How Much Snow?

Objective: To investigate how much snow would be needed to completely fill the classroom.

Learning Outcomes: I can work in a team. I can estimate distances in metres. I can measure accurately using a metre stick. I can work out the volume of a cuboid. I can use averages. I can round a calculator answer. I understand significant figures. I can convert between different units of volume.

Age Group: 8-12.

Method: Teacher-led dialogue alternating with team work. .

What you need: 1 litre of snow, 12 metre sticks, 6 Diennes thousand cubes, calculators.

Note: *This investigation offers enormous scope for investigating metric measurements and developing practical measuring skills. The progression below is a guide only. Feel free to depart from it and follow the children's interests. Use your judgement as to how far to take the investigation when you first tackle it. Pupils can return and develop it further in a subsequent year.*
Numerous photocopy masters are supplied in case you wish to use them. ***Do not attempt to use them all!*** *You may wish to use some as supplied, use individual whiteboards for other parts of the investigation, and in other places ask pupils to draw their own tables. Be flexible and have fun!*

Introducing the Investigation

Enter the classroom with a measuring jug containing 1 litre of snow. Leave the pupils to wonder what it's for!

Explain to the pupils that they will be doing an investigation that will use different areas of maths. Introduce how the investigation will work – explain that you will be using a mixture of teacher-led dialogue (asking children by name what they think, asking 'Why?' etc, to ensure that everyone is involved in the thinking process) and teamwork.

Explain that the pupils will be working in their teams, but you will be interrupting them regularly so that the teams can share ideas and learn from each other. Divide the class into six teams and ensure that they have both adequate space to write and can also gather together to chat.

Point out the equipment that you have brought for the investigation – metre sticks, 1000 cubes and calculators. Explain that the pupils will be allowed to use these later, but that their initial task will be to discuss how they might go about answering the key question that you are going to give them.

Initial Puzzle

Set the challenge 'How much snow would it take to completely fill the classroom'. Allow the pupils a few minutes to discuss in their groups (discussion only – no equipment allowed), while you circulate and listen in.

Class Discussion

Use teacher-led dialogue to ask for ideas and test them out with other members of the class. You may find the following suggestions helpful for developing the ideas that come up.

Ideas relating to the measuring of the classroom

- *"Measure the classroom."*

What would that mean? What would you measure? (elicit length, breadth, height) What would you measure it with? (metre sticks) What units of measurement would you use? (metres)

- *"See how many 1000 cubes would fit in the classroom."*

What do others think? Would that be useful? Why? How would you do it?

Ideas related to the 1000 cube

- *"Work out how many cubic centimetres are in the 1000 cube."*

What do others think? Would that be useful? Why?

How many cubic centimetres would fit into the 1000 cube? Why?

- *"The cube has a volume of 1 litre."*

What do others think? Is that correct?

Explain that the litre was actually invented to be exactly the volume of a 10cm by 10cm by 10cm cube.

- *"1 millilitre is the same as 1 cubic centimetre."*

True! How many millilitres in one litre? How many cubic centimetres in one litre?

Aim to establish the following equivalences:

1 litre = 1000 millilitres

1 millilitre = 1 cubic centimetre

1 litre = 1000 cubic centimetres

The Metre Cube - Demonstration and teaching input

Gather the pupils at a table. Hold up a 1000 cube. Building on any discussion that has already taken place with the whole class, establish how many cubic centimetres would fit into the 1000 cube. Ask why. (Pupils may know the rule (length x breadth x height) but not be able to explain why it works. Lead pupils to the answer by asking them to visualise cubes along one edge of the larger cube. How many? (10). Then visualise a whole layer. (10 rows of 10 = 100). Then visualise layer upon layer upon layer (10 layers of 100 = 1000).

Get the pupils help in building a cube using the 12 metre sticks. Discuss its name (cubic metre) and the reason for the name. Lead the class in understanding how many of the Diennes 1000 cubes would be needed to fill the cubic metre. (10 layers of 100 as with the smaller cube.) How many cubic centimetres would be in the cubic metre? (1000 1000s = 1 million). (This is an excellent visualisation of what 1 million actually looks like.)

