PENCILS

A science investigation pack for teachers of 5-7 year olds

CENTRE *for* INDUSTRY
EDUCATION COLLABORATION

Contents

Introduction: Stories across the curriculum

CHOOSING THE BOOK

Curriculum areas

The main emphasis is on science linked with stories, and the suggestions for choosing a story given in chapter one also apply to this chapter. It is often possible to choose a storybook which also covers other areas of the curriculum. However, do not try to fit all curriculum areas into the story where it will appear contrived, and where links between activities are unclear to the children. An activity with a tenuous link may not provide children with the same motivation and purpose for carrying it out.

When deciding on the number of areas of the curriculum to incorporate, you should also consider the school development plan and the time available for the activities resulting from the story. With limited time it may be necessary to link only 1-2 other curriculum areas. Similarly, the term's topic focus may be history, in which case linking only history and science to the story may provide sufficient activities.

There are some areas of the curriculum which provide generic activities to link with stories. For example, a technology activity can be to design and make a 'pop-up' version of the story in question; an English activity can be to re-tell the story in the children's own words; and a combined English and information technology activity can be to design and make a questionnaire to collect children's opinions of a story/ author/illustrator, etc. and collate the information on a database.

Illustrated example

The storybook Grandfather's Pencil and the Room of Stories by Michael Foreman has been selected to provide an example of how a story can be used as a stimulus for cross- curricular work. The remainder of this chapter describes suitable activities for use with 5-7 year olds.

Unlike Princess Smartypants, this story is too long to read to most 5-7 year olds in one story session. Choose suitable 'stopping points' according to which activities you intend to carry out with the children.

ACROSS THE CURRICULUM WITH GRANDFATHER'S PENCIL AND THE ROOM OF STORIES

Book choice

A well-known illustrator of children' books, Michael Foreman, has written this story as well as bring the story to life with beautiful artwork. The story has a strong imaginative element and can inspire activities for children to do in many areas of the curriculum. The activities chosen for this chapter are summarised in the table opposite.

Science & technology activities

These activities are linked, and all take a closer look at the manufacture of pencils. Activities are therefore described in the most logical, chronological order - thus mixing science and technology activities together. The key ideas covered are listed under each activity heading.

How pencils are made

An informative book 'Making Pencils' priced £2.99, is available from The Cumberland Pencil Museum, Southey Works, Greta Bridge, Keswick, Cumbria, England, CA12 5NG. The process for making coloured pencils is described using text, which can be read aloud, and a series of colour photographs. To arrange a visit to the Pencil Museum in Keswick, telephone: 01768 773626, or them at email: info@pencils.co.uk; website: http://www.pencils.co.uk.

Activity summary

Title	Description
making pencils	follow a recipe to make a pencil lead
soft or hard?	sorting a wide range of objects, before looking at
best glue for wood	use range of glues on blocks of wood to test
transportation in water	which materials float or sink
making paper	follow a recipe to make recycled paper
survey on colour choice	use of survey sheet to find others' opinions
history activities	ideas for discussion, interviews and practical tasks based on pictures in the storybook
geography activities	discussion of town development, locating countries of origin for pencil ingredients and transporting materials
art activities	use of illustrations in the storybook as the starting point for discussion of colour and various painting tasks
other curriculum areas	list of suggestions which teachers may choose to develop

1. Making pencils

Some simple instructions so that children can make their own coloured pencils.

OBJECTIVES

- To describe the simple physical properties of ae variety of everyday materials To identify and compare the suitability of a variety of everyday materials for particular uses.

A teacher, teaching assistant or parent helper should support this activity.

RESOURCES

- pencils
- clay
- iron oxide[1] or powder paint[1]
- sealable plastic bag
- cellulose paste
- small teaspoon
- dessert spoon
- painting aprons
- paper towels

Optional extension:

- candle wax (household candles)
- cooker hob
- old metal or glass dish (to melt wax in)
- pan of water

1 Iron oxide produces brown pencil leads that write on paper. It is available from pottery suppliers, or could be obtained from a local friendly secondary school. Powder paint offers a wider variety of colours, but the leads can only be used on surfaces such as concrete or brick - thus making 'playground pencils' for playing hopscotch, etc.

