**Part III**

**Curriculum Embedded Tasks**

* **Strand I: Energy Transformation**

**-Solar Cooker, Laboratory Investigation**

**-Connecticut Energy Use, STS Activity**

* **Strand II: Chemical Structures and Properties**

**-Synthetic Polymers, Laboratory Investigation**

**-Plastics Controversy, STS Activity**

* **Strand III: Global Interdependence**

**-Acid Rain, Laboratory Investigation**

**-Connecticut Brownfield Sites, STS Activity**

* **Strand IV: Cell Chemistry and Biotechnology**

**-Enzyme, Laboratory Activity**

**-Labeling Genetically Altered Foods, STS Activity**

* **Strand V: Genetics, Evolution and Biodiversity**

**-Yeast Population Dynamics, Laboratory**

**Investigation**

**-Human Population Dynamics, STS Activity**

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand I: Energy Transformations**



**Solar Cooker**

**Laboratory Investigation**

**Teacher Materials**

**Renewable Energy**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand I – Energy Transformations.

**Targeted Content Standard**

**9.3 - Various sources of energy are used by humans and all have advantages and disadvantages.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 6** Use appropriate tools and techniques to make observations and gather data.

**D INQ. 7** Assess the reliability of the data that was generated in the investigation.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning objective:**

Students will be able to use solar energy to heat water and understand the design factors that influence the effectiveness of capturing solar energy in this context.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

heat lamps or sunlight tape

cardboard thermometer

aluminum foil water

containers for water colored paper or paint

safety goggles

**Considerations:**

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow at least 60 minutes of instructional time for the students to design and conduct their experiment and a minimum of 30 minutes for the students to write about their results. As an alternative, the students can write their lab report for homework. These time frames are merely suggestions. Additional time is appropriate if the circumstances and schedule at your school call for it. A sample scoring rubric is provided for your convenience or you may design one of your own.

If the weather is unfavorable and the laboratory exercise must take place indoors, heat lamps can be used as an alternative to sunlight. If your students are unfamiliar with solar cookers, various designs and photographs of solar cookers may be found at these and many other sites:

[**http://solarcooking.org**](http://solarcooking.org)

[**http://pbskids.org/zoom/activities/sci/solarcookers.html**](http://pbskids.org/zoom/activities/sci/solarcookers.html)

The curriculum-embedded task can be integrated into a unit on energy sources and used in any high school physical or Earth science course. The curriculum-embedded task is intended to be used as a formative assessment during the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

**Curriculum-Embedded Laboratory Investigation Scoring Rubric**

**Statement of the Problem and Hypothesis**

3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.

2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.

1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.

0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

**Experimental Design**

3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.

2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.

1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.

0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

**Data Presentation**

3 Data are well organized and presented in an appropriate manner.

2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.

1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.

0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

**Conclusion**

3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.

2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.

1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.

0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance 10-12 points

Proficient performance 7-9 points

Marginal performance 4-6 points

Unsatisfactory performance 0-3 points

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Solar Cooker**

**Laboratory Investigation**

**Student Materials**

**Solar Cooker**

**Student Materials**

Most people in the United States use an electric stove or a natural gas stove to cook their food. This is not the case in much of the world. Approximately 50% of the people on Earth cook using fire from burning wood. However, due to overuse, wood is becoming a scarce commodity in many countries. In addition, burning wood is a major source of air pollution.

One alternative to cooking with wood is using solar cookers. These devices use energy from the sun to cook food without producing any pollution. While there are many designs for solar cookers, a simple solar cooker can be made from everyday materials. There are many factors that can influence the effectiveness of a solar cooker including the size of the collector, the orientation of the panel and the color of the container.

**Your Task**

You and your lab partner will design and conduct an experiment to investigate one factor that contributes to the effectiveness of a solar cooker in heating water. Factors you may want to investigate include: the shape of the collector, the shape of the water container, orientation of the collector, surface area or color of the container.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

**Suggested materials:**

heat lamps or sunlight tape

cardboard thermometer

aluminum foil water

container for water colored paper or paint

safety goggles

**Designing and Conducting Your Experiment**

**1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If … then … because …” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.

**2.** **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.

**3.** **Review** **your design with your teacher before you begin your experiment.**

**4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**Safety note: Students must wear approved safety goggles and follow all safety instructions.**

**When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

**Communicating Your Findings**

Working on your own, summarize your investigation in a laboratory report that includes the following:

* **A statement of the problem you investigated. A hypothesis (“If ... then … because …” statement)** **that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
* **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
* **Data from your experiment.** Your data should be organized into tables, charts and/or graphs as appropriate.
* **Your conclusions from the experiment.** Your conclusions should be fully supported by your data and address your hypothesis.
* **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions**. Also, include ways that your experiment could be improved if you were to do it again.

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand I: Energy Transformations**



**Energy Uses in Connecticut**

**Science, Technology & Society Teacher Materials**

**Energy Uses in Connecticut**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand I – Energy Transformations.

**Targeted Content Standard**

**9.3 - Various sources of energy are used by humans and all have advantages and disadvantages.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**D INQ. 10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

**Learning objective:**

Students will graph energy trends in Connecticut over several years and based on their research, they will explain the advantages and disadvantages as it relates to one trend in energy use.

**Materials:**

Access to computers/internet

Excel program

Graph paper and ruler (alternative)

**Considerations:**

If access to computers or the Excel program is difficult, the graphing portion may be done by hand. Not all students are equally comfortable with Excel worksheets and the related program features. Tutorial programs are available online and include features that will assist students in the conversion of units and graphing from spreadsheets. Tutorials on the use of Excel programs may be found at the following websites and many others:

<http://www.microsoft.com/education/Excel97Tutorial.mspx>

<http://www.j-walk.com/ss/excel/usertips/index.htm>

Should you prefer to have students work in metric units, you will want to provide them with the following equalities: 1 kW-hr = 3600 kJ = 2544 Btu (British thermal unit).

Two alternative Excel sheets are provided for differentiation purposes or you may use one of your own design.

**Student Name\_\_\_\_\_\_\_\_\_\_\_\_\_ Class\_\_\_\_\_**



**Energy Uses in Connecticut**

**Science, Technology & Society**

**Student Materials**

**Grades 9-10Energy Uses in Connecticut**

**Student Materials**

Energy is used everyday to heat and light our homes, schools and businesses. Have you ever thought about where the energy we use everyday comes from? How have these energy sources changed over the last several decades?

You have been provided with a spreadsheet containing some information about energy use and its sources in Connecticut from 1960 through 2001. Use this information and the Excel program to prepare a line graph showing the trends in the energy consumption from the following sources: coal; natural gas; nuclear; hydroelectric; and wood/waste over this time span.

**Your task is to choose one of the fuel sources (coal, natural gas, nuclear, hydroelectric or waste) and research the advantages and disadvantages of this particular energy trend as it is illustrated on the graph.** Does this trend support Connecticut’s initiative to significantly decrease the use of non-renewable resources by the year 2010? Some support materials for the study of energy resources may be found at the websites listed below and many others.

