Teaching kit

museum

Natural Science Museum
Rue Vautier 29 - 1000 Bruxelles
www.sciencesnaturelles.be
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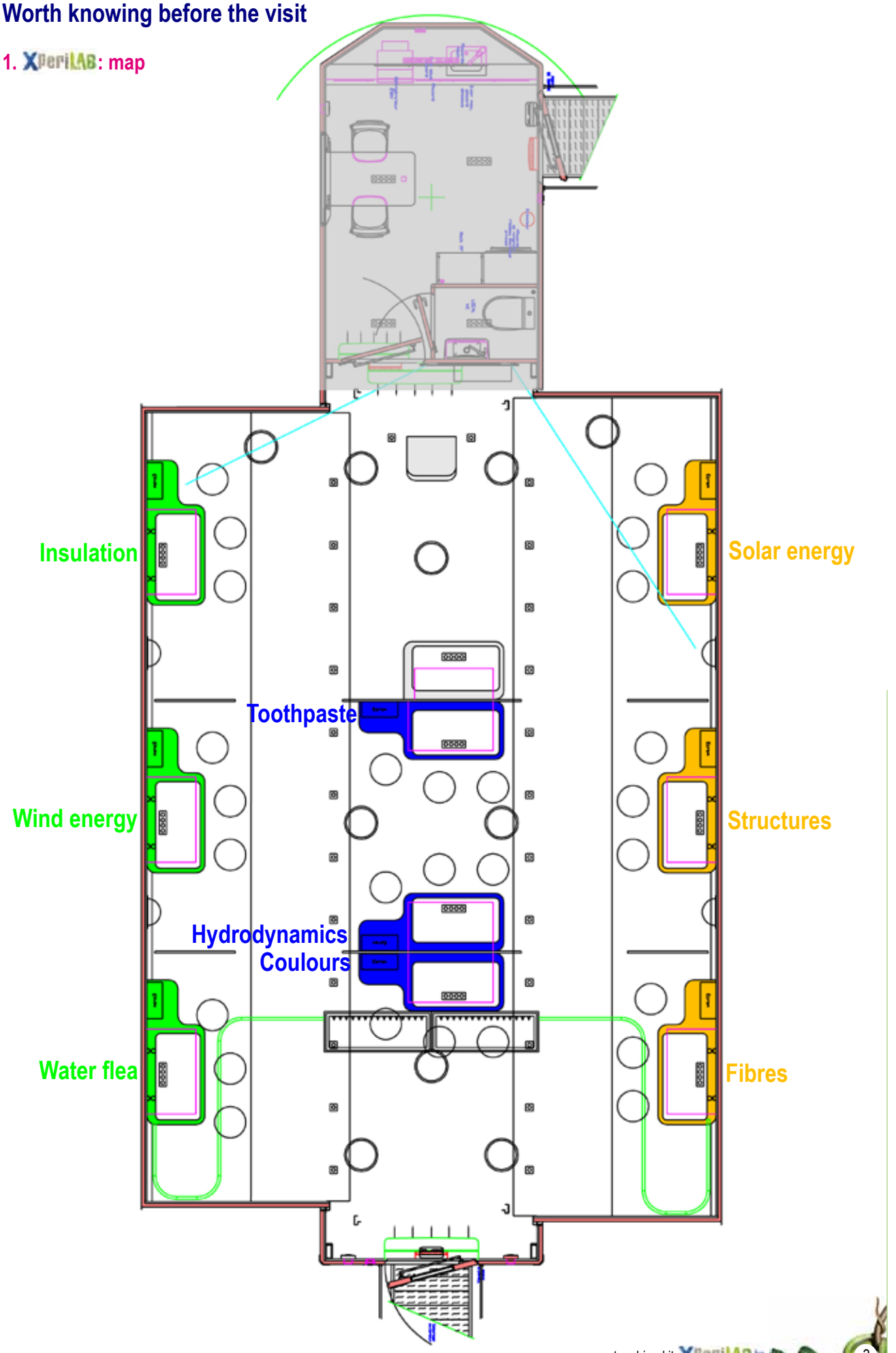
Worth knowing before the visit

1. XperiLAB: map



2. Purpose of XperiLAB.be ?

This mobile laboratory was designed to help arouse people's interest in science in general. The age group – 10 to 14 year olds – was chosen for a specific purpose: it is the age of discoveries, learning about the world outside and making the first choices. Rather than wishing to replace science education, this initiative is designed to complement it. Its purpose is to offer a different way of gaining an insight into science and understanding the key components of our environment, thereby developing a positive attitude towards the challenges of the future.

3. What happens in the lorry?

The young scientists are given some preparation at the entrance, where they are issued with a white apron.
The curtains open to reveal three colour areas, laboratories, each one containing three. Each group heads to its first laboratory. The nine subjects dealt with give prominence to biology, chemistry, physics and contemporary technologies.
A virtual moderator describes and supervises the activities.
When the experiments are completed, the students take part in a final joint activity together with the moderator.

4. General theme: the scientific method

Throughout the three experiments realised by the pupils the main theme is the scientific method. Observation is the core skill in one experiment: daphnia, colours or fibres. In a second experiment designing and testing will be to the fore: designing blades for a windmill, testing the speed of certain forms in water or testing the resistance to pressure of cylindrical and hexagonal shapes. A third experiment puts emphasis on reflection and deduction: a relative study on insulation of animals and buildings, a search for a protocol for making toothpaste or a comparative study on the consumption of (solar) energy.

During the joint activity the moderator will call attention to the importance of communication as a skill in the scientific world.

Back in class students and their teacher can elaborate on the numerous topics and identify the skills needed during each experiment.

5. Book XperiLAB.be

Go to www.xperilab.be, reservetion section.

6. Preparing for a visit to XperiLAB.be

A few weeks before your visit your class will be sent a preparation kit (by e-mail or post). The kit contains various items of information to be examined with the students prior to the visit to XperiLAB.be:

- Essential prior knowledge to have in the light of the operations explanations about some of the concepts so there is good understanding of the operations and advice about using specific scientific equipment.
- A plan for dividing the students into groups.

Some time should be paid to all of this to ensure the students are well prepared for their visit to XperiLAB.be and the experience is as enjoyable and instructive as possible.

XperiLAB.be

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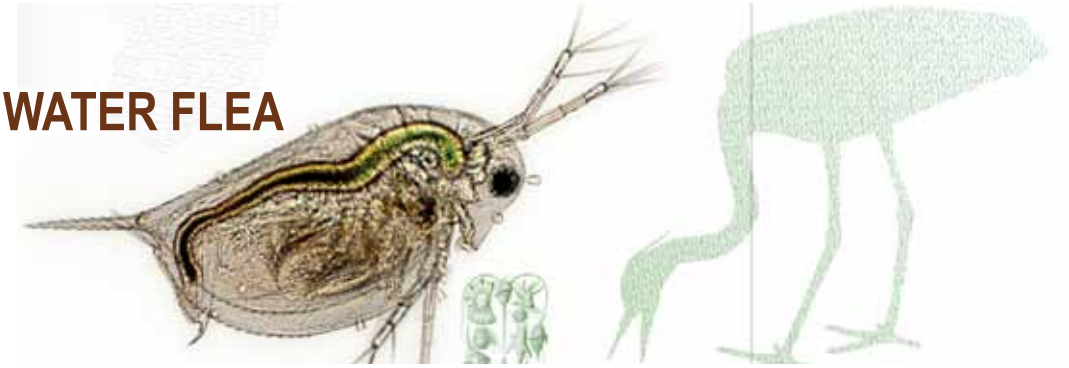
Green laboratory

1. WATER FLEA
2. WIND ENERGY
3. INSULATION

1. WATER FLEA



Choice of subject

A scientist discovering a new type of species first of all considers the characteristics and behaviour. The water flea's specific movement makes this an interesting species to observe. This tiny, discrete fresh water crustacean is a key link in its ecosystem chain. It does us a big favour by letting us know if the freshwater environments are polluted1. Water fleas are easy to find and breed, so they can be observed in the classroom setting. And one of the students may be an aquarium enthusiast who already knows this tiny creature!