KEY IDEAS

- Pencils are made from a mixture of things
- Coloured pencils are made from clay, paint, wax, glue and wood
- Pencil leads can be made by following a recipe.

In preparation for the activity, make a large copy of the recipe, given overleaf, and attach photocopies of the drawings beside the appropriate stage. Display labelled samples of all the ingredients on a table top below the illustrated recipe.

Quantities have been simplified for the children's use. About 30 g balls of clay should be used, which equates approximately to a 3 cm diameter ball. The 'big' spoon is a level dessertspoon, and the 'small' spoon is the teaspoon.

The cellulose paste must be mixed 10 minutes before the lesson. One level dessertspoon of powder added to a pint of water gives a suitable consistency.

teacher of 5-6 year olds
Dunfermline

I used the 'making pencil' illustrations along with captions. Some children could read the captions, while most followed the illustrations after discussion.

At the start of the activity ask the children what they think a pencil is made from. Many will already be familiar with wood (this is looked at in activities on, but few children will know what is inside the casing. Some may know it is called the 'lead'.

Tell the children that the lead is a mixture of ingredients, and that a recipe is needed to make one. Groups of children then make their own leads by following the recipe and with adult guidance.

Depending on the thickness of each lead, the recipe will make about three 8-9 cm pencil leads. Therefore 3 children can work together. They can make extra leads with any remaining mixture.

Pencil lead recipe

Ingredients

big spoon of powder (paint) ball of clay, like a big marble small spoon of paste

1. Put all ingredients in a bag.
2. Close the bag.
3. Squash them together.
4. Turn bag inside out, onto your hand.
5. Scrape mixture off the bag.
6. Roll into a lead shape.
7. Leave to dry overnight.

If using powder paint, each group can choose their own colour of pencil lead. The mixture should resemble 'crumbly' plasticine when taken from the bag, so it can be moulded in the palm to fully mix in the colour. Disposable gloves can be worn, though the colour from the mixture does wash off with soap and water.

Dry the leads overnight on paper towels.

Waxing the leads - optional stage of activity

This mimics the next stage of the lead-making process. It must be done by an adult, either at home or on a school hob where children can watch the start of the process from a safe distance. Half fill a bowl or biscuit tin with candles and place over a pan of boiling water. When the wax has melted, lower the leads (except spare leads made) into the wax, making sure they are submerged. Leave the leads to soak in the wax, over the boiling water, for 3-4 hours.

Note: Do not let the pan of water boil dry.

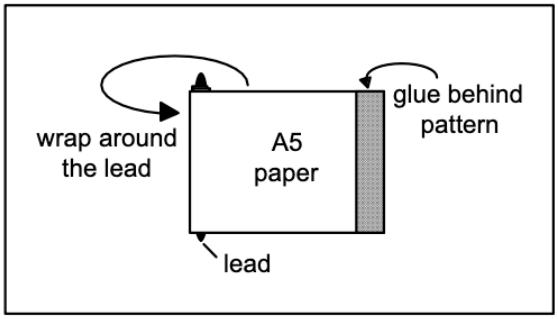
Using an old draining spoon, carefully remove the leads from the molten wax. Spread them out on paper towels to drain off as much excess wax as possible. Leave the leads overnight to dry.

Unsoaked and soaked leads can be compared by drawing with them. The soaking process is intended to prevent the lead crumbling or snapping when in use. The terms 'hard' and 'soft' can be discussed before carrying out the next activity.

Safety Note

Children must not handle, or come near, the pan of boiling water.

Each child designs a 'wrapper' for their pencil on an A5 sheet of paper (the width may need cutting to fit the pencil lead). The design takes up the 3-4 cm of the paper (as shown below), which is visible after wrapping around the lead. Children may choose to simply colour the strip to match the colour of the lead, or create a design. Add glue to the paper on the back of the coloured section, and wrap around the pencil.



The pencil is now ready for each child to test.

teacher of 5-6 year olds
Dunfermline

We had fun decorating the concrete slabs on the path in our Conservation Area.

SOFT OR HARD?

Key ideas:

- The words 'hard' and 'soft' can be used to describe and group items
- Hard things can be graded further
- Pencil leads vary in how hard they are.

