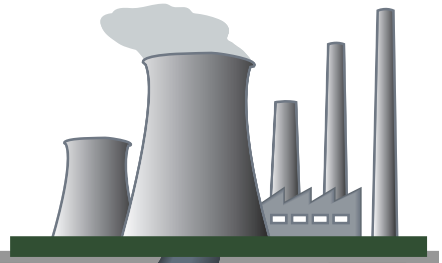


Chapter 1

4. How Much CO_2 Can You Store in a Tree?

How Much CO_2 Can You Store in a Tree?

Teacher Notes

Activity Description	The students find a tree within the school grounds to measure. The students measure the tree and record their results on scrap paper. Back in the classroom, they transfer these results onto the worksheet provided to help them make the calculations.
Time	1 hour
Learning Outcomes	• To understand that trees are a natural carbon sink • To calculate the amount of carbon stored in a real tree • To understand the implications of carbon sinks and sources
Student Organisation	Individual (calculation) and Groups (discussion)
Materials Needed	How Much CO_2 Can You Store in a Tree Student Worksheet, a tape measure **or** a metre stick and some string

Task

This task allows us to quantify the amount of carbon, and equivalent CO_2 gas, stored in a tree.

Talking Points

Trees are a natural carbon sink. Get the students to think about other CO_2 sources and sinks.

Sources:

Fossil fuels, leaks, biological sources

Sinks:

Oceans, atmosphere, plants, land, precipitation of carbonate minerals in rocks

Outdoor Instructions

1. Get the students to work in pairs. One student measures from the ground 1.3m (or chest height) up the trunk of the tree, the other marks their place. Then the second student measures the circumference of the tree at this height. The height ensures a fair representation of the tree circumference is recorded.
2. The students record each measurement, both times on scrap paper.

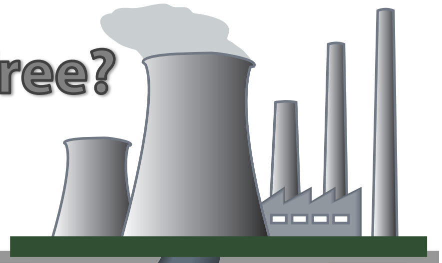
Talking Points

Get the students to think about what might affect the amount of carbon stored; do older trees store more carbon; does the type of tree make a difference; does the environment that the tree is in contribute to amount of carbon stored?

Classroom Instructions

Get the students to follow the instructions on the handout to complete the worksheet – there is a worked example at the end of this pack to help.

How Much CO_2 Can You Store in a Tree?



Teacher Notes

Discussion

Talk to the students about the link between trees and carbon: that carbon is locked up within trees but when trees are burnt for firewood, that carbon is released. Furthermore if the tree is buried and subject to heat and pressure over millions of years, the tree will become coal. Coal is a fossil fuel and burning fossil fuels releases CO_2 to the atmosphere. An increase in CO_2 in the atmosphere will lead to global warming.

Summary

Ask the students to think about how effective planting trees is, as a means to reduce carbon concentrations in the atmosphere. Consider: the rate at which trees grow, their environmental surroundings, the amount of carbon taken in from tree to tree and the lifetime of a tree. We may need a more immediate solution..

Worked Example

tree circumference 1		tree circumference 2	
132	cm	*144*	cm

A) Calculate the average of your two measured circumferences.

Why? This removes human bias from the measurements. Human bias is when the measurement is affected by the person who took it.

tree circumference 1		tree circumference 2		number of measurements
132	+	*144*	÷	*2*

= *138* cm

How much CO_2 can be stored in a tree?

Teacher Notes

average tree circumference		estimated dry weight	
138	cm	*1964*	kg

The estimated dry weight of the tree is a) the closest value to the average tree circumferences in the references figures or b) read off the graph, whichever you prefer your students to do.

B) Calculate the weight of carbon stored in the tree.

How? Most living things are half carbon. Therefore we can estimate the carbon content by dividing the dry weight of the tree by 2. See reference figures for dry weight estimates.

estimated dry weight				weight of carbon in tree	
1964	÷	2	=	*982*	kg

weight of carbon in tree		equivalent weight of CO_2	
982	kg	*3603.9*	kg

C) Calculate the equivalent weight of CO_2 gas stored as carbon in the tree.

How? We can calculate the equivalent weight of CO_2 stored as carbon in the tree by multiplying the estimated weight by the constant 3.67, as given by www.forestsforthefuture.co.uk.

weight of carbon in tree				equivalent weight of CO_2	
982	x	3.67	=	*3603.9*	kg

How much CO_2 can be stored in a tree?