**Nuclear Energy Resources**

* **Energy Information Administration: Nuclear**   
  <http://www.eia.doe.gov/fuelnuclear.html>
* **Office of Nuclear Energy, Science and Technology**<http://www.ne.doe.gov/>

**Hydroelectric Energy Resources**

* **National Hydropower Association**<http://www.hydro.org/>
* **Power Matters: Hydroelectric Power**   
  <http://www.tva.gov/power/hydro.htm>

**Biomass Energy Resources**

* **Energy Efficiency and Renewable Energy**<http://www1.eere.energy.gov/biomass/>
* **Connecticut Clean Energy Fund (click on Biomass from the list)**<http://ctcleanenergy.com/BasicsofCleanEnergy/TypesofCleanEnergy/tabid/66/Default.aspx>

**Coal Energy Resources**

* **Office of Fossil Energy-U.S. Department of Energy**<http://www.fe.doe.gov/programs/powersystems/cleancoal/index.html>
* **Coal Fired Power Generation**<http://www.rst2.edu/ties/acidrain/IEcoal/how.htm>

**Natural Gas Energy Resources**

* **Adventures in Energy**<http://www.adventuresinenergy.org/main.swf>
* **Natural Gas Supply Organization**<http://www.naturalgas.org>

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | Energy Information Administration  Last updated 12/15/2004 | | | | | | |  |  |  |  |  |  |  |
| Table 7. Energy Consumption Estimates by Source, 1960-2001, Connecticut | | | | | | | | | | | | | | | | | | | |
|  |  |  | **Petroleum Products** | | | | | | | | | | |  |  |  |  |  |  |
| **Year** | **Coal**  **(Trillion Btu)** | **Natural Gas**  **(Trillion Btu)** | **Asphalt & Road Oil**  **(Trillion Btu)** | **Aviation Gasoline**  **(Trillion Btu)** | **Distillate Fuel**  **(Trillion Btu)** | **Jet Fuel**  **(Trillion Btu)** | **Kerosene**  **(Trillion Btu)** | **LPG**  **(Trillion Btu)** | **Lubricants**  **(Trillion Btu)** | **Motor Gasoline**  **(Trillion Btu)** | **Residential Fuel**  **(Trillion Btu)** | **Other**  **(Trillion Btu)** | **Total Petroleum Prod.**  **(Trillion Btu)** | **Nuclear Electric Power**  **(Trillion Btu)** | **Hydroelectric Power**  **(Trillion Btu)** | **Wood and Waste**  **(Trillion Btu)** | **Other a,f**  **(Trillion Btu)** | **Net Interstate Electricity Flow/Losses**  **(Trillion Btu)** | **Total**  **(Trillion Btu)** |
| 1960 | 101.7 | 29.4 | 7.2 | 0.5 | 136.1 | 6.4 | 10.9 | 4.4 | 2.1 | 101.6 | 91.9 | 1.3 | 362.4 | 0 | 4.6 | 12.8 | 0 | -2.8 | 508.2 |
| 1961 | 107.5 | 31.4 | 6.5 | 0.5 | 136.1 | 6.2 | 11.1 | 4.4 | 2.1 | 103.9 | 93.5 | 1.4 | 365.8 | 0 | 3.9 | 13.2 | 0 | -3.5 | 518.4 |
| 1962 | 112.1 | 33.4 | 8 | 0.6 | 135.4 | 6.7 | 9.6 | 5 | 3.2 | 108.4 | 100.6 | 1.6 | 379 | 0 | 3.1 | 12.8 | 0 | -3.4 | 536.9 |
| 1963 | 117.4 | 35.6 | 6.7 | 0.9 | 133.6 | 6.8 | 8 | 5.7 | 3.2 | 112.3 | 102.3 | 3 | 382.5 | 0 | 2.9 | 13.3 | 0 | -4 | 547.7 |
| 1964 | 120.8 | 38.6 | 5.9 | 0.8 | 119.5 | 6.6 | 7.1 | 6.1 | 3.4 | 115.6 | 123.7 | 3.8 | 392.5 | 0 | 2.8 | 13.9 | 0 | -2.3 | 566.3 |
| 1965 | 128.6 | 41.7 | 8.8 | 0.9 | 123.4 | 8 | 7.4 | 5.5 | 3.4 | 120.5 | 107.9 | 3.7 | 389.4 | 0 | 2 | 13.5 | 0 | -3.2 | 572 |
| 1966 | 136.2 | 48.7 | 7.9 | 0.8 | 117.5 | 8.7 | 5.2 | 5.9 | 3.5 | 126 | 130.8 | 26.9 | 433.1 | 0 | 2.6 | 13.6 | 0 | -4.3 | 630 |
| 1967 | 109.5 | 50.8 | 7 | 0.7 | 121.1 | 9.6 | 4.5 | 5.8 | 2.9 | 128.8 | 159.6 | 29.7 | 469.7 | 6.1 | 4.1 | 14 | 0 | -6.3 | 647.9 |
| 1968 | 82.4 | 54.1 | 8 | 0.8 | 130 | 13.2 | 4.1 | 6.5 | 3.2 | 137.4 | 176.1 | 33.1 | 512.5 | 33.9 | 3.7 | 14.9 | 0 | -26.2 | 675.4 |
| 1969 | 59.2 | 58.4 | 8.5 | 0.7 | 134.7 | 14.9 | 4.2 | 7.3 | 3.4 | 142.8 | 203.9 | 33.2 | 553.6 | 40.2 | 4.4 | 15.3 | 0 | -36.3 | 694.8 |
| 1970 | 48.6 | 61.5 | 6.8 | 0.6 | 140.5 | 16.4 | 4.4 | 7 | 3.5 | 150.4 | 223.8 | 34 | 587.4 | 39.6 | 3.5 | 15.8 | 0 | -34 | 722.4 |
| 1971 | 36.4 | 62.4 | 8.1 | 0.6 | 140.4 | 12.4 | 4.4 | 7.1 | 2.9 | 155.2 | 212.6 | 2.7 | 546.4 | 84.2 | 4.1 | 16.1 | 0 | -64.9 | 684.7 |
| 1972 | 4.2 | 65 | 9.7 | 0.6 | 144.3 | 15.9 | 5.1 | 7.9 | 3.1 | 161.8 | 255.9 | 3.1 | 607.4 | 83.9 | 5.6 | 17.1 | 0 | -63.1 | 720.2 |
| 1973 | 2.6 | 63.5 | 10.4 | 0.6 | 148.2 | 14.2 | 3.4 | 8.2 | 3.3 | 166 | 272.2 | 3.4 | 629.8 | 46.9 | 4.6 | 17.2 | 0 | -18.8 | 746 |
| 1974 | 6.5 | 67.1 | 7.3 | 0.5 | 135.1 | 13.8 | 3.1 | 8 | 3.2 | 165.5 | 236.6 | 3.6 | 576.8 | 89 | 4.5 | 18 | 0 | -44.7 | 717.2 |