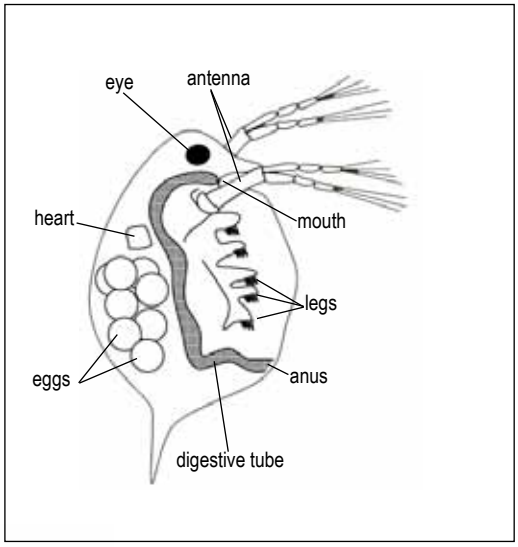
In XperiLAB

1. Take a water flea out of the aquarium and place it on a hollow glass plate.
2. Adjust the microscope.
3. Observer the live water flea and place the various organs and appendages in the right place on a virtual water flea.
4. Count the water flea's heartbeats

Class activities

1. A bit of theory

The water flea is a tiny fresh water crustacean. Its body is protected by a bivalve chitonous exoskeleton.



The 2 forked asymmetrical **antenna** have feathery highly mobile bristles that are primarily used for locomotion. The water flea gets about with swift jerky movements

The **single eye**, in fact comprising two eyes, is in the middle of the head

The 5 **pairs of thoracic legs** located between the two valves comprise the gills and are also involved in the movement.

The **mouth** is found in the notch between the head and the rib cage. It is at the entrance to the digestive tube, which ends in the anus, at the bottom of the ventral side. The mouth has a filter the water flea uses for collecting plankton microorganisms.

The **heart** is on the dorsal side. It beats 180 times a minute on average. Its purpose is to help transport the hemolymph in the body.

A breeding cavity under the heart contains eggs or embryos. When the conditions right, the females reproduce asexually via parthenogenesis: the unfertilised eggs develop directly to produce new female water fleas. These females produce more or less 35 eggs a week. When the conditions are not right (cold, overpopulation, shortage of food,...), they also produce males. These may impregnate the females, which then produce so-called "resistance" eggs but in lower quantities: scarcely two per female. These will hatch when the conditions are favourable once more. Females will emerge which, in their turn, reproduce asexually.

[1] *Les mots soulignés sont définis dans le glossaire en fin de chapitre*

Worth noting the jerky propulsion of the water flea, resulting from the beating of the antenna, which earned it the nickname "water flea".

Habitat

Water flees mainly live in stagnant fresh water. They are sometimes found in streams, places with slow currents. They like sites rich in organic matter from animal and plant waste, containing lots of infusoria on which the water fleas feed.

infusoria

Roles water fleas play in the ecological balance of fresh water environments

- They regulate the phytoplankton, thereby clarifying the water so the liquid environment receives the maximum amount of light;
- they are involved in the self-purification process in water polluted by nitrates and phosphates (pollution from farm, urban or industrial sources);
- they feed on large amounts of bacteria;
- they are a source of food for numerous fish species;
- they are an indicator species for determining water quality and are used to investigate water pollution;
- their movements help to disperse microorganisms, mix the water and harmonise the concentrations of oxygen and mineral ingredients.

2. Themes to explore

Fresh water food web (food chain)

Why not arrange an outing with the students to observe a stream or a pool. If that is out of the question, think about providing the students with items indicative of a fresh water food web. It is then up to them to sort the items out and determine the prey/predator relationships they have in common:

- what creatures feed on plants?
- what creatures depend on other creatures for their food? Determine the prey/predator relationships;
- are there any relationships between aquatic organisms and land-based organisms?
- what happens to the dead organisms?
- what part do plants play?

Combine the findings and look for a way of presenting them (in the form of a pyramid or a more intricate network depending on the class level).

Other food webs:

investigate other food webs on the basis of the fresh water food;
assess the importance of the smallest organism in a food web in maintaining biodiversity;
learn about the role human beings play in certain food webs.

Crustaceans

In the light of the knowledge acquired by the students who observed a water flea in XperiLAB and observing water fleas in the classroom (with a regular magnifying glass), show its characteristics and then compare them with those of other crustaceans that young people are more familiar with (such as shrimps).

3. Field and classroom activities.

Observing a stream or a pool

- Use a 1/20000 scale map of the National Geographical Institute (IGN) and a compass: geographical situation, orientation, any relationship with streams or springs;
- observation of the physical environment: bed, current, bottom structure, banks…;
- observation of live animals on the surface and in the water and/or their tracks: arthropods, amphibians, reptiles, larva. Consider their role in the ecosystem. Consider the adjustments made to breathing, locomotion, food. Observation of plankton. N.B.: very many tiny organisms can be seen with the naked eye. The observation of the plankton will obviously be facilitated if the school has good magnifying glasses, binoculars or microscopes. You could then think about identifying a few invertebrates with an identification key. Remember to put the water and the organisms back into the stream (or pool) where you found them;
- observation and drawings of plants on the sides of the pool, plants partly on the surface and those growing underwater: identification with the help of a key.
- introduction to the assessment of the water's biological quality (= biotic index): survey and observation of animal species, clarity, pH, temperature at different depths;
- observation of animals on the sides of the stream (pool) and/or their tracks: insects, birds, small mammals, amphibians, reptiles. Consider their roles in this ecosystem;
- sketch: areas with plant banks, any beaches, aquatic plants in evidence, the surrounding areas;
- the study report and the conclusions may be presented

as a mini exhibition, illustrated booklet for a blog …

Animal tracks

- The observation of the stream or pool may be followed up with an observation of the tracks:
- observation of animal tracks on the sides of the stream (or pool): insects, birds, small mammal, amphibians, reptiles;
- sort out the tracks and decide on their interrelation;
- in the light of the food-related tracks (indices) determine the food web for the place under consideration;
- consider the lifestyle and the role of each animal in this ecosystem;
- draw, take prints of the tracks discovered.
-

