

	<i>Page</i>
1. Introduction	2
2. The Clues	3
3. Preparation before the day	4
4. On the day	5
5. The Mystery of the Missing Ming Vase : the story so far ...	6
6. Checklists	7
7. Safety Assessments	8
8. National Curriculum links	9
9. Answer sheet	10
10. Copying sheets	11
11. The Clues	
(a) More than meets the eye ?	12-14
(b) A permanent stain ...	15-17
(c) A Shoe Clue	18-21
(d) Hanging by a thread	22-26
(e) A plastic problem	27-29
12. The Court Report	30-32
13. Tiebreaker	33
14. Posters	34-44

“THE MYSTERY OF THE MISSING MING VASE” is an “off the shelf” package which industrial and academic chemists can take into local schools and use to promote chemistry to pupils. The target age is pupils in YEAR 8 (12-13 year olds).

This folder includes posters, worksheets, guidance notes and equipment lists that can be photocopied as required. The aim is to minimise the amount of preparation work needed by both the school and visiting chemists. The package is flexible and can be easily adapted to suit local circumstances and requirements.

The package was prepared by Lorraine Barrass (Allied Colloids), Siobhan Anarah (Glaxo Wellcome), Caroline Low (James Black Foundation) and John Way (Parmiter's School, Garston).

We would like to thank the pupils of Parmiter's School, Hertfordshire; Huntington School, York; and Wilmington Boys Grammar School, Kent, for their help and suggestions in testing the package. We would also like to thank Miranda Mapletoft of the Chemical Industry Education Centre at the University of York.



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Founded 1881
Incorporated by Royal Charter
1907

The pupils' part in the investigation

The pupils are to take the part of a Forensic Chemist investigating the clues. Five "clue stations" will be set up around the classroom. Groups of pupils can investigate three to four clues per group in a double lesson. They will record their findings on the work sheets provided and report back to the other pupils at the end of the lesson. This will give a complete picture of all the evidence to be considered.

The clues (also see individual worksheets)

The clues are all self-contained and may be investigated in any order. They should be set up as individual stations around the room, with three sets of apparatus for each clue so that the pupils can work in groups of two or three. The class can then be divided into 5 groups and each group allocated a clue to start work on. The pupils should be given 15 minutes to complete each clue before they move onto the next workstation.

More than meets the eye

Investigates a scrap of paper bearing a message written in invisible ink. The scrap of paper was picked up by the police at the scene of the crime and may match a similar piece of paper found on the suspect when he was arrested. The aim of the experiment is to reveal the message which links the suspect to the scene of the arrest.

A permanent stain

Investigates an ink stain found on the pocket of the suspect's shirt using thin layer chromatography (TLC). The ink is extracted from the material and compared to that from a pen found at the scene of the crime.

A shoe clue

Looks at specimens of rock collected from the suspect's shoe and a footprint found at the scene of the crime. Visual and acid tests are used to compare the two samples.

Hanging by a thread

Involves examining a piece of thread that was found caught on a broken window at the scene of the crime. Samples of thread from the suspect's clothing are also available for analysis using both visual and flame tests.

A plastic problem

Investigates the identity of small scraps of plastic found at the scene of the crime. Density checks, burning and copper wire tests are used to identify the type of plastic involved.

PREPARATION BEFORE THE DAY

The package is designed to allow 12-13 year old children to investigate some of the applications of chemistry in the wider world. This needs to be done with the full collaboration of the teachers in the school that you approach. The package has now been tested in a number of schools and we recommend that you recruit and brief *at least* three other volunteers, preferably one per clue, from your organisation to help you on the day. The aim is to minimise the amount of preparation work that needs to be done by the school and to have a sufficient number of people around for the pupils to be able question you about what it really means to be a chemist!

1. Read through the package and familiarise yourself with the material.
2. Liase with a local teacher to explain the background to the package and establish a suitable date/lesson time to visit the school.

Once you have established contact with a class you need to carry out a small amount of preparation before the big day. A complete checklist is included in the package, but do not assume that the school will have any of the equipment listed - *always check first*. Try to get the teacher to distribute the story beforehand so that the children have a good idea of the background before you start.

In each case you will need to prepare a number of labels for the experiments, but the following clues need some additional preparation before the day :

<i>More than meets the eye</i>	prepare the “secret writing” filter papers and give them enough time to dry.
<i>A permanent stain</i>	prepare the scraps of fabric with a blot of ink and test out the TLC method so that you know what the result will be before the pupils do the experiment.
<i>A shoe clue</i>	make up a 1M solution of HCl.
<i>Hanging by a thread</i>	cut short lengths of each type of thread.

You also need to photocopy all the worksheets and posters before you arrive at the school and issue a timetable for the day to both the school and the helpers.

ON THE DAY

It will take approximately 1 hour for 4 people to set up the package.