Preliminary sorting can be done using a wide range of everyday objects. Suggestions are listed in the 'Resource ideas'. Initially, ask children to sort the items into P.E. hoops which have been labelled 'hard' and 'soft'. These hoops can be overlapped for more able children, so items which have hard and soft parts can be placed in the overlapping area.

After discussing this initial task, ask the children:

- Can the hard things be sorted again?

Then challenge the children to line up all the items from softest to hardest. This can be done by positioning items along a line or metre ruler labelled 'hardest' at one end and 'softest' at the other. Children may disagree about the finer detail of this sorting, which can lead you to show children a simple 'hardness test' for sorting hard things. Children push their thumb nails into the surface of an item. If a mark is left, the material is soft and if a mark is not left, the material is hard. Children can now sub-divide the materials into 4 categories, which could be 'very soft,' 'soft', 'hard', 'very hard'.

Resource ideas:

items for sorting can include pencils, chalk, coins, scissors, plastic pots, candles, stones, rulers (wooden and plastic), balls, clay pots, blu-tack, sponges, books, paint brushes, etc. variety of wood types (if available) variety of pencils, HB, H, 2H, B, 2B, etc.

Children now explore the hardness of pencils. They will find that the wood is quite soft, but the lead is hard. They may also notice that the wood used to make a pencil is softer than the wood used to make a ruler. This is because a soft wood is chosen so that it is easy to sharpen.

If available (from a joiner or the technology department of a secondary school), display wood blocks with pictures of the trees from which they come. The display could also include slices of tree, bark, logs, wooden carvings, etc. Allow children to handle the blocks, and try another simple hardness test on each one. This is done be scraping the corner of one block on the face of another. If the face of the block is scored, then it is a softer wood than the one used for scraping. Some woods will be clearly softer than others. The range can include jelutong, pine, oak, beech, cedar and mahogany.

Children also explore the hardness of different pencil leads by making patterns using HB, H, 3H, B and 3B pencils. They will feel and see the difference that each lead makes, for example:

Hard leads have a greater tendency to snap when sharp, and also produce finer lines than soft leads. The pencil in the story produces 'a lovely, soft line'. Ask the children if they know what sort of pencil this might be, e.g. a 2B pencil.

Activity Sheet 1: Pencil recipe illustrations

1.

2.

3.

4.

5.

6.

2. Using wood in pencils

Children consider how wood is transported and how wood is stuck to pencils.

OBJECTIVES

- To describe the simple physical properties of a variety of everyday materials

BEST GLUE FOR WOOD

Key ideas:

- Some glues are more effective than others at sticking wood

Resource ideas:

wood pieces (off cuts)
blu-tack sticky tape
range of adhesives, e.g. PVA glue, cellulose paste, Pritt stick, UHU glue, balsa cement, etc.

Describe to the children the way in which pencils are made, i.e. the lead is glued between two wooden pencil halves. The book 'Making Pencils' illustrates this process. Children can examine pencils closely to try and find the join.

Using small off cuts of wood, the children are asked to find out which is the best glue for sticking two pieces together.

To encourage fair testing, children use the same amount of glue each time (e.g. a teaspoonful), spread over the same area, and left to dry for the same length of time.

The children can test the strength of the join by simply trying to pull the two pieces of wood apart.

This activity can be extended to include sticking other materials together, e.g. paper to wood, card to card, etc. Children should find that different adhesives are suitable for sticking different materials together.

TRANSPORTATION IN WATER

Key ideas:

- Some materials float in water whilst others sink
- Logs are transported in water because wood floats

Resource ideas:

plastic tank or similar
watering can
objects representing a range of materials, e.g. pencil, rubber, pencil sharpener, paper, sponge, ruler, rubber band, table-tennis ball, scissors, paper weight, feather, marble, comb, etc.
plasticine
piece of guttering

Children begin by investigating a range of objects, finding out whether they will float or sink. This can be done by prediction, backed up with reasons, followed by observing what happens when each object is placed in the tank of water.

Show children the picture in the story again, which illustrates the means by which large logs are transported from the mountains down river.

