# Maths in Museums 



## INTRODUCTION

This new digital resource has been developed to support the numeracy framework in primary schools. The activities in the toolkit are based on using Amgueddfa Cymru - National Museum Wales' art, science and history collections. We hope they will support ways of using heritage to teach numeracy skills.

There are 22 bilingual activities in the toolkit primarily developed for year 6 pupils. The activities have been organised according to the following themes: geometry, number, data and measure. Activities for families to complete in the museum are also included.

The toolkit was developed in partnership with See Science and in consultation with primary and secondary school teachers throughout Wales.

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## CONTENT

## Geometry

Numbers
Measure
Data
Geometry and measures
Activities for families
Answers


## Geometry



The National Slate Museum

## Can you Measure

 a Mountain?


## Curriculum Link

Use mathematical techniques to measure very tall buildings. Develop angle measuring skills and drawings to scale.


Museum Link

The largest water wheel in mainland Britain can be seen at the National Slate Museum. The waterwheel was constructed in 1870 by De Winton of Caernarfon and is over 15 meters in diameter.


The water wheel at the Museum


## Details of the activity for teachers

Find the water wheel tower at the Museum. This houses the largest water wheel in mainland Britiain.

The pupils can find the height of the tower by using angles and an ancient device called an astrolabe. This device dates back as far as the third century. Use an astrolabe to measure the height of the water wheel tower.

The diagram shows you how to make a basic astrolabe using a protractor, a tube, a piece of string and a weight. You could even get the pupils to make their own protractor by marking the angles on a semicircle made of strong cardboard for example: www. astronomygcse.co.uk

Use Activity Sheet 1: How to measure tall structures and your astrolabe to measure the height of the water wheel tower.

# Resources and equipment needed for this activity 

To make the astrolabe: Protractor, cardboard, scissors, paper to create a tube, thin string, metal weight and adhesive tape

To make the scale drawing: Graph paper, ruler and sharp pencil

Activity Sheet 1:
How to measure tall structures

Activity Sheet 2:
How to measure
tall structures

## Extending

this activity
Investigate what
happens to the reading
on the astrolabe if
you move closer to or
further away from the
tower.

## Adapting this activity

Use this technique
in order to measure
any tall object. For
example a dinosaur or
a pit winding tower.

## Astrolabe

## ACTIVITY SHEET 1

## How to measure tall structures

Use your astrolabe in order to measure the height of the water wheel tower, which houses the largest water wheel in mainland Britain.


On graph paper draw your relationship to the tower using a suitable scale. Walk away from the wheel until you reach a point where the line from the protractor touches the top of the tower. Can you work out how tall the water wheel tower is?

## ACTIVITY SHEET 2

## How to measure tall structures

Investigate what happens to the reading on the astrolabe if you move closer to or further away from the tower


National
Museum Cardiff

## Symmetrical

 Ceramics

How many plates do you have in your home?

Have you used a plate today?
 What did you use it for?


What shape was it? Did it have a pattern on it? Can you describe the pattern?

## ©

## Curriculum Link

Develop an understanding of lines of symmetry and rotational symmetry using designs in the ceramics gallery.


## Museum Link

Explore different types of symmetry in the ceramics gallery, and design your own symmetrical plate. The Museum has an extensive collection of plates and dishes.


## Details of the activity for teachers

Explore the plates in the ceramics gallery. Use the designs on the ceramics to identify, classify and create symmetrical designs. Now find a plate with rotational symmetry of 2,4 and 8 . Complete the Activity Sheets and then design a plate!

You can use one of these templates or make your own. You might choose to use a paper plate for the design.

Try to include at least one type of symmetry. If you decide to use colours, they must be used symmetrically.

## Extending

this activity
Can you find
symmetrical designs on
plates anywhere else?
Also consider the
symmetry of the
whole building, both
inside and out e.g.
the entrance hall,
staircases, patterns in
floor tiles. How about
at home?

## Adapting this activity

This activity could
be adapted for
use in considering
symmetry in other contexts e.g. a Roman soldier's shield, tiling patterns in Roman mosaics or patterns in Welsh blankets at
the National Wool
Museum.

## Resources and equipment needed for this activity

Paper, coloring pencils, ruler, paper plates (optional) and protractor

Don't forget the resources
and equipment needed
Activity Sheet 1:
Symmetrical ceramics
Activity Sheet 2:
Design your own plate

## ACTIVITY SHEET 1

## Symmetrical ceramics

Can you identify any examples of symmetry in the plates and dishes you see around you? Here are some examples.


Number of lines of symmetry $=$
Order of rotational symmetry = $\square$


Number of lines of symmetry $=\square$ Order of rotational symmetry = $\square$


Number of lines of symmetry $=$ $\square$ Order of rotational symmetry = $\square$
 Number of lines of symmetry $=$ $\square$ Order of rotational symmetry = $\square$

## ACTIVITY SHEET 1

## Symmetrical ceramics

What about this shape? Where can you see it?


Number of lines of symmetry = $\square$
Order of rotational symmetry = $\square$

## ACTIVITY SHEET 2

## Design your own plate

Now it's your turn to design a plate!
You can use one of these templates or make one of your own. You may choose to use a paper plate for your design. Try to include at least one type of symmetry. If you choose to use colours, they must be used symmetrically.


## ACTIVITY SHEET 2 <br> Design your own plate

## ACTIVITY SHEET 2

Design your own plate


## ACTIVITY SHEET 2

## Design your own plate

Choose your own order of rotational symmetry. You should carefully consider the angles at the centre of the plate when you divide up the circle.


The National
Slate Museum

## Pattern Making



Are you wearing any clothes with printed patterns?



## Curriculum Link

Develop an understanding of circle geometry in a practical, hands-on manner.


## Museum Link

The pattern shop at Llanberis houses a vast collection of sculptured patterns, all necessary for the smooth running of the workshops at Dinorwig Quarry. Look at some of the properties of circles.


## Details of the activity for teachers

All around us there are wonderful patterns and shapes. The natural world is full of them. Free-form shapes are irregular and uneven, such as a leaf or a pebble. Geometric shapes are precise, such as rectangles, triangles and circles. Can you think of any geometric shapes that occur in nature?

In the patterns workshop, wooden patterns could be made on site for any metal object required.

What geometric shapes can you find?

Look at an assortment of wheels and cogs. Think of different ways you could sort them into groups. For example you could group ones with straight spokes and ones with curved spokes. Some have wide rims and others have narrow rims.

Do all the wheels have the same number of spokes?

Are all the wheels fully circular in shape?

What other shapes are there?

Don't forget the resources and equipment needed

## Extending

this activity
Produce a small wheel for one of the workshops. Use a piece of paper to design a wheel pattern. You can choose the number of spokes and the circumference. Add a circle in the middle for the axle to pass through.
Use your understanding
of the properties of a circle
to design your wheel
accurately. Note down your angles and other measurements.

Cast your wheel
Roll out a piece of
plasticine to a thickness of
approximately 1 cm . Place
your design template on
top of the plasticine and trace your design lightly into the modelling clay with a sharp pencil.
Use a scalpel to gouge out your pattern in the plasticine, leaving you with a mould for your wheel. Pour some liquid plaster of Paris into your mould and let it solidify. When it is solid remove it carefully from the mould, and you have cast your

## Additional <br> resources

A variety of circular
objects of differing
circumference size.
own wheel.

## Adapting this activity

This activity could be adapted to include the "patchwork pattern making" activity, which involves measuring the angles to form regular shapes and circles.

## Activity Sheet 1:

The properties of a circle
calculator, rolling pins, plasticine, plaster of Paris, scalpel, pencil and paper

## ACTIVITY SHEET 1

## The properties of a circle

Draw a circle and label the diameter of the circle. The circumference of a circle is the length of the edge around a circle. The diameter of a circle is a straight line going through the centre of a circle connecting two points on the circumference.



Pattern making at Llanberis

Choose a round object and measure its circumference as accurately as possible. Write down your answer in the table. Now measure the diameter and note this as well. Use a calculator to divide the circumference by the diameter and record your result. Now choose another round object. Measure this object in the same way.

| Circumference | Diameter | Circumference <br> $\div$ Diameter $=?$ |
| :--- | :--- | :--- |
|  |  |  |
|  |  |  |
|  |  |  |

What did you notice about the result?

Do you think this is the case with all round objects?

By what name is this relationship known to mathematicians?

This wheel has four spokes radiating at equal angles from the centre. If the whole angle of the circle measures $360^{\circ}$, then the angle between each spoke is $360^{\circ}$ divided by 4 , which equals $90^{\circ}$.

What is the angle between 8 spokes radiating at equal angles
 from the centre? (Hint - $360 \div 8$ )

Can you find a formula to help you calculate the angle of any number of spokes radiating at equal angles from the centre?

National
Museum Cardiff

## Changing Scales



Why do things that are close up to you appear large, and things that are far away appear small?


A boat far out in the sea can appear so small you can even cover it with your thumb.


## Curriculum Link

Using the grid method in order to enlarge or reduce 2D and 3D images. Using a scale factor, noting the point of origin in order to enlarge various shapes.


Museum Link
In this workshop the pupils take a look at a picture (or object) in the art galleries. They can explore mathematical techniques that enable artists to enlarge or reduce images.

A magnifying glass, on the other hand, will make the image appear much larger.


## Details of the activity for teachers

Explore how painters enlarge and reduce paintings using the paintings in the gallery. Then try scaling up your own picture.

This painting is by Jan van de Cappelle (1624-1679).

The large images of the boats are found in the foreground and the smaller images are found in the background. Some artists use various mathematically based techniques in order to enlarge or reduce images.

Look at the resource sheet which shows how a 2D image has been enlarged.

Visit the portrait gallery at National Museum Cardiff. Choose a portrait and divide up the image into a grid.

Ask the group to each draw an enlargement of a different square of the grid.

## Extending

this activity
You can apply these
techniques to other
paintings. Another
technique for enlarging
and reducing an image is
to use a scale factor.
Is it a good enlargement of the original - i.e. does it resemble that person? Suggest ways to improve the accuracy of your enlargement.

Investigate the effect
of enlargements on
the size of the area
using Extended Activity
Sheet 1.

## Adapting this activity

Use the grid technique
to enlarge an image
of a Roman soldier or
shield.

## Resources and equipment needed for this activity

Drawing equipment including pencils, crayons etc., squared paper and ruler

To build a Dürer screen you will need cardboard, cord, glue, adhesive tape, scissors and ruler

Resource Sheet 1:
Grid enlargement
Extended Activity
Sheet 1: Scale
enlargement

Don't forget the resources and equipment needed


## RESOURCE SHEET 1 <br> Grid Enlargement

This example shows how the 2D image has been enlarged by reproducing the content of each square in the grid onto a larger grid.


## 3D Enlargements

The German artist and draughtsman Albert Dürer (1471-1528) used a screen to enlarge 3D objects. He would make a screen (now called a Dürer screen) and by copying the outline of the subject line by line would draw it in the correct perspective. http://www.tate.org.uk


Abert Dürer's screen

This scales model of the ship is on display at the National Waterfront Museum in Swansea. Make your own Dürer screen and use the technique to draw the ship as accurately as possible.


## EXTENDED ACTIVITY SHEET 1

## Scale Enlargement

Another technique for enlarging and reducing an image is to use a scale factor. This example shows how the ship has been enlarged by a scale factor of 2 (or reduced by a scale factor of $1 / 2$ ). The origin in this case is at the axis intersection point $(0,0)$


Choose an obvious shape from the painting, for example you could enlarge the triangular shape of the sails.

Draw it - you could do this on maths paper. Investigate what happens to the area of the shape when you enlarge it by a scale factor of 2 . Now experiment:

- Start with shapes like squares and rectangles.
- Very irregular shapes can be enlarged on squared paper and the number of squares counted to investigate the effect of the enlargement scale on the area of your shape.
- Experiment with a different point of origin.

What happens to the position of the enlarged image?

The National Wool Museum

## Symmetrical

Patterns

When you look in a mirror, what do you see? You see a reflection of yourself. Images that reflect each other perfectly are called lateral symmetry.


