think about what their everyday objects are made of. Because raw materials are not well-known to many people, it might be better to start with something familiar such as with food items or clothing. Then there are different levels of raw materials and its final products, such as plastic vs. metals. Once the students are ready to dive into the topic of (mined) raw materials, the next questions can be posed:

Q: How do you make plastic, metals, iron?

- The answer is: You need raw materials. Also the first items were made of raw materials. But here we have raw materials which are mined.

⇨ Open the briefcase and show the inside to the children: there are many different rocks and some metals. The children can touch the metals and learn what they are and what they can be used for.

⇨ Raw materials = *"Mineral Raw Materials are mineral constituents of the earth's crust which are of economic value. In the most comprehensive sense this includes the so-called "mine output" as well as the output from processing at or near the mines (for instance, the up-grading of ores to concentrates)."* (*https://www.bmnt.gv.at/english/Energy---Mining/Mining/Definitions-of-Mineral-Raw-Materials.html*)

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Video: How can we make metals from rocks?

- ⇨ Where does metal come from? https://www.youtube.com/watch?v=zmjZC1cFOKk – Video "Where does metal come from?" by Mystery Doug (4:28min)

Children tend to think about the world in a very detailed and specific manner. Therefore, they probably want to learn how the rocks shown in the briefcase can be converted into the minerals and then into the products we use. This video is a good opportunity to tackle that question and to understand the process chain of a raw material.
There are a high number of other videos and documentaries on the internet; therefore, any other suitable video can be used for this stage.

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Game **Build Your Own Battery**:

Build your own battery (in elementary schools, the teacher will do the experiment and the children can help prepare it; older children can do their own experiments).

https://www.instructables.com/id/Battery-out-of-coins-and-foil/

What you need:
1)few copper pennies
2)a piece of aluminum foil
3)a piece of wet tissue or cardboard
4)a piece of led(for just testing the battery)
5)scissors
6)pencil(optional)
7)some salt(if you have vinegar ignore salt and water)

Instructions:
In a small bowl, add the vinegar or mix the salt in the water until the salt is dissolved.

Cut the paper towel (or coffee filters or cardboard) and aluminum foil into coin-sized circles.

Dip the cardboard circles into the vinegar and layer the coins in a pattern: penny, paper, aluminum foil. Finish the stack with a penny.

Once you have a large stack, you can test it out with your multimeter. You will want to turn it to a low voltage setting and test it out. To light up an LED light, you will need to reach about a 2 V reading on the multimeter.

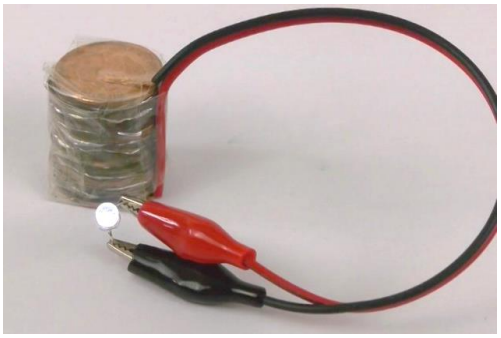

Abbildung 2 **https://www.genialetricks.de/voll-im-saft/**

Abbildung 1
https://www.youtube.com/watch?v=au7ayZWTfbg

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The „BATT-Memo-Game“ This game can be played like Memory.

This is a card **game** in which all of the cards are laid face down on a surface and two cards are flipped face up over each turn. The object of the **game** is to turn over pairs of **matching** cards.

The teacher can make copies and cut out of the pictures. Before playing the game, the teacher should discuss the meaning of the pictures with the students.

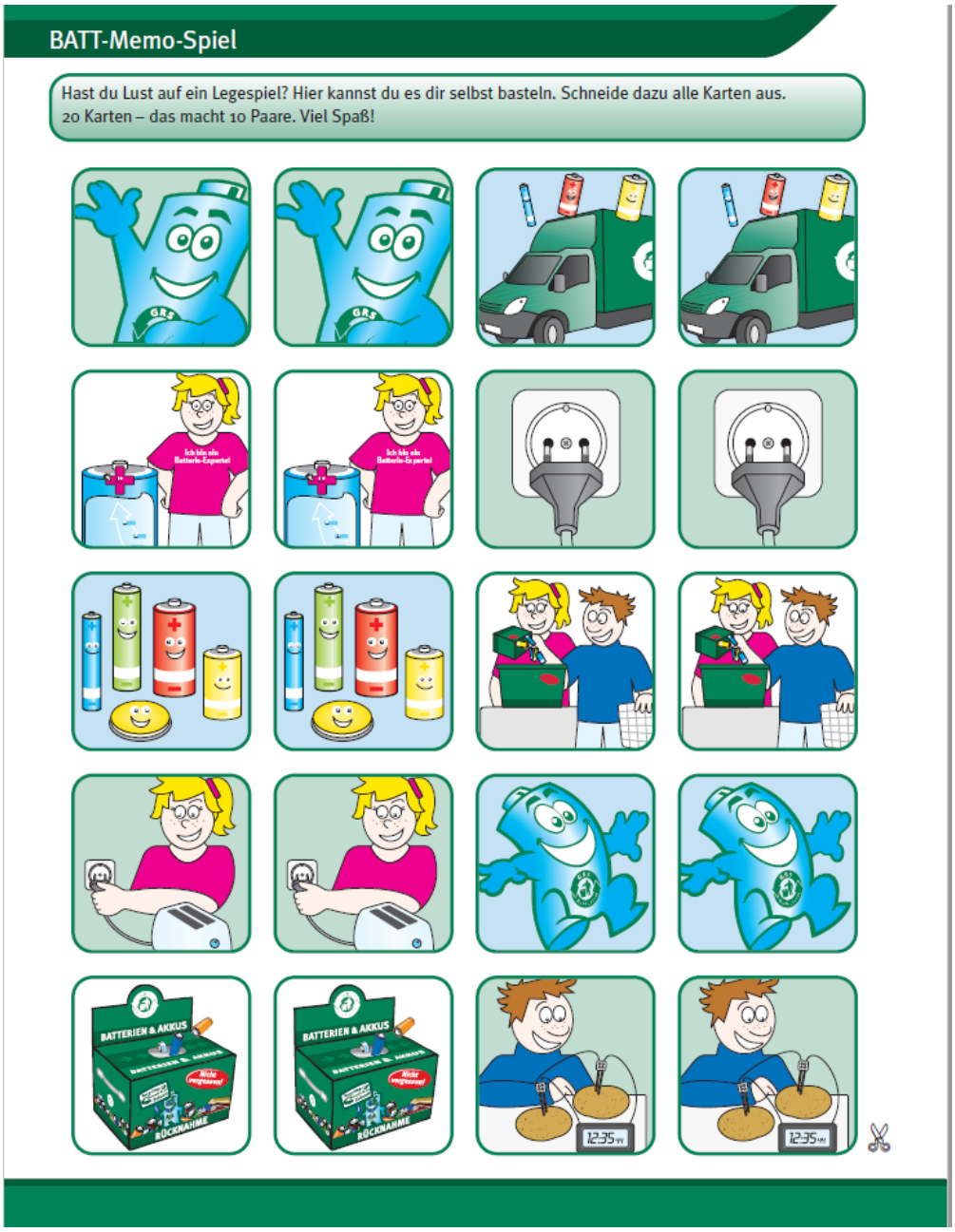

Abbildung 3 by GRS Batterien (https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwiny-n83MblAhUCL1AKHVdLCscQFjAAegQIABAC&url=http%3A%2F%2Fwww.grs-batterien.de%2Ffileadmin%2Fuser_upload%2FDownload%2FWissenswertes%2FGRS_Lehrmaterial_final.pdf&usg=AOvVaw01llqlUctn962F_VVEAi3y)

