



Castle maths trail - teachers' notes

Maths Week Scotland engages pupils with maths beyond the classroom and in the world around them. This teacher-led trail explores castles using maths challenges.

This trail is a cross-curricular activity covering the **Numeracy and Mathematics** and **Social Studies** areas of the Curriculum for Excellence.

Pupils will use mathematical knowledge and logical thinking skills to solve problems in a new context. In Social Studies pupils will cover aspects of People, Past Events and Societies.

These notes accompany the pupils' booklet and include:

- **The text from the pupil booklet**
- **(Answers to the challenges)**
- **More information on the maths, architecture and history covered in the trail**

PRACTICAL POINTS

- The trail is aimed at Second Level learners but there are suggestions for differentiation.
- The full trail takes approximately two hours.
- The trail is not sequential and can be completed in any order.
- Questions 1 and 5 can be completed pre or post-visit, in the classroom, while it is beneficial for the other questions to be completed on site.
- As the activity will mainly take place out of doors, wind and waterproof clothing is recommended.
- This trail can be used at any castle site. Find out how to book a free visit to a Historic Environment Scotland castle with your pupils at www.historicenvironment.scot/learn/free-learning-visits.
- Some sites may have clipboards, pencils and measuring tapes available to borrow. Please check before you visit.

The Maths Trail will help pupils explore these Second Level Numeracy & Mathematics topics:

Q1 - NUMBER, MONEY & MEASURE Number & number processes	
Having determined which calculations are needed, I can solve problems involving whole numbers using a range of methods, sharing my approaches and solutions with others. MNU 2-03a	<ul style="list-style-type: none"> • Multiplies whole numbers by two digit numbers.
Q2 - NUMBER, MONEY & MEASURE Measurement	
I can use the common units of measure, convert between related units of the metric system and carry out calculations when solving problems. MNU 2-11b	<ul style="list-style-type: none"> • Estimates to the nearest appropriate unit, then measures accurately: length, height and distance in mm, cm, m and km; mass in g and kg; and capacity in ml and l. Calculates the perimeter of simple straight sided 2D shapes in mm, cm and m. • Chooses the most apt measuring device, carries out the calculation, records results in correct unit.
Q2 - NUMBER, MONEY & MEASURE Angle, symmetry & transformation	
I have investigated angles in the environment, and can discuss, describe and classify angles using appropriate mathematical vocabulary. MTH 2-17a	<ul style="list-style-type: none"> • Uses mathematical language including acute, obtuse, straight and reflex to describe and classify a range of angles identified within shapes in the environment. • Knows that complementary angles add up to 90° and supplementary angles add up to 180° and uses this knowledge to calculate missing angles
Q3 - SHAPE, POSITION & MOVEMENT Properties of 2D shapes and 3D objects	
Having explored a range of 3D objects and 2D shapes, I can use mathematical language to describe their properties, and through investigation can discuss where and why particular shapes are used in the environment. MTH 2-16a	<ul style="list-style-type: none"> • Describes 3D objects and 2D shapes using specific vocabulary including regular, irregular, diagonal, radius, diameter and circumference. Applies this knowledge to demonstrate understanding of the relationship between 3D objects and their nets. • Identifies and describes 3D objects and 2D shapes within the environment and explains why their properties match their function.
Q4 - SHAPE, POSITION & MOVEMENT Angle, symmetry & transformation	
I can illustrate the lines of symmetry for a range of 2D shapes and apply my understanding to create and complete symmetrical pictures and patterns. MTH 2-19a	<ul style="list-style-type: none"> • Identifies and illustrates line symmetry on a wide range of 2D shapes and applies this understanding to complete a range of symmetrical patterns, with and without the use of digital technologies.
Q5 - NUMBER, MONEY & MEASURE Number & number processes	
Having determined which calculations are needed, I can solve problems involving whole numbers using a range of methods, sharing my approaches and solutions with others. MNU 2-03a	<ul style="list-style-type: none"> • Uses multiplication and division facts to the 10th multiplication table. • Multiplies and divides whole numbers by multiples of 10, 100 and 1000. • Multiplies and divides decimal fractions to two decimal places by 10, 100 and 1000. • Multiplies whole numbers by two-digit numbers.

Q1. SOUVENIRS SUMS



A French coach with 37 tourists arrives at the castle. They go to buy tickets and are offered a guide book which costs £2.50. Out of the whole group, 19 people do not choose to buy a guide book.

