Golden coins

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Subject: Chemistry.
Country of creation: Finland.
Countries of testing: Czech Republic, Poland and Belgium.

Aims of the GP

Students apply their knowledge of density and its measurement by using the volumetric difference method to distinguish experimentally between elements and alloys.

Teaching material

Lesson 1: Teacher demonstration experiment.
Needed: Gas burner, tripod or stove top, 2 beakers, HCl aq diluted, KOH aq 4 M, zinc powder, long tweezers, copper coins, tissue paper, water.
Lesson 2: Students work in groups. Needed: paper & pencil.
Lesson 3: Student experiment.
Needed (one possible selection): scales, small measuring cylinder, water, density chart, etc.

Age of the students:

12 years and older

Preparation and teaching time

Preparation: 30 min. Class time: 3 x 45 min periods.

Lesson Plan

A) Teacher demonstration experiment (1st lesson).

How to make golden coins? - Teacher demonstration experiment.

1. Fill a 100 ml beaker with 20 ml of weak hydrochloric acid.
2. Put in 1- or 2-Euro-cent coins (coins need to be copper coated!) collected from the students and let them sit for some minutes to get cleaned.
3. Fill a 100 ml beaker with 50 ml of a solution of potassium hydroxide (c = 4 mol/l) and add some powdered zinc (a spoonful).
4. Put the mixture on a tripod and heat it with the gas burner or stove top until it starts simmering.
5. Take the coins out of the acid using tweezers and drop them into the hot alkali.
6. Ask the students to observe and sketch.
7. After 1-2 minutes, take the now silvery coins out of the alkali and wash off the excess zinc and hydroxide solution with water.

8. Ask the students to remove the excess zinc and polish the coins very carefully using some soft tissue paper.
9. Using a pair of long tweezers, heat the dry and polished coin *very briefly* in the flame of the gas burner until it turns golden.
10. Cool the coin under running water before touching it.

(Source**:** http://www.chemieunterricht.de/dc2/tip/11_98.htm)

B) Planning (2nd lesson).

Is my coin really made of gold?

- Work in pairs or small groups
- Task given to the students:
  Plan an experiment that proves the golden coin to be made of real gold or some fake gold-like material.
  List all materials, equipment needed and a general outline of your experiment on a separate paper that you hand in.
- Since the students are not allowed to experiment with corrosive acids like HNO_3/HCl , the easiest way would be to use the specific density of gold. This needs to be looked up in a book (19.3 g/cm^3).
- In order to measure the density of a substance the students need to find the quotient of its mass and volume.

C) Student experiment (3rd lesson)

Is my coin really made of gold?

- Work in pairs or small groups.
- Carry out your experiment and write down your conclusion.
- The mass can be determined using a scale.
- The students could use the volume difference method in order to find out about the volume: put the coin into a small measuring cylinder filled with water and see how much water the coin uses up, e.g. how much the water level rises and calculate the difference in volume. The difference is the volume of the coin.
- The experiments can also be done with several coins at the same time, in case the scales are not appropriate.
- Maybe some students are able to determine the volume mathematically, using appropriate formulae.
- In any case, since our golden coins are not made of pure gold but contain metals with lower specific densities like copper, zinc, etc., the students will come up with a density much lower than that of pure gold, e.g. between 7 and 9 g/cm^3.

Questionnaire

Is copper a chemical element?

Yes.

No.

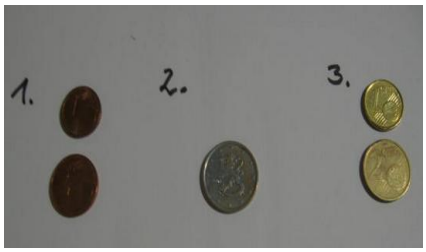

Image 1: Picture of coins by Anja Buntrock

Is brass a compound?

Yes.

No.

Is a coin a chemical element?

Yes.

No.

What happens to particles in the coin when heated in the burner flame?

- They get hot.
- They get closer together.
- They light up.
- They sparkle.
- They vanish.
- They get further apart.

What does density describe?

- Ratio of volume and mass.
- Ratio of mass and height.
- Ratio of length and weight.
- Ratio of weight and length.
- Ratio of mass and volume.
- Ratio of volume and height.

What is the unit of density?

- mg/l
- kg/cm^2
- cm^3/g
- g/cm^3
- cm^3/ml
- cm/l

What is brass made of?

- Copper and silver.
- Copper and gold.
- Copper and quicksilver.
- Copper and zinc.
- Gold and silver.
- Gold and zinc.

Does every element have its unique density?

Yes.

No.

How many ml do 20 cm^3 correspond to?

- 200 ml
- 2 ml
- 20^3 ml
- 0.2 ml
- 2 l
- 20 ml

Teacher reviews

According to the teachers that implemented this GP, their students enjoyed it very much. It was interesting for the students to see how coins could be turned into golden ones. The Polish teacher mentioned that one of her students even said “you’ve performed a miracle”, and that through this GP students could see very well how chemical substances work and react.

The greatest success of this GP is, as all the implementers mentioned, that “the children could show the result to their friends and to their parents” by taking the golden coins home. Students generally enjoy doing experiments where they produce something themselves that is either functional, that they can take home to demonstrate to their families and friends, or that they can even repeat at home.

The SPICE project

SPICE was a two-year project (December 2009 – November 2011) carried out by **European Schoolnet** (http://europeanschoonet.org) together with **Direção Geral de Inovação e Desenvolvimento Curricular** (http://sitio.dgidc.min-edu.pt/Paginas/default.aspx) from Portugal and **Dum Zahranicnich Sluzeb MSMT** (http://www.dzs.cz/) from the Czech Republic.

The primary objective of the SPICE project was to collect, analyse, validate and share innovative pedagogical practices, particularly those using inquiry-based learning, whilst enhancing pupils’ interest in the sciences. SPICE supported this objective by singling out, analysing and validating good practice pedagogies and practices in maths, science and technology (mostly ICT-based) and disseminating them across Europe. SPICE involved 24 teachers from 16 different educational systems (from 15 different countries). This teachers’ panel helped the SPICE partners in defining good practices that were then tested in classes by 41 teachers during the school year 2010-2011.

For more information see: **http://spice.eun.org**

Spice was funded with support from the European Commission.
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