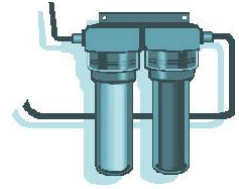




Filtration Investigation



Provided by TryEngineering - www.tryengineering.org

Lesson Focus

Lesson focuses on how filtration systems solve many problems throughout the world such as improving drinking water. Through this lesson, students work in teams to design and build a filtration system to remove dirt from water. Students select from everyday items to build their filter, test the resulting system evaluate the effectiveness of their filters and those of other teams, and present their findings to the class.

Lesson Synopsis

The "Filtration Investigation" lesson explores how engineering has developed various means to remove impurities from water. Students work in teams of "engineers" to design and build their own "filtration system" out of everyday items. Working with "muddy" water, students develop a design, and then build and test a system to remove as much impurities from the water as possible. Students view their own tests and those of other student team, evaluate their results, and present findings to the class. The group with the clearest "filtered" water is considered to have developed the best filter system.

Year Levels

Year 5 – Term 4; Year 7 – Term 1; Year 8 – Term 1.

Objectives

- ✦ Learn about engineering design.
- ✦ Learn about planning and construction.
- ✦ Learn about teamwork and working in groups.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- ✦ engineering design
- ✦ problem solving
- ✦ teamwork



Lesson Activities

Students learn how filtrations systems are of many sorts for many purposes. Students work in teams to design and build a filtration system out of everyday items that can remove the most "dirt" or sediment from water. They then test their filters and those of other student teams, determine the filter design that was the most effective in the class, evaluate their own results and those of other students, and present their findings to the class.

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Resources/Materials

- ✦ Teacher Resource Documents (attached)
- ✦ Student Worksheets (attached)
- ✦ Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- ✦ TryEngineering (www.tryengineering.org)
- ✦ Environmental Protection Agency (<http://www.derm.qld.gov.au>)- drinking water
- ✦ epa.qld.gov.au/environmental_management/
- ✦ Pacific Institute - The Worlds Water (www.worldwater.org)
- ✦ Curriculum Links (www.acara.edu.au)

Supplemental Reading

- ✦ Liquid Filtration (ISBN: 1408626241)
- ✦ Water Reuse (ISBN: 0071459278)

Optional Writing Activity

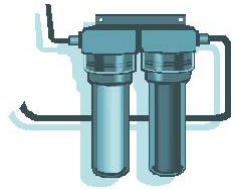
- ✦ Write an essay or a paragraph about the type of filtration systems campers might need to employ if they ran out of water and needed to consider drinking water from a stream of unknown water purity.

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Filtration Investigation



For Teachers: Teacher Resource

◆ Lesson Objective

Lesson focuses on how engineered filtration systems have impacted the availability of drinking water. Through this lesson, student "engineering" teams are challenged to remove as much sediment or "dirt" as possible from a muddy water source. The students work in teams to determine which everyday items they will use, then design and build their filtration system. Student teams test their own filters and compare their results with those of other student "engineering" teams. The team with best plan will be the test with the clearest "filtered" water. Students evaluate the effectiveness of their own filter systems and those of other teams, and present their findings to the class.

◆ Lesson Objectives

- ✦ Learn about engineering design.
- ✦ Learn about planning and construction.
- ✦ Learn about teamwork and working in groups.

◆ Materials

- ✦ Student Resource Sheet
- ✦ Student Worksheets
- ✦ Classroom materials:
 - Water basin for testing student filter systems
 - Supply of "muddied water" which can be made by taking 1 litre of drinking water and adding two tablespoons of dirt.
- ✦ One set of materials for each group of students:
 - Two cups of "muddied water"



Available Materials	Costs
<ul style="list-style-type: none"> • Plastic or paper cups • Straws • Cardboard • Cotton balls • Sand • Aluminum foil • Rubber bands • Sticky tape • Toothpicks • Paper towels • Plastic wrap • Small rocks (pebbles) • Cornflour • Flour • Charcoal • Any other materials 	

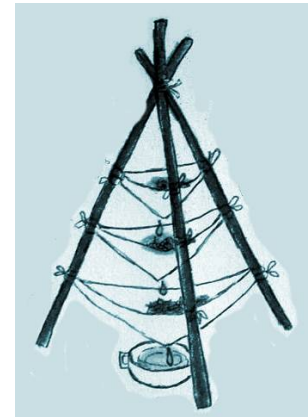
Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

◆ Procedure

1. Show student "engineering" teams their various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 2-3 students, providing a set of materials per group.
3. Explain that students must work as a team to design a filtration system to remove as much dirt or sediment from a provided water supply. The team with the clearest resulting water (based on a visual inspection) will have developed the best filter in the class.
4. Students meet and develop a plan for their filtration system, including a list of all materials they require for construction.
5. Student teams draw their plan and present their plan to the class. Students may adjust their plan based on feedback received at this stage.

