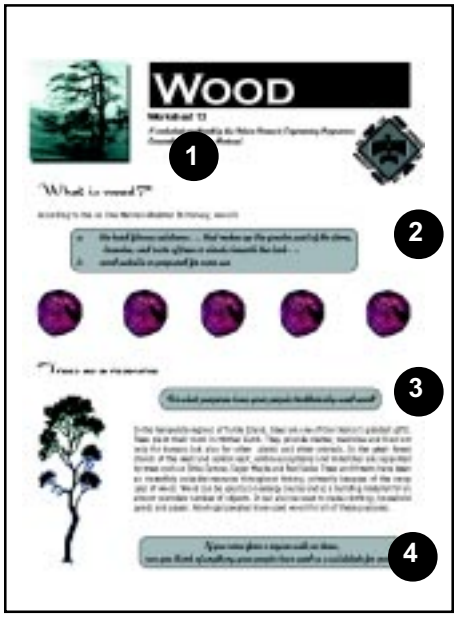
Wood

Worksheet 13

A worksheet produced by the Native Access to Engineering Programme

Teacher's Guide

Here are some suggestions for how can work with Worksheet 13, Wood.



1. Vocabulary

cell wall	phloem
cellulose	photosynthesis
clear cut	polysaccharide
composite material	renewable resource
compression	respiration
ecosystem	sap
deforestation	tension
grain	vascular system
lignin	wood
non-renewable resource	xylem

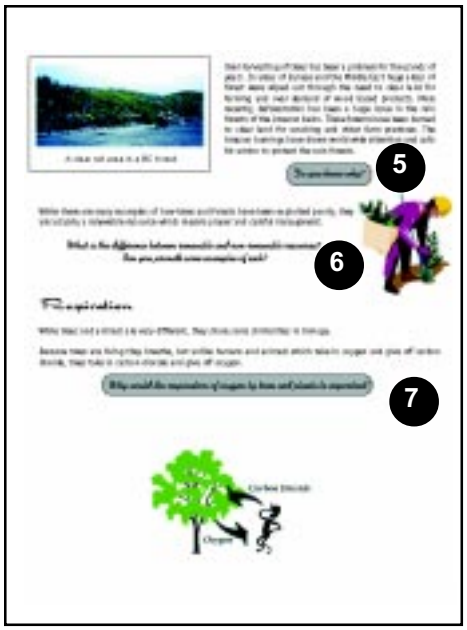
2. Definition. Do you students understand the definition? Can they demonstrate their understanding?

3. The answer to this question will depend on the nation and region in which you work. Below are some examples of traditional uses for wood:

   Shelter: longhouses, tipi supports
   Transportation: Canoe, kayaks, sleds, cradle boards
   Clothing
   Baskets
   Medicines derived from root and bark
   Tools and tool parts: axe handles, fishing hooks, arrow shafts

4. Again, the answer will depend on the region. Below are some materials which have been used as a substitute for wood.

   Shelter: snow, ice, soil, animal skins
   Transportation: animal skins, bone
   Tools: bone, rocks



5. There are a number of reasons that the burning of the Amazon rain forest has garnered so much world wide attention word wide.
   - The rain forest is home to a number of Aboriginal peoples including the Shipibo of Peru, and the Yanomami of Brazil and Venezuela. Many of these people have been forced to resettle in other areas, or have had to move from their traditional homelands as deforestation alters their hunting grounds.
   - The rain forest is a unique and richly diverse ecosystem in which there are countless plants and animals. These species, many of which are unknown and unique to the area, are being pushed to extinction through loss of habitat.
   - There is also concern that because the ecosystem is not well catalogued by science that it may contain plants with medicinal properties which we may lose forever.
   - The clearing of the forest is not providing fertile land for farming, but instead contributing to soil erosion and climate alteration.

