Name: ....

Grade: ....

School: ....

Date: ....

WithOnePlanet

> Module 1: Carbon
> Level: Years 7 to 8
> INQuIRY: Investigate
> Lesson 3: Carbon is energy; carbon is life
> Student worksheet

Lesson 3 – Worksheets

Investigate

Lesson 3
Student worksheet
Carbon is energy; carbon is life

Years 7 to 8

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Carbon is energy; carbon is life

Lesson 3a: Student worksheet

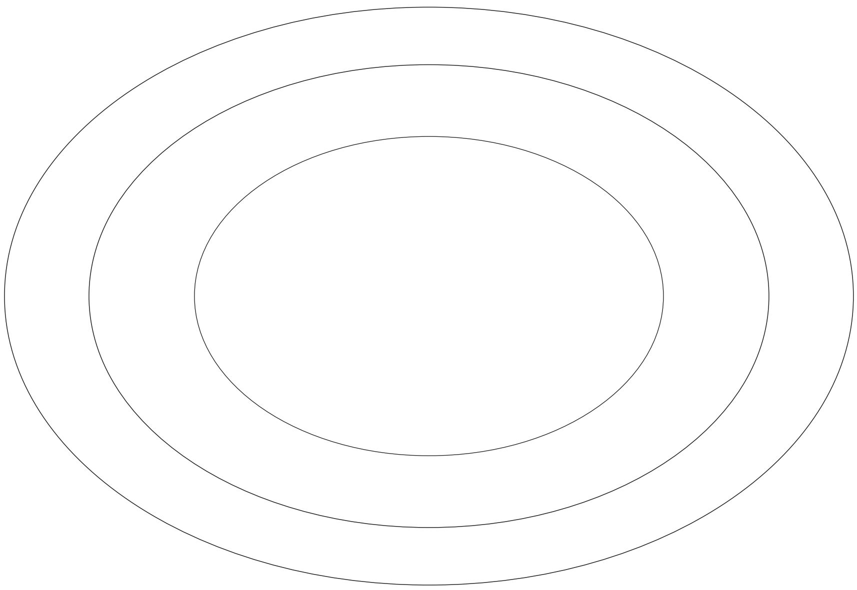
Activity 1a: Carbon under the microscope – carbon atoms

You are about to use an online simulation called Atom Builder to build a model of a carbon atom.

Preparation

Q1: Before you start using the simulation, plan what you are going to do by drawing a picture of how you would build a model carbon atom in the box below.

Put the following subatomic particles in the model:

6 protons	P P P P P P
6 neutrons	N N N N N N
6 electrons	E E E E E E
Model	

Using the *build an atom* simulation

Follow all of the instructions and complete all of the boxes.

A. Go to the URL: http://phet.colorado.edu/en/simulation/build-an-atom

B. Click on the first link.

C. Click on the **RUN NOW!** button.

D. Explore the simulation. Be sure to click on everything.

E. When your teacher says it is time to start …

> click on the **reset all** button

> open the boxes called **net charge** and **mass number**

> these boxes and the periodic table box will help you fill in the data needed below.

Q2: Experiment by putting some **protons** into the nucleus of the atom (on the X). Fill in the table below to keep track of what you are learning about protons. When you finish, put the protons back into the bowl.

Mass number?	Charge?	Stays on the X?	Symbol changes on the periodic table?

Q3: Experiment by putting some **neutrons** into the nucleus of the atom (on the X). Fill in the table below to keep track of what you are learning about neutrons. When you finish, put the neutrons back into the bowl.

Mass number?	Charge?	Stays on the X?	Symbol changes on the periodic table?

Q4: Experiment by putting some **electrons** into the nucleus of the atom (on the X). Fill in the table below to keep track of what you are learning about electrons. When you finish, put all of the electrons back into the bowl.

Mass number?	Charge?	Stays on the X?	Symbol changes on the periodic table?

Q5: Look over your data tables for **protons, neutrons and electrons**.

