## Part 1: Measurement and units (40 mins)

Keywords: measurement, width, length, mass, unit, standard units, unit conversion, rank

- Question students on what they believe a unit to be. Guide their suggestions and ideas to come up with the explanation that a unit is something we can use to represent a measurement or describe a magnitude.
- Split students into groups of 3 or 4 to complete Activity 1 .


## Activity 1: The Standard Unit

Measure the width of the room using your feet and record your answer.

Did everyone in the group get the same answer?

Why do you think this is?


Use the metre stick to measure the width of the room in cm , and record your answer.

Did everyone in the group get the same answer?

Why do you think this is?


Why do you think it is important to have a standard (common) unit?

- Discuss with the class the answers students gave for the last question. Mention e.g. speed signs and the speed dial in a car, or Mars Lander crash, to reiterate the importance of a standard unit.
- Concentrate on length units for Activity 2. As revision before starting the Activity get students to recall the standard units for length (mm, cm, m, and km) and the conversions ( $10 \mathrm{~mm}=1 \mathrm{~cm}, 100 \mathrm{~cm}=1 \mathrm{~m}, 1000 \mathrm{~m}=1 \mathrm{~km}$ ). Students are to complete Activity 2 individually.


## Activity 2: Unit Conversion

I have three pieces of string. String A has a length of 0.5 m , string B has a length of 25 cm , and string $C$ has a length of 200 mm .

1. Suppose you just look at the numbers and not at the units. Rank the strings from longest to shortest.
2. Now consider numbers and units. Again, rank the strings from longest to
 shortest.
3. Compare the two rankings. Which ranking is correct?
4. When comparing measurements, is it enough to just look at the numbers?

- Discuss the answer given to the last part of Activity 2. Pose the question that 'if we need to have measurements in a common unit to be able to compare them, why would we not just have one unit (e.g. just m ) and not use $\mathrm{cm}, \mathrm{mm}$ or km ?'
- As an introduction to Activity 3 revise (from primary curriculum) standard units and conversions for mass and time in a similar way to the introduction to Activity 2.


## Activity 3: Homework (start in class if time permits)

Show workings for each of the following:

1. It takes Kevin 6 steps to walk 3 m , but only 4 steps to jog 3 m . He first jogs for 60 m and then walks for 30 m . How many steps does he take?
2. Elena walked a distance of 800 m . Amy walked a distance of 1.2 km . Seán walked a distance of $90,000 \mathrm{~cm}$. Bronagh walked a distance of $1,100,000 \mathrm{~mm}$. Which student walked the furthest?
3. Sorcha, Maria and Nicole all started their homework at the same time. It took Sorcha 1.5 h , Maria 93 mins and Nicole 1 hr and $1,860 \mathrm{~s}$. Who finished first?
4. A shopper wants to put six items in a cardboard box. The box is big enough to fit everything in, but it can only hold up to 4 kg . There are 3 packets of butter, each with a mass of $454 \mathrm{~g}, 2$ bags of sugar, each with a mass of 0.5 kg , and a bag of apples with a mass of 1.326 kg . Can the shopper put all items into the cardboard box?

## Part 2: Area (40 mins)

Keyword: area

- Split students into groups of 3 or 4 to complete Activity 1.
- Give each group one $24 \mathrm{~cm} \times 12 \mathrm{~cm}$ laminated sheet, and a set of either $2 \mathrm{~cm} \times$ $2 \mathrm{~cm}, 3 \mathrm{~cm} \times 3 \mathrm{~cm}, 4 \mathrm{~cm} \times 4 \mathrm{~cm}$, or $6 \mathrm{~cm} \times 6 \mathrm{~cm}$ squares
- Have $5 \mathrm{~cm} \times 5 \mathrm{~cm}$ square sets ready for handing out later


## Activity 1

1. How many squares cover the large sheet? Record your answer here:
2. Swap a set of squares with another group. How many squares cover the large sheet now? Record your answer here:
Are your answers the same as before? $\qquad$

Do you think one answer is better than the other? Explain.
3. Explain how you can get different numerical answers but that both answers are correct.

