MYSTERY POWDERS

Mystery Powders is one of a series of enquiries and additional resources which together form **Beyond fair testing: Teaching different types of scientific enquiry,**

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Gatsby Science Enhancement Programme
Allington House (First Floor)
150 Victoria Street
London SW1E 5AE

The Mystery Powders materials were written by:
Rod Watson

Prepared for publication by: Miriam Chaplin
Designers: Pluma Design Ltd.
CD ROM development and online: kdr creative

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Science Enhancement Programme

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University of London

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MYSTERY POWDERS: OVERVIEW

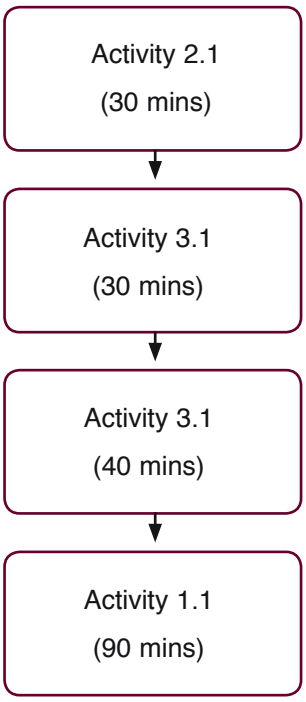
Enquiry type: Identifying enquiry

Section	Activity	Links to KS3 PoS/ Scheme of work	Links to KS4 PoS	Learning objectives Students will be able to:	Assumed prior Knowledge and Understanding
1. Core enquiry	1.1	**Sc1: investigative skills:** The main emphases are concerned with Planning, Obtaining and presenting evidence, Considering evidence and Evaluating. In order to do these students have to use knowledge and understanding from Sc3.	**How science works:** Practical and enquiry skills. Communication skills. The main emphases are selecting suitable analytical tests and ordering them so as to identify chemicals efficiently.	• use their knowledge and understanding of chemical reactions to reveal the identity of the unknown substances (by devising and using an identification key) • use their classification and analytical skills to provide sound evidence for the identity of the different substances, • record observations accurately and evaluate results to make conclusions.	• knowledge of ways of classifying chemicals according to their properties • use of keys to order chemical and physical tests in an efficient way to identify a range of chemicals
2. Background knowledge	2.1	**Sc3: Classifying materials** Patterns of Behaviour	**Chemical and material behaviour:** (b) Patterns of chemical reactions. In particular: • Different groups in the periodic table • Giant structures and small molecules • Substances with covalent, ionic, and metallic bonding	• use knowledge and understanding of specific chemicals to ask questions and to identify chemicals • use knowledge of chemical groupings to ask questions and to identify chemicals which share one or more properties.	None
3. Procedural understanding	3.1	**Sc1 Investigative skills:** Planning	**How science works:** Practical and enquiry skills.	• recognise good questions for identification and understand what makes the questions good or not so good. • write their own good questions.	None
	3.2	**Sc1 Investigative skills:** Obtaining and presenting evidence, Considering evidence and Evaluating.	**How science works:** Practical and enquiry skills.	• know that a key is a tool for doing a job, i.e. classifying or identifying, and that the quality of the key is judged by its efficiency in doing that job. • be able to judge the quality of keys by considering whether general or specific questions come first in the key.	

MYSTERY POWDERS: ROUTES

Route 1
(assumes students have already identified skills and knowledge to begin activity 1.1)
Overall time is roughly 1-2 hours.

Route 2
(uses all activities from sections 2 and 3 to provide relevant knowledge and procedural understanding to begin core enquiry in section 1)
Overall time is roughly 3-4 hours.



HEALTH AND SAFETY

For practical activities, the Science Enhancement Programme has tried to ensure that the experiments are healthy and safe to use in schools and colleges, and that any recognised hazards have been indicated together with appropriate control measures (safety precautions). It is assumed that these experiments will be undertaken in suitable laboratories or work areas and that good laboratory practices will be observed. Teachers should consult their employers' risk assessments for each practical before use, and consider whether any modification is necessary for the particular circumstances of their own class/school. If necessary, CLEAPSS members can obtain further advice by contacting the Helpline on 01895 251496 or e-mail science@cleapss.org.uk.

ACTIVITY 1.1:
IDENTIFYING CHEMICALS
(CORE ENQUIRY ACTIVITY)

WHAT STUDENTS DO

Students are introduced to the scenario of entering the laboratory on Monday morning and being presented with a number of unlabelled bottles containing different chemical substances., The students use the data cards supplied to identify the different chemical substances and match them with their correct labels.

Learning objectives

Students will be able to:

- use their knowledge and understanding of chemical reactions to reveal the identity of the unknown substances (by devising and using an identification key)
- use their classification and analytical skills to provide sound evidence for the identity of the different substances
- record observations accurately and evaluate results to make conclusions.

Note: If students do not have a list of criteria for good questions to use in an identification key, they should work through activities 3.1 and 3.2 before beginning part 1 of this core enquiry activity.

Resources needed for each group

- Data cards, from **Student Activity 3.1**
- At least one sheet of paper (for the key)

- **Apparatus:**

safety spectacles for each student
Bunsen burner
heat resistant mat
gauze
tongs
splints,
small deflagrating spoons or combustion spoons
test-tubes, test-tube holders and test tube racks
small beakers
glass stirring rods
source of 1.5 V DC (power packs or batteries)
wires plus crocodile clips
1.5V bulbs in holders.