Two things you notice are:

1. ______________________

2. ______________________

It's now time to apply your understanding of the atom …

Q6: Put three protons into nucleus of the atom. Fill in the following:

Name of atom: ______________________

Atom or ion? ______________________

Net charge: ______________________

Q7: Decide how you will build a **neutral atom** that is **stable**. Practice making atoms using your ideas.

Once you are able to do this several times on the simulation – starting with different numbers of protons – write out the steps of your building plan in the box below.

Steps to build a neutral atom starting with protons:

1. First I choose ______ protons and put them in the center (nucleus) of the atom.

2. ______________________

3. ______________________

4. ______________________

Q8: Use the information about your stable atom to complete the box below:

My stable atom has the following features:

____________________ mass

____________________ protons

____________________ neutrons

____________________ electrons

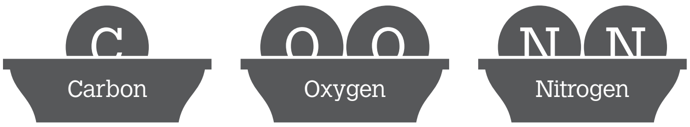
____________________ name of atom

Activity 1b: Carbon under the microscope – carbon molecules

You are now going to use the *Atom Builder* simulation to build some models of carbon molecules.

Preparation

Use the atoms in the cups below to complete **Q1** and **Q2** below:



Q1: Using some or all of the atoms in the cups above, draw a picture of a carbon monoxide molecule.

Q2: Using some or all of the atoms in the cups above, draw a picture of a carbon dioxide molecule.

Q3: What is the difference between the **carbon dioxide** molecule and the **carbon monoxide** molecule?

Ammonia is a molecule that has the formula NH3

Q4: Using some or all of the atoms in the cups above, draw a picture of an **ammonia** molecule.

In **TWO** molecules of ammonia (2NH3) …

Q5: How many nitrogen atoms are in there?

Q6: How many hydrogen atoms are there?

Using the *build an atom* simulation

Follow all of the instructions and complete all of the boxes.

A. Go to the URL: http://phet.colorado.edu/en/simulation/build-a-molecule
B. Click on the first link
C. Click on the **RUN NOW!** button
D. Discuss how you and your partner will build the molecules using the 3 kits of atoms
E. Build all of the molecules in the **'Your molecules collection 1'**.

Q7: Choose one of the molecules from your collection and draw it in the box below:

Name of molecule: ______________________________

This molecule is made up of : _______________ atom(s) and _______________ atom(s).

Q8: Talk with your partner about the information in the box below:

A **coefficient** is a large number in front of the molecular formula such as: $2\,H_2O$

$2\,H_2O$ means there is more than one molecule and multiples of atoms.

In this case: **2 water molecules with 4 hydrogen atoms and 2 oxygen atoms**.

Q9: Click on the **'collect multiple'** tab at the top of the screen.

> **Choose** collection 1 or 2 and **build** the entire 'collection' with your partner
> Be on the lookout for the 🙂 which means that you have completed the collection.

Q10: Discuss which atoms you would need to build **$2CO_2$** molecules in collection 1. Once you have done this, answer the questions below.

What is the name of the molecule when 2 oxygen atoms bond with 1 carbon atom? ____________________

If you have **$2CO_2$** molecules, how many different types of atoms are there? ____________________

Organise the type of atom(s) and the number present in the 2 molecules of CO_2 below:

Name of atom in molecule	Number of atoms present

Carbon is energy; carbon is life

Lesson 3b: Student worksheet

Activity 2: How small is a carbon atom?

Materials:

- a strip of paper cut from A4 paper (about 30 cm long) per pair of students
- pair of scissors
- ruler
- a lot of patience, care and a sense of humour!

Method:

1. Fill in the table below as you work through the activity by recording the length of the strip of paper.
2. Cut the strip of paper (30 cm in length) in half lengthwise (i.e. at the 15cm mark).
3. Put one half aside. Measure the length of the other half. (It should measure 15cm.)
4. Cut the measured half in half again. Again, put one half aside and measure and record the length of the other half.
5. Before you go any further, predict how many times you will be able to cut the strip in half.
6. Continue this process until you can no longer cut the strip in half.

