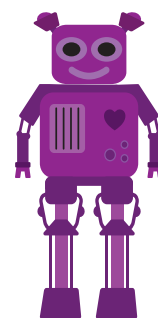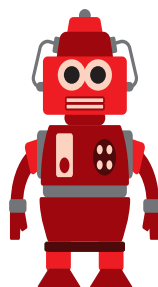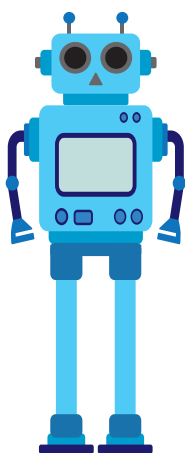# Reasoning in the classroom

Making robots

Support materials for teachers

Year 4

Llywodraeth Cymru
Welsh Government

Year 4 Reasoning in the classroom – Making robots

These Year 4 activities require learners to solve problems relating to the heights of robots. The first activity was included in the 2015 National Numeracy Tests (Reasoning). This is followed by one further activity.
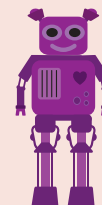
Activity 1

Making robots
Learners use the information provided to work out the heights of different robots.
Includes:
- Teachers' script
- PowerPoint presentation
- Making robots questions
- Markscheme

Activity 2

Magic robot
Learners work out which part of a magic robot has grown by considering multiples of 20, 30 and 40.
Includes:
- Explain and question – instructions for teachers
- Whiteboard – Magic robot
- Whiteboard – Growing robot
- Whiteboard – Robot's growing rules
- Resource sheet – Growing patterns
- Teachers' sheet – Growing patterns solutions
- Resource sheet – Our growing patterns

Reasoning skills required

Identify

Learners identify relevant number facts and mental strategies.

Communicate

They work together to reach a solution, explain their responses and set problems for others to solve.

Review

They use simple checking strategies to determine whether answers are sensible.

Procedural skills

- **Addition, subtraction**
- **Multiplication**
- **Multiples (of 20, 30, 40)**

Numerical language

- **Tall, tallest**
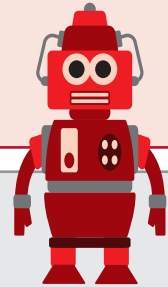- **Height**
- **Multiplication/times**
- **Multiple**

Making robots

Activity 1 – Making robots

Outline

This Year 4 activity requires learners to work out the heights of different robots.

You will need

TS **Teachers' script**
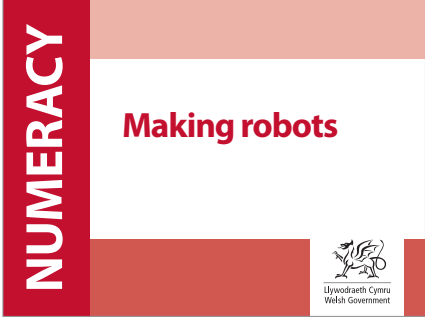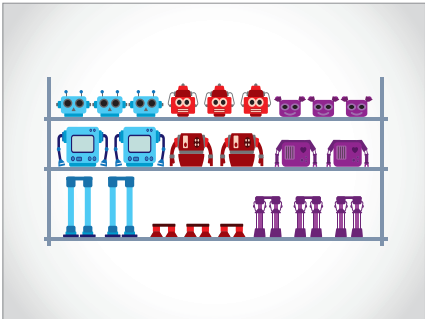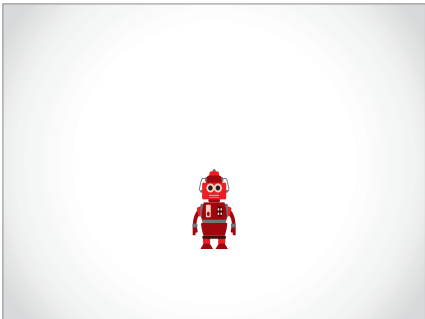
PowerPoint presentation

Q **Making robots questions**
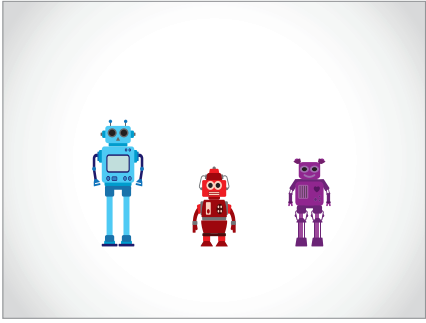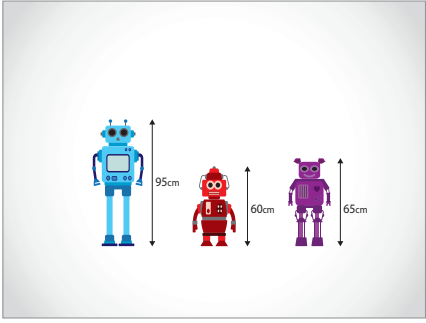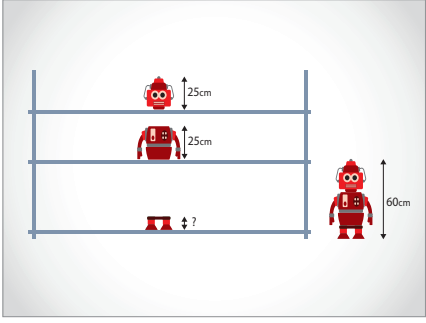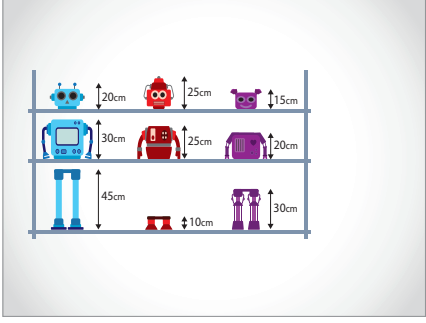Two pages for each learner, can be printed double-sided