How many people bought a book?

$$(37-19 = 18 \text{ or } 19 + ? = 37)$$

What is the total cost?

$$(18 \times £2.50 = £45)$$

Extension activity

(a) Use the ticket prices to work out the cost of entry to the castle for each part of the group.

i) 25 adults

$$(25 \times £6 = £150)$$

ii) 6 children age 5-15

$$(6 \times £3.60 = £21.60)$$

iii) 3 concessions

$$(3 \times £4.80 = £14.40)$$

iv) 3 children under 5

$$(3 \times £0 = £0)$$

(b) What is the total ticket price for the whole group?

$$(£150 + £21.60 + £14.40 = £186)$$

Admission prices:

Adult	£6
Child (5-15)	£3.60
Concession	£4.80
Under 5	free

TEACHERS' NOTES

This question could either be answered before the visit or set for the group to do while waiting for tickets to the castle to be collected.

The question can be used to introduce discussion about historic buildings like castles also being visitor and tourist attractions and places of work.

2) A DIFFERENT ANGLE

Accurate measurements were essential when building castles. Builders used lots of different ways of measuring including string, sticks, compasses and even body parts!

1 Choose a part of the castle with tall walls and a large flat space below and stand at the bottom of the wall. **Estimate in metres how high you think the castle is:**

_____ m.

2 With your back to the wall, walk forward in a straight line, stopping regularly to bend over and look between your legs, while being careful to check that it's safe. **Stop walking when you can see the top of the building back through your legs**, then measure the distance in metres between the castle and your stopping location using a measuring tape. **Write down the distance at the bottom the diagram (in metres).**

3 When you looked at the top of the castle through your legs, you were looking at a 45° angle, which you can see on the diagram. Look carefully at the diagram. **What three-sided shape is formed when you join up the three lines** of the ground, the castle wall and the dotted line extending at 45° from where you could see the top of the castle wall back through your legs?

It's a **(triangle)** shape.

4 Look at the angle where the line of the wall and the line of the ground meet. **Can you work out its size from just looking?** Write this on the diagram.

(90°)

5 You know two angles of this three-sided shape now. **Can you use the rules of this shape to work out the third angle** (between the top of the castle and the dotted line) and write it on the diagram?

(45°)

6 Have a think about the three angles. **What kind of three-sided shape is this?**

It's a **(right-angled isosceles triangle)** .

7 Are there other rules for this particular type of three-sided shape which will help you work out the height of the castle, using the measurement you took in Step 2?

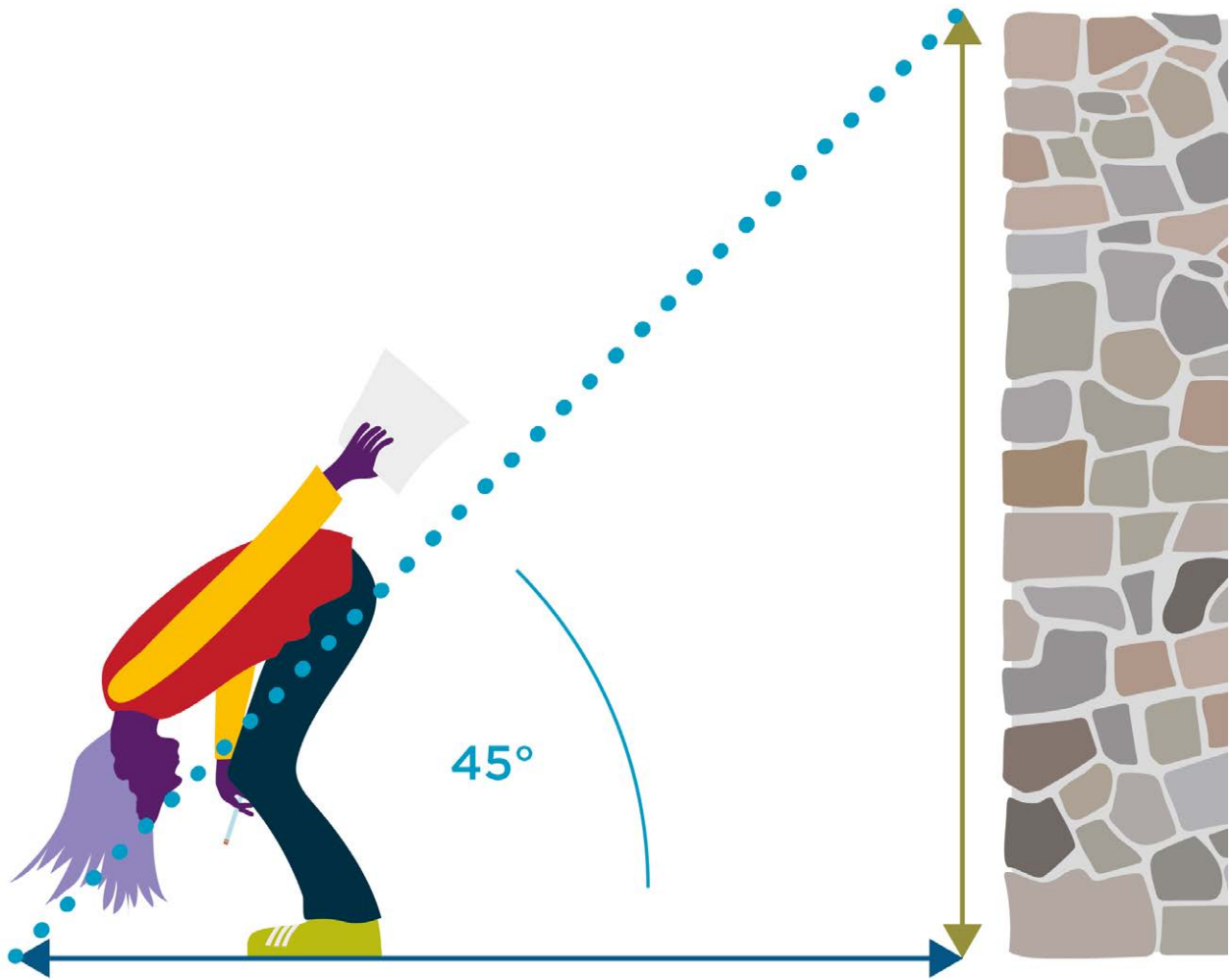
Write what you think the height of the castle is on the diagram (in metres).
Is it anywhere close to your original estimate?

