The king's crown

This project is all about designing a crown that is fit for a king.
There are a selection of different tasks. You can choose to do as many as you like.

Chemistry		Test waterproof materials
Biology		Investigate head circumference
Physics		Calculate density
Technology		Investigate shapes
Maths		Explore sequences
Engineering		Create a crown

We would love to see photos so please share with #CSGatHome.

The idea for this project came to us when we read "Connecting Primary Maths & Science: A Practical Approach" by Alan Cross and Alison Borthwick (p21 "The king has lost his crown!")

The king's crown
Waterproof materials

Story

The king often makes special appearances but these are often outside – even when it is raining! This means that the crown must be waterproof. Which materials could we use?

Equipment

- scales (or measuring jug)
- pouring pot (e.g. an empty bottle or a plastic cup)
- elastic band (or hair bobble)
- materials to test (e.g. plastic bag, cling film, newspaper, writing paper, foil, toilet paper, cereal box, tea towel)
- bowl
- timer

Glossary

When a material is saturated, it cannot absorb any more water.

Instructions

- Draw a table

materials	mass before (g)	mass after (g)	mass of water lost (g)

- Set the scales to zero and put on the empty pot
- Add 100 g of water and record this mass
- Cover the top of the pot with the material and secure in place with an elastic band
- Invert* the pot over the bowl for 60 seconds
  *turn it upside down
- Remove the material sample and measure the new mass
- Calculate how much water was lost

If you do not have scales, you could measure 100 ml in a measuring jug and then calculate the change in volume

Questions

- Which material is the most waterproof?
- Which material is the least waterproof?
- Is that what you predicted?
- Would any of the materials become less waterproof as they got wetter?
- How could you test this?
- Are there any materials that are really waterproof but that would not be great for making a crown?
- Which materials would be best for making a waterproof crown?

Further tasks

- Investigate head circumference
- Calculate density
- Explore sequences
- Investigate shapes
- Create a crown

Research Ideas

- What is the same and what is different:

  waterproof fabrics

  and

  water-resistant fabrics

The king's crown
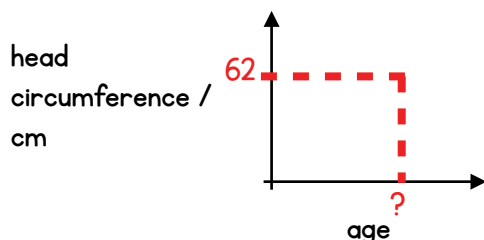## Head circumference

Equipment

• tape measure

Instructions

• What factors might affect the circumference of your head: age? Height? Weight? Hair style?
• Design a table to record any data that is needed. e.g.

age (years)	circumference (cm)

• Use the tape measure to measure the circumference of your head. How will you decide where to measure?
• To spot a pattern, you will need a large sample size and a range of data. Who else could you ask?
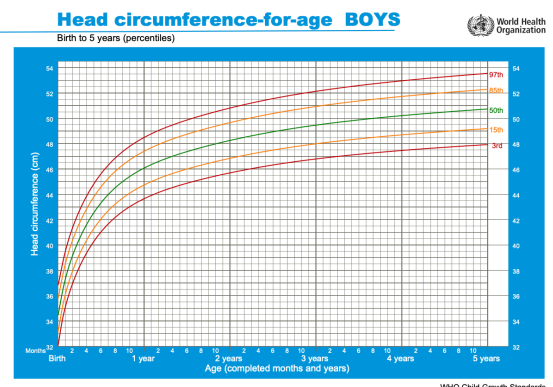
Questions and Research Ideas

• Can you spot any patterns?
• Can you use a spreadsheet to draw a graph of your data?
• Are there any results that do not fit the pattern?
• How confident are you that your pattern is always true?
• Is 62 cm a sensible size for the crown?
• If the circumference of the king's head is 62 cm, is it possible to predict his age?

head circumference / cm — 62 — ? — age

• How is the circumference of a baby's head measured before it is born?

