3D Science Unit Planner

Marietta City Schools

Grade & Course: Physical Science 9-12	Topic: Energy	Duration: 4 weeks
Teachers: MHS Physical Science PLC Teachers	Unit 4 Energy	

Georgia Standards and Content:

SPS4. Obtain, evaluate, and communicate information to explain the changes in nuclear structure as a result of fission, fusion and radioactive decay.

A. Develop a model that illustrates how the nucleus changes as a result of fission and fusion.
B. Use mathematics and computational thinking to explain the process of half-life as it relates to radioactive decay. (Clarification statement: Limited to calculations that include whole half-lives.)
C. Construct arguments based on evidence about the applications, benefits, and problems of nuclear energy as an alternative energy source.

SPS7. Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.

a. Construct explanations for energy transformations within a system. (Clarification statement: Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.)

b. Plan and carry out investigations to describe how molecular motion relates to thermal energy changes in terms of conduction, convection, and radiation.

c. Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels).

d. Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves.

Topics to Cover:

- **Types of Energy (chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear)**
- **Nuclear - Fission/Fusion - Radioactive Decay and Half-life**
- **Molecular Motion - conduction, convection, and radiation**
- **Specific Heat - insulation**
- **Phase changes - heating and cooling curves**

Lesson Content:

Definitions of Energy: Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. ● That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ● At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

Conservation of Energy and Energy Transfer ● Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. ● Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.

Energy in Chemical Processes and Everyday Life ● Although energy cannot be destroyed, it can be converted to less useful forms--for example, to thermal energy in the surrounding environment. ● Energy is also stored in the electric fields between charged particles and the magnetic fields between magnets, and it changes when these objects are moved relative to one another. ● The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and energy transfers by convection, conduction, and radiation (particularly infrared and light). ● In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures. ● Temperature is a measure of the average kinetic energy of particles of matter. ● The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. ● The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. Energy is transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation.

Narrative / Background Information

Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)
Units 1-4 Atomic Structure and Nuclear Reactions, Periodic Table, Chemical Bonding and Chemical Reactions, Atomic & Molecular motion, and Forces and Motion laid the foundation for completion of this unit.
The students rising to 9th grade in Fall 2021 may never have seen the 8th grade science classroom at all.
Link to GSE 8th Grade Science
These students have been exposed to the 8th Science GSE that lays the foundation for the high school Physical Science standards.
For this Unit and the ones that follow:
Students will need a basic knowledge of algebra and the basics of atomic and molecular structure

Year-Long Anchoring Phenomena: (LEARNING PROCESS) Operation of cars

Unit Phenomena (LEARNING PROCESS
Candles can be used to power a toy car. https://youtu.be/1lLqL6lR8XI

The candle-powered car is an application of the Seebeck Effect (Thermoelectric Effect). This effect is the result of thermal energy conversion directly into electricity. This phenomenon can be used to show energy conversion from heat to electricity to the kinetic energy of the car. A more detailed explanation will be required related to electron response to temperature differences in different materials. The Seeback circuit used in this candle-powered car can also be connected to a voltmeter and used as a temperature sensing thermocouple.

Amazon Link to purchase car (if requested):
https://www.amazon.com/Exergia-4032066066009-Candle-Car-Kit/dp/B00GA095MI

Nuclear Fission & Fusion - Nuclear Applications
There is a great deal of energy stored in the nucleus of an atom that can be harnessed for electrical power production but the use of nuclear power does come with risks.
Chernobyl Video

Inquiry Statement: Scientific and technical innovations allow us to observe, investigate, and analyze the movement and transfer of energy between systems in order to design products with desired features.

