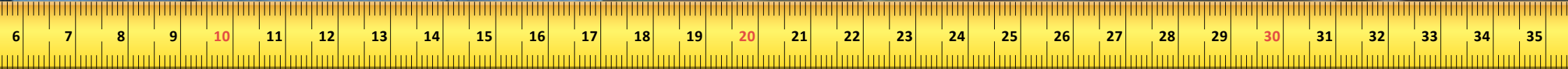




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TREE MEASURING

Connecting Trees with Curriculum for Excellence

Outdoor &
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TREE MEASURING

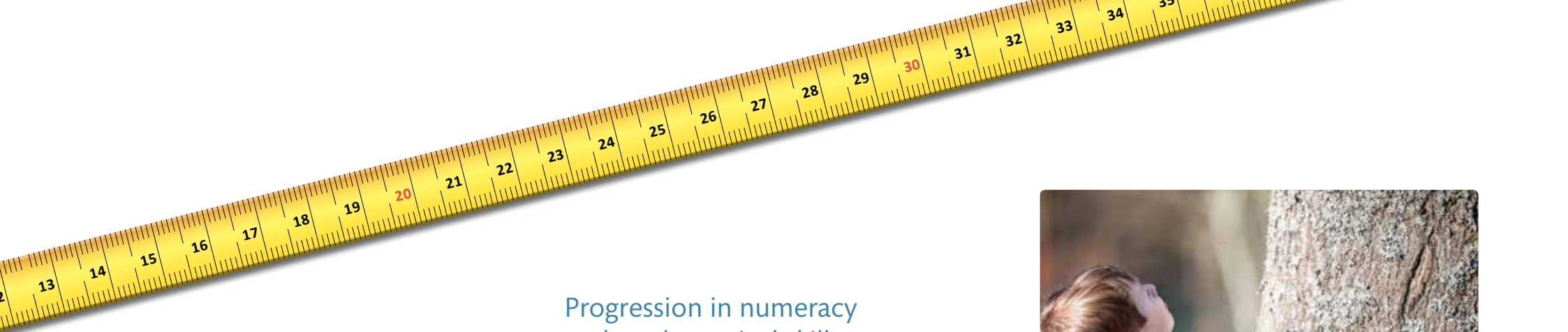
Connecting Trees with Curriculum for Excellence

Thanks to the author, Penny Martin and the *Tree Measuring* models.

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INTRODUCTION

Why use trees for measuring?

Trees can be found everywhere – in school grounds, local greenspace, park or woodland – in urban and rural settings alike. Trees can be found within walking distance of most schools, so it's easy to take learning outdoors.

From a child's point of view, trees can be large, tactile and sometimes charismatic, stimulating curiosity and imagination. With bark, leaves, seeds, twigs and branches, to growth, form and structure, any tree provides a wonderful free resource for learning and play outdoors, naturally supporting an interdisciplinary approach to learning.

This resource will focus on how the properties of trees can support [Progression in numeracy and mathematical skills](#) in particular.

Measuring the properties of trees – their height, spread, girth and internal structure – provides [a window into the world of work](#). In professional forestry and similar professions, these measurements carry real value and meaning.

Progression in numeracy and mathematical skills

This resource aims to reflect Education Scotland's guidance on [numeracy across learning](#) and the [numeracy and mathematics benchmarks](#).

Outdoor learning provides experiences in a real-world context, not in isolation. The activities contained in this resource can help to embed an understanding of mathematical concepts within the world outside the classroom.

The progression of these tree measuring activities with increasing challenge demands increasing sophistication in the learner's ability to:

- [interpret questions](#);
- [select and communicate processes and solutions](#);
- [justify choice of strategy used](#);
- [link mathematical concepts](#);
- [use mathematical vocabulary and notation](#);
- [use mental agility](#);
- [reason algebraically](#);
- [determine the reasonableness of a solution](#).

These activities encourage the development of numeracy skills and support their use in other curriculum areas. For example, using trees as a context for learning outdoors supports health and wellbeing across the curriculum, in particular providing opportunities for *planning for choices and changes*.



HOW TO USE THIS RESOURCE

The learning progression using trees for measuring from Early to Third and Fourth Levels (and Senior Phase), is shown as a schematic summary of each individual activity. Clicking on the summary descriptors will take you to the full description of each activity.

There is a focus on the mathematics and numeracy benchmarks, but also suggestions to *explore* and *extend* the learning, leaving plenty of scope for further creative approaches. As such, the curriculum areas shown are indicative only.

TREE MEASURING ACTIVITIES AND SKILLS PROGRESSION

EARLY/FIRST LEVEL

Aim: to help children learn about estimation, simple measurement and basic calculations, by measuring the height and girth of trees.

Estimating the girth of a tree	Working in groups using arm lengths or hand spans to measure the circumference of a tree.	Skills: estimation, measurement, data & analysis.
Measuring the girth of a tree	Working in pairs of small groups using a measuring tape to measure the circumference of a tree or several trees and charting the results.	Skills: estimating, measurement, data & analysis.
Estimating the height of a tree	Comparing the height of a tree by eye, to objects of a similar height to provide a sense of scale.	Skills: estimation, number processes, fractions, measurement, data & analysis.
Using a pencil to measure tree height	Working in pairs, using a pencil at a distance aligned to the tree height and partner, then pacing the distance between two points to estimate the height of the tree.	Skills: estimation, measurement, data & analysis.

TO SECOND LEVEL

SECOND LEVEL

Aim: to develop children's skills in estimating and measurement (measuring to the nearest cm), carrying out calculations using decimals and introducing angles. The children look at two ways of measuring tree height and calculate a tree's age from its girth.

Measuring tree height looking through legs	Working in pairs to estimate the height of a tree using the concept of measuring using angles and triangles.	Skills: estimation, measurement, angles, data & analysis.
Measuring tree height with a metre stick	Working in pairs to calculate the height of a tree using a metre stick and the concept of angles and triangles.	Skills: measurement, numbers, multiples.
Estimating the age of a tree, measuring girth of tree and calculating rates of growth	Working in pairs, using a pencil at a distance aligned to the tree height and partner, then pacing the distance between two points to estimate the height of the tree.	Skills: estimation, measurement, data & analysis.

TO THIRD/FOURTH LEVEL

THIRD/FOURTH LEVEL (AND SENIOR PHASE)

Aim: To involve students in developing and using simple tools for measuring tree height, spread and density using angles and simple formulae. This creates opportunities for discussions on the accuracy of their measurements and how they might be used in real life situations. For example: surveying their school grounds or local community spaces and developing tree planting schemes, and considering the mathematical skills needed in professions like forestry.

Using a clinometer to measure tree height	Working in pairs to make a tool and use this to measure the height of a tree using trigonometry, working to scale.	Skills: measurement, angle, symmetry and transformation, data and analysis, impact of maths in the world, 2D shapes & 3D objects.
Measuring tree height using a hypsometer	Make a tool then working together use this to measure tree height.	Skills: Measurement, angle, symmetry and transformation, data analysis.
Measuring the diameter of a tree trunk	Calculating the diameter of a tree by measuring circumference, using different measuring tools.	Skills: Measurement, Data & analysis, Mathematics – its impact on the world.
Measuring tree spread & crown	Working in groups, using a compass to explore symmetry of spread, and measuring branch length to calculate the crown area.	Skills: Measurement, 2D shapes and 3D objects, Angle, symmetry and transformation, data analysis, Mathematics – its impact on the world.
Measuring the area of ground covered by tree stems (trunks) in a hectare	Make a simple tool then working individually use this to estimate tree density in an area.	Skills: Measurement, Estimation and rounding, data & analysis, maths – its impact on the world.



EARLY/FIRST LEVEL TREE MEASURING (P1/P2 - P4 APPROX)

Aim

To learn about estimation, simple measurement and basic calculations by measuring of the height and girth of trees.

Suggested Precursor Activities

Creative Star Learning Ltd [Maths Outdoors](#) includes lots of playful ideas for using sticks and leaves among other resources to explore shape, symmetry, angles, patterns, number, money, measurement, data handling and open-ended exploration.

Before you start

Make sure that the children are familiar with the basic parts of a tree – roots, trunk, branches and leaves.



Early/First Level Curriculum for Excellence (see also CfE Benchmarks)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes			
		Measuring Girth: Hugging a tree	Measuring Girth: Measuring a tree	Measuring Height: Estimating the height of a tree	Measuring Height: Using a pencil to measure tree height
Numeracy & Mathematics	Number, money & measure: <i>estimating and rounding</i>	MNU 0-01a	MNU 1-01a	MNU 1-01a	MNU 1-01a
	Number, money and measure <i>– Number and number processes</i>			MNU 1-03a	
	Number, money & measure: <i>measurement</i>	MNU 0-02a; MNU 0-11a; MNU 1-11a; MNU 1-01a	MNU 1-03a	MNU 1-11a	MNU 1-11a
	Number, money and measure: <i>Fractions, decimal fractions and percentages</i>			MNU 1-07a	
	Information handling: <i>Data and Analysis</i>	MNU 0-20a; MNU 1-20a	MNU 1-20a; MNU 1-20b	MNU 1-20a	MNU 1-20b
	Shape, position and movement: <i>Angle, symmetry and transformation</i>				MTH 1-17a
Literacy & English	Listening and talking: <i>Tools for listening and talking; Understanding, analysing and evaluating</i>	✓		✓	✓
	Writing: <i>Organising and using information; Creating texts</i>	✓	✓		



Early/ First Level Curriculum for Excellence (continued)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes			
		Measuring Girth: Hugging a tree	Measuring Girth: Measuring a tree	Measuring Height: Estimating the height of a tree	Measuring Height: Using a pencil to measure tree height
Expressive Arts	Art and Design	✓			
Sciences	Planet Earth: Biodiversity and interdependence	✓	✓		
Social Studies	People, place and environment	✓	✓	✓	✓
Health & wellbeing across learning	Mental, emotional, social and physical wellbeing	✓			
	Planning for choices and changes	✓	✓	✓	✓
	Physical activity and sport	✓			



EARLY/L1: MEASURING TREE GIRTH:

HUGGING A TREE

Use arm lengths or hand spans to measure the circumference of a tree.