Ask the children to find out if any other materials can be transported in a similar way. Set up a piece of guttering (obtained from DIY stores), to act as a river. Hold the guttering in place at a slight (5°) angle with large lumps of plasticine. The 'river' can flow from a watering can, down the guttering and into a large water-play tray. Predictions made should have improved after carrying out the floating and sinking activity. Objects can be added to the water to find out which will move to the end of the river.

3. Making paper

Children think about the importance of recycling and follow simple instructions to make their own recycled paper.

OBJECTIVES

- To describe the simple physical properties of a variety of everyday materials
- To identify and compare the suitability of a variety of everyday materials for particular uses.

KEY IDEAS

- Paper can be recycled
- A 'recipe' is used to make recycled paper

Resource ideas:

paper (printer paper, newspaper or shredded paper) packet of paper towels muslin embroidery ring food colouring essential oil - optional (e.g. from Body Shop) hand whisk instant starch bucket rolling pin electric iron

Recycling is a theme in the story, e.g. the bedroom's wooden floorboards from the ship, and the paper woven into the bird's nest. These examples can be discussed before asking the children if they can think of other things which are recycled today, such as milk bottles, newspaper, glass, plastics, paper, drinks cans, etc.

A display can be made of 'new' and recycled paper products, e.g. kitchen roll, toilet roll, writing paper and envelopes. The recycled and new products can be compared in terms of colour, texture and cost.

This novel paper recipe produces circular paper, which can be coloured and perfumed. Rectangular paper can be made using wire mesh (available from Halfords).

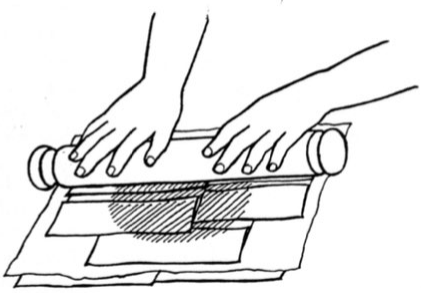
Copy a shortened version of the recipe, shown overleaf, onto large paper. Add photocopied drawings to the recipe beside the appropriate stages. An adult can provide additional support for children to complete the recipe.

Quantities given in the recipe are a guide. Accuracy is not essential.

Samples of all the ingredients and utensils can be labelled and displayed on a table top below the illustrated recipe.

Note: *Mixing the pulp in a liquidiser producers a very fine pulp, but leaves the machine black with print. Therefore, use only a liquidiser that won't be used for food!*

Children can use the paper to write letters, poems, etc. or draw pictures. Alternatively, the paper is compared with school paper for strength (how easily does it tear) or absorbency (does the ink spread when you write with a pen).



This recipe will produce approximately 4-5 sheets of paper per medium-size embroidery ring.

Paper recipe

Ingredients

4-5 sheets paper (50 g)
4 plastic cups water (800 ml)
1/2 - 1 teaspoon food colouring
5-10 drops essential oil
1 tablespoon instant starch

1. Tear paper into tiny pieces, if not pre-shredded.
2. Using a spoon, mix the paper and water in a bucket.
3. Finish the mixing with a hand whisk.
4. Mix in the perfume and colouring.
5. Place the muslin in the embroidery ring.
6. Spoon the pulp onto the muslin and squeeze out the water, using the spoon then paper towels.
7. Remove muslin and paper from ring and place between paper towels to roll out excess water. Repeat as necessary.
8. Iron (on a warm setting) the paper towel 'sandwich', peel out the paper and dry for 24 hours.

Safety Note

An adult must iron the paper and children can observe.

Activity Sheet 2: Paper recipe illustrations

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2.

3.