Story

We need to know how big to make the crown but the king has lost his tape measure. When you were born, you might have been given a health record with a graph like this:

Head circumference-for-age BOYS
Birth to 5 years (percentiles)

World Health Organization

WHO Child Growth Standards

It shows how head circumference changes as we grow. Can you collect data from the people in your household to decide how big the crown should be?

Glossary

Circumference tells us the perimeter (or distance around the edge) of a circle.

Further tasks

Test waterproof materials

Calculate density

Explore sequences

Investigate shapes

Create a crown

The king's crown
Calculate density

Equipment

- small measuring jug (1 ml = 1 cm^3)
- set of scales
- waterproof objects that will sink in water

Instructions

- Draw a table

object	mass g	volume before cm^3	volume after cm^3	volume object cm^3	density g / cm^3

- Use the scales to find the mass of your object
- Fill your jug about 2/3 full of water
- Record the volume of water
- Carefully put the object in the water without bubbles
- Record the new volume
- How can you calculate the volume of the object?
- Use a calculator to find the density of the object:

$$mass \div volume$$

Story

King Hiero was told that his crown was pure gold but he thought that he was being tricked. He asked Archimedes to check. Archimedes knew how much gold was needed to make a crown of that mass but he did not know how to find out the volume of gold used to make the beautiful crown without changing the shape. Puzzled, he decided to have a bath whilst he thought about it. As he got into the bath, the water overflowed and he realised that the change in volume was equal to the volume of his submerged body. He could use this method to find the volume of the crown. He was so excited that he ran straight outside (naked!), shouting "Eureka!"

Glossary

Density tells us how much stuff is in a given volume. For example, 1 kg of feathers is not very dense so takes up a large volume but 1 kg of lead is very dense so has a small volume.

Questions and Research Ideas

- Predict which object is the most dense.
- Is the density of the objects the same or different?
- Can you order the objects from most dense to least dense? Was your prediction correct?
- The density of water is 1 g / cm^3 . Are your objects more dense, less dense or the same density as water?
- How could you find the density of an object that floats?
- How did Archimedes use this method to find out if the crown was solid gold?

Further tasks

- Investigate head circumference
- Test waterproof materials
- Explore sequences
- Investigate shapes
- Create a crown

The king's crown
Investigate shapes

Equipment
- website: scratch.mit.edu

Instructions
- Go to scratch.mit.edu and click 'Create'.
- To add the pen extension, click the blue box in the bottom left had corner.
- Click the yellow 'Events' tab and select your first block e.g. 'when this sprite clicked' means your code will run when you click the picture.
- Experiment with the pen blocks and the motion blocks.
- What shape do you think this will draw?
- Can you draw:
  - a rectangle?
  - a triangle?
  - a rhombus?
  - a crown shape?
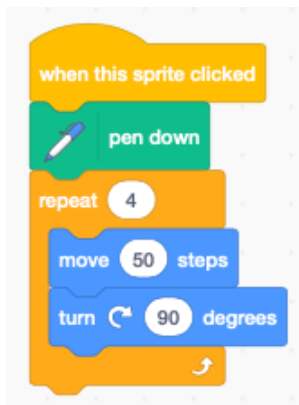
If you are new to scratch, try remixing this project:
https://scratch.mit.edu/projects/391400105/

Story
The crown needs to be decorated with different shaped jewels. Experiment with different designs. You can do this on paper but the king loves it when people use technology to solve problems.

Glossary
The angles on a straight line add up to 180°.

The interior angles of a shape are on the inside. The interior angles of a triangle add up to 180°. All 3 angles in an equilateral triangle are equal.

How many degrees will your pen need to turn to draw an equilateral triangle?

Questions and Research Ideas
- Can you change the colour and thickness of the pen?
- Can you draw a repeating sequence of shapes? Try:
  - Using 'pen up' and 'pen down' between shapes
  - Using a repeat block to create a loop (click 'Control')
  - Defining a block to draw the shape (click 'My Blocks')
- Research how computer programs are used in 3D printing.