If you stood on your head, would you appear the same as your friends standing on their feet? Of course not - you would be upside down. Images that look the same when they are upright or upside down have rotational symmetry.


## Details of the activity for teachers

Look at the blankets in the Museum. Traditional woollen blankets woven in Wales contain patterns that are repeating and symmetrical.

Look at the information panels and find out what 'warp and weft' means.

Symmetry can be rotational. The image is the same when it is rotated about a central point.

Symmetry can be lateral. The image is reflected on the other side of the line or axis.

Does the pattern on the blanket pattern contain lateral or rotational symmetry, or both? Design a symmetrical pattern of your own using Activity Sheet 1.

## Extending

this activity
Weave a symmetrical
pattern using paper or
card using Extended
Activity Sheet 1. Weave
a pattern of particular
dimensions or area.

## Adapting this activity

Look at traditional symmetrical patterns
from other parts of the world.

## Additional resources

A traditional
Welsh woollen
blanket containing
symmetrical and
repeating patterns

Resources and equipment needed for this activity

Small hand mirror, coloured pencils, coloured card (at least two colours), scissors, glue and squared paper

Activity Sheet 1:
Symmetrical patterns
Extended Activity
Sheet 1: Paper weaving

Don't forget the resources and equipment needed


## ACTIVITY SHEET 1

## Symmetrical patterns

The intended pattern would be planned and designed on squared paper before the weaving process could begin.

Using squared paper, design you own symmetrical patterns.
Some examples are shown here for you to complete. The patterns can be used to complete lateral or rotational symmetry.



## EXTENDED ACTIVITY SHEET 1

Paper weaving
Using the paper that will form you warp, fold it in half and cut from the fold to within 1 cm of the open edge. Unfold the warp, as in figure 1.

figure 1

WARP


## WEFT



Thread the weft through the slits you have made in your warp, as in figure 2. Secure the weft and warp together by gluing two strips of paper on the wrong side, as in figure 3.
figure 2

figure 3


# Numbers 



St Fagans National History Museum

## Pennies and

## Farthings



## Details of the activity for teachers

What was the purpose of the toll gate?
What is the language on the sign? What was the language spoken by of the majority of the population in Wales during this time? Why is the sign not written in Welsh?

## Pre-decimalisation

 currency. The board on the outside of the tollgate records the prices paid in order to pass through the toll gate.What do you notice about the currency? What kind of currency do the symbols $£-\mathrm{s}$-d represent? It is known as pre-decimal currency. After the Norman Conquest in 1066, the pound was divided into twenty shillings or 240 pennies and remained so until decimalization on 15 February 1971.

Role play - make a selection of possible random choices. Refer to the sign on the toll house wall in order to calculate the cost of passing through the toll gate. The "toll gate keeper" will be required to calculate the total of monies paid by the travellers, combining halves and quarters to make whole numbers.

## Extending

this activity
Use counting strategies and reasoning in order
to create a specified
sum of money using the
minimum number of
coins possible.
Research the
background to "Decimal
Day" on 15 February
1971. Think of a way
to go about converting
the values of pre-
decimal currency to its
decimal equivalent.

## Adapting this activity

The activity can
be adapted to the
context of an "old-
fashioned shop"
or "pay day" at a
workplace.

## Resources and equipment needed for this activity

## Additional

resources
Paper set of pre-
decimal coinage.

## Pre-decimal currency

A means of selecting an event at random for example dice, choice box etc

Activity Sheet 1:
Role play

Resource Sheet 1:
Old money
Activity Sheet 2:
Old money
Activity Sheet 3:
Calculating value

Don't forget the resources and equipment needed

## ACTIVITY SHEET 1

## Role play

Nominate one member of the group to be the toll gate keeper. Other members of the group can be travellers or farmers / drovers who wish to pass through the toll gate. The toll gate keeper is responsible for calculating the daily takings.


Decide whether you wish to be a farmer or a traveller. Use the sign on the tollhouse wall to calculate the cost of passing through the tollgate. If you are a farmer decide how many animals of each type you have travelling with you e.g. 10 cows and 50 sheep. Ask the tollgate keeper to calculate the cost of passing through the tollgate. Ask thetollgate keeper to calculate the cost of passing through the tollgate.

If you are a traveller decide how you will travel e.g. a horse and cart or a mule and wagon wain. Ask the tollgate keeper to calculate the cost of passing through the tollgate.

| The Farmer or Drover |  |
| :--- | :--- |
| 10 | Oxen |
| 20 | Cows |
| 25 | Cattle |
| 40 | Calves |
| 50 | Hogs |
| 75 | Sheep |
| 80 | Lambs |


| The Traveller |  |
| :--- | :--- |
| Horse | Coach |
|  | Chariot |
| Mule | Landau |
|  | Gig |
|  | Wagon Wain |
|  | Cart |
|  | Not drawing |
|  | Carrying lime |

## ABERYSTWITH SOUTH GATES (CLEAR ABERYSTWITH NORTH GATES.

Rate of Toll to be taken at this Gate,
For every Horse or other Beast drawing any Coach, Chariot, $\mathcal{L}-\boldsymbol{-}-\lambda$ Berlin, Landau, Landaulet, Barouche, Chaise, Phaeton,
Vis-a-Vis,Calash, Curricle, Car, Chair,Gig,Hearse, Caravan Litter, or any such like Carriage - - 0-0-6 For every Horse or other Beast, except Asses drawing any Waggon,Wain, Cart, or other such like Carriage - 0-0-4 For every Ass drawing any Cart, Carriage, or other vehicle-0-0-2 For everyHorse or Mule, laden or unladen, and not drawing 0-0-12 For exe Ass, laden or unladen and not drawing- - $0^{-\frac{1}{2}}$ For every fiorse or otherAnimal employed in carrying,drawing. or conveyine any lime to be used for the purpose of manureo-0-2 For every drove of Oxen, Cows, or Neat Cattile, the sum of Ten Pence per Score, and so in proportion for any greater or less number For every drove of Calves, Hogs, Sheeps, or Lambs, the sum of Five Pence per Score, and so in proportion for any greater orless number. HXEMPTION FROM FOLIAS
Horses or Carriages attending herMajesty, or any of the Royal Family, or returning therefrom; Horses or Carriages emploved for the repairs of any Turnpike Roads, Highways, or Brideses:Horses or carriages emplozed in carrying Mapure (save Lime) for improving Lands, orPloughs, or implements of Husbandry; Horses employed in Husbandyy, going to or returning from Plough, or to or from Pasture, or Watering place, or going to be or returning from being Shoed, and Horses not going or returning on those occations more than two miles on the Turnpike Road on which the exemption is claimed; Persons going to, or reluruing from, their proper parochial Church or Chapel, Persons going to, or ret. ing from, their usual place of religious worship tolerated by $L$ aw, on Sumdays, er $n$ any day on whichDevine Service is ordered to be Celebrated; Inkabitants of any Parish or Township foind to. or returning from aitending the Funeral of any Penson who shall die gr be baried io the Parish, Township, orhamlet, in Which any turnpike Road shall lie, any Rector, Vicar; or Curate, ow his parochial duty within his Parish;Horses, Carts, or Wag gons, conveying Vagrants sent loy passes, or any Prisoner sent by legal warrant: Horses or Carriages conveying the Mails; Horres of any officer or Soldier on march or dut, Horses or Carriades conveying the Arms or Baggage of any such Soldiers o Officers, of returning therefrom
 Carriages eavying or conveying any person to and from County, i,n ens; any Hors payning any Agricultural produce which stall have growics. produce, and whiat shall not have be en sold. Sheep going iobe washed; Horses drawing or not drawing, whieh shall not passmore than three hundred yards along the Turnpike Road.

## RESOURCE SHEET 1

## Old money

$$
\begin{array}{lll}
\text { Name } & \text { Commonly } & \text { Value in "old" } \\
\text { of coin } & \text { known as } & \text { pence (d) or } \\
& & \text { in shillings (s) }
\end{array}
$$

| Farthing |  | $1 / 4$ of a penny |
| :--- | :--- | :--- |
| Halfpenny | Ha'penny | $1 / 2$ penny |
| Penny | copper | 1 d |
| Three pence | Thruppence | 3 d |
| Six pence | a Tanner | 6 d |
| Shilling | a Bob | 12 d |
| Florin | Two Bob Bit | 2 s |
| Half a crown |  | 2 s 6 d |
| Crown | Quid | 5 s |
| Sovereign |  | 20 s |
| Guinea* |  | $21 \mathrm{~s}(1$ Sovereign |
|  |  | and 1 shilling $)$ |

* Though there was no coin called the Guinea it was often used to purchase "gentlemanly goods" such as horses or paintings.


## ACTIVITY SHEET 2

## Old money

Arrange the coins according to their values starting with the smallest value.


## ACTIVITY SHEET 3

## Calculating value

Try to use the minimum number of "old" coins to pay for goods.
For example if you had to pay 7 shillings and 9 pence [7/9d] you would need a minimum of 3 coins - crown, half a crown and a thruppence.

Calculate the smallest number of coins you would need to pay these costs.

| Cost | Coins needed | Number of coins <br> needed |
| :--- | :--- | :--- |
| 7 shilling (s) and 9 old pennies (d) | Crown, Half a crown, threepence | 3 |
| 12 old pennies(d) |  |  |
| 10 shillings (s) and 4 old pennies(d) |  |  |
| 15 shillings (s) and 2 old pennies (d) |  |  |
| Sovereign |  |  |

Calculate the change you would need to give from a sovereign.

| Cost | Change from a sovereign |
| :--- | :--- |
| 7 shilling (s) and 9 old pennies (d) |  |
| 12 old pennies(d) |  |
| 10 shillings (s) and 4 old pennies(d) |  |
| 15 shillings (s) and 2 old pennies (d) |  |
| Sovereign |  |

## Playing with dice



How many faces are there on each dice? Is this always true?


## Details of the activity for teachers

One pair of dice is required for the whole group. Each pupil needs a copy of the tables shown on the Activity Sheet.

Discuss if the dice look similar to ones the pupils have seen before.

Roman soldiers played games with dice. Their dice were usually cubes with spots on each face, just like we use today. The Romans were playing with these dice two thousand years ago!

They put two dice in a cup, shook the cup and threw the dice onto a table. Then they added the numbers of spots on the top faces of the two dice.

Games involved trying to predict the total on the two dice. What possible totals can you get from adding the numbers on two dice?

Write down the possible combinations.

Why can't you get a total of 1 ?

Use the Activity Sheet to investigate how a wise Roman might have picked a particular number.

Alternatively, if time and space are available, nominate a pupil to represent each of the numbers 2, 3, 4... 12 . The nominated pupils should stand in a row in 'numerical' order. Each time the dice are thrown, the pupil representing the total takes a step forward. The first pupil to take twelve steps 'wins'.

## Extending

this activity
What numbers are the
least likely totals? Why is
this? What probability do
they each have?
What difference would
it make if the game
involved finding the
difference rather
than adding the two
numbers each time?

## What difference would

it make if the game
involved multiplying
rather than adding the
two numbers each
time?
What difference would
it make to use different
shaped dice e.g.
4 -sided (tetrahedral) or
8 -sided?
What assumption have we had to make about all the dice involved?

## Resources and equipment needed for this activity

Pens or pencils and one pair of dice

Don't forget the resources
Activity Sheet 1:
Dice race

## ACTIVITY SHEET 1

## Dice race

Roll the two dice and call out the total. In the table below, put a tick in the first empty box to the right of this total. Keep throwing the dice and putting a tick next to the total each time. The first number to fill its row with ticks 'wins'.

| Dice total |  |  |  |  |  |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 2 |  |  |  |  |  |  |  |  |  |  |  | Winner |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |  |  |  |  |

Repeat the whole process and complete the second table.

| Dice total |  |  |  |  |  |  |  |  |  |  |  | Winner |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 2 |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |  |  |  |  |  |  |

## ACTIVITY SHEET 1

Dice race


Why are some numbers more likely than others?
Consider whether or not it is possible to get some of the totals in different ways. Complete the table to show the totals for different results for the two dice.

|  | Dice 2 |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :---: |
|  |  | 1 | 2 | 3 | 4 | 5 | 6 |  |
| Dice 1 | 1 |  |  |  |  |  |  |  |
|  | 2 |  |  |  |  |  |  |  |
|  | 3 |  |  |  |  |  |  |  |
|  | 4 |  |  |  |  |  |  |  |
|  | 5 |  |  |  |  |  |  |  |
|  | 6 |  |  |  |  |  |  |  |

There are $\qquad$ possible results for the two dice

The most likely total is $\qquad$

This is because $\qquad$
$\qquad$
$\qquad$
$\qquad$

The probability of getting this number is $\qquad$


## How did

## Romans count?



How many times each day do you need to count things?


