SECTION THREE: STUDENT ACTIVITIES

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GRIDSHEETS:

- cm squared paper ........................................... 121
- cm squared dotty paper .................................... 122
- cm isometric paper ........................................ 123
Colours
Student material

Choose four colours.

*Copy this pattern and colour it in, using a different colour for each piece of the pattern;*

You have now found one way to colour the pattern.

*How many different ways can you colour it?*
Colours

Teacher material

National Curriculum levels 2–9

*Equipment:* Squared paper (p.121), colours

This investigation encourages students to be systematic.

Some students may interpret ‘ways of colouring’ as meaning using dots or stripes. When students begin the investigation, make sure that they understand that ‘ways of colouring’ means different *arrangements* of colours.

You might like to suggest that when students have as many solutions as possible, they can arrange them to make a wall poster.

Using combinatorics, there are 24 different ways to colour the design.

*Extension:* Students could invent their own designs to work on.

This could lead to an investigation of the relationship between the number of spaces to be coloured and the total number of possibilities.
Cone Code Worksheet
Student material

Decode the message by cutting out and assembling the net of the cone.

Try to make your own cone codes.
Cone Code Worksheet
Teacher material

National Curriculum Levels 2-10

Equipment: Scissors, glue, card or stiff paper

This activity is a good introduction to practical work. It is best done individually.

The low attainers may need to use the cone net on the worksheet as a template for their own nets. Most students should be encouraged to draw their nets using ruler and compass.

Initially most students will need to make a cone and write the message on the constructed cone, in order to produce a cone code. When they have had some practice at this they should be encouraged to try to write the message on the net first.

Extension: What is the plan (bird's eye) view of a cone? How can images be drawn on the cone to produce vertical lines and horizontal lines in various places on the plan view? How are these images transformed when the cone is opened out into its net? What are the inverses of those transformations?
Digit Add
Student Material

Start with any 2-digit number.

Add the digits together.

Take this answer away from the number you started with.

Do this for other numbers.

What do you notice?

Try 3-digit numbers
... 4-digit numbers

Dotty Triangles
Student material

This triangle is 4cm tall.

1. How many dots are there on the perimeter of this triangle?

2. How many dots are there inside this triangle?

3. How many dots on the perimeter and inside altogether?

4. What is the area of the triangle?

Do the same for these triangles:

Choose one question to investigate for bigger triangles.

Can you find any rules?
Digit Add

Teacher material
National Curriculum levels 2–10

Equipment:
Calculators (optional)
This activity will lead most students to a generalisation fairly quickly. It is a good investigation for students who are not used to investigating. Here is a list of possible outcomes, from easiest to hardest:

- Noticing that the sum of the digits in the answer is always 9
- Noticing that the answer is always a number in the three times table i.e. divisible by three
- Noticing that the answer is always a number in the 9 times table, i.e. divisible by 9
- Producing the explanation in words of why the answer is a multiple of 9
- Producing an algebraic proof of this

Extension:
Make your own rules for using the digits of a number to produce a result. Can you find any number patterns using your rules?

Dotty Triangles

Teacher material
National curriculum levels (3–) 4–10.
Students working on level 3 may have difficulty with the area question. They can investigate successfully at their own level without using this.

Equipment:
cm squared dotty paper (p.122), ruler
This activity leads to an early discovery of number pattern from a geometrical situation. Some students may need the meaning of the word perimeter explained.

- The number of dots on one edge of the triangle is one greater than the length of the side shown.
- The number of dots around the edge of the triangle is three times the length of the side shown.

The activity can lead to the exploration of triangle numbers and in some cases square numbers. High attainers can be expected to produce algebraic solutions.

Where n is the length of the side shown:
Dots around the edge = 3n
Dots inside = \( \frac{(n - 1)(n - 2)}{2} \)
Dots altogether = \( \frac{(n + 1)(n + 2)}{2} \)
Area = \( \frac{n^2}{2} \)

Extension:
Try this for different shaped triangles.
Estimating and Measuring Length

Student material

This activity is about drawing lines and guessing how long they are. You will work in a group. Each of you will draw some lines of your own.

Choose how long you want your lines to be and draw them.

Write down how long they are on a separate piece of paper without letting the others see it.

Put your rulers away, and the piece of paper which says how long the lines are.

Now pass round your papers which have the lines on.

Guess how long the lines are. Write your guesses down.

Keep passing papers round until you have guessed the lengths of everyone's lines.

Now compare results.

Fiona Frog

Student material

Fiona Frog is at the bottom of a well 10 m deep.

Each hour she climbs up 1m then falls back 0.5m.

How long is it before Fiona is out of the well?

What about different depths of wells?
Estimating and Measuring Length

Teacher material

National Curriculum levels 3-7

Equipment:

Plain paper, pencil, eraser, cm and mm rulers

This activity is practical and collaborative. It provides a stimulating situation for students to practice accurate drawing of lengths, and estimating.

Students will discover that they need to label their lines. Different students in the group may use different measures both for labelling and for estimating; some may use integers, only some may use halves and some decimals. This is likely to stimulate discussion in the group. Students could learn from one another about cm and mm and about decimals to one decimal place. All the students will improve in their estimates as they get more practice. Any student who is not fully confident in using a ruler for measuring will gain confidence from this activity.