Establish the equivalences:

1 litre = 1000 cubic centimetres

1 cubic metre = 1000 litres

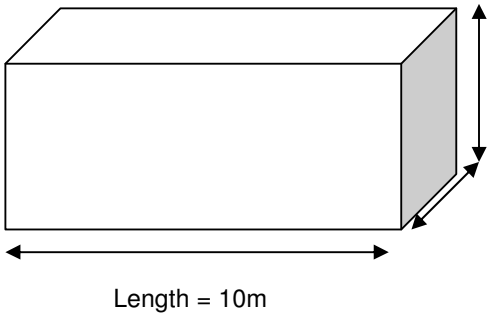
1 cubic metre = 1 000 000 cubic centimetres.

Discuss the correct recording of cubic metres. (m^3) Explore with the group what the ^{3} represents. Why do we use m^2 to represent square metres? What does the ^{2} represent?

With reference to the cubic metre you have constructed, discuss the idea of dimensions. (length is 1-D, area is 2-D, volume/capacity are 3D)

Estimating the volume - Group discussion

Remind the pupils of the problem solving strategy 'use a diagram'. Show the pupils how to sketch a diagram of a cuboid as a representation of the classroom. Send them back to their teams to work out how many of the giant cubic metres would fill the classroom and to draw their own diagram and calculations to record their findings. They should *estimate* the length, breadth and height of the room. *No measuring is allowed yet.*



Volume = 10 x 7 x 3 = 210 m^3

Averaging results - Class discussion

Gather the estimates for the dimensions of the classroom from the different groups.

eg Length: 10, 9, 9, 10, 10, 12
Width: 7, 5, 6, 7, 8, 7
Height: 3, 3, 4, 3, 2, 3

Discuss the methods of averaging that the pupils know. Introduce or revise the idea of the median: put the numbers in order and take the 'medium' value. (If there are 2 numbers in the middle, go half way between.)

Eg Length: 9, 9, 10, 10, 10, 12 Median 10
Width: 5, 6, 7, 7, 7, 8 Median 7
Height: 2, 3, 3, 3, 3, 4 Median 3

Ensure that everyone is secure in how to find the volume of the room using these numbers as an example. (Seven cubes would fit along one edge of the room, build a wall – three rows of seven = 21. Visualise 10 such walls filling the room etc. Total volume 210 m^3.)

Accurate measuring - Group discussion

Next discuss how the pupils would measure the room using metre sticks. Tell them they will have two sticks per group. Ask them to volunteer possible sources of error and highlight things to remember:
eg

- Measure in a straight line.
- Take care not to leave finger spaces between sticks.
- Agree where to measure from and to (beware of wall cupboards etc)
- Remember to turn the stick round when you reach the wall so that the zero is at the wall for measuring the last piece.
- Take great care with counting. (The greatest potential source of error is miscounting the number of metres!)
- Be courteous to other groups measuring across your path.

Group work

Get measuring. If you are short of time, get three groups to measure the length of the room and three to measure the width. The first group finished can help you to measure the height.

Working with metric measurements - Class Discussion

Gather the results for the measurements. Discuss them. Depending on how the results are given to you (eg 7m 11cm, 7.2m, 7.23m) discuss how to express measurements in metres and whole centimetres or in decimal fractions of a metre. Establish through discussion that the most useful way to write them in this instance will be decimal fractions of a metre, since they will need to use calculators to work out the volume.

Revise correct pronunciation of eg 7.23m (seven point two three metres). Revise the fact that 7m 8cm is 7.08m and 7m 80cm is 7.8m.

Dealing with differences in answers - Group discussion

Look at the three measurements for the width of the room. How close are they? Discuss how to deal with the results. If the numbers are very close you could use the median again, or use the mean. If one is clearly different to the other two you could consider whether this group may have miscounted or forgotten to turn their stick around. Discuss options:
eg

- Re-measure
- Discount the 'different' measurement and average the other two
- Take the median etc

Agree as a class what to do.

