# Student worksheet

## GREEN LABORATORY

### STUDENTS’ AGE

The experiment is suitable for students in the upper secondary school (age 16 to 18).

### Topics

green chemistry, chemical reactions, equations

OBJECTIVES  
Students should

* get acquainted with the principles of green chemistry
* understand different types of chemical reactions
* be able to study chemical reactions experimentally

### INTRODUCTION

You've landed a summer job at a green chemistry laboratory with a very attentive and dedicated lab manager. He asks you and your colleagues to investigate greener alternatives for 3 different chemical reactions done at the laboratory.

### LAB EQUIPMENT

* test tubes
* test tube rack
* steel wool
* 10 mL graduated cylinder
* spatula
* forceps
* pH paper
* gas burner
* matches
* watch glass

### CHEMICALS

* 0.5 M CuCl2
* 0.5 M HCl
* magnesium ribbon
* 0.1 M CuSO4
* 0.1 M K2CO3
* 0.1 M CaCl2
* 0.1 M NaCO3
* CaO (s)
* deionised water
* copper wire

SAFETY INFORMATION  
Mandatory personal protective equipment: lab coat, goggles and gloves. Carry out the work in the fume cupboard/hood. Before starting, it is necessary to carefully read the instructions for safe work. The waste must be handled properly /according to the description in the risk assessment (see the Teacher guide).



### PROCEDURE

In this experiment you will be testing three different reactions pairs (A-C). For each pair of reactions your aim is to determine the greener option of the reactions by comparing how well each reaction follow the 12 principles of green chemistry. Do both reactions of a reaction pair side-by-side and write down your observations? Write reaction equations for reactions. Finally choose the greener reaction in A, B and C.

1. Familiarize yourself with the 12 principles of green chemistry
2. Do the experimental work, starting with the reaction pair A. Synthesis of magnesium chloride:
3. Measure 5 mL of 0.5 M copper(II) chloride in a test tube. Add a small piece of magnesium ribbon.
4. In another test tube measure 5 mL of 0.5 M hydrochloric acid and add a small piece of magnesium ribbon.
5. Write down your observations and the corresponding reaction equation for the reactions involved in pair A.
6. Do the reactions B. Synthesis of copper or calcium carbonate:
7. Measure 4 mL of calcium chloride in a test tube. Add 4 mL of sodium carbonate.
8. In another test tube, measure 4 mL of copper(II) sulfate and 4 mL of potassium carbonate.
9. Write down your observations and the corresponding reaction equation for the reactions involved in pair B.
10. Do the reaction pair C:
11. Synthesis of copper(II) oxide: Take a piece of copper wire and heat it at the hottest point of a a gas burner flame for 30 seconds. After the wire has cooled, scrape its surface with a spatula.
12. Synthesis of calcium hydroxide: Using a spatula, put a small amount of solid calcium oxide into a test tube. Add water.
13. Write down your observations and the corresponding reaction equation for the reactions involved in pair C.

### Questions for discussion

1. What does green chemistry mean?
2. How can one measure the “greenness” of a chemical reaction?
3. Which of the reactions were greener in pairs A, B and C?