1. Put up the posters around the room and outside the classroom. Put the map at the front of the room with the sample of the forensic evidence underneath. You can put these in individual plastic bags and label where they were found if you want to add effect.
2. Set up the five clue stations with three identical sets of equipment at each station. Allocate a helper to each clue.
3. Divide the children into 5 groups when they first enter the class and allocate each group to a clue. Issue badges to the children and tell them to write their names on them for the benefit of the helpers.
4. Introduce yourself and your helpers to the class.
5. Introduce the storyline and explain the pupils' part in the investigation - this is much easier if the teacher has handed out the story beforehand. You need to tell them to fill out their answers on the Court Report, which is the formal way in which forensic evidence is presented when the case comes to court.
6. Start the children on the investigation. Each helper should briefly explain their clue and help the children as necessary.
7. Keep an eye on the time - allow 15 minutes for each clue.
8. Once the investigation is complete, ask each group of children to verbally summarise the results of their last clue to the rest of the class.
9. Briefly run through the answers, thank everyone and hand out any prizes/souvenirs that you have brought with you.
10. Tidy up !

The night was dark and stormy. It was 3 am and the clouds were skidding across the sky. Most of the inhabitants of Stansbridge were fast asleep and no one noticed as a silent figure made its way up the path leading to the Metropolitan Museum. If anyone had been nearby they might have heard the crunch of gravel beneath his feet, or heard the sound of breaking glass as the figure jumped in through the window and made his way to the display cabinet in the corner of the room. It was not until he broke the glass that protected the priceless Ming Vase from damage that the alarm was triggered. The sound was deafening and the figure paused only to bundle the vase into a canvas bag before he left the room the same way as he had entered.

The police arrived within five minutes, but the burglar had already disappeared into the darkness. He might have escaped unseen if it had not been for Old Harry the tramp who was roused from his sleep in the doorway of a shop on Trumpington Street by the sound of running footsteps coming towards him. It took the police a little time to establish that the Ming Vase was the only thing that had been stolen. The thief had clearly known what he was after and Inspector Thornton thought that he had probably stolen it to order. If this was the case then they did not have much time before the vase was passed on through unseen pairs of hands and disappeared from view. It was WPC Young who noticed the footprints outside the window and bent down to examine them closer. She also noticed a scrap of paper lying on the path. It did not appear to have anything written on it, but there seemed to be the trace of an indentation of the paper and she picked it up to show the Inspector. "Send it to the forensic laboratory" said Thornton "I want a complete search of this room and I want the report on my desk by yesterday morning, got that?" "You'll be lucky" retorted the constable "three of them went down with the 'flu yesterday and some of the others are looking a bit green today!"

The broken window yielded another clue when they noticed some fibres caught on the jagged edge of the glass and a careful search of the room produced a pen and several scraps of plastic. Each sample was carefully packaged and sent for analysis.

Meanwhile, it was down to the team to search for anyone that might have seen or heard anything unusual. They knew the precise time that the burglar had left and concentrated on finding witnesses who had been in the area at the time. DC Fowler was the first to think of Old Harry. He always slept in one of the doorways on Trumpington St. Could he have seen anything?

It was Harry's description that gave them their first lead and was instrumental in leading them to the Green Dragon pub. The vase had disappeared, but the police were sure that the suspect they arrested was involved in the robbery. How could they tie the evidence together? Had they got the right man? The race was on, but some help would be required to solve the Mystery of the Missing Ming vase and this is where you come in.....

A permanent stain

The ink may have come from this pen. However, the evidence is circumstantial until further experiments have been undertaken. The class should suggest further experiments they could do to establish this more firmly, such as fingerprinting the pen etc?

A shoe clue

The rock found on the bottom of the suspect's shoe is limestone and matches that found at the scene of the crime. There is also a limestone path leading up to the museum. This shows that the suspect was at the scene of the crime especially when tied to the evidence from *Hanging by a thread* (see below).

A plastic problem

The plastic sample is PVC. Whilst this clue was picked up at the scene of the crime, there is no obvious link between it and the suspect. This is one example of the many pieces of material presented to the forensic chemists which may, in fact, be of no relevance to the case.

More than meets the eye

The suspect was picked up at the Green Dragon Pub at 3pm. He did not have the vase in his possession and had presumably passed it on. However, the other half of the note found on his person does match the piece found at the scene of the crime. This clue is strong evidence that the suspect is guilty.

Hanging by a thread

The piece of cotton found on the broken window does match the cotton of the suspect's shirt, as does the inkstained sample used in *A permanent stain*. This is also strong evidence that the suspect is guilty.

Overall the forensic chemists have provided evidence that links the suspect to the crime. However, there were many other clues found which also require investigation. The class should realise how easy it can be to draw the wrong conclusions from the limited evidence that they have obtained.