| 1975 | 1.3 | 64.3 | 8.4 | 0.5 | 125.9 | 12 | 3.3 | 8.2 | 2.4 | 167.2 | 204.4 | 3.4 | 535.7 | 89.6 | 5.1 | 17.1 | 0 | -20.8 | 692.3 |
| 1976 | 1.2 | 66.4 | 7.4 | 0.4 | 141.1 | 11 | 4.1 | 8.9 | 2.7 | 171.4 | 206.2 | 6.6 | 559.8 | 136.2 | 4 | 19.9 | 0 | -40.5 | 746.9 |
| 1977 | 1.2 | 64.7 | 6.1 | 0.6 | 138.5 | 12.3 | 2.9 | 8.9 | 2.8 | 174 | 202.2 | 8 | 556.2 | 141.9 | 4.5 | 19.6 | 0 | -34 | 754.1 |
| 1978 | 0.8 | 66 | 7.6 | 0.5 | 137.3 | 12 | 2.7 | 8 | 3 | 174.5 | 215.2 | 8.8 | 569.6 | 151.7 | 3.7 | 22.7 | 0 | -39.2 | 775.4 |
| 1979 | 1.1 | 68.8 | 5.6 | 0.4 | 165.9 | 13.5 | 2.1 | 5.4 | 3.1 | 165.4 | 169.2 | 10.5 | 541.2 | 138.2 | 4.8 | 24.6 | 0 | -14.5 | 764.1 |
| 1980 | 0.4 | 74.2 | 4.2 | 0.4 | 129.9 | 11.2 | 2.8 | 5.5 | 2.8 | 158.7 | 184.4 | 11 | 510.9 | 129.1 | 2.7 | 35.3 | 0 | -20.6 | 731.8 |
| 1981 | 0.9 | 78.7 | 5.2 | 0.4 | 114.9 | 8.9 | 2.4 | 4.9 | 2.6 | 158.9 | 135.4 | 13.9 | 447.5 | 139.8 | 2.7 | 36.5 | 0 | -0.7 | 705.4 |
| 1982 | 0.8 | 80.4 | 5.2 | 0.3 | 119.4 | 6.1 | 2.2 | 5.1 | 2.4 | 157.9 | 133.9 | 10.7 | 443.1 | 150.9 | 3.9 | 37.2 | 0 | -10 | 706.2 |
| 1983 | 0.7 | 76.6 | 4.9 | 0.3 | 98.5 | 5.4 | 1.7 | 5.2 | 2.5 | 160.4 | 146.6 | 9.3 | 434.8 | 126.4 | 4 | 39.4 | 0 | 9.5 | 691.4 |
| 1984 | 1.5 | 83.5 | 6.2 | 0.3 | 119.7 | 5.7 | 1.3 | 5 | 2.7 | 162.1 | 157.7 | 10.5 | 471.2 | 155 | 3.9 | 36.4 | 0 | -31.3 | 720.2 |
| 1985 | 21.3 | 80.6 | 13.9 | 0.4 | 120.5 | 6.1 | 4 | 4.6 | 2.5 | 162.8 | 132.3 | 10 | 457.2 | 135.1 | 2.8 | 36 | 0.1 | -2.6 | 730.4 |
| 1986 | 21.2 | 81.3 | 14.1 | 0.4 | 130.6 | 7.1 | 3.2 | 4.1 | 2.5 | 167.4 | 140.1 | 6.4 | 475.8 | 197.5 | 3.9 | 31.1 | 1.5 | -66.9 | 745.3 |
| 1987 | 21.4 | 94.7 | 14.2 | 0.3 | 137.7 | 10.1 | 3.3 | 5.7 | 2.8 | 170.3 | 119.1 | 6.4 | 470 | 214.5 | 3.6 | 27.1 | 2 | -63.8 | 769.4 |
| 1988 | 23.1 | 90.9 | 12.3 | 0.2 | 149 | 12.2 | 4.1 | 5.5 | 2.7 | 172.5 | 137.4 | 6.4 | 502.4 | 235.9 | 3.4 | 30.6 | 2.3 | -87.5 | 801.1 |
| 1989 | 23.8 | 102 | 11.9 | 0.2 | 161.1 | 12.7 | 3.8 | 5.8 | 2.7 | 169.5 | 139.3 | 6.3 | 513.4 | 207 | 4.6 | 30.7 | 0.8 | -65.2 | 817.1 |
| 1990 | 38.5 | 109 | 10.5 | 0.5 | 135.5 | 13.3 | 1.8 | 5.8 | 2.8 | 163.6 | 104.1 | 7.1 | 444.9 | 209.3 | 6 | 28.3 | 0.2 | -64.8 | 771.3 |
| 1991 | 38.6 | 116 | 13.1 | 0.1 | 129.8 | 12.7 | 2.1 | 5.4 | 2.5 | 167.4 | 91.3 | 8.2 | 432.8 | 128.4 | 4.5 | 29.9 | 1.9 | 17.7 | 769.5 |
| 1992 | 39.2 | 126 | 11.1 | 0.1 | 146 | 13 | 1.4 | 6.8 | 2.6 | 171.2 | 68.3 | 8.5 | 429.1 | 175.6 | 4.4 | 34.1 | 3.2 | -8.6 | 803.2 |
| 1993 | 37.3 | 126 | 10.5 | 0.2 | 134.7 | 13.1 | 1.6 | 6.1 | 2.6 | 173.9 | 55.5 | 8.6 | 406.6 | 229 | 4.2 | 34.2 | 3.7 | -45 | 796 |
| 1994 | 38.6 | 134 | 11.1 | 0.1 | 128.4 | 13.9 | 1.5 | 5.4 | 2.7 | 170.9 | 47.6 | 8.8 | 390.3 | 210.7 | 5 | 35.2 | 4.2 | -22.4 | 796 |
| 1995 | 40.8 | 145 | 12.7 | 0.2 | 124.2 | 14.1 | 1.4 | 5.1 | 2.7 | 159.5 | 42.8 | 8.4 | 371.1 | 197 | 3.6 | 43.2 | 4.5 | -26.3 | 778.9 |
| 1996 | 41.1 | 139 | 10.4 | 0.2 | 129.1 | 15.4 | 1.3 | 5.5 | 2.6 | 170.4 | 65.4 | 21.8 | 422.1 | 65.4 | 6.5 | 48.3 | 4.7 | 101.4 | 828.6 |
| 1997 | 45 | 149 | 8.1 | 0.1 | 129.2 | 13.4 | 1.6 | 6.3 | 2.8 | 171.7 | 92.3 | 23.8 | 449.2 | -1.3 | 4.5 | 43.7 | 6 | 126.9 | 822.6 |
| 1998 | 32.6 | 135 | 3.7 | 0.3 | 115.8 | 12.5 | 2 | 8.1 | 2.9 | 175.1 | 94.2 | 23.9 | 438.5 | 34 | 4.6 | 42.8 | 5 | 113.1 | 805.5 |
| 1999 | 15.2 | 156 | 4.4 | 0.2 | 130.5 | 13.9 | 2 | 6.1 | 2.9 | 189.1 | 90.7 | 23.9 | 463.7 | 132.5 | 4.3 | 43.4 | 5.5 | 32 | 852.5 |
| 2000 | 36.2 | 164 | 4.5 | 0.2 | 137.3 | 14.7 | 2.9 | 7.7 | 2.9 | 182 | 74.4 | 23.5 | 450.1 | 170.7 | 5.3 | 43.4 | 5.6 | -20.4 | 854.6 |
| 2001 | 40 | 149 | 4.7 | 0.4 | 144.6 | 13.4 | 2.6 | 8.8 | 2.6 | 184.6 | 56.8 | 20.3 | 438.7 | 161.2 | 2.9 | 38.7 | 1.7 | 20.5 | 853.1 |

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand II: Chemical Structures and Properties**



**Synthetic Polymers**

**Laboratory Investigation**

**Teacher Materials**

**Synthetic Polymers**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standard and expected performances for high school, as described in the Core Science Curriculum Framework under Scientific Inquiry, Literacy and Numeracy, Strand II – Chemical Structures and Properties.