## XI M VIII

## Details of the activity for teachers

Romans understood that counting was extremely important.

The Romans used counting for:

- dealing with money
- working out the number of soldiers who needed meals
- playing games with dice.

Can you think of any others? The numbers we write today ( $1,2,3,4$...) are called Arabic numbers. Romans used a different system for writing down numbers, based on seven different symbols or numerals.

Find examples in the Museum. Can you work out what number they are?

Roman numerals are still sometimes used today. Examples are:

- a clock face
- the date (year) written at the very end of a TV programme to show when it was made.

Can you think of any others? Complete Activity Sheet 1: Using Roman numerals.

## Extending

this activity
Can you write some
sums using Roman
numerals?

| Roman <br> numeral | Arabic <br> number |
| :--- | :--- |
| I | 1 |
| V | 5 |
| X | 10 |
| L | 50 |
| C | 100 |
| D | 500 |
| M | 1,000 |

## Resources and equipment needed for this activity

Pens or pencils
Activity Sheet 1:
Using Roman numerals
Don't forget the resources and equipment needed

## ACTIVITY SHEET 1 <br> Using Roman Numerals

## Complete the tables.

| Roman | Arabic |
| :--- | :--- |
| XII |  |
| XXV |  |
| CL |  |
| LVI |  |
| DCV |  |
| MC |  |
| CXV |  |
| MI |  |
| CXXXVII |  |
| MDCLXVI |  |


| Roman | Arabic |
| :--- | :--- |
| IV |  |
| XIV |  |
| XLVIII |  |
| CXC |  |
| CDXCV |  |
| CXLIX |  |
| MCDV |  |
| MCMLXXV |  |
| CMXCIX |  |
| MCDXIV |  |


| Roman | Arabic |
| :--- | :--- |
|  | 7 |
|  | 15 |
|  | 123 |
|  | 3000 |
|  | 1111 |
|  | 725 |
|  | 212 |
|  | 2057 |


| Roman | Arabic |
| :--- | :--- |
|  | 9 |
|  | 24 |
|  | 401 |
|  | 464 |
|  | 2400 |
|  | 979 |
|  | 1997 |
|  | Yhis Year <br> were brorn |

## Make up some puzzles of your own

| Roman | Arabic |
| :--- | :--- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |


| Roman | Arabic |
| :--- | :--- |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

National Museum Cardiff

## Shapes <br> and lines



Where can you find shapes that fit together? Are they all the same or are they different shapes?


What are parallel lines? Where can you see them around you?



## Curriculum Link

Develop knowledge of the properties of different types of polygons. Develop understanding and use of geometrical vocabulary.


## Museum Link

Explore different types of polygons and their associated vocabulary by observing Multi-cut tree by David Nash, which is in Gallery 7 at the National Museum Cardiff.

## Details of the activity for teachers

Find David Nash's
Multi-cut tree (2001).
Walk around the
sculpture. Remember not to touch it.

Discuss how you could describe the sculpture to someone who hasn't seen it. Try to describe it in a few words.

What does the word parallel mean? Can you see the parallel lines in the sculpture?

This sculpture is full of 2D shapes, which we call a polygon. A polygon is a 2D shape with a number of straight sides.

Can you see any examples around you? What about other real-life examples?

Complete the worksheets.

## Adapting

this activity
Can you find
other examples of
interlocking shapes?
The activity could be adapted for use in considering parallel lines in stratified rock formations e.g. in cliffs or seams of slate.

A link can be made to tessellations i.e. when interlocking shapes are repeated. Conditions (angles)
can be explored
when this is possible.

## Extending

this activity
Measuring angles
Choose one point where
several lines meet.
Measure all of the angles
around that point. Write
the number of degrees
inside each angle.
Add up your answers.
What is your total?
Repeat this for a different point. What is
your total this time?
What should the total
be for yet another point?

## Harder:

- Find the total for the angles inside any quadrilateral.
- Find the total for the angles inside any pentagon.
- Find the total for the angles inside any hexagon.
- Find the total for the angles inside a polygon with any number of sides.
- By taking appropriate measurements, can you find the area or perimeter of any of the shapes?

You could also consider creating a 2D collage or 3D model in the classroom using coloured corrugated card.

Activity Sheet 1:

Using parallel lines<br>Activity Sheet 2:<br>Naming shapes<br>-

Paper, coloured pencils, rulers, protractors (if measuring angles)

## Resources and equipment needed for this activity

## ACTIVITY SHEET 1

## Using parallel lines

A polygon is a 2D shape with any number of straight sides. This large polygon is filled with lots of different smaller polygons.

Fill each polygon with parallel lines like the sculpture. Vary the slope of the parallel lines from one polygon to the next. Use a different colour each
 time you change to another polygon. Try to use as few colours as possible but make sure that no two polygons sharing a side are filled in the same colour.

How many colours did you need to use?
$\square$

Use a ruler and pencil to make up your own design of shapes to be filled with parallel lines.

Try to include as many of the following as you can:

- a square
- a rectangle
- a hexagon
- a pentagon
- a parallelogram
- a trapezium
- a kite
- an equilateral triangle
- an isosceles triangle
- a reflex angle


Draw an arrow from each shape to the correct name one has already been done for you.


## Hexagon



Kite

Rectangle

## Parallelogram

## Trapezium

## Square

## Isosceles

triangle

## Pentagon

The National Slate Museum

## The <br> Bargain




## Curriculum Link

Develop numeracy skills that include the four rules of arithmetic, in the context of a profit and loss calculation.


Museum Link
Step into the shoes of generations of quarrymen who would bargain regularly in order to have permission to quarry the slate. Calculate all the income and cost implications for the quarrymen so that they can strike their bargain.

## Details of the activity for teachers

A family or a group of workers had to 'bargain' for the right to mine a specific area on one of the quarry's levels. Generally, there were four members to each group. The two strongest men took responsibility for the more physical work. The most experienced man would split the slate and work in the sheds or the "wall" and the youngest member worked as an apprentice.

Every four weeks the group had to strike a new bargain with the quarry steward in order to extract the slate from the rock. The price they offered for this right depended on the quality of the rock. Care had to be taken before agreeing on the four-weekly bargain. If they offered too much it would result in no pay, or even losses.

A good splitter was able to split the slate to a thickness of 5 mm . Calculate how many splits the splitter could make in a block of slate measuring 10 cm wide. Demonstrate your strategy.

The splitter could cut as many as 400 slates in a day. If he did this every day over the period ( $5^{1 / 2}$ days a week), how many slates would he succeed in splitting?

Resources and equipment
needed for this activity
Paper, pencil and a calculator

Activity Sheet 1:
Deductions

Don't forget the resources and equipment needed


## Extending <br> this activity

After splitting the slate,
it needed to be stacked
in an orderly fashion. In order that the steward of
the quarry could count
the stacked slate quickly,
they were stacked in
batches of fifty, with
the fiftieth slate laid
perpendicular to the
others, marking the
amount.
Show how a standard
daily load was set out in
order to count it.
The quarryman was paid the value of 100 slates for every 128 produced.
This ensured that
any financial loss due
to brakeage when
transporting the slate was borne by the quarryman and not the seller or buyer.
If the quarryman
succeeded in splitting 400 slates in a day, for how many slates was he paid?

## Adapting this activity

The profit and loss scenario can be adapted for many contexts, for example shopkeeper, mining manager, shipping
etc.

## ACTIVITY SHEET 1

## Deductions

At the end of each four weeks the quarrymen collected their payment for their efforts. Included with each payment slip was a notice of deductions. The deductions included a charge for:

- ropes
- explosives
- sharpening and renewing tools
- a contribution to the site hospital.

As well as charging for the amount used a fixed fee was included in the deductions. Select appropriate amounts to insert in the table, and calculate the profit or loss for the period of four weeks. You'll find this information as you go round the museum.

| Year | 1850 | 1900 | 1950 |
| :--- | :--- | :--- | :--- |
| Value of the slate quarried <br> within the period | The standard pay <br> in this period was <br> between 12 and 16 <br> shillings a week | Approximately 24 <br> shillings a week | Approximately <br> 110 shilings a week |
| Fixed costs | No site hospital | One shilling | NHS founded |
| Contribution to the <br> hospital |  |  |  |
| \% of the value of the slate <br> for using |  |  |  |
| - ropes \% |  |  |  |
| - explosives \% |  |  |  |
| - tools \% |  |  |  |
| Surplus or loss for the <br> period |  |  |  |

## ACTIVITY SHEET 1

Deductions
Any surpluses were divided up between the four members of the group.
Allocate your surpluses between the four members in your selected ratios.

## Splitter:

Excavator A:
Excavator B:
Apprentice:

| Members of the group | 1850 | 1900 | 1950 |
| :--- | :--- | :--- | :--- |
| Splitter |  |  |  |
| Excavator A |  |  |  |
| Excavator B |  |  |  |
| Apprentice |  |  |  |



Big Pit National Coal Museum

## Up and Down

the Mine?


Have you been in a lift recently?

$\square$

## Curriculum Link

This activity will provide opportunities for you to develop skills in interpreting numbers and using them in appropriate calculations.


## Museum Link

Interpret numerical information about the number of workers in the mine and the amount of coal produced in a working day.

If 5 pupils could fit in the lift how many trips would be needed to transport all the pupils from your class in one lift?


## Details of the activity for teachers

It was a tricky job to work out how to get everyone in and out of the mine. Mine bosses also needed to work out how much coal could be transported from the coal face efficiently. We are going to look at the numbers of people working underground in the mine during 1 whole day in the 1940s. In a typical day, there were 300 men working underground at Big Pit, with each one working for one shift.

Day shift: 150 men Afternoon shift: 100 men Night shift: 50 men

The lift cage could carry around 20 men at one time.

Complete the Activity Sheet to work out how many lift trips were needed to carry the men down the mine.

We also need to know how many loads of coal were transported up from underground by the lift.

Coal was loaded into small trucks, called 'drams'. 1 dram carried 1 tonne of coal.

2 drams would come up in the cage at any one time.

During both the day shift and the afternoon shift, there would be 20 men cutting coal at the coalface itself.

The number of drams filled would vary for example

5 men would fill 8 drams each per shift.

10 men would fill 4 drams each per shift.

3 men would fill 2 drams each per shift.

2 men would fill 1 dram each per shift.

The night shift would produce only 2 drams of coal in total plus 5 drams of waste - this was the maintenance shift.

Use this information to answer questions in the Activity Sheet.

## Extending

this activity
Whenever possible,
the lift would not travel empty. So, if men were carried down, coal
might then be carried up. Try to work out
the smallest possible
number of complete
trips (that's down and
up) that could be made
in each shift. This does
NOT just mean that
you add up all your
previous answers. Use
the Extension Activity
Sheet 3 : Total number of lift trips.

## Extending this activity <br> in a different context

Around half the men would have a cup of tea in the Big Pit canteen at the end of each shift. Can you
work out how many cups of tea were
made in 10 years?

## Resources and equipment needed for this activity

Pens or pencils, calculators (if needed)

Activity Sheet 1 :
How many trips?
Activity Sheet 2:
How many trips
carrying coal?