Glossary

fresh water: water that is not salty
hollow glass plate: glass plate used to examine living organisms under the microscope.
exoskeleton: or external skeleton, in contrast to an endosqueleton. A kind of small carapace to support and protect an animal. Lots of invertebrates, such as insects, crustaceans and molluscs have an exoskeleton
chitin: one of the main components of the exoskeleton, chitin plays a protective role.
hemolymph: equivalent of blood in arthropods
parthenogenesis: reproduction in which an organism develops from an unfertilised female gamete. This type of reproduction is found amongst certain types of plant and animal species
infusoria: microorganisms comprising a single cell with a separate core, living off decomposing vegetable matter.
phytoplankton: in water floating, microscopic small vegetable organisms like algae or certain bacteria.
food web: combination of food chains for a group of organisms living together in a specific environment.
identification key: taxonomic succession of alternatives, applicable to the characters of a specimen, used for the stage-by-stage identification of a described and named taxon and hence to provide it with a name

References

Bibliography

- Allons pêcher dans un ruisseau et Clé simplifiée des principaux invertébrés macroscopiques des eaux stagnantes – publications du Centre technique et pédagogique de la Communauté française. www.restode.cfwb.be/pgres/ctp/ctp.htm
- Guide de la vie des eaux douces – Malcolm Greenhalgh et Denys Ovenden – Delachaux et Niestlé – 2009
- Les petits animaux des lacs et rivières – L-H Olsen, J. Sunesen et B.V. Pedersen – Delachaux et Niestlé – 2008
- Le livre des traces et des empreintes – David Melbeck – Milan jeunesse – 2009
- Carnet de nature : traces et empreintes – Frédérik Lisak – Milan jeunesse - 2000
- Guide des traces d'animaux – P. Bang et P. Daehlström – Delachaux et Niestlé – 2009
- Guide du pisteur débutant – Vincent Albovy – Delachaux et Niestlé – 2009

2. WIND ENERGIE

Choice of subject

Most young people have no doubt already seen an old or contemporary windmill. Most children have probably blown on the sails of an old or contemporary toy windmill. But why do some sails turn better than others? Why does the direction of the sails assume such importance? This is what will be investigated in the laboratory.

In XperiLAB

Short virtual visit inside a wind turbine, from top to bottom. Tests involving different sails, shape, size, angle, number:

1. cut out the sails;
2. attach them to the rotor and choose their angle;
3. start the ventilator (constant power);
4. read the outcome of each test on a measuring instrument and type this on the screen. These operations are repeated with different sails.

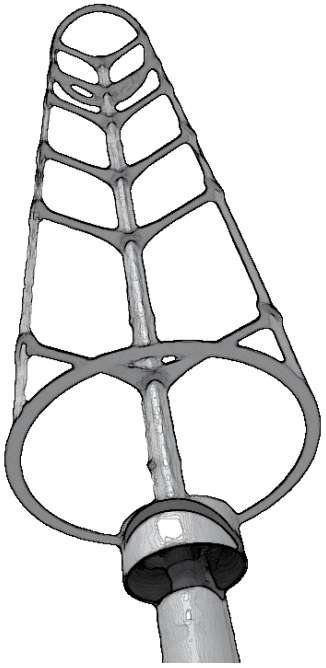
Class activities

1. Un brin de matière

For thousands of years people have been using wind energy to propel sailing boats or turn the sails of windmills. The mechanical energy obtained provided the power to mill grains, press oilseed products, forge iron and copper, produce paper or pump water.

This technology is still used to capture mechanical energy but its main purpose is to generate electricity.

Simply a contemporary version of a windmill, the wind turbine converts the wind's kinetic energy obtained from the movement of the wind into electrical power.



Vertical wind turbine

There are now two types of wind turbines:

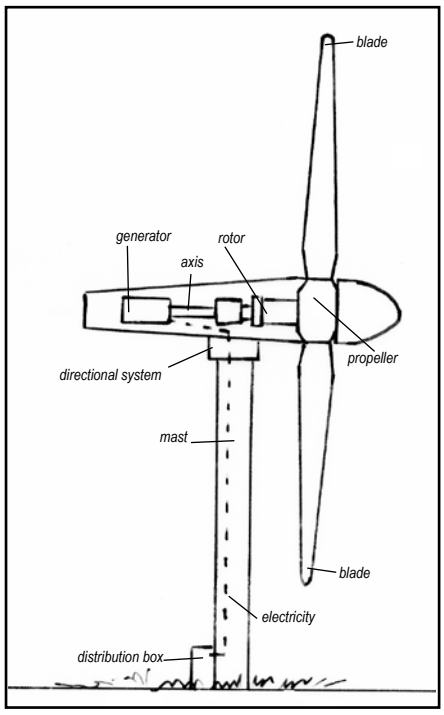
- horizontal axis turbines whose rotors looks like an aircraft propeller;
- vertical axis turbines, which are the most common ones.

Horizontal axis wind turbine

The vertical mast can sometimes be higher than 100 m, so that the blades are at a height where the wind speed is comparatively high and regular. The rotor is mounted atop the mast. A propeller, generally comprising three blades, is attached to the rotor axis. The nacelle contains the generator and system for regulating the electric power. The distribution box, at the foot of the mast, is hooked up to the electricity network to carry power generated by the turbine. The directional system is designed to turn the nacelle so the blades are facing the wind.

2. How does it work?

1. The wind makes the blades turn
2. The blades turn the axis
3. The axis drives the rotor
4. The rotor drivers the generator
5. The generator generates the electricity
6. The electricity is carried to the electricity network.



The wind turns the blades between 10 and 18 revolutions/ minute. The wind turbines operate at wind speeds of between 15 and 100 km/h. Above this speed they have to be halted for safety reasons. The optimum performance is achieved during wind speeds of 40 to 45 km/h.

Advantages of wind energy

- As the energy is renewable it is inexhaustible, unlike fossil fuels;
- as it is a clean form of energy no pollution is created apart from the manufacture of the wind turbine itself.

Inconveniences of wind energy

- wind turbines are expensive to produce;
- as the equipment itself is cumbersome, this creates serious difficulties in terms of construction, transport, assembly and maintenance;
- the volume of energy produced depends entirely upon the wind.

Worth noting:

in Greek mythology, Aeolus ruled over the Aeolian Islands between Sicily and Italy. According to the stories of Homer and Virgil, Aeolus kept the wind locked away in the bowels of the earth.

3. Themes to explore:

Where does the wind originate?

It is best to take the students out on a windy day and encourage them to ask a series of questions:

- What is wind?
- Warm/cold wind?
- Light wind/strong wind?
- How come it is blowing today but not yesterday?
- Is there a relationship between the wind and the landscape
- Is there a relationship between the wind types and shapes of plants?
- Do insects and birds use the wind to fly?

Human beings use the wind

Sailing, aviation and aerodynamics, kiting, beach sailing, weather vanes, anemometers...

What energy for what purpose, for whom?

Start a discussion where the students are required to form mental images about the energy theme.

- What is energy?
- What releases energy?
- Who needs energy?
- What is it used for?

What is meant by the terms renewable energy, green energy, fossil fuel, nuclear energy?

Get the students to make a list of "electrical items in the classroom: lights, audio equipment, computers, radiators, school bell, … Next consider what makes each of these objects work.