Note: Specific hazards and the relevant CLEAPSS Hazcard are given beside individual chemicals

Note: Only the acids will have correct chemical labels on them (otherwise it will give students the answers before they start!). Make sure you have agreed a consistent identification code with technicians for whichever chemicals you use, so you know what students are using. For example, students may be given 'substance x', but you will know from your code list that 'substance x' is magnesium oxide.

Chemicals:

Bottles of 2 mol.dm^{-3} hydrochloric acid (irritant): ***see Hazcard 47***

Bottles of 1 mol.dm^{-3} sulfuric acid (irritant): s***ee Hazcard 98***

plus small amounts (a spatula full) of each of the following per student (in the form of powder, crystals or fine turnings for heating, but a small lumps or ribbons for conductivity tests on the solid):

- Carbon
- Sulfur: ***see Hazcard 96***

  Heating sulfur produces toxic fumes of sulfur dioxide and must be done in a fume cupboard
- Zinc: ***see Hazcard 107***
- Aluminium: ***see Hazcard 1***
- Copper
- Copper (II) oxide (Harmful if swallowed; dust irritates eyes and lungs): ***see Hazcard 26***
- Copper (II) carbonate (Harmful if swallowed; dust irritates eyes and lungs): ***see Hazcard 26***
- Calcium carbonate
- Anhydrous sodium carbonate (Irritating to the eyes): ***see Hazcard 95***
- Sodium chloride
- Magnesium oxide
- Sugar
- Copper (II) sulfate(VI) -5-water (Harmful if swallowed): ***see Hazcard 27***

NOTES AND SUGGESTIONS FOR CLASSROOM ACTIVITIES

SAFETY

Before selecting which chemicals to include for identification by a group of students, you should make a formal Risk Assessment.

For example, factors you should consider which particularly apply in this activity are

- *The form and quantity of the sample: powders usually react much more spectacularly than granules, turnings or lumps. If students over-fill the deflagrating spoon with powdered metal, for example, the resulting display may be impressive enough to tempt students to repeat the test needlessly, and split powder may cause blockage of the Bunsen burner.*
- *Inhalation hazards. Heating sulfur can produce unpleasant, hazardous fumes and should be done in a fume cupboard. Supervise the use of metal oxide powders to avoid spillages and the release of powder which could be inhaled.*

It is important to emphasise the need for safety from the start of the enquiry:

- *Students should wear suitable eye protection when heating substances or handling chemicals.*
- *There is no need for any solutions to be heated in these tests.*
- *In addition to tests based on the data cards provided, students may also want to use other knowledge of chemistry to test for specific chemicals.* ***You will need to check these tests for possible hazards before the students carry them out.***
- *You will also need to monitor the quantities of solid and solutions used by students: only a few grains of the powders are needed for the tests with acids or for the heating tests; test tubes should be filled to a depth of no more than 2 cm with the solution as this will avoid the liquids bubbling over the sides of the test tubes if gases are produced.*

Differentiation

The difficulty of the enquiry can be altered by reducing or adding the number of unknown substances. This also has implications for the Risk Assessment of the activity.

The students could also be presented with the scenario of having more bottles than labels or some incomplete labels (e.g. coppe…) or even having only some of the data cards. For example:

	Number of unlabelled bottles	Number of complete labels	Number of incomplete labels
Easiest	6	6	0
↕	6	13	0
	9	13	0
	13	13	0
Hardest	13	11	2

Encouraging effective observation: supporting the use of the data cards

The descriptions on the data cards include phrases such as '**conducts**', '**gas produced**' or '**copper deposited**'.
These phrases describe properties of the substance, but in order to translate this into effective observation, some students may need you to ask,
'**What would you expect to see** if it conducts?' or
'**What would you expect to see** if a gas is produced? or
'**What would you expect to see** if copper is deposited?'

Additionally, you may need to discuss with students the effect that using a lump or a powder might have on some of the observations: things may happen slowly or apparently not at all with a lump, while same substance in powder form may react quickly and possibly spectacularly! Similarly, powders and turnings may not show the conductivity observed when using a strip of metal.

There are three parts to this enquiry:

- **Part 1:** Planning your tests
- **Part 2:** Obtaining evidence by constructing and using a key
- **Part 3:** Evaluating your key

Part 1: Planning your tests

Plenary:

Provide each group of students with a set of data cards.
Ask the students to suggest questions which might help to split large groups of chemicals into smaller groups.
Try to elicit the idea that it is not a good strategy to ask questions which are specific to an individual chemical early on.

Group work:

Ask each group

1. to write down the questions they are going to ask before they ask the question

and

2. to identify what questions they think they could ask in order to identify individual chemicals.

Whilst they are working, look at the questions that they are writing and discuss in their groups their reasons for choosing those questions.

SAFETY
Check that the tests that the students are planning to carry out are both sensible and safe.

Part 2: Obtaining evidence by constructing and using a key

Group work:

Students construct their keys, carry out the tests and present their results in a table.

SAFETY
Students will be carrying out a range of different practical tests on different chemicals. This needs particularly careful supervision to maintain safe working.

Part 3: Evaluating your key

Students evaluate their keys against previously agreed criteria for good questions (see Teacher notes for **Activity 3.1** and **Student Activity 3.1: *Ten Questions***).