Extension Activity Sheet 3:
Total number of trips
Activity Sheet 4: Thirsty work

## ACTIVITY SHEET 1

## How many trips?



We are going to look at the numbers of people working underground in the mine during 1 whole day in the 1940s. In a typical day, there were 300 men working underground at Big Pit, with each one working for one shift:

## Day shift: 150 men <br> Afternoon shift: 100 men <br> Night shift: 50 men

The lift cage could carry around 20 men at one time. Complete the Activity Sheet to work out how many trips were needed to carry the men down the mine.
Round up your answer to the nearest whole number.

How many trips were needed per day to carry the men DOWN?

1. Number of trips down needed for the day shift men.

2. Number of trips down needed for the afternoon shift men. $\square$
3. Number of trips down needed for the night shift men. $\square$
4. Total number of trips down per whole day for the men. $\square$

How many trips were needed per day to carry the men UP at the end of all the shifts?
5. Total number of trips up per whole day for the men. $\square$
6. What assumptions have you had to make in your calculations?
$\square$
7. Why is it not correct to add up all the men first then divide to find the number of trips?

## ACTIVITY SHEET 2

## How many trips carrying coal?

We also need to know how many loads of coal were transported up from underground by lift. Coal was loaded into small trucks, called 'drams'.

## 1 dram carried 1 tonne of coal.

2 drams would come up in the cage at any one time.
During both the day shift and the afternoon shift, there would be 20 men cutting coal at the coalface itself. 5 of these men would fill 8 drams each per shift.
10 men would fill 4 drams each per shift. 3 men would fill 2 drams each per shift. 2 men would fill 1 dram each per shift. The night shift would produce only 2 drams of coal in total plus 5 drams of waste - this was the maintenance shift.
Use this information to answer the questions.

## How many trips were needed per day to carry the coal UP?

1. Total number of drams of coal produced during the day shift.

2. Number of trips up needed for getting the coal to the surface $\square$ during the day shift.
3. Total number of drams of coal produced during the afternoon shift.

4. Number of trips up needed for getting the coal to the surface during the afternoon shift.

5. Total number of drams of coal and waste produced during the night shift.

6. Number of trips up needed for the night shift coal and waste.
$\square$
7. Total number of trips up per whole day for coal and waste.

## EXTENSION ACTIVITY SHEET 3

## Total number of trips

Whenever possible, the cage lift did not travel empty. So, if men were carried down, coal might then be carried up. Try to work out the smallest possible number of complete trips (that's down and up) that could be made in each shift.

This does NOT just mean that you add up all your previous answers.

## 1. Day shift

Number of trips down for the men
Number of trips up for the men
Number of trips up for the coal

## 2. Afternoon shift

Number of trips down for the men $\square$
Number of trips up for the men


Number of trips up for the coal


## 3. Night shift

Number of trips down for the men $\square$
Number of trips up for the men
Number of trips up for the coal

$\square$
5. How many complete trips were made per year? (Assume that the mine was fully working for 6 whole days per week and for 52 weeks per year.)
4. How many complete trips were made per whole day.


## ACTIVITY SHEET 4 <br> Thirsty work

Around half the men would have a cup of tea in the canteen at the end of each shift.

1 How many cups of tea were drunk in the canteen during each whole day?
$\square$
2. How many cups of tea were drunk in the canteen during a whole year? (Assume that the mine was fully working for 6 whole days per week and for 52 weeks per year.)
$\square$
3. How many cups of tea were drunk in the canteen during 10 years?


## Wool

## to Woven




## Curriculum Link

Perform numerical calculations aiding their metal arithmetic and calculating ability.


## Museum Link

Develop numerical skills while following the trail at the woollen mill, from wool to woven.


## Details of the activity for teachers

At the National Wool Museum find the display with the old-fashioned shears. In the past these were used to remove the sheep's fleece. It was a time consuming job.

It took 8 times longer than modern shearing equipment. Follow the process from the shearing of the sheep to the weaving of the cloth using the Resource Sheets provided.

## Extending

this activity
Mathematics within a
scientific experiment.
Carry out an experiment
to show which fabric
makes the best
insulator.

## Adapting this activity

This activity could be adapted to a context involving the process of coal mining.

## Resources and equipment needed for this activity

Clipboard, pencil, graph paper (optional), stopwatch, sheep dot to dot and calculator

Activity Sheet 1:
Wool to Woven
Activity Sheet 2:
Willowing

Activity Sheet 3:
Carding
Activity Sheet 4: Spinning and Winding

Activity Sheet 5:
Weaving

Don't forget the resources and equipment needed


## ACTIVITY SHEET 1

## Wool to Woven

## Sheep Shearing Competition

Divide your class into two or more teams. Ask each team to nominate a question master and a time keeper. The remaining members of the team will take it in turn to stand on the "hotspot" to answer a question.

An adult will referee the competition awarding a mark for each correct answer by the team. The team that finishes shearing the sheep (i.e. completing the sheep dot to dot) in the fastest time will win the competition.

## Shearing competition with old fashion shears

Add / deduct 1, 11, 21, 31 $\qquad$ or 91 to a given number, example $30-1=29 ; 30+21=51$; $30+91=121 ; 30-21=9$. When your answer is correct you can join 2 dots in the picture below. The first to join all the dots wins.

## Dot to Dot



## ACTIVITY SHEET 1

## Willowing

The fleece is put through a willower. This untangles the wool, removes impurities such as dust and sand and disentangles it on a roller with metal teeth to create a soft, fluffy mass of fibres. Approximately $10 \%$ of the wool counts as waste at this stage.


Choose a weight, deduct $10 \%$ to find out the amount that's left.

| Amount in | Deduct 10\% | Amount Left |
| :--- | :--- | :--- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |



## ACTIVITY SHEET 3

## Carding

Carding produces fully disentangled, soft rolls of wool called rovings or rolags, for spinning into yarn. Originally done by hand, a carding engine was invented about 140 years ago. Oil and water is added to the wool at this stage of the process. These measurements are known as imperial measurements.


Use the graph to work out how much oil and water you need to add to the amount of wool used in the carding process. For example when carding 30lb of wool, you would need to use approximately 2 pints of oil and 1.8 pints of water.


Shows the combination of wool to water

## ACTIVITY SHEET 4

## Spinning and Winding

Spinning pulls and twists the fibres together to form a continuous thread. This turns the soft wool into strong woollen yarn. Before machines a portable spindle and whorl was used. In the 19th century fast and efficient spinning machines were invented, transforming the woollen industry. Winding, unwinding and winding again are all essential processes in preparing yarn for weaving. Each of the bobbins on the winding machine contains 300 meters of thread and weighs about 60 grams. Each 100 meters of thread therefore would weigh 20 grams.

## Matching game

Match the length with the correct weight.


## ACTIVITY SHEET 5

## Weaving

1.3 kg of wool is required to weave a blanket of $2.5 \mathrm{~m}^{2}$

Imagine that the blanket consisted of 3 colours in the ratio 50:30:20

How much wool of each colour would you require?

## Colour A

50\% (half) of the total wool needed $50 \%$ of $1.3 \mathrm{~kg}=650 \mathrm{~g}$

## Colour B

30\% of the total wool needed
$30 \%$ of $1.3 \mathrm{~kg}=390 \mathrm{~g}$

## Colour C

20\% of the total wool needed $20 \%$ of $1.3 \mathrm{~kg}=260 \mathrm{~g}$

Change the ratios and number of colours and calculate the amount of each colour wool you need in order to produce your blanket.

Colour A


## Colour C

Create your own blanket using 3 colours. Calculate the amount of each colour wool you need.
Colour A


## Colour C

# Measure 



The Rhyd-y-Car cottages at the Museum

St Fagans National History Museum

## Building

## houses



## Details of the activity for teachers

By the end of the Second World War in 1945, the number of people made homeless in Britain was 2.25 million.

The aluminium bungalows like the one at the Museum were made in factories that once produced aircrafts.

They were called Pre-fabricated houses. Completed houses came off the production line at the rate of one every twelve minutes.

Explore the features of this house.

Your task is to build and assemble a house.

Use the drawing provided as a guide.

You need to draw an accurate version and cut it out to assemble your house.

Your finished house will have an approximate scale of $1: 80$. This means that 1 cm on your house represents 80 cm in real-life.

## Extending

this activity
Use the numeracy
activity provided to
answer questions
without a calculator.
Design a net and
build a house with a
non-rectangular base
e.g. with an L-shaped
floor plan.
Research different
types of pre-fabricated
houses currently
available all over
the world.

## Adapting this activity

You could adapt this activity for use in
other museums.

## Resources and equipment needed for this activity

Paper or card (possibly with 1 cm squares), pencils, coloured pencils, rulers, scissors and glue

Calculators may be required

## Activity Sheet 1:

Building a
pre-fabricated house
Activity Sheet 2:
Pre-fab house
production numbers

Don't forget the resources and equipment needed

## ACTIVITY SHEET 1

## Building a pre-fabricated house

Your task is to draw and assemble a house. The drawing is not accurate and should be used as a guide. You need to draw an accurate version and cut it out. Then assemble your house.

Your finished house will have an approximate scale of 1:80. This means that 1 cm on your house represents 80 cm in real-life. You may wish to use squared paper.

If possible, use thin card. You should use the joining tabs (shown in grey) to stick the house together. They should be less than 0.5 cm thick each time.
If you have time, add windows and a door, and possibly a floor plan (to include living room, kitchen, 2 bedrooms + bathroom with doors to go from one room to the next).

If you are really ambitious, you can add a chimney (bearing in mind that it must sit on a sloping roof). You may wish to decorate the outside of your house with drawings of garden plants.



## ACTIVITY SHEET 2 <br> Pre-fab house production numbers

Answer the following questions without a calculator where possible.

1. Write the number 2.25 million in full.
$\square$
2. Complete this box of useful facts before answering the questions that follow.

| 1 minute $=\ldots \ldots$. $\ldots$. seconds | 1 day = | hours | 1 year = .-.-.-.-. - days |
| :---: | :---: | :---: | :---: |
| 1 hour = _-. . . minutes | 1 week = |  |  |

3. One completed pre-fabricated house came off the production line every 12 minutes. Describe an activity you could do that might take 12 minutes.
$\square$
4. How many seconds are there in 12 minutes? Show your calculation.
$\square$
5. How many houses could be produced in 1 hour?
6. How many houses could be produced in 1 day?

## ACTIVITY SHEET 2

## Pre-fab house production numbers

7. How many houses could be produced in 1 week?
8. How many houses could be produced in 1 year?
9. How many houses could be produced by 2 factories in 1 year?
10. How long would it take 1 factory to produce 600 houses?
11. How long would it take 10 factories to produce $1,000,000$ houses?
12. What assumption did you need to make in answering questions 5 to 11 ?

St Fagans National History Museum

## The Gardener's

## Challenge



What do the vegetables need in order to grow well?


## Curriculum Link

Solve problems within the context of an area. Draw to scale in order to show the measurements of the area.


## Museum Link

In this workshop, the pupils have an opportunity to develop their understanding of area as they pay a visit to the Rhyd-y-Car cottages. They will be required to design a plan of the produce grown in the cottage gardens.


## Details of the activity for teachers

In the nineteenth century, there were no synthetic pesticides or fertilizers available. Gardeners needed to plant their gardens carefully in order to maintain the health of their soil. They would do this by rotating crops, applying both green and animal manure, and allowing areas to lie fallow in order to regenerate. Rotating crops helped maximise yield and reduce problems with pest and disease.

Each year the gardeners at St Fagans plan the garden at each of the six Rhyd- y -Car cottages.

Look at Activity Sheet 1: The gardener's challenge. The pupils' challenge is to plan a vegetable plot to grow all the vegetables required.

## Extending

this activity
Find a recipe of your
choice and then prepare
a meal using at least
3 items of garden
produce.

## Adapting this activity

This activity can be
adapted for the
quarrymen's cottages
at the National Slate
Museum at Llanberis.