Fiona Frog

Teacher material

National Curriculum levels 4-10

This activity can be regarded as an investigation for most students. However, for higher attainers it is merely a puzzle which they should solve quite quickly.

Higher attaining students may calculate that Fiona progresses at a rate of 0.5m per hour and that it will therefore take her 20 hours to cover 10m. This is not the answer. The 19th hour will see her out of the well, and, as she is out, she does not fall back.

Having realised the catch these students should solve the puzzle for different depths of wells quite quickly.

Average attainers and those just below average will discover this result by recording Fiona’s progress in incremental stages. When the answer 19 is found, students investigating wells of different depths will find some short cuts, and most should be able to come up with some sort of rule for predicting how long it will take Fiona to get out, given the depth of the well.
Flow-Chart
Student material

Think of a number between 0 and 10

add 10

double it

is it over 100

yes

subtract it from 200

is the number you've got over 70?

yes

Write it down

no

no

Investigate the outcome from this flow-chart using different starting numbers.

What happens if you change '70' to a different number?

Investigate.
Flow Chart
Teacher material

National Curriculum levels 6–10

*Equipment:* Calculators (optional)

This activity is particularly suitable for collaborative work, as students can share the burden of generating results.

Students must take care to keep track of where they have got to in the flow-chart. They will need to devise a logical method for keeping a record of their results.

There are many number patterns in the sequences produced. Students should make sure they have exhausted the possibilities of this particular flow-chart before they start changing ‘70’ to a different number.

*Extension:* Can you write a computer program to generate the results for this investigation?
Lift Regulations

Look at these regulations:

Maximun Load

8 persons

640kg

How many children could use the lift at the same time?

Would it be safe for 8 fully grown men to use the lift at the same time?

Links

Draw 5 dots.

Draw the largest number of links you can, joining the 5 dots. (Links must not cross each other.)

Can you arrange your dots differently to increase the maximum?

When you are sure you have the maximum number of links for 5 dots investigate for different numbers of dots.

Can you find a rule to work out the maximum number of links for any number of dots?
Lift Regulations
Teacher material
National Curriculum level 4–10

Equipment:
Bathroom scales, calculator

This problem-solving activity poses a question, but does not give students any guidance on how to solve it. They have to decide for themselves what to do.

Most students will weigh some people and do calculations based on those weighings.

Encourage students to write down: the results of their weighings; any assumptions they make and their calculations.

Extension:
How many people could use a lift whose maximum load is 100kg?
Can you write a rule to determine the number of people, given the maximum load in kilograms?

Links
Teacher materials
National Curriculum levels 2–10

Equipment:
Rough paper, ruler, pencil, eraser

For this activity there are direct instructions to follow. It can therefore be used with students not used to investigating. It is very good for encouraging the technique of trial and improvement.

Students should be encouraged to try out rough drawings freely and then to write a clear statement when they think they have found the maximum. If they subsequently decide that this is not the maximum, encourage them to write a new statement presenting the evidence, but not crossing out the earlier one. Students may think the maximum number of links produces the series of odd numbers.

Are the maxima really the multiples of 3?

Extension:
What happens if lines are allowed to cross?
Loopy Numbers
Student materials

Here is the rule for making Loopy Numbers:

Start with any number.

Divide by three, if you can.

Otherwise, add sixteen.

*Example*

\[
5 \rightarrow +16 \rightarrow 21 \rightarrow +3 \rightarrow 7 \rightarrow +16 \rightarrow 23 \rightarrow +16 \rightarrow 39 \rightarrow +3 \rightarrow 13
\]

What happens if you carry on?

Choose different starting numbers and investigate what happens, using the rule for Loopy Numbers.
Loopy Numbers
Teacher material

National Curriculum levels 2–10

Equipment:

Calculator, plain paper

This activity can be done collaboratively. Individual students can choose different starting numbers and share their findings. It is a good activity for practice in generating results and being systematic.

The activity is also useful for the practice of arithmetic and in increasing familiarity with whole numbers.

Students will learn to recognize whether or not a number is divisible by three.

The results of the investigation are loops of numbers. Lower attaining students are likely to produce lines or chains of numbers, as shown on the student material. Most students will notice that chains contain either all odd or all even numbers. It may take them some time to realize that the numbers are repeating.

Other students will draw the results as a loop. They may draw many loops, some containing the same numbers.

Higher attaining students will realize that loops which contain the same numbers can be combined by showing other ‘feeder’ numbers on the same loop.

\[ e.g. \]

\[ \]

If many large numbers are included, the loops become small in relation to the ‘feeder chains’. The results will be look more like trees.

\[ e.g. \]
Mathematics Trail

Teacher material

There is no student material for this activity

National Curriculum levels 1-6

Equipment:

Clipboard, paper, pencil, plastic bag

Everywhere in the world around us we encounter mathematics—symmetry being one of the most notable forms. If you are fortunate to have a maths trail of your locality, prepared by a local teachers’ centre, it is appropriate to take 1st years on it, even if it was originally prepared for primary children.

If no such prepared trail exists, and you do not have time to prepare one yourself, there can be benefits in preparing your students generally for what to look out for in the environment, then taking them out for a short walk to see what they themselves can discover.

