Science in a Technical World
correlated with
State of New York
Learning Standards for Mathematics, Science, and Technology

Commencement Level

Standard 1: Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

Scientific Inquiry

- **The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.**

Students:

- **Hone ideas through reasoning, library research, and discussion with others, including experts. (See "Data and Results," for instance Paint 81-83; Food 67-70; Petroleum 57-62; Drugs 69-72; Lab 53; Forensics 53-55; See also Wastewater, "the Product," 59; Semiconductors "Final Team Challenge" 45-50)**
- **Work toward reconciling competing explanations; clarifying points of agreement and disagreement (See, "Connecting to the Problem," for instance, Wastewater 16, 18, 21, 24, 32, 36, 54, etc.; Polymer 13, 29, 35, 39, 51; Paint 27, 30, 36, 38, 43, 61, 80; Plant 18, 27, 29, 42, 47; Carbonated Beverage 13, 22, 35, 37, 40, 45; Pulp and Paper 12, 21, 24, 29, 32, 39, 42; Food 14, 16-17, 28-29, 31-32, 35-36, 41, 42-43, 61; Petroleum 14-15, 17, 20, 23, 30, 34-35, 37, 41, 45, 48, 52, 55; Drugs 15, 19, 22, 24-25, 30-31, 38, 45-52, 54, 58, 66-67; Lab 9, 13, 26, 27, 33, 36, 38, 40, 43, 45, 50; Forensics 13, 16, 18, 21, 25-26, 29, 31, 34, 38, 44, 48, 52; Semiconductors 11, 13, 16, 19, 25, 30, 35, 40, 43-47)**

- **Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity**

Students:

- **Devise ways of making observations to test proposed explanations. (See, for instance, Carbonated 11-12, 14, 21, 23, 27; Pulp and Paper 13, 17, 22, 25, 29, 33, 37; Plant 15, 23, 27, 35, 43; Paint 14, 31, 43, 51,**

57, 68, 72; Polymer 25, 33, 36, 44, 54; Wastewater 25, 27, 36, 51; Food 12, 14 , 17, 20, 24, 30, 33, 37, 40; petroleum 15-16, 18-19, 20, 26, 30, 35; Drugs 15, 20, 22, 27, 31, 39, 46, 59; Lab 9, 21, 28, 33, 36, 39, 40; Forensics 14, 17, 26, 31, 35, 44; Semiconductors 10, 12, 14, 27, 32, 35, 40, 45)

- **Refine their research ideas through library investigations, including electronic information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion. (Each title in *STW* is based on collaborative group work involving intensive peer feedback.)**
- **Develop and present proposals including formal hypotheses to test their explanations, i.e., they predict what should be observed under specified conditions if the explanation is true.(See, for instance, Carbonated 16, 22; Polymer 15, 16, 29; Paint 66; Carbonated 16, 22, 35; Food 14; Petroleum 13; Drugs 14-15; Lab 9; Forensics 12-13, 16-17; Semiconductors 9-10)**
- **Carry out their research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations as necessary. (See, for instance, Carbonated 12, 14, 16, 21, 23; Polymer 10-13, 16, 19, 25; Paint 3, 9, 11, 16; Plant 7, 9, 11; Pulp and Paper 10, 12; Wastewater 1, 7, 9, 10; Food 7, 9, 10, 11, 12, 13, 14, 17, 20, 24, 30, 33, 37; Petroleum 11, 13, 15, 17, 18, 20,; drugs 9, 13, 14, 15, 19, 22; Lab 5, 7, 9, 13; Forensics 9, 12-13, 14; Semiconductors 7, 9, 10, 12, 14, 15)**

- **The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.**

Students:

- **Use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, matrices) and insightfully interpret the organized data. (See, for instance, Carbonated 13, 15, 22, 26, 24-25, 53-54; Polymer 18, 24, 28, 35, 47, 51; Paint 20, 26, 30, 35, 38, 48, 56; Plant 17, 26, 34, 36, 47; Pulp 16, 28, 46; Wastewater 32, 36, 51, 53; food 28, 34, 36, 39, 53, 59, 60; Petroleum 9, 19, 29, 32; Drugs 21, 34, 35, 36, 39, 51, 65, 70, 71, 72; Lab 11, 20, 25, 32, 36, 39; Forensics 19; Semiconductors 15, 19)**
- **Assess correspondence between the predicted result contained in the hypothesis and the actual result and reach a conclusion as to whether or not the explanation on which the prediction was based is supported.(See "Analyzing the Data," for instance, Plant 17, 20-21, 26, 29; Wastewater 32,**

36, 47, 51; Pulp 16, 21, 24, 28, 35, 42; Plant 17, 26, 29, 42, 47; Paint 20, 30 , 38, 56, 76, 80; polymer 13, 28, 42, 54; Carbonated Beverages 13, 22, 40, 49, 51; food 16, 20, 27, 31, 39, 40, 60; Petroleum 20, 29, 34, 36, 41, 44, 48, 52, 55; Drugs 18, 22, 24, 30, 37-38, 44, 51, 54, 58, 66; Lab13, 18, 25, 33, 38, 40, 43, 49; Forensics 16, 21, 24, 29, 31, 34, 42, 48; Semiconductors 13, 15, 19, 23, 30, 34, 39, 43

- **Based on the results of the test and through public discussion , they revise the explanation and contemplate additional research. (See, for instance, "Arriving at Conclusions," Plant 17-18, 21, 26, 29; carbonated Beverages 13, 26, 40, 49; Polymer 15, 35, 39, 61; Paint 21, 27, 56, 76, 80; Pulp 21, 24, 32; Wastewater 32, 48, 54; food 16, 20, 27, 31, 35, 39, 40, 60, 65; Petroleum 17, 20, 23, 29, 34, 36, 44, 48, 55; drugs 18, 24, 38, 44, 52, 54, 58, 66-67; Lab 13, 20, 25, 40, 43, 49, 50; Forensics 13, 16, 21, 25, 29, 31, 34, 42, 48; Semiconductors 13, 16, 19, 23, 25, 30, 35, 40, 43)**
- **Develop a written report for public scrutiny that describes their proposed explanation, including a literature review, the research they carried out, its result, and suggestions for further research. (See "Data and Results," for instance, Paint 81-83; Carbonated Beverages 53-56; Pulp 47-49; Plant 49-53; Paint 81-83; Food 67-70; Petroleum 57-62; Drugs 69-72; Lab 53; Forensics 53-55; Semiconductors 45-50)**

Engineering Design

- **Engineering design is an iterative process involving *modeling* and *optimization* used to develop technological solutions to problems within given constraints.**

Students engage in the following steps in a design process:

- **Initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation. (Each volume in *STW* requires students to investigate an unfamiliar technologically-based situation.)**
- **Develop work schedules and plans which include optimal use and cost of materials, processes, time, and expertise; construct a model of the situation, including developmental modifications while working a high degree of quality (craftsmanship). (See "Technician Orientation," for instance, Plant 7-13; Food 7-12; Petroleum 11-13; Drugs 9-11; Lab 5; Forensics 9-11; Semiconductors 7-10)**
- **In a group setting, devise a test of the solution relative to the design criteria and perform the test; record, portray, and logically evaluate performance test results through qualitative, graphic, and verbal means; and use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impacts**

and new problems, and suggest and pursue modifications. (See for instance, "SOPs and SLAMS," Wastewater 61-78)

Standard 4: Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical importance of ideas in science.