## Resources and equipment needed for this activity

Squared paper, pencil, ruler, crayons or coloured pencils and calculator (optional)

Activity Sheet 1:
The gardener's challenge

Don't forget the resources and equipment needed

## ACTIVITY SHEET 1

## The gardener's challenge

You are a resident in one of the Rhyd-y-Car cottages.
Your challenge is to grow:

- Between $20 \mathrm{~m}^{2}$ and $30 \mathrm{~m}^{2}$ of potatoes
- Between $15 \mathrm{~m}^{2}$ of $25 \mathrm{~m}^{2}$ of runner beans
- Between $10 \mathrm{~m}^{2}$ and $20 \mathrm{~m}^{2}$ of cabbages
- Between $8 m^{2}$ and $20 m^{2}$ of leeks
- Between $8 \mathrm{~m}^{2}$ and $15 \mathrm{~m}^{2}$ of turnips
- Between $5 m^{2}$ and $10 m^{2}$ of peas
- Between $12 \mathrm{~m}^{2}$ and $18 \mathrm{~m}^{2}$ of broad beans

And leave between $5 \mathrm{~m}^{2}$ and $10 \mathrm{~m}^{2}$ to lie fallow.
Draw a plan on squared paper, showing how you would arrange your vegetable plots so that you can grow all (but no more) than is required. Assume the garden measures 25 m long by 5 m wide. A straight path 1 m wide needs to run the whole length of the garden. You can locate this path wherever you like in the garden.

Extending the difficulty of the task:

- Each particular vegetable plot must be a square or rectangular shaped block.

Prepare a plan for the following year bearing in mind that due to crop rotation you cannot plant the same vegetable in the plot it occupied during the previous year.

- Research how many plants can be planted in each meter square, and order the correct number of plants or seeds for your garden.




## How steep is

 your slope?


## Curriculum Link

Develop your knowledge and understanding of measuring gradient. Practice data handling skills.


## Museum Link

Do you understand the meaning of gradient and how to measure gradient? Carry out an investigation into the effect of varying the gradient of a slope by using a working model of the incline.


## Details of the activity for teachers

In order to climb or descend from one level to another you must navigate a slope. Some slopes are very steep, while others are very gentle.

A good skier would be happy to ski on a very steep slope, while a poor skier would rather a gentler slope.

In mathematics, the steepness of a slope is measured by its gradient. Look at the incline in the quarry. What words would you use to describe this slope?

To measure the gradient of a slope all you need to do is measure vertical and horizontal lines. Look around you to find examples of vertical and horizontal lines.

## Extending

this activity
Is it possible for anything to roll uphill?
Investigate the
mechanical puzzle of
William Laybourne's
(1627-1719) uphill
roller.

## Additional <br> resources

A working model
of the incline.

Resources and equipment needed for this activity

Dot paper, colouring Activity Sheet 1: pencils, measuring tape, a ruler and a stick

The gradient of a slope

Activity Sheet 2:
Measuring the time it takes up and down the incline

Don't forget the resources and equipment needed

## ACTIVITY SHEET 1

## The gradient of a slope

We measure the gradient by dividing the rise by the run.

- Rise is how far up (vertically)
- Run is how far along (horizontally)



Gradient $=8 \div 4=2$

Measure the gradient Look around for levels on which you can rest a stick so that one end is off the ground, and the other end touches the ground.

Use a measuring tape to measure the rise. Do the same for the run. Now use the formula to measure the gradient of your slope.


## ACTIVITY SHEET 2

## Measuring the time it takes to move up and down the incline

The purpose of the incline was to use the slope to transport the slate effectively from one level to another. You can see the carriages in the photograph moving up and down the incline. The force of gravity would pull the carriage full of slate from the top of the incline, to the bottom.

As the loaded carriage descended, a pull force would draw the empty carriage at the bottom of the incline, upwards.

Measure the weight of the your load and the angle of the incline. Then record the time it takes an empty carriage to move from the bottom to the top of the incline. Record your results in the form of a table.

| Angle <br> Load | Steep Slope $\left.{ }^{\circ}{ }^{\circ}\right)$ | Moderately Steep Slope ( ${ }^{\circ}$ ) | Gentle Slope $\left({ }^{\circ}\right)$ |
| :---: | :---: | :---: | :---: |
| Heavy load (gram) |  |  |  |
| Moderately <br> heavy load <br> (gram) $\square$ |  |  |  |
| Almost empty load (gram) |  |  |  |

Predict what would happen if both carriages were completely empty. Think of a way to display your information.

Either use the incline at the National Slate Museum or create your own model of an incline.


## Counting Ladies and Quarrymen



Where else have you seen things made out of slate?


## Curriculum Link

Develop an understanding of measuring an area of regular and irregular shapes.

## 111 <br> Museum Link

Welsh slates may well be the best in the world as they are easy to split yet very strong. These qualities mean that they are particularly suitable for roofs. Water and ice don't affect them at all. The slates were called by different names according to their sizes from 'Ladies' to 'Countesses' and 'Duchesses' and 'Princesses' to the 'Queens'. Arrays of slates of differing sizes are on display at the Museum.

## Details of the activity for teachers

We can measure regular and irregular areas by counting the number of whole and partly covered squares.

## What does perimeter mean?

## What is area?

A constant sized perimeter does not mean that the area contained within will also be constant.

The slate quarried at Dinorwig and other north Wales quarries has been used to tile roofs throughout the world. The refurbishment of 10 Downing Street in the 1960s used slate from
the Penrhyn Quarry. The Wales Millennium Centre in Cardiff Bay is also built using Welsh slate.

The amount of slate needed for the job depends on the area of the aspect.

## How do we measure the area?

To estimate the area without doing complex sums use a grid and count the squares. Measure a piece of string (between 30 cm and 50 cm is a good length) and tape the ends together to form a loop. Place the loop on squared paper, and count the number of whole squares within the loop.

If the loop covers bits of squares, estimate the fraction of each square covered, and add up the fractions. Add this total to your whole square area to calculate the area of your shape.

Experiment using regular and irregular shapes. Your loop (known as the perimeter) is a constant length.

What do you notice about the area?

## Extending

this activity
The number of tiles needed to cover a specified area varies with the size of the tile.
Imagine you want to tile
a roof of a building.
Select some metric
measurements for the
height and length of the
roof. Remember it has a
front aspect and a rear
aspect. Select which
tile size you wish to
use. Use the metric
measurements.
For added difficulty:
allow an overlap of
5 cm per row of tiles.

## Adapting this activity

Calculating the area of tessellating
patchwork shapes.


## Resources and equipment needed for this activity

Squared paper, thin string, adhesive tape, new clay, rolling pins, knife to cut the clay and A4 size paper

Activity Sheet 1:
Counting tiles
Activity Sheet 2:
All kinds of Ladies

Don't forget the resources and equipment needed


## ACTIVITY SHEET 1

## Counting tiles



A good slate splitter could split the slate into tiles of 5 mm thick. Roll out a sizable lump of new clay or salt dough to a thickness of 5 mm . From your dough cut rectangles measuring 6 cm by 5 cm . You will need to roll and cut out enough rectangles laid out edge to edge to cover a sheet of A4 paper.

How many rectangles did you need to cut out?
$\square$
Is there a quick way to count your tiles?

Vary the measurements of your tiles for example 5 cm by 4 cm .
What is the minimum number of tiles you will need to cover your A4 paper now?

## ACTIVITY SHEET 2

## All kinds of Ladies

After splitting the slate, it was trimmed into various sizes to be sold. The tile size was given a name. The names and sizes of the tiles are shown in this table:

| Name | Imperial measurement |
| :--- | :--- |
| Princesses | $24^{\prime \prime} \times 14^{\prime \prime}$ |
| Duchesses | $24^{\prime \prime} \times 12^{\prime \prime}$ |
| Countesses | $20^{\prime \prime} \times 12^{\prime \prime}$ |
| Narrow Countess | $20^{\prime \prime} \times 10 "$ |
| Wide Ladies | $16^{\prime \prime} \times 12^{\prime \prime}$ |
| Broad Ladies | $16^{\prime \prime} \times 10 "$ |
| Narrow Ladies | $16^{\prime \prime} \times 8 "$ |
| Drains | $9 " \times 41 / 2 "$ |



## Imperial to Metric

## Converting Measurements

Construct a conversion graph that will help you convert the imperial measurements into metric measurements. One inch is approximately equal to $21 / 2 \mathrm{~cm}$.

| Name | Imperial measurement | Total size in inches | Total size in meters |
| :--- | :--- | :--- | :--- |
| Princesses |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

## Tessellating

Shapes


How did some people in the past entertain themselves before the invention of modern-day electronic gadgets?



## Curriculum Link

In these activities, the pupils have an opportunity to investigate the world of shape. This will include looking at tessellating shapes, and investigating the relationship between regular shapes and their internal angles.


## Museum Link

In this workshop the woollen blankets on display at the National Wool Museum form the inspiration that leads to investigating tessellating shapes, angles and area.


## Details of the activity for teachers

Explore the blankets in the Museum.

Regular tessellation is when one regular shape will fit together with no overlaps or gaps. Here are tessellating regular hexagons. Cut out regular shapes (squares, triangles etc.) from A4 paper and experiment to see whether they will tessellate.

Investigate whether all triangles and all quadrilaterals will form a regular tessellation. Irregular tessellation are when more than one shape is used to tessellate.

Experiment as before with 2 different shapes to make a tessellating pattern. (Triangles with rhombi, and octagons with squares make good combinations).

Explain why these shapes make successful tessellating partners.

Complete Activity Sheet 1: Investigating regular shapes and angles.

## Extending

this activity
Make your own
handmade tessellating patchwork.

3D tessellation
Take a close look at a
football. What regular
shapes have been
used in combination
to create this spherical
shape?
Draw what your net
would look like if laid
out flat.
Does it tessellate when laid out flat? Explain
why or why not.

## Adapting this activity

Use "polydron"
mathematics product
to build your own 3D
tessellating shapes.
Use a tangram, an
ancient Chinese puzzle.
After measuring
and cutting out the
appropriate pieces,
the pupils could
explore the myriad of
different images made
by combining these
simple seven shapes.
For those interested in
competitive activities,
there is a bingo
board game involving
tangram pieces that
the pupils can design
and build.

## ACTIVITY SHEET 1

## Tessellating shapes

## Regular tessellation

Regular tessellation is when one regular shape will tessellate.

Take a look at the pattern in the quilt of tessellating regular hexagons.

Experiment with other regular shapes to see whether they will tessellate.

Investigate to find out whether all triangles and all quadrilaterals will form a regular tessellation.

## Irregular tessellation

Here, more than one shape is used to tessellate.
Experiment with various shapes to make a tessellating pattern.

Remember that triangles with rhombi, and octagons with squares make good combinations.

Explain why these shapes make successful tessellating partners.


## A woollen blanket


$\square$

## ACTIVITY SHEET 1

## Tessellating shapes

## 3D tessellation

Take a close look at a football.


What regular shapes have been used in combination to create this spherical shape?
$\square$
Draw what your net would look like if laid out flat.
$\square$
Does it tessellate when laid out flat?
Explain why or why not.

## ACTIVITY SHEET 2

## Investigating regular shapes and angles

This regular shape has 6 sides. It can be divided into 4 triangles.


Divide some other regular shapes into triangles.


What relationship can you see between the number of sides and internal triangles?

## ACTIVITY SHEET 2

## Investigating regular shapes and angles

Sum of the internal angles


If the sum of the internal angles of a triangle is always $180^{\circ}$, calculate the sum of the internal angles of the above shapes.

| Number of sides | Number of triangles | Sum of internal angles | Sum of internal angles <br> $\div$ number of sides |
| :--- | :--- | :--- | :--- |
| 4 sides |  |  |  |
| 7 sides |  |  |  |
| 10 sides |  |  |  |

## EXTENDED ACTIVITY SHEET 1

## Tangrams

A tangram is a popular ancient Chinese puzzle.
Using squared paper, reproduce the square as shown. Cut the square into the 7 tangram pieces. Use all 7 pieces to build each of the figures in turn. Can you explain why the images are different yet measure exactly the same surface area? You may like to trace both images on squared paper and compare the squares to see where the difference lies.


There are hundreds of images you can make using the seven tangram pieces. Look on the internet for some you could copy. You could even have a go at devising your own image with the seven tangram pieces.