**Targeted Content Standard**

**9.6 - Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 6** Use appropriate tools and techniques to make observations and gather data.

**D INQ. 7** Assess the reliability of the data that was generated in the investigation.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning Objective:**

Students will investigate a synthetic polymer (polyethylene) and how the polymer can be processed to produce products with different characteristics.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

plastic dry cleaning bags sandpaper (coarse and fine)

markers ruler

clear kitchen wrap empty coffee cans

plastic sandwich bags rubber bands

ball bearings (different masses) ring stands or clamps

scissors safety goggles

**Considerations:**

Students will need some background information on the structure of polyethylene and the terminology used to describe the different arrangements of the polymer, for example low density polyethylene (LDPE) versus high density polyethylene (HDPE). The differences in the stress-strain behaviors of polyethylene in the products the students are investigating are due in large part to how the materials are processed. Background information on the processing of plastics and specific information about polyethylene may be found at these and many other sites:

**http://www.teachingplastics.org**

**http://americanplasticscouncil.org/s\_apc/index.asp**

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow at least 60 minutes of instructional time for the students to design and conduct their experiment and a minimum of 30 minutes for the students to write about their results. As an alternative, students can write the lab report for homework. These time frames are merely suggestions. Additional time is appropriate if the circumstances and the schedule at your school call for it. A sample scoring rubric is provided for your convenience or you can design one of your own.

This curriculum-embedded task can be integrated into a unit on polymer chemistry in any high school physical or Earth science course. The curriculum-embedded task is intended to be used as a formative assessment during the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

**Curriculum-Embedded Laboratory Investigation Scoring Rubric**

**Statement of Problem and Hypothesis**

3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.

2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.

1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.

0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

**Experimental Design**

3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.

2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.

1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.

0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

**Data Presentation**

3 Data are well organized and presented in an appropriate manner.

2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.

1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.

0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

**Conclusions**

3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.

2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.

1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.

0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance 10-12 points

Proficient performance 7-9 points

Marginal performance 4-6 points

Unsatisfactory performance 0-3 points

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Synthetic Polymers**

**Laboratory Investigation**

**Student Materials**

**Synthetic Polymers**

**Student Materials**

Polymers are large molecules consisting of chains of small molecules called monomers joined together in a repeating pattern. In the early 1900s, scientists began to understand the chemical makeup of natural polymers and how to make synthetic polymers with properties that complement those of natural materials. One simple synthetic polymer chemists developed is polyethylene. They developed it by repeating units of the monomer ethylene (H2C=CH2). Polyethylene is a very large, zigzag-shaped molecule. One small part of a polyethylene chain is shown below.

-(CH2- CH2)-n

H H H H H

| H | H | H | H | H

---C | C | C | C | C |

| C | C | C | C | C---



H | H | H | H | H |

H H H H H

Chemists and engineers have learned to process and modify molecules of polyethylene in different ways to manufacture common household products with a variety of characteristics. Polyethylene is used to make plastic trash bags, dry cleaning bags, milk jugs and soda bottles. In industry, materials made from polyethylene are tested for what are called “stress-strain behaviors.” Stress-strain behaviors include:

**tensile strength -** theamount of pulling force placed upon a material before it breaks

**abrasion resistance -** toughness of material against scraping, scuffing or scarring

**puncture resistance -** ability of a material to keep moving objects from perforating the

surface

**Your Task**

You and your lab partner will design an experiment that investigates a stress-strain behavior among various plastic products made of the synthetic polymer polyethylene.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

**Suggested materials:**

plastic dry cleaning bag coffee can

plastic kitchen wrap rubber bands

plastic sandwich bag ring stands/ or clamps

plastic grocery bag ruler

ball bearings (different masses) safety goggles

scissors

markers

sandpaper (coarse and fine)

**Designing and Conducting Your Experiment**

**1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If … then … because …” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.

**2.** **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.

**3.** **Review your design with your teacher before you begin your experiment.**

**4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**Safety note: Students must wear approved safety goggles and follow all safety instructions.**

**When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

**Communicating Your Findings**

Working on your own, summarize your investigation in a laboratory report that includes the following:

* **A statement of the problem you investigated. A hypothesis (“If ... then … because …” statement)** **that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
* **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
* **Data from your experiment.** Your data should be organized into tables, charts and/or graphs as appropriate.
* **Your conclusions from the experiment.** Your conclusions should be fully supported by your data and address your hypothesis.
* **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions**. Also, include ways that your experiment could be improved if you were to do it again.

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand II: Chemical Structures & Properties**



**Synthetic Polymers**

**Science, Technology & Society**

**Teacher Materials**

**Synthetic Polymers**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand II – Chemical Structures and Properties.

**Targeted Content Standard**

**9.6 – Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**D INQ. 10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

**Learning objective:**

Students will evaluate the credibility of information provided by different websites as it relates to the risks versus benefits of using plastic products.

**Materials:**

Access to computers/Internet

**Considerations:**

Students will need background information on the strategies used to evaluate the credibility of online resources. The media specialist at your school may provide instruction on this topic or you may want to collaborate with the media specialist on a lesson for your classes centered on this inquiry standard. A template for the student activity is provided for your convenience or you may create your own.

You will find several strategies for tips on how to evaluate the trustworthiness of online sites at these and other websites:

[http://mason.gmu.edu/~montecin/web-eval-sites.htm](http://www.mason.gmu.edu/~montecin/web-eval-sites.htm)

<http://www.lib.berkeley.edu/TeachingLib/Guides/Internet/Evaluate.html>

**Student Name:\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_\_**



**Synthetic Polymers**

**Science, Technology & Society**

**Student Materials**

**Grades 9-10**

**Synthetic Polymers**

**Student Materials**

One of the most important factors in researching an issue online is evaluating the credibility of the source of information. Anyone may publish their work online but not everyone who publishes information is interested in providing data-driven, unbiased and balanced information to the reader. Some sources online are interested in promoting a product or an industry. Other sources try to sway opinions without any credible facts to backup their views.

You are trying to evaluate the risks versus benefits of using plastic products. During your research you find the sites and articles listed below. **Your task is to evaluate the credibility of the sources of information by filling out the template on the following page.**  Use the background information and skills provided to you by your teacher to evaluate the sources. Remember to document your evidence as to the kind of site, authority of the author, the point of view of the author/site, date of publication and any other information that is important in the evaluation of the reliability of the site.

[http://www.packagingtoday.com](http://www.packagingtoday.com.introenvironment.htm)

[http://muextension.missouri.edu/explore/wasteman/wm0002.htm](http://www.muextension.missouri.edu/explore/wasteman/wm0002.htm)

<http://www.americanplasticscouncil.org/s_apc/sec.asp?CID=298&DID=897>

<http://www.whoi.edu/science/B/people/kamaral/plasticsarticle.html>

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name of Website** | **Kind of site**  **(.edu,.org, .com)** | **Author/Source** | **Date of**  **Publication** | **Point of view of author/site** | **Reliability of the information provided** |
|  |  |  |  |  |  |
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**Assessing the Credibility of Information**

**Write a brief assessment about the credibility of the sources you investigated:**

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand III: Global Interdependence**



**Acid Rain**

**Laboratory Investigation**

**Teacher Materials**

**Acid Rain**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for high school, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand III – Global Interdependence.