## Activity 2

1. Form a group with at least 1 more student. Go to the website http://www.shodor.org/ interactivate/activities/AreaExplorer/. Determine the area of a few shapes, and check your answers. (Click the "Draw New Shapes" button to go to a new shape.)
2. Now tick the "Only Draw Rectangular Shapes" box and draw a new shape. Determine the area by counting the total number of squares. Also count the number of squares on the length of the shape and the number of squares on the width of the shape. Write down your answers in the table on the next page, in the row marked "Shape-1".

Repeat this for at least 3 more shapes.

|  | area <br> (number of squares) | number of squares <br> along the length | number of squares <br> along the width |
| :--- | :--- | :--- | :--- |
| Shape 1 |  |  |  |
| Shape 2 |  |  |  |
| Shape 3 |  |  |  |
| Shape 4 |  |  |  |
|  |  |  |  |

3. Can you and your partner see a relationship between the numbers in each row? If so, write it down.

Explain in words how you can calculate the area of a rectangle if you know its length and width.

## Activity 3: Whole class discussion

- Discuss with the class the need for standard units. A possible pathway is to ask students for a clear complete way of describing the area, e.g. 8 blue squares or 24 green squares; etc.
- Link back to standard unit for length. Introduce the need for standard units like $\mathrm{cm}^{2}, \mathrm{~m}^{2}, \mathrm{~mm}^{2}$.
- Get students to predict how many $\mathrm{mm}^{2}$ there are in $1 \mathrm{~cm}^{2}$.
- Overhead slide on converting $\mathrm{mm}^{2}$ to $\mathrm{cm}^{2}$. Get students to take notes, and discuss the notes they have taken.


## Activity 4: Homework

1. A shape is 30 cm long and 10 cm wide. What is its area? Show your work.
2. Determine the area of your book in $\mathrm{cm}^{2}$. Record how you did this.

Do you think another student reading this would be able to understand your method and do it for their own book? If not, change your answer until you think it is understandable to somebody else.
3. What is the area of the front of a cereal box? What is the area of the side of a cereal box? Show your work like you did in question 2.

## Part 3: Area and volume ( 40 mins )

Keywords: area, volume, irregular, estimate

## Activity 1: The area of irregular shapes

1. Explain why you cannot find the area of this shape by multiplying length and width.

2. Somebody put a number of 1 cm by 1 cm squares on top of the shape.

Estimate the area of the shape.

3. How could you use graph paper to get a really good estimate of the area of a shape? Explain carefully what you would do.
4. What is the area of one large square in the graph paper below?

And of a small square?
Use the graph paper to find the area of your thumb. Describe clearly what you did.


## Activity 2:

1. What kind of shape is this?

2. Measure the area of one side. How did you do this?

Area is a 2-dimensional idea, so it only deals with flat things. The shape is 3dimensional. We say it is a cubed unit.
3. How many cubed units make up this cube? Be careful as you count. You cannot see all of the units.


Answer: $\qquad$
How many cubed units are in these blocks?


Answer:


Answer: $\qquad$

Volume is the amount of space an object takes up.
You can measure volume by counting the number of cubed units that fit
4. What is the volume of each of the blocks in Question 3?

Left block: $\qquad$ ; Right block: $\qquad$
Is the size of the small cube units in each of the blocks shown the same?
$\qquad$ .

As with area, we need standardised units of volume. If the small cube measures 1 cm on each side, then its volume is described as "one centimeter cubed". This is written as $1 \mathrm{~cm}^{3}$.
5. Each of the small cubes has a volume of $1 \mathrm{~cm}^{3}$. What is the total volume of each of these shapes?


Answer: $\qquad$


Answer: $\qquad$
6. For the shapes shown below record (a) their volume, if each small cube has a volume of $1 \mathrm{~cm}^{3}$, and the measurement of (b) their length, (c) their width and (d) their height.


Volume:
Length:
Width:
Height:


Volume:
Length:
Width:
Height:
7. How could you calculate volume from the length, width and height? Tick which of the following options you think is correct. Use the information given above to help you discover the correct answer:
a. $\quad V=l+w \times h$
b. $\quad V=l-w+h$
c. $V=l \times w \times h$
d. $\quad V=l+w-h$.

Check your answer with your teacher.