M **Markscheme**

Presentation to be shown to learners before they work on Making robots

The text in the right-hand boxes (but not italics) should be read to learners. You can use your own words, or provide additional explanation of contexts, if necessary. However, if you are using this as an assessment item, no help must be given with the numeracy that is to be assessed.

Slide 1		*(Keep this slide on the screen until you are ready to start the presentation.)*
Slide 2		This picture shows shelves in a factory. What do you think is made in the factory? Yes, robots. On this top shelf *(point)* there are robot heads. On this middle shelf *(point)* there are robot bodies. And on this bottom shelf *(point)* there are robot legs. The people that work in the factory put together a head, a body and legs to make a complete robot. Can you picture in your head what the complete red robot would look like?
Slide 3		Here it is . . . the complete red robot. Let's see what the blue robot and the purple robot look like.

Slide 4		Here they are. Which robot is the tallest? Yes, it's this one *(point)*, the blue robot. Which is the shortest? Yes, the red robot, but it is not much shorter than the purple robot. Let's see how tall each robot is.
Slide 5		How tall is the red robot? That's right, it is 60cm *(point and if necessary explain that the arrow shows the top to the bottom of the robot)*. And how tall is the purple robot? *(65cm)* So how much taller is the purple robot than the red robot? Well done, 5cm. How did you work it out? *(discuss)*
Slide 6		The head, body and legs of the red robot are on the shelves. The head is 25cm. The body is 25cm. Can you work out for me how tall the legs are? Very good, they must be 10cm. Tell me why. *(Discuss, helping learners understand that as 25 + 25 = 50, another 10 is needed to make 60)*
Slide 7		Now we can see all the different robot parts on the shelves. Remember that the numbers show you how tall each robot part is. When the robots are being made, the head, body and legs are usually all the same colour. But sometimes they make special robots for special days like birthdays. Special robots have three colours – the head, the body and the legs are all different colours.
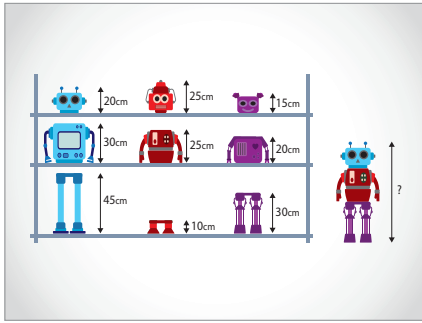
| Slide 8 | | Here is a special robot *(point to the robot on the right)*. Tell me what colour its head is . . . its body . . . its legs. Good, it has a blue head, red body and purple legs. All three colours are different.

Can you work out how tall this special robot is?

Very good, 75cm. How did you work it out?

(Discuss, helping learners to understand that the parts are 20, 25 and 30 and that 20 + 25 + 30 = 75)

Now you are going to answer some questions about special robots. Don't forget, special robots **must** have three different colours.
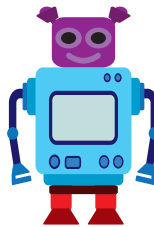
Remember to set out your work clearly so that someone else can understand what you are doing and why.

(If you are using this item for assessment purposes, you may wish to limit the time available, e.g. 10 minutes.) |

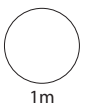| | 20cm | | 25cm | | 15cm |
| | 30cm | | 25cm | | 20cm |
| | 45cm | | 10cm | | 30cm |
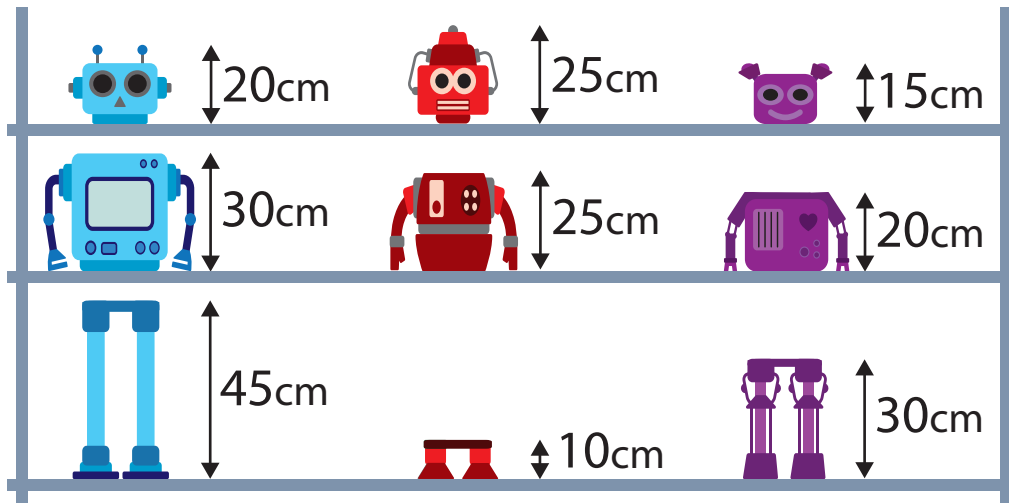
Special robots have three different colours.
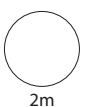
How tall is this special robot?