**Targeted Content Standard**

**9.8 - The use of resources by human populations may affect the quality of the environment.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 6** Use appropriate tools and techniques to make observations and gather data.

**D INQ. 7** Assess the reliability of the data that was generated in the investigation.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning objective:**

Students will be able to identify building materials that are resistant to the effects of acid rain based on their data.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

containers with lids limestone chips

graduated cylinder marble chips

vinegar red sandstone chips

pH paper/meter pea stone

safety goggles access to a balance

**Considerations:**

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow about 60 minutes of instructional time for students to design and set up their experiments. Additional instructional time will be necessary for students to collect data for this activity as the change in the condition of the building materials will take several hours. If your schedule is such that class does not meet every day, then further adjustments for the activity will be necessary. Allow a minimum of 30 minutes for students to write about their results. As an alternative students can complete the lab report for homework. A sample scoring rubric is provided for your convenience or you may design your own.

Suggested materials for students to test have been listed in the laboratory activity. You can change these materials based on the supplies available to you or ask the students to bring in other building materials to test.

Any small container with a cover will work for this activity, including small jars or petri dishes. Vinegar with an approximate pH of 3 has been suggested as a substance to simulate acid rain. If the odor is too intense another weak acid may be substituted at the discretion of the teacher. Keep in mind safety considerations and the fact that average acid rain has a pH between 4.0 and 5.5.

The quantity of vinegar that is introduced to the building material is not specified in the student instructions. You can control the maximum amount of vinegar available to a team of students (20 ml per material tested) to conserve supplies or direct all students to use the same quantity of vinegar and building materials to pool data and compare results.

Some relevant information on acid rain is available at these and many other sites:

**http://www.epa.gov/highschool/air.htm**

[**http://www.geocities.com/narilily/buildings.html**](http://www.geocities.com/narilily/buildings.html)

[**http://www.ec.gc.ca/acidrain/**](http://www.ec.gc.ca/acidrain/)

The task can be integrated into a unit on environmental science in any high-school physical or Earth science course. The curriculum-embedded task is intended to be used as a formative assessment during the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

**Curriculum-Embedded Laboratory Investigation Scoring Rubric**

**Statement of Problem and Hypothesis**

3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.

2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.

1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.

0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

**Experimental Design**

3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.

2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.

1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.

0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

**Data Presentation**

3 Data are well organized and presented in an appropriate manner.

2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.

1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.

0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

**Conclusions**

3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.

2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.

1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.

0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance 10-12 points

Proficient performance 7-9 points

Marginal performance 4-6 points

Unsatisfactory performance 0-3 points

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Acid Rain**

**Laboratory Investigation**

**Student Materials**

**Acid Rain**

**Student Materials**

Acid rain is a major environmental issue throughout Connecticut and much of the United States. Acid rain occurs when pollutants, such as sulfur dioxide from coal burning power plants and nitrogen oxides from car exhaust, combine with the moisture in the atmosphere to create sulfuric and nitric acids. Precipitation with a pH of 5.5 or lower is considered acid rain.

Acid rain not only affects wildlife in rivers and lakes but also does tremendous damage to buildings and monuments made of stone. Millions of dollars are spent annually on cleaning and renovating these structures because of acid rain.

**Your Task**

Your town council is commissioning a new statue to be displayed downtown. You and your lab partner will conduct an experiment to investigate the effect of acid rain on various building materials in order to make a recommendation to the town council as to the best material to use for the statue. In your experiment, vinegar will simulate acid rain.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

**Suggested materials:**

Proposed building materials:

containers with lids limestone chips

graduated cylinder marble chips

vinegar (simulates acid rain) red sandstone chips

pH paper/meter pea stone

safety goggles access to a balance

**Designing and Conducting Your Experiment**

**1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If … then … because …” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.

**2.** **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.

**3.** **Review** **your design with your teacher before you begin your experiment.**

**4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**Safety note: Students must wear approved safety goggles and follow all safety instructions.**

**When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

**Communicating Your Findings**

Working on your own, summarize your investigation in a laboratory report that includes the following:

* **A statement of the problem you investigated. A hypothesis (“If ... then … because …” statement)** **that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
* **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
* **Data from your experiment.** Your data should be organized into tables, charts and/or graphs as appropriate.
* **Your conclusions from the experiment.** Your conclusions should be fully supported by your data and address your hypothesis.
* **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions**. Also, include ways that your experiment could be improved if you were to do it again.

**Grades 9-10**

**Curriculum Embedded Performance Task**

**Strand III: Global Interdependence**



**Connecticut Brownfield Sites**

**Science, Technology & Society**

**Teacher Materials**

**Connecticut Brownfield Sites**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand III – Global Interdependence.

**Targeted Content Standard**

**9.9 - Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**D INQ. 10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

**Learning objective:**

Students will formulate a question about a Brownfield site that may be answered through scientific investigation and then design the investigation.

**Materials:**

Access to computers/Internet

**Considerations:**

More than 290 sites in Connecticut have been identified as “Brownfield Sites.” These are parcels of property once used for industrial, commercial or manufacturing purposes and now typically are abandoned due to **suspected** contamination. Often these unused parcels adversely affect the quality of living in the area and may pose potential health risks to local citizens. Financial assistance is available from the state and federal governments to assess and remediate these sites.

The Connecticut Brownfield Inventory is updated on a regular basis and may be accessed at the Connecticut Department of Environmental Protection’s website: [http://dep.state.ct.us/wst/remediation/brownfields/brownfields.htm](http://www.dep.state.ct.us/wst/remediation/brownfields/brownfields.htm).

The objective of this exercise is to allow students to explore environmental issues that are close to home. The students are not expected to create a protocol for retrieving a specific chemical such as toluene from a site. Instead the task is to formulate a general procedure for exploring the effect the contamination may have on the site or nearby property. Students may design an investigation that focuses on one specific chemical and its contamination plume at the site. They may consider where the sampling will occur (water, soil, air) and other parameters of the investigation such as the number of test sites, distances from the source, etc. Other students may design an investigation with a focus on one contaminant and its influence on a particular species of plant or animal in the area. If students are not able to identify the suspected contaminants at the site based on the general information on the inventory, the list below can be used for direction.

|  |  |
| --- | --- |
| **Contaminant** | **Possible source of contamination** |
| **Heavy metals:**  arsenic, cadmium chromium, lead,  mercury | metal finishing/plating shops, manufacturing and foundries, coal burning power plants |
| **Gasoline/constituents of gasoline:**  gasoline, benzene,  ethylbenzene, toluene,  xylene | gasoline stations, tank farms, pipelines |
| **Solvents:**  tetrachloroethlyene,  trichloroethylene,  III-trichloroethane | dry cleaners, machine shops,  metal finishing/plating shops |

This is an opportunity to invite an environmental engineer to the classroom to discuss the assessment and remediation processes at Brownfield sites. The time frame of assessment, follow-up remediation and cost may surprise students.