## ACTIVITY SHEET 2

## Tangrams

Make a tangram bingo board game.
The objective is to collect the shapes you need to make a tangram image. Use a dice to move around the board collecting the various tangram pieces. The winner is the player who can complete the tangram shapes on the bingo board. An example is given, though you can be as creative as you like with the options on the boards.


## ACTIVITY SHEET 2

## Tangrams

## Insert tangram image here

Insert tangram image here

Insert tangram image here

Insert tangram image here

## Data



Collecting the census through
role play at the Museum


The National
Waterfront Museum
in Swansea

## Census

 taking

Curriculum Link
Using data skills

How many people live
in your house?

Can you think of some reasons why the government might need to know details about the population?

How many people live in the house next door?


## Museum Link

The exhibit showing details of the 1851 census forms the inspiration for this activity. The information is stored on three computers, each computer containing the census details of 4 dwellings.


## Details of the activity for teachers

A census is the procedure of systematically acquiring and recording information about the members of a particular population. It is a regularly occurring and official count. Other common censuses include agriculture, business, and traffic censuses.

Use the information in the gallery about life in 1851, at the National Waterfront Museum in Swansea. We've included some of this information on the resource sheets here for you. The properties are all dwellings that were close to the current location of the Museum.

They contain a wealth of interesting information which can be recorded in a variety of ways. Then use the questions provided as examples to interpret and analyse the data provided on the resource sheets.

## Extending

this activity
Use the information
to create your
own database.
Carry out research on
the 1861 census. Can
you identify some of
the individuals from
the 1851 census? www.
ukcensusonline.com

## Adapting this activity

Take a census of your class. Decide on the information you would like to collect. For example - who lives in your house? You could also collect details
about the pets, cars, electronics, pocket money etc.

Access to the census data held on the computer, or a hard copy of the information. Paper, pencil, graph paper, ruler, protractor, coloured pencils.

## Activity Sheet 1:

Recording and analysing data

Resource Sheets: 1, 2 \& 3
Data

Don't forget the resources and equipment needed


## ACTIVITY SHEET 1

# Recording and analysing data 



## Tables

A table is a useful way to write down a number of pieces of information about different things. You could start by recording the information for each of the dwellings in a suitable table. Think about the title you want to give to the table. What headings will you need?

## Tally Marks

We use tally marks to count. Think about what you want to count, and how you are going to record the information. For example, you could use a tally system to count how many males

| Heading | Heading | Heading |
| :--- | :--- | :--- |
| Information | Information | Information |
| Information | Information | Information |
| Information | Information | Information | lived in each dwelling.

## Bar charts

Bar charts are one way of showing the information from a frequency table. Use bar charts for discrete information. You could record the ages of each individual living in a particular dwelling. Which of the dwellings is the best to give you a range of different ages? Think about how you will label your chart using title and

| Heading | HH |
| :--- | :--- |
| Heading | HH III |
| Heading | HH I | axes. Do you need a key?

## ACTIVITY SHEET 1

## Recording and analysing data

## Histogram

Another way of showing the information is in a histogram. A histogram is slightly different from bar charts, as it is used to record continuous rather than discrete data. You could show a histogram of all the females between certain ages. Think about the category size. How can you avoid gaps? How can you include every member? What system might you use to count
 the number of women in each age category?

## Pie charts

Pie charts are another way of representing information. Each segment represents a fraction of the total amount. For example you could use a pie chart to display the place of birth of the inhabitants within a dwelling. You will need to think about the criteria of each category (segment). How can you avoid the situation where an inhabitant falls into more than one category?


## Caroll diagram

A Carroll diagram is used for grouping things in a yes/no fashion. You could use the census categories information to complete the Carroll diagram

| Address of <br> dwelling | Born in <br> Swansea | Not born in <br> Swansea |
| :--- | :--- | :--- |
| Head / Family <br> member | Information | Information |
| Not a family <br> member | Information | Information |

## Population: 6 Wind Street



Yellow group list of females

Blue group list of children (under 16 years)

Green intersection -

Intersections:
Orange $=$ female
family members
Purple = family members
less than 30 years old
Green = female's less
than 30 years old
Brown = female family members
less than 30 years old
list of female children
In white area -
none of the above
i.e. male adults

## Population: Males residing at 20 Little Wind Street



Light purple group male lodgers

Dark purple group male lodgers who are married

White -
male non-lodgers

| Yellow group - <br> list of all females | Intersections: |
| :--- | :--- |
| Blue group - <br> less than 30 years old | Orange = female <br> family members |
| Red group - <br> list of family members | Purple = family members <br> less than 30 years old |
| White area - <br> none of the above <br> i.e. male non-family <br> members of 30 years and over. | Green = female's less <br> than 30 years old |
| Brown = female family members |  |
| less than 30 years old |  |

## Interpreting Data

What does the information suggest to you? Ask some questions such as:

- Is this a wealthy or a poor dwelling? What are the clues?
- Is this a family dwelling? How can we tell?
- Why would there be more visitors in one of the properties (10 Wind Street) than in the others? How can we make this assumption?


## Data

The average is a number expressing the central or typical value in a set of data. Statisticians use three different methods to ascertain an "average" value.

## The mean

This method involves adding the numbers together and dividing the total by the amount of numbers.

## Use the Formula Total age $\div$ No of inhabitants to answer the following question:

Q
Find the mean age of the inhabitants at the Royal Institute of South Wales.
A
$(47+7+13+11+9) \div 5=17.4$ years
Discuss the pros and cons of using this method of calculation.
The median
If you place a set of numbers in order, the median number is the middle one.
If there are two middle numbers, the median is the mean of those two numbers.
Q
Find the median age of the inhabitants at the Royal Institute of South Wales.
A
$\begin{array}{lllll}7 & 9 & 11 & 13 & 47\end{array}$
What are the good and bad points of using this method of calculation?
The mode
The mode is the value that occurs most often.
There is no modal number for the inhabitants of the Royal Institute of South Wales as all the inhabitants are of different ages.

Can you find the address of a dwelling where there is a modal average?
What does this suggest about the relationship of the inhabitants?
The range
The range is the difference between the highest and lowest values in a set of numbers. To find it, subtract the lowest number in the distribution from the highest.

Can you find the address of the dwelling with the highest and lowers range?
How would you go about arranging all the information in order to calculate the highest and lowest range?

## RESOURCE SHEET 1

Data 1

## 4 Anchor Court

Name: Samuel Hughes
Relation to head: Head
Status: Married
Age: 54
Employment: Channel Pilot
Place of birth: Swansea

Name: Mary Hughes
Relation to head: Wife
Status: Married
Age: 52
Employment: Housewife
Place of birth: Swansea

Name: Catherine Hughes
Relation to head: Daughter
Status: Not known
Age: 23
Employment: Not known
Place of birth: Swansea
Name: Eleanor Hughes
Relation to head: Daughter
Status: Not known
Age: 17
Employment: Seamstress
Place of birth: Swansea
Name: Samuel Hughes
Relation to head: Son
Status: Not known
Age: 17
Employment: Not known
Place of birth: Swansea

## 17 Wind Street

Name: Ebenezer Pearse
Relation to head: Head
Status: Unmarried
Age: 28
Employment: Bookseller, Stationer and Printer
Place of birth: Bristol

Name: Elizabeth Pearse
Relation to head: Mother
Status: Widowed
Age: 52
Employment: Proprietor of houses
Place of birth: Launceston

Name: John W. Pearse
Relation to head: Brother
Status: Unmarried
Age: 29
Employment: Corn factor
Place of birth: Yeovil

Name: Sarah G. Pearse
Relation to head: Sister
Status: Unmarried
Age: 14
Employment: Scholar
Place of birth: Crewkerne
Name: Charles T. Pearse
Relation to head: Brother
Status: N/A
Age: 12
Employment: Scholar
Place of birth: Crewkerne

Name: Charles Britten
Relation to head: Assistant
Status: Unmarried
Age: 25
Employment: Assistant
Place of birth: West Indies - British Subject

## Royal Institute of South Wales

Name: May Ivy
Relation to head: Housemaid
Status: Unmarried
Age: 30
Employment: Housemaid
Place of birth: Crewkerne
Name: Hugh Mahony
Relation to head: Resident Curator
Status: Married
Age: 47
Employment: Museum curator
Place of birth: Ireland

Name: Hugh Mahony
Relation to head: Son
Status: N/A
Age: 7
Employment: Scholar
Place of birth: Swansea
Name: Ellen Mahony
Relation to head: Daughter
Status: N/A
Age: 13
Employment: Scholar

Name: Elizabeth Mahony
Relation to head: Daughter
Status: N/A
Age: 11
Employment: Scholar
Place of birth: Swansea

Name: Catherine Mahony
Relation to head: Daughter
Status: N/A
Age: 9
Employment: Scholar
Place of birth: Swansea

## 5 York Street

Name: Thomas Prater
Relation to head: Head
Status: Married
Age: 43
Employment: Housebuilder
Place of birth: Portreath, Cornwall
Name: Margaret Prater
Relation to head: Wife
Status: Married
Age: 46
Employment: Not known
Place of birth: Swansea
Name: Frances Prater
Relation to head: Daughter
Status: N/A
Age: 13
Employment: N/A
Place of birth: Swansea

Name: Alfred Prater
Relation to head: Son
Status: N/A
Age: 11
Employment: N/A
Place of birth: Swansea

Name: Margaret Prater
Relation to head: Daughter
Status: N/A
Age: 6
Employment: N/A
Place of birth: Swansea

Name: Edward Prater
Relation to head: Son
Status: N/A
Age: 4
Employment: N/A
Place of birth: Swansea

Name: George Taylor
Relation to head: Lodger
Status: Unmarried
Age: 23
Employment: Solicitor's clerk
Place of birth: N/A
Name: Margaret Prytharsh
Relation to head: Lodger
Status: Widow
Age: 40
Employment: Freehold proprietress
Place of birth: Stranthford

Name: Mary Hammon
Relation to head: Lodger
Status: Unmarried
Age: 73
Employment: Spinster
Place of birth: Fishguard
Name: Martha Williams
Relation to head: Lodger
Status: Unmarried
Age: 56
Employment: Spinster
Place of birth: Killamarsh
Name: Thomas Wilson
Relation to head: Lodger
Status: Unmarried
Age: 26
Employment: Ship broker and Sail Maker
Place of birth: Durham, Sunderland
Name: William Butler
Relation to head: Lodger
Status: Unmarried
Age: 26
Employment: Landscape painter and Art teacher
Place of birth: Killamarsh, Derbyshire

## RESOURCE SHEET 2 <br> Data 2

## 2 Burrows Road

Name: Dr George Gwynne Bird
Relation to head: Head
Status: Married
Age: 48
Employment: Doctor, Magistrate, Alderman FCS
Place of birth: Crickhowell

Name: Mary Gwynne Bird
Relation to head: Wife
Status: Married
Age: 44
Employment: Housewife
Place of birth: Swansea
Name: George Gwynne Bird
Relation to head: Son
Status: N/A
Age: 6
Employment: N/A
Place of birth: Swansea
Name: Mary Gwynne Bird
Relation to head: Daughter
Status: N/A
Age: 4
Employment: N/A
Place of birth: Swansea

Name: William Evans
Relation to head: Servant
Status: Married
Age: 26
Employment: House Servant
Place of birth: Pembroke
Name: Mary Williams
Relation to head: Servant
Status: Unmarried
Age: 19
Employment: House Servant
Place of birth: Pontardullais

Name: Jane Morris
Relation to head: Servant
Status: Unmarried
Age: 22
Employment: House servant
Place of birth: Llanwenarth, Monmouthshire

## 6 Wind Street

Name: Bernard Hennessy
Relation to head: Head
Status: Married
Age: 28
Employment: Watchmaker and tool maker
Place of birth: Dublin

Name: Elizabeth Hennassey
Relation to head: Wife
Status: Married
Age: 25
Employment: Housewife
Place of birth: Warmister
Name: Bernard Hennessey
Relation to head: Son
Status: Not Applicatble
Age: 5
Employment: Not Applicable
Place of birth: Swansea