| cm |

1m

Another special robot is **50cm** tall.

What **colours** are its head, body and legs?

Its head is _____

Its body is _____

Its legs are _____

2m

Robots and their heights are shown on shelves:

- Blue robot head: 20cm
- Red robot head: 25cm
- Purple robot head: 15cm
- Blue robot body: 30cm
- Red robot body: 25cm
- Purple robot body: 20cm
- Blue robot legs: 45cm
- Red robot legs: 10cm
- Purple robot legs: 30cm
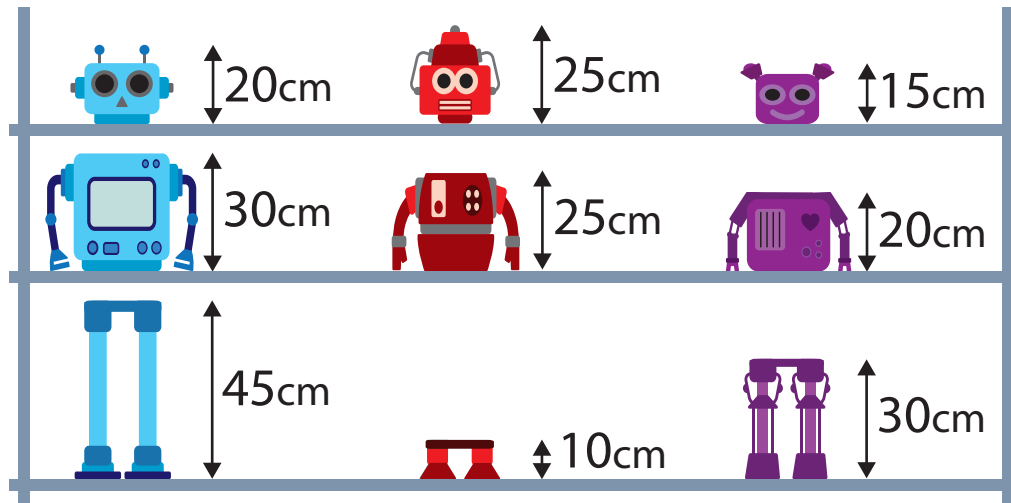
Special robots have three different colours.

Describe the **tallest** special robot.

Its head is _____

Its body is _____

Its legs are _____

The special robot is _____ cm tall.

3m

Activity 1 – Making robots – Markscheme

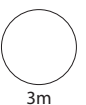| Q	Marks	Answer
i	1m	**55**cm

Q	Marks	Answer	
ii	2m	All three correct, i.e. head **blue** body **purple** legs **red**	◄ **Ignore dimensions given alongside colours, even if incorrect**
	Or 1m	head **20** body **20** legs **10** Or head **purple** body **red** legs **red**	◄ **Has given dimensions not colours** ◄ **Height 50cm, but not three different colours**

Activity 1 – Making robots – Markscheme (continued)

Q	Marks	Answer
iii	3m	All four correct colours/dimensions, i.e. head **red** or **25** body **purple** or **20** legs **blue** or **45** height **90**
	Or 2m	As for 3m but 90 is incorrect or omitted Or head **purple** or **15** body **red** or **25** legs **blue** or **45** height **85** Or head **red** or **25** body **blue** or **30** legs **purple** or **30** height **85**
	Or 1m	As for 2m but 85 is incorrect or omitted Or head **red** or **25** body **blue** or **30** legs **blue** or **45** height **100**

◄ **Throughout, if both colours and dimensions are given on the answer lines for head, body and legs, accept provided one set is completely correct even if the other set is incorrect**

◄ **One of the two next-tallest special robots**

◄ **The other next-tallest special robot**

◄ **The tallest robot, but not a special robot**

Activity 1 – Making robots – Exemplars

Part ii

Its head is ___B___ Its body is ___P___ Its legs are ___R___	Correct; **2 marks** • As each colour begins with a different letter, the use of initials is unambiguous.
Its head is ___blue 20___ Its body is ___purple 25___ Its legs are ___red 10___	Correct; **2 marks** • As the colours are correct, 2 marks can be given, even though the purple dimension is incorrect.
Its head is ___20m___ Its body is ___20m___ Its legs are ___10m___	20, 20, 10; **1 mark** • This learner has given the correct dimensions – the incorrect units can be ignored.
Its head is ___15cm___ Its body is ___25cm___ Its legs are ___10cm___	Incorrect; **0 marks** • Although these dimensions relate to purple, red, red the colours are not stated. This learner has made two errors which is why no marks can be given.