Global Context/Exploration: Scientific and technological innovation

Science & Engineering Practices:	**Disciplinary Core Ideas: (KNOWLEDGE & SKILLS)**	**Crosscutting Concepts: (KNOWLEDGE & SKILLS)**
SEP: • Develop and Use Models • Construct explanations • Plan and carry out investigations • Analyze and interpret data • Use mathematics and computational thinking ATL: • Make inferences and draw conclusions • Collect, record, and verify data **Thinking (or critical thinking)**: Draw justifiable conclusions based on processing, interpreting and evaluating data gained from scientific investigations. **Communication (or interaction):** Use appropriate scientific terminology, data tables and graphs to make the meaning of your findings clear to an audience of your peers.	Types of Interactions The strong and weak nuclear interactions are important inside atomic nuclei—for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones. Definitions of Energy Conservation of Energy and Energy Transfer Energy in Chemical Processes	**Energy and Matter** **Systems and Systems Models** **Key and Related Concepts:** Systems (Key) Related: Energy Movement

Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)

Common Misconceptions about Energy

1. Energy is truly lost in many energy transformations.
2. There is no relationship between matter and energy.
3. If energy is conserved, why are we running out of it?
4. Energy can be changed completely from one form to another (no energy losses).
5. Things “use up” energy.
6. Energy is confined to some particular origin, such as what we get from food or what the electric company sells.
7. An object at rest has no energy.
8. The only type of potential energy is gravitational.
9. Gravitational potential energy depends only on the height of an object.
10. Doubling the speed of a moving object doubles the kinetic energy.
11. Energy is a “thing.” This is a fuzzy notion, probably because of the way we talk about newton-meters or joules. It is difficult to imagine an “amount” of an abstraction.
12. The terms “energy” and “force” are interchangeable.
13. From the non-scientific point of view, “work” is synonymous with “labor.” It is hard to convince someone that more “work” is probably being done playing football for one hour than studying an hour for a quiz.

Key Vocabulary: (KNOWLEDGE & SKILLS)

Types of Energy and Conservation of Energy	Nuclear Energy	Thermal Energy	Optional: Energy Sources and the Environment
energy **work** **force** **system** **chemical energy** **mechanical energy** **electromagnetic energy** **light** **sound** **thermal energy** **electrical** **nuclear energy** **kinetic energy** **potential energy** **elastic potential energy** **chemical potential energy** **gravitational chemical energy** **law of conservation of energy** **projectile motion** **power** **friction**	**fission** **fusion** **radioactive decay** **half-life** **isotopes**	**temperature** **thermal energy** **heat** **specific heat** **heat transfer** **average kinetic energy** **conduction** **convection** **convection currents** **radiation** **solar radiation** **thermal insulator** **solar collector** **thermodynamics** **heat engine** **heat pump** **internal combustion engine** **heating curve** **cooling curve** **phase changes**	**fossil fuel** **combustion reactions** **petroleum** **fractional distillation** **nonrenewable resources** **natural gas** **coal** **renewable resources** **photovoltaic cell** **hydroelectricity** **wind energy** **geothermal energy** **biomass** **energy transformations** **environmental impacts** **population** **carrying capacity** **pollutant** **hazardous waste** **photochemical smog** **acid precipitation** **agriculture** **deforestation** **urban development**

Inquiry Questions:

Factual - What is the energy associated with motion?

What is potential energy?

What type of energy is stored in the nucleus of the atom?

What is radioactivity?

What is half-life?
What is the main source of energy for earth?

Conceptual – What makes heat rise?

When does the breaking of chemical bonds release energy?

How can a material at a certain temperature have all of its molecules at the same energy?

How do nuclear reactions show the changes in an atom's nucleus?
How does half-life demonstrate the instability of certain isotopes?

Debatable - What are some other ways to save energy in a car besides turning off the air conditioner and rolling down the windows?

Since gravity is unlimited, can we use it as an infinite energy source?

What are the advantages and disadvantages of nuclear power?
Do the advantages of nuclear power outweigh the disadvantages?

Formative: Assignments and set CFA's will be given throughout the process

Summative: Students will be formatively and summatively assessed throughout the unit and then the students will take a common summative assessment over all of standard 7. Common formative assessments will be give 2x throughout the process to be able to identify areas of need before the CSA.

Unit Objectives: Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.