ACTIVITY 2.1:
KNOWLEDGE OF CHEMICALS

WHAT STUDENTS DO

Students revise some of the groups into which they have divided chemicals in Key Stages 3 and 4.

Learning objectives

The students will be able to:

- use knowledge and understanding of specific chemicals to ask questions identify chemicals
- use knowledge of chemical groupings to identify chemicals which share one or more properties.

Resources

There are no specific student activity materials for this section, but we suggest that you use the data cards from **Student Activity 3.1** to carry out a range of sorting activities and group/class discussion, using

- a printed set of data cards for each group, with the name of the chemical

and/or

- data cards from the pdf or word file **Student Activity 3.1** on the CD, used with a computer and data projector, or printed onto transparencies for use with an overhead projector.

NOTES AND SUGGESTIONS FOR CLASSROOM ACTIVITIES

Some possible sorting activities and discussion questions:

- (As a class) Which of these chemicals…. are coloured solids? ….. are soluble in water? ….react with hydrochloric acid? Etc.
- (As a class) How could you tell if one of these chemicals reacts with an acid?
- (In groups or pairs) Sort the cards into groups, then ask another pair of students to work out what property you chose to sort by.
- (In pairs) Play ‘snap’, looking for cards that share a property
- If you write the name of the chemical on the back of each data card, students could play a variation of ‘pelmanism’, by turning one card over, then using their knowledge of properties to identify another chemical which shares one of the properties of the first chemical: if they turn over a card which **does** share a property, they can turn over another card (and so on), removing all the ‘matched cards’ which form a group. If the card **is not** a correct match for any property, it must be placed face down again and another student takes a turn…

Chemical knowledge and chemical analysis
The skills and processes of carrying out a chemical analysis cannot be separated from knowledge and understanding of chemistry. Knowledge of chemistry is necessary to be able to recognise chemicals, how they change and what they produce.

In order to identify chemicals using a key, students need to know about

1. some properties of specific chemicals
2. some characteristic properties of **groups of chemicals**

General questions related to major groupings in chemistry are best used early in a key. As more is found out about specific chemicals using a key, the questions need to become more and more specific.

1 Knowledge of specific chemicals
The set of data cards provided in **Student Activity 3.1** contains some basic information about the chemicals to be identified.
Sometimes a single characteristic of a chemical may be used to identify it uniquely. Physical features often give strong clues as to what a chemical is: in a school laboratory, for example, a yellow powder might be sulfur, while a white crystalline solid with cubic crystals might be sodium chloride; at a higher level, scientists often use techniques such as IR spectrometry to identify particular chemicals by their characteristic spectrum.
The set of chemicals listed in **Activity 1.1** contains several chemicals with strong visual clues to help them to be recognised.

2 Knowledge of chemical groupings
It is worth spending some time at the beginning of this enquiry revising with the class some of the major groupings of chemicals that students have come across and how these relate to properties such as appearance, melting points, or electrical conductivity of solids.

All these properties can be used in this enquiry. Different kinds of groupings to consider could be:

- Metals and non-metals
- Different groups in the periodic table
- Giant structures and small molecules
- Substances with covalent, ionic, and metallic bonding

It is often difficult to identify a chemical using just one specific test and several tests are needed. In this second kind of approach chemicals can be identified by placing them in successively smaller groups until eventually there is only one chemical in the group and it is identified. In the enquiry in section 1, students use a key to help with this process.
Knowledge and understanding of how chemicals are grouped is helpful here. For example, electrical conductivity of solids is a good test for sorting out the metals from non-metals (with the exception of carbon in the form of graphite). Once the group of metals has been identified, knowledge of the reactivity series can help students sort out metals within this group.

Similarly for those solids that dissolve, electrical conductivity of solutions allows ionic solids to be identified because they conduct electricity. The next step in identification then becomes one of devising a test to distinguish between different kinds of ionic solids. For example, carbonates can be identified because they react with dilute acids, releasing carbon dioxide.

ACTIVITY 3.1:
TEN QUESTIONS

WHAT STUDENTS DO

Students ask the teacher 'yes/no' questions to try to identify the chemical that the teacher has selected without revealing its identity. Students then repeat this process in groups.

Learning objectives

Students will be able to:

- recognise good questions for identification and understand what makes the questions good or not so good
- write their own good questions.

Resources needed

- **Student Activity 3.1: *Ten questions.*** (The instructions and recording table are on separate sheets so that you can print out as many or as few tables as you wish to use with each class)
- Data cards for **Student Activity 3.1**

NOTES AND SUGGESTIONS FOR CLASSROOM ACTIVITIES

Plenary:

Demonstrate the process to the students. Think of a substance (from among those presented in the cards) and have the students ask questions. Direct them towards asking only 'yes/no' questions. Allow a maximum of ten questions to find out what the chemical is.

Group work:

Ask students to repeat the process in their group, using copies of the ***'Ten questions to identify a chemical'*** table. Encourage them to identify most helpful and least helpful questions and to be ready to explain their answers.

Note: If you have a data projector or an interactive whiteboard, the easiest way to do this would be to use the 'word' version of **Student Activity 3.1: *Ten questions*** to display a copy of the ***'Ten questions to identify a chemical'*** table and fill it in as students contribute to the discussion.

Plenary:

Repeat the process once more, writing the questions on the board. After the identification of the chemical, go back to the questions and ask which ones were most helpful and which were least helpful. Ask why some questions are good and others not so good.