Activity 1 – Making robots – Exemplars (continued)

Part iii

|	
Its head is _R_ Its body is _P_ Its legs are _B_ The special robot is _0.90m_ cm tall.	Correct; **3 marks** • The colours are unambiguous and 0.90m is equivalent to 90cm.
Its head is _red which is 25cm_ Its body is _purple which is 20cm_ Its legs are _red which is 45cm_ The special robot is _90cm_ cm tall.	25, 20, 45, 90; **3 marks** • As 25, 20, 45, 90 are correct, 3 marks can be given even though the colour of the legs should be blue not red. The learner has shown sufficient understanding.
75cm 25cm 20cm 45cm Its head is _____ Its body is _____ Its legs are _____ The special robot is _____ cm tall.	25, 20, 45, not 90; **2 marks** • The drawing clearly shows the relevant dimensions. If the total had been correct, this learner would have scored all 3 marks.
Its head is _25 red_ Its body is _20 purple_ Its legs are _40 blue_ The special robot is _80m_ cm tall.	Red, purple, blue, not 90; **2 marks** • Even though the dimension for blue is incorrect, as all three correct colours are given this learner scores 2 marks.
Its head is _red_ Its body is _blue_ Its legs are _pink_ The special robot is _____ cm tall.	Red, blue, purple, not 85; **1 mark** • This learner has used pink for purple, but as the shades are similar this is unambiguous and can be accepted.

Magic robot

Activity 2 – Magic robot

Outline

This Year 4 activity requires learners to work out from its overall height which part of the robot has grown. It is a pre-algebraic activity in which learners solve problems before setting their own for other pairs/small groups to solve.
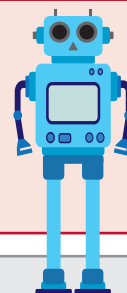
You will need

WB **Whiteboard – Magic robot**

WB **Whiteboard – Growing robot**

WB **Whiteboard – Robot's growing rules**

R **Resource sheet – Growing patterns**
One for each pair/small group

T **Teachers' sheet – Growing patterns solutions**

R **Resource sheet – Our growing patterns**
One for each pair/small group

Activity 2 – Magic robot

Explain

Remind learners of the robots in **Activity 1 – Making robots**. On the whiteboard show **Magic robot** and point out that, just as the robots in Activity 1 have three parts to them, so too does this robot. Discuss the measurements of the robot, then ask how tall it is altogether *(90cm)*. Write this total on the whiteboard alongside the measurements, as it is a key part to what follows.

Next explain that what makes the robot magic is that any one of its three parts can grow in height. Only one part at a time can grow, so the other two parts stay the same height, but then that part can shrink back to normal and another of its parts can grow.

Show **Growing robot** and ask them to work out for the two 'growing' robots which part of the robot has grown and by how much. *(Robot 1 has grown the height of its body by 30cm; Robot 2 has grown the height of its head by 40cm.)* Help learners to see that with Robot 1 the height of the body has doubled, and, with Robot 2, the height of the head has been multiplied by three. The rule is that the robot can only grow parts of its body in multiples of the height of the part it is growing *(so the height of each part can be multiplied by 2, or 3, or 4, etc.)* Show **Robot's growing rules** on the whiteboard and check for understanding.

Return to **Growing robot** and ask how tall both 'new' robots are *(120cm and 130cm)*. In their pairs/small groups, ask learners to work out how they can check this. *(The height of the original robot plus the additional 30cm/40cm)* But what if they were just told the overall height of the robot and not which part of its body had grown? Could they work out which part had grown just from the overall height? Give them a copy of **Growing patterns** and ask them to work out how the robot has grown, checking their answers. *(Solutions with comments are provided in **Growing patterns solutions**. If appropriate, learners can be challenged to see if there is more than one solution and if not, to convince you why not.)*

Finally, ask learners to set their own 'growing patterns' for another pair/small group to solve. **Our growing patterns** provides a template for them to use.

Question

- Could the robot grow by 10cm? Why/why not? *(Because the shortest of its body parts is 20cm, and it can only grow by multiples of its parts)*

- What method are you going to use to work out which body part has grown? *(One way is to find the difference between the original height and the new one and work out whether it is a multiple of 20, 30 or 40.)*

- Why might there be more than one solution? *(If the growth is a multiple of more than one of 20, 30 and 40)* What solutions can you find? How can you convince me that no other solutions are possible?

