Name: ....

Grade: ....

School: ....

Date: ....

WithOnePlanet

> Module 1: Carbon
> Level: Years 5 to 6
> INQuIRY: Investigate
> Lesson 4: The carbon detectives
> Student worksheet

Lesson 4 – Worksheets

Investigate

Lesson 4
Student worksheet
The carbon detectives

Years 5 to 6

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INQuIRY

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Open education
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The carbon detectives

Lesson 4: Student worksheet

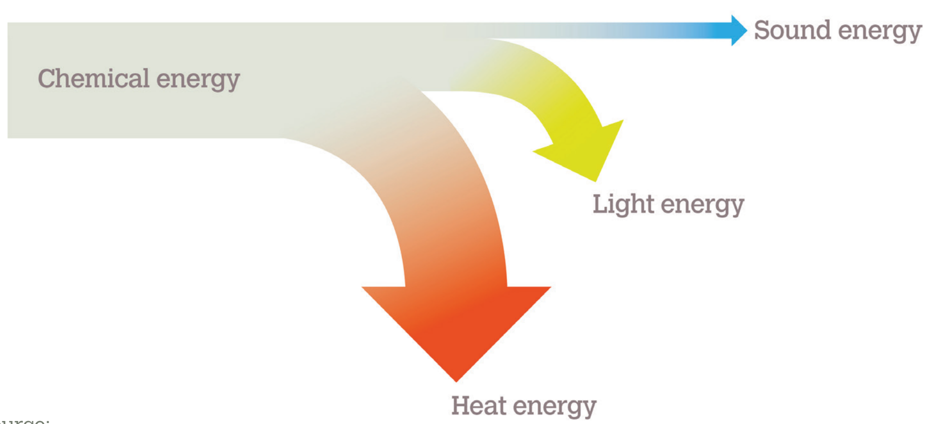
Introduction

When carbon moves between different parts of the carbon cycle, energy can also be transformed from one form into another.

For example, when a forest is burnt during a fire, the carbon moves from living things (as carbon in plants) into the atmosphere (as carbon dioxide in the air). At the same time, energy changes, or **transforms**, from chemical energy stored in the plant into the …

Heat energy
Light energy } of **fire**
Sound energy

These energy transformations can be represented in a **Sankey** diagram, like the one for burning shown below.



Source:
WithOnePlanet, *Sankey diagram* infographic 2015.

While heat, sound and light energy are all useful for humans, they do not last very long and cannot travel large distances. For example, if you light a match, you only get a short burst of heat, light and sound before the fuel is burnt and the match goes out.

One form of energy that humans have found is very useful is electricity. Electricity can be transported long distances (e.g. from a power station hundreds of kilometres away to your own home) and can last a long time if there is enough of it. Think about how long your refrigerator has been running without ever being switched off!

Humans have also worked out how to transform the chemical energy stored in carbon compounds, such as fossil fuels (coal, oil, natural gas) into electrical energy. This has enabled us to do a whole lot of things that we couldn't do beforehand. This list is endless!

Experiment 1: Making a lemon battery

Aim

In this activity you will:

> make a 'lemon battery' that you can use to produce electricity

> observe a peanut being burnt to produce heat and light

Materials

> a 2 cm piece of thick copper wire or a 2 cm x 3 cm flat sheet of copper

> a galvanised iron nail

> a sheet of coarse sand paper

> one lemon

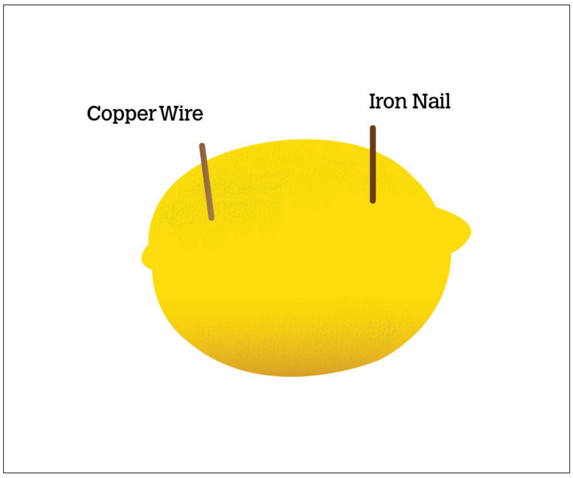
> a voltmeter or multimeter (set to measure voltage)