Number of cuts	Approximate length of strip
0	30 cm
1	15 cm
2	7.5 cm (easy?)
3	
4	
5	
6	
7	
8	1 mm (you're doing well to get this far!)

9	
10	
12	
14	
18	1 micron (1 millionth of a m, one thousandth of a mm)
22	
26	
31	The size of one carbon atom!

Experiment A: Endothermic and exothermic reactions

Introduction

Chemical reactions can involve both a transfer and transformation of energy.

Energy transformation means that the form that the energy takes (e.g. heat energy, sound energy, chemical energy) changes.

Energy transfer means that the energy moves from one object to another (e.g. from one chemical to another).

When a chemical reaction releases heat energy, the reaction is known as an *exothermic* reaction (exo = release thermic = heat). When a chemical reaction absorbs, or uses up, heat energy, the reaction is known as an *endothermic* reaction (endo = absorb, thermic = heat).

Aim

Write your own aim in the space below after reading through this practical.

Hypothesis

What do you think will happen when the citric acid and sodium bicarbonate are combined?

Materials

- > eye protection
- > 50 g sodium bicarbonate powder
- > 100 mL (approx. 5 teaspoons) citric acid solution
- > a polystyrene cup
- > a lid for the cup, or a piece of aluminium foil that entirely covers the mouth of the cup
- > a teaspoon
- > thermometer
- > glass stirring rod
- > scissors
- > stop watch.

Safety

Refer to the Material Safety Data Sheet for citric acid and sodium bicarbonate before use. (Data sheets provided by suppliers at time of product purchase.)

Wear eye protection at all times during this experiment.

Method

1. If your lid does not already have a hole for the thermometer, cut a small hole into the lid. Be careful not to make the hole bigger than the size of the thermometer.
2. Pour 100 mL of citric acid solution into the polystyrene cup, cover the cup with its lid, and then insert the thermometer through the hole in the lid. Immediately record the temperature of the solution.
3. Add 5 teaspoons of sodium bicarbonate to the citric acid in the cup. Stir it in well with the citric acid using the stirring rod and then place the lid onto the cup again. Immediately insert the thermometer.
4. Immediately record the temperature of the mixture, and then take a temperature reading every two minutes after that for a total of 20 minutes. Use a stopwatch to monitor the time.
5. Construct a table in the Results section below to record your results.

Results

Table: Construct your own table, with your own *descriptive* title in the space below. Remember to include units (e.g. °C) in your table.

Graph: Using the data in your table, plot a line graph of time (minutes) versus temperature (oC) on the grid below. Time should appear on the χ–axis and temperature should appear on the γ–axis. Remember to include units (e.g. °C) in your table.

χ-axis

γ-axis

Discussion

Record your answers to the discuss questions in the spaces provided.

Q1: What happened to the temperature during this reaction?

Q2: Is this reaction an example of an endothermic or an exothermic reaction?

Q3: Why was it important to keep the cup covered with a lid during this experiment?

During this experiment, a chemical reaction took place between citric acid and sodium bicarbonate. Carbon dioxide, water and a chemical known as sodium citrate were produced. All these chemicals, with the exception of water, contain carbon.

Q4: Address the following two parts:

a. Which of these chemical(s) is/are the reactant(s) in this chemical reaction?

b. Which of these chemical(s) is/are the products(s) in this chemical reaction?

Q5: During this chemical reaction, energy was transformed from one type or form into another.

a. In which form(s) was the energy before the reaction?

b. Which form(s) did the energy transform into during the reaction?

Q6: Does this reaction store energy in a carbon-containing molecule or release energy from a carbon-containing molecule? How do you know?

Evaluation

Record your answers to the evaluation questions in the spaces provided.

Q1: Do you think this experiment successfully demonstrated the way that carbon stores or releases energy? Why/why not?

