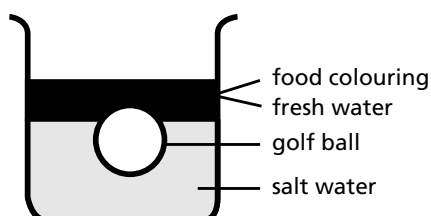


Investigating carbon

Worksheet answers

Activity 1: Water density A

1. Draw beaker showing the position of: salt water, fresh water, golf ball and food colouring.



2. Which water has higher density? Salt or fresh? How do you know?

Salt water has greater density than fresh water as it sinks to the bottom of the beaker or container. It is more dense as it has a greater mass than fresh water in the same volume, it contains more molecules.

3. Describe where in the ocean you may find salt and fresh water. How is fresh water added to the ocean?

Fresh water would usually be found sitting on top of salt water in the ocean. Fresh water is added to the ocean by rain, iceberg melts, glacier melts, river or other freshwater bodies entering the ocean.

Activity 2: Water density B

1. Describe how ice cubes and hot water behaved when added to the trough of room-temperature water.

Ice cubes sink to the bottom and slowly melt, releasing blue dye. Red-coloured warm water floats along the top. As time passes and the temperature evens out, the two colours mix together.

2. When is cold water added to the ocean?

Cold water can be added to the ocean through rain or snow, icebergs melting, glaciers melting and freshwater entering the ocean from land.

3. What happens to this cold water as it mixes through the ocean?

Cold water initially sinks. Where it comes into contact with warmer water it will mix and begin to rise. If it doesn't mix with warm water it continues to sink.

Activity 3: Water temperature

BEAKER	OBSERVATIONS
hot	<i>The soft drink level dropped quickly. Bubbles of gas emerged from the stopper rapidly.</i>
room-temperature	<i>The soft drink level dropped slowly. Bubbles of gas emerged from the stopper slowly.</i>
cold	<i>The soft drink level barely moved. Bubbles of gas were barely seen emerging from the stopper.</i>

1. Summarise what happened in this experiment.

As soft drink warmed up by being immersed in room temperature or warm water it released gas. Bubbles of gas leaked out of the stopper and the level of the soft drink went down.

2. How does this experiment relate to the ocean? Predict where around the world more or less CO₂ may be absorbed into the ocean?

Carbon dioxide is stored in the ocean, partly as dissolved gas. As the temperature of the ocean changes more or less carbon dioxide can dissolve. Warm water absorbs and stores less carbon dioxide than cold water.

Warm ocean water, such as that found near the equator, absorbs and stores less carbon dioxide than cold water, such as that found near the poles.

3. What do you think might happen to the ocean's ability to absorb and dissolve carbon dioxide as ocean surface temperature warms?

As the ocean surface temperature warms less carbon dioxide will be absorbed and stored.

Activity 4: Water acidity

1. Did tap water or seawater change pH when carbon dioxide (in your breath) was bubbled in?

Tap water changed pH quickly: after 10 seconds of blowing it was more acidic. Sea water changed more slowly.

Activity 5: Phytoplankton from space

1. What do you observe in the animation?

The animation focuses on the Pacific ocean and Southern Hemisphere. There are blue and pink colours moving, swirling and pulsing in the ocean, and green shades growing and shrinking on land.

2. What do you think these represent?

On land the green patterns show changing seasons and plant cover. There is increased and decreased foliage cover, depending on the season. In the ocean it is the same: there are seasonal variations in plant matter.

3. What do you observe in this animation?

A light blue colour moves up and down (northwards and southwards.) Light blue patterns on the Equator stay roughly the same over the time. There is yellow shading along some coastlines.

4. What do you infer from this observation?

The amount of photosynthesis varies seasonally. Parts of Earth that experience a change in the amount of light during the year show variation in photosynthesis. The amount of photosynthesis around the Equator is consistent through the year, as light and warmth are consistent.

The greatest amount of chlorophyll is in found in bands along coastlines where the sea is shallower. Here there are seagrass beds, mangroves and salt marshes.

There are areas of the ocean where there are no plants or photosynthesis.

Activity 6: Phytoplankton under the microscope

Drawings will vary.