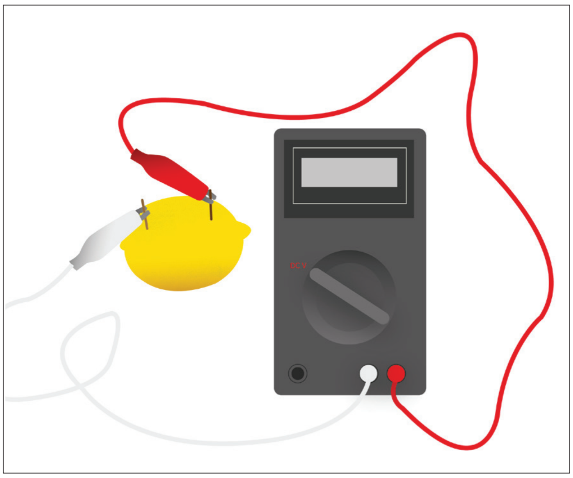
> an LED

> 2 alligator clips

Method

1. Use sandpaper to smooth any rough spots on the pieces of copper and iron.
2. Squeeze the lemon gently with your hands or roll it on the bench top, but be careful not to rupture the lemon's skin.
3. Push the sharp end of the iron nail and the piece of copper wire or sheet into the lemon so they are as close together as you can get them without them touching each other. See the diagram below left for details.



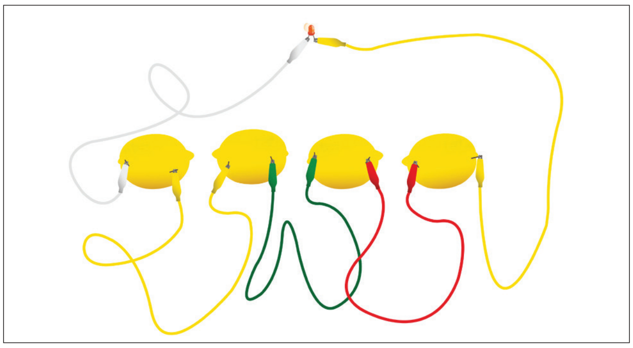


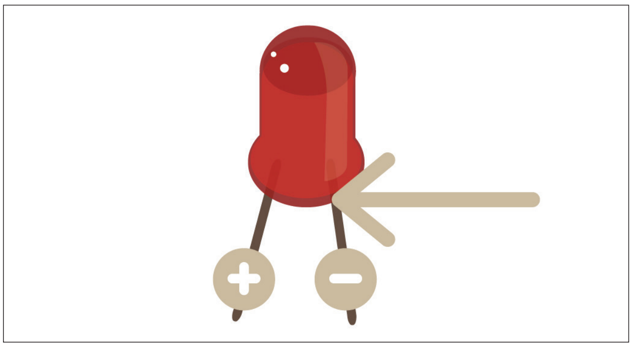
4. Connect one of the alligator clips to the copper and the other alligator clip to the iron nail.
5. Attach the alligator clip connected to the copper to the POSITIVE terminal on the voltmeter or multimeter and the alligator clip connected to the iron nail to the NEGATIVE terminal on the voltmeter or multimeter. See the image above right for details.
6. If you are using a multimeter, switch it on and observe if a reading (a number) comes up on the voltmeter or multimeter.

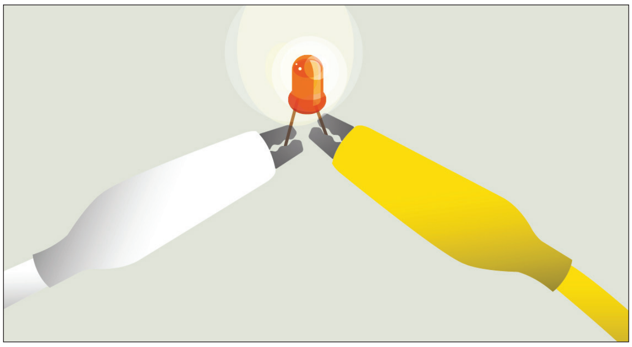
Source:
WithOnePlanet, *lemon battery* infographic 2015.

Unfortunately, your lemon battery does not produce enough current to power any devices (such as light globes, fans or motors). However, by connecting many lemon batteries in series, as shown in the images below, you may be able to power a small LED (light).

7. Team up with some other groups and arrange at least 4 lemons (as shown in the images below). Connect the first and last lemon in the row to an LED.