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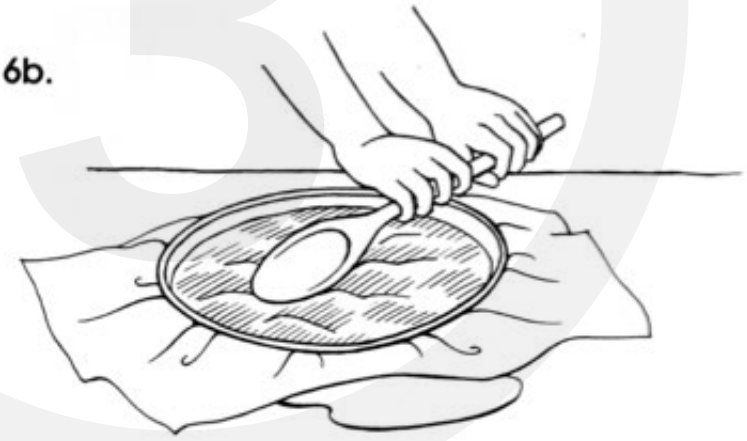
6a.

Activity Sheet 3: Paper recipe illustrations

6b.



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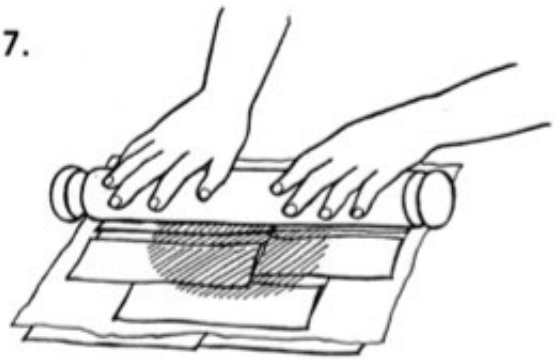


8a.

8b.

4. Cross curricular suggestions

Some suggestions for linking the story to other curriculum areas.

SURVEY ON COLOUR CHOICE

Companies carry out surveys (market research) with members of the public, to find out preferences for the order of coloured pencils in a transparent packet. Details are given in the book 'Making Pencils' (see page 16).

Children carry out their own surveys to find out preferences for colour arrangements. The colours of pencils could be limited to 3- 4 to reduce the number of possible colour combinations, or children could simply choose 6 colour combinations they like, and gather data on these.

Children design their own questionnaire, or one can be given to them to complete with others. Pages 37-39 can be photocopied for this purpose. Page 37 shows all the combinations of a red, orange and yellow crayon. Page 39 allows children to choose 6 combinations of colours. Children colour the pencils appropriately before completing the survey. They can produce a class bar chart to show the popularity of the different colour combinations.

Alternatively, data can be gathered to enter into a database. The information is then sorted and computer-produced lists, bar charts, etc. obtained. Each child gathers information from two people - themselves, and a brother, sister, or child in another class. For this data collection, modify pages 37 and 39 to suit the format of the database.

For example:

- Replace the sentence 'Tick the order you like best' with 'Write your name under the order you like best.'
- Add a box to the back of the sheet for each person to complete:

name_____	name_____
circle your age:	circle your age:
5 6 7 8	5 6 7 8
9 10 11 12	9 10 11 12
13 14 15 16	13 14 15 16
boy ☐	boy ☐
girl ☐	girl ☐

HISTORY ACTIVITIES

As the majority of the book is set in the past, you can discuss the historical features with the children. Suggestions for questions to form the basis of discussion are listed below:

- What clues are in the pictures which tell us that the boy lived in the past?
- How has Jack's bedroom changed since his grandfather was a little boy?
- How has the area outside Jack's house changed since his grandfather lived there?
- Will a pencil factory be quiet, like the pencil workshop described in the story? Why? What sounds do you think you would hear?
- This is a story. How could you find out whether Michael Foreman has written about Jack's grandfather's time as it really was?

Children compare two pictures and list similarities and differences. Interesting pictures are (1) the bedroom opposite the workshop compared with the bedroom with spacecraft models and (2) the house and surroundings in grandfather's time compared with Jack's time.

(1) the bedrooms

Differences		Similarities
old	new	both
picture of ship	model rocket	globe
picture of soldier	model jet aircraft	paper
bottle of ink		pencil
bedroom chest		

(2) the house and surroundings

Differences		Similarities
old	new	both
horse & carriage	pleasure boat	bridge
old style of car	car park	house
old style of bus	blocks of flats	bridge lights
	modern style of car (taxi)	
	modern style of bus	

To answer other questions above, children can carry out a range of activities, such as:

- Talk to elderly people (relations, friends of the school) about life when they were young, asking questions accompanied by pictures from the storybook, and asking additional questions about home life, the war, etc.
- Talk to people (relations, friends of school) who work in factories about noise levels and working conditions
- Use the book 'Making Pencils' to look at pictures of modern pencil making factories
- Look at stationery/art suppliers' catalogues to compare with the things in the old art shop
- Compare photographs and pictures in history books with those in the storybook, and find out in what period the book is based.