This consideration of questions leads in to the idea of using a 'key'. Most students have probably used simple keys before, but it is worthwhile going over the idea once again:
A key is a tool which helps us to unlock something. In this case, it helps us to find out what the chemical is, by asking a series of questions, each one being determined by the answer to the previous question. Chemical knowledge can help inform the construction of the key, but what counts in the end is whether the key is an efficient tool for getting the job done. It can act in two ways:

1. **It can help us to assign a chemical to an appropriate group in a scheme of classification.** Allocating a chemical to a group is useful because groups have a number of properties in common, so placing a chemical in a group gives us more information about it. Questions that allow us to place chemicals in groups can be related to the underlying structure of chemical classifications, such as 'metal carbonates', 'metals' or indeed groups in the periodic table.
2. **It can also help us to identify particular chemicals.** To do this, the key must include questions that are specific to a particular chemical. For example, asking whether a chemical is blue or not helps to pick out some copper compounds.

Types of question which are not helpful in doing either of these are:

Questions about a property which….	Example
…is shared by all members of the sample	'Does it sink in water?'
…..is difficult to operationalise	'Does it have a melting point greater than 500°C?' 'Does it conduct electricity when molten?'
….. shows too much variability within samples of the same substance	'Is it shiny?' This is a weak version of the question, 'Does it have a metallic lustre?' Whether it is shiny is difficult to decide and depends on the solid form – whether it is presented as crystals, a powder or perhaps as a piece of metal foil.
…is too specific, i.e. the question is an attempt to ***guess the substance*** and pick off one substance at a time for identifying.	'Does it have a gold colour?' (This is a useful question to confirm the identity of gold, but is not a good question if there is no reason to suspect the substance is gold). 'Is it white?' is a much better question as it is much less specific: There are many white and non-white solids and whether they are white or not is related to underlying chemical characteristics.
…. is double-barrelled	'Is it a soft powder?'

Effective sets of questions are those that enable identification in as few steps as possible. If the key allows us to pick off chemicals one at a time, using very specific questions right from the start, its effectiveness depends too much on luck. If you are identifying ten chemicals, you might be lucky and pick the right question on the first time, but you also might be unlucky and have to use ten questions to identify the chemical. **Using general questions to allocate chemicals to groups is a good strategy to start with. This can be followed up with specific questions to sort out members of groups and identify specific chemicals.**

ACTIVITY 3.2:
EVALUATING KEYS

WHAT STUDENTS DO

Students work in small groups and use two different keys to identify chemicals. They then evaluate the quality of the keys.

Learning objectives

Students will be able to:

- know that a key is a tool for doing a job, i.e. classifying or identifying, and that the quality of the key is judged by its efficiency in doing that job.
- be able to judge the quality of keys by considering whether general or specific questions come first in the key.

Resources needed

- **Student Activity 3.2: *Evaluating keys***
- Class sets of:

Apparatus:

safety spectacles
Bunsen burners
heat resistant mats
gauzes
tongs
splints
small deflagrating spoons or combustion spoons
test-tubes, test-tube holders and test tube racks
small beakers
glass stirring rods
source of 1.5 V DC (power packs or batteries),
wires plus crocodile clips,
1.5 V bulb in holder.

Chemicals:

Bottles of 2 mol.dm^{-3} hydrochloric acid (irritant): *see Hazcard 47*
Samples of:

- magnesium oxide, labelled chemical P
- magnesium carbonate, labelled chemical Q
- copper chloride crystals, labelled chemical R (toxic if swallowed): *see Hazcard 27*
- clean magnesium ribbon cut in 2cm pieces, labelled chemical S (highly flammable); *see Hazcard 59*. **Magnesium ribbon burns with a bright white flame. Students should not stare at the flame.**

NOTES AND SUGGESTIONS FOR CLASSROOM ACTIVITIES

Student Activity 3.2 contains Key 1 and Key 2. Both keys have been designed to identify chemicals in the following set: copper chloride, iodine, iron, lead nitrate, magnesium, magnesium oxide, magnesium carbonate, potassium carbonate.

SAFETY

- *Students should wear eye protection.*
- *You will need to monitor the quantities of chemicals being used by students. Make sure that students do not help themselves to additional pieces of magnesium ribbon!*
- *Test F describes a test for iodine in order to provide an example of a specific test for a chemical: iodine is **not** one of the chemicals students should be provided with for this activity, however.*

Group work:

Have students divide their groups into two halves to identify P, Q, R and S. One half of each group uses key 1 and the other half uses key 2.

Students follow through the key. For each test, they record (in the table) the questions being addressed by each test and the answers to these questions. This eventually leads them to the identification of chemical P. Next they repeat this procedure for chemicals Q, R and S.

When the students have used both keys to identify the chemicals, they fill in the table for the comparison of the two keys with the number of steps used needed to identify each chemical. They then compare the keys and judge which key is best.