Comparative study of renewable energy and fossil fuel

- look for definitions;
- look for different renewable energies;
- look for different fossil fuels;

- small investigation of their environmental impact;
- assessment of the advantages and disadvantages of using each of these types of energy

Human beings and energy

- Where do human beings get their energy from?
- What does an energy drink, a energy bar contain?
- Human metabolism: the digestive tract

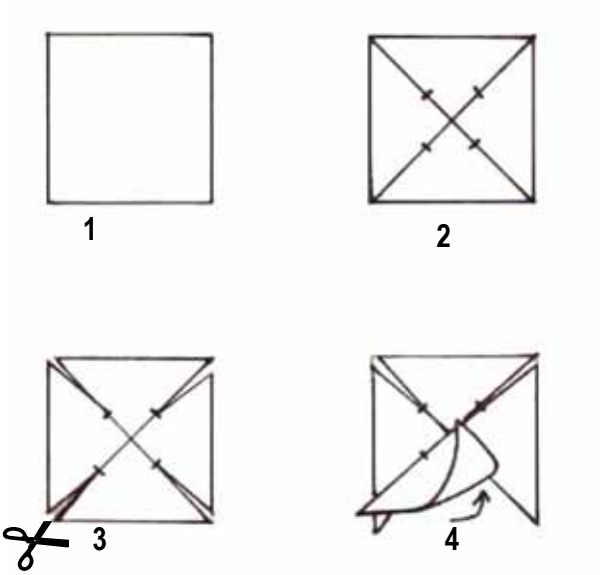
History of windmills

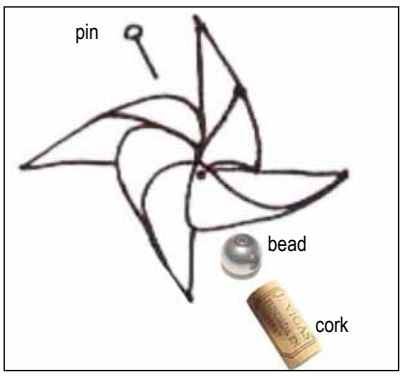
Regions of the world, evolution, use...

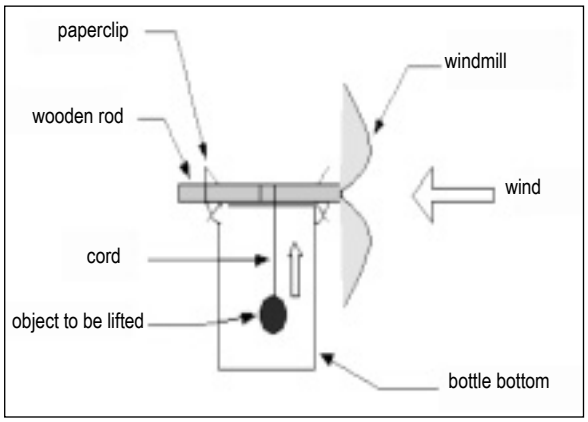
4. Class activities

Make a toy windmill that can lift a weight, such as an eraser.

1. Draw diagonal lines on a square piece of paper (dimensions as required) and mark 4 points, at an equal distance from the centre.
2. Cut along each diagonal, from the edge to the point.
3. Fold two opposite angles towards the centre.
4. Push a large-headed pin through the 4 assembled corners.
5. Thread a bead onto the pin at the back of the windmill then a cork.
6. Attach the windmill to the end of a stick.
7. Attach the cord to the middle of the stick. Suspend a tiny weight to the end of the cord.
8. Assemble everything on the bottom of a bottle.
9. Place the mill facing the wind!







Glossary

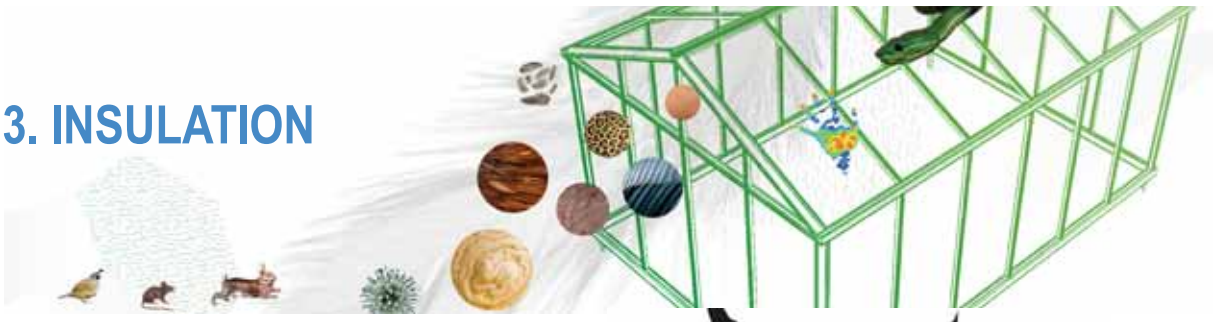
oilseed: referring to a vegetable oil or fat.
kinetic energy: energy a body possesses owing to its actual motion.
metabolism: series of chemical transformations undergone by all kinds of substances or molecules within a cell or organism.

References

Bibliography

- Le guide de l'éolien : techniques et pratiques – Corinne Dubois – Eyrolles – 2009
- Le mini-éolien – Emmanuel Riolet – Eyrolles - 2010
- Kezako : l'électricité – P. Nessman et P. Allen – Mango jeunesse – 2002
- Kezako : les aliments – C. Zeitoun et P. Allen – Mango jeunesse – 2007
- Comment bien manger ? Kate Knighton – Editions Usborne – 2009
- Le pétrole, de ses origines à son utilisation – Sylvie Cauvin – Le Pommier - 2010
- Le pétrole , raconté sous forme d'une histoire pour les élèves de 10-11 ans
- Physique-chimie 5e – livre du professeur – Nicolas Cheymol et Michael Hoff - Magnard (collection Incandesciences) – 2006
- Physique-chimie 5e – Hélène Carré-Montréjaud – Nathan - 2010

3. INSULATION



Choice of subject

Insulation is a theme of everyday life that opens the door to several different subjects. It can be considered from the point of view of the natural sciences, human equipment down the ages and contemporary technology.
As a result of concern about protecting the environment insulation is now at the forefront of research activities in the building materials industry and the textiles industry.

In the light of an example showing the importance of insulating properties in the animal kingdom, the activity developed for XperiLAB extends the issue to applications in everyday life.

In XperiLAB

With an infrared camera

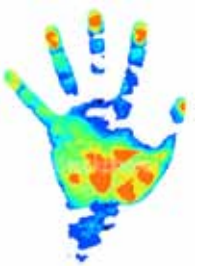
1. Assess and test the efficiency of the coat/plumage of three preys when faced with their common predator.
2. Analyse and compare the insulation of two slate roofs and their respective Velux roof windows

Class activities

1. A bit of theory

- A lot of adaptations exist in the animal kingdom to insulate creatures against the heat and cold (see teaching kit «survivors of the X-TREME»: **www.sciencesnaturelles.be/educa/pdf/xtreme_dossier_didactique.pdf**)

The more efficient insulation is the less heat escapes. Insulation limits the flow of heat in both directions: «incoming» heat or «outgoing» heat.



Some predators use sensory organs, called heat-sensitive pits or loreal pits, to detect infrared radiation given off by their prey. This is the case with the timber rattlesnake (American snake) considered during the XperiLAB experiment.
Loreal pits are cavities located in a snake's head. Crotalinae have these pits between their eyes and nostrils. They are covered with cells that have heat receptors conveying information about temperature variations to the brain. Consequently, timber rattlesnakes are able to detect a deer mouse at night because the heat these mice give off is higher than the surrounding temperature. Loreal pits allow predators to decide exactly how far away their prey are.