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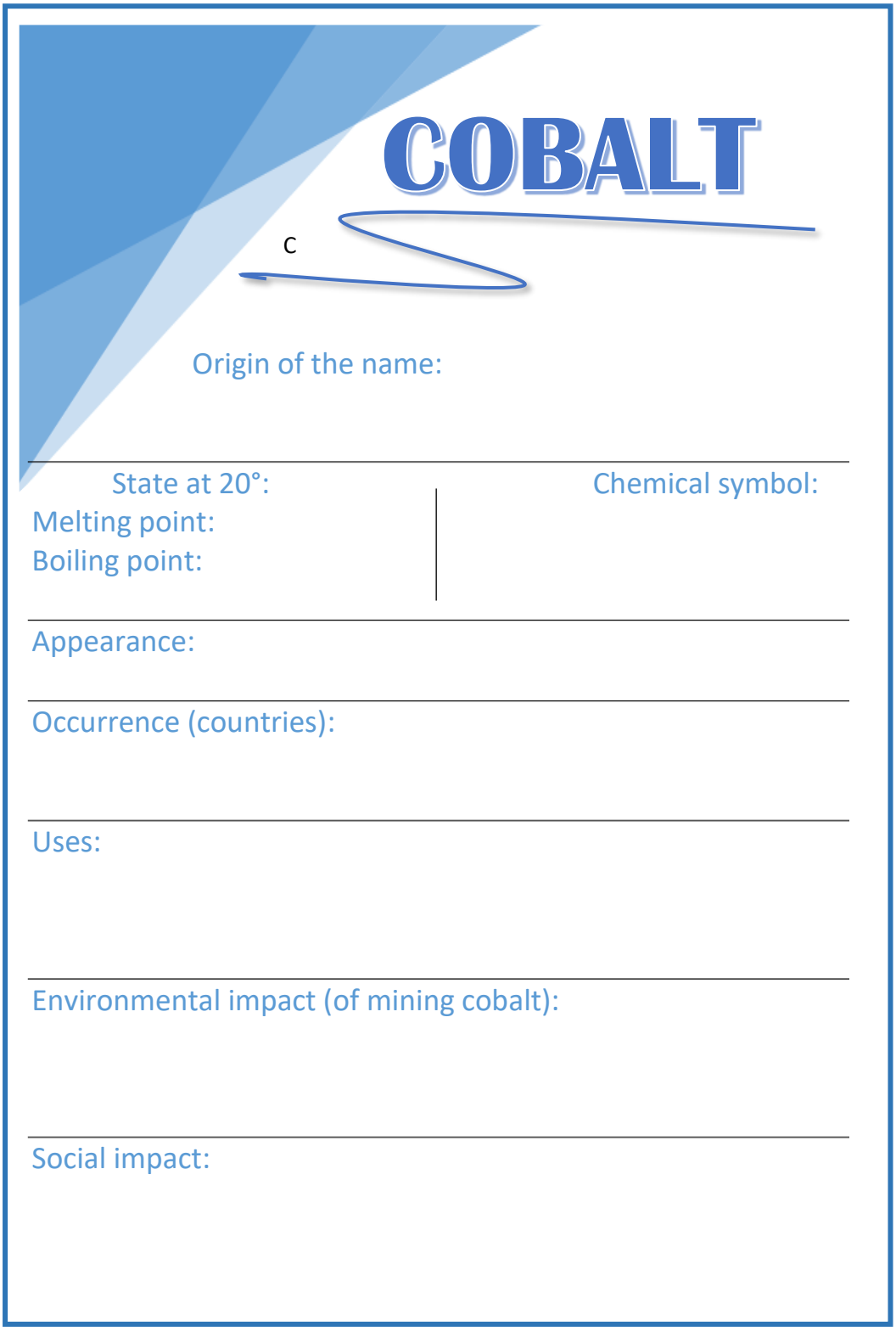
Poster Session – create a poster

Use this template and create a poster about the metal Cobalt.

Depending on the age of the students, they can either search the internet for information or extract the information from material provided by the teacher.



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Cobalt – Raw materials

Find the hidden words in the word search.

S	C	Q	I	P	B	G	A	B	Q	I	M	C	D	Y
T	M	E	R	Y	T	H	R	I	T	E	O	Q	E	Z
X	S	A	H	E	R	E	P	P	O	C	D	A	T	K
J	L	F	G	X	Z	C	K	B	K	E	I	N	I	Z
S	A	U	E	N	X	Y	E	A	F	M	L	N	T	Z
P	I	F	B	V	E	D	N	R	S	D	V	U	L	Q
L	R	G	C	K	I	T	G	D	A	U	R	C	A	E
A	E	N	U	O	T	H	I	R	T	M	G	Z	B	U
T	T	I	I	F	N	W	J	C	N	J	I	E	O	L
E	A	C	N	M	L	G	K	E	H	R	I	C	C	B
M	M	K	S	A	W	R	O	B	Y	X	N	C	S	C
W	W	E	S	K	U	T	T	E	R	U	D	I	T	E
Y	A	L	N	I	R	E	Y	R	E	T	T	A	B	B
I	R	Y	M	E	S	R	L	U	K	C	P	I	L	G
T	L	A	B	O	C	O	H	Q	T	H	B	U	Q	K

These words are hidden:

COBALTITE BATTERY RAWMATERIALS NICKEL

METAL CONGO MAGNETIC COPPER ORE

CERAMICS ERYTHRITE SKUTTERUDITE COBALT

BLUE

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Specific questions addressed to the behaviour education

At the end of the games, the teacher will propose reflecting about how our daily activities that can help to protect the environment.

Questions:

What are raw materials?
Why do we need raw materials?
Which raw materials does our modern society need?
Under which conditions are these raw materials extracted?
What properties do they have?
How do they look processed and unprocessed?
What happens to the devices that contain all the metals when they are no longer needed?

Cobalt:
What is the story of the name “cobalt?”
Where can you find cobalt?
Is cobalt important for humans?
What does cobalt look like? When is it blue or pink?
Why do we use cobalt in batteries and in which ones?

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7. THEMATIC BRIEFCASE: SECONDARY RAW MATERIALS

The aim of the **Secondary Raw Materials (SRM) Thematic Briefcase** is: (i) to get the pupils familiar with the potential in waste as a **secondary raw material**, (ii) to present the pupils the concepts of both, **linear and circular economy**, (iii) to highlight the actions like **recycling, re-using** and **repairing** within the circular economy, (iv) and to motivate children to come up with their ideas of implementation of circular economy in their daily lives (in school, at home, at playground, etc.).