Skills

Estimation, measurement, data & analysis.

Resources

Tree(s); enough children to encircle a tree;
Extension: paper/pens/cloth/clay.



ACTIVITY

1. Working in a group. Choose a tree you like.

Explore

How can we work out how big it is all the way round (its girth)?

2. Decide how many people are needed to measure the tree's girth using outstretched arms, touching one another's fingertips, standing around the tree.

3. Experiment with different measures, like hand spans, around the tree.

4. Discuss and decide how to get consistency in measurements between different trees.

Explore

How would you describe the shape and girth of your chosen tree to someone else?

Choosing a site with a variety of trees will enable the group to discuss how the girths of different trees vary, and to choose the appropriate form of measurement whether it is arm lengths or hand spans (or something else!).



How many people?

Extension

Make handprints on paper or cloth to show how many hand spans each tree required – hang these from your tree or make a picture washing line outdoors!

Why not make up a name for your tree from the words used to describe it? Can you find out the real name of the tree? Try writing the name on a rolled-out piece of clay or mud and stick it on your tree!



L1: MEASURING TREE GIRTH:

MEASURING A TREE

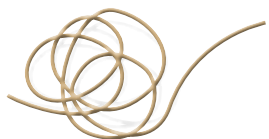
Working in pairs or small groups use a measuring tape to measure the circumference of a tree or several trees and chart the results.

Skills

Estimating, measurement, data & analysis.

Resources

Tree(s); a measuring tape
(optional – a piece of string/rope)



ACTIVITY

1. Work in pairs to measure the girth of a tree
2. Choose a tree.

Explore

Look at the shape of a tree's trunk – is it the same size (girth) all the way up?

3. Girth is usually measured at 1.3 metres up from the ground. For children, one metre or underarm height can be used.

Explore

Let each child measure each other up to their underarm to see if this is a good approximation for one metre.

This helps them to begin to understand how they can use their own body as a measuring tool and the importance of consistency in measurement. (For foresters, diameter of trees at breast height (1.37m) is a commonly used measure).

4. If you are in school grounds, a park or woodland that has a number of different species, you can measure a few of each species. Identify your trees using the Woodland Trust Nature Detectives [Leaf ID](#) or [Twig ID](#) sheets.
5. Draw a diagram or chart that shows the different girths of each species of tree measured. You could plot this outdoors using rope to show your x and y axis,



Measuring tape

with pebbles or sticks to show number, and leaves to indicate species, or on the hard surface of the school grounds using chalk.

Explore

Is there wide variation both within the same species of tree and between different tree species?

Explore

What might be possible reasons for this?

For example, the trees might be different ages or the same ages, or in different growing conditions (like close together or far apart).

L1: MEASURING TREE HEIGHT:

ESTIMATING THE HEIGHT OF A TREE

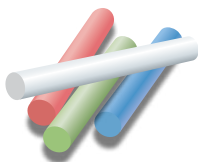
Compare the height of a tree by eye, with objects of a similar height to provide a sense of scale.

Skills

Estimation, number processes, fractions, measurement, data & analysis.

Resources

Tree(s); measuring tape; (chunky chalk).



ACTIVITY

Explore

How tall is the tree compared to e.g. a person or a nearby building?

This can lead to discussions about closer objects looking bigger while those that are far away seem smaller.

Explore

What do you need to do to make your estimate better?

1. Working in pairs the children can estimate the height of a tree by measuring one child.
2. This child then stands beside the tree.
3. Their partner imagines how many times the measured child fits (head to foot) into the height of the tree (from the ground to the top of the tree).
4. Multiply the number of times the child fits, say 4 times, by the height of the child, say 1 metre, to get the height of the tree.
5. Describe how the tree height can be measured this way using the language of fractions.



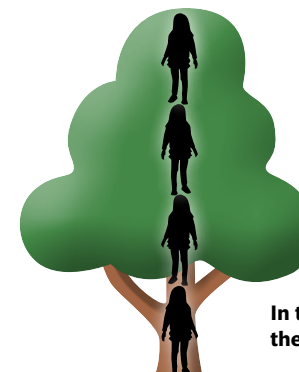
How many times does the person fit into the tree height?

Extension

Draw the length of your tree in chalk on a hard surface playground, and draw around the shape of your partner lying lengthways at the base of the 'trunk' of your chalk tree.

Can you draw the tree's shape to make it look like the one you measured?

Mark in chalk how many times your partner's body fitted into the tree.



**In this example
the tree is 4m tall**

L1: MEASURING TREE HEIGHT:

USING A PENCIL TO MEASURE TREE HEIGHT

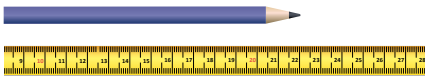
Use a pencil at a distance aligned to the tree height and partner, then pace the distance between two points to estimate the height of the tree.

Skills

Estimation, measurement, data & analysis.

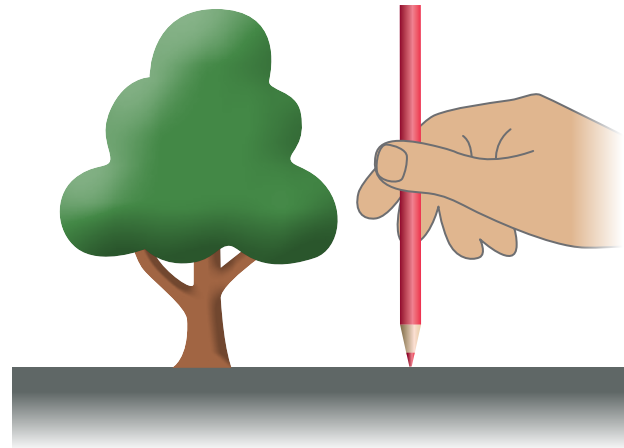
Resources

A tree(s); a pencil, a measuring tape/trundle wheel; stick, chalk or similar to mark position on ground.



ACTIVITY

1. Work in pairs
2. Child 1 stays beside their tree; Child 2 walks away from the tree but looks back at intervals.
3. When they look back, Child 2 holds a pencil at arms' length vertically and lines it up with the tree. Child 2 keeps walking until the bottom of the tree is level with the bottom of the pencil, and the top of the tree is level with the top of the pencil.



Using a pencil to measure tree height

4. Staying in the same spot, Child 2 turns the pencil to a horizontal position, with the end of the pencil still at the base of the tree.

5. Child 1 now walks away from the tree, at a right angle until they reach the "point" of the pencil from Child 2's view. Child 2 shouts "stop" as this point.

6. Child 1 marks this spot.

7. The distance between this mark and the base of the tree is the height of the tree.

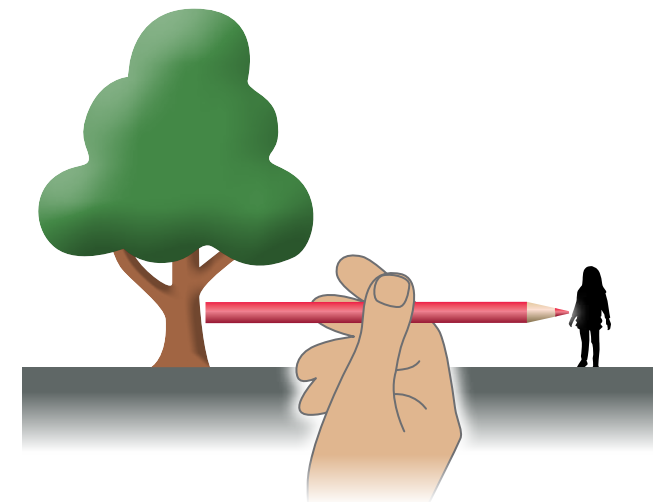
8. Measure this distance roughly by pacing out.

9. Measure this distance exactly by using a measuring tape or trundle wheel. Compare the results.

Extension

Draw a right-angled triangle on the hard surface of a school playground, marking the length of the distance walked on the ground, and the height of the tree.

Can you draw this to scale?



SECOND LEVEL TREE MEASURING (P5-P7 APPROX)

Aim

Develop skills in estimating and measurement (measuring to the nearest cm) by carrying out calculations using decimals and introducing angles. The children look at two ways of measuring tree height and calculate a tree's age from its girth.

Before you start

Make sure that the children are familiar with the basic parts of a tree – roots, trunk, branches and leaves, and have experience of Early/First Level Tree Measuring Activities.