Prepare students by giving them one example of reflective symmetry, one example of rotational symmetry, and one example each of numbers as label and numbers as measures.

Here is a list of the sorts of examples which students might find:

Reflective Symmetry
— in buildings;
— in parts of buildings e.g. doors, windows, etc.;
— in leaves;
— in pavements;
— in street furniture, e.g. lamp-posts, bollards.

Rotational Symmetry
— in some architectural decorations on buildings
— in high street logos, e.g. NatWest sign.

Numbers as Labels
— as bus numbers;
— as prices;
— as fire hydrant numbers;
— as house numbers.

Numbers as Measures
— as heights of overhead bridges in metres;
— as vehicle lengths;
— as van or lorry payloads
— as time restrictions on bus lanes;
— as parking information;
— as percentage information in the windows of building societies.
Measuring Small Thicknesses

Student material

Can you measure the thickness of a piece of paper?
If you had a large pile of paper, a ruler and a calculator you could:
— measure the height of the pile;
— count how many papers there are;
— divide the height of the pile by that number.
This gives you the thickness of one sheet.

*Use this method to measure some small thicknesses e.g.*

- A different sort of paper, e.g. sugar paper from the art room
- A penny
- A tissue
- An envelope
- A folder

You should be able to do this without a calculator if you fix the quantity you measure at, say, 10 or 100.

*Measure the thickness of each of the items again.*
Are your answers the same?
How accurate are your results?

Necklaces

Student material

With 2 jet beads and 3 pearls
I can make two different necklaces:

![Diagram of necklaces](attachment:image.png)

*How many different necklaces could I make with 2 jet beads and 4 pearls?*

*Investigate for other numbers of pearls.*
What happens if I have more than 2 jet beads?
Measuring Small Thicknesses

Teacher Material

National Curriculum levels 6-10

Equipment:

Quantities of different sorts of paper, e.g. cartridge, tissue, crepe, banda, photocopy, duplicating, card, corrugated card, etc.

Quantities of envelopes—different sorts if possible. (You could borrow these from the school office.)

Unused folders

Pennies, any other coins in quantity

This is a practical activity and it can be done in pairs. It is not recommended for larger groups. It encourages accurate measuring and gives a meaning to some very small numbers.

Encourage students to indicate what units they are measuring in, and to be careful about the position of the decimal point.

Highattainers should be encouraged to think very carefully about the last question. Students working at National Curriculum level 10 should be able to indicate the exact range in which the ‘true’ measurement lies.

Necklaces

Teacher material

National Curriculum levels 2-10

This activity is good for practice in generating results and being systematic. A large number of results have to be generated before any number patterns can be seen.

Encourage students to check that the necklaces they draw really are different. Some students may find it helpful if you give them counters of two different colours so they can represent the problem in a more concrete way.

All students should be encouraged to write down clearly how many different necklaces they have found for a particular number of pearls. High attainers may find a formula for the number of necklaces given the number of pearls. Students should be encouraged to stay with the 2 jet bead problem until they can see a pattern.

Where \( n \) is the number of pearls and there are 2 jet beads, the number of necklaces is given by:

\[
\frac{n}{2} + 1 \text{ if } n \text{ is even.}
\]

and

\[
\frac{(n + 1)}{2} \text{ if } n \text{ is odd}
\]

i.e. \([n/2 + 1]\)
Nonagon Diagonals

Student material

This is a regular nonagon.

Here is one way to draw in two diagonals.

*How many ways can you find to draw in two diagonals?*

---

Noughts and Crosses

Student material

You can win a game of noughts and crosses by getting three in a line like this:

```
  O
 /|
O  
 /|
  O
```

*How many winning lines are there altogether?*

Choose a different sized grid to start with.

*How many winning lines are there on your grid?*

Count how many winning lines there are for other grids.
Nonagon Diagonals

**Teacher Material**
- National Curriculum levels 1–10
- Nonagon worksheet (p.120), sharp pencils, rulers, erasers

**Equipment:**
- Generating results for this activity is easy even for the very lowest attainers. It encourages students to be systematic—if they are not systematic they will find that they produce duplicated results i.e. the same pair of diagonals in the same orientation. Students should be encouraged to check for, and eliminate, identical results.

It is best to leave to the students the decision about whether or not to include congruent results, i.e. reflections or rotations of earlier results. Some students may decide to eliminate rotations but to keep reflections. Low or average attainers will probably not be sufficiently advanced in these concepts to be able to notice all the congruent examples. High attainers may be able to predict, without drawing all the results, how many ways there would be.

**Extensions:**
- What happens with different numbers of diagonals?
- What happens if the shape has a different number of sides?

---

Noughts and Crosses

**Teacher material**
- National Curriculum levels 2–10
- Squared paper (p.121), pencil, eraser

**Equipment:**
- This activity requires students to be systematic when they are generating results—it is not easy to find all the winning lines for a grid. To check that they have found them all, students will need to persevere.

When they are sure they have all the winning lines, they should be encouraged to look for number patterns.

They may notice that the number of winning lines is always even or that it is always a multiple of four. High attaining upper school students may be able to find an algebraic formula for the results. A correct formula will be some version of:

\[ 4(n^2-3n + 2) \]

**Extension:**
- What happens if you need four in a line to win?
In the palace there are 48 rooms.
36 of the rooms have fireplaces.
20 of the rooms have mirrors.