The SRM Thematic Briefcase is presented to pupils like a storyline; step by step together with pupils we discover our needs for the circular economy actions (in school, at home, in the construction sector, in the market, etc.) Therefore we have developed content for the briefcase with examples of circular economy where waste became SRM and are turned into new products. This is not only a direct lecture for pupils, but together with teacher we aim to discover why is this important, why are our actions necessary and how can we overcome the negative connotation that the word "*waste*" is carrying.

I. Briefcase contents:

The Secondary Raw Materials (SRM) Thematic Briefcase (Figs. 15 and 16) includes the following content:
- samples of different SRM,
- various products manufactured with recycled materials, and
- items for support to explanations.

Fig. 15 and 16: The Secondary Raw Materials (SRM) Thematic Briefcase: front, the back and its content.

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II. The Briefcase Storyline

The Briefcase Storyline starts with an introduction of the importance of the minerals (raw materials) in our daily lives which is presented through a short **clip**[5] about raw materials disappearing from our daily lives, followed by a **presentation** to reinforce the relevance of the minerals, and a short **clip**[6] showing life of kids in mines outside Europe.

At the beginning we ask pupils about the raw materials in general (what they are, examples, groups, etc.) and what can happen if we continue to exploit primary raw materials (considering population growth, lack of raw materials, increasing our demands, etc.) and what is happening with items that we no longer use (accumulation of waste → influence of the environment and human health, etc.). This is demonstrated throughout the figures (Fig. 17) with small stones, each presenting raw materials (this is the linear economy concert). If we continue doing so we or generations to come will no longer have the possibility to exploit the raw materials and will have enormous quantities of waste. We also show pupils photos of large quantities of waste around the World (Fig. 17).

Fig. 17: Linear economy concept.

Pupils recognize the problem and we continue to present them the circular economy concept (Fig. 18) with the familiar item - the plastic bottle. In this case we ask pupils what they would do with it after its usage since they are familiar with phrase recycling. Here we explain to them, that we want to keep the items in the circle as long as possible before we discard them only when it no longer holds a value. In this way, we reduce the usage of primary raw materials and we reduce the quantity of accumulated waste. Again, this is also demonstrated with small rocks which are circling instead of going

[5] https://www.youtube.com/watch?v=IXawf9OBOyw
[6] https://m.facebook.com/story.php?story_fbid=372230530361535&id=276157035868006

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horizontal line (from exploitation to waste). Here we also present the circle of circular economy and actions like repair, re-use and recycle. We ask pupils about examples they might use on daily basis and how they can contribute to be a part of this. Some examples are: when pupils outgrow the toy or do not want to play with it anymore, they donate it to other pupil instead of throwing it away; old jeans can be used for a new item (bag/coin wallet); plastic bottles can be used for various purposes (pottery, a screw, etc.) and in some countries people get paid to bring empty plastic bottles (deposit); etc.

Fig. 18: The circular economy concept.

Next we have prepared several items (Table 1) and with each a story about its formation and usage. The idea is to show the pupils an item referred as a waste and they need to provide some ideas how this waste can be used as a SRM. Below are examples of such cases found inside the Briefcase.

Table 1.:

No.	Item used	Explanation
1	**Cardboard packaging for milk and juices**	On the sample of cardboard packaging for milk and juices we will demonstrate the recycling. Tetra Pack consists from cardboard/paper, aluminium foul and plastic. From there we can recycle and use this SRM for further usage: - paper into wipes and toiled paper (a great example is Innovative circular practice in Slovenia[7,8] where 8 municipalities are collecting cardboard packaging, which they put into processing to produce hygiene paper, which is then used by institutions that collect raw material separately);

[7] http://www.eko-iniciativa.si/novice/v-ljubljanskih-mlekarnah-so-vzpostavili-prvi-interni-snovni-krog-embalaze-tetra-pak.html
[8] http://circular-economy.city/kro%C5%BEni-projekti/index

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No.	Item used	Explanation
		- plastic cup into granules or plastic filament and then to new 3D printed item; - aluminium foil to aluminium-plastic granules and into new products, etc. 
2	**Orange peel bioplastics**	Orange's peel and bioplastics is used for 3D printing (a cup)[9]. 
3	**Plastic bottle cup and plastic bottle**	Plastic bottle is grinded into small pieces and then to granules/filaments from which new plastic items can be made. From plastic bottle cups we can make new items also by 3D printing.

[9] https://www.youtube.com/watch?v=Nc4T6crRzU4

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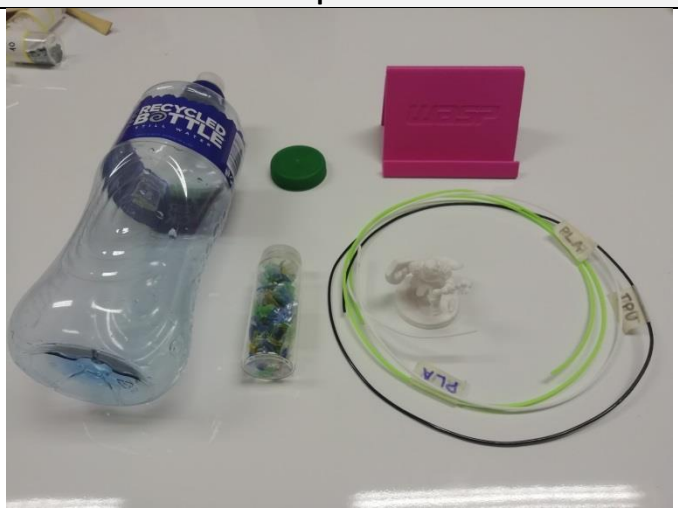
No.	Item used	Explanation
		
4	**Copper wire**	Copper wire and plastic around the copper wire are separated and grinded. Both can be used for further processing and usage. 
5	**Various samples form ash, sludge, etc.**	These materials can be used in the cement industry, geotechnical composites, concrete, upper layer in asphalt, glassmaking, in asphalt, for road construction, etc. We prepared a sample of concrete for linear economy and one for circular economy where many samples from secondary raw materials can be used. 

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No.	Item used	Explanation
		
6	**Asphalt core with rubber (truck tires), a piece of rubber, crushed truck tires**	We asked pupils who use the tires and what we do with them once they are not safe to use anymore. We show pupils a picture of tires' landfill and ask them how we can use tires in circular economy. We show them possibility of using crushed tires (waste rubber) which can be used in the asphalt.

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No.	Item used	Explanation
		 
7	**Various wastes items** (brass shavings, brass, tinned bronze) which can be recycled and reused.	Various samples of "waste" are shown where we explain to pupils, that this secondary raw material has a lot of potentials since a lot of metals can be recovered from items like these.