TEACHERS' NOTES

The angles of triangles always add up to 180° and as a right-angle is 90° and the other angle is 45° , the final angle must also be 45° .

Right-angled isosceles triangles have at least two equal sides. One of these equal sides is the distance from the castle wall to the viewer. The other is the height of the wall, so the answer is the same.

Castle wall calculated to be _____ metres high



_____ metres measured

(between the foot of castle wall and where you could see the top of the castle when looking backwards through your legs)

TEACHERS' NOTES

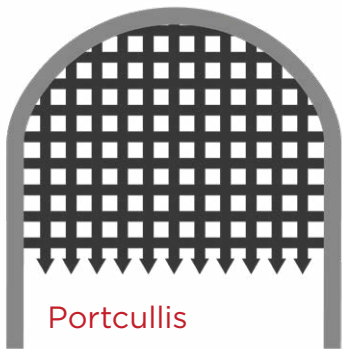
The activity can be carried out in various locations of the castle where there is a safe and level space in which to carry out measurements.

Explanatory resource: <https://nrich.maths.org/2434>

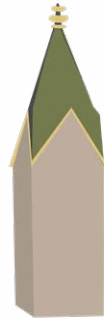
3) SHAPE SPOTTING



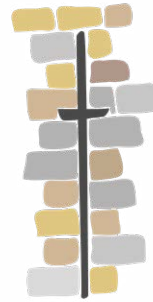
Explore the castle to find structures like these images. Discuss the properties of the 2D shapes and 3D objects you find and why you think they were used when building the castle.



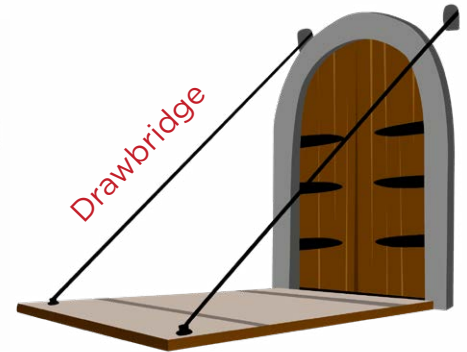
Portcullis



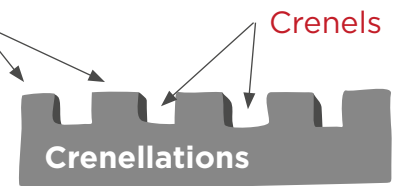
Ambry



Merlons



Drawbridge



Crenels

Crenellations

TEACHERS' NOTES

Castles are made up of lots of different structures. Your pupils have been tasked with spotting rectangles, triangles, cylinders and arches in the castle.

There are plenty of structures to find but here are some suggestions with some extra information on why these were chosen for each feature.

Cylinder

Round walls were difficult to build as they required more precise and complex maths. But they are very useful shapes for deflecting missiles, difficult to undermine, and gave defenders a wide field of view to spot and fire upon attackers.

- Turrets and towers provided soldiers inside a full field of view to watch for and fire upon attackers.

Rectangle

Rectangles were easy and cheap shapes to build making them natural choices for most buildings.