A professional in environmental engineering or environmental science may give students feedback on the feasibility of their proposed scientific investigations. Local community members may speak to the prior use of the property or to the process by which the site was identified as a Brownfield site.

**Student Name:\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Connecticut Brownfield Sites**

**Science, Technology & Society**

**Student Materials**

**Grades 9-10Connecticut Brownfield Sites**

**Student Materials**

More than 290 sites in Connecticut have been identified as “Brownfield Sites.” These are parcels of property once used for industrial, commercial or manufacturing and are now typically abandoned due to **suspected** contamination. Often these unused parcels adversely affect the quality of living in the area and may pose potential health risks to local citizens. Financial assistance is available from the state and federal governments to assess and remediate these sites.

Find a Connecticut Brownfield site near your hometown by clicking on the Brownfield Inventory link found at the Connecticut Department of Environmental Protection’s website: [http://dep.state.ct.us/wst/remediation/brownfields/brownfields.htm](http://www.dep.state.ct.us/wst/remediation/brownfields/brownfields.htm). What has the property been used for that led it to being identified as a Brownfield site? Use a search engine such as Google or DogPile to research one of the potential contaminants at the site. If you have trouble identifying a specific contaminant from the nearby Brownfield site, ask your teacher for clarification from the master list he or she has been given.

**Your task is to formulate a question about the site that may be answered through scientific investigation and to design the investigation.**  Do not worry about the specific steps needed to isolate the contaminant or specific techniques used to measure the contaminant’s effect on the environment. Focus on writing a general plan for your investigation including the independent and dependent variables to be studied, general procedures you will follow and the data you will collect. Include a control group if appropriate.

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand IV: Cell Chemistry and**

**Biotechnology**



**Enzymes**

**Laboratory Investigation**

**Teacher Materials**

**Enzymes**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for high school, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand IV – Cell Chemistry and Biotechnology.

**Targeted Content Standard**

**10.1 The fundamental life processes depend on the physical structure and the chemical activities of the cell.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 6** Use appropriate tools and techniques to make observations and gather data.

**D INQ. 7** Assess the reliability of the data that was generated in the investigation.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning objective:**

Students will be able to identify the best enzyme for juice production and variables that affect the ability of an enzyme to function.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

apple sauce droppers splash-proof safety goggles

pectinase enzyme stirring rods access to a balance

cellulase enzyme graduated cylinder paper towels for cleanup

funnels access to tap water

filter paper paper cups

lab aprons access to a stopwatch, watch or clock

**Considerations:**

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. Students will need a minimum of 90 minutes to complete this laboratory exercise if you expect their lab reports to be written during class time. You should allow at least 60 minutes of instructional time for the students to design and conduct their experiment and a minimum of 30 minutes for the students to write about their results. As an alternative the students can complete the lab report for homework. A sample scoring rubric is provided for your convenience or you may design one of your own.

A guideline for the quantity of enzyme to be used is provided due to the concern about conserving costly supplies. Once students identify which enzyme or combination produces the greatest quantity of juice, you can encourage them to explore another variable effect on juice production such as change in temperature or pH. This extension relies on the availability of enzyme supply and instructional time. Check with the science supply house of your choice for the availability and cost of the enzymes. Remember the shelf life of the enzymes is six months when refrigerated.

The task can be integrated into a unit on cell chemistry in any high school biology course. The curriculum-embedded task is intended to be used in the course of normal instruction as a formative assessment. The Connecticut Academic Performance Test-Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

**Background Information on the Enzymes Used in This Activity**

**Cellulase**

The enzyme **cellulase** breaks down **cellulose**. Cellulose is a polymer made out of long branching chains of glucose and it is one of the main components of plant cell walls. Cellulose accounts for about 50 percent of all the organic materials on Earth. Unfortunately, humans, like all other mammals, do not contain the enzyme cellulase and therefore can’t digest cellulose.

Scientists purified the enzyme cellulase and currently it is used in the food industry for the production of wine and juices. The enzyme is also used in the production of plant-based materials such as paper, light basswood, rayon fibers and photographic films.

**Pectinase**

The enzyme **pectinase** breaks down **pectin**. Pectin is a complex carbohydrate that is part of the plant cell wall. Pectin acts like “glue,” holding plant cell walls together. Pectin is soluble in water, and in a mild acidic environment it becomes sticky. These properties make pectin very useful in the production of jams and jellies. When the enzyme pectinase is added to mashed fruits it breaks down the pectin in the fruit cell walls, thus facilitating the industrial production of fruit juices.

**Curriculum-Embedded Laboratory Investigation Scoring Rubric**

**Statement of Problem and Hypothesis**

3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.

2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.

1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.

0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

**Experimental Design**

3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.

2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.

1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.

0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

**Data Presentation**

3 Data are well organized and presented in an appropriate manner.

2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.

1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.

0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

# Conclusions

3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.

2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.

1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.

0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance 10-12 points

Proficient performance 7-9 points

Marginal performance 4-6 points

Unsatisfactory performance 0-3 points

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Enzymes**

**Laboratory Investigation**

**Student Materials**

**Enzymes**

**Student Materials**

**Introduction: Apple Juice**

A Connecticut company is in the business of making and selling apple juice. To make apple juice, apple sauce is strained through filters to remove the juice. The company would like your help in testing the impact of different enzymes on the production of the apple juice. You will investigate the ability of these enzymes to remove more juice during this process and decide the most cost effective plan to increase juice production. The following is a list of the enzymes along with their prices:

Pectinase: $ 50 per liter

Cellulase: $100 per liter

Enzymes are proteins that catalyze chemical reactions in the cells of all living organisms. Enzymes control many vital functions in the cell, including the release of energy during the breakdown of nutrients into smaller molecules and the synthesis of complex cell materials from the small molecules. In this lab you will work with two plant enzymes – cellulase and pectinase.

**Your Task**

You and your lab partner will design and conduct an experiment to determine **which enzyme or combination of the two enzymes maximizes juice production.** Once you complete the laboratory investigation, you will evaluate which enzyme will be the most cost effective to use in juice production.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

**Suggested materials:**

apple sauce droppers

pectinase enzyme stirring rods

cellulase enzyme graduated cylinder

funnels access to tap water

filter paper paper cups

lab aprons access to a watch or clock with a second

splash-proof goggles access to a balance

paper towels for cleanup

**Designing and Conducting Your Experiment**

**1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If … then … because …” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.

**2.** **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.

**3.** **Review your design to your teacher before you begin your experiment.**

**Note:** The enzyme(s) should be well mixed into the apple sauce to be effective. Use 5-10

drops of enzyme per 50 grams of apple sauce (approximately two ounces).

**Safety notes: As in any laboratory experiment, you must not eat or taste any of the materials. Students must wear approved safety goggles and follow all safety instructions.**

**4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

**Communicating Your Findings**

Working on your own, summarize your investigation in a laboratory report that includes the following:

* **A statement of the problem you investigated**. **A hypothesis (“If ... then … because …” statement) that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
* **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
* **Data from your experiment**. Your data should be organized into tables, charts and/or graphs as appropriate.
* **Your conclusions from the experiment**. Your conclusions should be fully supported by your data and address your hypothesis.
* **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions**. Also, include ways that your experiment could be improved if you were to do it again.