Answers

Chemical	Steps needed using Key 1	Steps needed using Key 2
P	3	5
Q	3	5
R	3	5
S	3	2

1. Key 1.
2. See notes above.

Plenary:
First, summarise the number of steps needed to identify each chemical (see answers below).
Next, discuss with the class the efficiency of the keys. Here are the main points to make about the two keys:

- Key 2 seems to be less efficient than key 1. This is because key 2 uses a strategy of specific tests which identify the chemicals one by one, right from the start. In key 2 the first question asked ('Is it attracted to a magnet?') applies to and identifies iron. The second question ('Does it conduct electricity?') applies to the only other metal in the samples (i.e. magnesium) and singles it out. If you are lucky and your question anticipates the right chemical (e.g. chemical S, magnesium) it is identified rapidly, but often this is not the case (chemicals P, Q and R) and so you are left working through irrelevant tests.

- Key 1 uses a different approach. It starts with general questions, which are related to classifications used by chemists, and then moves onto specific questions to identify particular chemicals later. For example, the question 'Is it white?' relates to the periodic table. Elements are not white, nor are transition metal compounds. These are separated off from compounds of groups I, II and III. Similarly the question 'Does it melt or vaporise easily?' relates to the structure of matter: giant structures (metallic, covalent and ionic) have high melting and boiling points as opposed to molecules, which have typically low melting and boiling points. Both metals, and some non-metals found close to the metals in the periodic table (e.g. carbon and silicon), have giant structures. Other non-metallic elements are made up of small molecules (e.g. hydrogen H_2, and oxygen O_2) or single atoms (inert gases). Compounds of metals with non-metals have giant ionic structures (e.g. NaCl), whereas most compounds of non-metals only consist of molecules (e.g. H_2O, CO_2). Using questions for the key which relate to the general classifications in chemistry enables more efficient division of these chemicals into groups. After this has been done fewer specific tests are needed to identify the each of the chemicals uniquely.

Activity 1.1: Identifying chemicals

Your school has a new state of the art chemistry laboratory. Unfortunately there is a problem with the roof. Over the weekend there have been heavy thunder storms and you come in to school to find the laboratory has been flooded. Some bottles of chemicals have lost their labels. By careful searching, you find the labels, but the problem is

Which label goes with each bottle?

Your job is to design a way of identifying the chemicals so that your teacher can put the right labels back on each bottle.

Use the data cards provided to produce a key to identify each 'mystery powder'.

There are three parts to this activity:

- Part 1: Planning your tests
- Part 2: Obtaining evidence by constructing and using a key
- Part 3: Evaluating your key

Part 1: Planning your tests

Look at the data cards:
Write down some 'yes/no' questions which will help you split the chemicals into groups. Your questions should involve simple tests that you can carry out in the laboratory.
Label each of the questions test A, test B, test C etc.

Write down some 'yes/no' questions which will identify each individual chemical.

SAFETY

Show your list of questions to your teacher: you must not carry out any test until your teacher has checked what you are planning to do.

Activity 1.1: Identifying chemicals

Part 2: Obtaining evidence by constructing and using a key

Try arranging the questions into a key. You will be given a sheet of paper on which to construct your key.

Once you have got a key that allows you to identify each chemical, check it with your teacher and then try it out by carrying out the tests on the chemicals.

SAFETY

Wear eye protection when heating substances or handling chemicals.

Record your results for each chemical in a table:

Substance being tested:

Test letter	Question asked	Yes or No?

Which label fits each chemical?

Part 3: Evaluating your key

Write a paragraph evaluating your key. Consider the following points:

- Did your key allow you to identify each of the chemicals?
- Were the questions you asked in each test clear?
- Were the tests simple to perform?
- Did the order of the questions work well?
- If you could design your key again, would you make any changes?

Activity 3.1: Ten Questions

What chemical am I thinking of?

Ask ten questions to find out which chemical has been chosen.

In a group, take it in turns getting one member of the group to think of a chemical without telling the others. This needs to be a chemical that you know something about, because you are going to answer questions about it. You could use the data cards to help you with this.

The rest of the group need to try and work out what the chemical is by asking questions. The person who has thought of the chemical can only answer 'yes' or 'no'.
Each member of the group needs to take it in turn to ask a question until they guess the chemical correctly.

Use a copy of the '***Ten questions to identify a chemical***' table to record each question that is asked and the answer it gets.

You only have ten questions to try to find out the right chemical, so, choose your questions carefully.

After each set of ten questions (or when you have identified the chemical, whichever comes first), complete the table to show

- the name of the chemical
- how many questions it took to identify it

Sort the questions into two groups:

- which questions were most helpful
- which questions were least helpful

ACTIVITY 3.1: TEN QUESTIONS

'Ten questions to identify a chemical' table

Question	Answer Yes/no	This was a helpful question	This was not a helpful question
What was the chemical?			
How many questions did it take to identify this chemical?			

'Ten questions to identify a chemical' table

Question	Answer Yes/no	This was a helpful question	This was not a helpful question
What was the chemical?			
How many questions did it take to identify this chemical?			

'Ten questions to identify a chemical' table

Question	Answer Yes/no	This was a helpful question	This was not a helpful question
What was the chemical?			
How many questions did it take to identify this chemical?			