Teacher Notes

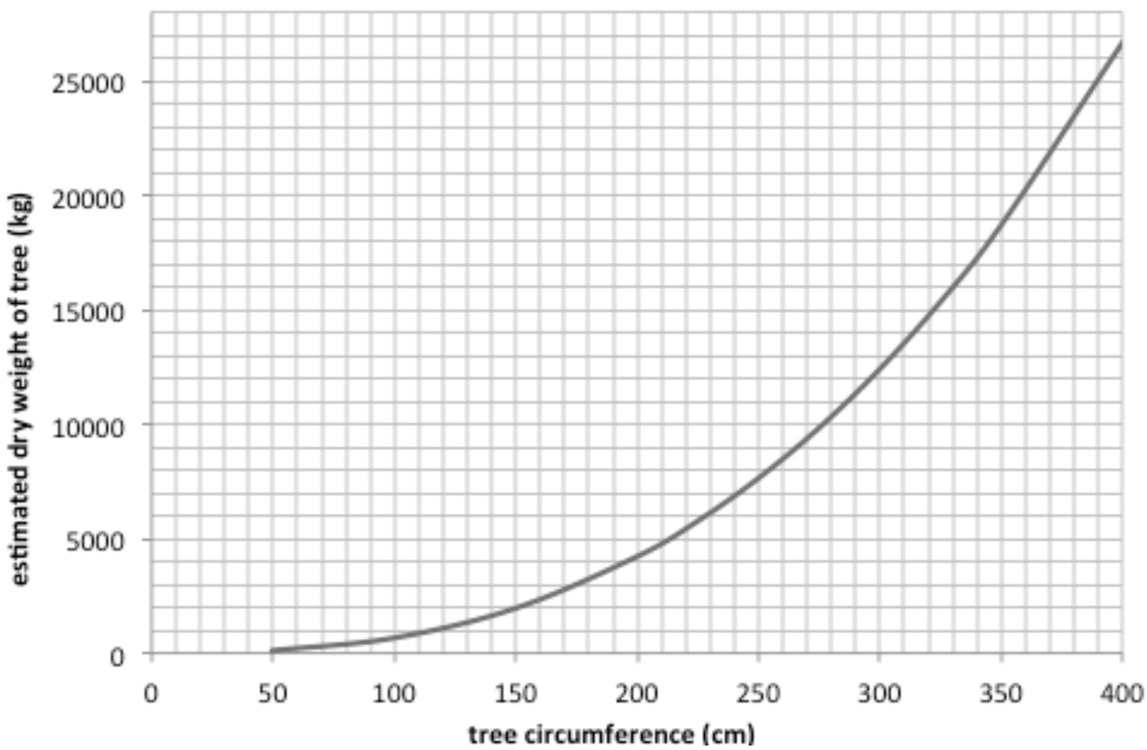
Reference Table: Dry Weight of a Tree

Circumference (cm)	Tree dry weight (kg)
50	106
100	668
150	1964
200	4221
225	5771
250	7641
275	9842
300	12410
325	15350
350	18700
400	26674

These values, provided by ***Forest Research****, are for an individual hardwood tree in Westonbirt Arboretum. They should be used as an* ***example****.*

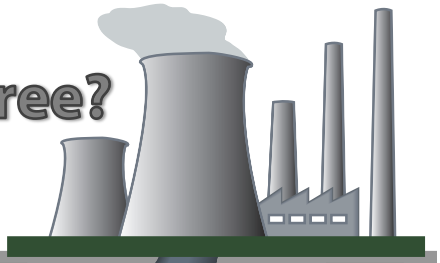
Trees will grow at different rates across the UK depending on, for example, the species, soil, drainage, slope aspect and climate conditions.

Reference Graph: Dry Weight of a Tree



How Much CO_2 Can Be Stored in a Tree?

Student Worksheet



! Plants, flowers and trees absorb CO_2 from the atmosphere. They use this CO_2 gas during photosynthesis to create carbohydrates, which help them grow. This process locks away CO_2 in the plant structure and helps regulate the levels of CO_2 in our atmosphere. The size of the tree directly relates to the amount of CO_2 locked inside. Older trees store more CO_2.

This activity consists of a field experiment. You and a partner measure a nearby tree before using some simple calculations to estimate the amount of CO_2 gas secured by the tree.

How Much CO_2 Can Be Stored in a Tree Experiment
You will need:

- A soft tape measure or/ string and a metre rule
- This worksheet
- A research partner
- A nearby tree

Field Instructions:

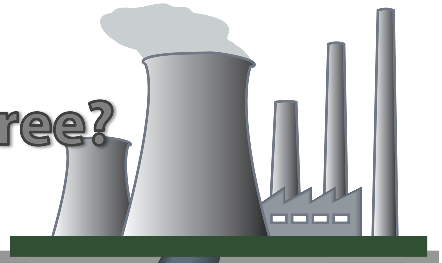
1. Take turns in pairs.
2. Measure 1.3m from the ground up the trunk of the tree and hold your finger on that point.
3. Ask your partner to measure around the trunk of the tree at the height you are holding your finger. Record your results on scrap paper and transfer these into your worksheet in class. (You should have two measurements, yours and your partner's).

Classroom Instructions:

1. Copy your tree measurements over from your scrap paper to the worksheet.
2. Calculate the average tree circumference.
3. Use this to estimate and record the dry weight of the tree using the table or the graph provided.
4. Calculate and record the weight of carbon stored by the tree.
5. Calculate the equivalent weight of CO_2 stored in the tree as carbon, over the tree's lifetime of growth.