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand IV: Cell Chemistry & Biotechnology**



**Bio-engineered Food**

**Science, Technology & Society**

**Teacher Materials**

**Bio-engineered Food**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand IV – Cell Chemistry and Biotechnology.

**Targeted Content Standard**

**10.3** - Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**D INQ. 10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

**Learning objective:**

Students will assess the risk versus benefit of genetically altered food sources and use their research to defend a position in favor of or opposed to labeling genetically altered foods.

**Materials:**

Access to computer/Internet

**Considerations:**

Information specific to genetically altered food sources may be found at these and many other websites:

[http://scope.educ.washington.edu/gmfood/](http://www.scope.educ.washington.edu/gmfood/)

[http://pewagbiotech.org/newsroom/releases/062702.php3](http://www.pewagbiotech.org/newsroom/releases/062702.php3)

<http://www.who.int/foodsafety/publications>

[http://actionbioscience.org/biotech/](http://www.actionbioscience.org/biotech/)

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_Class:\_\_\_\_\_\_**



**Bio-engineered Food**

**Science, Technology & Society**

**Student Materials**

**Grades 9-10**

**Bio-engineered Food**

**Student Materials**

The advancements in the field of biotechnology have allowed scientists to insert genes into food sources so the altered DNA produces new proteins that lead to new characteristics in the plants. By inserting a gene into a particular plant, the resulting protein may make the plant resistant to insects or resistant to a particular herbicide. The farmers’ ability to yield larger crops greatly improves when these alterations are made. Other genetic modifications improve the nutritional quality of food.

Several products you buy at the grocery store including corn, beets, canola and soy are probably genetically modified, but you have no way of knowing unless the manufacturer chooses to label the product. Opponents to genetically modified food fear that future studies may uncover health risks linked to ingesting this altered form of DNA. Others suggest that the use of genetically altered plants may result in the overuse of chemicals to control weeds, and ultimately cause adverse environmental conditions. Currently there is not a law that mandates the labeling of genetically modified food products.

**Your task is to design a persuasive pamphlet in support of or in opposition to the mandatory labeling of genetically altered food based on scientific evidence.**  Use several sources to support your stance and remember to consider the credibility of your sources when defending your position. Here are some websites that will help start your research on the risks and benefits of genetically modified food:

<http://scope.educ.washington.edu/gmfood/>

<http://pewagbiotech.org/newsroom/releases/062702.php3>

<http://www.who.int/foodsafety/publications>

<http://actionbioscience.org/biotech/>

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand V: Genetics, Evolution and**

**Biodiversity**



**Yeast Population Dynamics**

**Laboratory Investigation**

**Teacher Materials**

**Yeast Population Dynamics**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for high school, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand V – Genetics, Evolution and Biodiversity.

**Targeted Content Standard**

**10.6 Living organisms have the capability to produce populations of unlimited size, but the environment can support only a limited number of individuals from each species.**

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 1** Identify questions that can be answered through scientific investigation.

**D INQ. 3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment.

**D INQ. 4** Design and conduct appropriate types of scientific investigations to answer different questions.

**D INQ. 5** Identify independent and dependent variables, including those that are kept constant and those used as controls.

**D INQ. 6** Use appropriate tools and techniques to make observations and gather data.

**D INQ. 7** Assess the reliability of the data that was generated in the investigation.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**Learning objective:**

Students will be able to identify the relationship between a change in environmental conditions and yeast population. Some of the variables students will investigate include changes in pH, light and temperature.

Listed below are the suggested materials for the laboratory exercise. You may use additional materials if they are available.

**Materials:**

25% molasses solution graduated cylinder

stock yeast solution splash proof goggles

baker’s yeast metric ruler

clean test tubes (18 mm x 150 mm) electronic balance sensitive to .001g (optional)

clean test tubes (25 mm x 150 mm) graduated disposable pipettes

**Considerations:**

Teams of two students are ideal for laboratory work, but circumstances may necessitate teams of three students. You should allow at least 60 minutes of instructional time for the students to design and set up their experiment and at least 15-20 minutes of instructional time over five days to collect data as the yeast population changes. The school schedule may dictate additional days if classes do not meet everyday. At the conclusion of the experiment you should allow about 30 minutes for the students to write about their results or you may prefer to have the students complete the lab report for homework. A sample scoring rubric is provided or you may design your own.

The lab activity focuses on the growth patterns of yeast cultures and the impact of different environmental factors (e.g., light, temperature, pH, nutrients) on the population dynamics. Students are given the general procedure for growing yeast and measuring the carbon dioxide as a waste product of cell respiration. The quantity of waste product is directly related to the size of the yeast population. Students then may choose their own variable on population growth to investigate (e.g. light, pH, temperature, concentration of food). Remember the collection period is over five days and this will have a major impact on instructional time if you allow students to observe the results of the general procedure before designing their investigation versus performing the general procedure at the same time of their own investigation.

**Note:** Students may need guidance in measuring the volume of the carbon dioxide. They are provided with a metric ruler to measure the height of the bubble but you may need to give them the formula for a cylinder so they may calculate the volume in cubic centimeters and convert that into milliliters (volume of a cylinder = π r2h).

A 25% molasses (un-sulfured) stock solution needs to be prepared from the concentration at time of purchase from the grocery store. In a 500 ml volumetric flask dilute 125 ml of molasses with water until the solution reaches the glass marking on the neck of the flask (% solution = volume of solute/volume of solution x 100 %.) Failure to dilute the molasses will result in destruction of the yeast cells.

A yeast suspension needs to be prepared one hour before the lab. (1 gram of yeast per 100 ml of water). You may use ordinary baker’s yeast from the supermarket (*Saccharomyces cerevisiae*), or you can order yeast strains from a biological supply company.

**Safety note: Some students have severe allergies to yeast and will need an alternative laboratory investigation. See the school nurse for specific health-care considerations.**

Some background information about population dynamics may be found at these sites:

**http://www.nationalgeographic.com/eye/overpopulation/science.html**

**http://www.accessexcellence.org/AE/AEC/AEF/1996/webb\_population.html**

This task can be integrated into a unit on population dynamics in any high school biology course. The curriculum-embedded task is intended to be used as a formative assessment during in the appropriate instructional unit. The Connecticut Academic Performance Test – Generation III will include some open-ended items that will assess scientific inquiry and communication skills in the same context as this task.

**Curriculum-Embedded Laboratory Investigation Scoring Rubric**

**Statement of Problem and Hypothesis**

3 The problem and hypothesis are stated clearly and completely. Clear identification of independent and dependent variables.

2 The problem and hypothesis are stated adequately. Adequate identification of independent and dependent variables.

1 The problem and/or hypothesis are poorly stated. Poor identification of independent and dependent variable.

0 The statement of the problem and/or hypothesis is very limited or missing altogether. No identification of independent and dependent variables.

**Experimental Design**

3 The experimental design matches the stated problem. Variables are held constant. The procedures are clear, complete and replicable. A control is included when appropriate.

2 The experimental design generally matches the stated problem. Attempt at holding variables constant is made. Procedures are generally complete. Minor modifications or clarifications may be needed.