- Could the robot's height be 140cm? Why not? *(This encourages learners to communicate their reasoning.)* What other heights can you find that are not possible?
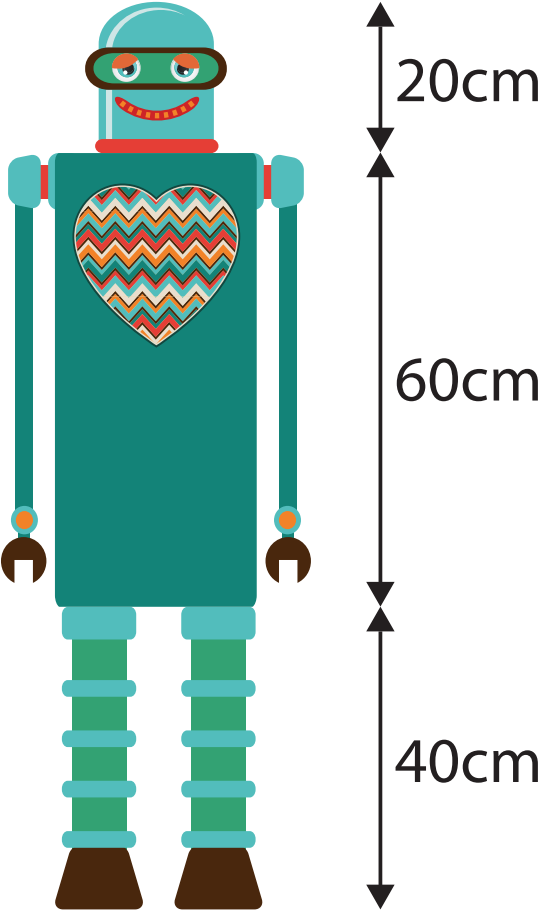
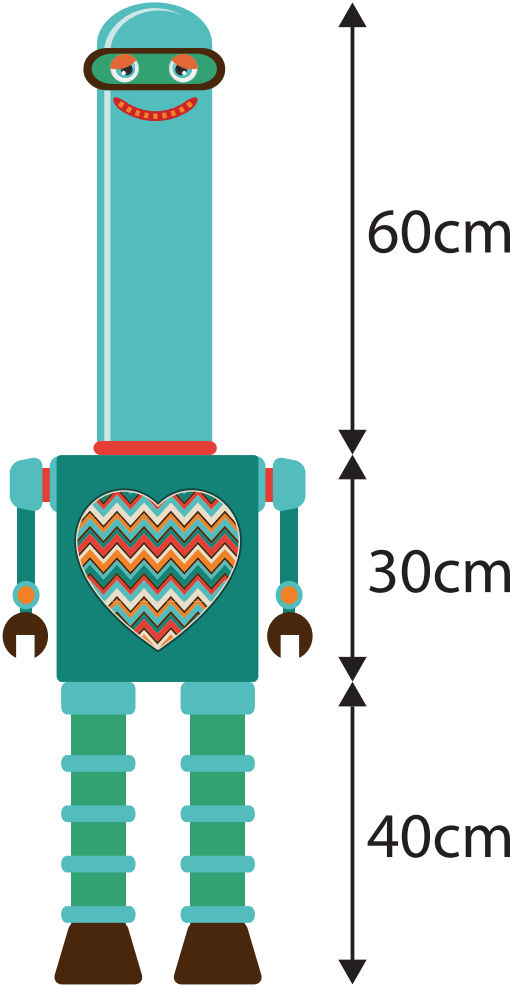**Magic robot**

20cm

30cm

40cm
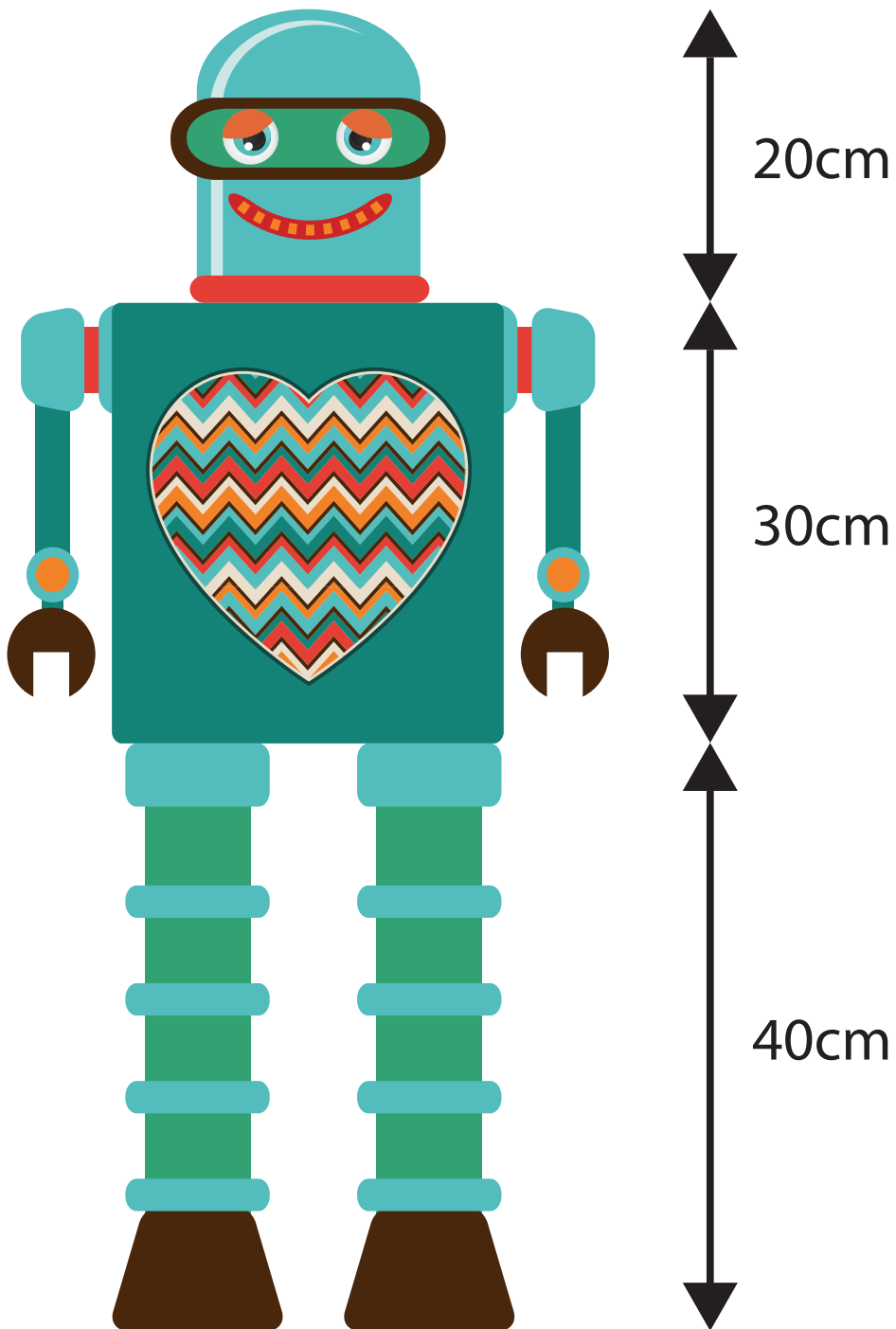
I am _____ cm tall.

