

Theories of Time Travel: Spacetime Physics and Wormholes

Grades 6, 7, 8

If we could unify quantum gravity, quantum mechanics, and general relativity into one theory, physicists argue that time travel would be possible. Journey with us through a study of black holes, negative energy, and cosmic strings as we research current theories of time travel. Study the experiments of physicists around the world and what they have revealed about paradoxes and mutable timelines. Create your own theory of time travel based on your research.

Catapults to Curveballs: The Physics of Projectile Motion

Grades 6, 7, 8

If you have ever launched a model rocket or kicked a field goal, you have explored the amazing world of ballistics. Ballistics is the study of projectiles and projectile motion. Investigate how air resistance and spin affect the flight of projectiles. Use mathematical computations and physics to forecast how far projectiles will fly and where they will land. Build your own devices such as slingshot catapults and water rockets to predict the path of objects. Was your 3-pointer shot more than luck? Come find out!

Chemistry: The Essential Element

Grade: 6, 7, 8

Welcome to the laboratory that is the world in which you live. Experiment with domestic chemicals, environmental materials, foods, and living organisms to discover the chemical nature of substances, their properties, reactions, and uses in daily life. Engage in a series of experiments to test your hypotheses about the reaction of substances. Investigate chemical solutions to everyday challenges and unleash the chemist in you.

Smart Cities: Reimagining Urban Infrastructures

Grades 6, 7, 8

From data-optimized traffic lights to hydrogen-powered taxis, the modernization of networks and data offer many solutions to the livability and sustainability of cities. Set out on a journey across the globe into cities utilizing intelligent infrastructures such as Amsterdam, Copenhagen, Dubai, Hong Kong, New York City, and Oslo to explore how the Internet of Things (IoT) can optimize services in transportation, healthcare, security, economic development and housing, waste, and water. Investigate how sensors and data networks collect data on energy usage, pollution levels, and other topics to correct and predict usage and patterns. Debate how intelligent systems can become a breach of privacy and undermine our freedoms to make decisions. Propose how technology and innovation can reimagine a city near you.

Geometry and Spatial Sense

Grades 6, 7, 8

Spatial understanding is necessary for interpreting, understanding, and appreciating our inherently geometric world. Many everyday tasks such as designing a treehouse, solving a jigsaw puzzle, or laying out a garden require spatial reasoning abilities. This course will help you develop those abilities through discussions and hands-on investigations. You'll explore mathematical relationships such as congruence, symmetry, and

reflection; learn geometric formulas to calculate area, surface area, perimeter, circumference, and volume; and explain your findings using geometric terminology. You and your classmates will explore the geometric properties of regular polygons and create your own polyhedra using paper-folding techniques. By creating two- and three-dimensional drawings and physical models, you'll study tessellations, similarity, measurement, polygons, and curved shapes. You'll leave this course with a solid understanding of foundational geometry concepts and a well-developed spatial sense.

Biopsychology

Grades 9, 10, 11, 12

Why do you react a certain way or feel the way you do in response to external influences? The answer may be found in biopsychology, a branch of psychology that deals specifically with how the brain and neurotransmitters act upon the body, influencing what we do, say and feel. This field leans heavily on neuroscience and includes the study of the brain, the nervous system, and neurotransmitters. Anatomy, physiology, and statistics are also essential in the study of biopsychology. Embark on a study of science and math to gain an understanding of the biological processes that stimulate your thoughts, behaviors and feelings.

Green Technologies: The Hue of the Future

Grades 9, 10, 11, 12

Sustainable technology or green technology helps reverse the harmful effects of human behavior on our environment. From clean energy, reducing negative impacts of greenhouse gasses, to preserving Earth's resources, come propose new ways to use technology that promotes conservation and sustainability. Use creative problem-solving processes to propose innovative solutions that create a synergy between environment benefits and economics. Explore the role government and policy play in the journey towards a greener human lifestyle. Investigate how ingenuity and imagination can open resourceful solutions such as vertical farming, living buildings, bio-degradable bodies, and edible pollution. Educate others and advocate for green technology that will take off in your future.

Fundamentals of Mathematical Modeling

Grades 9, 10, 11, 12

Have you wondered how anthropologists reconstruct skulls or astronomers detect new planetary systems? It's in the art and science of mathematical modeling! Mathematical modeling uses tractable mathematical formulations and numerical analyses to provide insight, answers, and guidance with the undiscovered, unexplainable, and unimaginable world around us. Work in project teams to analyze problems, formulate mathematical models, and calculate solutions to validate results. Use advanced mathematics and modeling structures to define, improve, and evaluate real-world challenges. Make mathematical sense of global challenges and use abstract reasoning to forecast solutions for the future. (Prerequisite: Algebra I)

Discrete Mathematics

Grades 9, 10, 11, 12

How do we know we need more area codes or identify hacked or illegal servers? These scenarios are addressed through combinatorics and graph theory, in other words, discrete mathematics! Discrete mathematics is the

study of mathematical structures that are countable, distinct, and separable. Investigate how the math of combinatorics allows you to count things that are much too large to be counted conventionally. Explore how to solve real-world puzzles or explain the food chain through graph theory. Use discrete structures such as set theory, probability, logic, and statistics to learn different approaches to problem solving. Solutions to our world's most challenging problems may not be as discrete as you think!