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No.	Item used	Explanation
		
8	Bio- charcoal, compost, mine tailings, excavated soil, etc.	Combination of various waste (SRM) can be beneficial for productive soil which can demonstrated with a plant in this new soil which represents great base/media for the plant to grow. 
9	**Construction and demolition waste (C&D)**	Waste brick can be used as recycled aggregates, e.g. aggregate from recycled construction and demolition wastes.
10	**Different industrial waste**	Waste from thermal processes (slags, sludges), waste from power and incineration plants, iron, steel and glass industry, extractive/mining industry etc. can be used as manufactured aggregates (e.g. aggregates from recycled industrial wastes); hydraulically bound and unbound construction composites (e.g. green concretes).
11	**Waste generated by municipal services**	Waste generated by municipal services e.g. inert heavy fraction from municipal solid waste and sewage sludge from municipal waste water treatment, some fractions of municipal waste e.g. plastics can be used as a recycled soil.

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I. Specific questions addressed to the behaviour education

Questions:

- What is the difference between primary and secondary raw materials? Give 3 examples for each.
- Why it is important that we start using circular economy instead of linear economy? Give 3 examples for each.
- We presented a few examples of using secondary raw materials in the circular economy – which one was the most surprising for you?
- Why are we recycling? What happens after your sort out your waste in different containers?
- Give 3 examples where you can implement circular economy in everyday routine in school or at home.
- Where can the waste material (SRM), e.g. from the house demolition, be used?
- One school is collecting cardboard packaging for milk and juices. Would you be interested in doing this as well? Do you see any other potential of waste to become SRM in school?
- What do you do with clothes once you outgrow them but are still in a good condition?

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8. THEMATIC BRIEFCASE: Slovenian version of the Daily Uses Briefcase

The original Briefcase (IGME consolidated workshop) consists of 10 minerals-elements and 10 objects-uses: things made with the ore elements of each mineral. Meanwhile the Slovenian Physical Briefcase consists of 23 minerals and more than 30 different objects. And it is the intention of the partner to update regularly with new minerals and objects to ensure its liveability and increase the demand of teachers and other interest groups of using it on the regular basis.

Figure 19: The Slovenian Physical Briefcase for primary raw materials.

I. Briefcase contents:

Table 1: *Minerals inside ZAG Physical Briefcase*

MINERALS	***Element/material (search and find using clues)***	***OBJECTS***
Cinnabar	*Mercury (Hg)*	*Thermometer, frugal lead bulb*
Kyanite	*Aluminium (Al)*	*Soda can*
Sphalerite or Blende	*Zinc (Zn)*	*Wire covered with zinc*
Fluorite	*Fluor (F)*	*Toothpaste*
Galena	*Lead (Pb)*	*Lead battery, Pb-metal (soft), Lead bullets, fishing/sinker weight*
Lepidolite	*Lithium (Li)*	*Li-ion battery*
Magnetite	*Iron (Fe)*	*Horse shoe*
Malachite	*Copper (Cu)*	*Bronze wire, coin (euro), bronze plate, bronze plumbing pipe*
Orthoclase	*Aluminium/Potassium - Porcelain*	*Cup*
Wolframite	*Tungsten (W)*	*Light bulb*
Gypsum	*Plaster*	*Gypsum plaster (in medicine)*

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MINERALS	*Element/material (search and find using clues)*	*OBJECTS*
Kaolinite	*Kaolin*	*Paper, rubber (eraser)*
Graphite	*Carbon (C)*	*Pencil*
Hematite	*Iron (Fe)*	*Pigments, powder (make-up)*
Bauxite	*Aluminium (Al)*	*"Deo can", CD*
Chromite	*Chromium (Cr)*	*Green glass bottle*
Quartz	*Silicon (Si)*	*Green glass bottle, sand watch*
Spodumene	*Lithium (Li)*	*Li-ion battery*
Rutile	*Titanium (Ti)*	*Powder (make-up), ceramic cup*
Muscovite	*Aluminium (Al) & Potassium (K)*	*Powder (make-up)*
Talc	*Magnesium (Mg) & Silicon (Si)*	*Powder (cosmetics & medicine)*
Bournite	*Copper (Cu)*	*Bronze wire, coin (cent), bronze plate, bronze plumbing pipe*
Halite	*Salt*	*Kitchen salt*

II. The Briefcase Game

The Slovenian Physical Briefcase can be used in several ways. And most importantly it can be very easily adapted to the pupils' age. The material is divided into two trays: one with the minerals and other with the daily objects. Each mineral from the Physical Briefcase has belonging clues that helps you to find the proper object.

The basics are the same as described at IGME's description given earlier in this document.

Different options of using Physical Briefcase:

1) Link one mineral to the one object

Teacher arranges minerals on one site and belonging objects to the other (preferably not in the same order as belonging minerals). Than pupil or group of them try to connect the mineral with the matching object. They also have a chance to use four clues for each mineral, to find out its name and properties. If they find the belonging object without a clue they get 5 points, with each clue pupils lose 1 point (e.g. if they use two clues to relate mineral and object the maximum score is 3 points for the particular mineral).

2) Link one mineral to the several objects

The principals are the same as described under first option, however, in this case one mineral can be linked to several objects. Pupils can use the same 4 clues for each mineral. And the scoring is the same as explained before. The teacher decides the number of minerals taking into account pupils' age and background knowledge.

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Figure 20: Match the mineral with all belonging elements.

3) Link the object with containing minerals

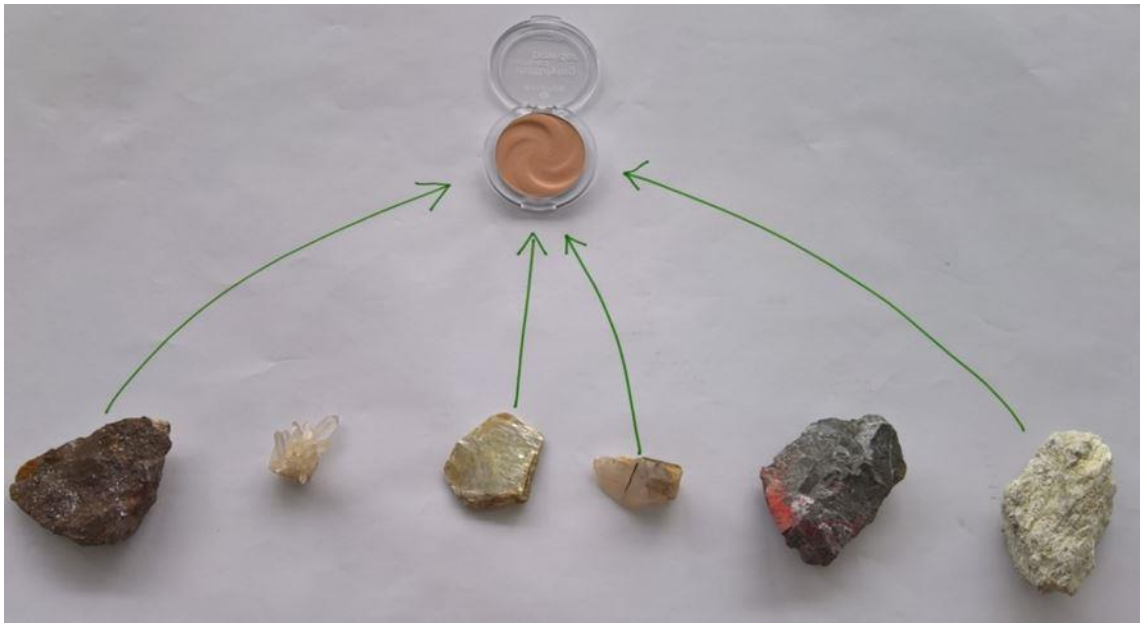

Figure 21: Match the object with all belonging minerals

The principals are the same as described under first option, however, in this case one object can be linked to the several minerals. Pupils can use the same 4 clues for each mineral. And the scoring is the same as explained before. The teacher decides the number of minerals taking into account pupil age and background knowledge.

