N4 • Estimating length, using standard form

Mathematical goals

To help learners to:

- interpret decimals using metric units;
- estimate lengths;
- interpret standard form;

and to discuss and understand these processes.

Starting points

Some learners will have encountered decimals and standard form before. The opening discussion is used to recall these ideas.

Materials required

For each pair of learners you will need:

- Card set A – *Objects*;
- Card set B – *Measurements*;
- Card set C – *Measurements in standard form*;
- Card set D – *Comparisons*;
- calculator;

and optionally:

- glue stick;
- felt tip pen;
- large sheet of paper for making a poster.

Time needed

At least 1 hour.

Suggested approach

Beginning the session

Explain that the distance from your nose to your finger tip is about one metre. Record this fact in the centre of the board. Ask learners to name objects or everyday distances that have lengths that are approximately 10 m, 100 m, 1 000 m, 10 000 m and then 0.1 m, 0.01 m, 0.001 m and 0.0001 m, using questions such as the following:

What is about 10 times as long as this?
(The distance across this room.)
What is 10 times the distance across the room?
(A sprint.)
What is 10 times the length of a sprint?
(Just over half a mile.)
What is one tenth the distance from nose to finger tip?
(The width of your hand.)
What is one tenth the width of your hand?
(The width of your little finger.)

List learners' answers on the board. This produces a table like this:

Metres	Rough size	Standard form
10 000	about 6 miles	10^4 m
1000	just over $\frac{1}{2}$ a mile	10^3 m
100	sprint	10^2 m
10	distance across this room	10^1 m
1	distance from nose to finger tip	10^0 m
0.1	width of hand	10^{-1} m
0.01	width of little finger	10^{-2} m
0.001	diameter of this blob •	10^{-3} m
0.0001	hair's breadth	10^{-4} m

Explain that, as we move up and down the list, we are multiplying and dividing lengths by ten. Introduce the standard form notation at this point.

Discuss the relationships between the lengths of objects in the list:

How long is the room in hand widths?

How far is 6 miles in hand widths?

Explain the relative significance of the decimal places:

Sarah is 1.6321 m tall. Is this a reasonable statement? Why?

Think of 1.6321 m as "One nose to finger tip + 6 hand widths + 3 finger widths + 2 full stops + 1 hair's breadth".

How would this number change if she put high heels on?
. . . if she flattened her hair slightly?
. . . if she sat down?

The examples may now be used to estimate the lengths of other everyday objects. Ask learners to name objects that are, for example, 0.02 m long (about two finger widths) or 0.005 m long (about the length of five full-stops placed side by side) and so on.

Working in groups

Give each pair of learners Card set A – *Objects* and Card set B – *Measurements*. Ask learners to match the objects to the corresponding measurements. If learners get stuck, suggest that they first arrange the objects in order of size.

Learners who struggle may find it helpful to work with a smaller set of cards, omitting those that show the greatest and smallest distances.

Six cards in Card set B have been left blank. It is intended that learners should use these to write their own estimates for the objects in Card set A with which they will be more familiar: the length of a fly/stapler/telephone/truck, the height of a desk, the wingspan of an aircraft.

When learners have completed this task, issue Card set C – *Measurements in standard form*. Learners should try to match these cards to the others on the table. There are six blank cards for learners to express their own estimates in standard form.

Next, ask each pair of learners to put aside the estimates that they produced themselves. They should then try to arrange the remaining cards in order of size. Thus learners should have the following items in order:

Nucleus of an atom	0.00000000000001	1×10^{-14} m
Length of a virus	0.0000002	2×10^{-7} m
Diameter of the eye of a fly	0.0008	8×10^{-4} m
Diameter of a 1p coin	0.02	2×10^{-2} m
Height of a door	2	2×10^{0} m
Height of a tall skyscraper	400	4×10^{2} m
Height of a mountain	8 000	8×10^{3} m
Distance between two furthest places on earth	20 000 000	2×10^{7} m
Distance from earth to moon	400 000 000	4×10^{8} m
Size of a galaxy	800 000 000 000 000 000 000	8×10^{20} m

Issue Card set D – *Comparisons*. Ask learners to place the arrow cards between each pair in the list to show how many times each item is greater in length than the item before. Two cards have been left blank for learners to complete.

Learners can check their answers using calculators. They may also enjoy making posters showing the completed arrangement of all the cards.

Learners who find the work straightforward may begin to manipulate numbers in standard form:

How many times taller is the mountain than the skyscraper?

How did you work this out?

How can you get this from heights expressed in standard form ($4 \times 10^2 \times ? = 8 \times 10^3$)?

Reviewing and extending learning

Discuss the various approaches that learners have used during the session and ask them to report back on what they have learned.

You may like to extend this work to explore the transformation of units. Use the fact that 1 km is 1 000 m.

How tall is the mountain in km?

How high is the skyscraper in km?

Can you give me that answer in standard form?

What learners might do next

Learners may enjoy making a poster displaying other quantities and numbers in standard form, for example comparing weights or capacities of various objects.

Further ideas

This activity uses multiple representations to deepen understanding of number. This type of activity may be used in any topic where a range of representations is used. Examples in this pack include:

- **N5 Understanding the laws of arithmetic;**
- **A1 Interpreting algebraic expressions;**
- **SS6 Representing 3D shapes.**

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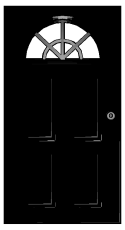
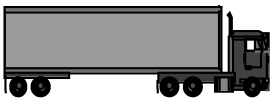
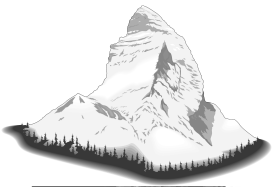
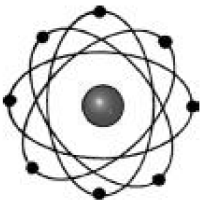
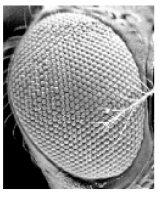
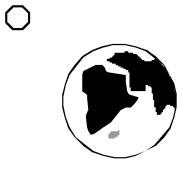
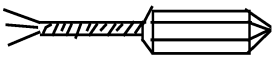
N4 Card set A – *Objects*

Wingspan of an aircraft 	**Length of a stapler** 	**Height of a door** 	**Size of a galaxy** 
Length of a truck 	**Height of a mountain** 	**Length of a fly** 	**Nucleus of an atom** 
Height of a tall skyscraper 	**Height of a desk** 	**Length of a telephone** 	**Diameter of the eye of a fly** 
Diameter of a 1p coin 	**Distance from earth to moon** 	**Length of a virus** 	**Distance between two furthest places on earth** 

N4 Card set B – *Measurements*

2 m	400 000 000 m
0.02 m	800 000 000 000 000 000 000 m
20 000 000 m	400 m
0.0008 m	0.00000000000001 m
8 000 m	0.0000002 m

N4 Card set C – *Measurements in standard form*

4×10^{8} m	2×10^{0} m
2×10^{-2} m	2×10^{-7} m
8×10^{3} m	4×10^{2} m
8×10^{20} m	8×10^{-4} m
2×10^{7} m	1×10^{-14} m

N4 Card set D – *Comparisons*

× 20 000 000	× 4 000
× 2 000 000 000 000	× 25
× 100	× 200
× 20 000 000	× 20
× 2500	× 20