If your students are interested in the rain forest there are a number of good resources and lesson plans online.
Discovery Channel, The A to Z of Rain Forests
http://school.discovery.com/homeworkhelp/worldbook/atozscience/r/458390.html
Lesson plans
http://www.coe.wayne.edu/~mpettap/lesson/rain.htm
http://www.eecs.umich.edu/~coalitn/sciedoutreach/funexperiments/agesubject/lessons/newton/rainforestplant08.html
http://www.lessonplanspage.com/RainForestUnitA.htm
RainForest Action Network
http://www.ran.org/ran/kids_action/index1.html

6. Renewable resources are those such as trees and hydro-electric power which with careful management can be sustained indefinitely. Non-renewable resources are those such as oil, gas and most metals and minerals which cannot be replaced. For more information about non-renewable resources see the NAEP's Mining worksheet, http://www.nativeaccess.com/Worksheets/Default.htm.

7. The absorption of carbon dioxide by trees and plants is important for a number of reasons. First of all, it sustains the plants: carbon is converted through photosynthesis into the sugars plants use for food.

   Secondly, trees and plants play a large role in the carbon cycle. Carbon, in its many forms, cycles much as water does. It is absorbed in some processes – like plant respiration – and released in others – like burning and decay. Carbon dioxide is one of the major green house gases; its release into the atmosphere is one of the factors which scientists believe is contributing to global climate change. In the carbon cycle, there are carbon sources and carbon sinks. Sources are those processes which release the element and sinks are those processes which store it. Trees and plants are carbon sinks.

In 1997, industrialized nations (including Canada) met in Kyoto, Japan to discuss the reduction of greenhouse gases. They developed the Kyoto Protocol an agreement in principal through which they would reduce their emissions of carbon dioxide and five other heat-trapping greenhouse gases to 5.2 percent below 1990 levels. Although just over 3 years old, the agreement has not been ratified by most of the author countries because of disagreements as to how carbon (and other emissions) are to be credited and debited. Canada's position is that countries with large forest tracks should be able to figure the carbon stored in these trees as a reduction in production. Other countries oppose this position because they say carbon storage in trees is only temporary and so there is no real reduction in carbon production, only a delay.

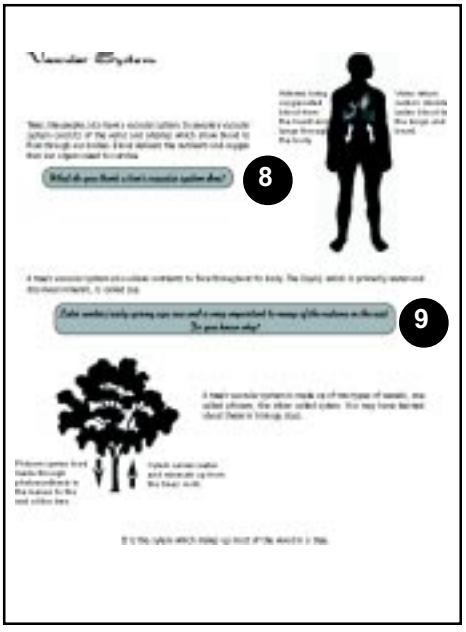
For more information about the carbon cycle check out:
A Trip Around the Carbon Cycle
http://library.thinkquest.org/11226/
Exploring the Environment
http://www.cotf.edu/ete/modules/carbon/efcarbon.html
Global Carbon Cycle
http://geosys.mit.edu/~chem/