GEOGRAPHY ACTIVITIES

- Compare the two pictures in the story which show Jack's house in both his own and his grandfather's time.
- Discuss the way in which the buildings have grown up around the house, and for what purpose the buildings might be used. Draw their attention to the multi storey car park and the other buildings - which are probably offices and people's homes in high-rise flats.
- Locate countries on a globe or a world map, showing all the countries which supply ingredients for making pencils. For example, the Cumberland Pencil Factory obtains its ingredients from the following countries (all listed in the book Making Pencils):

Country...	Supplies...
California, USA	wood (slats)
Great Britain & Germany	clay & pigments
Iraq & Iran	gum (glue)
Brazil, The Czech Republic & Japan	wax

Graphite for writing pencils comes from Sri Lanka, China and Korea.

Once the countries have been located, discuss how and why each ingredient is transported to Cumbria, e.g. by road, ship, train, etc. Pictures can be drawn by the children, showing the load in transit, or can simply be cut from magazines. (The ingredients are actually transported from overseas by boat and overland by road.)

Display a sample of each ingredient, or the equivalent available in school, around a large world map on a wall. Use coloured wool to connect the ingredients to each relevant country. Pictures of the mode of transport can be displayed below each ingredient, e.g. ships for the wood, trains or lorries for the clay, etc.

ART ACTIVITIES

An activity in which children experiment with different types of **pencil leads** has already been described on page 20. Although described as a science activity, this can be further developed as an art activity. Children create patterns using the different thick and thin, soft and hard lines. They also try shading with different types of pencil, shading overlapping shapes to produce a range of blacks and greys.

Colour is an important element of Michael Foreman's book. Discuss this using some of the following questions:

- What colours are used most /least in the book?
- What colours does Michael Foreman use to show night time? Why doesn't he use black?
- How does he show the sunrise? Why?
- How are trees in the background different to those at the front?
- Which things are brightly coloured (yellow, red)? Why do you think this is?
- Is any white paper left unpainted? How would this change the picture?

As a result of discussing these questions, children can do one or more of the following painting activities:

- Experiment in mixing watery shades of one colour, such as blue, green or brown
- Paint a background using only two thinly mixed colours, say blue and green, and (when dry) add grandfather's house and the bridge to the background, starting with pencil, and then painting in with the same colours as shown in the book
- Paint a forest on blue sugar paper by painting small blue background trees, allowing these to dry, then painting green-leaved foreground trees
- Paint a sunrise, using yellows, oranges and reds (leaving no white paper)

The pictures children have made of the house and bridge can have 'overlays' made to show the modern buildings. Children use coloured pencils to reproduce the multi storey car park and office blocks. These are cut out and stuck on some of the children's drawings, to display beside others.

OTHER CURRICULUM IDEAS

As mentioned, you must decide on the number of curriculum areas and activities which children will do, avoiding tenuous links and considering the priority subjects for the term or topic.

Teachers have suggested a number of activities which may be incorporated into a topic based on the book, and these are listed below:

- Animals' habitats
- Animals which live in a forest
- Day time & night time animals
- Types of trees
- Nest building and the materials used
- Day and night, sun and moon
- Light and dark, shadows, sources of light
- The wind and its effect on paper (can you make a piece of paper fly?) and the sails of a ship, kites
- Methods for picking up something from a narrow crack
- Making boats
- Natural and synthetic materials
- Range of materials which 'make marks', e.g. stones, chalk, etc.
- Waterproofing
- Writing the paper's story
- Designing and making a pencil holder
- Designing and making 'pencil people'.