Important Note: To turn on an LED you must determine the '+' and '-' connections. If you look closely at the red plastic base of an LED you will notice a 'flat' spot (indicated by arrow in the image above). The wire that comes out beside the flat spot must connect to the '-' side of your lemon battery, the other wire to the '+' side. *Your teacher can help you with this if you are unsure what to do.*

Observe if the LED glows (even if only dimly).

Source:
WithOnePlanet, *lemon battery* infographic 2015.

Results and discussion

Q1: Did you get a reading on your voltmeter/multimeter? If so, what voltage did your lemon battery register?

Q2: What happened when you connected a series of lemon batteries together? Were you able to get the LED to glow?

Q3: Draw a *Sankey* diagram in the space below to show the energy transformation that occurred (or should have occurred!) in your lemon battery. (*An example of a Sankey diagram is shown on the first page of this worksheet.*)

Experiment 2: Burning a peanut

Watch the video demonstration of a peanut being burnt and then answer the questions below. (You may need to watch the video more than once to observe everything that happens.)
<http://www.youtube.com/watch?v=cw7q433ynYg>

WARNINGS: It is important that you DO NOT try to conduct this experiment at home. Peanuts and other nuts can cause allergic reations.

Q1: Did the peanut change in any way from before being burnt to after being burnt? If so, how?

Q2: How many kilojoules of energy did the peanut produce? Is this what you expected for a single peanut (or did you expect less or more than this)?

Source:
Pascoscientific 2013, Energy content of food, viewed 18 October 2013, <http://www.youtube.com/watch?v=cw7q433ynYg>.

When a peanut is burnt, the chemical energy stored in the peanut is released. In foods, such as nuts, the chemical energy is stored in the nutrients that the food contains. These nutrients include carbohydrates (or sugars), fats and oils, and proteins. All of these nutrients contain large amounts of carbon.

Q3: Draw a *Sankey* diagram in the space below to show the energy transformations that occur when a peanut is burnt. (*An example of a Sankey diagram is shown on the first page of this worksheet.*)

Q4: What happens to the carbon that is released from the peanut when it is burnt? Where does it go?

Conclusion

Q1: For both the lemon battery and the burning peanut, in what form was the energy originally?

Q2: In the box below, list all the forms of energy that were produced in the lemon battery and burning peanut experiments.

Carbon fieldwork

Student worksheet

Activity A: Carbon in the sea

Introduction

Carbon moves between different parts of the carbon cycle using many different processes. This activity examines the movement of carbon between different parts of the carbon cycle.

Many marine animals make their own shells to protect themselves from predators in the sea. These hard coverings are often made of a carbon compound called calcium carbonate, which is often white in colour, resulting in the many white-coloured shells you can see washed up on many beaches. Marine animals are able to take dissolved carbon dioxide from the water and use chemical reactions to turn it into calcium carbonate.

Unfortunately, calcium carbonate only remains hard when the acidity in the water is low. If the acid content of the sea water is increased (through ocean acidification due to climate change, for example), then these shells begin to dissolve, exposing these marine animals to their predators.

Aim

In this activity, you will be:

> observing a number of different naturally occurring carbon compounds
> observing the movement of carbon between different parts of the carbon cycle

Materials

> a collection of shells
> tap water
> universal indicator solution
> a soda siphon and carbon dioxide cartridge

Method

1. Observe a collection of shells. Describe their appearance (size, colour, texture) and record your description in the *Results table* provided.
2. Measure the pH (acidity level) of some tap water.
   – To do this, add a few drops of universal indicator to the water.
   – Determine the pH level of the water by comparing the colour of the water to the colours on the pH chart provided. Record this information in the *Results table* provided.
   – Observe whether the pH you identify is acidic, neutral or basic (alkaline). Record this information in the *Results table* provided.
3. Place a sample of your shells into a container of the same type of tap water as used above.
4. Observe what happens to the shells in the water and record your observations in the *Results table* provided.
5. Using a soda siphon, inject carbon dioxide into a sample of the same type of water to produce 'soda water'.
6. Repeat steps 2-4 above using the soda water. Record all information in the *Results table* provided.

Results

Results table: Description and observations of shells when placed in tap water and soda water.

Description of shell appearance (size, colour, texture, etc.)		
	Tap water	Soda water
What is the pH of the water? (when universal indicator was used)		
Is the water acidic, neutral or basic? 1-6 = acidic 7 = neutral 8-12 = basic		
What happened to the shells when they were placed in the water?		

Discussion

Answer all questions in the spaces provided.

Q1: What differences (if any) did you notice in what happened to the shells when they were placed in tap water compared to when they were placed in soda water?