2. Themes to explore

Living creatures react

- sense organs;
- variety of stimuli
- variety of reactions to the stimuli

Food webs

- producers, consumers and decomposers;
- predation;
- parasitism

Heat

- heat / temperature;
- heat exchange: analysis of different materials;
- qualities of a heat insulator.

3. Class activities

Are my classroom and school well insulated?

- draw a plan of the building to be studied. You may have to seek the help of people with more knowledge about this subject: such as parents architects, engineers and surveyors;
- gather information about the systems established for insulation purposes: double glazing, roof insulation, wall insulation... some of the information is easy to find because the items are visible, while other information may be harder to discover. In that case ask people who are familiar with the subject: the caretaker, local authority officials who can provide drawings, the school maintenance department...;
- when the information is gathered, show it on the map;
- draw conclusions about the findings;
- propose solutions

References

1. Bibliography

- Le grand livre de l'isolation – Thierry Gallauziaux et David Fedullo – Eyrolles – 2010
- L'isolation thermique écologique – Jean-Pierre Oliva et Samuel Courgey – Terre vivante- 2010

2. Websites:

- www.sciencesnaturelles.be/educa/pdf/xtreme_dossier_didactique.pdf

Blue laboratory

4. COULOURS
5. HYDRODYNAMICS
6. TOOTHPASTE

4. COULOURS

Choice of subject

When the pigments of basic colours are mixed the eye sees the colour black.

When light beams coloured primary red, primary green and primary blue are superimposed the eye sees white.
In illuminated conditions, a colour appears wherever you look.
In the shadows the same colours seem dull.
No colour can be seen when there is total darkness, which means things around us are no longer perceptible to the eye.
Reflection and absorption of light provide clues as to what these phenomena are.

The many subjects that can be considered in addition to the principles of physics include history and the use of pigments, the functions of colours and light among animals and plants, the perception of colours in the animal kingdom…

In XperiLAB

1. Observe paper chromatography in an aqueous solution.
2. Combine the light of several light sources and observe the synthesis of these additions.

Class activities

1. A bit of theory

Chromatography

The word chromatography comes from the Greek words Khrôma, Khrômatos, colour and Graphein, to write.
Chromatography is a technique for separating the constituents of a mixture.
It is combined with a suitable detection system. Taken together they allow a qualitative and/or quantitatife investigation to be made of the relevant mixture.
This may involve a mixture of pigments, as in the case of paper chromatography undertaken in XperiLAB.
However, other mixtures are possible: blood to assess how many vitamins it contains, substances collected at crime scenes or suspected doping among athletes … There are several chromatographic methods and their applications cover all fields of chemical analysis.

In the case of paper chromatography undertaken in XperiLAB, a sample of pigments (line with a black felt pen) is placed on a "stationary phase" (porous paper). The sample is carried along the stationary phase through a "mobile phase" (water), which moves via capillary action.
In the light of its affinity with the different phases, each component of the sample moves at its own speed. This is way the various components gradually separate from each other.

No light no colour!

Light and colour are inextricably linked. The colour we see is the result of a combination of the light and the lighting angle, the physical characteristics of the setting
(moisture, heat…), and the observer's eye and brain.
Up until the 17th century, colour was regarded only as a pigment, whose three basic colours are cyan, magenta and yellow.
Isaac Newton, astronomer, mathematician, physicist and philosopher, revolutionised the concept of colour by showing that white light refracted through a prism was broken up into multicolour rays. In doing so he proved that colours are constituents of white light and without light there are no colours!
Newton presented these colours on a disc: red, orange, yellow, green, blue, indigo and purple. When the disc was turned quickly, the central area appeared white, showing white light is reconstituted as a result of adding the seven colours of

the spectrum. However all you need is to add together three colours to produce a white light: red, green and blue. These are the primary colours in the case of light rays.
Adding colours to produce white light is called additive synthesis.

2. Themes to explore

The eye, visual organ
• The human eye and the variety of eyes in the animal kingdom …

Colour in the living world:

• In plants, in animals:
• Colours that attract, colours that are not noticed, camouflage, change, intimidate, …

The rainbow
• the phenomenon, the light spectrum, the symbol.

The aurora
• the phenomenon of the northern lights or southern lights;
• the aurora on other planets, the Hubble Telescope photographs them.

Les études sur la lumière blanche et les couleurs
Isaac Newton, astronome, mathématicien, physicien et philosophe : recherche du parcours de l'homme et de ses découvertes, en particulier ses études sur la décomposition de la lumière blanche à travers un prisme.

Investigations of white light and colours
Isaac Newton, astronomer, mathematician, physicist and philosopher: find out about the man's life and his discoveries, particularly his investigations into the decomposition of white light through a prism.

3. Class activities

Decompose white light through a prism
Acquire a prism and try it out!

Make and try out a Newton disc
Materiel: a sheet of white paperboard measuring 15x15cm, a sheet of black paperboard measuring 25x25cm, compass, scissors, colour felt pen, glue, a cork, 1 nail, 1 wooden stick (meat skewer).
How to make it:
1. use a compass to draw a 15 cm disc on the white paper;
2. divide the disc into 7 equal parts (geometry lesson ☺);
3. colour each part with one of the following colours:npurple, indigo, blue, green, yellow, orange, red;
4. glue the coloured disc to the centre of the black paper;
5. stick the nail in the centre of the disk and push it into an end of the cork;
6. push the wooden stick into the other end of the cork;
7. make it turn and observe it.

Why?
Our eye is incapable of observing more than 25 images/second. Anything higher and the images overlap. This is what is called the "persistence of vision". If the disc turns faster than 25 revolutions/second, the image the eye sends to the brain is the image of the superimposed colours. Consequently, the light makes us see white!

Glossary

aqueous solution: water
capillary action: study of interfaces between a liquid and the air or between a liquid and a surface. It occurs when blotting paper absorbs ink or a sponge soaks up water.

References

1. Bibliography

- Le monde lumineux des océans – Catherine Vadon – Belin – 2010
- Comment voyons-nous ? S. Chokron et C. Marendez – Le Pommier – 2005
- Kezako : la couleur – P. Nessman et P. Allen – Mango jeunesse – 2002
- Kezako : la lumière – P. Nessman et P. Allen – Mango jeunesse – 2005
- La lumière à la loupe – Roland Lehoucq – Le Pommier - 2005
- Maîtriser les couleurs à l'aquarelle – Jan Hart – Fleurus – 2008

2. Websites:

- www.snof.org
- www.profil-couleur.com
- www.meteo.org/phenomen/aurore.htm

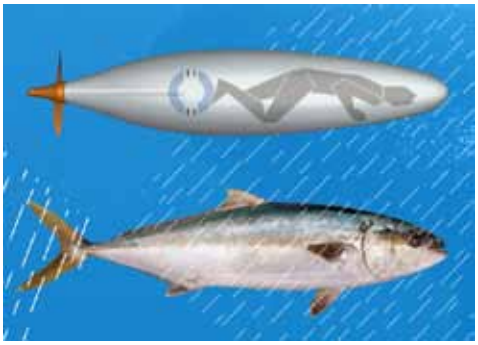
3. Painting

- Impressionism and Fauvism are bursting with colours. Artists belonging to these movements include Van Gogh, Gauguin and Matisse.
- "Colour above all and may be more than a drawing is a liberation". Henri Matisse
- The hallmarks of the Post-Impressionist movement "Nabi" are large flat areas of colours and a lot of light. Artists belonging to this movement include: Paul Sérusier, Edouard Vuillard and Pierre Bonnard.