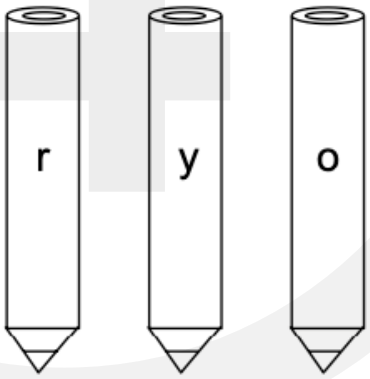
VISIT A FACTORY

The manufacture of many products is based on the principles described above for making pencils, i.e. using recipes and monitoring the quality of products. It may be possible for children to observe manufacturing processes first hand by visiting a local factory. The product should be something familiar to the children, e.g. ice-cream, crisps or biscuits. Contact the manufacturer to find out if they conduct tours, and to ask about regulations for school visits, and the number and age-range of children they are willing to invite.

Activity Sheet 4: Colour order Survey

Tick the order you like best.

r = red y = yellow o = orange



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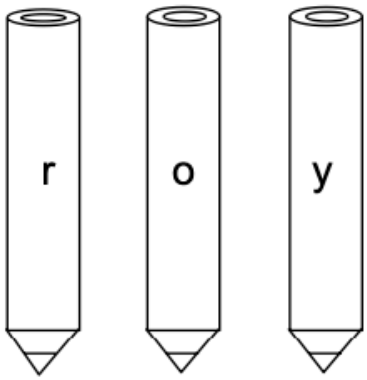

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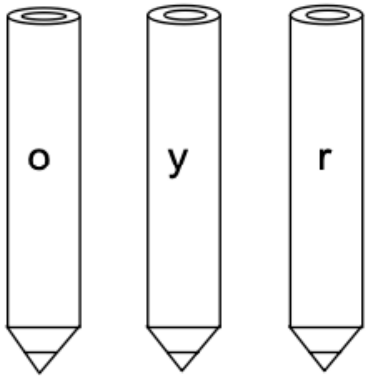

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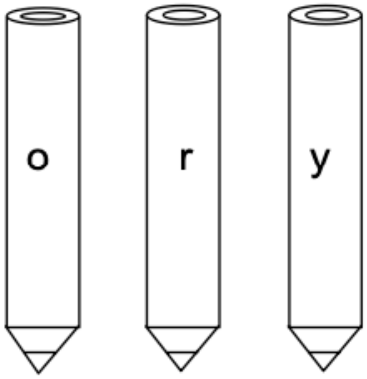

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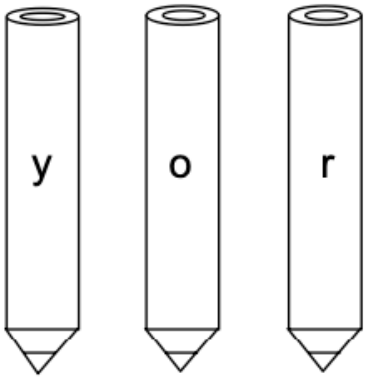

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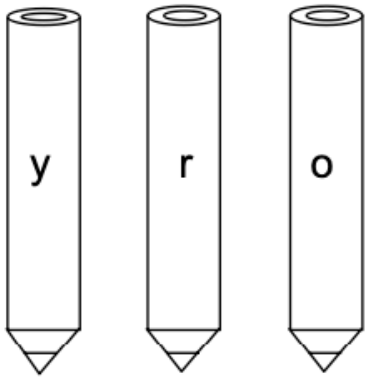
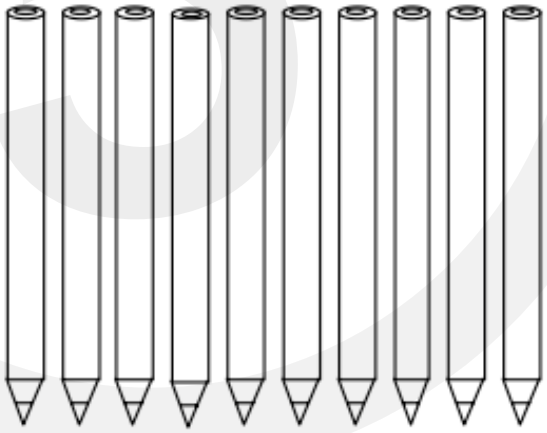


6. ☐

Activity Sheet 5: Colour order Survey

Tick the order you like best.