Usual height

20cm

30cm

40cm
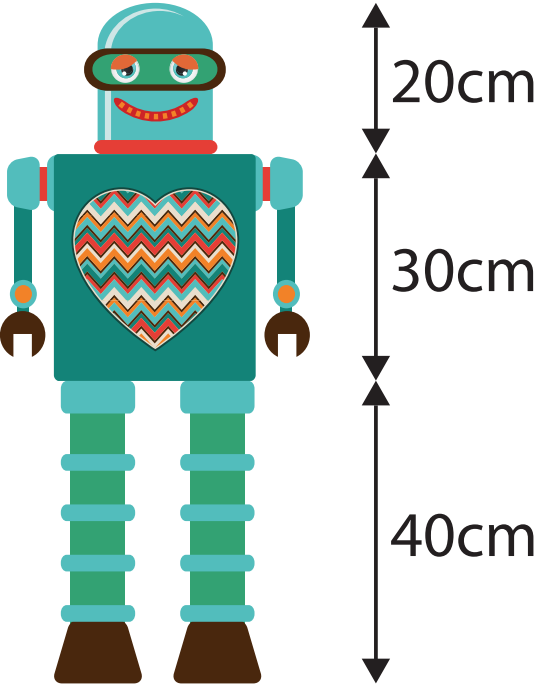
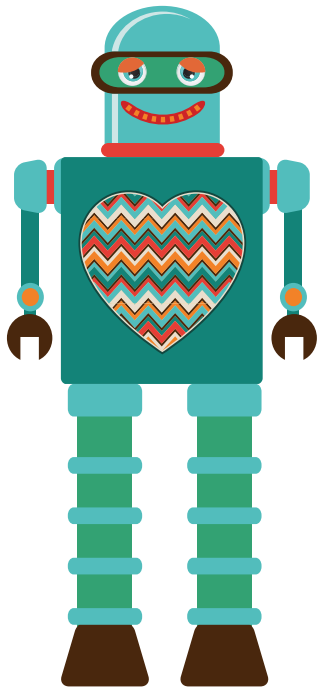Total height: 90cm

Robot 1

20cm

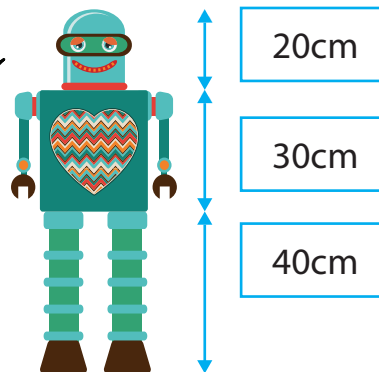60cm

40cm

Robot 2

60cm

30cm
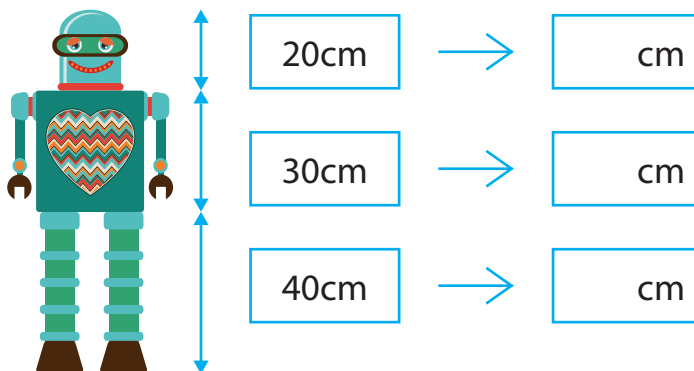
40cm

Robot's growing rules

Only one part of me can grow at any time.