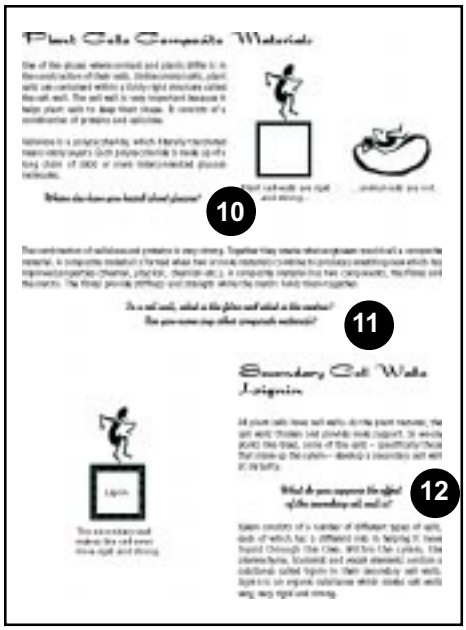
For more information about the debate surrounding the Kyoto Protocol:
Convention of the Parties 6
http://cop6.unfccc.int/modules/none.asp?pageid=16
Guide to the Climate Change Negotiation Process
http://www.unfccc.int/resource/process/components/response/respkp.html
Climate Change
http://www.gov.ab.ca/env/climate/fk_1.html

8. Like a human's vascular system, a tree's vascular system provides for the transport of vital nutrients through the body of the plant.

9. In late winter and early spring, the nations in the east tapped maple sugar trees for their sap. They then processed the liquid through boiling to produce maple syrup.

Supplemental information is available at
Maple Syrup
www.schoolnet.ca/aboriginal/science2/syrup-e.html
Maple Syrup Industry in Ontario
http://www.gov.on.ca/OMAFRA/english/crops/facts/maple.htm#preface





10. Glucose is the primary sugar found in human blood. People who have diabetes monitor their glucose levels to gauge how much insulin their bodies are producing. In this way, they are able to regulate their insulin levels.

11. In a cell well the cellulose is the fibre and the proteins are the matrix. For more information about composite materials see the NAEP curriculum set on materials: http://www.nativeaccess.com/Worksheets/Default.htm

12. The answer to this question is found in the caption for the illustration. The secondary cell wall makes the cell even more rigid and strong. In wood all of these rigid cells work together to support the tree.

13. To learn more about material properties see the NAEP curriculum set on materials: http://www.nativeaccess.com/Worksheets/Default.htm

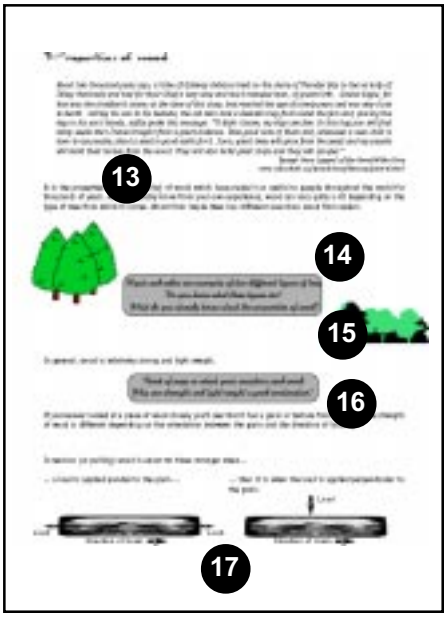
14. Maple is an example of a deciduous tree. A cedar is a coniferous tree.

Deciduous trees generally have broad leaves which are shed before a cold or dry season, with new leaves appearing in the spring. In areas where the climate is quite steady and temperature, deciduous trees may keep their leaves throughout the year.

Coniferous trees have smaller, waxy leaves, often needles shaped, which usually remain on the tree all year.

There are other ways of classifying trees. It might be an interesting exercise for your students to examine the ways in which trees can be classified. Depending on the time available to you, their exploration and discussion could extend into the standard biological classification of species.

15. Your students probably already known a lot about wood. This activity will help them to see differences between types of wood.



Materials

Several different pieces of wood – balsa, maple, cedar etc.
The pieces don't have to be big, but 15cm lengths or so would be good. All the pieces should be approximately the same size
Tools – hammer, nails, plane, sand paper etc.
Water
Paint
Any other materials which will help students explore their pieces of wood

Activity

1. Divide the students into groups.
2. Give each group 2 different pieces of wood.
3. Tell them they have 20-30 minutes to find out as much as they can about each piece.
4. Let them explore the wood with the materials provided.
5. You may want to prompt them with question which will direct their activity:
   Which piece of the two is harder?
   Which piece is more impact resistant?
   Do both pieces float?
   Which one is easier to drive a nail into?
   Do they both absorb paint at the same rate?
   Which one is easier to plane?
   Are they approximately the same weight?
   What differences and similarities can you see just by looking at the wood?
   What kind of sound does each piece make?
   Etc?