Activity 7: Phytoplankton rap

1. What does 'we are producers' mean?

Phytoplankton produce oxygen needed for life on earth, phytoplankton are also food for zooplankton.

So phytoplankton produce the requirements for life for other organisms.

2. How do they do this?

By photosynthesis – capturing sunlight energy to make sugar and in the process releasing oxygen.

3. What's the name of the process that causes dead phytoplankton and bits of phytoplankton to end up in the deep ocean?

biological pump

4. What is 'marine snow'?

Marine snow is "dead or poo-ed" - a mixture of dead phytoplankton and zooplankton, plus bits of phytoplankton that have been eaten but not digested or retained by zooplankton. In other words, plankton 'remains' sinking down in the ocean.

5. What does 'we are sequesters' mean?

We are sequesters means that phytoplankton store carbon away for a long time. This happens when marine snow made up of plankton remains makes its way to sediments on the ocean floor.

Activity 8: Plan a phytoplankton investigation

1. Which factor did you test?

Responses will vary.

2. Why is this factor essential for phytoplankton to survive?

Responses will vary.

3. What did your test show?

Responses will vary.

4. Can you explain what happened?

Responses will vary.

5. Phytoplankton are an important carbon store in the ocean. Relate observations from your investigation to the wider issue of carbon in our atmosphere.

Students should relate that variation in phytoplankton growth due to environmental change such as warming, nutrient availability change or change in carbon dioxide levels affects the ability of phytoplankton to store carbon. Students should comment on the importance of phytoplankton as a carbon store.

Activity 9: Seagrass services

1. What are some services that seagrasses provide to the coastal environment?

Seagrasses stabilise sediments.

Seagrasses protect coastlines.

Seagrasses are vital habitats for fish.

Seagrasses have a role in regulating global carbon through carbon sequestration.

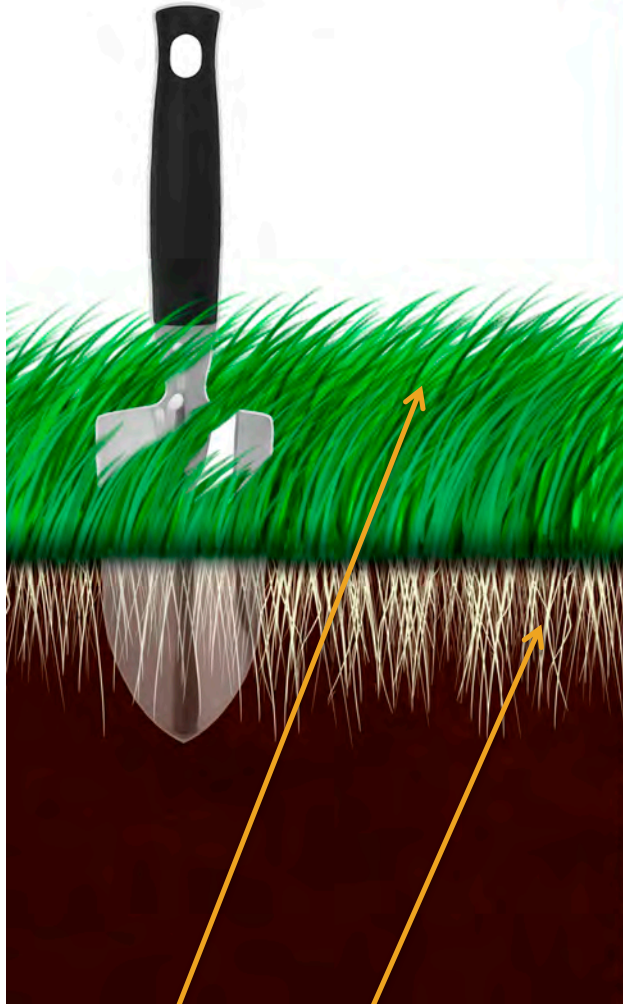
2. Why is it useful for these students to experiment to find the best way to replant and restore seagrass beds?

Seagrass sequesters carbon, so restoring and extending seagrass may be useful in mitigating climate change caused by increased carbon dioxide in the atmosphere.

Replanting will restore services such as protection and fish habitat.