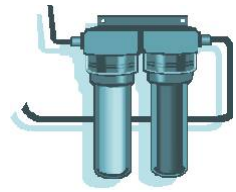


Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Filtration Investigation



For Teachers: Teacher Resource (continued)

6. Student teams build their filtration system. They may determine that additional materials are needed to complete this step. If so, they need to indicate the new materials or quantity of materials on their design worksheet.
7. Next....teams will test their filtration system using "muddy" water provided by the teacher. Students will evaluate the clarity of the "filtered" water based on the "grade of clarity" scale below, and assign a number to each team's work.

Completely clear (as drinking water might appear)	About a quarter of the dirt remains	About half of the dirt remains	About three quarters of the dirt remains	Completely muddy (as original source water appeared)
0	1	2	3	4

8. Teams then complete an evaluation/reflection worksheet, and present their findings to the class.

◆ Time Needed

Two to three 45 minute sessions

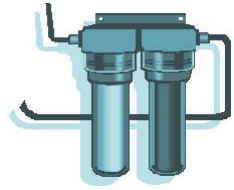
◆ Tips

- Be sure to stress that the "filtered" water, no matter how clear, is not suitable for drinking.
- For younger students, do not provide charcoal as a filtration option.
- Suggest to student teams that layers of filters -- or perhaps many filtration stages - - may result in the most effective filtration system.
- Teams may require additional materials which they will request of the teacher, or they may be encouraged to exchange building materials with other teams.

◆ Extension Ideas

- Consider setting a budget for the project, assigning a cost to each material, and requiring teams to "buy" materials from the teacher to create their filtration system.

Filtration Investigation



Student Resource: What is Filtration?

There are many different methods of filtration, each has a goal of separating substances. Filtration systems are important to providing safe drinking water, to separating materials for many purposes such as research or gathering pure samples of an element. The simplest way to "filter" is to pass a mixture, or solution, of a solid and a fluid (such as water and dirt or mud) through a porous material or system so that the solids are trapped as the fluid passes through. Panning for gold is an example of a filter, where prospectors hold pans with holes punched in the bottom, or fitted with a screen through riverbeds thought to contain gold nuggets. The materials too big to fit through the screen are then explored to see if gold has been gathered.



Filtration is used in waste treatment facilities where settling tanks allow for separation. The concept of filtration is found all around us, in community services and everyday items at home. An example is a coffee filter used in a coffee maker. The filter prevents the coffee grounds from reaching a coffee cup, but allows for smaller materials or particles of the coffee to pass through, resulting in a cup of coffee without coffee grounds. There are many different types of filters used in making coffee, some made out of paper, some out of recycled paper, and some using metals coated in gold. In each case, the size of the openings -- even microscopic -- will determine how much of the particles will make it through.



◆ How Gravity Can Help

Liquids usually flow through the filter by gravity. This is the simplest method, and can be seen by revising the coffeemaker example. The water usually sits in the filter, and then drips down to a receptacle (cup or coffee pot) as a result of gravity. In chemical plants, gravity is also used to separate -- and is an economical method as it requires no additional energy. Sometimes pressure is added to speed up the filtration process...but if too much pressure is added to the system, the filter may clog or even tear or break.

◆ Filtration Materials and Stages

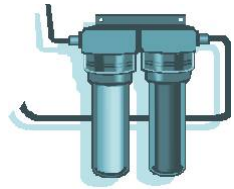
Many materials can be used for making a filter...all depending upon the types of liquids, solids, or gases that need to be separated. Some filtration materials include paper, sand, cloth, charcoal, and rocks. Often staged filters are employed...where a liquid, for example, might pass through a series of different filters. In this case, sometimes the first filter will eliminate larger particles, while the second, third, or fourth filter will eliminate smaller and smaller particles or sediment. The image to the right shows a rough filtration system that might be made from sticks using three different stages of filtration...but there are many ideas for systems and engineers must develop new systems based on the challenges they face!