Second Level Curriculum for Excellence (see also CfE Benchmarks)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes		
		Measuring height of a tree: looking through your legs	Measuring height of a tree: using a metre stick	Measuring Girth: Tree Girth and Age
Numeracy & Mathematics	Number, money & measure: <i>time</i>			MNU 2-10b
	Number, money and measure – estimating and rounding	MNU 2-01a		
	Number, money & measure: <i>Number and number processes</i>		MNU 2-03a	
	Number, money and measure: <i>measurement</i>	MNU 2-11a	MNU 2-11a; MNU 2-11b	MNU 2-11a; MNU 2-11b; MNU 2-11c
	Number, money and measure: <i>Fractions, decimal fractions and percentages</i>			
	Number money & measure: <i>Multiples, factors and primes</i>		MTH 2-05a	MTH 2-05a
	Information handling: <i>Data and Analysis</i>	MNU 2-20b		MNU 2020B; MN2-21A
	Shape, position and movement: <i>Angle, symmetry and transformation</i>	MTH 2-17a; MTH 2-17b; MTH 2-17d		
	Shape, position & movement: <i>Properties of 2D shapes and 3D objects</i>			MTH 2- 16a
Literacy & English	Listening and talking: <i>Tools for listening and talking; Understanding, analysing and evaluating</i>			✓
	Writing: <i>Organising and using information; Creating texts</i>			✓



Second Level Curriculum for Excellence (continued)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes		
		Measuring height of a tree: looking through your legs	Measuring height of a tree: using a metre stick	Measuring Girth: Tree Girth and Age
Sciences	<i>Planet Earth: Biodiversity and interdependence</i>			✓
Social Studies	People, place and environment	✓	✓	✓
	People, past events and societies			✓
Health & wellbeing across learning	Planning for choices and changes	✓	✓	✓

L2: MEASURING TREE HEIGHT:

LOOKING THROUGH YOUR LEGS

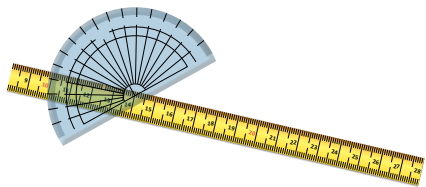
Work in pairs to estimate the height of a tree using the concept of measuring with angles and triangles.

Skills

Estimation, measurement, angles, data & analysis

Resources

Tree(s); measuring tape, protractor.



ACTIVITY

1. Work in pairs or groups, trying this out in turn.
2. Choose a tree
3. Child 1 walks away from the tree, every so often bending forward to look through their legs back to the tree.
4. When they can just see the top of the tree, child 1 stops and child 2 marks the spot.
5. Try taking 'metre length' strides between the tree and the marked spot, and pace the distance, to give an estimate in metres.
6. Measure the distance along the ground from the tree to the marker. This is roughly equal to the tree's height.

This works because maths says that if you can see the top of a tree at a 45-degree angle, then the height of the tree is equivalent to the distance that you are from that tree.

Extension

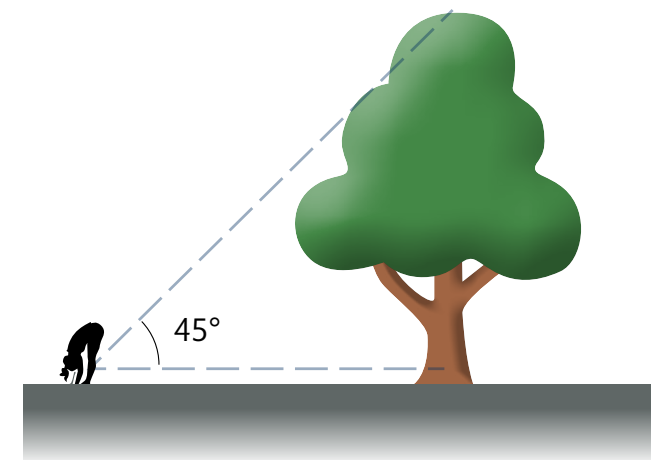
Using a protractor, ruler and chalk/pencil, draw a right-angled triangle on the hard surface of a school playground, or on a piece of paper, marking the



Looking through your legs

length of the distance walked on the ground, and the estimated height of the tree, marking in the 90 and 45-degree angles. What is the remaining angle? What kind of shape is this? (a right isosceles triangle).

Make a model tree and model person in plasticine to scale and find a way to show the relationship between them, using the triangle.



L2: MEASURING TREE HEIGHT:

USING A METER STICK

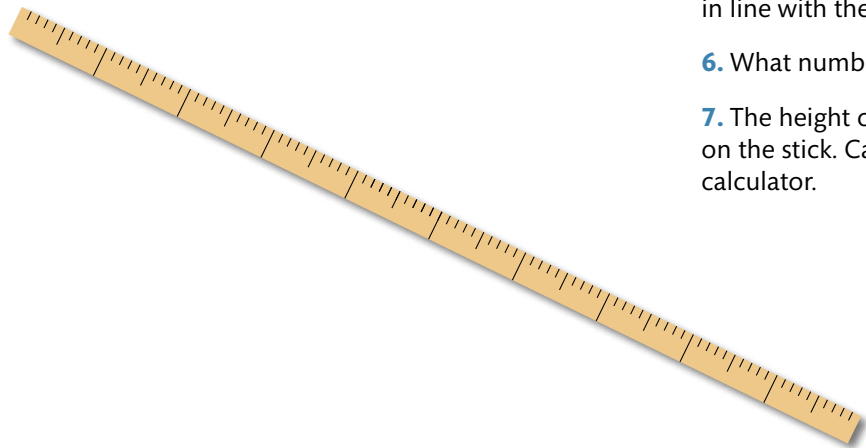
In pairs calculate the height of a tree using a meter stick and the concept of angles and triangles.

Skills

Measurement, numbers, multiples.

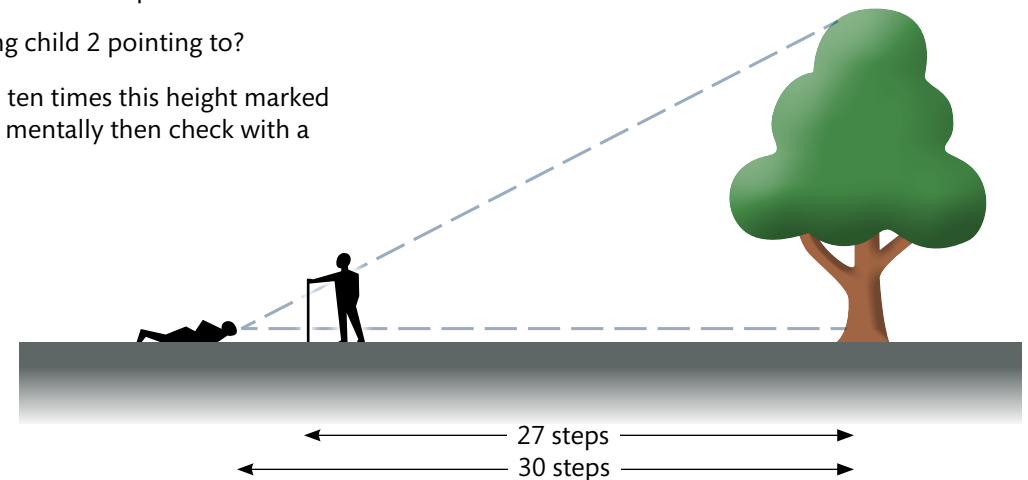
Resources

Suitable tree(s); A meter stick.



ACTIVITY

1. Work in pairs and choose a tree.
2. Both children stand up against the trunk of their chosen tree.
3. Child 1 walks 30 steps away from the tree, lies down on the ground and looks up at the top of the tree.
4. Child 2 walks 27 steps from the tree and holds up a meter stick.
5. Standing child 2 should move their finger up and down the stick until the child 1 lying down can see it is in line with the tree top, and shout stop.
6. What number is standing child 2 pointing to?
7. The height of the tree is ten times this height marked on the stick. Calculate this mentally then check with a calculator.



L2: MEASURING TREE GIRTH:

TREE GIRTH AND AGE

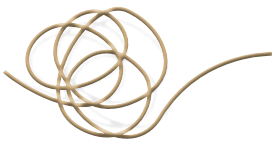
Estimate the age of a tree by counting rings on a cut stump, measure the girth of a tree using simple formulae, and calculate rates of growth comparing different trees.

Skills

Time, measurement, multiples, 2D shapes & 3D objects, data & analysis.

Resources

Range of tree species; cut log/tree stump (optional); tape measure/string; tree identification keys; magnifying glass (optional).

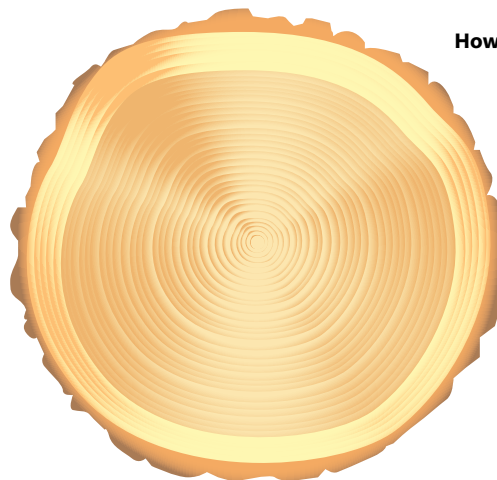


ACTIVITY

How old is a tree? Look at a variety of trees in your school grounds, local park or woodland.