3. Label the following diagram with places where grass and seagrasses sequester (store away) carbon. Place a star next to the best place.

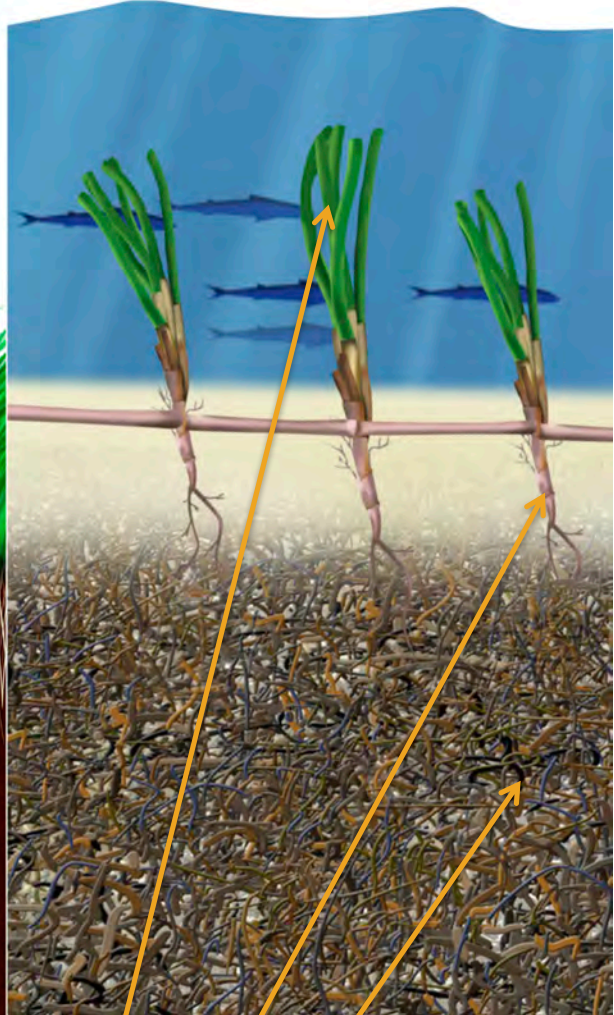
Grass



leaves

roots

Seagrass



leaves

roots

matte

Matte is the scientific spelling. Seagrass remains do resemble a mat and therefore mat could be considered correct as well, as would 'dead leafy material and roots' or 'old roots' or similar.



Activity 10: Carbon cycle diagram interrogation

1. Which is the largest carbon sink (storage)?
deep ocean (Earth's crust is also a possible answers)
2. Which is the smallest carbon sink shown?
marine biota
3. How much carbon (GtC) is held in soil?
1580 GtC
4. How much carbon (GtC) is held in fossil fuels (oil, gas and coal)?
3000 GtC in coal and 300 GtC in oil and gas
5. Where is there a 'two-way' movement (flux) of carbon?
 - *between atmosphere and biosphere*
 - *between ocean surface and atmosphere*
 - *between ocean surface and deep ocean*
 - *between ocean surface and marine biota*
6. Between which stores is the largest flux of carbon? How much carbon is involved?
The flux between atmosphere and vegetation (or biosphere) is 121 GtC per year.
7. How much carbon goes into the atmosphere as a result of using fossil fuels and cement production (GtC/year)?
5.5 or 8 GtC/year (depending on which diagram is used)
8. Find two differences in information between cycles in these diagrams. Why do you think this is?
land use change: unlabelled on NASA diagram and without return flux of 1.5 although there is a value of 1.6 on NASA diagram near the other type of trees
 - *rivers: flux unstated in NASA diagram*
 - *fossil fuel sink: presented differently in the two diagrams*
 - *fossil fuel and cement production flux of carbon to atmosphere*
 - *ocean surface to deep ocean flux (91.6 or 96.1)*

Differences could be because of an error, because different methods are used to calculate amounts, because amount are estimates, because knowledge has changed between when diagrams were drawn, or there are differences in what is included in the represented sinks and stores.
9. Use either the NASA or IPCC diagrams to complete the flow diagram below. It should represent the carbon sink and amounts in GtC (gigatonnes of carbon) and GtC/year (gigatonnes of carbon per year).