Here is a Venn diagram showing this information.

Check that the diagram shows that:
- there are 48 rooms altogether;
- 36 have fireplaces;
- 20 have mirrors.

Here is another way to put numbers in the Venn diagram.

Check that this diagram shows that:
- there are 48 rooms altogether;
- 36 have fireplaces;
- 20 have mirrors.

*Can you find another way to put numbers in the Venn diagram?*

How many different ways are there?

*Change the numbers in the problem and investigate what happens to the answer.*

---

**Parallelogram Patterns**

*Make a pattern using this parallelogram:*

Your pattern can have gaps.

*Make a repeating pattern and make sure that you draw enough of it to show how it repeats.*

Does your pattern show a reflection of the parallelogram? If not, draw a pattern which does.

Does your pattern show a rotation of the parallelogram? If not, draw a pattern which does.

*Can you draw a pattern which shows reflection and rotation?*
Student Activities, continued

Palace Rooms

Teacher material
National Curriculum levels 4-10

Equipment:
Counters, rough paper, pencil, eraser

This activity is good for the development of logical reasoning. Students will need to check that their diagrams fit the original information. Most students will take some time to generate all 13 different diagrams.

Using 48 counters on a large blank Venn diagram will be helpful to most students. They should record each different arrangement of the counters in smaller diagrams on a separate piece of paper. High attainers may work out that there are 13 ways without drawing them all.

Very high attainers may find a way to predict how many ways there would be, given the number of rooms, how many have fireplaces and how many have mirrors. This could provide an opportunity to introduce them to the formal notation of set theory.

Extension:
Can you write a computer program which will work out the answer for you?

Parallelogram Patterns

Teacher material
National Curriculum levels 3-7 (Extension -10)

Equipment:
cm square dotty paper (p.122), card, scissors, glue, tracing paper, mirrors, plain paper, colours, pencil, eraser, ruler

This is a practical activity which reinforces the concept of rotation and reflection. The students should already have done some work on these concepts but it need not have been at an advanced level. They could have met reflection as the notion of ‘flipping’ and rotation as the notion of ‘turning’.

It is best to leave to the students the decision about whether or not the parallelograms may overlap. Most students will find it helpful to cut out a template of the parallelogram and use this to draw their pattern.

Some students may prefer to cut out lots of parallelograms and stick them down to make their pattern.

Students may use a mirror to check for reflection, and tracing paper to check for rotations.

Extensions:
Invent a different shape to do this activity with.

The following extension takes the activity up to level 10:

Describe exactly, using the language of transformations, how the pattern is generated starting from one parallelogram.
Pinboard Paths

Student material

How many paths are there from one corner of a 3 × 3 pinboard to the opposite corner?

Here are three done for you:

See if you can find all the rest.

When you are sure you have found them all, try investigating a 4 × 4 pinboard.

Sevens

Student material

This is a game for two players.

RULES OF THE GAME

You take turns in drawing crosses in the squares.
At each go, a player can draw either one cross, or two crosses next to each other.
Use a different colour pen from your partner.
If you cannot go, you lose.

THE INVESTIGATION

Play the game several times.

See if you can find out anything about how the game works. Here are some ideas for you to work on—or you can choose your own:

• Are there things you can do to make sure you win?
• Does it make any difference who goes first?
• Can you draw what the seven squares look like near the end of the game?

Can you say who would win the game you have just drawn?

• If you go first, does it make any difference whether you start with one cross or two?
• If you go first, does it make any difference where you put your cross or crosses?

You might need to play the game against yourself, using two different-coloured pens. This could help you to see how the game works.
Pinboard Paths

Teacher material
National Curriculum levels 1-10

Equipment: cm square dotty paper (p.122), colours, pencil, eraser

This activity is good for generating results. Even very low attainers can
draw many different paths. It is also good for collaborative work.

Students will have to persevere to find all the ways. A ‘path’ should be
continuous and it should not meet itself. For most students, the examples
on the student material will make this clear—some may ask you for
clarification.

When students say they think they have found all the ways, ask them how
they can be sure. This will encourage them to be systematic in their
checking. If they already have one, they will explain their system to you.
Do not let students proceed to $4 \times 4$ until they have convinced them-
selves that they have found all the ways on a $3 \times 3$.

Extension: Classify your paths according to how many lines they contain.

High attainers might like to try to draw a tree diagram to represent all
possible results for a $3 \times 3$ pinboard.

Sevens

Teacher material
National Curriculum levels 4-10

Equipment: squared paper (p.121), colours

This activity is suitable for pairs of students working together.

Generating results is easy as these come from playing the game. Using
the results to draw conclusions is difficult. Students will need to pose
their own questions, be systematic, and record their findings clearly.

Some students may choose to work from the beginning of the game,
looking at possible moves and strategies. They may discover that there
are 13 possible first moves. This reduces to 7 if symmetry is taken into
account. High attainers may discover that for every first go there are
between 5 and 10 possible moves which the partner can make. Altogether
there are 55 possible second moves.