Explore: which trees do you think are the oldest and why? (Older trees will tend to be taller, larger and with wider trunks.)

In addition to growing in height, trees add a layer of wood to their circumference each year. Spring growth is porous and light in colour while darker wood is formed at the end of the growing season. This darker



How many rings?

wood primarily provides support and strength. The two together represent one year's growth, known as an annual ring. The pattern of annual rings can tell us a lot about the life story of a tree. Counting the rings on the cross section at ground level provides the total age of the tree.

If a log/cut stump of a tree trunk is available, children can count the annual rings. It is, however, sometimes quite hard to see all the rings, particularly if they are very close together – so it may need to be a rough estimate. Wide spaced rings represent periods of rapid growth, while narrow rings represent periods of slow growth.

(See the [Growing Green Activity Pack](#) for more information on tree trunk structure and function).

However, you don't have to cut a tree down to work out its age! Instead, the girth of a living tree can be used to estimate its age.

1. Use a tape measure or piece of string, to measure around the trunk at approximately a child's head height (about 1 metre from the ground) – measure to the nearest centimetre. This is the girth or circumference of the tree.
2. Roughly, every 2.5cm of girth represents about one year's growth. So, to estimate the age of a living tree, divide the girth by 2.5. For example, a tree with a girth of 40cm will be sixteen years old.
3. Carry out a census of trees in the local area. Which are the oldest? Which are the youngest?
4. Show this information in timelines or charts.

Explore

Can you identify the tree being measured?

(tip: use the [Tree Name Trail publication](#) or [online](#) or other keys to find out).

If you know the species of tree you are measuring, you can make this work more accurate, as different types of tree grow at different speeds.

5. Using the growth rate table below, check the type of tree you have measured and divide the girth by the number given. For example, a sycamore with a girth of 110cm is about 40 years old ($110 \div 2.75 = 40$).

Species of tree	Growth of girth per year (cm)
Average	2.5
Oak and beech	1.88
Pine and spruce	3.13
Sycamore	2.75

Whether a tree is in woodland or in the open, also makes a difference to growth.

Explore

Why do you think this is? Will woodland trees grow faster or slower than trees in the open?

Trees in the open grow faster because there is less competition from other trees, for light, water and nutrients.

6. Build this into your calculations. For example, an average woodland tree increases in girth by approximately 1.25cm per year.

Explore

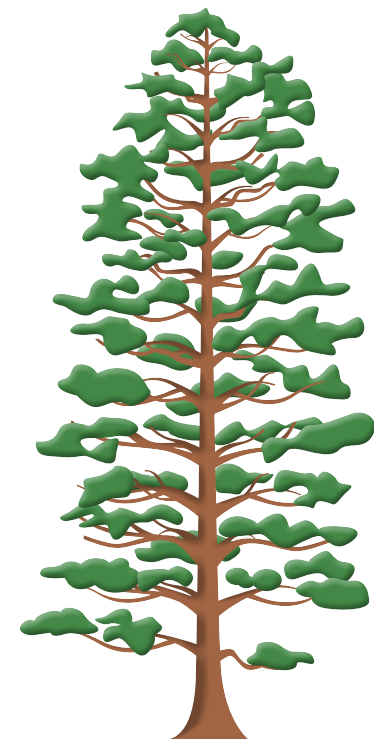
Can you see any conifers?

Conifers (pines, spruces, larch, firs) usually grow a whorl of branches each year. If you count the number of whorls of branches up the trunk, you get an approximate age. This is easiest with young trees – up to about 20 years old!

7. Estimate the age of any conifers present using this method. Compare it to the method using girth measurement using the data in the table below. How similar are your results?

Extension

Draw a timeline for your tree in chalk in the playground. Research and mark on this significant moments or events in recent history that this tree would have lived through.



Whorls - this tree is 16 years old

THIRD/FOURTH LEVEL TREE MEASURING (S1–S3 APPROX) AND SENIOR PHASE (S4–6)

Aim

To involve students in developing and using simple tools for measuring tree height, spread and density using angles and simple formulae. This creates opportunities for discussions on the accuracy of their measurements and how they might be used in real life situations. For example: developing a tree planting scheme in their school grounds or local community, and considering the mathematical skills needed in professions like forestry.

Before you start

Make sure that the students have had experience of First & Second Level Tree Measuring Activities.

Third/Fourth Level Curriculum for Excellence (see also CFE Benchmarks)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes				
		Measuring tree height: making and using a clinometer	Tree Spread and Crown Measuring	Measuring the Diameter of a Tree Trunk	Measuring tree height using a hypsometer	Measuring the area of ground covered by tree stems (trunks) in a hectare
Numeracy & Mathematics	Number, money & measure: <i>estimating and rounding</i>				MNU 4-01a	MNU 4-01a
	Number, money and measure: <i>measurement</i>	MNU 3-11a	MNU 3-11a; MTH 3-11b; MTH 4-11b	MNU 3-11a; MTH 3-11b; MTH 4-11b	MNU 3-11a	MNU 3-11a
	Number, money & measure: <i>Data and Analysis</i>	MNU 3-20a; MTH 3-20b	MNU 3-20a; MNU 4-20a; MTH 4-20b	MNU 3-20a; MNU 4-20a; MTH 4-20b	MNU 3-20a; MTH 3-20b	MNU 3-20a; MTH 3-20b
	Number, money and measure: <i>Angle, symmetry and transformation</i>	MTH 3-17b MTH 4-17b	MTH 3-17b; MTH 3-19a		MTH 3-17b; MTH 4-17b	
	Shape, position & movement: <i>Properties of 2D shapes and 3D objects</i>	MTH 4-16a	MTH 3-16a; MTH 4-16b		MTH 4-16a	
	Mathematics – its impact on the world, past, present and future	MTH 4-12 a	MTH 4-12a	MTH 4-12a	MTH 4-12 a	MTH 4-12 a



Third/Fourth Level Curriculum for Excellence (continued)

Curriculum area	Organiser	ACTIVITY + Numeracy experiences & outcomes				
		Measuring tree height: making and using a clinometer	Tree Spread and Crown Measuring	Measuring the Diameter of a Tree Trunk	Measuring tree height using a hypsometer	Measuring the area of ground covered by tree stems (trunks) in a hectare
Literacy & English	Listening and talking: <i>Tools for listening and talking; Understanding, analysing and evaluating</i>	✓	✓			
	Writing: <i>Organising and using information; Creating texts</i>		✓	✓		
Sciences	Planet Earth: <i>Biodiversity and interdependence</i>		✓			
Social Studies	People, place and environment		✓			✓
	People in society, economy and business	✓	✓	✓	✓	✓
Technologies	Technological Developments in Society and Business				✓	✓
	Craft, Design, Engineering and Graphics	✓		✓	✓	✓
Health & wellbeing across learning	Planning for choices and changes			✓		✓

SENIOR PHASE

Some of the more advanced methods described in this *Tree Measuring* resource for Third and Fourth level might be suitable to support Mathematics, plus Science and Technological subjects, for CfE Senior phase at school (S4, S5, S6).

The SQA course skills, knowledge and understanding for each Maths course (Nat4, Nat 5, Higher, Adv. Higher) is summarised in the Appendix.

Additional Senior Phase resources not included here

Advanced Tree Measuring Technologies

Illustrated by Forestry Commission Forest Research.

Forest Research is the research agency of the Forestry Commission. Measuring tree and wood properties (particularly those of sawn timber) is an important part of understanding the potential of the national forest resource. Some traditional methods, like using clinometers, to measure the height of a tree, and measuring the diameter of a tree at breast height (DBH) to estimate volume, are described in this resource.

It is important for students to understand however, that technological developments mean that these may no longer be the most accurate or efficient methods. Forest Research web pages **Measuring tree and wood properties** describe state-of-the-art technologies, and pioneer methods, to measure properties that are vital for commercial exploitation.

These resources can support the study of Mathematics and Technologies at National 4, National 5, Higher and Advanced Higher levels.



L3/4: MEASURING TREE HEIGHT:

MAKING AND USING A CLINOMETER

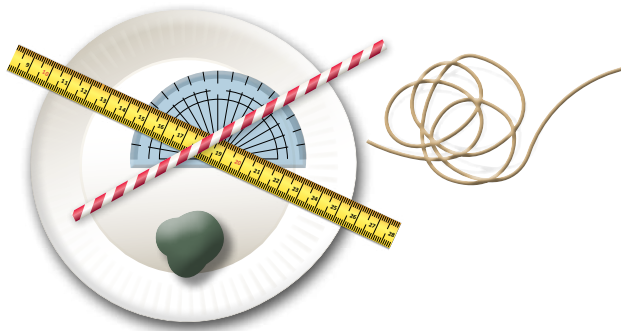
In pairs make a tool and use this to measure the height of a tree using trigonometry, working to scale.

Skills

Measurement, angle, symmetry and transformation, data and analysis, impact of maths in the world, 2D shapes & 3D objects.

Resources

Tree(s); paper plate, a straw (or empty pen tube), some string, a weight (like plasticine), glue or sticky tape, scissors and a measuring tape/wheel, (optional – protractor).