Name: Richard Hennessay
Relation to head: Son
Status: Not Applicatble
Age: 3
Employment: Not Applicable
Place of birth: Swansea
Name: Bessy Hennessay
Relation to head: Daughter
Status: Not Applicatble
Age: 18 months
Employment: Not Applicable
Place of birth: Swansea
Name: Margatet Lucus
Relation to head: Servant
Status26
Employment: Nanny
Place of birth: Swansea

## Computer 2-4 Gloucester Place

Name: Starling Benson
Relation to head: Head
Status: Unmarried
Age: 42
Employment: Magistrate
Place of birth: Dulwich

Name: Ann Nash
Relation to head: Servant
Status: Unmarried
Age: 36
Employment: Servant
Place of birth: Swansea

Name: Phoebe James
Relation to head: Servant
Status: Unmarried
Age: 35
Employment: House Servant
Place of birth: N/A

Name: Thomas Anthony
Relation to head: Servant
Status: Unmarried
Age: 44
Employment: House Servant
Place of birth: Cardiff

## Computer 2-20 Little Wind Street

Name: John Williams
Relation to head: Lodger
Status: Married
Age: 31
Employment: Copper Ore labourer
Place of birth: Swansea

Name: John Hicks
Relation to head: Lodger
Status: Married
Age: 53
Employment: Publican and agricultural labourer
Place of birth: Pitham, Cornwall
Name: Elizabeth Hicks
Relation to head: Lodger
Status: Married
Age: 49
Employment: Publican
Place of birth: Clawton, Devon

Name: Hannah
Relation to head: Daughter
Status: N/A
Age: 19
Employment: N/A
Place of birth: Halsworthy, Devon

Name: Samuel
Relation to head: Son
Status: N/A
Age: 12
Employment: N/A
Place of birth: Swansea

Name: David
Relation to head: Son
Status: N/A
Age: 7
Employment: N/A
Place of birth: Swansea
Name: Henry Smith
Relation to head: Lodger
Status: Unmarried
Age: 29
Employment: American Seaman
Place of birth: Not known

Name: John Thomas
Relation to head: Lodger
Status: Unmarried
Age: 22
Employment: Farmer's man
Place of birth: Barnstaple

Name: John Stephens
Relation to head: Lodger
Status: Unmarried
Age: 21
Employment: Farmer's man
Place of birth: Barnstaple

Name: Charles Mackhearling
Relation to head: Lodger
Status: Not known
Age: 47
Employment: British Seaman
Place of birth: Not known
Name: Charles Mickley
Relation to head: Lodger
Status: Unmarried
Age: 35
Employment: British Seaman
Place of birth: Not known - British subject
Name: Thomas Skirrip
Relation to head: Lodger
Status: Widower
Age: 35
Employment: British Seaman
Place of birth: Not known - British subject

## RESOURCE SHEET 3 <br> Data 3

## The Mackworth Arms, 10 Wind Street

Name: Elizabeth Deane
Relation to head: Head
Status: Unmarried
Age: 43
Employment: Innkeeper
Place of birth: Speen, Berkshire
Name: Ann Thomas
Relation to head: Charwoman
Status: Widow
Age: 45
Employment: Charwoman
Place of birth: Cambridge
Name: Mary Wilks
Relation to head: Chambermaid
Status: Unmarried
Age: 32
Employment: Chambermaid
Place of birth: Llansamlet

Name: Esther Jones
Relation to head: Waitress
Status: Unmarried
Age: 24
Employment: Waitress
Place of birth: Swansea
Name: Elizabeth Roberts
Relation to head: Waitress
Status: Unmarried
Age: 22
Employment: Waitress
Place of birth: Pembrokeshire
Name: Jemima Williams
Relation to head: Kitchen Maid
Status: Unmarried
Age: 24
Employment: Kitchen Maid
Place of birth: Holywell, Sir Flint
Name: Edward Thomas
Relation to head: Visitor
Status: Not known
Age: 69
Employment: Commercial Traveller, Soap trade
Place of birth: Bryngan, Hereford

Name: George J. Wait
Relation to head: Visitor
Status: Not known
Age: 35
Employment: Commercial Traveller, Drapery
Place of birth: London

Name: Frederick Meredith
Relation to head: Visitor
Status: Not known
Age: 37
Employment: Commercial Traveller, Drapery
Place of birth: Bristol

Name: Josiah Williams
Relation to head: Boots
Status: Unmarried
Age: 24
Employment: Boots
Place of birth: Swansea
Name: Evan Davies
Relation to head: Boots
Status: Unmarried
Age: 22
Employment: Boots
Place of birth: Llancarfon, Carmarthenshire
Name: William Thomas
Relation to head: Not known
Status: Not known
Age: 50
Employment: Ostler
Place of birth: Colchester
Name: George T. Cowdery
Relation to head: Visitor
Status: Not known
Age: 34
Employment: Commercial Traveller, Chemist and Druggist
Place of birth: Woodhay, Hants
Name: Frederick Ware
Relation to head: Visitor
Status: Not known
Age: 23
Employment: Commercial Traveller, Woollen trade
Place of birth: Cullompten, Devon

## Burrows Lodge

Name: George Grant Francis
Relation to head: Head
Status: Married
Age:37
Employment: Cynghorydd y Dre
Place of birth: Not known

Name: Sarah Francis
Relation to head: Wife
Status: Married
Age: 37
Employment: housewife
Place of birth: South Shields,

Name: George G. Francis
Relation to head: Son
Status: N/A
Age: 7
Employment: N/A
Place of birth: Not known
Name: John Richardson Francis
Relation to head: Son
Status: N/A
Age: 9
Employment: N/A
Place of birth: Not known
Name: Arnold Francis
Relation to head: Son
Status: N/A
Age: 5
Employment: N/A
Place of birth: Not known
Name: James C. Richardson
Relation to head: Visitor
Status: Not known
Age: 33
Employment: Ship owner
Place of birth: South Shields

Name: Not known
Relation to head: Servant
Status: Not known
Age: Not known
Employment: Servant
Place of birth: Not known
Name: Not known
Relation to head: Servant
Status: Not known
Age: Not known
Employment: Servant
Place of birth: Not known
Name: Not known
Relation to head: Servant
Status: Not known
Age: Not known
Employment: Servant
Place of birth: Not known

## 1 Anchor Court

Name: Jane Jones
Relation to head: Head
Status: Widow
Age: 64
Employment: Washing Woman
Place of birth: Llandybie
Name: Philip Jones
Relation to head: Son
Status: Unmarried
Age: 17
Employment: Servant
Place of birth: Swansea

Name: William Newkes
Relation to head: Lodger
Status: Married
Age: 22
Employment: Cabinet maker
Place of birth: Swansea
Name: Mary A. Newkes
Relation to head: Lodger
Status: Married
Age: 28
Employment: Dressmaker
Place of birth: Combe Martin
4 Cambrian Place
Name: Eliza Richardson
Relation to head: Wife
Status: Married
Age: 59
Employment: Shipowner's wife
Place of birth: Northumberland
Name: George Richardson
Relation to head: Son
Status: Unmarried
Age: 18
Employment: Clerk in Bonded Stores
Place of birth: Swansea
Name: Mary Morgan
Relation to head: Servant
Status: Widow
Age: 59
Employment: Cook
Place of birth: Southampton

The National
Waterfront Museum

## Which <br> Direction?




## Curriculum Link

Using eight point compass directions. measuring to scale. Using angles and Bearings regular shapes and their internal angles.


Museum Link
The panoramic view of Swansea Bay on display at the National Waterfront Museum forms the inspiration for this map skills activity.


## Details of the activity for teachers

Which direction?
Have you ever climbed to the top of a hill or a mountain and looked all around?

From your vantage point you can get an unbroken view of the whole surrounding region. This is known as a panoramic view.

The National Waterfront Museum Swansea has a scene of the surrounding area from the top of Kilvey Hill.

Pupils may use an ordinance survey map to:

- find the height above sea level of Kilvey Hill
- identify which the part of the scene you would see when facing due south
- name the easterly and westerly headlands visible from this vantage point.


## Extending this activity

Go exploring in the
environment around your school. Prepare an
orienteering trail using
compass directions or
bearings and distances.

## Adapting this activity

Imagine you are a
Roman general leading
your troops.
Plan a march
from one place to
another. Measure the
directions/ bearings
and distances you
plan to travel with
your legion to get to your destination.

## Additional

## resources

## Compass

Resources and equipment needed for this activity

Items to make a compass: Metal needle, magnet, cork, shallow dish and water

Ordinance Survey map Explorer 165
Protractor and ruler Map of Swansea Bay / Bristol Channel

Activity Sheet 1: How to
make your own compass
Activity Sheet 2:
Eight point compass

## Activity Sheet 3:

Bearings

Don't forget the resources and equipment needed

## ACTIVITY SHEET 1

## How to make your own compass

It is possible to create your own compass in much the same way people did hundreds of years ago.

## You will need:

A metal darning needle
A bar magnet
A cork or piece of polystyrene
A shallow bowl containing approximately 3 cm of water.
The first step is to magnetise the needle. Do this by rubbing the needle with a magnet. Stroke the needle in the same direction, rather than back and forth, using steady, even strokes. Lift the magnet away from the needle after each stroke to reduce the chance of de-magnetising the needle.

After 50 strokes, the needle will be magnetised. Now place your needle on top of the cork, and place the cork (and needle) into the shallow bowl of water.

Due to a lack of friction the cork will rotate in the water, allowing the magnetised needle to spin until it points to the magnetic North Pole.


## ACTIVITY SHEET 2

## Eight point compass

## Recommended Map

(Explorer 165, scale 4 cm to 1 km )
On an Ordnance Survey map, locate the Television Mast on Kilvey Hill (672941).

1. From the mast, ascertain the approximate direction of the following places:

2. Insert the place names on the eight point compass according to their approximate direction.
3. Using your map, measure the distances (as the crow flies) to the named places from the mast at Kilvey Hill.

| Dan-y-graig | Pentre Chwyth |
| :---: | :---: |
| Ty-draw | Swansea Castle |
| Townhill | Hafod |
| Prince of Wales Dock | Chapel (Remains) |

4. In the table below:
a. Order the places according to their distance - nearest to furthest
b. Use the scale on your map to ascertain the actual distances

| Place name in order with the closest to Kilvey <br> Hill first | The actual distance |
| :--- | :--- |
|  |  |
|  |  |

## ACTIVITY SHEET 3

Bearings
The life boat station at Mumbles Head is a well-known landmark. Mumbles Coastguard Rescue Team is part of the UK's H.M. Coastguard Rescue Service, the volunteer wing of Her Majesty's Coastguard.

Imagine you are out on a boat in the deeper waters of Swansea Bay. There are no road names or landmarks to pinpoint your location. How do you let the coastguard know your precise whereabouts?

A system known as bearings is used by sailors. In order to locate a boat, the coastguard needs two pieces of information:
-the bearing from your position to the coastguard station - your distance from the coastguard station.

## How do we measure the bearing?

Start by facing north. Moving in a clockwise direction, measure the angle to the coastguard station from your "north". A bearing is always written as a 3-figure measurement, so a bearing of less than 100 would be written with a 0 in front (for example $65^{\circ}$ would be recorded as $065^{\circ}$ ).

Use a map of the south Wales coastline for this activity.

## Extend the activity

How do we calculate the bearing from the coastguard station to the boat?

## Challenge

Suppose the angle from the boat to the coastguard station in the original diagram is $130^{\circ}$. Can you work out the bearing from the coastguard to the ship without measuring the angle? (Hint: think of the rule for supplementary angles.)


# Geometry and measures 



Big Pit National
Coal Museum

## Identifying lines, angles and shapes



What shapes can you find within a drawing like this?



## Curriculum Link

Develop an understanding of how to identify and label lines, angles and shapes within a complex shape.


Museum Link
Develop an understanding of how to identify and label lines, angles and shapes using a diagrammatic representation of the Big Pit winding gear. This is one of the most visible landmarks at Big Pit.


Big Pit winding gear

## Details of the activity for teachers

The winding gear has always been at the heart of the Big Pit activities. The winding engine controls cables that carry the lift cages up and down.