Other students may choose to look at what happens just before the game
finishes. They may realise that if they are presented with only one blank
square a win is guaranteed. This is also the case if they are presented with
only two adjacent blank squares but with only two non adjacent blank
squares they will lose. Consequently, they can win if presented with three
adjacent, blank squares, as they can cross out the middle one. This
process of tracing the possibilities backwards from the end of the game
can carry on as the reasoning skills of the student allow.

Extension: What happens if you play the game with a different number of squares?
The Solar System

Student material

Try to make a drawing (or model) of the solar system.

First, do all your calculations to work out how large you will make each planet, and how far they will be from the sun.

You could make a poster for the science room or you could arrange with your teacher to stick your planets on the ceiling.

Here is some information you will need:

<table>
<thead>
<tr>
<th>PLANET</th>
<th>Distance from Sun (miles)</th>
<th>Diameter (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth</td>
<td>93 million</td>
<td>7 927</td>
</tr>
<tr>
<td>Jupiter</td>
<td>483 million</td>
<td>88 800</td>
</tr>
<tr>
<td>Mars</td>
<td>141 million</td>
<td>4 200</td>
</tr>
<tr>
<td>Mercury</td>
<td>36 million</td>
<td>3 100</td>
</tr>
<tr>
<td>Neptune</td>
<td>2794 million</td>
<td>27 800</td>
</tr>
<tr>
<td>Pluto</td>
<td>3760 million</td>
<td>*</td>
</tr>
<tr>
<td>Saturn</td>
<td>886 million</td>
<td>74 200</td>
</tr>
<tr>
<td>Uranus</td>
<td>1783 million</td>
<td>29 300</td>
</tr>
<tr>
<td>Venus</td>
<td>67 million</td>
<td>7 700</td>
</tr>
</tbody>
</table>

*Information for Pluto is not available as there has been no close fly-by. A probe is due to take off in 1992 which will provide this information in the year 2015.

Sport Rules

Student material

Choose a sport or game.

Talk about these questions:

- What are the rules of the game?
- What items do you need to play it?
- Does it use — a pitch?
  — a board?
  — or a table?
- If it does, what size is it?
  How is it marked?

When you think you have enough answers —

Imagine someone who knows nothing about the game. 
How would you explain it to them?

Write a magazine article to explain the game. You can use pictures and diagrams.
The Solar System

Teacher material

Equipment:

National Curriculum levels 4–10

Ruler, metre rule or yard stick, tape measure or steel tape, poster paper, colours, calculator

This is a practical problem-solving activity. It is suitable for small groups of students working collaboratively. Allow at least two lessons for students to complete the task. The first lesson to be used for discussion and planning and the second lesson for executing those plans.

Students working at National Curriculum Level 4 will need some help with scale. This could come from you or from other students in the group.

Students may begin their discussion by trying to decide upon a suitable scale for their drawing. They will discover that the distances from the sun are very large compared to the diameters of the planets. A drawing which is small enough to fit inside a large room will contain planets which are so small they will be impossible to draw.

Encourage students not to give up or get demoralised at this stage. Point out to them that people have made models or drawings of the solar system and that compromises have to be made. Students may decide to do one or more of the following:

- Omit some of the outlying planets
- Construct their model outside, where there is more space
- Indicate by labelled arrows how far away the outlying planets would be
- Use different scales for the distances from the sun and the diameters of the planets
- Draw attention to planets the size of tiny dots by drawing larger rings round them

Encourage students to be consistent once they have decided what compromises they are going to make.

Sport Rules

Teacher material

Equipment:

National Curriculum levels 2–10

Trundle wheel (for measuring pitch), tape measure or steel rule, poster paper, colours, squared paper, access to the library

This is a practical problem-solving activity. It is best done in pairs. Allow at least two lessons for the task to be completed, the first lesson to be used for planning and research, the second for the presentation.

Logical reasoning is required to describe the rules of a sport or game. For the description of the rules, students should use their own knowledge of the game, not reference books. (Reference books may be used to find the size of a pitch.) On no account should sentences or diagrams be copied from books.

Spatial reasoning will be used when students describe the pitch, board or table used for the game. The activity is also likely to involve measurement and number work.

Encourage students to choose a sport or game in which they are both interested.
Stamp Tearing
Student material

This is a book of ten stamps:

If I remove one stamp I can leave the book looking like this:

or like this:

What could the book look like if I remove two stamps?
(You may only remove stamps from the end of a row.)
There are 3 possible answers.
Draw them all.

How many answers are there for three stamps?
—four stamps?
—ten stamps?

Do this for a book of 12 stamps arranged like this:

Do this for other books of two rows of stamps.
Stamp Tearing

Teacher material

National Curriculum levels 1–10

Equipment: cm squared paper (p.121)

The generation of results is very easy at the beginning of this activity. Even the very lowest attainers will be able to draw all the ways of removing small numbers of stamps. Most students will notice that the number of ways is one more than the number of stamps removed. This pattern breaks down at 6 stamps. Many students will discover this, and find symmetry in the results for smaller numbers and larger numbers of stamps removed. Higher attainers may be able to indicate a way of predicting how many ways there would be for any number of stamps removed from any two-row book of stamps.

Extension: What happens if the stamps are arranged differently?

For example 12 stamps could be arranged like this:
Star Signs
Student material
You will need a list of the people in your class and their birth dates.