Activity 3.1: Ten Questions

Data Cards

CARBON (C) (graphite)	
Appearance:	Dull, black solid
Solubility in water:	Insoluble
Effect of heat:	Little change
Electrical conductivity of solid:	Conducts
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Does not react
Reaction with dilute sulfuric acid:	Does not react

SULFUR (S)	
Appearance:	Dull, yellow solid
Solubility in water:	Insoluble
Effect of heat:	Melts, burns with a blue flame
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Does not react
Reaction with dilute sulfuric acid:	Does not react

ZINC (Zn)	
Appearance:	Shiny, silver-grey solid
Solubility in water:	Insoluble
Effect of heat:	No effect on moderate heating
Electrical conductivity of solid:	Conducts
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Reacts to form a colourless solution; Gas produced
Reaction with dilute sulfuric acid:	Reacts to form a colourless solution; Gas produced

ALUMINIUM (Al)	
Appearance:	Shiny, silvery solid
Solubility in water:	Insoluble
Effect of heat:	No effect on moderate heating
Electrical conductivity of solid:	Conducts
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Does not react for a few minutes, then reacts to form a colourless solution; Gas produced
Reaction with dilute sulfuric acid:	Does not react

Activity 3.1: Ten Questions

COPPER (Cu)	
Appearance:	Shiny, brown solid
Solubility in water:	Insoluble
Effect of heat:	Turns black
Electrical conductivity of solid:	Conducts
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Does not react
Reaction with dilute sulfuric acid:	Does not react

COPPER OXIDE (CuO)	
Appearance:	Dull, black solid
Solubility in water:	Insoluble
Effect of heat:	No effect
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not dissolve in water and so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Reacts (when warmed) to form a blue solution
Reaction with dilute sulfuric acid:	Reacts to form a blue solution

COPPER CARBONATE ($CuCO_3$)	
Appearance:	Dull, green solid
Solubility in water:	Insoluble
Effect of heat:	Turns blacks - Gas produced
Electrical Conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not dissolve in water , so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Reacts to form a blue solution; Gas produced
Reaction with dilute sulfuric acid:	Reacts to form a blue solution; Gas produced

CALCIUM CARBONATE ($CaCO_3$)	
Appearance:	Dull, white solid
Solubility in water:	Insoluble
Effect of heat:	Little change
Electrical Conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not dissolve in water , so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Reacts to form a colourless solution; Gas produced
Reaction with dilute sulfuric acid:	Little effect

ACTIVITY 3.1: TEN QUESTIONS

SODIUM CARBONATE (Na_2CO_3)	
Appearance:	Dull, white solid
Solubility in water:	Soluble
Effect of heat:	No effect
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Conducts; Gas produced
Reaction with dilute hydrochloric acid:	Reacts to form a colourless solution; Gas produced
Reaction with dilute sulfuric acid:	Reacts to form a colourless solution; Gas produced

SODIUM CHLORIDE (NaCl)	
Appearance:	Dull, white solid
Solubility in water:	Soluble
Effect of heat:	No effect
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Conducts; Gas produced : Chlorine smell
Reaction with dilute hydrochloric acid:	Dissolves to form a colourless solution
Reaction with dilute sulfuric acid:	Dissolves to form a colourless solution

MAGNESIUM OXIDE (MgO)	
Appearance:	Dull, white solid
Solubility in water:	Insoluble
Effect of heat:	No effect
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not dissolve in water, so conductivity cannot be tested
Reaction with dilute hydrochloric acid:	Reacts to form a colourless solution
Reaction with dilute sulfuric acid:	Reacts to form a colourless solution

SUGAR ($C_{11}H_{22}O_{11}$)	
Appearance:	Dull, white solid
Solubility in water:	Soluble
Effect of heat:	Melts - Bubbles - Turns black
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Does not conduct
Reaction with dilute hydrochloric acid:	Dissolves to form a colourless solution
Reaction with dilute sulfuric acid:	Dissolves to form a colourless solution

Activity 3.1: Ten Questions

COPPER SULFATE ($CuSO_4$)	
Appearance:	Dull, blue solid
Solubility in water:	Soluble – forms blue solution
Effect of heat:	Forms white powder and water vapour
Electrical conductivity of solid:	Does not conduct
Electrical conductivity of solution:	Conducts; Copper deposited; Gas produced
Reaction with dilute hydrochloric acid:	Dissolves to form a blue solution
Reaction with dilute sulfuric acid:	Dissolves to form a blue solution

Activity 3.2: Evaluating keys

Keys can be used for identifying chemicals, but what are the features of a good quality key? If you were asked to make up a key, how would you decide what questions to ask and what order to put them in?

Try out two different keys and decide which one is best.

Two different keys are given below. Some questions are the same in both keys, but they are placed in a different order.

Work in a small group. Divide your group into two halves:
One half uses **Key 1** to identify chemicals P, Q, R and S and fills in the **table of results for key 1.**
The other half uses **Key 2** to identify chemicals P, Q, R and S and fills in the **table of results for key 2.**
Both half-groups need the sheet **'Tests for chemicals',** which describes tests A to G.

SAFETY

Wear eye protection when handling chemicals and carrying out these tests.

