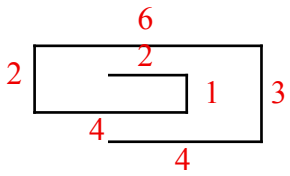
ZOOM

The topic is enlargement and the respective effect of scaling in 1, 2 and 3 dimensions.

The workshop is aimed at children in Y5. The numerical cases are simple and no use is made of algebra. It can be adapted accordingly for older children.

Ask the children what they think a 'zoom' lens does or what a 'zoom' photocopier does. Explain that in the workshop they will be studying the effect of *enlarging* shapes, that is to say, preserving the original shape but changing the size.

Part 1: Scaling in 1 dimension

materials needed	*activity (Teacher demonstration/Pupil experiment)*
Acetate as described	**E1** *Teacher demonstration (with pupil involvement)* The children see a paperclip and, beneath it, an identical clip straightened out. Below that they see a bigger, similar paperclip. Beneath it, an identical clip straightened out is concealed by a card. Invite a child to mark on the whiteboard the point to which s/he thinks the clip will reach.
Squared paper, X 30	**E2** *Pupil experiment* The children draw a paperclip as a flattened, square spiral. They add the segment lengths and draw a line representing the same paperclip straightened out.  They then draw a paperclip where each segment is twice as long. They then draw it straightened out and realise that it must be twice as long as the first one. They repeat the experiment with a clip 3 x as long.

The accompanying discussion is an excuse to introduce the children to the idea of *ratio*.

Part 2: Scaling in 2 dimensions

Squared papers with graduations
1mm, 2 mm, 10 mm; 2mm, 4 mm, 20 mm; x 30

E2 *Pupil experiment*

The children draw (the beginnings of) a picture in the upper left quadrant of the finely-graduated paper. To help locate parts of the picture, they label the squares **A** to **I** left to right, **1** to **9** bottom to top from an origin halfway down the left-hand side of the sheet. They label the whole of the coarsely-graduated sheet in the same way, but starting from an origin in the bottom left-hand corner of the sheet. They then (begin to) 'square up', i.e. transfer their picture part by part from the first sheet to the second. They can take their sheets home at the end of the workshop and complete the task – possibly adding detail and colour.

Introduce the idea of *area*, measured by how many squares of the same size one can count within an outline.

A3 rubber band enlarger (as described), x 15

E3 *Pupil experiment*

The rubber band enlarger is an A3 drawing book. It has a hole drilled through the bottom left-hand corner in which a peg is inserted. The drawing book is open at the top page. Two identical rubber bands, joined with a knot, are provided. Instruct the children:
1. to draw a small picture – or write a word – in the bottom left-hand quadrant,
2. to loop one end of the doubled band over the peg, the other round a pencil,
3. to follow their picture with the knot, leaving the pencil to its own devices.

Each child of the pair has the chance to draw a picture to take home.

Ask the children to describe what's happened and compare it with what happened on the squared paper.

Ask them what will happen if *three* equal bands are knotted together.

OHP on trolley, whiteboard, blank acetate, dry-wipe pen, x 1

E4 *Teacher demonstration (with pupil involvement)*

Offer the acetate and dry-wipe pen to a volunteer to make a simple drawing. Ask the children what difference it will make if you push the trolley back from the whiteboard. Project the picture. Ask a second volunteer to trace it on the whiteboard. Hold the original acetate against the result. Step it upwards and sideways to show how to determine the *scale factor*. Move the trolley till the scale factor is, say, 4. Ask the children how many times as great the *area* of the new picture is.

Set-up as for **E4**, acetates of postage stamps, corresponding postcards

E5 *Teacher demonstration (with pupil involvement)*

Choose the acetate of a particular stamp and set it on the OHP. Ask a volunteer to hold up the corresponding postcard against the whiteboard. Ask his/her partner to move the trolley till the image of the stamp fits the postcard.

Data projector with Internet connection

E6 *Teacher demonstration/Homework*

Show www.powersof10.com/film or suggest visit as homework.