## Activity 3: Homework

1. What is volume?
2. What is the volume of a box that has a height of 6 cm , a width of 2 cm and a length of 3 cm ?
3. What is the volume of the blocks shown? (Use a ruler, show all your work, and give your answer in $\mathrm{cm}^{3}$.)


## Part 4: The Volume of Irregular Objects ( 40 mins)

Keywords: meniscus, volume, overflow can, graduated cylinder, beaker.

## Activity 1

You need a block, a pebble, a stone, a graduated cylinder, a beaker, and an overflow can.

graduated cylinder

overflow can

1. Measure the volume of the block. List all measurements made and show all calculations.
2. Put water into the graduated cylinder so that the bottom of the meniscus is at the 30 ml mark. (Note: 1 ml is the same as $1 \mathrm{~cm}^{3}$ ).
3. Lower the block into the graduated cylinder. Read and record the mark at the new water level.

New water level mark $=$ $\qquad$ .
4. What is the difference in ml between the two readings? Record your answer.

Answer:
5. Compare the answer you calculated in question 1 to the answer you got in question 4 . What do you notice?
6. Use what you have learned to measure the volume of the pebble. In your lab book write a report on what you did under the usual headings.

## Activity 2

Use the block, a graduated cylinder, a beaker, and an overflow can.

1. Put the beaker under the spout. Fill the overflow can with water until a little water runs into the beaker. Now empty the beaker and put it back under the spout.
2. Lower the block into the can. Collect the overflowing water in the beaker. Use the graduated cylinder to find the volume of the overflown water.
3. Compare this answer to the answer calculated in questions 1 and 4 of activity 1 . What do you notice?
4. Use what you have learned to measure the volume of the stone. In your lab book write a report on what you did under the usual headings.

## Activity 3: Homework

1. A student was asked to measure the volume of a wooden toy. When she lowered the toy into an overflow can, it floated. Some of the toy remained above the water. $25 \mathrm{~cm}^{3}$ of water overflowed.

Is the volume of the toy $25 \mathrm{~cm}^{3}$ ? Explain your answer.

If your answer is "no", how could the student measure the volume of the toy?

# Part 5: Why some things float in water, and other things sink ( 80 mins) 

Keywords: float, predict, test, record, method, with the aid of, density

Collect an apple, a pear and a potato from the trolley. You can use any other equipment from the trolley that you need.

1. Why do you think some things float and some things sink?
2. Find, and record the mass of an apple. $\qquad$ .

Find, and record, the mass of the pear. $\qquad$ .

Find, and record, the mass of the potato $\qquad$ .

Predict whether the apple, the pear and the potato will float in water. Refer to your answer to question 1 .

| Object | Will float | Will not float |
| :---: | :--- | :--- |
| Apple |  |  |
| Pear |  |  |
| Potato |  |  |

Explain your predictions here:
3. Test whether the apple, the pear or the potato float and record your answers in the table below.

| Object | Tick here if it <br> floated | Tick here if it <br> sank | Was your <br> prediction correct? |
| :---: | :---: | :---: | :--- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

4. Cut off a tiny piece of potato, as small as you can cut. Predict whether this tiny piece will sink or float.

I predict that this small piece of potato will float.
I predict that this small piece of potato will sink.


Drop the tiny piece of potato into a beaker of water. Tick the box to show what happened.

The small piece of potato floated.
The small piece of potato sank.

5. Look at your answer to question 1. Do you think the answer you gave there is correct? If not, explain why it is not correct, and try and improve your answer.
6. Measure and record the volume of the apple, the pear and the potato. With the aid of a diagram, explain how you did this and record your results in the table.

| Object: | Volume in $\mathrm{cm}^{3}$ |
| :--- | :--- |
| Apple |  |
| Pear |  |
| Potato |  |

7. Find the mass of $100 \mathrm{~cm}^{3}$ of water. Explain how you did this is the space below.

The mass of $100 \mathrm{~cm}^{3}$ of water is $\qquad$

What is the mass of $1 \mathrm{~cm}^{3}$ of water? Show your work.
8. Complete the table below. Use your results from question 1 and from question 7. To complete column three, calculate the mass of $1 \mathrm{~cm}^{3}$ of the apple, the pear and the potato.

| Object description | mass (g) | volume $\left(\mathrm{cm}^{3}\right)$ | mass of $1 \mathrm{~cm}^{3}(\mathrm{~g})$ |
| :---: | :---: | :---: | :---: |
| Apple |  |  |  |
| Pear |  |  |  |
| Potato |  |  |  |

Is the mass of $1 \mathrm{~cm}^{3}$ of an apple greater or less than the mass of $1 \mathrm{~cm}^{3}$ of water?