ACTIVITY

Explore

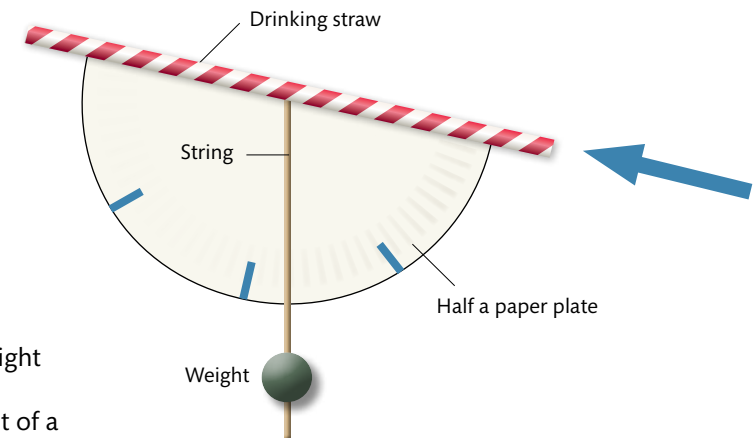
Why do we need to know a tree's height?

Foresters use tree height for many things. Tree height can give a clue as to how old a tree is. It can also reflect the quality or fertility of the soil. The height of a tree can indicate a tree's dominance within the forest canopy, and is used to calculate the amount of timber per tree.

It's usually impossible to reach the top of a tree to measure its height. Various instruments are used by foresters to measure tree height, using basic trigonometry. A clinometer/inclinometer is a tool that is used to measure the angle of elevation, or angle from the ground, in a right-angled triangle.

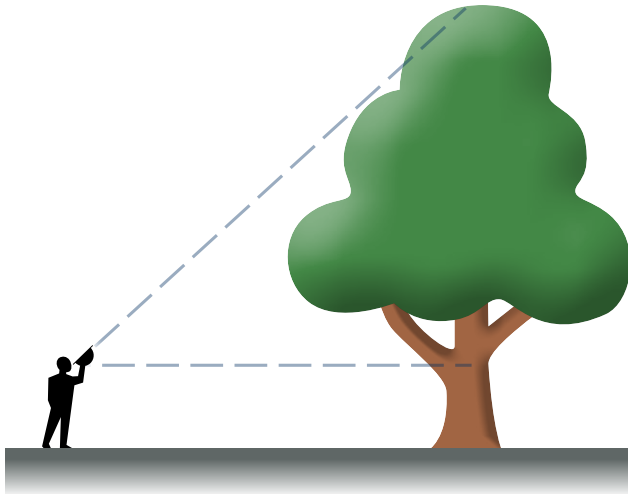
The observer stands at a fixed horizontal distance from the base of the tree and determines the angle from the fixed point to the top of the tree and from the fixed point to the base of the tree.

In this activity, first make a clinometer, in order to calculate the height of a tree. (NB. Inclinometer/clinometer templates can also be found [online](#)).



1. Make a clinometer

- Cut a paper plate in half and exactly half way along this cut edge stick a piece of string with a weight on the end, so that it dangles beyond the edge of the plate.
- Find the middle of the plate's curved edge (marked 0° in the picture). A position exactly half way between 0° and the cut edge of the plate is 45° . For accuracy, use a protractor to mark 45° . (Place the protractor's straight edge along the plate's cut edge, with its centre exactly half way along.)
- Glue a straw or an empty pen tube along the cut edge.
- Discuss how the care taken in marking and cutting the clinometer will affect the accuracy of the results.



Using the clinometer

Extension

Can you develop a plan of all or part of your school grounds showing the school's trees as scale models?

The NRICH Enriching Mathematics website includes a slightly different version of how to make a clinometer. See [Making Maths](#).

For a teacher's view on this activity, plus an alternative inclinometer template and illustrations, see [The Maths Magpie](#).

The Field Studies Council also provide a [Trees and Carbon resource](#) to find out how much carbon is locked up in a living tree and make comparisons with everyday life.

2. Measure a tree, working in pairs

- Student 1 looks through the straw so that the treetop is visible. Student 1 then walks backwards, away from the tree, keeping the top in the sights.
- Student 2 follows and notes when the weighted string lines up with the 45° line. Stop when this happens and measure your distance from the tree.
- This distance is equal to the height of the tree minus your height to your eyes (because to be most accurate the triangle has to finish at your feet not your eyes).
- Find out how tall you are, add this to the distance from the tree and you have an accurate measurement of the tree height. (For example, if the distance from the tree is 4 metres and the child with the clinometer is 1 metre tall, the height of the tree is $4\text{m} + 1\text{m} = 5\text{m}$.)

3. Provide a scale drawing or model of your tree.

L3/4: MEASURING SPREAD AND CROWN

SPREAD AND CROWN MEASURING

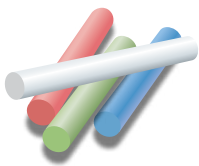
Working in groups, use a compass to explore the symmetry of spread, and measure branch length to calculate the crown area.

Skills

Measurement, 2D shapes and 3D objects, Angle, symmetry and transformation, data analysis, Mathematics – its impact on the world.

Resources

Tree(s); a compass, chalk and a measuring tape.



ACTIVITY

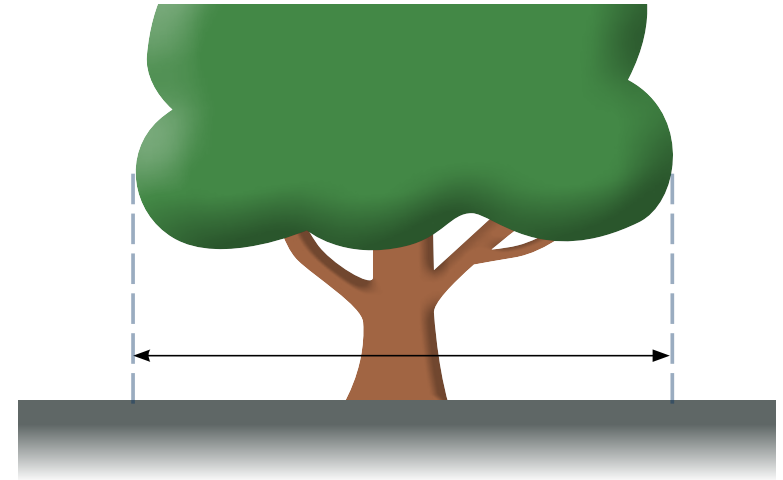
Explore

How far do your trees spread? We can see the branches but what about the roots? What job do the roots do? Did you know that the spread of the branches gives a good indication of how far the roots spread underground?

Explore

Does the tree spread evenly in all directions? (Is it symmetrical?) If not, what are the possible reasons?

For example, the growth of the branches may favour the sunnier/ less windy/ more open side etc.



Tree spread symmetry

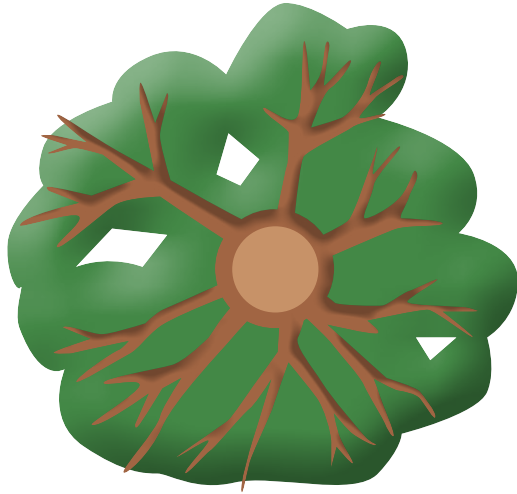
Tree spread symmetry

1. Chose a tree, working individually or in pairs.
2. Use a compass to chalk mark north, south east and west on the trunk of a tree.
3. Walk in the four directions in turn, counting the paces until the end of the branch tips above are reached each time.
4. Record the distance paced in each direction.

Explore

Does the tree spread evenly in all directions? (Is it symmetrical?) If not, what are the possible reasons?

For example, the growth of the branches may favour the sunnier/less windy/more open side, etc.



Crown measuring

Crown measuring

The crown spread of a tree is the distance its branches spread away from its trunk.

1. Work in threes.
2. Find the branch that sticks out the farthest from the tree trunk. One person stands directly under the tip of the branch.
3. Another person goes to the opposite side of the tree, and finds the branch that sticks out the farthest on that side and stands under its tip.
4. While they are both facing the tree, each person takes one or two steps to the side of the trunk so that the distance can be measured between them without having the tree trunk in the way. (i.e. one person steps to their right, and the other to their left they should both be on the same side of the tree.)
5. The third person measures the distance between them.

6. Repeat this, looking this time for the shortest branches.

7. Discuss how to calculate the average crown spread (adding the two distances together and dividing by two).

8. Recreate this crown spread visually in 2D by drawing a polygon in chalk to scale, between measured points on a hard surface, on the hard surface of the school playground. Note the compass points on the longest and the shortest branch points.

Sometimes the second measurement is taken at 90° from the first measurement.

Explore

Are there any lines of symmetry in your polygon?

Explore

Why is it important to consider the spread and eventual height of trees? For example, when planning what to plant in your school grounds.

What is the traditional use and timber value of the trees you have looked at? Have a look at online resources e.g. [FCS An Easy Guide to Forest Trees and Their Uses](#).

