IMSA Fusion

IMSA Fusion is a teacher professional development and student STEM enrichment program for Illinois students who are talented, interested and motivated in mathematics and science. IMSA Fusion places a special emphasis on students who are historically underrepresented in those areas. Fusion works with teachers and students in grades 4-8.

In brief, the program goals are:

- Maintain or increase students interest, involvement and literacy in science and mathematics

- Enhance the knowledge and skills of teachers in science, mathematics, and technology; stimulate excellence in schools

- Stimulate excellence in schools' science and mathematics programs

- Help increase access to programming for students who are historically under-resourced in science, mathematics and technology and for all areas of the state

By design, the IMSA Fusion curriculum is inquiry based, problem centered and integrative. The learning experiences focus on helping students "learn how to learn" and emphasize logic, mathematical thinking and experimental scientific thinking. Topics relate to the students' lives, thereby arousing their curiosity and increasing their motivation to learn.. Teachers from each participating school are supported with on-going professional development for the delivery of the curriculum and use of appropriate pedagogy.

Living in a Material World

Designed for Grades 6-8

Materials science is an interdisciplinary field concerned with the understanding and application of the properties of matter. Materials scientists study the connections between the underlying structure of material, its properties, its processing methods, and its performance in applications.

Scholars have long classified eras of ancient civilizations by their progress in materials science, coining such terms the Stone Age, Bronze Age and Iron Age. What is known about ancient cultures, especially those without written records, often comes from a scientific examination of the artifacts they left behind. Advances in materials science often went hand-in-hand with other cultural developments. In many cases it was the development of new materials that enabled advances in other realms of human accomplishment. When neighboring nations and cultures came into conflict, whether economic or military, dominance was often achieved by employing more advanced materials.

Although its importance goes back to antiquity, the concept of material science, as a discipline of study, is rather new. Educational programs at the college level now abound and career opportunities in this field are very rewarding for those with the passion and ability to pursue them.

Students completing this curriculum will understand:

- The course of human civilization often hinged on developments in materials science.
- Technology and engineering require an understanding of quantifiable material properties.
- Material properties are determined by chemical composition and small-scale structure.
- Unknown materials may often be identified by testing their material properties.

Living in a Material World
Unit Summaries

Setting the Stage

This unit introduces students to the importance of material properties by having them select appropriate materials for the design of a complex machine operating in a severe environment. Next, students construct a timeline for the wall of their Fusion classroom. In all subsequent activities, developments in the field of materials science will be placed in historical context using this timeline. Finally, students begin to understand the importance of small-scale structure by performing a kinesthetic simulation of atoms forming a crystal. A conceptual understanding of crystalline structure is important to several subsequent activities.

Age of Stone and Bronze

This unit begins with an activity in which students examine rocks with differing fracture characteristics which depend on crystalline structure. Students design methods for evaluating which rocks make the best tools for cutting and scraping simulated animal hide. Stone tools were replaced by copper and bronze as soon as people discovered how to smelt ores into metals. Students will study the process of copper smelting and then evaluate the material properties of copper, tin, and bronze.

Living in a Material World
Unit Summaries

Wood Works

Wood has many useful properties, including flexibility. Students will experiment with different techniques for making a permanent bend in wooden craft sticks. Once they master the process, students will design and construct a small wooden ship, using curved timber, which must float and hold a cargo. To keep things water-tight, students will make a tar-like caulking compound.

The Iron Age

This unit begins with an experiment in which students simulate the heat treatment of steel in an attempt to improve the temper of pasta “sword blades”. The next activity examines the chemistry of iron. After examining the smelting of iron ore, student look at the reverse reaction of iron corroding into rust. They will exploit a catalyst’s material properties to drastically increase the rate of rust formation. Armed with this experience, students will perform an exercise in forensic engineering to determine why a bridge in Wisconsin recently failed. Finally, they learn about make techniques to make corrosion resistant steel and use their knowledge to identify several samples of unknown metals.

Living in a Material World Unit Summaries

Silicates and Light

This unit begins be examining the interactions of matter and light. Students will experiment with a model to learn why materials have such a wide range of visual appearances. Then students will learn about stained glass. After observing patterns in the design work of architect Frank Lloyd Wright, students will use linear equations to design and create their own work of art.

I'm Rubber, You're Glue

Students will learn why different formulations of rubber have unique material properties. They will make super balls, from both natural and synthetic rubber, and evaluate their performance. Finally they will learn about the deadly ball games played in ancient Mezzo America. Students will build scale models of a ball court and experiment with the rules of these games as an exercise in experimental archaeology.

Living in a Material World Unit Summaries

Plastic Dreams

Plastics have revolutionized our manufactured world but they have also raised serious environmental issues. Students will examine the chemical and material structure of different plastics. They will perform research before engaging their peers in a debate about one of the many environmental aspects of plastics production, recycling, and biodegradation.

Textiles

Students take on the role of clothing designers in this problem-centered unit. Customers need fabrics which meet their specific requirements. Before making the best possible recommendations, students will need to perform many experiments to determine the material properties of both natural and synthetic fibers and fabrics.

Living in a Material World Unit Summaries

Tag Team Secret Messages

In the lesson “Tag Team Secret Messages” students form teams and choose an encryption method previously learned from the unit to encrypt a list of phrases. Keeping the method a secret, they pass their coded list of phrases to another team to decipher. A variety of strategies will be used by the teams to uncover the method of encryption.

Who Holds the Key?

Today’s secure internet protocols are derived from a system known as “public key encryption” which makes use of one-way functions. In “Who Holds the Key?” students will be introduced to an asymmetric cipher and will learn the reasoning behind using an asymmetric cipher. Then, students will use graph theory and the idea of one-way functions to construct a Perfect Code public key cryptosystem for other teams to try and crack.

Secret Communications: Sharing Concealed Messages Unit Summaries

Secret Codon: A Genetic Cipher

“Secret Codon: A Genetic Cipher” explores the way the human body uses DNA codes to build the various proteins that make each human unique. An internet-based animation will allow students to observe the processes of transcription and translation which allows protein synthesis to occur in the cells. Students will encode a message using a table of DNA codons, send the complementary codons to a partner to be transcribed into mRNA, and then use an mRNA Secret Codon Wheel to decode the message.

The Final Challenge

“The Final Challenge” is an integration of the knowledge gained of some basic encryption approaches with the creativity, tenacity, and persistence needed to follow a trail of encrypted messages that lead the teams to a final goal. This lesson requires teamwork and advanced inquiry techniques as students race to complete the challenge and reach the goal so that they can assist others in the task.

Living in a Material World
Unit Summaries

Outta this Material World

In this final unit, students examine familiar classroom objects with the eye of a materials engineer. They relate the object's function with its designer's choice of materials. Moving beyond the familiar, students research the most challenging task for a materials scientist, the design of a space suit which protects an astronaut in the extreme environment of space.