Q2: Why do you think these differences exist?

Q3: What happens to marine animals if their shells decompose?

Q4: Where does the carbon from the shells go when they decompose?

Q5: **Challenge question**: What happens to our oceans if a lot of shells of marine animals decompose over a short time? (You may need to research the answer to this question.)

Conclusion

The conclusion is relevant to Parts A, B and C and is located at the end of this document.

Activity B: Carbon on land

Introduction

Carbon is present in the air as carbon dioxide. Using the process of photosynthesis, carbon in the air is captured by trees and turned into carbohydrates or sugars (such as sucrose). This carbon compound can then be used by the tree for its energy or for growth of new roots, stems and leaves.

Another way to think about this is that trees don't grow out of the soil, they grow out of the air!

It is possible to measure the amount of carbon captured by a tree by measuring how big its trunk is and using this data in a special carbon calculator. The carbon calculator (North Sydney Council 2013) takes into account both the **girth** of the tree (i.e. how big its trunk is) and the **type** of tree (Australian native hardwood, softwood or rainforest tree).

Once you know how much carbon is locked up in a single tree or a small group of trees, it is then possible to work out how much carbon a **forest** of trees holds. This information is particularly useful when looked at for a whole state, such as Victoria, or an entire country, such as Australia. From this information, predictions of future carbon storage in trees can be made.

It is also interesting to note how much carbon is lost - that is, returned to the atmosphere - during forest fires.

Aim

In this activity, you will be:

> calculating the amount of carbon captured in a small group of trees of the same species.

Materials

- a group of trees (approximately 20 or more) of the same species in a small geographical area
- a tape measure
- numbered flags (from 1 – 20 or more) on stakes (for identifying the trees that will be measured)
- access to the North Sydney Council Carbon Calculator website:
  <http://www.northsydney.nsw.gov.au/carbon/carbon.html>
  (This part of the task can be completed at any time after the tree measurements are taken.)

Method

1. Place a stake with a coloured flag at the base of each tree that you are going to measure.
2. Record the type of tree – native hardwood, softwood or rainforest tree - you are measuring in the *Results table* provided.
3. Note the number on the flag for the tree you are measuring.
4. Using a tape measure, measure up the tree to breast height (130 cm from the ground).
5. At breast height, use the tape measure to measure the circumference (in centimetres) of the tree (i.e. around the trunk).
6. Record the circumference of each tree measured in the *Results table* provided.
7. Using the North Sydney Council Carbon Calculator, calculate the amount of carbon captured in each in kg, and record this information in the *Results table* provided.
8. The calculator will also provide you with a carbon dioxide equivalent (CO_2-e) in kg that the tree has removed from the atmosphere. Record this value for each tree in the *Results table* provided.

Source:

North Sydney Council 2013, *North Sydney Council Carbon Calculator*, viewed 18 December 2013, <http://www.northsydney.nsw.gov.au/carbon/carbon.html>.

Results

Tree type (native hardwood, softwood or rainforest):

Tree species name (if known):

Results table: The amount of carbon stored in a population of trees.

Tree number	Circumference at breast height (cm)	Carbon stored in tree (kg)	Carbon dioxide equivalent [CO_2-e](kg)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
		Total amount of carbon (kg) stored in group of trees = kg	Total CO_2-e stored in group of trees = kg

Discussion

Q1: What was the total amount of carbon and carbon dioxide (equivalent) stored in the group of trees you measured?

Q2: Is this the sort of result that you thought you would get? Why/why not?

Q3: There are many different types of forest, ranging from dry temperate to tropical rainforest. Which type of forest do you think could store more carbon – dry temperate or tropical rainforest? Why?

Conclusion

The conclusion is relevant to Parts A, B and C and is located at the end of this document.

Activity C: Carbon and fire

Introduction

When the bush or a forest burns, the carbon that was once locked up in trees is released back into the atmosphere, mostly as carbon dioxide. Often the carbon that is stored in the soil is also burnt and released.

However, not all of the plant matter or soil carbon is burnt. Some of it remains in the environment as dead plant matter. Over time, this will decompose and be slowly released into the atmosphere. It will help to feed other living things in the environment (even new or recovering plants), and is released over a very long period.

Eventually, many forests can recover from fire, but this can take many years. In fact, some Australian forests actually **depend** on regular burning in order for the seeds of some species (such as some *Acacias*) to germinate and grow.

Aim

In this activity, you will be:

> comparing an area of recently burnt forest to a forest area without any recent signs of fire.