CHEMICALS	Aqueous KOH (2g in 40ml of water) Aqueous FeSO ₄ (25g in 250ml of water) Ethanol 1M aqueous hydrochloric acid
GLASSWARE	Watch glasses Capillary tubes, or pipettes for making spots on the TLC plates 500 ml beakers 25ml dropping bottles
GENERAL EQUIPMENT	Filter paper Pasteur pipettes Microscopes and microscope slides Bunsen burners Tongs Fume cupboard(s) HB pencils Copper wire Sticky labels - for name badges and labelling samples Scissors Small polythene bags for samples
TEST SAMPLES	Fibre tip pens Scraps of cotton material - preferably an old shirt Rock samples (available from...) Thread samples (available at most haberdashers) Plastic samples (available from Aldrich and other chemical suppliers)

Teachers are responsible for ensuring that the pupils know the procedures for safe handling of the chemicals involved and are suitably equipped for all experimental work.

SAFETY GLASSES MUST BE WORN FOR ALL PRACTICAL WORK

CLUE	SUBSTANCES USED	RISK ASSESSMENT
<i>A permanent stain</i>	Ethanol Glass tlc plates	Flammable Sharp edges -handle with care
<i>A shoe clue</i>	HCl (1M aq)	CORROSIVE To be supplied in dropping bottles. A few drops are to be put onto rock samples on watch glasses.
<i>A plastic problem</i>		Pupils need to be warned of the dangers of heating plastics in a bunsen burner flame. A fume cupboard is ESSENTIAL for this experiment.
<i>More than meets the eye</i>	KOH solution (1M aq.) FeSO ₄ (0.4M aq)	CORROSIVE used by supervisors to write on paper for secret message. Pupils need to be warned not to rub the paper
<i>Hanging by a thread</i>		Pupils need to be warned of the dangers of heating cloth in a bunsen burner flame. A fume cupboard should be used for this experiment if possible.

Although this package does not constitute a full investigation, it relates to the areas in **Key Stage 3** of the National Curriculum (1995) noted below and may make a contribution to the development of the skills listed. Page references are to the Curriculum published January 1995.

**O v e r a l l
programme of
study
(Page 14)**

Pupils should be given opportunities to :

- 1 a** use practical tasks to acquire scientific knowledge, understanding and skills.
- 1 b** use both first-hand experience and secondary sources of information, and to decide which sources to use.
- 2 a** relate scientific knowledge and understanding to familiar phenomena and to things that are used every day.
- 3 b** consider how scientific knowledge and understanding needs to be supported by empirical evidence.

**Experimental
&
Investigative
Science
(Page 15)**

Pupils should be taught :

- 2 a** to use a range of apparatus and equipment safely and with skill.
- 2 b** to make observations to a degree of precision appropriate to the context.
- 2 c** to make sufficient relevant observations for reliable evidence.
- 2 d** to repeat observations where appropriate.
- 2 e** to record evidence clearly and appropriately as they carry out the work.
- 3 a** to present qualitative data clearly.
- 3 e** to use results to draw conclusions.
- 4 a** to consider whether the evidence is sufficient to enable firm conclusions to be drawn.

**M a t e r i a l s
&
t h e i r
p r o p e r t i e s
(Page 19)**

Pupils should be taught :

- 1 i** about methods, including chromatography, that can be used to separate mixtures into their constituents.

COPYING WORKSHEETS

You will need one set of worksheets for each pair within the team, but only one Court Report per team. Notes for the teachers and helpers are included after each clue.

1. More than meets the eye?
2. A permanent stain
3. A shoe clue
4. Hanging by a thread
5. A plastic problem
6. Court Report
7. Tie breaker

POSTERS

The following pictures should be blown up using a photocopier to make A3 posters and used to decorate the room.

1. The Mystery of the Missing Ming Vase
2. Wanted Poster
3. Stolen Poster
4. Map of Stansbridge - this is the map to which "More than Meets the Eye" refers.
5. Plan of the Metropolitan Museum - this shows the paths around the Museum and is referred to in "A Shoe Clue".

There are also individual posters for each clue station :

1. More than meets the eye
2. A permanent stain
3. A Shoe Clue
4. Hanging by a thread
5. A plastic problem

Court Report on the Burglary at
the Metropolitan Museum,
Stansbridge

Names of team members :

Date

Statement of Truth

You need to record your findings for each clue that you have completed. These results will be presented to the Court at the trial as evidence for the prosecution

A Shoe Clue

Description of exhibit

- The sample was found to match
- The sample was **not** found to match

This means that :

A Permanent stain ?

Description of exhibit

- The sample was found to match
- The sample was **not** found to match

This means that :

Hanging by a thread

Description of exhibit

The sample was found to match

The sample was **not** found to match

This means that :

More than Meets the Eye

Description of exhibit

The message reads

This means that :

A Plastic Problem

Description of exhibit

The sample was found to match

The sample was **not** found to match

This means that :