Work out the star sign of each person in the class.

The star sign chart will help you:

<table>
<thead>
<tr>
<th>Star Sign</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aries</td>
<td>21st March–20th April</td>
</tr>
<tr>
<td>Taurus</td>
<td>21st April–21st May</td>
</tr>
<tr>
<td>Gemini</td>
<td>22nd May–21st June</td>
</tr>
<tr>
<td>Cancer</td>
<td>22nd June–23rd July</td>
</tr>
<tr>
<td>Leo</td>
<td>24th July–23rd August</td>
</tr>
<tr>
<td>Virgo</td>
<td>24th August–23rd September</td>
</tr>
<tr>
<td>Libra</td>
<td>24th September–23rd October</td>
</tr>
<tr>
<td>Scorpio</td>
<td>24th October–22nd November</td>
</tr>
<tr>
<td>Sagittarius</td>
<td>23rd November–21st December</td>
</tr>
<tr>
<td>Capricorn</td>
<td>22nd December–20th January</td>
</tr>
<tr>
<td>Aquarius</td>
<td>21st January–19th February</td>
</tr>
<tr>
<td>Pisces</td>
<td>20th February–20th March</td>
</tr>
</tbody>
</table>

Display your results clearly.

What is the most common star sign in this class?

Strips of Squares
Student material
Here are some examples of strips of 6 squares with 2 squares shaded:

```
[Shaded squares]
```

How many examples can you find?

What about strips of different lengths?

What about shading more than two squares?
Star Signs

Teacher material

National Curriculum levels 1–4 (Extension -10)

High attainers will need to do the first extension.

Equipment:

A list of students in the class with their birth dates, squared paper, colours

This activity is suitable for a pair of students. The first extension is suitable for a small group of about four students working collaboratively.

This activity does not necessarily involve surveying the class.

Students work out everyone’s star signs using the written material provided. You may decide however, not to provide the birth date list so that students are required to survey the class in order to collect this information.

Students may produce an ordered list or a chart.

Extensions:

Design a personality questionnaire and see if you can find out if there is any connection between star sign and personality.

Chinese year:

Which animals are people in this class?

Are they like the descriptions of those animals?

Resources for extensions:


- *The Chinese New Year*, Minority Group Support Service, Coventry Education Authority
Strips of Squares

Teacher material

National Curriculum levels 1-10

Equipment:

Squared paper (p.121), ruler, pencil, colours

This is a useful investigation all round. Even the lowest attainers will be able to generate a variety of results. There is plenty of scope for all the investigation processes to occur.

It is best to leave it to students to decide whether or not to include reflections. These who generate results systematically will find it easy to avoid repeats.

Checking for completeness will also be more straightforward. High attainers may indicate some results without actually drawing them, e.g. 'There are five examples with the 2 squares joined together'.

In a strip of six squares, most students should be able to find all 15 examples of two squares shaded, although some students may need to persevere. The answer is 9 if reflections are excluded. If the length of the strip is started at two and increased incrementally, a series of numbers is produced. This gives the triangle numbers if reflections are included. An even more interesting sequence is produced if reflections are excluded.

Extension:

This activity will produce an extended piece of work if all avenues are thoroughly explored.
Tower of Hanoi
Student material

The tower must be moved from the first peg to the last peg.

RULES

Only one ring can be moved each go. A bigger ring can never go on top of a smaller ring.

*How many goes does it take to move the tower?*

Use strips of paper to work out your answer.

How many moves would it take if there were only two rings?

How many moves would it take if you had four pegs?

*Investigate for different numbers of pegs and rings.*
Tower of Hanoi
Student material

National Curriculum levels 3-10

Equipment:
Strips of coloured paper of 5 different lengths
Strips of the same length should be the same colour.

Some students will work at the 3 ring 3 peg problem for some time. They may not initially keep track of their number of moves. They may repeat the puzzle many times and eventually establish that 7 is the minimum number of moves. For some students this could be the conclusion of the activity.

Encourage students to make sure they have the minimum number of moves before they change their parameters.

If students have taken a long time to find the answer 7, encourage them to reduce, rather than increase, the number of rings.

Students will generate results more easily if they use 2 or 3 rings to start with and if they introduce more pegs when using larger numbers of rings.

Table of Results

<table>
<thead>
<tr>
<th>Number of Pegs</th>
<th>Number of rings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>
Washington Underground

Student material

This map shows the underground railway system in Washington D.C. in the United States of America.

Usually underground systems are drawn so that they can be used easily by travellers for planning and following their journeys.

*Draw such a map of the Washington Underground.*
Weaving Puzzle
Student material

Colour this pattern so that it looks like the result of weaving three different coloured ribbons.
Washington Underground

Teacher material

National Curriculum levels 6–10

Equipment:
Large (A3) sheets of plain paper, pencil, eraser, colours
Copy of the London Underground map (optional)

This activity is suitable for pairs of students. They can discuss together the best form of presentation.

Encourage students to make initial rough plans. Make sure they are happy with their draft before they draw it out neatly.

Most students should produce a map which shows the central area and the intersections more clearly.

Weaving Puzzle

Teacher material

National Curriculum levels 3–10

Equipment:
Paper of three different colours, pencil, ruler, scissors, colours

This activity is suitable for individuals. It helps however, if a group of individuals are working on it as they can discuss their progress and tell one another what they are trying out.