Things to consider:

- Is there room or need for a wide spreading tree to provide shade and shelter, or do you need to allow sunlight to reach other plants?
- How far apart should you plant your trees so they don't crowd each other when fully grown?
- If a tree reaches its full height or falls down, would it damage overhead cables?
- Remember, some trees can be pruned or coppiced to restrict their growth, or contained as a hedge.

Explore

What skills are needed to do the job of a tree surgeon?

Explore

Can you spot any trees that have been pruned or coppiced, or might need to be?

L3/4: MEASURING TRUNK DIAMETER:

MEASURING THE DIAMETER

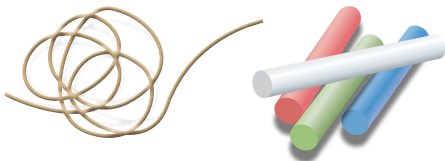
Calculate the diameter of a tree by measuring circumference, using different methods.

Skills

Measurement, Data & analysis, Mathematics – its impact on the world.

Resources

Trees; Measuring tape, string, chalk, calculators and/or callipers.



ACTIVITY

Measuring the circumference of a tree can help us estimate its age. Once we have the circumference, we can also calculate the diameter.

Measuring the diameter of a tree trunk at a standardised height (called 'diameter at breast height' or DBH) is a technique used by foresters growing trees for wood products. The diameter often correlates with the tree's wood volume. This helps foresters to estimate the amount of volume in a tree, its timber value, and how it should be managed and used. N.B. Volume is the amount of space occupied by the wood of the tree, while mass is the amount of matter it contains.

The two most common instruments used to measure DBH are a girthing or diameter tape (a 'd-tape') and callipers.

Without a d-tape, it is also possible to find the diameter of the tree using a string, a measuring tape, chalk and a calculator.

Help! What if my tree trunk isn't straight or branches?

If the trunk of the tree divides or branches at a height less than 1.3m from the ground, measure the smallest circumference below the lowest branch. If the tree has a branch or a bump at 1.3m, it is better to measure the diameter slightly below or above the branch/bump.



Measuring diameter using string and measuring tape

Work individually or in pairs.

1. With the measuring tape, measure 1.3m up the trunk of the tree from the ground. Mark this height with chalk.

Explore

Why 1.3 m?

This is a standard measure used as an approximation of a typical person's breast/chest height. Tree trunk (stem) diameter at breast height (DBH) and tree height (H) are commonly used measures of tree growth by foresters.

2. Wrap your string around the tree trunk at 1.3m.

3. Make sure the string is straight and tight around the trunk, and mark or cut the circumference on the string.

4. Measure the length of string to get the circumference of the tree.

5. Convert the circumference measurement to diameter by dividing the circumference by Pi (3.14).

Measuring diameter using callipers

A tree calliper has an arm and two prongs, one of which is free to slide along a graduated scale on the arm.

1. If your school CDT department has callipers, use these; or make your own, using the template provided and the end of this pack. This would be an opportunity for interdisciplinary work between Maths and CDT.

2. Open the 'jaws' and place on the tree at right angles to the stem (trunk) at a height of 1.3 metres (known as 'breast height')

3. Move the sliding arm until it touches the stem. Make sure the arm is at right angles to the scale on the callipers.

4. Read off the diameter from the scale to the left of the sliding arm. Take another reading at right angles to the first reading (i.e. at 90 degrees around the tree) and work out the average of the two readings.

5. This provides the diameter in centimetres.

Explore

Why is it better to take an average of 2 calliper readings at 90 degrees rather than just one?

Think about natural variation in tree trunk shape and circumference. You could compare this by measuring the circumference of a man-made cylindrical pole e.g. a lamp post.

Explore

Compare the results from both techniques to measure the same tree.

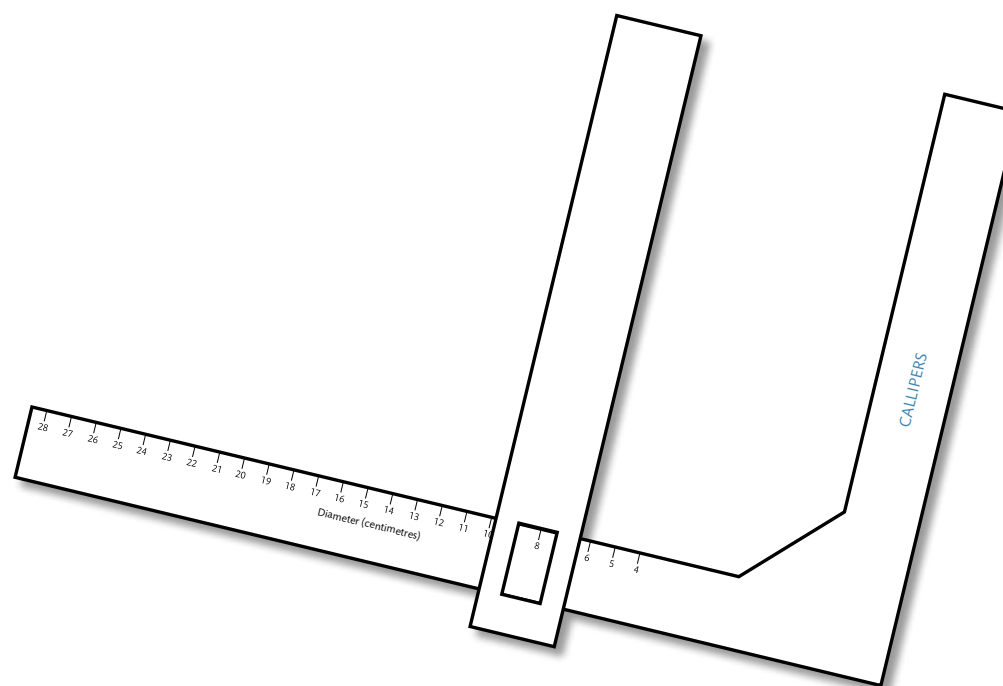
How similar are the results? Which method do you think provided the most accurate measure, and why?

Extension

Identify the trees you have been measuring.

(Tip: use the *Tree Name Trail* [publication](#) or [online](#) or other keys to find out.)

Decide how to illustrate the relationship between species – diameter and what sort of data plot to use (e.g. using a scatter diagram). Can you see any patterns emerging?



L3/4: MEASURING HEIGHT:

USING A HYPSONETER

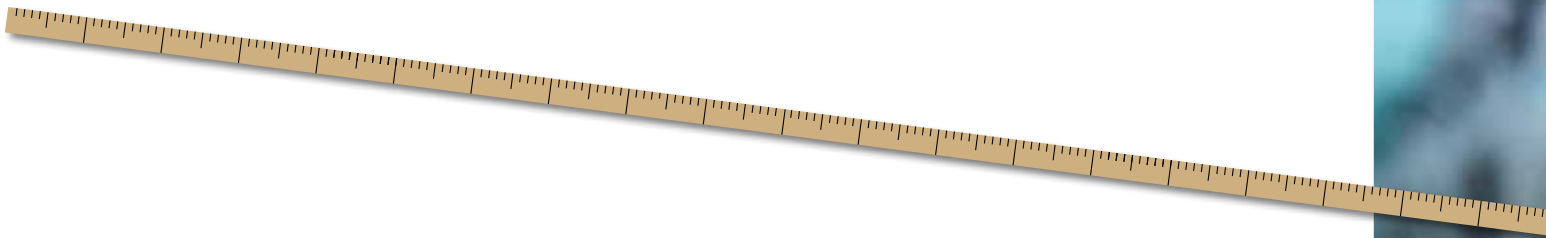
Make, and use, a hypsoneter then working together use this to measure tree height.

Skills

Measurement, angle, symmetry and transformation, data analysis.

Resources

Tree(s); 2 meter sticks or measuring tape; hypsoneter.



ACTIVITY

Various instruments are used by foresters to measure tree height. This includes the Christen's hypsoneter, a linear scale on a stick. Like the clinometer, the measurements use basic trigonometry. The hypsoneter must be positioned at a fixed distance from the eye, and the observer must stand a specified distance from the tree to measure height.

1. Work in pairs
2. Make your hypsoneter by cutting out the shape on stiff card, from the template provided.
3. Select the tree you want to measure for height.
4. Lean a 2 meter stick vertically against the tree at its base. Mark this point clearly e.g. using a coloured band, or get a partner to stand and indicate this point.



5. Walk far enough from the tree so that when looked at through the hypsometer, the top of the tree is no more than 45 degrees up.
6. Move backwards and forwards until the whole of the tree is within the end brackets of the hypsometer scale.
7. Read off the scale the number nearest to the top of the 2m stick or pointer. Label the meter stick so that is clear in the diagram
8. This number is the approximate height of the tree in metres.

Explore

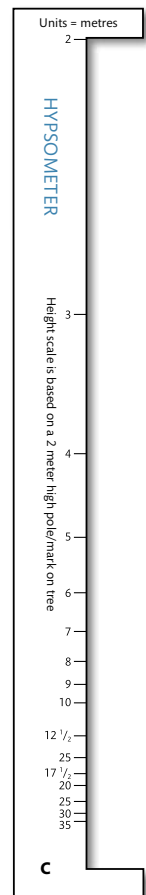
Would this technique for tree height measurement be possible in forests or plantations where many trees grow close together?