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There are 4 clues for each mineral and related object. One mineral can refer to several objects and vice versa. For easier work pupils are allowed to use magnifying glass and magnet. Matching the right mineral with belonging objects without clues is 5 points, but finding out with 1 clue is 4 points, etc.

Depending on the pupils age the Briefcase will be adopted. For instance, for younger pupils in the primary school only basic minerals will be used, meanwhile older pupils/students (secondary school) will work with the entire Briefcase. For each particular use of Briefcase the entire content will be adopted, meaning minerals and objects. While Slovenian version of Physical Briefcase offers various options of its use and will be also regularly updated with new minerals and objects we named it "Living Physical Briefcase".

With following clues for each mineral, teachers or any other user can lead its participants to its related object.

1. CINNABAR HgS

1. The metal that this mineral is made of is a toxic element, but is very useful when used in measuring tools.
2. Its vapours are toxic and its leakages pollute. In the Roman Ages, when they still didn't know the toxicity of this metal, some women dyed their lips and chicks with the red of its oxides.
3. It amalgamates easily with gold and silver.
4. It is the only common metal that appears liquid in nature at room temperature.

RELATED OBJECTS: Thermometer, frugal lead bulb

Figure 22: Cinnabarite and liquid Hg with belonging objects.

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2. KYANITE Al_2SiO_5

1. The name of this mineral comes from the Greek term "kianos", meaning "blue".
2. It contains a metal which is light coloured, very light weighed, cheap to obtain, easily recyclable and has many industrial applications.
3. The metal is used in the manufacturing of deodorants, since it inhibits the action of the sweat glands and the development of bacteria that cause bad smell.
4. Given that this is a metal very resistant to corrosion, it is used to make car tires and window frames as well as in the famous "silver foil" used to wrap sandwiches. It is also used to manufacture beer cans.

RELATED OBJECTS: Soda can

Figure 23: Kyanite with belonging object.

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3. SPHALERITE OR BLENDE (Zn,Fe)S

1. One of the names of this mineral comes from the German word "blende", which means cheat, because sometimes it can be confused with galena. The metal that makes up this mineral has a bluish white colour.

2. It is an essential element of our diet because it favours the growth of our body. It is present in meat, fish, bird meat, egg yolk, liver, sea food, legumes, mushrooms, whole grains, etc.

3. The automobile industry is its main consumer. It is also used in the manufacturing of antidandruff shampoo thanks to the properties of zincpiritione. One of the greatest producers worldwide of this metal was the Reocín deposit in Cantabria.

4. It is mostly used to galvanize, that is, to coat iron and steel to protect them against corrosion.

RELATED OBJECTS: Wire covered with zinc

Figure 24: Sphalerite with belonging objects.

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4. FLUORITE CaF_2

1. One of this mineral's elements is frequently used in blast furnaces to lower the melting point of steel.
2. When mixed with silica, a high-quality glass is obtained, which can be used to glace ceramics or to produce fiberglass.
3. Besides in fluorite, the element is present in dissolved sea water salts.
4. One of its better-known uses is in toothpastes manufacturing.

RELATED OBJECTS: Toothpaste

Figure 25: Fluorite with belonging object.

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5. GALENA PbS

1. The metal that makes up this mineral is very, very heavy. It is used in car batteries because when plates of this element are bathed in sulphuric acid, they produce electricity. Its presence makes batteries very heavy.
2. The Romans made water tubing of this metal. However, it is toxic and when it enters the human body, it produces lead poisoning or saturnism.
3. This last name comes from the name the alchemist gave to this metal "Saturn". Beethoven suffered this illness, and it is probable that it caused his deafness.
4. Thanks to this metal we can fish, since it is used in the plumb bobs.

RELATED OBJECTS: Lead battery, Pb-metal (soft), Lead bullets, fishing/sinker weight

Figure 26: Galena with belonging objects.

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6. LEPIDOLITE $K(Li,Al)_3(F,OH)_2AlSi_4O_{10}$

1. This mineral's name comes from a Greek word that means "scale" because it is a silicate with flaky structure. From that word also comes the scientific name of butterflies "Lepidoptera" given because of the scales they have in their wings.
2. One of the most curious uses of the metal which this mineral is made of, is in psychiatry to treat bipolar disorder, which is related to the lack of this element in the organism.
3. It is an alkaline element and its name comes from the Greek "lithos", which means "stone". The reason for that is that it was the only alkaline element discovered in a mineral. The rest of the alkaline elements (sodium, potassium, rubidium, cesium and francium) were found in plant tissues.
4. Is the lightest known element. Its density is half of the density of water. It is used in electric batteries (e.g. in mobile phones) and in heat conducting alloys.

RELATED OBJECTS: Li-ion battery

Figure27: Lepidolite with belonging objects.

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7. MAGNETITE $Fe^{2+}Fe^{3+}{}_2O_4$

1. This mineral is formed by a well-known metal which represent more than 95% of all metals used. It is considered the metal by excellence. It is very abundant in the Earth's crust and also in the meteorites.

2. To provide higher hardness and resistance to corrosion, it is alloyed with nickel, chrome, tungsten, vanadium, cobalt and more.

3. It has magnetic properties and it is mostly used in the manufacturing of steel.

4. It is, after aluminium, the most abundant metal on Earth.

RELATED OBJECTS: Horse shoe

Figure28: Magnetite with belonging object.

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8. MALACHITE $Cu_2(OH)_2(CO_3)$

1. The metal that makes up this mineral is soft and red. Its widespread use gave its name to de Chalcolithic archaeological period which developed from 5000 B.C.

2. It is often used in alloys such as bronze and brass. It is the third most used metal in the World, following aluminium (Al) and iron (Fe).

3. The 1, 2 and 5 euro cents coins coating are made of this metal. It is one of the few materials that doesn't degrade or lose its physical and chemical properties in the recycling process.

4. Electricity owns a lot to this metal, since electric wires are made from it.

RELATED OBJECTS: Bronze wire, coin (euro), bronze plate, bronze plumbing pipe

Figure29: Malachite with belonging objects.

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9. ORTHOCLASE $K(AlSi_3O_8)$

1. It is a very common mineral in the terrestrial crust and envase (continental crust). It is part of granites and gneisses. It contains silicon (Si), aluminium (Al) and potassium (K).

2. It is used in the manufacturing of glass, mostly for containers. Aluminium provides the glass strength and toughness, and potassium lowers the melting temperature of the material.