Part 3: Scaling in 3 dimensions

Stock of Centicubes, stock of Multilink cubes

E7 *Pupil experiment*

Ask one of each pair to build a simple model using Centicubes, e.g. a 3-D letter 'L'. Ask the other to make a copy using Multilink cubes.

Ask each pair to replicate the Multilink model using Centicubes. Now that the children have in front of them the smaller and larger models made from the same physical units, they may confirm that the larger model is twice as wide, twice as deep and twice as high as the smaller.

Tell them that we call the amount of space filled by each model its *volume*. As in 2-D we can count unit squares to measure *area*, in 3-D we can count unit cubes to measure *volume*.

Ask them to work out the *ratio* between the *volumes* of the larger and smaller models.

Stock of Polydron Framework triangles

E8 *Pupil experiment*

Give one of each pair a single triangle; the other, 4 triangles with which to make an identical but larger shape. Point out that in mathematics if two objects are of different sizes but the same shape we say they are *similar*.

Ask the children what the *scale factor* of the *enlargement* is.

Ask them how they are going to determine how many times the *area* has been multiplied since this time they have no unit squares to count.

As for **E6**

E9 *Pupil experiment*

Show what you intend one of each pair to make this time:
a square-based ('Egyptian') pyramid, built from 4 triangles.

Tell the other to build a *similar* one with *scale factor* 2.

Ask them by how many times the *area* has been multiplied.

Ask them by how many times the *volume* – this time not of the plastic but the air inside – has been multiplied.

Stock of Polydron Framework triangles and squares

E10 *Pupil experiment*

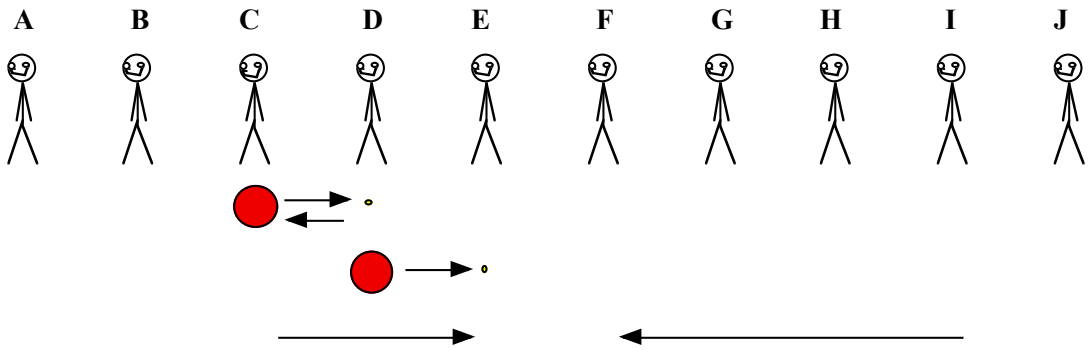
Now each pair has the freedom to build a model of their own design, and choose the *scale factor* by which the original is to be *enlarged*.

43 cm beach ball, golf ball, x 1

17 named disks*, x 1

E11 *Teacher demonstration (with pupil involvement)*

Ask 10 volunteers to stand facing the class.
Space them equally.
Give one the beach ball, the child immediately to the right, the golf ball.



Explain that the line forms a ‘cosmic ruler’.
Point out that the step from the child with the beach ball to the child with the golf ball shrinks everything 10 times; a step the other way enlarges everything 10 times.
Transfer the balls as shown, asking what happens between **C** and **E**, between **I** and **F**, and so on.

Use the cosmic ruler to measure the change in scale between different objects. Give a labelled disk to one of the children in the line. Give a volunteer a second disk and ask him/her to give it to the correct child in the line. Discuss what the objects are on a level appropriate to the class.

Choose from the following. The number, for your benefit only, shows the order of size in metres as a power of 10. The colour distinguishes the object by type.

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The Virgo Cluster	23
The Local Group	22
The Milky Way	21
Aldebaran	11
The Sun	9
Jupiter	8
The Earth	7
A golf ball	-1
The ball in a biro	-2
A full stop	-3
A white blood cell	-4
A bacterium	-5
A virus	-7
A protein molecule	-8
A glucose molecule	-9
A carbon atom	-10
An atomic nucleus	-13

P.S. 2.7.11