Do the same for the length of the room.

Group Task

Once you've agreed as a class on the length, width and height, then give the children calculators and get them to calculate the volume.

Degrees of accuracy - Class Discussion

The calculator answer is likely to be long. (eg 188.76318) Explore the idea of degrees of accuracy.
1 figure accuracy (1 significant figure (sf)) 200 m^3
2 figure accuracy (2 sf) 190 m^3
3 figure accuracy (3 sf) 189 m^3 etc

Explore what the volume would be in litres, to the different degrees of accuracy.
1 fig accuracy (1 sf) 200 000 litres, 2 fig accuracy (2 sf) 190 000 litres, 3 fig accuracy (3 sf) 189 000 litres etc

Explore what the volume would be in cubic centimetres, to the different degrees of accuracy.
1 fig accuracy (1 sf) 200 000 000 cm^3, 2 fig accuracy (2 sf) 190 000 000 cm^3,
3 fig accuracy (3 sf) 189 000 000 cm^3 etc

If necessary, revise the reading of large numbers!

Group Task
Complete a table showing the volume to the different degrees of accuracy.

Further lines of development

What weight of snow would fill the classroom?
Weigh 1 litre of snow. Use the results from the previous volume calculation to work out the weight of snow that would fill the whole room.

How much water does snow make when it melts?
Allow 1 litre of snow to melt and find out what volume of water it makes (about ¼ litre). Discuss why this is. (Snow is ¾ air, ¼ water).

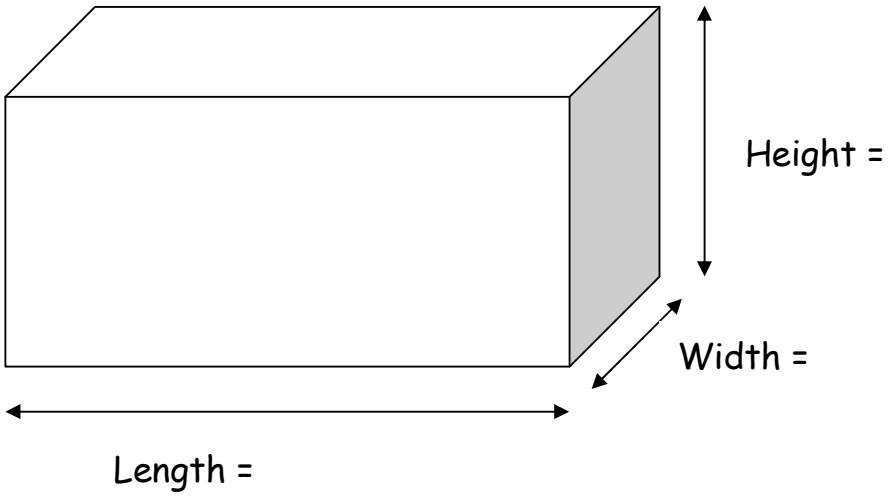
What does water weigh?
Weigh an empty litre jug. Weigh it with one litre of water and work out the difference. Establish that 1 litre of water weighs 1kg. Explain that this is why 1kg was invented to be the weight it is.

How do powers work?
Explore the difference between $10m^3$ and $(10m)^3$. The first would be the volume of 10 one-metre cubes placed end to end. The second would be the volume of a giant cube: 10 metres long, 10 metres wide and 10 metres high.

Name: _____ Class: ____ Date: _____

Estimating the Room

Estimate the length, width and height of the room.



Record your estimates and the estimates of the other groups.

GROUP	Length	Width	Height

Name: _____ Class: ____ Date: _____

Finding the Median Estimate

Work out the median value for the different estimates.

First put the estimates in order.