Discussion

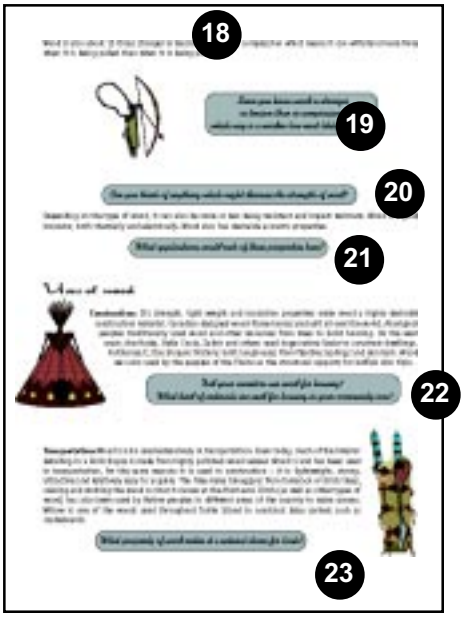
Once the students have made their observations they should share them with the rest of the class. Through sharing they should be able to make generalizations about wood (it all floats, it has a grain), and identify differences between the types of wood provided to them.

16. Strength and light-weight are generally desirable qualities in engineering materials. Aboriginal people have used these properties of wood to their advantage for a long time. Some examples are provided in the table below.

Wood Product	Strength	Light weight
Canoe	Could carry large loads	Light enough to portage
Bows	Withstood repeated bending stresses without breaking	Light enough to carry through woods for long periods of time
Arrows	Could withstand impact	Could travel through the air for fairly long distances

What other examples can your students provide?

17/18. For more information on loads, tension and compression see the NAEP curriculum set on structures:
http://www.nativeaccess.com/Worksheets/Default.htm



19. A wooden bow is most likely to break somewhere near the middle due to the stress caused by the repeated bending when it is drawn. It will tend to snap in towards the user.

    A bow might also break around the points where the tension wire is connected to it.

20. Wood which is too wet looses strength. So does wood that had been exposed to too much heat.

21. The applications of the properties are in the section which follows. What can your students come up with on their own before moving on to the next section?

22. The answer to both of these questions will vary depending on the nation and region. Housing materials used today include wood, fibreglass, concrete and steel.

23. Wood floats.

24. We tend to put handles on tools for two reasons. First of all, the handles protect our hands from the work being down by the tool – cutting, pounding etc. Secondly, attaching handles to tools turns them into levers and allows us to apply a force while doing less work ourselves.

    For more on levers, work and force see the NAEP curriculum set on simple machines:
    http://www.nativeaccess.com/Worksheets/Default.htm

25. Many different instruments are made from wood: violins, clarinets, guitars, pianos, cellos etc.

26. Because cricket and baseball bats make contact with a hard ball you would want the material they are made from to be very strong and highly impact resistant.

Solutions

Problem 1a: Arithematic and percentage

I. What do we know?
- Original forest area: 2,860,000 km^2
- Current forest area: 1,800,000km^2

II. Determine how much has been destroyed

Area destroyed = Original forest area – Current forest area
= 2,860,000 km^2 - 1,800,000km^2
= 1,060,000km^2

We need the area destroyed to find the answer to the second part of the question.

III. Determine percentage destroyed

$$\%\ \text{destroyed} = \frac{\text{Area destroyed}}{\text{Original forest area}} \times 100$$
$$= \frac{1{,}060{,}000 km^2}{2{,}860{,}000 km^2} \times 100$$
$$= 37.1\%$$

Answer
1,060,000km^2 or 37.1% of the Brazilian rain forest has been destroyed.