3. With this mineral we can produce our crockery or the tiles that cover the bathrooms in most of our homes.

4. With the products made from this mineral you can have breakfast or a tea comfortably, since it's from the orthoclase that porcelain is produced.

RELATED OBJECTS: Cup

Figure30: Orthoclase with belonging object.

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10. WOLFRAMITE (Mn,Fe)WO_4

1. During World War I the metal that makes up the wolframite reached a great importance as a strategical metal because it was used to make the shielding plates of war machines.

2. It was discovered in 1783 by the Spanish Elhúyar brothers. Its properties were not developed until mid-XX century, when its ability to improve the steel properties was discovered. It can be cut with a saw, forged or stretched in threads.

3. It is also known as tungsten that means "heavy stone" in Swedish. It is used in the manufacturing of metals which are almost as hard as diamond.

4. Edison, one of the most famous inventors of all times, has a lot to thank to this metal, since bulbs filaments are made of it.

RELATED OBJECTS: Light bulb

Figure31: Wolframite with belonging objects.

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Additional minerals in Slovenian physical briefcase:

11. GYPSUM $CaSO_4 \cdot 2H_2O$

1. It is the most common sulphate mineral. It is naturally widespread and widely mined.
2. Its colour is clear, colorless, white, gray, yellow, red or brown. It has low hardness.
3. Its varieties known as "satin spar" and "alabaster" are used for a variety of ornamental purposes; however, their low hardness limits their durability. Alabaster has been used for sculpture in Ancient Egypt, Mesopotamia, Acient Rome, Byzantine Empire, etc.
4. It is used as: manufacture of wallboard, cement, plaster of Paris, soil conditioning, a hardening retarder in portland cement.

RELATED OBJECTS: Gypsum plaster (in medicine)

Figure32: Gypsum with belonging object.

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12. KAOLINITE $Al_2Si_2O_5(OH)$

1. It is one of the most common minerals. It is a soft, earthy, usually white, mineral (dioctahedral phyllosilicate clay), produced by the chemical weathering of aluminum silicate minerals like feldspar commonly used in industry.
2. Its name is derived from "Gaoling" (Chinese: 高嶺; pinyin: Gāolǐng; literally: 'High Ridge').), a Chinese village near Jingdezhen in southeastern China's Jiangxi Province. Rocks rich with this mineral are also known as "China clay". Nowadays it is also called white dirt, chalk or white clay.
3. Humans sometimes eat this mineral for health or to suppress hunger, a practice known as geophagy. Consumption is greater among women, especially during pregnancy.
4. The main use of the mineral kaolinite (about 50% of the time) is the production of paper; its use ensures the gloss on some grades of coated paper.

RELATED OBJECTS: Paper, rubber (eraser)

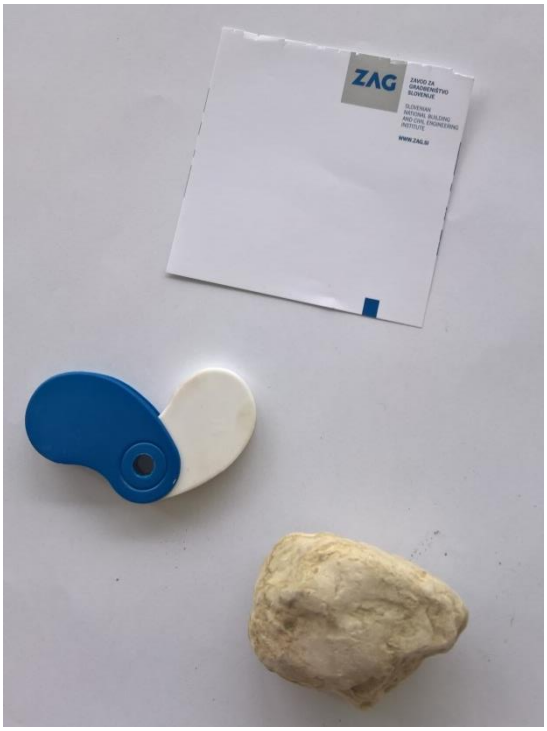

Figure33: Kaolinite with belonging objects.

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12. GRAPHITE C

1. Archaically referred to as plumbago. In the 4th millennium BC, during the Neolithic Age in SE Europe, the Marița culture used it in a ceramic paint for decorating pottery.
2. It occurs in metamorphic and magmatic rocks as well as in meteorites. It may be the second or third oldest mineral in the Universe.
3. It occurs naturally as a crystalline form of the element carbon in this form and is the most stable form of carbon under standard conditions. Under high pressures and temperatures it converts to diamond.
4. It is used in pencils and lubricants. It is a good conductor of heat and electricity. Its high conductivity makes it useful in electronic products such as electrodes, batteries, and solar panels.

RELATED OBJECTS: Pencil

Figure34: Graphite with belonging object.

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13. HEMATITE Fe_2O_3

1. It is one of the most abundant minerals on Earth's surface and in the shallow crust. It is an iron oxide, with several colour shades such as black to steel-gray to silver; red to reddish brown to black.
2. It is the world's most important ore of iron. As primary mineral it can contain up to 70 % of iron.
3. The mineral is used to produce pigments, preparations for heavy media separation, radiation shielding, ballast, and many other products.
4. It's name is from the Greek word "haimatitis" which means "blood-red". Primitive people discovered that it could be crushed into fine powder and mixed with a liquid for use as a paint or cosmetic. Cave paintings, known as "pictographs," dating back to 40,000 years ago were created with its pigments (available in different shades of red and orange).

RELATED OBJECTS: Pigments, powder (make-up)

Figure35: Hematite with belonging objects.

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14. BAUXITE *(mixture of hydrous aluminum oxides, aluminum hydroxides, clay minerals, and insoluble materials such as quartz, hematite, magnetite, siderite, and goethite)*

1. Surprisingly is not a mineral. It is a rock composed mainly of aluminum-bearing minerals.
2. It is the main source of the rare metal gallium (Ga) used in electronics.
3. It is typically a soft material with a hardness of only 1 to 3 on the Mohs scale. It is white to gray or most commonly reddish brown. It is the primary ore of aluminum. The ore must first be chemically processed to produce alumina (aluminum oxide). Almost all of the aluminum that has ever been produced has been extracted from this mineral.
4. Among its wide use in industry, it is also used for cans and as a reflective layer on CDs.

RELATED OBJECTS: "Deo can", CD.

Figure36: Bauxite with belonging objects.

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15. CHROMITE (Fe, Mg)Cr_2O_4

1. Its minerals can occur in layered formations that can be hundreds of kilometres long and a few meters thick
2. It is dark grey to black in colour with a metallic to submetallic lustre and a high specific gravity.
3. It is the only ore containing chromium which can be economically exploited.
4. Its extracted metal element used to induce hardness, toughness, and chemical resistance in steel. The alloy produced is known as "stainless steel. It can be also used as a pigment (dark green to black colour) for glass, glazes, and paint, and as an oxidizing agent for tanning leather.

RELATED OBJECTS: Green glass bottle

Figure37: Chromite with belonging object.