5. HYDRODYNAMICS

Choice of subject

Always present in the animal kingdom competition enables creatures to defend themselves, to hunt for food and reproduce. Speed of movement is of vital importance for some aquatic organisms for hunting purposes or for fleeing from danger. Signs of convergence are observed in some organisms, such as marine mammals, whose body shape has evolved so they are better adapted to aquatic life.
Human beings have drawn inspiration from these examples to achieve supreme hydrodynamic performances in the realms of sport and technology.



methods do top swimmers use to be competitive

In XperiLAB

Test in an aqueous medium the shapes of three fish: tuna (spindle-shaped), red scorpion fish (ovoid) and trunkfish (almost spherical).

Class activities

1. A bit of theory

Fluid, liquid and gas dynamics, together with the study of turbulences are subjects covered by higher physics. The properties of fluids, such as pressure, density and temperature are included in the study of hydrodynamics. This subject is obviously too complicated to be addressed as part of the process for stimulating scientific curiosity in the third stage of primary school and the first stage of secondary school. However, testing the efficiency of various shapes for moving in water and the observation of turbulences in XperiLAB may be starting point for investigating how living things adapt to their environment.

2. Themes to explore

Adapting to the aquatic environment
Fish: morphology, breathing, nutrition, way of living.
Are human beings adapted to the aquatic environment? What

Competition
Life on earth first appeared in the oceans. The adaptive capacity has continued to diversify ever since for a whole host of reasons: defence, protection, camouflage, motion, looking for food, or reproduction. They have tended towards the same end: efficiency. When living organisms colonised the land and skies the same process went on.
In the classroom, look for examples of certain living things adapting to improve efficiency in the light of their environment.

Evolutionary convergence
Observe and compare the morphology of groups of animals with the same living conditions:
• a fish, an ichthyosaur (an extinct marine reptile), a penguin, a dolphin;
• a pterosaur (an extinct flying reptile), a bird, a bat;
• a hummingbird and a hummingbird hawk-moth
Next look for visible and invisible signs of these animals adapting to their environment: morphology, breathing, looking for food, defence and reproduction.
Draw conclusions about evolutionary convergence:
subject to the same environmental conditions, different specifies may acquire similar morphological structures or capabilities.

3. Class activities and activities in the swimming pool

Ideas for activities and making things are described in the discovery document for the
"Animal Olympic Games" exhibition
www.sciencesnaturelles.be/educa/pdf.dossiers/fr/JO_dossier_decouverte.pdf

References

1. Bibliography

- Les sciences en action – Chris Smith et Dave Ansell – Chantecler – 2010
- Atlas junior : la science – Paolo Cocco – Editions atlas – 2006

Literature

- « Vingt mille lieues sous les mers », Jules Verne
- « Moby-Dick ou le Cachalot », Herman Melville

2. Websites

- www.fishbase.org
- www.mumm.ac.be/FR
- www.sciencesnaturelles.be/educa/dossiers/finished (Teaching kit on Whales and Dolphins)

3. Museums

- L'Aquarium-Museum in Liège : www.aquarium-museum.ulg.ac.be/fr/index.php
- Sea Life center, Blankenberge: www.sealifeeurope.com/index.php?lang=fr

6. TOOTHPASTE

Choice of subject

In the light of this activity, XperiLAB makes a link between physics/chemistry and the daily lives of young people. Dental hygiene is a starting point for addressing a wide variety of subjects.

In XperiLAB

1. Investigate a toothpaste's properties.
2. Prepare the dental paste and analyse the ingredients.

Class activities

1. A bit of theory

About teeth

The teeth of human beings have several purposes:

- eating: each type of tooth has a specific job to do, depending on its shape and location. The incisors sever, the canines rip and tear, molars and premolars crush and chew;
- aesthetic: they support the cheeks and lips and help the smile to form.

Teeth need to be cleaned as they are constantly being attacked by bacteria and acids.
This is the main purpose of toothpaste.

Toothpaste

Toothpaste is defined as a paste or gel dentifrice used with a toothbrush as an accessory to clean and maintain the aesthetics and health of teeth.

Toothpaste in the form of a paste, gel or, less commonly, powder, is spread on a toothbrush. A vital aid to oral health, it acts in various areas, according to its composition. Toothpaste:

- helps to loosen plaque formed by a build-up of bacteria;
- prevents gum diseases;
- acts as a protector, reducing the risk of tooth decay;
- helps to keep the breath fresh.

Plaque

Plaque comprises salivary proteins, sugars (foodstuffs) and bacteria and is constantly being deposited on the surface of the teeth, which need regular brushing to prevent plaque building up, resulting in tartar deposits and oral diseases.

Oral health

A few hygiene practices help to prevent tartar deposits, tooth decay and gum diseases. They all tend to one and the same end: eliminating plaque!

The main methods used are:

- manual toothbrush;
- electric toothbrush;
- tongue cleaner;
- toothpaste;
- dental floss;
- mouthwashes

Worth noting:

- tools used to clean teeth have turned up in archaeological finds everywhere in the world. These are generally toothpicks made from wood, feathers, thorns and porcupine quills. Small branches with frayed ends have also been discovered.

- It was in the United States that toothbrushes were mass-produced for the first time. They were made from bone and had pig bristles.

- Iguanodon means iguana tooth.

2. Themes to explore

Fluoride

- mineral element found in the earth's crust;
- used in industry and daily life;
- toxicity.

Teeth in the animal kingdom

- dentition adaptations according to the diets;
- most of the world's animals do not have teeth. What do they do for feeding?

Human teeth

- growth: milk teeth, permanent teeth;
- number of teeth;
- name and specialisation of the different types of teeth;
- teeth structure: enamel, ivory, pulp, root, cementum.

Story of toothpaste

Oral health has been a human concern since time immemorial. As underscored by the toothpicks, chewing sticks, small branches, strips of material, bird feathers, animal bones and porcupine quills discovered during archaeological digs.

Dental pastes were used in Egypt as early as 5000 BC.

3. Class activities and activities in the swimming pool

- A tooth brushing session in the classroom;
- A visit to the dentist/A dentist is invited to the classroom;
- Fossil teeth.

Références

1. Bibliography

- Les merveilleux pouvoirs du bicarbonate de soude – Clémence Lefèvre – Exclusif – 2009
- Les incroyables vertus du bicarbonate du soude – Alexandra Moro Buronzo – Jouvence - 2009

2. Website

- www.sourirepourtous.be

3. Art

- L'art dentaire à travers la peinture, Armelle et Pierre Baron, ACR Edition Vilo

Orange laboratory

7. FIBRES
8. STRUCTURES
9. SOLAR ENERGY

7. FIBRES

Choice of subject

Fibres are found everywhere. They might be almost microscopic but they are part and parcel of everyday life. They form the basis for lots of materials and structures.
It is sometimes difficult to decide what a fibre-containing object is made from. Is it made from natural fibres? If it is are they vegetable, mineral or animal? If it is made from synthetic fibres, how have they been made?
Apart from being reflected in many ways in the day-to-day lives of young people this subject provides links to biology and chemistry.