1 The experimental design matches the stated problem to some extent. Little attempt to hold variables constant. Procedures are incomplete. Major modifications or clarifications may be needed.

0 The experimental design does not match the stated problem, is very incomplete or missing. There is no attempt to hold variables constant.

# Data Presentation

3 Data are well organized and presented in an appropriate manner.

2 Data are organized and presented in an appropriate manner. Minor errors or omissions may be present.

1 Data are poorly organized or presented in an inappropriate manner. Major omissions or errors may be present.

0 Data are very poorly organized or presented in an inappropriate manner or missing altogether.

**Conclusions**

3 Conclusions are fully supported by data and address the hypothesis. Reliability of data and validity of conclusions are thoroughly discussed.

2 Conclusions are generally supported by data and address the hypothesis. Minor errors in interpretation of results may be present. Discussion of reliability of data and validity of conclusions is limited.

1 Conclusions are supported by data and address the hypothesis to a limited extent. Major errors in interpretation of results may be present. There is little discussion of the reliability of the data or validity of conclusions.

0 Conclusions are not supported by data, do not address the hypothesis or are missing. There is no discussion of the reliability of data or validity of conclusions.

Excellent performance 10-12 points

Proficient performance 7-9 points

Marginal performance 4-6 points

Unsatisfactory performance 0-3 points

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_**



**Yeast Populations Dynamics**

**Laboratory Investigation**

**Student Materials**

**Yeast Populations**

**Student Materials**

Yeast is a single-cell fungus that produces carbon dioxide as a byproduct of cellular respiration. The release of carbon dioxide causes bread dough to rise. Because the yeasts are small and reproduce rapidly, yeast organisms are useful for studying various factors such as food availability, temperature change and a shift in pH that may influence the rate at which a population grows. These cells produce carbon dioxide gas as a waste product and the amount of carbon dioxide produced directly relates to the number of living yeast organisms.

**Your Task**

You and your lab partner will grow yeast in a molasses solution (food for the yeast) and investigate how one factor influences the change in yeast population growth as measured by the amount of carbon dioxide produced.

**Suggested materials:**

teacher prepared yeast suspension test tube rack

teacher prepared 25% molasses solution pH paper

several 1 ml graduated dropping pipettes clean test tubes (18 mm x 150 mm)

100 ml graduated cylinder clean test tubes (25 mm x 150 mm)

metric ruler safety goggles

weak acid/base (provided at teacher’s discretion) lab aprons

refrigerator/microwave electronic balance (optional)

**Designing and Conducting Your Experiment**

**1. In your words, state the problem you are going to investigate. Write a hypothesis using an “If … then … because …” statement that describes what you expect to find and why.** Include a clear identification of the independent and dependent variables that will be studied.

**2.** **Design an experiment to solve the problem.** Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant.

**General Procedure for growing yeast populations:**

1. Place 35 ml of 25% molasses solution into a small test tube.
2. Stir the yeast suspension and then place 1 ml of the yeast suspension into the same test tube.
3. Place the test tube in the rack.
4. Wash and rinse your hands. Place your palm over the end of the small test tube and invert it five times.
5. Carefully slide a larger tube down over the smaller tube. Quickly invert the tubes so the mouth of the large tube is up.
6. Using a metric ruler measure the height of the air bubble (mm or cm) in the smaller tube and record. Place in the test tube rack.
7. Incubate these samples for 24 hours at 30 degrees Celsius.
8. Measure the bubble and record the **change in the size due to carbon dioxide gas production** on your data table. (Subtract the initial gas bubble size from the total bubble size. Remember you will need this data to calculate the total **volume of carbon dioxide each day over five days**.)
9. Repeat steps 6-8 for five days.

**3.** **Review** **your design with your teacher before you begin your experiment.**

**4. Conduct your experiment.** While conducting your experiment, take notes and organize your data into tables.

**Safety note: Students must wear approved safety goggles and follow all safety instructions. When you have finished, your teacher will give you instructions for cleanup procedures, including proper disposal of all materials.**

**Communicating Your Findings**

Working on your own, summarize your investigation in a laboratory report that includes the following:

* **A statement of the problem you investigated. A hypothesis (“If ... then … because …” statement)** **that described what you expected to find and why.** Include a clear identification of the independent and dependent variables.
* **A description of the experiment you carried out.** Your description should be clear and complete enough so that someone could easily replicate your experiment.
* **Data from your experiment.** Your data should be organized into tables, charts and/or graphs as appropriate.
* **Your conclusions from the experiment.** Your conclusions should be fully supported by your data and address your hypothesis.
* **Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions**. Also, include ways that your experiment could be improved if you were to do it again.

**Grades 9-10**

**Curriculum-Embedded Performance Task**

**Strand V: Genetics, Evolution & Biodiversity**



**Human Population Dynamics**

**Science, Technology & Society**

**Teacher Materials**

**Human Population Dynamics**

**Teacher Materials**

This curriculum-embedded science performance task is related to the content standards and expected performances for Grades 9-10, as described in the Core Science Curriculum Framework, under Scientific Inquiry, Literacy and Numeracy, Strand V – Genetics, Evolution, and Biodiversity.

**Targeted Content Standard**

**10.6 –** Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.

**Targeted Scientific Inquiry, Literacy and Numeracy Standards**

**D INQ. 2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information.

**D INQ. 9** Articulate conclusions and explanations based on research data, and assess results based on the design of an investigation.

**D INQ. 10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

**Learning objective:**

Students will research and evaluate population growth data in two different countries and offer explanations for factors that influence the projected change in human population in one of the countries.

**Materials:**

Access to computers/Internet

**Considerations:**

A Power Point slideshow is suggested as the performance activity for this task. If access to this program is problematic, the mechanism for the student report may be changed.

**Student Name:\_\_\_\_\_\_\_\_\_\_\_\_ Class:\_\_\_\_\_\_**



**Human Population Dynamics**

**Science, Technology & Society**

**Student Materials**

**Grades 9-10**

**Human Population Dynamics**

**Student Materials**

The human population has existed for a little more than 500,000 years. About 10,000 years ago, the total human population was about 3 million people, most of them hunters and gatherers. The development of early agriculture provided a stable supply of food and as a result the human population increased rapidly and reached one billion (1,000,000,000) in 1840. The development of technology and medicine in the 20th century reduced the death rate and increased the growth rate even further. Despite these advances, human population growth differs dramatically country by country. **Your task is to design a presentation using a Power Point slide show to compare the population dynamics in an underdeveloped country and a developed country using the parameters outlined below.**

**Interpreting Population Data**

Select two countries, one developed and one underdeveloped, from those listed courtesy of the U.S. Census Bureau at [www.census.gov/ipc///www/idbsum.html](http://www.census.gov/ipc///www/idbsum.html).

1. Compare and contrast the shapes of the population graphs in 2005 for the developed and underdeveloped countries that you selected.
2. Compare the changes in populations of both countries from 2005 to those projected to 2025.

**Factors Affecting Population Changes**

1. Research and describe three factors that affect changes in the human population of one of the countries you studied.
2. Research and explain how one technological advance might affect the change in the human population from 2005 to 2025 in one of the countries you studied. Is the advancement of technology a positive or negative influence on population dynamics? What is your evidence?

Be sure to document any sources you used in your research.