- Crenellations are composed of high merlons and low crenels. These rectangular merlons would offer protection against enemy fire and the crenels would allow the defenders to fire out.
- Rectangular arrow slits give archers a good space to fire out of but help protect them as it is more difficult to fire at them.
- Windows and doors in the castle.

Arch

Stone masons used arches as they are strong structures. The shape of the arch compresses the stones and locks them together. Arches like these have been used in building for nearly 1000 years.

- Doorway and window arches create strong, decorative openings. Door and window lintels provide strength.

Triangle

Triangles are very strong shapes because any force applied to them is evenly spread through all three sides.

- Many of the lintels above doors and windows are triangular. These are largely decorative but may also be designed to allow water to run off.



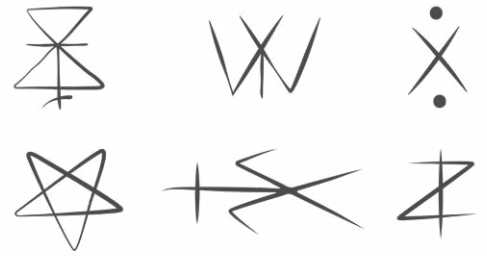
4) MASONS' MARKS

Masons took large hunks of stone from quarries and turned them into the blocks needed to build castles.

After carving each block they would mark it with an individual symbol called a mason's mark. This mark was so the mason could claim the stone and get paid for their work.

Each symbol would have between two and five straight lines.

See if you can spot any masons' marks around the castle.



TEACHERS' NOTES

Masons were given their mark by the Master Mason after they had completed their training.

Masons' marks were normally made of 2-5 strokes of the chisel.

The marks would normally be hidden in the original buildings so stones where you can see masons' marks have probably been moved from their original place.

It can be difficult to find masons' marks on castles today as much of the surface of stones has eroded away.

Ask site staff if there are any to spot during your visit.

5) CASTLE FEAST

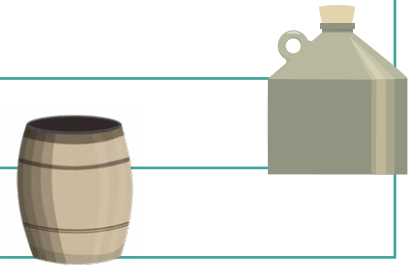
The lord of the castle has ordered his cook to plan a special feast for 50 people for the arrival of the king and queen. There will be 50 guests at the feast in the great hall.

Can you work out how much food the cook can give each person if it's divided up equally amongst the guests?

You can answer as grams, kilos, litres or items per person.



	Amount in larder	Amount per guest
Swans	2 (15 kg each)	(2 x 15 kg = 30 kg 30 kg ÷ 50 = 0.6 kg or 600 grams)
Chickens	10 (1 kg each)	(10 x 1 kg = 10 kg 10 kg ÷ 50 = 0.2 kg or 200 grams)
Salmon	3 (5 kg each)	(3 x 5 kg = 15 kg 15 kg ÷ 50 = 0.3 kg or 300 grams)
Eels	5 (3.5 kg each)	(5 x 3.5 kg = 17.5 kg 17.5 kg ÷ 50 = 0.35 kg or 350 grams)
Eggs	6 dozen	(6 x 12 = 72 72 ÷ 50 = 1 egg each with 22 left over)
Cheese	5 kg	(5 kg ÷ 50 = 0.1 kg or 100 grams)
Bread	30 loaves (400 g each)	(30 x 400 g = 12000 grams/12 kg 12,000 grams ÷ 50 = 0.24 kg or 240 grams)
Apples	100	(100 ÷ 50 = 2 apples)
Wine	100 flagons (1 litre per flagon)	(100 x 1 litre = 100 litres 100 ÷ 50 = 2 litres)
Ale	1.5 barrels* (50 litres each)	(1.5 x 50 = 75 litres 75 litres ÷ 50 = 1.5 litres)



*Weak ale was drunk by everyone - including children - as the water wasn't safe to drink.

TEACHERS' NOTES

This question can encourage exploration of the kitchen and great hall and discussion of food and drink, cooking and preparation, feasting and entertainment. Additional information can be found on the HES website:

www.historicenvironment.scot/learn/learning-resources/teaching-resources

- Tips:**
- To make the calculations easier, change the number of people at the feast to 10.
 - To increase the challenge, portion sizes for 10 of the guests could be doubled and the allocation of the remaining 40 portion sizes would need to be adjusted.

We hope your pupils enjoyed the Castle Maths Trail - do share your **#LearningWithHES** with us on social media and send us any suggestions for improving this resource to learning@hes.scot.