When both 'half-groups' have identified P, Q, R and S, work together as a whole group to complete the table below and to answer the questions

Chemical	Steps needed to identify the chemical using Key 1	Steps needed to identify the chemical using Key 2
P		
Q		
R		
S		

1. Which key was better?

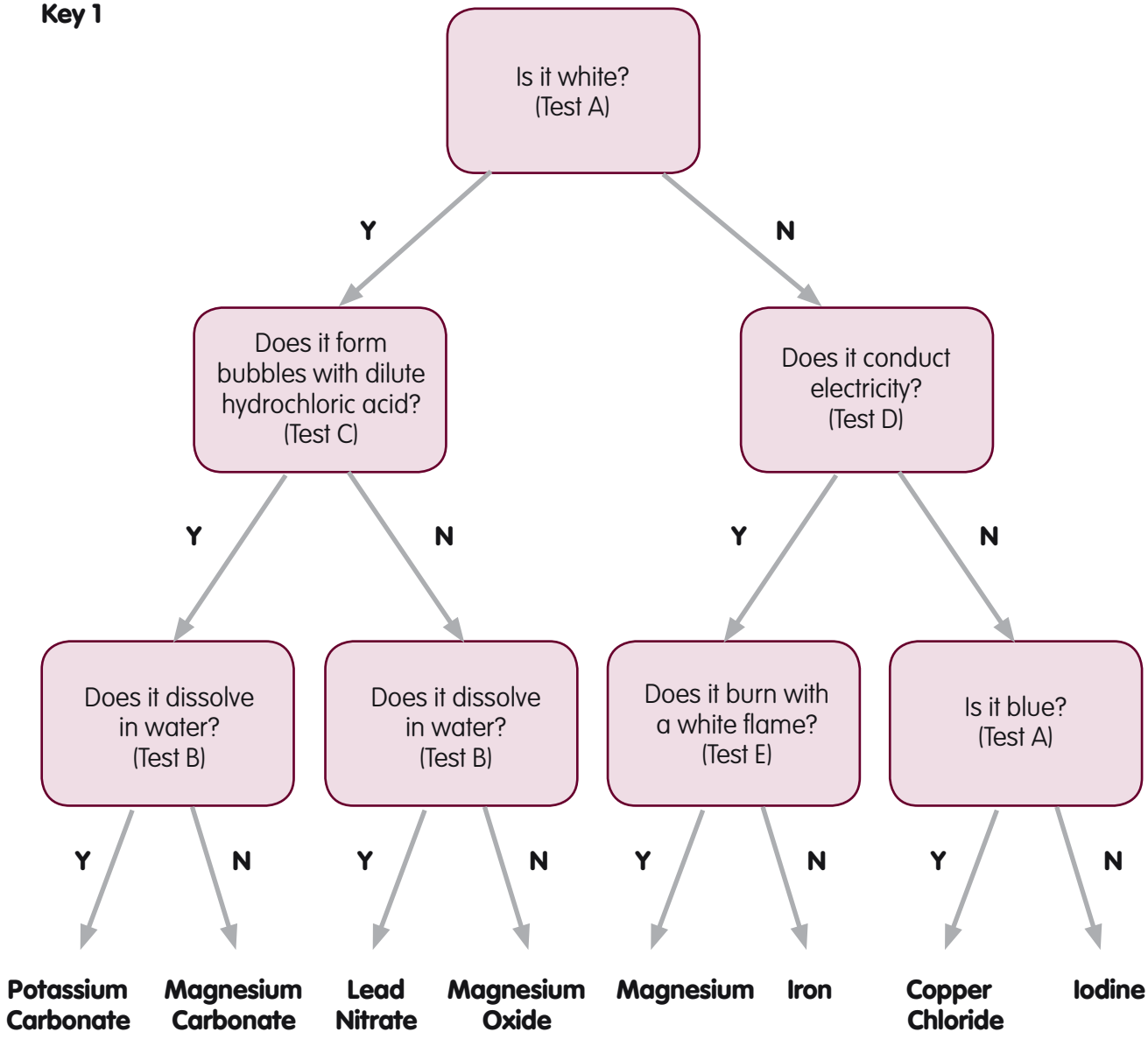
2. Explain your answer to question 1.

Activity 3.2: Evaluating keys

Half group using Key 1:

Use Key 1 to identify 'chemical P'. Start with the question at the top. To answer the question you will need to do test A (see **'Tests for chemicals'** below). Record your question and the answer in the 'Table of results for Key 1'. Follow the arrow on the key to the next question and test. Carry out the test and record your answer to the question. Keep going until you have identified chemical P.
Next, move on to chemical Q and use the key to identify this.
Repeat with chemical R and then S.

Key 1



Activity 3.2: Evaluating keys

Table of results for Key 1

Chemical P Question	Answer (Yes or No)
Is it white?	

What is the name of the chemical?

Chemical Q Question	Answer (Yes or No)
Is it white?	

What is the name of the chemical?

Chemical R Question	Answer (Yes or No)
Is it white?	

What is the name of the chemical?