Astrophysics

Grades 9, 10, 11, 12

When the sun runs out of fuel, will it explode in a giant supernova or fade into a white dwarf? Does every galaxy revolve around a supermassive black hole? Will the universe keep expanding or eventually collapse upon itself? Astrophysics—the study of the physical laws governing astronomical objects and the universe—is key to determining how the universe started, how it works, and where it's headed. In this course, you and your classmates will learn about scale and distances between planets, stars, and galaxies. You'll explore stellar evolution; the birth, life, and death of stars and their inner workings; and consider how objects such as neutron stars and black holes are formed. You'll investigate galaxies, including the Milky Way, comparing their shapes, compositions, and rotational speeds, and calculate distances to other galaxies using Hubble's Law. Lastly, you'll explore topics in modern cosmology, such as the Big Bang and inflationary universe hypotheses, and consider the ultimate fate of the universe.

Biotechnology

Grades 9, 10, 11, 12

The Human Genome Project has sequenced all of the approximately 20,000 genes in human DNA. How did scientists gather this information? Can it help cure congenital diseases or cancer? What ethical questions does it present? This course explores the intersection of biology, genetics, and technology and its impact on society. You'll review fundamental principles of cell biology and genetics, including mitosis, meiosis, and Mendelian inheritance, and get to know the structure and function of DNA and RNA, sources and types of mutations. You'll explore biotechnology's applications in medicine, aquaculture, agriculture, and industry, and work in the lab to isolate the DNA molecule from common bacteria and split genes using restriction enzymes. You and your classmates will examine DNA vaccines, conduct gel electrophoresis, and model polymerase chain reaction. You'll leave the course with an understanding of how the field of genetics impacts society, current research in molecular biology, and insight into the future of genetic inquiry and technology.

Chemistry in Society

Grades 9, 10, 11, 12

From artificial sweeteners in diet soft drinks to batteries in electric cars, chemistry is integral to our everyday lives. This course investigates chemistry as a means to solving real-world problems. You'll learn about the periodic table, atomic structure, and chemical bonding. In the lab, you and your classmates will investigate solubility, test water samples to identify potential toxins, and participate in a simulation of a town hall meeting to debate how to preserve a community water source. Working in a lab, you'll learn how chemistry is used to improve the world around us. You'll examine alternative fuels, the biochemistry of food, and pharmaceuticals using real-life scenarios simulated in the classroom. You'll conduct calorimetric experiments, prepare biodiesel while investigating alternative fuels, prepare aspirin while learning the healing and toxic properties of pharmaceuticals, and leave the course prepared to take Grades 9, 10, 11, 12 chemistry.

Geometry Through Art

Grades 9, 10, 11, 12

Connections between mathematics and art can be found in every culture. This introductory course explores shapes, properties, and constructions of modern geometry, and analyzes works of art ranging from ancient Greek statues to Salvador Dalí paintings. You'll learn foundational concepts of Euclidean geometry such as lines, angles, triangles, and other polygons, tessellations, and two-dimensional symmetry. Using what you've learned about points, lines, and planes, you'll investigate the development of perspective in Renaissance art before venturing into three dimensions, analyzing polyhedral and considering their place in ancient art. Finally, you'll explore non-Euclidean geometry and its connections to 20th-century art, including the drawings of M.C. Escher. Through lectures, discussions, modeling, and group work, you and your classmates will gain a strong foundation in geometry and an appreciation for the mathematical aspects of art.

The Golden Ratio: Nature's Number

Grades 9, 10, 11, 12

Some of the greatest mathematical minds of all ages, from Pythagoras and Euclid in ancient Greece, through the medieval Italian mathematician Leonardo of Pisa and the Renaissance astronomer Johannes Kepler, to present-day scientific figures such as Oxford physicist Roger Penrose, have spent endless hours over this simple ratio and its properties. Biologists, artists, musicians, historians, architects, psychologists, and even mystics have pondered and debated the basis of its ubiquity and appeal. In fact, it is probably fair to say that the Golden Ratio has inspired thinkers of all disciplines like no other number in the history of mathematics. The ratio goes far beyond the world of science and mathematics to include the works of DaVinci and Dali in art and French composers Satie and DeBussy in music. Students will also consider the use of the ratio in architecture and advertising.