Explore the shapes in the tower.

Make a drawing of the side view of the tower. What shapes can you find?

How many shapes
can you name?
Complete the Activity Sheets.

## Extending this activity

Estimate the height of the Big Pit winding gear above the ground. Compare this with the 90m distance travelled underground by the lift.

Complete Activity Sheet 2 Measuring angles.

Investigate the angle total for any triangle
or quadrilateral (four-
sided shape).
Investigate the
angle total along
a straight line e.g.
$\mathrm{K} \hat{\mathrm{N}}+\mathrm{N} \hat{\mathrm{J}} \mathrm{G}+\hat{\mathrm{J}} \mathrm{H}$

## Adapting this activity

This activity could
be adapted for use
in considering any
interlocking shapes in
2D e.g. the 'Multi-cut
tree' by David Nash
at National Museum
Cardiff or patterns
in Welsh blankets at
the National Wool
Museum in Dre-fach Felindre.

## RESOURCE SHEET

## To support the lines, angles and shapes activities

This diagram represents a side-view of the tower which supports Big Pit's winding gear.


## ACTIVITY SHEET 1

## Lines, angles and shapes

## What shapes can you find?

Label the diagram with the names of the shapes you can find. The capital letter at each vertex (where straight lines meet) can help to describe lines, angles and shapes.

## For example:

The horizontal line all the way across the bottom could be called EI or IE.
The angle at the bottom left (outside the main shape) could be called EF̂D or DF̂E (notice the 'hat' on top of the middle letter, to show it's an angle).

The triangle at the bottom right could be called $\Delta \mathrm{GHJ}$ (though the order of the three letters doesn't matter for a triangle). The rectangle that forms the top part of the tower could be called PSTB (notice this time that the letters go round the shape in order - but it doesn't matter where you start, or which direction you go next).

1. Name a horizontal line.
$\square$
2. Name a vertical line.
$\square$
3. Name a line that is neither horizontal nor vertical.
$\square$
4. Name the longest line.
$\square$
5. Name a pair of parallel lines.
$\square$
$\square$
6. Name a pair of perpendicular lines.
$\square$
$\square$
7. Name three different right angles.

8. Name an acute angle.
$\square$
9. Name an obtuse angle.

10. Name three different triangles.
$\square$

11. List three triangles that are congruent (identical) to $\Delta$ VTA.
$\square$

12. Name a trapezium.
$\square$
13. How many rectangles can you find within the whole diagram? (Remember that some rectangles can be made up of more than one shape.)
14. How many triangles can you find within the whole diagram? (Remember that some triangles can be made up of more than one shape.)

## ACTIVITY SHEET 2

## Measuring angles

Estimate the size of each angle, then use a protractor to check your estimate each time.

|  | Angle | Estimate | Measurement |
| :---: | :---: | :---: | :---: |
| 1. | CDM |  |  |
| 2. | QSV |  |  |
| 3. | BVT |  |  |
| 4. | LOK |  |  |
| 5. | JGN |  |  |
| 6. | KJG |  |  |
| 7. | OKL |  |  |
| 8. | KJ N |  |  |
| 9. | JH G |  |  |
| 10. | You choose! |  |  |
|  |  |  |  |
|  |  |  |  |

# Activities <br> for families 

## Art in Wales - Tudor Portraits

The following questions only refer to the portraits you see on the walls of the gallery, and not to the miniature portraits or objects in the display cabinets.

1. How many portraits are there of just one person?

## 2. How many people are wearing a ruff?

3. How many people have a moustache?
$\square$
4. Add the number of people holding a flower to the number of people holding a leek.

5. Subtract the number of ladies with their heads covered from the number of men with their heads covered.

6. Multiply the number of skulls by the number of crowns that appear in the paintings.

7. How many golden dragons can you find?
8. What is the total number of feet you can see in the paintings?
9. Find the man with the longest wig. Divide the number of years he lived by the number of portraits of a single man.
$\square \div \square=\square$
10. How many swords can you find?
$\square$

## Now crack the code!

| Letter | A | B | C | D | E | F | G | H | I | J | K | L | M |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Number | 26 | 15 | 4 | 8 | 7 | 9 | 21 | 14 | 10 | 17 | 25 | 12 | 19 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Letter | N | 0 | P | Q | R | S | T | U | V | W | X | Y | Z |
| Number | 11 | 5 | 13 | 23 | 3 | 22 | 6 | 1 | 16 | 24 | 18 | 2 | 20 |

Use the numbers in your 10 answer boxes to find the letters to fill the blanks below.


You should reveal the name of a powerful and important man.


## Timeline information hunt

As you wander around the buildings take a look at the information about the building on the boards. Use the details to gather the information needed to complete the timeline


Oakdale Workers' Institute



## Activities using the number line

Use the Timeline to calculate the difference in age between two buildings. The "Counting on" method is a very good way to calculate the difference in time between two events.

## For example:

How many years following Pen-rhiw Chapel was the Workers' Institute built?


Therefore the difference in age between the buildings is 139 year

## Answers

## Ceramic symmetry

1. 0,4
2. 0, 2
3. 10, 5
4. 0, 3
5. 8, 8

## Playing with dice

|  | Dice 2 |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  | 1 | 2 | 3 | 4 | 5 | 6 |
| Dice 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|  | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|  | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|  | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|  | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

There are 36 $\qquad$ possible results for the two dice
The most likely total is $\qquad$ ...7.............
This is because it can happen in the most (six) different ways.
The probability of getting this number is $\qquad$ $.6 / 36$ or $1 / 6$ $\qquad$

## Roman numerals

| Roman | Arabic |
| :--- | :--- |
| XII | 12 |
| XXV | 25 |
| CL | 150 |
| LVI | 56 |
| DCV | 605 |
| MC | 1100 |
| CXV | 115 |
| MI | 1001 |
| CXXXVII | 137 |
| MDCLXVI | 1666 |


| Roman | Arabic |
| :--- | :--- |
| IV | 4 |
| XIV | 14 |
| XLVIII | 48 |
| CXC | 190 |
| CDXCV | 495 |
| CXLIX | 149 |
| MCDV | 1405 |
| MCMLXXV | 1975 |
| CMXCIX | 999 |
| MCDXIV | 1414 |


| Roman | Arabic |
| :--- | :--- |
| VII | 7 |
| XV | 15 |
| CXXIII | 123 |
| MMM | 3000 |
| MCXI | 1111 |
| DLV | 555 |
| MDXXX | 1800 |
| LXXII | 72 |
| CCXII | 212 |
| MLVII | 2057 |


| Roman | Arabic |
| :--- | :--- |
| IX | 9 |
| XXIV | 24 |
| CDI | 401 |
| XCV | 95 |
| CDLXIV | 464 |
| MMCD | 2400 |
| CMLXXIX | 979 |
| MCMXCVII | 1997 |
| e.g. MMXV | This Year |
| e.g. MMVI | The year <br> you were <br> born e.g. <br> 2006 |

Shapes and lines


## Up and Down a Mine

## People

1. $150 \div 20=7 \frac{112}{2}$ or $7 \cdot 5$, which must be rounded up Answer: $\qquad$ .. 8. $\qquad$
2. $100 \div 20=5$ Answer: $\qquad$ 5.. $\qquad$
$3.50 \div 20=2 \frac{1}{2}$ or $2 \cdot 5$, which must be rounded up Answer: $\qquad$ 3. $\qquad$
3. $8+5+3$ = 16 Answer: $\qquad$ .16 $\qquad$
4. Answer: $\qquad$ 16. $\qquad$
5. e.g. The same number of men could fit in the lift each time.

No extra trips for carrying equipment etc. down into the mine.
7. Because it does not allow for remainders in the division calculation for each shift. $(300 \div 20=15)$

Coal
8. $5 \times 8=40$
$10 \times 4=40$
$3 \times 2=6$
$2 \times 1=2$
Total $=40+40+6+2=88$ dram
Answer: $\qquad$ 88
9. $88 \div 2=44$ Answer: $\qquad$ ..44.. $\qquad$
10 Answer: $\qquad$ 88 $\qquad$
11. Answer: $\qquad$ .44 $\qquad$
12. $2+5=7$ Answer: $\qquad$ .. 7. $\qquad$
$13.7 \div 2=31 / 2$ or $3 \cdot 5$, which must be rounded up Answer: $\qquad$
$\qquad$
14. $44+44+4$ = 92 Answer: $\qquad$ 92...........

Total number of lift trips
15. $8+8+44-8=52$ or $8+44$ Answer $\qquad$ . 52. $\qquad$
16. $5+44=49$ Answer: $\qquad$ .. 49 $\qquad$
17. $3+4=7$ Answer: $\qquad$ ... $7 .$. $\qquad$
(or, by allowing a half load of men $+a$ half load of coal to go up together, $2 \cdot 5+3 \cdot 5=6$ )
18. $52+49+7=108$ (or $52+49+6=107$ ) Answer: $\qquad$ 108. $\qquad$
19. $108 \times 6=648$ (or 642 ) per week $648 \times 52=33696$ (or 33384 ) per year Answer: 33696
Note: these numbers are not accurate because we have not accounted for e.g. children working underground. Also worth noting is the fact there were in fact 2 lifts to counterbalance each other, so 1 complete 'cycle' could be considered as 2 'trips'.

Thirsty work
20. $300 \div 2=150$ (or $150 \div 2=75,100 \div 2=50,50 \div 2=25$ then $75+50+25=150$ ) Answer: $\qquad$ 150. $\qquad$
21. $150 \times 6=900$ per week $900 \times 52=46800$ per year Answer: $\qquad$ 46800 $\qquad$
$22.46800 \times 10$ Answer: $\qquad$ .468000 .. $\qquad$

## Building houses

1. 2250000
2.60 seconds, 60 minutes, 24 hours, 7 days, 365 days (or 366 in a leap year, or $365 \cdot 25$ on average)
2. e.g. eat breakfast, read a story, walk from home to the shop etc
3. $12 \times 60=720$ seconds
4. $60 \div 12=5$ houses in 1 hour
$6.5 \times 24=120$ houses in 1 day
5. $120 \times 7=840$ houses in 1 week
$8.120 \times 365=43800$ houses in 1 year
$9.43800 \times 2=87600$ houses in 1 year
$10.600 \div 120=5$ days
6. 10 factories would produce $10 \times 120=1200$ in 1 day

OR $10 \times 840=8400$ in 1 week
OR $10 \times 43800=438000$ in a year
Number of days $=1000000 \div 1200=833 \cdot 33$ days
OR Number of weeks $=1000000 \div 8400=119 \cdot 05$ weeks
OR Number of years $=1000000 \div 438000=2 \cdot 28$ years
12. e.g. the factories worked constantly / machines never broke down / people never took a break

## Identifying lines, angles and shapes

Part A
13. 9 rectangles
14. 19 triangles

Part B

1. $90^{\circ}$
2. $30^{\circ}$
3. $113^{\circ}$
4. $40^{\circ}$
5. $60^{\circ}$
6. $50^{\circ}$
7. $48^{\circ}$
8. $48^{\circ}$
9. $48^{\circ}$
10. The angles add up to $180^{\circ}$ because they are inside triangle GOJ.
11. They are equal because they are corresponding angles (with lines LK, NJ and GH being parallel).

## Art in Wales - Tudor Portraits

1. How many portraits are there of just one person? 14
2. How many people are wearing a ruff? 7
3. How many people have a moustache? 11
4. Add the number of people holding a flower to the number of people holding a leek. $2+1=3$
5. Subtract the number of ladies with their heads covered from the number of men with their heads covered. 7-5 = 2
6. Multiply the number of skulls by the number of crowns that appear in the paintings. $2 \times 3=6$
7. How many golden dragons can you find? 1
8. What is the total number of feet you can see in the paintings? 8
9. Find the man with the longest wig. Divide the number of years he lived by the number of portraits of a single man. $50 / 10=3$
10. How many swords can you find? 3

| $\mathbf{H}$ | $\mathbf{E}$ | $\mathbf{N}$ | $\mathbf{R}$ | $\mathbf{Y}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

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