Problem 1b: Unit conversion

I. What do we know?
- rate of cutting: 66 acres/s
- 2.471 acres = 10,000m2

II. Convert time units

$$\frac{\text{acres}}{\text{hr}} = \frac{66 \text{ acres}}{\text{s}} \times \frac{60 \text{s}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}}$$
$$= 237{,}600 \text{ acres/hr}$$

III. Convert area units

$$\frac{m^2}{\text{hr}} = \frac{237{,}600 \text{ acres}}{\text{hr}} \times \frac{10{,}000 m^2}{2.471 \text{ acres}}$$
$$= 961{,}554{,}026 m^2/\text{hr}$$

Answer
961,554,026m^2 of Canadian rain forest is cut in one hour.

Problem 2: Volume or area, Pythagorean theorum, ratios

I. What do we know?

- Required dimensions of the timber beams is 15 cm x 15 cm x 4m
- Each log is cut 4 meters long, so there is no waste in length.

II. Assumptions we're making

Engineers often have to make assumptions in order solve problems. The trick is in learning to make logical assumptions, or assumptions which will allow you to make calculations which will be a good approximation of the real answer.

- The logs have circular cross-sections.
  We can make this assumption, because the cross section of a tree trunk is a close approximation of a circle.
- All the cut logs have the same cross-sectional diameter and the vertices of the cut timber beam lie on the outside edge of the log.

  This assumption is a little harder to justify, as not all of the cut logs will have the same diameter. Essentially what we assume here is that only logs within a certain range of cross-sectional diameters – some a little smaller than desired, some a little bigger than desired - will be used for timber beams. Over a large number of logs the diameters will average out.

III. Look carefully at the question being asked, before you start solving.

The question is asking you to find the portion of the log that is sent to the wood chipper. That would be the portion of the log not included in the cut timber beams.

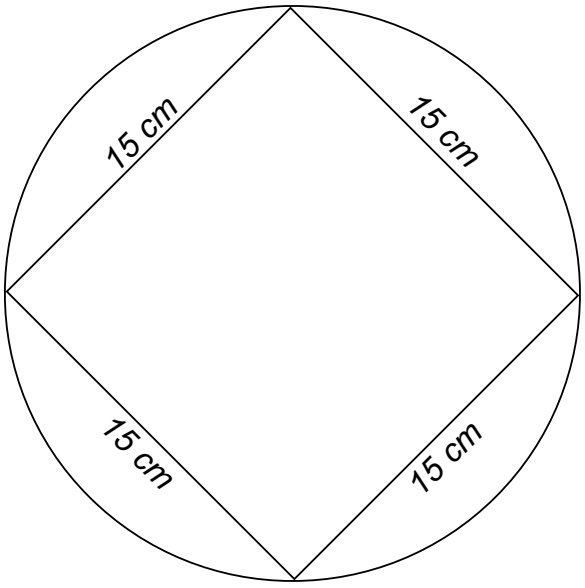
When a question asks for a portion it is asking you to look for a ratio, fraction or percentage. In other words, it is asking you to compare one amount to another. In this case, we are trying to compare the amount of wood thrown away with the amount originally in the log.

You're gut feeling for solving the problem may tell you to figure out the volumes of the original log and cut timber beam – and from there the amount left over. But before you start off think a bit about how volumes are calculated.

Volume (square cross-section)	= side x side x length	= (square cross-sectional area) x length
Volume (circular cross-section)	= Π x radius^2 x length	= (circular cross-sectional area) x length

If the length in the two volumes to be compared is the same it can be considered a constant and removed from the equation. In other words, in this case, comparing areas will give you the same answer as comparing volumes. The area method will be used here.

It does not matter what method your students use to complete the problem. It might be interesting to have them complete it both ways, compare the results and then talk to them about how constants can be cancelled out in certain cases.