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16. QUARTZ SiO_2

1. It forms at all temperatures and it is highly resistant to mechanical and chemical weathering and heat.
2. This mineral is the most common material identified as the mystical substance maban in Australian Aboriginal mythology. It is found regularly in passage tomb cemeteries in Europe in a burial context, such as Newgrange or Carrowmore in Ireland. In Prehistoric times this minerals were knapped as part of the lithic technology (e.g. stone tools).
3. It is the most abundant mineral found at Earth's surface, and its unique properties make it one of the most useful natural substances.
4. Glass making, abrasive, foundry sand, hydraulic fracturing proppant, gemstones

RELATED OBJECTS: Green glass bottle, sand watch

Figure38: Quartz with belonging objects.

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17. SPODUMENE $LiAl(SiO_3)_2$

1. It is a pyroxene mineral and serves as a source of lithium.
2. It is an important source of lithium for use in ceramics, mobile phone and automotive batteries, medicine, Pyroceram and as a fluxing agent. Lithium is extracted from this mineral by fusing in acid.
3. The name is derived from the Greek language (spodumenos (σποδυμενος)) and means "burnt to ashes," owing to the opaque, ash-grey appearance of material refined for use in industry.
4. Triphane is a synonym of spodumene, but also used for colourless or yellowish varieties

RELATED OBJECT: Li-ion battery

Figure39: Spodumene with belonging objects.

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18. RUTILE TiO_2

1. It is composed primarily of titanium dioxide (TiO2), and is the most common natural form of TiO2. Other rarer polymorphs of TiO2 are known including anatase, akaogiite, and brookite.
2. Natural form of mineral may contain up to 10% iron and significant amounts of niobium and tantalum.
3. Its name derives from the Latin rutilus, red, in reference to the deep red colour observed in some specimens when viewed by transmitted light. Otherwise it has various colures from Reddish brown, red, pale yellow, pale blue, violet, rarely grass-green; and also black if contains high concentration of Nb–Ta.
4. Its small needles present in gems are responsible for an optical phenomenon known as asterism. Asteriated gems are known as "star" gems and are generally more valuable than their normal counterparts. The main uses of this mineral are the manufacture of refractory ceramic, as a pigment, and for the production of titanium metal.

RELATED OBJECTS: Powder (make-up), ceramic cup

Figure40: Rutile with belonging objects.

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19. MUSCOVITE $KAl_2(AlSi_3O_{10})(F,OH)_2$

1. It is the most common mica, found in granites, pegmatite, gneisses, and schist.
2. In the seventeenth century and before it was called Muscovy Glass, Cat Silver, and Lapis Specularis (stone mirror).
3. It is used in the manufacturing of paint, joint compound, plastics rubber, asphalt roofing, cosmetics, and drilling mud
4. It is easily identified because its perfect cleavage allows it to be split into thin, flexible, elastic, colourless, transparent sheets with a pearly to vitreous lustre. It is the only common mineral with these properties.

RELATED OBJECTS: Powder (make-up)

Figure41: Muscovite with belonging object.

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20.TALC $Mg_3Si_4O_{10}(OH)_2$

1. It is usually green, white, grey, brown, or colourless. It is a translucent mineral with a pearly lustre.
2. One particular issue with commercial use of this mineral is its frequent co-location in underground deposits with asbestos ore.
3. It is the softest known mineral and is assigned a hardness of 1 on the Mohs Hardness scale.
4. Its powder has the ability to absorb moisture, absorb oils, absorb odour. It is used as a filler, coating, pigment, dusting agent and extender in plastics, ceramics, paint, paper, cosmetics, roofing, rubber and many other products.

RELATED OBJECTS: Powder (cosmetics & medicine)

Figure42: Talc with belonging objects.

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21. BOURNITE Cu_5FeS_4

1. It is known as peacock ore, is a sulphide mineral.
2. It is an important copper ore mineral and occurs widely in porphyry copper deposits along with the more common chalcopyrite.
3. It is an excellent healing stone, which can harmonise the cellular structure of the body, it help to reduce fever and swelling and stimulate and regulate the flow of adrenaline. It can also assist in the treatment of convulsive conditions.
4. It has a brown to copper-red colour on fresh surfaces that tarnishes to various iridescent shades of blue to purple in places.

RELATED OBJECTS: Bronze wire, coin (euro), bronze plate, bronze plumbing pipe

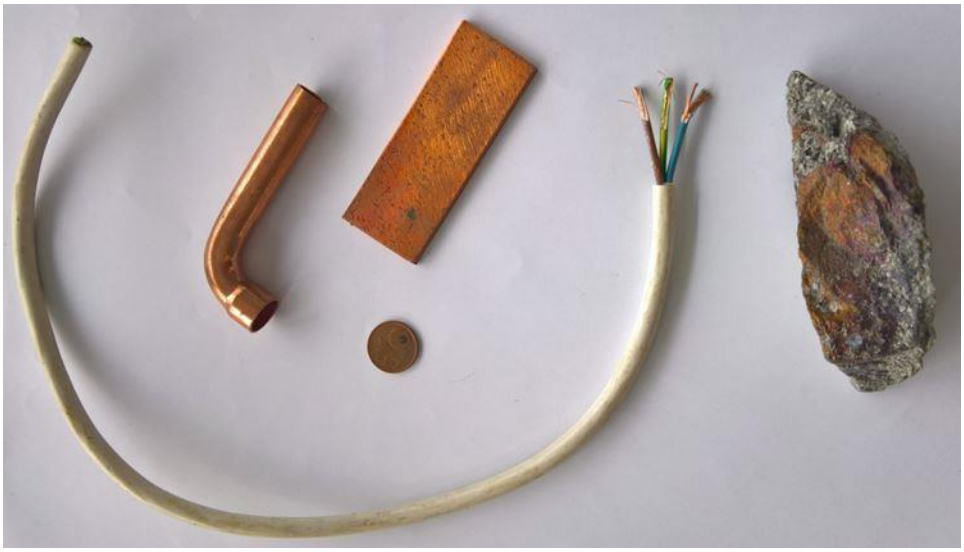

Figure 43: Bournite with belonging objects.

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22. HALITE NaCl

1. It can be produced from sea water or from rocks.
2. It served as money at various times and places in the history, and it has been the cause of bitter warfare. Its importance is seen in the word "salary" which was derived from the word "salt.
3. When it is mixed with iodine it prevents iodine deficiency that causes intellectual and developmental disabilities (idiotism).
4. It is commonly known as rock salt, and often used in kitchen or both residentially and municipally for managing ice.

RELATED OBJECTS: Kitchen salt

Figure44: Halite with belonging objects.

III. Specific questions addressed to the behaviour education

Questions:

- Where in your home you can find metals (in which objects)?
- Why do you think recycling of metals is very important?
- What do you think is more appropriate regarding handling electronic devices after they stop working – to throw them away and buy a new one, or to repair them? Why?
- What is NIMBY and why this way of thinking is wrong?
- Why do we call some minerals "blood" minerals? Is there anything we can in order to reduce this type of mineral exploitation?