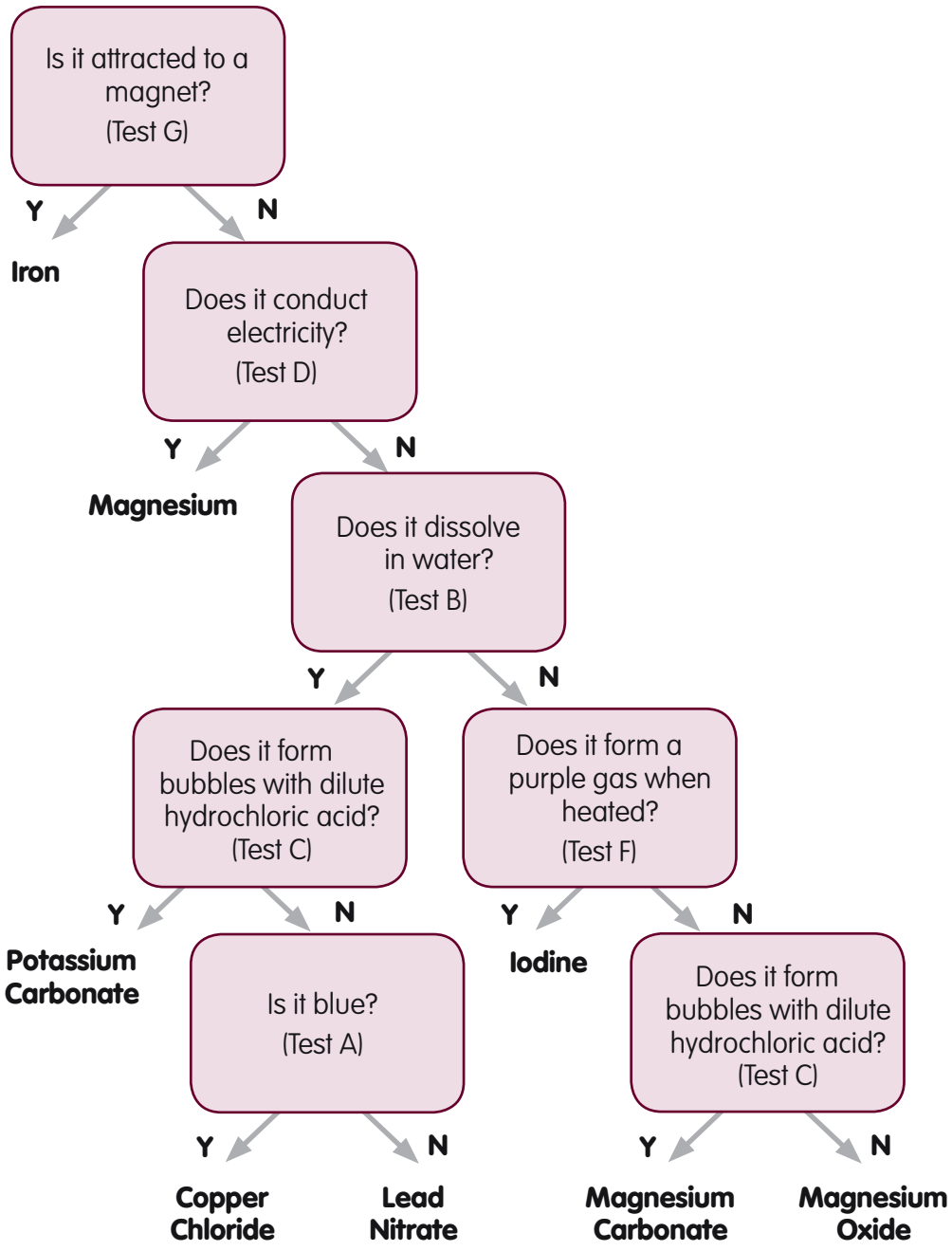
Chemical S Question	Answer (Yes or No)
Is it white?	

What is the name of the chemical?

Activity 3.2: Evaluating keys

Half group using Key 2:

Use Key 2 to identify 'chemical P'. Start with the question at the top. To answer the question you will need to do test G (see 'Tests for chemicals' below). Record your question and the answer in the 'Table of results for Key 2'. Follow the arrow on the key to the next question and test. Carry out the test and record your answer to the question. Keep going until you have identified chemical P.
Next, move on to chemical Q and use the key to identify this.
Repeat with chemical R and then S.



Activity 3.2: Evaluating keys

Table of results for Key 2

Chemical P Question	Answer (Yes or No)
Is it attracted to a magnet?	

What is the name of the chemical?

Chemical Q Question	Answer (Yes or No)
Is it attracted to a magnet?	

What is the name of the chemical?

Chemical R Question	Answer (Yes or No)
Is it attracted to a magnet?	

What is the name of the chemical?

Chemical S Question	Answer (Yes or No)
Is it attracted to a magnet?	

What is the name of the chemical?

Activity 3.2: Evaluating keys

Test A
Look at the sample and notice its colour.

Test B: Does it dissolve in water?
Fill a small beaker to a depth of about 2cm with cold water. Add about half a spatula full of the chemical to the water. Stir with a glass stirring rod for a few minutes or until it dissolves.

Test C: Does it form bubbles with dilute hydrochloric acid?
Fill a small beaker to a depth of about 2cm with dilute hydrochloric acid. Add about half a spatula full of the chemical to the acid. Note whether bubbles of a gas are produced.

Test D: Does it conduct electricity?
Make up a simple circuit including a light bulb. Test that it is working. Now place a small piece of the solid in the circuit and see whether the bulb lights.

Test E: Does it burn with a white flame?
Either by using tongs or by placing a small amount of the solid on a deflagrating spoon, heat the solid in a roaring Bunsen flame. Note whether it burns and the colour of the flame.
Safety: Magnesium burns with a bright white flame. If there is a white flame, DO NOT STARE at it; the bright light can damage your eyes. ⚠

Test F: Does it form a purple gas when heated?
Place a very small amount (no more than the size of a grain of rice) of the solid in a test-tube. Heat gently to start with. If nothing happens, heat more strongly. If a purple gas is formed, stop heating and place the test-tube in a test-tube rack to cool.
Safety: The purple gas is poisonous, so avoid breathing it in. ⚠

Test G: Is it attracted to a magnet?
Place a magnet close to the solid. Note whether the solid is attracted.