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Filtration Investigation



Student Resource: Engineering Students Serve Nicaraguan Communities

The provision of a safe, sustainable supply of water has been a challenge for millennia. It remains the most pressing environmental problem in much of the developing world, and is increasingly difficult even in the developed world. Emerging pathogens and new chemical contaminants, changing climates, population growth, and watershed encroachment all lead to pressures that will require innovative scientific and policy responses. Engineers all around the world are working on this issue. It is said that providing safe drinking water is one of the greatest engineering feats of all time. To solve many of the world's problems, engineers and other individuals work in teams, bringing their individual expertise to work on issues as a group.

"Engineers Without Borders" is an international non-profit humanitarian organization established to partner with developing communities worldwide in order to improve their quality of life. This partnership involves the implementation of sustainable engineering projects, while involving and training internationally responsible engineers and engineering students. The quest for potable water is one of the group's current focus areas.

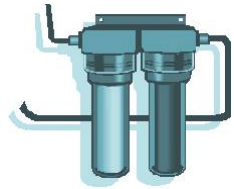
In addition, many universities are focused on supporting the quest for potable water globally. For example, recently a group of students from West Virginia University's College of Engineering and Mineral Resources had the opportunity to do something a little outside the norm and, in the process, made a difference in the lives of people in two small communities in Nicaragua. The students are members of Engineers Without Borders, and spent some time in Nicaragua where they assessed the water supplies of the two small towns of Rancho Grande and Cerro Verde and helped build and install water filtration systems for the towns' children's feeding centers.



Engineers Without Borders schools Outreach program activity – building a water filtration system from everyday materials.

Because of a lack of regulation and poor infrastructure, the inhabitants of the towns are continually exposed to pathogens in their water supply. By measuring turbidity, pH, temperature, nitrate, chlorine and fecal coliforms in the water supply, as well as installing the water filters, the project aimed to improve overall health conditions for the town's children.

Filtration Investigation



Student Worksheet: Design Your Own Filtration System

You are part of a team of engineers who have been given the challenge of developing an filtration system to eliminate as much dirt or mud as possible from a water sample you have been provided. If your system works, you'll end up with water that looks completely clear. How you accomplish the task is up to your team! The team with the clearest resulting water (based on a visual inspection) will have developed the best filter in the class.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. You'll need to determine which materials you'll request from the many everyday items your teacher has available. As a team, come up with your best design and draw it in the box below. Be sure to indicate the materials you anticipate using, including the quantity you'll request from your teacher. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.



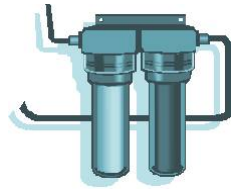
Design:

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Filtration Investigation



Student Worksheet (continued):

Materials Required (list each items and the quantity you expect to use):

◆ Construction Phase

Build your filter system. During construction you may decide you need additional items or that your design needs to change. This is ok -- just make a new sketch and revise your materials list. You may want to trade items with other teams, or request additional materials from your teacher.

◆ Testing Phase

You will be provided with two cups of "muddy" water by your teacher. You'll test your filter in a classroom basin and gather the "filtered" water for later evaluation. Be sure to watch the tests of the other teams and observe how they designed their filters, including what materials they selected.

◆ Evaluation Phase

You and your class will be responsible for assigning a "grade of clarity" to each sample of filtered water. Use the following chart to determine the results of each team's work.

Completely clear (as drinking water might appear)	About a quarter of the dirt remains	About half of the dirt remains	About three quarters of the dirt remains	Completely muddy (as original source water appeared)
0	1	2	3	4

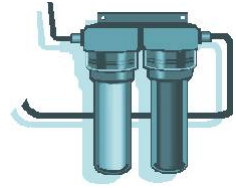
Then, evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

Filtration Investigation



Student Evaluation Form

1. Did you succeed in creating a filtration system that passed the source water? What "grade of clarity" did you achieve?

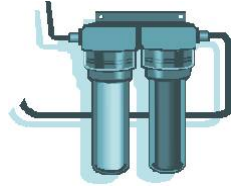
2. What aspect of your design do you think worked best? Why?

3. What aspect of your design would you have revised if given more time? Why?

4. What was unique about the design of the filtration system in your class that had the best results on this challenge? How did it work better than yours, if it did, and what would you have done differently if you had seen this design prior to developing your own?