Each part can only be 2 times, or 3 times, or 4 times, or . . . times my usual height.
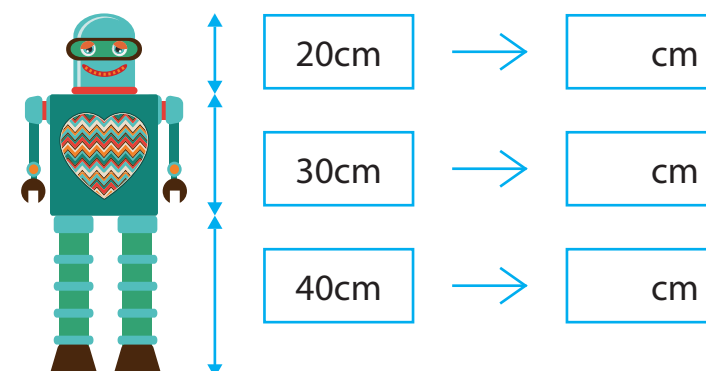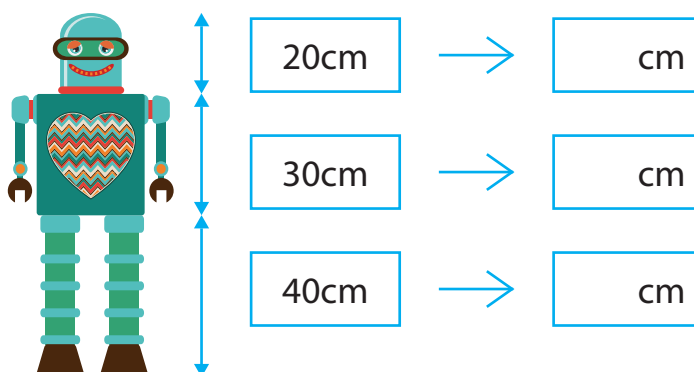
This is my usual height.

20cm

30cm

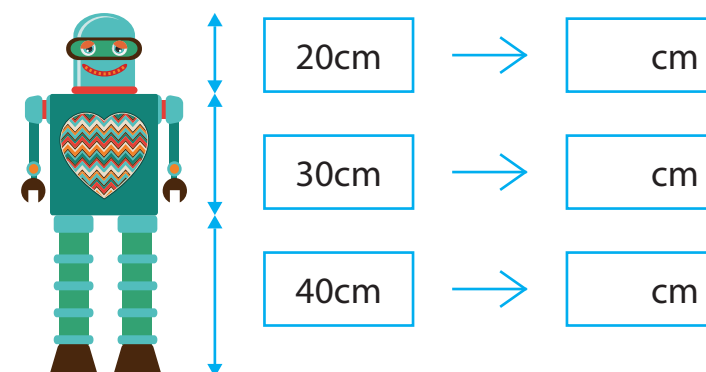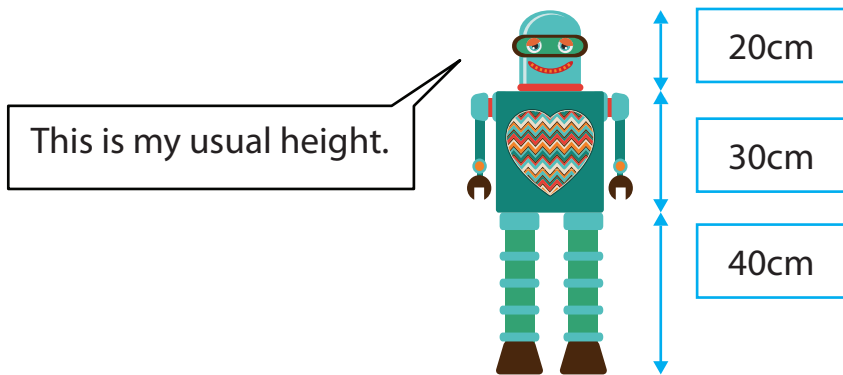40cm

Total height 180cm

20cm → cm

30cm → cm

40cm → cm

Total height 170cm

20cm → cm

30cm → cm

40cm → cm

Total height 150cm

20cm → cm

30cm → cm

40cm → cm

Total height 210cm

20cm → cm

30cm → cm

40cm → cm

This is my usual height.