Can you find out what foresters do in this situation?

This triangulation method assumes trees grow straight up. Can you see how much the tree you are measuring leans from its base? Discuss how this might increase errors in your results.



Using the hypsometer



L3/4: MEASURING THE AREA OF GROUND COVERED BY TREE STEMS (TRUNKS)

NUMBER OF TREE STEMS IN A HECTARE

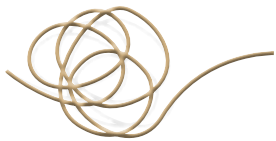
Make a simple tool and use this to estimate tree density in an area.

Skills

Measurement, Estimation and rounding, data & analysis, maths – its impact on the world.

Resources

Group of trees, card, template, string.



ACTIVITY

Foresters use the relascope as a simple, handy and quick method to estimate the density of trees (amount of timber) in a given area. The relascope and its use for measurement was invented and introduced by Austrian forest scientist Walter Bitterlich in 1947.

Make the relascope

1. Cut out shape on stiff card using the template provided.
2. Attach a bit of string, about 55cm long, by threading it through the hole marked x.
3. Tie a knot at both ends so it can't come out.
4. Your relascope is now ready to use.

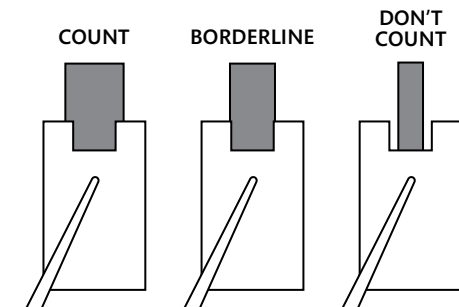
Measuring using a relascope

1. Walk into a group of trees and stand on one spot – this is your sampling point.
2. Hold the relascope at eye-level at the length of the attached string, away from the eye.



Using the relascope

3. Move in a circle (360 degrees) on the spot and count any tree at 1.3 m above the ground (breast height), which is wider than the notch in the relascope. (Tip: it might help to first mark those trees in your sample area which are taller than 1.3 m). Don't count any tree narrower than the notch. If a tree is borderline, count it in. (NB. Bigger trees near you are more likely to be counted as in). This action is known as the 'relascope sweep'.



4. Multiply the trees you have counted by the relascope factor (marked on the relascope). For example, if you count 7 trees, the answer is $7 \times 2 = 14$. Is the relascope factor always 2? What is the relascope factor?

5. The answer provides an estimate of the area of the cross-section of the trees (known as the basal area) in square metres of tree stem area in a hectare. (1 hectare = an area $100\text{m} \times 100\text{m}$ or $10,000 \text{ m}^2$.) In the above example, the group of trees sampled will cover an area of 14 m^2 within one hectare.

6. Compare the results of several students surveying the same area.

7. Can you explain any variation in your results?

Explore

If you have sampled the area of trees in your school grounds, can you find out the total area of your school grounds in square metres and hectares?

Based on the results above, calculate what proportion of your school grounds area is covered by trees. How accurate is this estimate do you think?

How are the trees in your school grounds being cared for and sustained? You might want to compare the current tree cover with historical maps of your area.

Extension

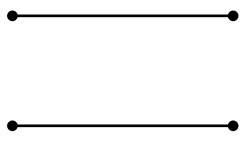
Involve your CDT department to make a relascope from a suitable material.



The relascope

Diameter (centimetres)

28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4

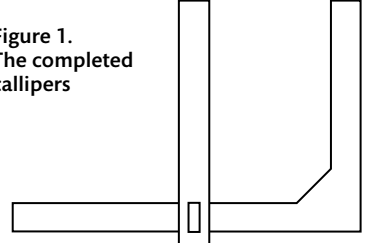


B

How to make the callipers

1. Cut out shapes **A** and **B**.
 2. Cut the two slots near the bottom of **B**.
 3. Thread the longer arm of **A** through the slots in **B** (the order should be over-under-over).
- Your calliper should look like Figure 1.

Figure 1. The completed callipers



How to use the callipers

1. Open the 'jaws' and place on the tree at right-angles to the stem at a height of 1.3m (known as 'breast height').
2. Move the sliding arm until it touches the stem. Make sure the arm is at right-angles to the scale on the callipers.
3. Read off the diameter from the scale to the left of the sliding arm.
4. Take another reading at right-angles to the first reading (i.e. at 90 degrees around the tree) and work out the average of the two readings.

How to make the (Christen's) hypsometer

1. Cut out shape **C**.
- Your hypsometer is now ready to use.

How to use the hypsometer

1. Select the tree you want to measure for height.
2. Lean a 2 metre long stick vertically against the tree at its base. Alternatively, measure 2 metres up from the base of the tree and mark the point. Make sure it's clear - you need to be able to see it from a distance.
3. Walk far enough from the tree so that, when you look at the length of the tree through the hypsometer, the top of the tree is no more than 45 degrees up (see Figure 2).
4. Move backwards and forwards until the

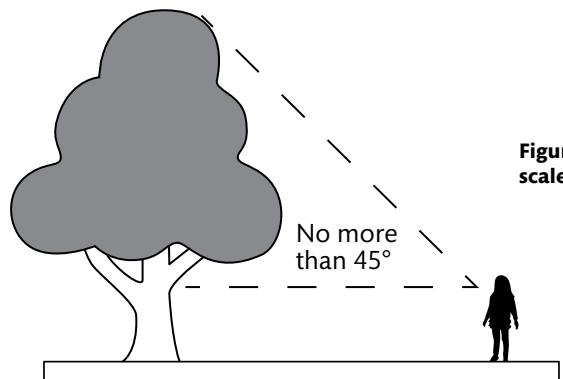


Figure 2. Correct distance from tree for hypsometer measurement.

whole of the tree is within the 'I' of the hypsometer scale (see Figure 3).

5. Read off the scale the number nearest to the top of the 2 metre stick or mark.
- The number is the approximate height of the tree in metres.

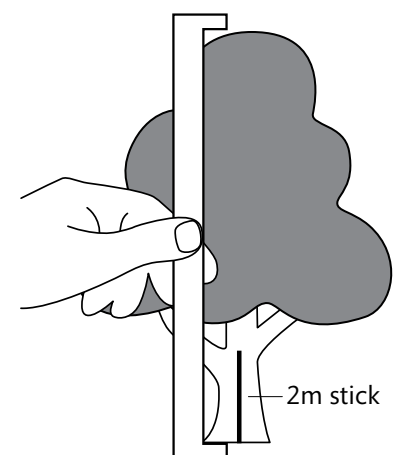


Figure 3. Lining up the hypsometer scale for measurement.

Units = metres

2
3
4
5
6
7
8
9
10
12 1/2
25
17 1/2
20
25
30
35

HYPSONETER

Height scale is based on a 2 meter high pole/mark on tree

DIY TREE MEASURING KIT

Make the tools more durable by gluing this sheet to card before cutting them out

How to make the relascope

1. Cut out shape **D**.
 2. Attach a piece of string, about 55cm long, by threading it through the hole (marked **X**) and tying a knot at both ends so it can't come out.
- Your relascope is now ready to use.

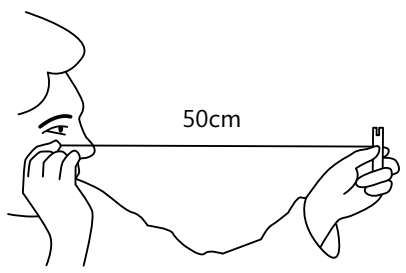


Figure 4. The correct way to hold the relascope (keep a distance of 50cm between the eye and relascope).

How to use the relascope

1. Walk into a group of trees and stand in one spot (this is your 'sampling point').
 2. Hold the relascope at eye-level at the length of the attached string away from the eye (see Figure 4).
 3. Move in a circle (360 degrees) on the spot and count or don't count the trees at 1.3 metres above the ground (breast height) depending on whether the tree is wider than the 'notch' of the relascope (count the tree) or narrower than the notch (don't count the tree). See Figure 5 for guidance. (Bigger trees near you are more likely to be counted as 'in'.) This action is known as a *relascope sweep*. If a tree is 'borderline' (see Figure 5) then count as 'in'.
 4. Multiply the number of trees you have counted by the relascope factor (marked on the relascope). For example, if you counted 7 trees and the relascope factor is 2, the answer is 7 times 2 equals 14.
- Your answer is an estimate of the area of the cross-section of the trees (known as basal area) in square metres of tree stem area in a hectare. (1 hectare equals an area 100 by 100 metres or 10,000 square metres).

Figure 5. When to count/not count a tree.

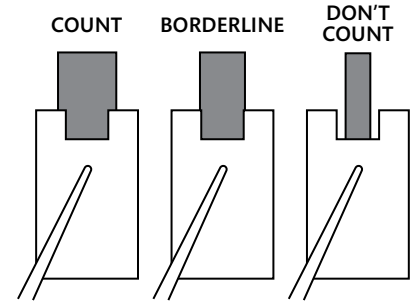
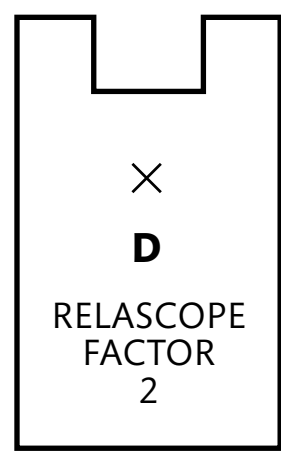


Figure 5. When to count/not to count a tree

A

CALLIPERS

C

APPENDICES

EARLY/ FIRST LEVEL NUMERACY & MATHEMATICS Organiser/Benchmarks

Number, money & measure: estimating and rounding MNU 0-01a

- Checks estimates by counting. (Early)
- Checks the reasonableness of calculations by comparing the final solution with the estimate
- Uses different strategies to estimate an answer to a calculation or problem, for example, doubling.