5. Did you decide to revise your original design while in the construction phase? Why? How?

Filtration Investigation



Student Evaluation Form (continued):

6. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

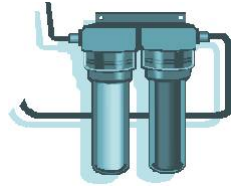
7. Do you think your filter would have been able to withstand water running through it for an hour? Why?

8. Do you think you would have been able to complete this project easier if you were working alone? Explain...

9. If you could have used a material or materials that were not provided to you, what would you have requested? Why do you think this material might have helped with the challenge?

10. What was your favorite part of the challenge? Design Phase? Building Phase? Testing Phase? Why?

Filtration Investigation



For Teachers: Alignment to Curriculum Frameworks

Note: All lesson plans in this series are aligned the Australian Curriculum for Science and Mathematics.

	Year Level			
	5	6	7	8
Science Understandings	Solids, liquids and gases have different observable properties and behave in different ways (ACSSU007 – Yr 5)		Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)	Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152)
Science as a human endeavour	Science understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives (ACSHE083 – Yr 5) Scientific knowledge is used to inform personal and community decisions (ACSHE217 – Yr 5)		Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management (ACSHE121 – Yr 7); (ACSHE136 – Yr 8) Science knowledge can be developed through collaboration and connecting ideas across the disciplines of Science (ACSHE223 – Yr 7); (ACSHE226 – Yr 8)	
Science Inquiry Skills	With guidance, select appropriate investigation methods to answer questions and solve problems (AC SIS086 – Yr 5) Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data (AC SIS087 – Yr 5) Use equipment and materials safely, identifying potential risks (AC SIS088 – Yr 5) Compare data with predictions and use evidence in developing explanations (AC SIS218 – Yr 5) Communicate ideas, explanations and processes (AC SIS093 – Yr 5)		Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (AC SIS124 – Yr 7); (AC SIS139 – Yr 8) In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (AC SIS126 – Yr 7); (AC SIS141 – Yr 8) Summarise data and use scientific understanding to identify relationships and draw conclusions (AC SIS130 – Yr 7); (AC SIS145 – Yr 8) Reflect on the method used to investigate a question or solve a problem, evaluate quality of data collected and identify improvements to the method (AC SIS131 – Yr 7); (AC SIS146 – Yr 8) Use scientific knowledge and findings from investigations to evaluate claims (AC SIS132 – Yr 7); (AC SIS234 – Yr 8) Communicate scientific ideas and information for a particular purpose (AC SIS133 – Yr 7); (AC SIS148 – Yr 8)	

Mathematics Links

Activity	Concept / Year Level							
	Number and Algebra				Measurement and Geometry		Statistics and Probability	
	Number and place value	Real numbers	Money and financial maths	Linear and non-linear relationships	Using units of measurement	Geometric reasoning	Data and representation and interpretation	Shape
Filtration Investigation			Yr 8 (budget)		Yr 6		Yr 5 - 9	

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
<ul style="list-style-type: none"> Process data using simple tables Data analysis skills (graphs) Analysis of patterns and trends Use of metric units 	<ul style="list-style-type: none"> Literacy Numeracy Critical and creative thinking Personal and social capacity ICT capability 	<ul style="list-style-type: none"> Sustainability

Science Achievement Standards

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They analyse how the form of living things enables them to function in their environments. ***Students discuss how scientific developments have affected people's lives and how science knowledge develops from many people's contributions.***

Students ***follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe and improve the accuracy of their observations.*** Students construct tables and graphs to organise and identify patterns. They ***use patterns in their data to suggest explanations and refer to data when they report their findings. They describe ways to improve the fairness of their methods and communicate their ideas, methods and findings using a range of texts.***

Year 7

By the end of Year 7, students ***describe techniques to separate pure substances from mixtures.*** They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students ***describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.***

Students identify questions that can be investigated scientifically. They ***plan fair experimental methods, identify variables to be changed and measured.*** They ***select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions. They summarise data from different sources,***

Filtration Investigation

Developed by IEEE as part of TryEngineering
www.tryengineering.org

Modified and aligned
to Australian
Curriculum by
Queensland Minerals
and Energy Academy

describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.

Year 8

By the end of Year 8, students compare physical and chemical changes and **use the particle model to explain and predict the properties and behaviours of substances**. They identify different forms of energy and describe how energy transfers and transformations cause change in simple systems. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They **explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborate to generate solutions to contemporary problems**.

Students identify and construct questions and problems that they can investigate scientifically. They **consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others. They use appropriate language and representations to communicate science ideas, methods and findings in a range of texts types**.