Encourage students to cut out strips of coloured paper and try to weave them to form the pattern shown.

This puzzle is not easy. It takes some thought to crack it but students enjoy the process and do not find it frustrating.

This activity encourages students to think about angles and about the three dimensions, as ribbons disappear under other ribbons.

Extension:
Other weaving patterns can be found in the Cabbage Pack produced by Maths in Work. See Resource List (p.124).
The Weather
Student material

Work with a partner.

This project is about the weather.
You are going to measure the temperature outside, and the daily rainfall.
When you have been doing this for some time you will know more about
the weather.

On the first day, learn how to take measurements from the thermometer
and the rain gauge.

Plan how you are going to record your daily results.

Decide how long you are going to spend on this experiment.
(e.g. a week, a fortnight, half a term, a term)

Discuss your final presentation. The following questions might help:

- Will you use graphs and charts? What sort?
- How will you label the axes?
- Could you give a talk to the rest of the class about this project?
- Could you do a poster for your classroom?

When you have finished your project, answer these questions:

How much do you expect the temperature to vary from day to day?

Given the temperature, can you say whether it is raining or not?

About how much rain falls in a day?
Weather Forecasts
Student material

Work with a partner.

This project is about weather forecasts.

Choose a weather forecast which both of you can listen to or watch every day.

Here are some suggestions:

- The Radio 4 forecasts after the 8am news
- A forecast on your favourite radio station
- Breakfast television forecasts, BBC 1 or Independent Television
- The forecast after the 6pm news on BBC 1

Make sure you listen to or watch the forecast at the same time each day.

Are the weather forecasts correct?

To answer this question you will need to make a note of what weather is forecast and then see what the weather actually is on that day.

Decide how long you are going to do this experiment for. (e.g. two weeks, three weeks, half a term)

Decide which part of the weather forecast you are going to check.

- Will you do temperature?
- Will you do rainfall?
- You can check windspeed only if your school has the right instrument. Ask your teacher.

Plan how long you are going to record your daily results.

Rainfall
When you make a note of the weather forecast, you need to write down the exact words—for example, heavy showers, light drizzle.

How will you decide whether the forecast was accurate or not?

When you have finished the experiment, present your results clearly, so the rest of the class can see what you have found out.
The Weather
Teacher material
National Curriculum levels 3–10

Equipment:
Outdoor thermometer, rain gauge, clipboard, squared paper, graph paper, colours
Suitable for a pair of students, this activity is an extended practical problem. It can be done in collaboration with the science department.

It is important that the students themselves choose how to record and present their results. The main mathematical value of this kind of activity comes from the mathematical decisions which students have to make, e.g. deciding what scale to put on an axis when drawing a graph.

Students are likely to produce bar charts or graphs. They may colour code ranges of temperatures. They may write something about variations in temperature. Higher attainers might discuss the correlation between temperature and rainfall.

Weather Forecasts
Teacher material
National Curriculum levels 4–10

Suitable for a pair of students. Could be done in collaboration with the science department.

This activity is intended for students who have successfully completed The Weather (p.117), and are keen to do more on this topic.

It requires regular work at home and will therefore not be suitable for some students.

Equipment:
Maximum thermometer, rain gauge, wind speed gauge (optional), clipboard, squared paper (p.121), graph paper, colours

Students may choose to focus either on rainfall, or temperature, or both. They might code each day’s forecast according to how accurate it turns out to be, e.g. accurate, inaccurate, misleading.

They might calculate the proportion (percentage) of days when the forecast was accurate.
Nonagon Worksheet
Isometric Paper
APPENDIX C

Equipment Suppliers

E J Arnold & Son Ltd
Parkside Lane
Dewsbury Road
Leeds LS11 5TD
0532 772112
Free catalogue available.

Hestair Hope Ltd
St Phillip’s Drive
Royton
Oldham OL2 6AG
061 652 1411
Free catalogue available.

Taskmaster DLM
Morris Road
Leicester LE2 6BR
0533 704286
Free catalogue available.

Tarquin
(see entry below)

Resource List

Association of Teachers of Mathematics
7 Shaftesbury Street
Derby DE3 8YB
0332 46599

One of the two ‘big’ maths associations, originally founded in 1952 as the Association for Teaching Aids in Mathematics, it became the ATM in 1962. They publish two journals (Mathematics Teaching and Micromath), as well as many extremely useful booklets and resources for maths teaching. A very valuable source, especially for investigative ways of working in the classroom.
Free catalogue available.

Leone Burton, Thinking things through
This book, published by Basil Blackwell in 1984 is a very good start to problem-solving and investigative ways of working, and contains a comprehensive list of strategies and processes used by students in solving problems.

Chelsea Diagnostic Mathematics Tests

These tests were developed during the Concepts in Secondary Mathematics and Science Project conducted at Chelsea College between 1974 and 1979. There are ten tests in all, covering the main topics in the mathematics curriculum, and they yield accurate diagnostic information on student attainment. The tests are published by NFER-Nelson, Darville House, 2 Oxford Road East, Windsor, Berks SL4 1DF.