Further tasks
- Test waterproof materials
- Investigate head circumference
- Calculate density
- Explore sequences
- Create a crown

The king's crown
Explore sequences

Equipment

- pencil
- ruler

optional:
- protractor
- pair of compasses

Glossary

The corner of a shape is called the vertex.

The plural is vertices.
e.g. a triangle has 3 vertices.

Story

The crown needs to have a circumference of 62 cm. It must be decorated with a repeating pattern of different shaped jewels. Can you find the cost 2 or more different sequences? You only have £50 to spend.

Instructions

- Draw five 2 cm x 2 cm squares
- Inside each square, draw a different shaped jewel.
  e.g. a triangle, a square, a rectangle, a pentagon and a hexagon
- How many of these jewels will fit on the 62 cm crown?
- Design at least two different repeating patterns?
  How many jewels will you use in your motif?
- The jewels cost 20p per edge and 10p per vertex.
  How much does each jewel cost?
- You have £50 to spend on jewels for the crown. Can you afford to buy all of the jewels for your patterns?

Constructing triangles

To draw an equilateral triangle:

- Use a ruler to draw a 2 cm line.
- Set your compasses so they are 2 cm apart.
- Put the point of the compasses at one end of the line and draw an arc.
- Move the compasses to the other end of the line and draw another arc.
- Use the ruler to join point where the lines intersect to each end of the line.
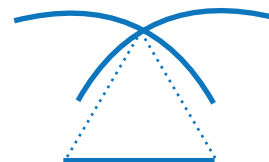
Questions and Research Ideas

- What happens to the cost when you change the spacing between the jewels?
- Use <, > or = to complete this statement:
  the cost of a square ...... the cost of a rectangle
- Can you write an expression for the cost of a jewel? Let n be the number of vertices.
- What other costs are there?
- How much do real jewels cost?
- In the 1670s, Charles II spent £13,000 on pieces for his Coronation. How many of your crowns could he have got for that much money?

Further tasks

- Test waterproof materials
- Investigate head circumference
- Calculate density
- Investigate shapes
- Create a crown

The king's crown
Create a crown

Equipment
- Junk
- Craft materials
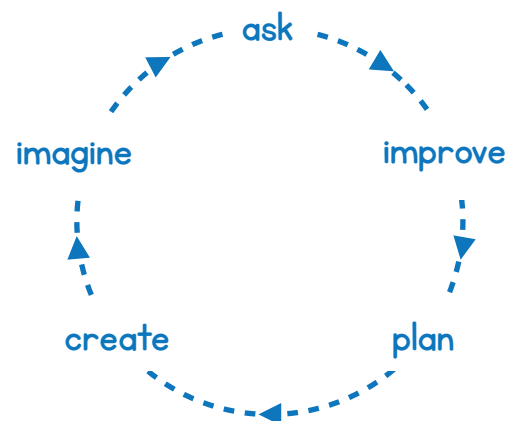
Instructions

Create your crown. It must:
- have a circumference of 62 cm
- use a maximum of 3 materials
- be waterproof
- be decorated with a repeating pattern of jewels that cost less than £50

- Ask an adult to take a photo of your finished creation and share it with us on our social media using #CSGatHome

Questions and Research Ideas

- Why have you chosen those materials?
- How have you made everything stick together?
- If you could use any materials, what would you use?
- What was the most difficult part of the process?
- How could you improve your crown?

Research how different types of headwear are made. e.g.
- wooly hats
- helmets
- baseball caps
- crowns and tiaras
- stetsons (cowboy hats)

Story

The king is very pleased with your choice of materials and the pattern of jewels that you have designed. Now you need to make the crown.

Glossary

The design process is a cycle as we continue to improve our products. Describe what you have done at each stage.

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        ask
imagine     improve

create      plan
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Further tasks

- Test waterproof materials
- Investigate head circumference
- Calculate density
- Investigate shapes
- Explore sequences