Physical Setting

- **Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.**

Students:

- **Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them. (See, for instance, Polymers 13-29; Pulp 19; Carbonated 24; Petroleum 8; Drugs 32-33, 36-37, 40, 42, 44, 46, 51, 55; Semiconductors 31)**
- **Use kinetic molecular theory to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance. (Polymer 17)**

The Living Environment

- **The continuity of life is sustained through reproduction and development.**

Students:

- **Explain how organism, including humans, reproduce their own kind. (Plant 16)**

- **Human decisions and activities have had a profound impact on the physical and living environment.**

Students:

- **Explain the impact of technological development and growth in the human population on the living and nonliving environment. (See Wastewater 1, 43-48)**
- **Explain how individual choices and societal actions can contribute to improving the environment. (See Wastewater generally; Food 5,6; Petroleum generally; Drugs 5-8; Lab 3; Semiconductors generally)**

Standard 5: Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

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- **In a group setting, devise a test of the solution relative to the design criteria and perform the test; record, portray, and logically evaluate performance test results through qualitative, graphic, and verbal means; and use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impacts and new problems, and suggest and pursue modifications. (See for instance, "SOPs and SLAMS," Wastewater 61-78)**

Tools, Resources, and Technological Processes

- **Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful forms.**

Students:

- **Test, use, and describe the attributes of a range of material (including synthetic and composite materials), information, and energy resources (See Paint , Pulp, Polymers, Petroleum, Semiconductors generally)**
- **Select appropriate tools, instruments, equipment and use them correctly to process materials, energy, and information. (See Safety recommendations in each volume, for instance, Wastewater xvii-xix)**

History and Evolution of Technology

- **Technology has been the driving force in the evolution of society from an agricultural to an industrial to an information base.**

Students:

- **Explain how technological inventions and innovations have cause global growth and interdependence, stimulated economic competitiveness, created new jobs, and made other jobs obsolete. (Each volume in *STW* focuses on a particular technological or technical career.)**

Impacts of Technology

- **Technology can have positive and negative impacts on individuals, society, and the environment and humans have the capability and responsibility to constrain or promote technological development.**

Students:

- **Explain that although technological effects are complex and difficult to predict accurately, humans can control the development and implementation of technology. (See Wastewater generally; also Plant, Polymers, etc.)**

Management of Technology

- **Project management is essential to ensuring that technological endeavors are profitable and that products and systems are of high quality and built safely, on schedule, and within budget.**

Students:

- **Help to manage a group engaged in planning, designing, implementation, and evaluation of a project to gain understanding of the management dynamics. (Each title in *STW* involves complex group activities that require students to organize their work in meaningful ways.)**

Standard 7: Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Connections

- **The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena**

Students:

- **Analyze science/ technology/society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action. (See, for example, Wastewater, Petroleum, and Drugs generally)**
- **Analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost/benefit and risk/benefit tradeoffs made in arriving at the optimal choice. (See, for instance, Paint, Carbonated, Petroleum, and Semiconductors especially)**
- **Design solutions to real-world problems on a community, national, or global scale using a technological design process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution. (See Wastewater, Forensics, and Semiconductors)**
- **Explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (an if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results. (See, for instance, Carbonated 11-12, 14, 16, 21, 23, 27; Food 12, 14, 15, 17, 20, 24, 30, 31, 33, 37, 40; Drugs 15, 20, 22, 27, 31, 39, 46, 59)**

Strategies

- **Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology, and presenting results.**

Students participate in an extended culminating mathematics, science, and technology project. The project would require students to:

- **Work effectively**
- **Gather and process information**

- **Generate and analyze ideas**
- **Observe common themes**
- **Realize ideas**
- **Present results (Each title in *STW* requires students to work collaboratively on an extended project involving scientific/technological issues—See for instance Plant 2)**

Key to Abbreviations Used:

Carbonated=The Carbonated Beverage Industry
Plant=The Plant Tissue Culture Industry
Pulp=Pulp and Paper Research and Development
Wastewater=Upgrading the Wastewater Treatment Plant
Drugs=Discovering New Medicinal Drugs
Forensics=Forensic Science
Paint=Paint Research and Development
Polymer=Polymer Research and Development
Food=Food Safety
Petroleum=Refining Petroleum
Lab=Medical Laboratory Technology
Semiconductors=Making Semiconductors