Is the mass of $1 \mathrm{~cm}^{3}$ of a pear greater or less than the mass of $1 \mathrm{~cm}^{3}$ of water?

Is the mass of $1 \mathrm{~cm}^{3}$ of a potato greater or less than the mass of $1 \mathrm{~cm}^{3}$ of water?

Density is a measure of how much mass is contained in a given unit of volume of a substance $e . g .1 \mathrm{~cm}^{3}$. If one object has more mass in a unit volume than another, then

Is the density of the apple greater or less than the density of water?

Is the density of the pear greater or less than the density of water?

Is the density of the potato greater or less than the density of water?
9. Examine your results on which object floated and which sank (question 3). Read your statements on density (question 8). How could you predict if an object will float in water?

## Lesson 6: Predicting if an object will float or $\operatorname{sink}(40 \mathrm{mins})$

- Density is a measure of how much mass is contained in a given unit of volume.
- Density is found by dividing the mass by the volume.
- $1 \mathrm{~cm}^{3}$ of water has a mass of 1 g .
- The density of water is $1 \mathrm{~g} / \mathrm{cm}^{3}$.

1. You are given some cubes. Each of the cubes is made from a different material. Number the cubes 1, 2 and 3 .
2. Find the density of each of the cubes. In your lab book write a report on how you found the density and show your calculations and results. Then complete the table below and predict whether each cube will sink or float in water.

|  | density | prediction | was your prediction correct? |
| :--- | :--- | :--- | :--- |
| Cube 1 |  |  |  |
| Cube 2 |  |  |  |
| Cube 3 |  |  |  |

3. Test your prediction and complete the final column. If your prediction was correct, explain why you made this prediction. If your prediction was incorrect, can you try to explain why your prediction was incorrect?
4. Given two iron cubes and two aluminium cubes of the dimensions and masses shown, calculate the density of each cube. Use your calculator.

| Material | Length <br> $(\mathrm{cm})$ | Width <br> $(\mathrm{cm})$ | Height <br> $(\mathrm{cm})$ | Volume <br> $\left(\mathrm{cm}^{3}\right)$ | mass <br> $(\mathrm{g})$ | Density <br> $\left(\mathrm{g} / \mathrm{cm}^{3}\right)$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Aluminium | 3 | 2 | 2 |  | 32.4 |  |
| Aluminium | 2 | 4 | 2 |  | 43.2 |  |
| Iron | 3 | 2 | 3 |  | 142.2 |  |
| Iron | 2 | 2 | 2 |  | 63.2 |  |

## DENSITY IS A PROPERTY OF A SUBSTANCE. It REMAINS THE SAME NO MATTER WHAT THE MASS OR VOLUME OF THAT SUBSTANCE.

## Activity 2: Homework

1. The mass of $1 \mathrm{~cm}^{3}$ of aluminium is 2.7 g . What is the density of aluminium?
2. If the mass of $1 \mathrm{~cm}^{3}$ of aluminium is 2.7 g , what is the mass of $4 \mathrm{~cm}^{3}$ of aluminium?
3. If a piece of aluminium has a volume of $3 \mathrm{~cm}^{3}$, what is the mass of this piece? (Recall that $1 \mathrm{~cm}^{3}$ has a mass of 2.7 g )
4. Before the tetra pack was invented milk was delivered and sold in bottles. It was usual to shake the bottle before opening. Find someone who remembers these milk bottles and ask them why it was important to shake the bottles before opening. Their answer
 should help you with the following question:

Which is more dense: milk or cream?

## Part 7: Challenge (40 minutes)

Arrange these materials in order of increasing density: raspberry; oil; blueberry; water; apple; lego; styrofoam.

Write a report on what you did. Make sure to include diagrams and tables where appropriate.

