## Chemical analysis

### Pure and impure

In everyday language, the word "pure" normally refers to things which are natural like milk. In chemistry, it means one element or compound that is not mixed with anything else.

We can tell if something is pure or impure by looking at its melting or boiling point. If we do an experiment and find that it has a wide melting point like 50-58°C, then it is impure. If it has a very sharp melting point like 54°C then it is pure.

1. A student pours some mineral water into a glass. Is it a pure or impure substance?
2. A student receives a bottle of pure ethanol. In their textbook it says that ethanol's boiling point is 78°C. What temperature will they have to heat it to in order to turn it into a gas?
3. They find that it starts to turn into a gas at 71°C. What can they conclude about the ethanol's purity?
4. Ethanol is a simple molecular substance. Does it conduct electricity?
5. Explain your answer to the previous question.
6. A student heats up a liquid and records the temperature. Use the table to the right and graph paper to plot how the temperature changes over time.
7. Draw a curve of best fit
8. At which point does the liquid start to boil?
9. Is it a pure or impure substance?

| Time (minutes) | Temperature (°C) |
|---|---|
| 0 | 21 |
| 1 | 30 |
| 2 | 39 |
| 3 | 43 |
| 4 | 45 |
| 5 | 47 |
| 6 | 53 |
| 7 | 62 |

### Formulation

A formulation is a complex mixture with lots of different substances in it. Each substance has a different role and are added in specific proportions to make sure that the properties are as desired. Formulations include medicines, fuels, alloys and paints.

10. A student wants to make a formulation of chemicals X, Y and Z. First they take a small amount of Y and add it to X. Explain how the student could use the mixture's boiling point to prove that it is an impure substance.
11. There is a naturally occurring mixture of Y and Z that can be extracted from trees. A different student says that because it is natural it is a pure substance. Explain why the student is incorrect.
12. Explain why it is important that the student measures the volumes of X, Y and Z when mixing them together.
13. The resulting mixture can be separated back into X, Y and Z. Which process can be used for this separation?
14. Alloys can be considered as formulations. What is an alloy?
15. Explain why alloys are harder than pure metals.
16. A scientist wishes to make an alloy of iron and carbon for use as a car body. Explain why it is important that the scientist uses precise amounts of carbon when making the alloy.

### Chromatography

More information and questions about chromatography can be found in the required practicals booklet.

### Gas tests

Many reactions release gases. We can use the simple tests below to establish which gas is being produced.

| **Gas** | Test | Result |
|---|---|---|
| **Hydrogen** | Place a lit splint in a test tube full of the gas | Hydrogen burns rapidly with a pop sound |
| **Oxygen** | Place a glowing splint in a test tube full of the gas | Oxygen will relight the splint |
| **Carbon dioxide** | Bubble the gas through limewater | Carbon dioxide will turn the limewater cloudy |
| **Chlorine** | Put damp litmus paper near the gas | Chlorine will turn the paper white |

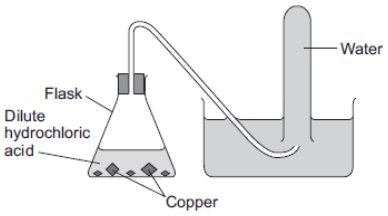
17. In a chemical reaction, a gas is released. It is unknown whether the gas is oxygen or hydrogen. Describe a test that can be used to establish which gas it is.
18. A student conducts electrolysis on liquid sodium chloride. Name the metal and a gas which are produced.
19. Explain why the electrolysis would not work if the sodium chloride was solid.
20. How can the student test for the presence of the gas.
21. The student repeats their electrolysis with a solution of sodium chloride dissolved in water. What is the formula of sodium chloride when dissolved in water? Include a state symbol in your answer.
22. In this case, the metal is not produced. Explain why.
23. What substance is produced instead?
24. What test can be used to confirm the identity of the substance?
25. A student boils the solution they prepared in question 21. Would you expect it to have a sharp boiling point or a wide one? Explain your answer
26. When magnesium carbonate ($MgCO_3$) reacts with hydrochloric acid (HCl), it forms magnesium chloride, carbon dioxide and water. Write a word and symbol equations for this reaction. (Hint: you will need to use the charge of magnesium and chloride ions to work out the formula of magnesium chloride)
27. Explain why the mass appears to decrease in this reaction

28. How can the scientist confirm that carbon dioxide is produced?
29. Carbon dioxide does not conduct electricity. Use its structure and bonding to explain why.
30. Carbon dioxide has a low melting point. Using its structure and bonding explain why.
31. Draw a dot and cross diagram of carbon dioxide.
32. Magnesium is not found in the earth as the metal itself and must be extracted from magnesium carbonate. Why can it not be extracted by reduction with carbon?
33. The reaction below shows what occurs when water is electrolysed:
    $2H_2O \rightarrow 2H_2 + O_2$
    How can the products be tested for?
34. *Challenge: where do each of the products form*
35. A student fully electrolyses 100g of water. What mass of hydrogen and oxygen will be produced?
36. A student uses 4.32g of water and obtains 0.48g hydrogen. Use this data to check that the equation in 32 is balanced correctly. You must show all your working.

**GCSE questions**

37. A student was trying to produce hydrogen gas. **Figure 1** shows the apparatus she used.

**Figure 1**




No gas was produced. The student's teacher said that this was because the substances in the flask did **not** react.

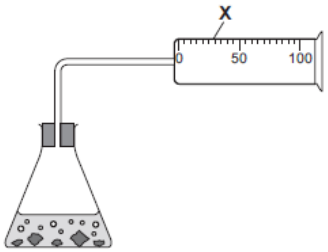
(i) Suggest why the substances in the flask did **not** react.

(ii) Which two substances could the student have put in the flask to produce hydrogen safely? Circle one answer

Gold and dilute hydrochloric acid

Potassium and dilute hydrochloric acid

Zinc and dilute hydrochloric acid




(b) Another student did produce hydrogen from two substances. **Figure 2** shows the apparatus the student used to collect and measure the volume of the hydrogen gas.Give the name of the apparatus labelled **X**.

(c) The student did the experiment four times. Her results are shown in the table below.

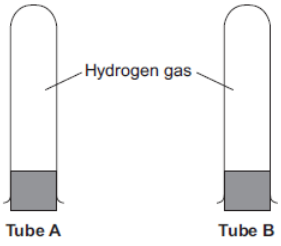
| **Experiment** | **Volume of hydrogen collected in one minute in $cm^3$** |
|---|---|
| 1 | 49 |
| 2 | 50 |
| 3 | 35 |
| 4 | 48 |

(i) One of the results is anomalous. Which result is anomalous? Give a reason for your choice.

**(ii)** Calculate the mean volume of hydrogen collected in one minute.

(iii) Give a reason why the experiment should be repeated several times.

(d) A teacher collected two tubes full of hydrogen gas, as shown in **Figure 3**.




She tested tube **A** with a lighted splint as soon as she took the bung out.

She tested tube **B** with a lighted splint a few seconds after taking the bung out.

(i) Suggest why tube **B** gave a much louder pop than tube **A**.