How Much CO_2 Can Be Stored in a Tree?

Student Worksheet



tree circumference 1 ________ cm

tree circumference 2 ________ cm

A) Calculate the average of your two measured circumferences.

Why? This removes human bias from the measurements. Human bias is when the measurement is affected by the person who took it.

tree circumference 1 ________ + **tree circumference 2** ________ ÷ **number of measurements** ________

= ________ **cm**

average tree circumference ________ **cm**

estimated dry weight ________ **kg**

B) Calculate the weight of carbon stored in the tree.

How? Most living things are half carbon, therefore we can estimate the carbon content by dividing the dry weight of the tree by 2. See reference figures for dry weight estimates.

estimated dry weight ________ ÷ 2 = **weight of carbon in tree** ________ **kg**

How much CO_2 can be stored in a tree?

Student Worksheet

weight of carbon in tree

kg

C) Calculate the equivalent weight of carbon dioxide gas stored as carbon in the tree.

How? We can calculate the equivalent weight of CO_2 stored as carbon in the tree by multiplying the estimated weight by the constant 3.67, as given by www.forestsforthefuture.co.uk.

weight of carbon in tree × 3.67 = equivalent weight of CO_2 kg

equivalent weight of CO_2

kg

Reference Table: Dry Weight of a Tree

Circumference (cm)	Tree dry weight (kg)
50	106
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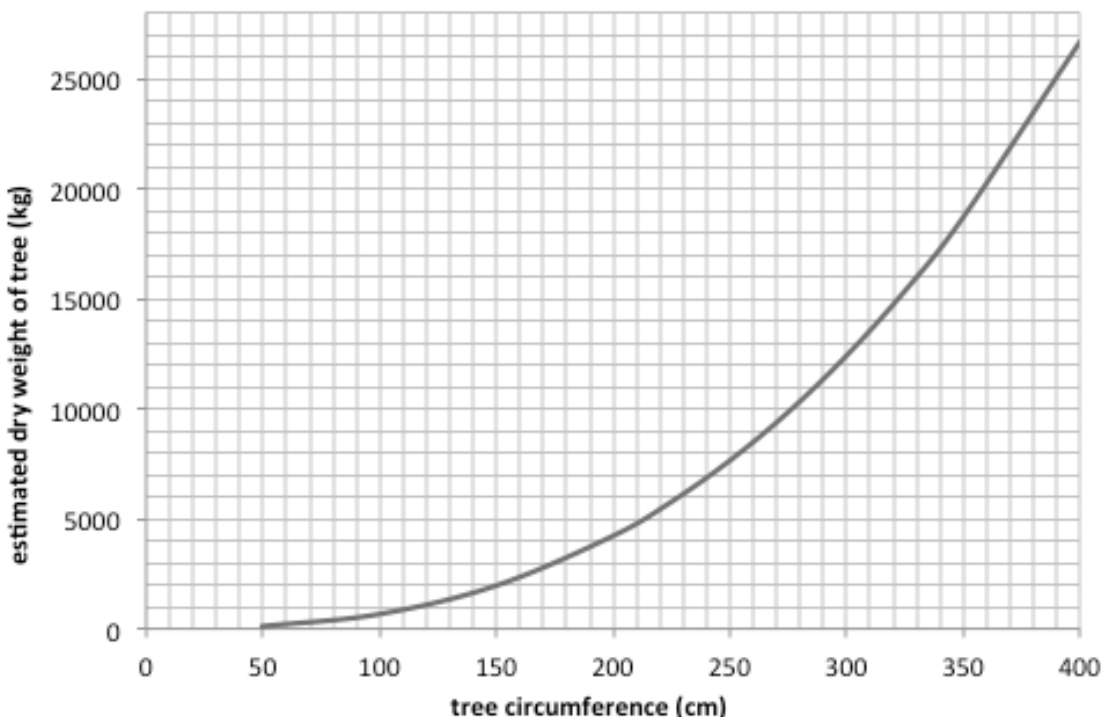
Trees will grow at different rates across the UK depending on, for example, the species, soil, drainage, slope aspect and climate conditions.

How much CO_2 can be stored in a tree?

Student Worksheet

Reference Graph: Dry Weight of a Tree



So, you have just calculated that the tree you measured contains ______ kg carbon, and ______ kg equivalent weight of CO_2 gas.

! For scale
The average UK coal-fired power station emits 1kg of CO_2 per kWh generated.
1kWh of electricity will power:

- ONE **dishwasher** for 1 hour
- ONE **TV** for 3 hours
- ONE **games console** for 5 hours
- ONE **laptop** for 22 hours
- ONE **hoover** for 2 hours
- ONE **freezer** for 4 hours
- ONE pair of **straighteners** for 11 hours
- ONE **aquarium** for 33 hours

! Note
A molecule of CO_2 gas contains two (relatively heavy) oxygen atoms for every single carbon atom, so a single CO_2 molecule weighs more than a single carbon atom.