GAIM

Graded Assessment in Mathematics:
GAIM is an assessment scheme which provides investigations and practical problems as coursework tasks. These activities can be used independently from the assessment scheme. The material is published by Macmillan Education. The assessment scheme is administered by LEAG. For more information contact:
Mundher Adhami, Graded Assessment, Stewart House, 32 Russell Square, London WC1B 5DN.
01 636 8000 ext 4710

ITeMs

c/o F R Watson
Department of Education
University of Keele
Keele
Staffordshire
ST5 5BG

A collection of ‘leads’ to be followed in the tracking down of new resources, ITeMS is an acronym for Ideas in the Teaching of Mathematics and Science. Published sporadically, the most recent issue is number 5, dated March 1987, although there is no way of knowing when number 6 will appear.

ITeMS can currently be obtained by sending 80p to F R Watson at the above address.
Appendix C, continued

Jonathan Press
York House
Bacons Lane
Chappel
Colchester
Essex CO6 2EB
07875 2343

Major importer of American books of mathematical activity, including materials available from the National Council of Teachers of Mathematics (NCTM) and Creative Publications. Free catalogue available.

Mathematical Association
259 London Road
Leicester
0533 703877

The older of the two 'big' maths associations, the MA was originally founded as the Association for the improvement of Geometrical Teaching (AIGT) in 1871, and changed its name in 1897. The MA publishes five journals:

The Mathematical Gazette—aimed primarily at maths for 16-19 year olds;
Mathematics in School—aimed at the 11-16 age range;
Mathematics Round the Country—for primary teachers;
Struggle—focusing on the problems low attainers have with maths;
Plus—a magazine intended for school students.

As well as these journals, the MA also publishes reports and books that relate to the teaching of mathematics. Free catalogue available.

Maths in Work
28 Woburn Square
London WC1H 0AA
01 636 8000 ext 4311

This project was set up with the aim of forging closer links between the mathematics used in industry and that used in schools. Some of the project's publications (for example Wrap it up!, which deals with packaging) are published by Macmillan Educational, Houndmills, Basingstoke, RG21 2XS. The remainder (including Cabbage, focusing on the mathematics involved in textiles) are available from the project at the address above.

Open University Centre for Mathematics Education
Milton Keynes
MK7 6AA
0908 74066

As well as the well-known undergraduate mathematics materials, the OU also produce inservice materials for mathematics education, all of which is of a very high standard. Free catalogue available.

Oxford Certificate of Educational Achievement

OCEA is a scheme which provides assessment in a broad range of achievements and experiences, and is probably unique in attempting to record personal skills and achievements alongside assessments in the traditional curriculum areas. They have produced a series of teachers' guides all of which focus on the problems associated with making criterion-referenced assessments.

You can get further information on OCEA from Anne Mathews, University of Oxford Delegacy of Local Examinations, Ewert House, Ewert Place, Summertown, Oxford OX2 7BZ.

Shell Centre for Mathematical Education
University Park
Nottingham
NG7 2RD
0602 50610

The Shell Centre publishes a series of workpacks entitled Numeracy through problem-solving. Packs so far include Problems and patterns with number, The language of graphs and Design a board game. Free catalogue available.
SMILE Centre
Middle Row School
Kensal Road
London W10 5DB
01 960 7330

SMILE is an acronym for Secondary Mathematics Independent LEarning—a project run by teachers to produce high quality learning materials for the mathematics classroom. The resources developed so far is probably the most comprehensive such collection that exists, and is always being expanded.

Tarquin Publications
Stradbroke
Diss
Norfolk
IP21 5JP
037 984 218

Excellent selection of books, posters, software, gridsheets, wooden puzzles and very cheap reflections boards, which can be used instead of mirrors.
Free catalogues available.

West Sussex Institute of Higher Education
Mathematics Education Centre
The Dome
Upper Bognor Road
Bognor Regis
West Sussex
PO21 1HR
0243 865581

WSIHE publishes a variety of materials which focus around two broad themes: investigative ways of working and micros in mathematics. In particular, the work of Marion Bird (Generating Mathematical Activity in the Classroom) provides a series of very useful starting points for teachers wanting to start investigative work.

Educational Publishers
(phone numbers only)

Addison Wesley  0734 79400
Edward Arnold  01 637 7161
Batsford  01486 8484
Bell & Hyman  01 407 0709
A & C Black  01 242 0946
Blackie  041 772 2311
Basil Blackwell  0865 722146
Cambridge Educational  0223 312393
Chambers  031 225 4463
Croom-Helm  01 658 8513
Falmer Press  0256 840366
Framework Press Ltd  0524 39602
Ginn & Co  0296 88411
Harrap  01 248 6444
Heinemann Educational  01 637 3311
Hodder & Stoughton  0732 450111
Holmes McDougall  031 554 9444
Holt (et al)  0323 638221
Longman  0279 26721
Macmillan Education  0256 29242
Methuen  0264 62141
John Murray  01 493 4361
Thomas Nelson  0932 46133
NFER-Nelson  07535 58961
Oxford  0865 56767
Pitman  01 242 1655
Routledge  04912 78321
Schofield & Sims  0484 607080
SRA  04912 5959
Stanley Thornes  0242 584429
Ward-Lock Educational  01 486 3271
Arnold Wheaton  0532 772112