In XperiLAB

1. Use a microscope to enlarge a fibre prepared on a glass plate 40x then 400x.
2. Determine the fibre with the help of an identification key.
3. Identify its origins and its use in everyday life.
4. Determine as many fibres as possible.

Class activities

1. A bit of theory

What is a natural fibre?
A natural fibre is an elongated filament item. Fibres are the buildings blocks in particular of plant (wood, grass) and animal tissues (mammal fleece), and certain minerals (asbestos).

A) Natural animal fibres
Wool: keratin fibre of sheep: their fleece. Keratin is fibrous protein mainly produced by mammals. Wool is primarily used for its heat properties.

- Alpaca: keratin fibre from alpaca hair
- The alpaca is a mammal belonging to the camelid family.
- Alpaca wool is known for its softness, heat, resistance and lightness.
- Mohair, cashmere, silk.

B) Natural plant fibres

- Cotton: fibre obtained from the cotton plan. This herbaceous (Gossypum herbaceum) or woody (Gossypum arboreum) plant belonging to the malvaceae family is grown for the white down released after flowering. The fibre can be used as it is for hygiene purposes (absorbent cotton for example) but the cotton fibres are generally spun and weaved before being used. The fabric produced is soft to the touch and hypoallergenic. As it can resist extremely high temperatures it can be sterilised. Cotton is also highly absorbent and has a high degree of air permeability.
- Linen, hemp, jute, wood...

C) Natural mineral fibres
Asbestos is a term referring to certain minerals that easily decompose into long and flexible fibres. The most well known mineral of this type is chrysotile, which is commonly known as white asbestos and mainly used in the construction industry. Discovered as being able to cause asbestosis leading to lung cancer, the material is banned in most countries.
Actinolite, tremolite and anthophyllite, minerals belonging to the amphibole family, are also covered by the term asbestos. These minerals are banned because of the toxic elements they contain.

What is an artificial fibre?
Artificial fibre is made from natural raw materials.

- Viscose: fibre obtained via physical and chemical processes on the basis of cellulose extracted from wood. The viscose filaments are used to make spun viscose and rayon, both of which are extensively used in the textile and garment industry, Viscose is also used to make cellulose films, sponges and medical dialysis casings for blood purification.

What is a synthetic fibre?

A synthetic fibre is obtained via synthesis, on the basis of chemical compounds, primarily hydrocarbons or starch.

- Nylon, acryl, aramid, polyester

2. Themes to explore

Paper

- history;
- manufacture, consumption and environmental impact;
- different types of paper;
- wasp nests, a fine example.

Use of an identification key

In XperiLAB, the experiment based on fibres applies to observing and determining fibres with an identification key. Students taking part in this experiment may explain how they undertook the identification. They can work together on revealing the principle governing the identification technique.

3. Class activities

Making and using a cloth loom

1. Materiel: a wooden frame of any size, headless nails, a hammer and some thread.
2. Preparing the frame: hammer the nails in regularly on the top and bottom of the frame. The space between the nails will depend on the thickness of the thread used.
3. Preparing the warp threads: attach a long thread to the first nail in the top row. Next go back and forth between the nails in the two rows so as to connect the nails facing each other. Finish by attaching the thread to the final nail.
4. Weaving: with another thread, called the weft, move perpendicularly to the warp thread, above then below each warp thread. Turning back at the end of the row, alternate above and below. Tighten the rows as you proceed to produce a fabric that is solid.
5. Test different fibres, analyse the properties of the fabrics that contain them and understand how they are used in everyday life.
6. Experiment with varying the weft: weave by taking 2, 3 …warp threads at a time.

Using a thread counter

A thread counter is an object that is rarely used in everyday life. A tiny magnifying glass on a base, with a size and a measuring range magnifying 10x in most cases, the thread counter is used to analyse the density of a fabric's weft, the juxtaposition of the pixels on a computer screen, the ink grain on a printed page …

Glossary

hypoallergenic: where the risks of an allergic reaction are low.

asbestosis: refers to a pulmonary fibrosis causing chronic respiratory failure owing to breathing in asbestos over a long period of time.

References

1. Bibliography

- *Pour la Science*, n°spécial de Décembre 1999, « Fibres textiles et tissus biologiques »
- *Science*, 30/07/2010, vol 329 pp 528-531
- Kezako : la vie microscopique – C. Zeitoun et P. Allen – Mango jeunesse – 2008
- Le ver à soir – Paul Starosta – Milan jeunesse – 2007

Literature

- Les trois fileuses, conte des frères Grimm
- Rumpelstilzchen, conte des frères Grimm

2. Websites

- www.snv.jussieu.fr/bmedia/textiles/index.html
- www.naturalfibres2009.org
- http://memotextile.free.fr

3. Museums

- Museum of Narrow Woven Fabrics, Comines-Warneton. By appointment only for groups: 05 655 56 00
- Hosiery Museum, Quevaucamps. By appointment only for groups: 06 968 95 16
- Paper Mill Herisem/ Anciennement Cartonnerie Winderickx, Beersel By appointment only for groups: 02 381 07 70
- Paper Museum, Malmédy. Tel.: 08 033 70 58

4. Painting

- The Spinner – William Bourguereau
- The Spinner – J.J. de Boissieu
- The Spinner – Jean-François Millet

8. STRUCTURES

Choice of subject

Ever since they started creating objects and buildings, people have drawn their inspiration from structures observed in nature. An appropriate structure primarily allows a reduction to be made in the amount of material required for a construction. It can also optimise the place it occupies in space and its resistance to pressure.
That is what is analysed in this experiment.

In XperiLAB

1. Identify in natural elements a structure comprising cylinders and a structure comprising hexagonal prisms.
2. Compare and analyse the place these structures occupy in space and the quantity of material they use.
3. Test each of the two structure's resistance to pressure.

Class activities

1. A bit of theory

The combs of bee and wasp nests

3 polygons that can cover a plane regularly without losing any space: the equilateral triangle, the square and the hexagon. The hexagon perimeter is the smallest one of the 3 polygons

in relation to the same surface to be covered. Consequently, this is the one requiring the less raw material on a surface and aloft in 3 dimensions. This is why a structure made of regular prisms with a hexagonal base is chosen for many technological applications.

Generally speaking, the higher the number of angles, the higher the structure's
resistance. A structure made of cylinders has the most resistance to pressure because the cylinder has numerous corners. However, this structure occupies a bigger area in space than the structure made of prisms with a hexagonal base and the amount of raw material required for its construction makes it much heavier! That is why prisms with a hexagonal base are favoured both in nature and technological research.

2. Themes to explore

Geometry

- Investigation of polygons and polyhedrons.

Forces

- highlighting the "action/reaction" principle;
- mass/weight relationship;
- pressure: a relationship between force and the surface.

Bees

- visit to a hive;
- bees' position in the animal kingdom;
- general anatomical description of a bee;
- function of the various bee organs and system;
- social organisation;
- honey production;
- role of bees and their relationship with the environment;.

Arthropods

See Teaching kit: "Mini-Jungle" and "Charmantes Bestioles": www.sciencesnaturelles.be/educa/dossiers/finished

3. Class activities

Repeat the XperiLAB experiment:

1. Materiel: paper, glue and weights (such as books)
2. Cut 14 rectangular strips out of the paper (A4 cut in 4; in Xperilab, paper weighing 60gr is used).
3. Prepare 7 cylinders and 7 prisms with hexagonal bases.
4. Next check how much space and/or raw material each structure requires.
5. Test their resistance to pressure by placing weights.