Q2: Describe one way that the experiment could be changed to further increase the success of this experiment AND explain how this change would improve the experiment.

Conclusion

Write a conclusion in the space below that includes the following information:

> A statement that relates to the aim
> A statement about whether or not your hypothesis was supported
> A brief summary of your results.

Experiment B: Endothermic and exothermic reactions

Introduction

Chemical reactions can involve both a transfer and transformation of energy.

Energy transformation means that the form that the energy takes (e.g. heat energy, sound energy, chemical energy) changes.

Energy transfer means that the energy moves from one object to another (e.g. from one chemical to another).

When a chemical reaction releases heat energy, the reaction is known as an exothermic reaction (exo = release thermic = heat). When a chemical reaction absorbs, or uses up, heat energy, the reaction is known as an endothermic reaction (endo = absorb, thermic = heat).

Aim

Write your own aim in the space below after reading through this practical.

Hypothesis

What do you think will happen when the calcium chloride and sodium bicarbonate (also known as baking soda or 'bicarb') are combined?

Materials

- eye protection
- 1 teaspoon calcium chloride powder
- 50 g sodium bicarbonate
- water
- 200 ml glass beaker
- a polystyrene cup
- a lid for the cup, or a piece of aluminium foil that entirely covers the mouth of the cup
- a teaspoon
- a tablespoon
- thermometer
- scissors
- stop watch

Safety

Refer to the Material Safety Data Sheet for calcium chloride powder and sodium bicarbonate solution before use. (Data sheets provided by suppliers at time of product purchase.)

Wear eye protection at all times during this experiment.

Method

1. If your lid does not already have a hole for the thermometer, cut a small hole into the lid. Be careful not to make the hole bigger than the size of the thermometer.
2. In a 200 mL glass beaker, make a sodium bicarbonate solution by dissolving about 2 tablespoons of sodium bicarbonate into 100 mL of water. Stir until no more sodium bicarbonate will dissolve.
3. Pour 50 mL of the sodium bicarbonate solution into the polystyrene cup, cover the cup with its lid, and then insert the thermometer through the hole in the lid. Immediately record the temperature of the solution.
4. Add 1 teaspoon of calcium chloride powder to the sodium bicarbonate solution in the cup and close the lid. Immediately insert the thermometer.
5. Immediately record the temperature of the mixture, and then take a temperature reading every 30 seconds after that for a total of 2 minutes. Use a stopwatch to monitor the time.
6. Construct a table in the Results section below to record your results.

Results

Table: Construct your own table, with your own *descriptive* title in the space below. Remember to include units (e.g. °C) in your table.

Discussion

Record your answers to the discussion questions in the spaces provided.

Q1: What happened to the temperature inside the cup during this reaction?

Q2: Is this reaction an example of an endothermic or an exothermic reaction?

Q3: Why was it important to keep the cup covered with a lid during this experiment?

During this experiment, a chemical reaction took place between the calcium chloride and the sodium bicarbonate. Calcium carbonate and sodium chloride were produced. Both the sodium bi*CARBON*ate and the calcium *CARBON*ate contain carbon, as indicated by their chemical names.

Q4:

a. Which of these chemical(s) is/are the reactant(s) in this chemical reaction?

b. Which of these chemical(s) is/are the products(s) in this chemical reaction?

Q5: During this chemical reaction, energy was transformed from one type or form into another.

a. In which form(s) was the energy before the reaction?

b. Which form(s) did the energy transform into during the reaction?

Q6: Does this reaction store energy in a carbon-containing molecule or release energy from a carbon-containing molecule? How do you know?

Evaluation

Record your answers to the evaluation questions in the spaces provided.

Q1: Do you think this experiment successfully demonstrated the way that carbon stores or releases energy? Why/why not?

Q2: Describe one way that the experiment could be changed to further increase the success of this experiment AND explain how this change would improve the experiment.

Conclusion

Write a conclusion in the space below that includes the following information:

> A statement that relates to the aim
> A statement about whether or not your hypothesis was supported
> A brief summary of your results.