20cm

30cm

40cm

Total height 180cm

20cm → 20cm

30cm → **120cm**

40cm → 40cm

Total height 170cm

20cm → 20cm   **100cm**

30cm → 30cm | OR | 30cm

40cm → **120cm**   40cm

Total height 150cm

20cm → 20cm   **80cm**

30cm → **90cm** | OR | 30cm

40cm → 40cm   40cm

Total height 210cm

→ **140cm**   20cm   20cm

→ 30cm | OR | **150cm** | OR | 30cm

→ 40cm   40cm   **160cm**

R
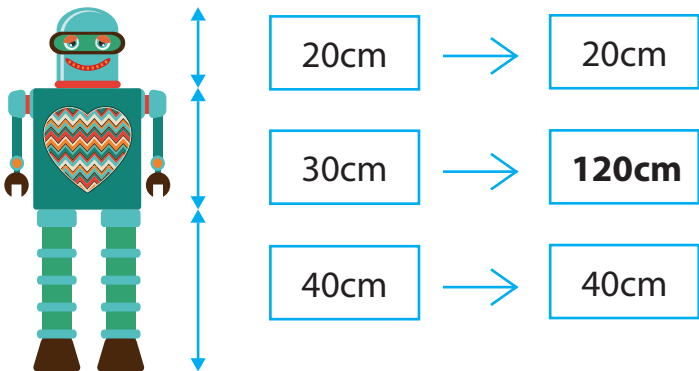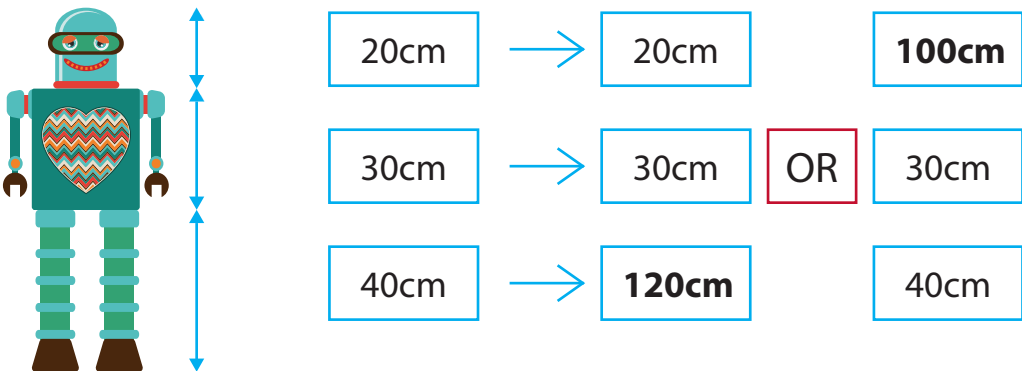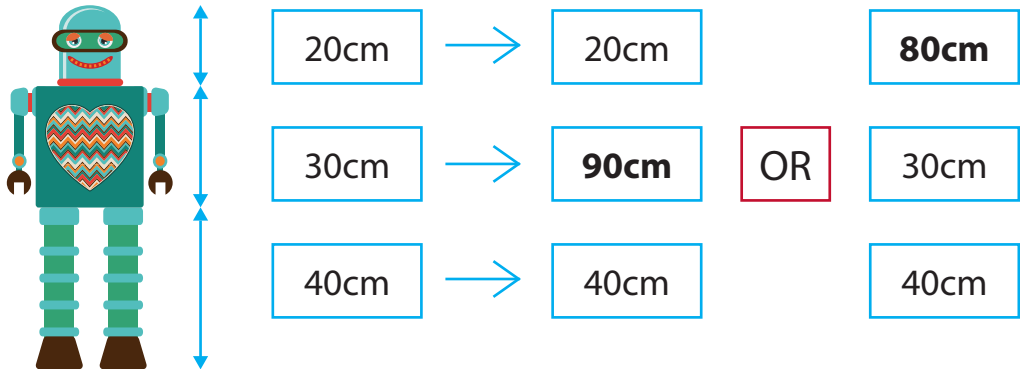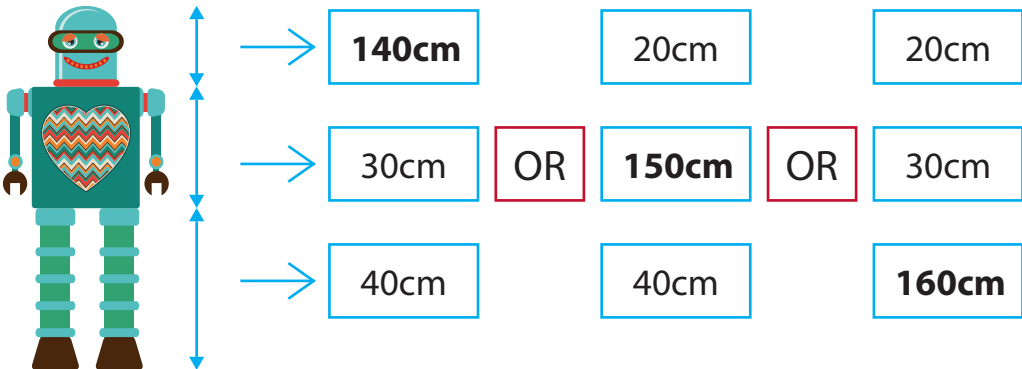
This is my usual height.
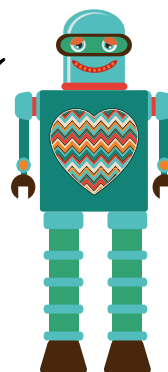
20cm

30cm

40cm

Total height [ ] **cm**

Total height [ ] **cm**
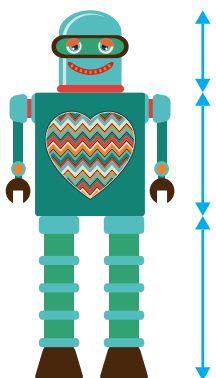
20cm	→	cm
30cm	→	cm
40cm	→	cm

20cm	→	cm
30cm	→	cm
40cm	→	cm