Number, money & measure: measurement MNU 0-02a; MNU 0-11a; MNU 1-11a; MNU 1-01a; MNU 1-03a

- Compares and describes lengths, heights, weights and capacity using everyday language including longer, shorter, taller, heavier, lighter, more and less. (Early)
- Estimates, then measures, the length, height, weight and capacity of familiar objects using a range of appropriate non-standard units. (Early)
- Uses knowledge of everyday objects to provide reasonable estimates of length, height, weight and capacity (L1)
- Uses knowledge of everyday objects to provide reasonable estimates of length, height, weight and capacity.
- Makes accurate use of a range of instruments including rulers, metre sticks, digital scales and measuring jugs when measuring length, height, weight, mass and capacity using the most appropriate instrument for the task.
- Records measurements of length using the appropriate standard units, in centimetres (cm) and metres (m) Compares the measure with the estimate.

Number, money and measure - Number and number processes MNU 1-03a

- Uses correct mathematical vocabulary when discussing the four operations including, subtract, add, sum of, total, multiply, product, divide and shared equally.

Number, money and measure - Fractions, decimal fractions and percentages MNU 1-07a

- Explains what a fraction is using concrete materials, pictorial representations and appropriate mathematical vocabulary.

Information handling: Data and Analysis MNU 0-20a; MNU 1-20a; MNU 1-20a; MNU 1-20b

- Asks simple questions to collect data for a specific purpose.
- Applies counting skills to ask and answer questions and makes relevant choices and decisions based on the data.
- Contributes to concrete or pictorial displays where one object or drawing represents one data value, using digital technologies as appropriate.

- Selects and uses the most appropriate way to gather and sort data for a given purpose, justifying choice of method, for example, a survey, questionnaire or group tallies.
- Uses a variety of different methods, including the use of digital technologies, to display data, for example, as block graphs, bar graphs, tables, Carroll diagrams and Venn diagrams.

Shape, position and movement - Angle, symmetry and transformation MTH 1-17a

- Finds right angles in the environment and in well-known 2D shapes.

SECOND LEVEL NUMERACY & MATHEMATICS Organiser/Benchmarks

Number money & measure - Estimation and rounding MNU 2-01a

- Applies knowledge of rounding to give an estimate to a calculation appropriate to the context.

Number money & measure - Measurement MNU 2-11a; MNU 2-11b; MNU 2-11c

- Uses the comparative size of familiar objects to make reasonable estimations of length, weight, area and capacity.
- Estimates to the nearest appropriate unit, then measures accurately
- Chooses the most appropriate measuring device for a given task, reading scales accurately, carrying out the required calculation and recording results in the correct unit.
- Demonstrates understanding of the conservation of measurement.

Number money & measure - Number and number processes MNU 2-03a

- Multiplies and divides whole numbers and decimal fractions with at least 3 decimal places mentally by 10, 100 and 1000.
- Multiplies and divides whole numbers and decimal fractions with at least 3 decimal places by multiples of 10

Number money & measure - Multiples, factors and primes MTH 2-05a

- Identifies multiples and factors of whole numbers and applies knowledge and understanding of these when solving relevant problems in number, money and measurement.

Number money & measure - Time MNU 2-10b

- Uses and interprets a range of electronic and paper-based timetables and calendars to plan events or activities and solve real life problems.

Shape, position & movement - Angle, symmetry and transformation

- Measures and draws accurately a range of angles using rulers and protractors and applies knowledge of the relative size of angles to solve problems in a range of contexts.

Shape, position & movement: Properties of 2D shapes and 3D objects MTH 2-16a

- Identifies and describes 3D objects and 2D shapes within the environment and explains why their properties match their function.

Information gathering - Data and analysis MNU 2-20b MN2-21A

- Devises ways of collecting data in the most suitable way for the given task.
- Collects, organises and displays data accurately in a variety of ways including through the use of digital technologies, for example, creating surveys, tables, bar graphs, line graphs, frequency tables, pie charts and spreadsheets.
- Analyses, interprets and draws conclusions from a variety of data and communicates findings effectively.
- Draws conclusions about the reliability of data taking into account, for example, the author, the audience, the scale and sample size used.
- Displays data appropriately making effective use of technology and chooses a suitable scale when creating graphs.

THIRD/ FOURTH LEVEL NUMERACY & MATHEMATICS Organiser/Benchmarks

Number, money and measure: Measurement MNU 3-11a; MTH 3-11b; MTH 4-11b

- Chooses appropriate units for length, area and volume when solving practical problems.
- Converts between standard units to at least 3 decimal places and applies this when solving calculations of length, capacity, volume and area.
- Calculates the area of a 2D shape where the units are inconsistent.
- Finds the area of compound 2D shapes and explains the method used.

Number Money & Measure: Estimation and rounding MNU 4-01a

- Uses a given tolerance to decide if there is an allowable amount of variation of a specified quantity, for example, dimensions of a machine part.
- Uses tolerance to choose the most appropriate degree of accuracy for real life calculations, selects and communicates processes and solutions.

Shape, position and movement - Properties of 2D shapes and 3D objects MTH 3-16a; MTH 4-16b

- Demonstrates a variety of methods to accurately draw 2D shapes, including triangles and regular polygons (given the interior angle), using mathematical instruments.

Shape, position and movement: angle, symmetry and transformation MTH 3-17b; MTH 3-19a

- Applies knowledge and understanding of scale to enlarge and reduce objects in size showing understanding of linear scale factor
- Uses similarity to find unknown lengths and areas of 2D shapes
- Uses bearings in a navigational context including creating scale drawings.
- Identifies all lines of symmetry in 2D shapes.

Information handling: data and analysis MNU 3-20a; MTH 3-20b; MNU 4-20a; MTH 4-20b

- Sources information or collects data making use of technology where appropriate
- Interprets raw and graphical data.
- Interprets data sourced or given.
- Analyses data and draws appropriate conclusions.
- Uses statistical language, for example, correlations to describe identified relationships.
- Calculates the mean, median, mode and range of a data set.
- Determines if data is robust, vague or misleading by considering, for example, the validity of the source, scale used, sample size, method of presentation and appropriateness of how the sample was selected.

Mathematics – its impact on the world, past, present and future MTH 4-12 a

- Contributes to discussions on the role of mathematics in everyday life and in the workplace.
- Contributes to presentations on the role of mathematics in everyday life and in the workplace.
- Investigates the mathematical skills required for a range of careers including those in STEM subjects.

Properties of 2D shapes and 3D objects MTH 4-16a

- Calculates the length of a side in a right-angled triangle using trigonometry.

Angle, symmetry and transformation MTH 4-17b

MATHEMATICS: SQA course skills, knowledge and understanding

Some of the more advanced methods described in this Tree Measuring Resource for Third and Fourth level would also be suitable to support Mathematics, Science and Technological subjects for **CfE Senior phase** at school (S4, S5, S6).

The skill, knowledge and understanding is summarised below for each course of Mathematics study. This information and further SQA Maths documents can be found here <https://www.sqa.org.uk/sqa/48674.html?subject=Mathematics>.

The highlighted text may be useful to link to the demands made of the students in the different tree measuring activities.

COURSE	Course aims to develop learners' ability to:
National 4	<ul style="list-style-type: none"> • understand and use straightforward mathematical concepts and relationships • select and apply straightforward operational skills in algebra, geometry, trigonometry and statistics within familiar mathematical contexts • select and apply straightforward skills in numeracy • use straightforward mathematical models • use mathematical reasoning skills to interpret information presented in straightforward ways, to select a strategy to solve a problem, and to communicate solutions
National 5	<ul style="list-style-type: none"> • understand and use mathematical concepts and relationships • select and apply operational skills in algebra, geometry, trigonometry and statistics within mathematical contexts • select and apply skills in numeracy • use mathematical models • use mathematical reasoning skills to interpret information, to select a strategy to solve a problem, and to communicate solutions
Higher	<ul style="list-style-type: none"> • understand and use a range of complex mathematical concepts and relationships • select and apply operational skills in algebra, geometry, trigonometry, calculus and statistics within mathematical contexts • select and apply skills in numeracy • use mathematical reasoning skills to extract and interpret information and to use complex mathematical models • use mathematical reasoning skills to think logically, provide justification or proof and solve problems • communicate mathematical information with complex features
Advanced Higher	<ul style="list-style-type: none"> • the ability to use mathematical reasoning skills to think logically, provide justification and solve problems • knowledge and understanding of a range of complex concepts • the ability to select and apply complex operational skills • the ability to use reasoning skills to interpret information and to use complex mathematical models • the ability to effectively communicate solutions in a variety of contexts • the ability to explain and justify concepts through the idea of rigorous proof • the ability to think creatively

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