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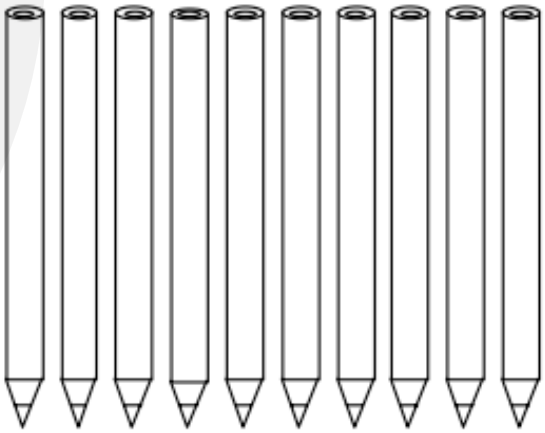
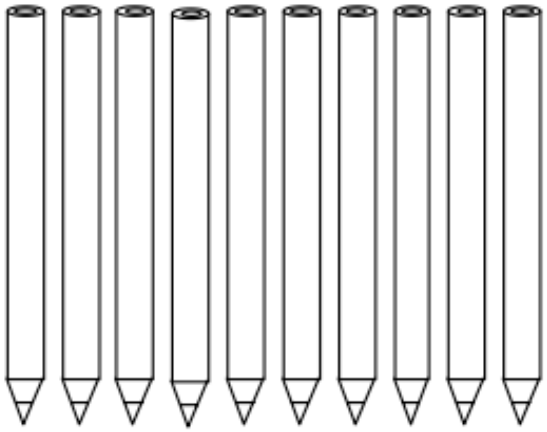


2. ☐



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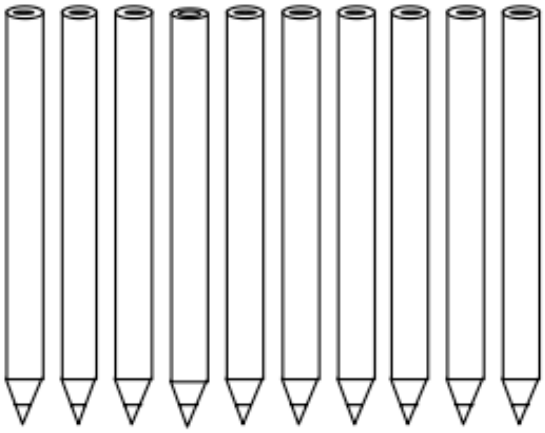

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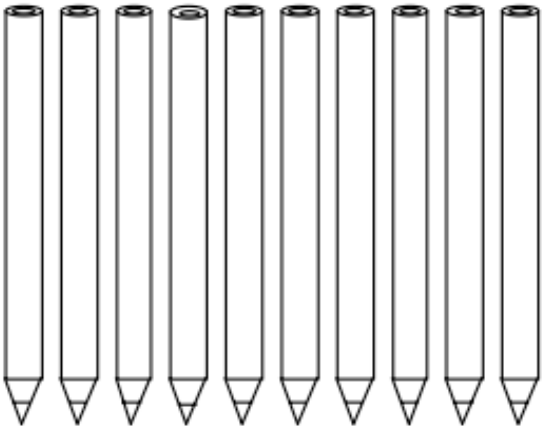

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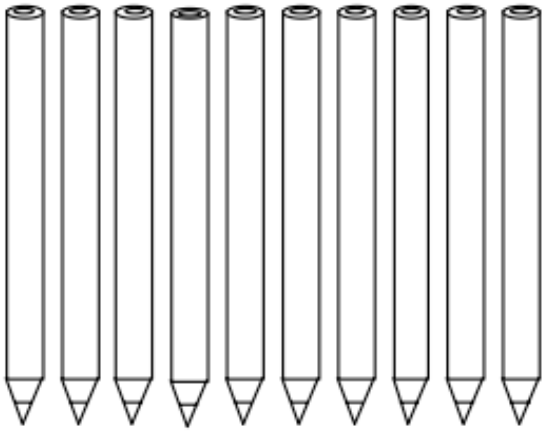

6. ☐

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