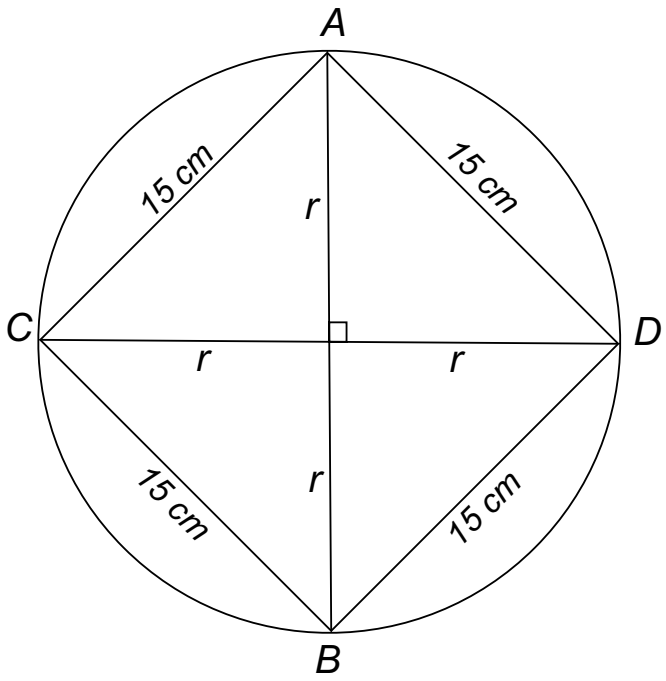


IV. Calculate the cross-sectional surface area of the timber beams.

Area $_{square}$ = side x side
= 15cm x 15cm
= 225 cm^2

V. Determine the radius of the log's cross-section required to calculate the area of the log's cross-section.

Because the timber cross-section is square and its vertices touch the outer edge of the log, the radius, r, can be determined using the Pythagorean theorum. If you bisect the square twice with lines AB and CD you end up with four right equivalent triangles of equal area. The radius, r, is also the length of the unknown triangle sides.



Pythagorean theorum says that $a^2 + b^2 = c^2$. Substituting in our known values we get:

$(15cm)^2 = r^2 + r^2$
$225cm^2 = 2r^2$
$\frac{225cm^2}{2} = r^2 = 112.5cm^2$
$r = \sqrt{112.5cm^2}$
$r = 10.6cm$

VI. Calculate the cross-sectional surface area of the log.

$$\begin{aligned} \text{Area}_{\text{circle}} &= \Pi r^2 \\ &= \Pi(10.6\text{cm})^2 \\ &= 353\ \text{cm}^2 \end{aligned}$$

VII. Determine the amount of wood to be sent to the wood chipper.

$$\begin{aligned} \text{Area}_{\text{chipper}} &= \text{Area}_{\text{circle}} - \text{Area}_{\text{square}} \\ &= 353\ \text{cm}^2 - 225\ \text{cm}^2 \\ &= 128\ \text{cm}^2 \end{aligned}$$

VIII. Determine the portion of each log sent to the wood chipper.

Since the question asks for portion you can set up a ratio, estimate a fraction or provide a percentage.

$$\text{Portion sent to wood chipper} = \frac{\text{Area}_{\text{chipper}}}{\text{Area}_{\text{circle}}}$$

$$= \frac{128\ \text{cm}^2}{353\ \text{cm}^2}$$

or approximately 1/3

To express the portion sent to the wood chipper as a percentage,

$$\%\ \text{chipper} = \frac{\text{Area}_{\text{chipper}}}{\text{Area}_{\text{circle}}} \times 100$$

$$= \frac{128\ \text{cm}^2}{353\ \text{cm}^2} \times 100$$

$$= 36\%$$

so 36% or just over 1/3 of the log is sent to the woodchipper.

Answer
36% or just over 1/3 of the log is sent to the woodchipper.

Notes

Notes