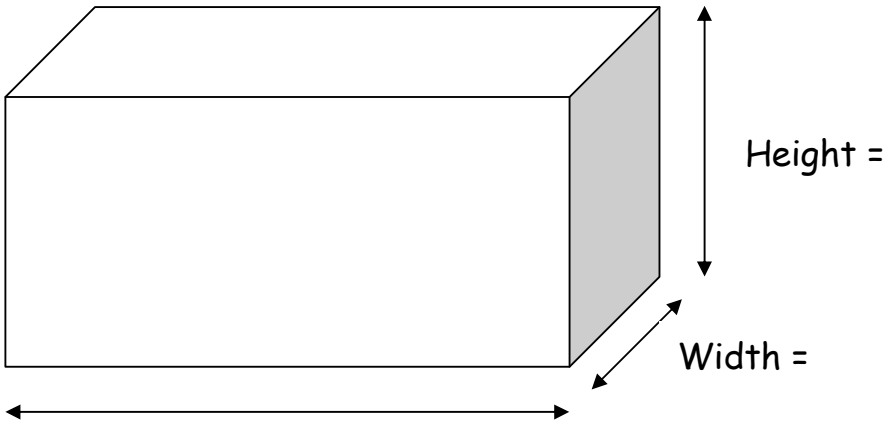
Length: ____ ____ ____ ____ ____ ____

Width: ____ ____ ____ ____ ____ ____

Height: ____ ____ ____ ____ ____ ____

Now work out the half way point between the middle two in each row.

Record the median estimates on this diagram.



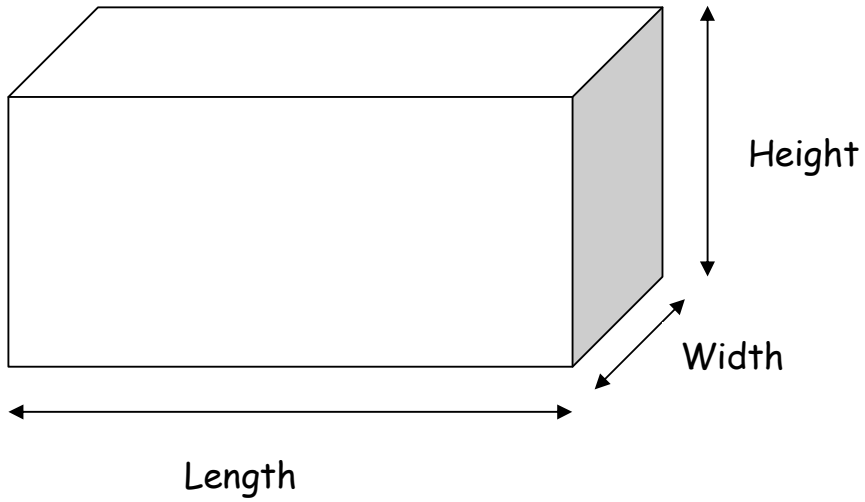
Calculate the volume. (Length x width x height)

Volume =

Name: _____ Class: ____ Date: _____

Accurate Measurements from Our Group

Measure the room accurately.



Record the measurements for your group. Make each measurement three times and work out an average.

	Length	Width	Height
1st Try			
2nd Try			
3rd Try			
Average			

Name: _____ Class: ____ Date: _____

Accurate Measurements

Record the best measurements for each group.

GROUP	Length	Width	Height

Find an average for each.

Length = Width = Height =

Use a calculator to get an accurate figure for the volume.

Volume =

Name: _____ Class: ____ Date: _____

Rounding to Significant Figures

Record the volume to 1 figure, 2 figure and 3 figure accuracy.

	Volume (m^3)
Calculator answer	
1 figure accuracy (1 significant figure)	
2 figure accuracy (1 significant figures)	
3 figure accuracy (1 significant figures)	

1 m^3 = 1000 litres 1 litre = 1000 cm^3

1 m^3 = _____ cm^3

Convert the volume to litres and **cubic centimetres!**

	m^3	**litres**	**cm^3**
1 figure accuracy			
2 figure accuracy			
3 figure accuracy			