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9. THEMATIC BRIEFCASE: THE PHONE MINERALS

The phone Briefcase targets at children 5-14 years old aims to provide the students basic knowledge about the elements/raw materials we can find in a mobile phone, the importance of the use of resources and address terms such as resource scarcity and sustainability, but also highlight the importance of the appropriate disposal and recycling of mobile phones to recover all the valuable metals that are contain on it.

The briefcase is based on the WEEE and waste batteries school kit (Elektroaltgeräte- und Altbatterien- Schulkoffer) bought to the Elektroaltgeräte Koordinierungsstelle Austria GmbH (Austrian Coordination Body For Waste Electrical And Electronic Equipment).

I. Briefcase contents:

- A disassembled mobile phone and several components
- Metal sheets
- Material recycled
- Visual aids, photos and videos, showing the applications (younger)
- Raw materials kit that contains:
    - o Chalcopyrite -> copper
    - o Post crystalline Silicon
    - o Magnetite -> iron
    - o Bauxite -> Aluminium
    - o Lepidolite –> Lithium
    - o Oil shale -> petroleum
    - o Clay mineral montmorillonite
    - o Gold
    - o Quartz -> Silicon
    - o Tantalum ore -> tantalum
    - o Post crystalline silicon granulate
- magnetic magnifier
- Didactic guides with worksheets and teaching materials

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II. The Briefcase Game

The students have to examine the raw materials in the material case that we can find in a mobile phone.

Metal	%	In the briefcase	Number	Aplication
Cupper	*15%*	*Chalcopyrite*	*Nº 1*	*Printed circuit board, various cables and compounds*
Silizium	*8-15%*	*polysilicon*	*Nº 2*	*Microchip*
Iron	*3-8%*	*Magnetite*	*Nº3*	*Screws, springs*
Aluminum	*4-9%*	*Bauxite*	*Nº 4*	*Battery casing*
Lithium	*3-4%*	*Lepidolite*	*Nº 5*	*Battery*
Plastic	*40-60%*	*Bituminous Silicon Rock.*	*Nº6*	*Case, keyboard, Some parts of the printed circuit board*
Ceramic	*3-10%*	*clay*	*Nº 7*	*Insulators and capacitors.*
Gold	*< 1%*	*gold*	*Nº 8*	*Contacts, thin wires.*
Silizium		*quartz*	*Nº9*	
Tantalum	*< 1%*	*Coltan*	*Nº 10*	*Condensers*
Silizium		*Silizium granulat*	*Nº11*	*Microchips*

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They have to use the magnetic magnifier and try to answer the next questions.

1. What color is the raw material? How would you describe the raw material?

2. How is density estimated: the raw material is relatively light or heavy?

3. What do you think you get a metal or a non-metal from the raw material?

4. How do you think the raw material grates? Like a nail (harder than 2-3), a knife (hardness ≥5) or even scrape the glass (hardness ≥7)?

5 What minerals can it be or what raw material is extracted from it? Do you know the name?

6 What components of the mobile phone could be manufactured from that mineral? Place the corresponding component of the mobile phone next to the raw material.

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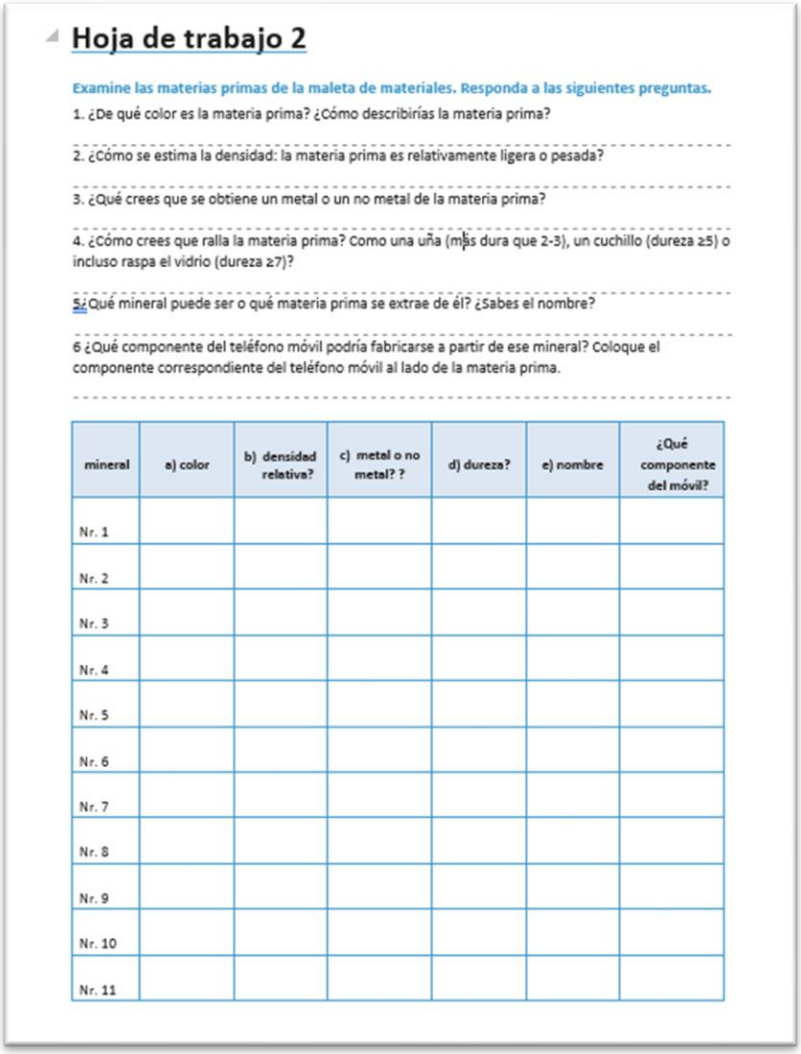

Hoja de trabajo 2

Examine las materias primas de la maleta de materiales. Responda a las siguientes preguntas.

1. ¿De qué color es la materia prima? ¿Cómo describirías la materia prima?

2. ¿Cómo se estima la densidad: la materia prima es relativamente ligera o pesada?

3. ¿Qué crees que se obtiene un metal o un no metal de la materia prima?

4. ¿Cómo crees que ralla la materia prima? Como una uña (más dura que 2-3), un cuchillo (dureza ≥5) o incluso raspa el vidrio (dureza ≥7)?

5¿Qué mineral puede ser o qué materia prima se extrae de él? ¿Sabes el nombre?

6 ¿Qué componente del teléfono móvil podría fabricarse a partir de ese mineral? Coloque el componente correspondiente del teléfono móvil al lado de la materia prima.

mineral	a) color	b) densidad relativa?	c) metal o no metal? ?	d) dureza?	e) nombre	¿Qué componente del móvil?
Nr. 1						
Nr. 2						
Nr. 3						
Nr. 4						
Nr. 5						
Nr. 6						
Nr. 7						
Nr. 8						
Nr. 9						
Nr. 10						
Nr. 11						

II. Specific questions addressed to the behaviour education

Questions:

- How many and what different raw materials are in a mobile phone?
- You know where the raw materials come from and how they are extracted?
- Where do these substances come from and under what conditions do they degrade?
- Why do we have to recycled the mobiles
- What resources can we obtain from these mobiles recycled?

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