Materials

> An area of forest that shows signs of recently being burnt and an area of forest without any recent signs of fire. (Alternatively, you can use photographs of two such areas. These are available in Appendix A at the end of this document.)

Method

1. Observe an area of forest (or photographs of an area of forest – see Appendix A) that has recently been burnt in a forest fire.
2. In the *Results table* provided, note your observations of the evidence of fire, the development of the understorey, the amount of forest-floor litter, the quality of the habitat available for small mammals, the evidence of regeneration by plants, and other observations that you may have.
3. You may also wish to take photographs of this area for further observations at a later time.
4. Now observe an area of forest (or photographs of an area of forest – see Appendix A) that has NOT recently been burnt in a forest fire.
5. Repeat steps 2 and 3 for this unburnt section of forest.

Results

Results table: Observations of burnt and unburnt sections of forest.

Type of forest	**Unburnt forest**	**Burnt forest**
Evidence of fire (List your observations here)		
Development of the understorey (Are there many small to medium sized plants underneath the remaining tall trees? Is there a wide variety of plants or just plants of a similar species?)		
Amount of forest-floor litter (How much debris – fallen leaves, branches, etc. – is there?)		
The quality of the habitat available for small mammals (How many & what types of places are available for small mammals to hide in, live in, etc.?)		
Evidence of regeneration by plants (Is there regrowth on existing plants? How much? Are any new plants starting to grow? How many?)		
Any other observations		

Discussion

Q1: What happens to carbon stored in plant matter and soil when there is a bushfire?

Q2: What benefits do you think a well-developed understorey has for life in a forest?

Q3: What benefits do you think lots of leaf litter has for life in a forest?

Q4: Which type of forest – burnt or unburnt – do you think contains:

a. the most stored carbon?

b. the most biodiversity (total number of animal and plant species)?

Conclusion

The conclusion is relevant to Parts A, B and C and is located on the next page.

Appendix A: Photographs of unburnt and recently burnt forest

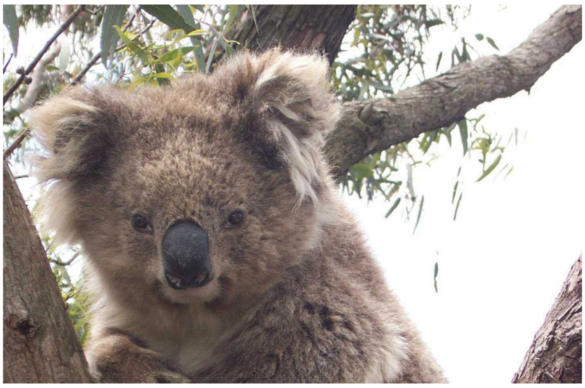
Fire has been used as a bushland management tool for tens of thousands of years throughout much of Australia. Fire provides small plants with short life cycles a chance to compete with larger long lived plants for a few years.

Open burnt plant community – Recently burnt plant communities contrast sharply with unburnt areas. Whilst all of the plants look dead many survive the fire and re-sprout from the roots which are protected below the ground or from larger trunks.

Eucalypt re-sprouting – The thick bark of many Eucalypts protect buds on trunks and larger branches which can grow rapidly after fire. Many Eucalypt trees will survive fire events through these Epicormic buds shown here.

Seedlings – Amidst the litter on the forest floor after fire many seedlings will appear. These ones here are from the Native Parsnip which is a short lived plant that was an important food plant for the local traditional Aboriginal people.

The quality of the habitat available for small mammals: Small mammals such as this Southern Brown Bandicoot need ground cover to hide in. After a fire is a dangerous time for them.



Other affects of fire: Gum trees protect their leaves after a fire with poisons that make the leaves unpalatable for koala's. These stay in the leaves for up to 3 years so burnt bushland is not favoured by koala till the phyto-toxins are less concentrated.

Source:

Photos: Jo Fyfe, Bron Merritt and Mick Robertson Royal Botanic Gardens, Melbourne.

Conclusion (relevant to Parts A, B and C)

Answer all questions in the spaces provided.

Q1: Using the table below, list all the different forms of carbon and the places you found carbon during this activity.

Different FORMS of carbon	Different PLACES carbon can be found
e.g. sugar	e.g. dissolved in water

Q2: What process is involved in moving carbon:

From the water into shells?

From shells into the water?

From the air into trees?

From trees into the air?

From trees into the soil?

Q3: Do you think regular bushfires are a good thing or a bad thing for Australian dry temperate forests? Why?