To continue further with this investigation and test according to other criteria:

- change the sizes of the basic strips while keeping the same quantity of paper used;
- do the test with other prisms: square base, triangular base.

References

1. Bibliography

- Raconte-moi l'abeille – L'abeille dans l'enseignement maternel et primaire. Travail pédagogique réalisé par le centre d'Etude et d'Information Agricole de Mons-Jurbise.
- L'abeille – Paul Dessart – IRSNB – 1994
- Mouches à miel (les abeilles et la ruche) – La Hulotte n° 28/29 spécial
- Guide de l'abeille – Armin Spürgin – Delachaux et Niestlé – 2010
- L'étonnante abeille – Jürgen Tautz – de boeck – 2009
- Carnets de nature : la ruche – Benoît Charles et Léon Rogez – Milan jeunesse – 2007
- L'abeille – Paul Starosta – Milan jeunesse – 2002
- Meubles en carton – Mireille Cardon et Sonia Cardon – Editions de Saxe – 2009

2. Websites

- Structures - architecture
  www.neomansland.info/2007/11/larchitecture-naturelle
  www.solarimpulse.com/index.php?lang=Fr

3. Art

- Cubism and geometrical shapes in painting
- Gare de Liège Guillemin – Calatrava.

9. SOLAR ENERGY

Choice of subject

The words "renewable energy" are now on everyone's lips, while solar collectors and panels are multiplying on roofs !
The Solar Impulse (solar plane/ Bertrand Picard and André Borschberg) succeeded in flying at night in the spring of 2010, using solely solar energy stored during the day!
Could XperiLAB operate with solar energy? This challenge brings young people face to face with issues forming part of their everyday lives: solar cells or in what quantity and for what uses? Let us consider the fors and againsts

In XperiLAB

1. Operate small electrical equipment using photovoltaic cells.
2. In the light of the tests calculate the solar panels required to provide XperiLAB with power during one session.

Class activities

1. A bit of theory

The sun is the earth's main source of energy.
Sunshine is responsible for the water cycle, the wind and photosynthesis. Photosynthesis in plants and certain bacteria forms the basis of the food chains of the entire animal kingdom.

Passive solar energy

People have been using solar energy since prehistoric times: by setting up camps on the southern flanks of valleys, choosing caves to live in facing south and, later on, orienting dwellings, farmland and crops on the basis of the sun and the dominant winds. In the second century BC, according to an old legend, the mathematician Archimedes is supposed to have arranged the position of the Greek soldiers' bronze shields so the sun's rays were reflected towards the sails of the Roman vessels, thus setting them on fire! These methods for using energy are called passive because they derive their benefits from the direct contribution of sunshine. Bioclimatic architecture research is increasingly opting for solutions for using a maximum of passive solar energy.

Solar thermal energy

This involves the conversion of heat transmitted by the sunlight into thermal energy.
The heat can be used straight away, without undergoing any conversion. In this case, the energy is collected in a solar collector, a kind of well-insulated box, covered with black glass to absorb as much heat as possible. It contains tubes where air or a heat conducting fluid circulates. In both cases, the heat collected is used straight away for various purposes, such as obtaining hot water or heating a building.
However, the sun's heat can also be used to produce electricity. In solar thermal power plants, the sun's rays are concentrated by parabolic mirrors and the recovered heat is channelled towards a boiler. The water in the boiler is then converted into steam. The steam drives a turbine coupled to a generator, which produces electricity.

Photovoltaic solar energy

It was in the 19th century that the German physicist Heinrich Hertz discovered that certain metals emit electrons on

contact with sunlight. He also noted that the quantity of electrons emitted depended on the light intensity. This is the photoelectric effect. Continuing with his research he managed to produce an electric current from the electrons obtained. This is exactly what happens in photovoltaic cells. The stage was set for photovoltaic solar energy.
It was during the 20th century that the photovoltaic cell came into being. It is made of silicon, a chemical compound found in many minerals, especially in quartz. Silica undergoes a series of chemical reactions (oxidation-reduction, purification, distillation) to be converted into silicon, which is used on an industrial scale to produce thin plates 200 micrometres thick (1 micrometres = 0.001 mm), whose surfaces are inlaid with metal strips. The photovoltaic cell is ready!
Photovoltaic cells can be used on their own. For example,

for calculators, watches and garden lamps. They can also be grouped together to form solar panels. These are used in areas where no electricity network is available: at sea, in the mountains, in deserts and in space for satellites. They also serve to supply electricity for parking meters, bus shelters, private homes or certain public areas. Finally, photovoltaic solar power plants, comprising several connected solar panels (serial or parallel), produce electricity on a larger scale.

2. Themes to explore

The sun

- central star of our solar system;
- no sun means no water in a liquid state on our planet;
- no sun means no photosynthesis;
- the sun and climates;
- what is a solar eclipse;
- the sun: benefits and risks.

What energy for what and whom?

- renewable energy and fossil fuel;
- power;
- energy and human beings;
- These subject are considered at length in the "Wind Energy" report, p. 10.

Photosynthesis

- the process;
- the case of the sunflower;
- the importance of photosynthesis for all living beings;
- photosynthesis and food chains.

The sun in mythology

3. Class activities

Making a photovoltaic solar module.

Many ecologically-oriented shops offer construction kits to operate several objects with photovoltaic cells.

Materiel: a small motor, a few photovoltaic cells, some electrical equipment. A few applications:

- a small ventilator;
- make a calculator;
- a clock for the classroom…

Glossary

Electron: particles that are found in atoms, and have an electrical charge.

References

1. Bibliography

- La grande imagerie : le soleil – Emilie Baumont et Hélène Grimault – Fleurus – 2010
- La grande imagerie : la météo – Emilie Beaumont et Cathy Franco – Fleurus - 2009
- Le soleil notre étoile – Roland Lehoucq – Le Pommier
- Le soleil , expliqué sous forme d'une histoire pour les élèves de 10-11 ans
- Miniguide tout terrain : phénomènes météo – Jean-Louis Vallée – Nathan – 2010
- L'énergie solaire et photovoltaïque pour le particulier – Emmanuel Riolet – Eyrolles – 2008
- Le solaire chez soi – Vincent Albouy – Edisud – 2009
- Montages photovoltaïques à bricoler soi-même – Jean-Paul Blugeon – Ulmer – 2010

- Imagia Mythologies – Emilie Beaumont et Sylvie Baussier – Fleurus – 2010
- La mythologie ; ses dieux, ses héros, ses légendes – Edith Hamilton – Marabout – 2007
- Contes et légende de la mythologie grecque – Claude Pouzadoux – Nathan – 2007

Literature

- Le chat et le soleil – Maurice Carême
- Le coucher du soleil romantique – Charles Beaudelaire

2. Websites

- www.le-systeme-solaire.net
- www.energies-renouvelables.org
- www.embarcaderedusavoir.ulg.ac.be/archives/calendrier2008/FichesPeda/dossierpeda.pdf

3. Painting

- "Image of sunrise and the London parliament at sunset " – Claude Monet
- The fall of Icarus – Pieter Brueghel the Elder (Royal Museum of Fine Arts- Brussels)