Learning Activities and Experiences	Inquiry & Obtain: (LEARNING PROCESS)	Evaluate: (LEARNING PROCESS)	Communicate: (LEARNING PROCESS)
Week 1:	Students will complete a choice board project over the types of energy or other project Energy Intro Project Types of Energy Exploration Discovery Education https://google.discoveryeducation.com/learn/player/293b465e-f3c6-44cc-a26f-19445bf6e343 Students will examine open and closed systems and explain how energy is conserved and that a change in energy means work has been done. Exploring Heat Discovery Education - Studio Board and Exploration https://google.discoveryeducation.com/learn/signin?next=https%3A%2F%2Fstudio.discoveryeducati	Students will complete a graphic organizer summarizing each type of energy Energy types Studio Board - Investigation completion	Choice board completion and sharing of product CFA

	on.com%2Fview%3Fid%3D5e2ac4c1-260d-4a67-abae-8b0d03213b63 Calculating Heat Energy https://app.discoveryeducation.com/learn/player/4d15aa4b-bc9f-4750-9b78-cb88aea67ffd **Students will be able to explain the concept of heat capacity and how to figure out the amount of energy transferred between substances through taking notes, performing practice questions, and participating in demonstrations.** **Energy Transformations Conduction, Convection, and Radiation** **GaVS - Heat Transfer** **http://cms.gavirtualschool.org/Shared/Science/PhysicalScience15/Energy_Shared/PhysicalScience_Energy_Shared6.html** **Specific Heat** **https://teaching.betterlesson.com/lesson/635246/specific-heat** Explore through Explain Part II: **PPT & Guided Notes** (Balloon Phenomenon can be substituted in place of soda bottle/blow torch). (Stop before going into calorimetry). http://cms.gavirtualschool.org/Shared/Science/PhysicalScience15/Energy_Shared/PhysicalScience_Energy_Shared7.html	Specific Heat Practice http://cms.gavirtualschool.org/Shared/Science/PhysicalScience15/Energy_Shared/PhysicalScience_Energy_Shared8.html	
Week 2	Nuclear Energy Nuclear Reactions: Fission & Fusion w/ Chernobyl Phenomenon Direct Instruction - fusion, fission, spontaneous radioactive decay Penny Half-Life introduction	Guided Practice - Chernobyl half-life calculation Penny Half-life lab	Half-life of group isotope calculations (C-13, O-18, U-235, U-238, Bi-213) Students need to calculate half-lives and present/write on how soon they will be inert (4 half-lives) Differentiate - Students briefly research the use of their isotope they calculated and present/turn in audio recording

			Penny half-life lab graphs https://drive.google.com/file/d/1WqAf4zQEr89PIs6LYQ5sNhM_-io_AHur/view?usp=sharing
Week 3:	**Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels).** **Too Hot to Handle Virtual Lab** **https://app.discoveryeducation.com/learn/player/6932e175-5707-4469-bbdc-97cd6957882b** **Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves.** **CK12 Exploration Phase Change Simulation** **https://interactives.ck12.org/simulations/chemistry/phases-of-matter/app/index.html?screen=sandbox** Students will review and practice the previous knowledge gained.	Heating and Cooling Curves Heating and Cooling Curves Pre-Assessment (What do students recall from States of Matter?) https://www.ck12.org/c/chemistry/heating-and-cooling-curves/asmtpractice/Heating-and-Cooling-Curves-Practice/?collectionCreatorID=3&conceptCollectionHandle=chemistry-::-heating-and-cooling-curves&collectionHandle=chemistry#	Too Hot to Handle Virtual Lab Completion CFA CSA
Differentiation Strategies	• **Student Choice** • **Shared interest centers** • **Immediate Feedback with opportunities to re-submit without penalty** • **3D Assessments / Tiered Assessments** • **Go Further Activities**		

Resources (hyperlink to model lessons and/or resources):
Resources are created and shared within the professional learning community (PLC) of all Physical Science Teachers. We collaborate on creating quality learning experiences for all students within the classroom environment.

NGSS Physical Science Framework:
https://www.nextgenscience.org/sites/default/files/HS%20PS%20topics%20combined%206.12.13.pdf

Discovery Education / GPB Physics in Motion Series/ CK12

Holt Science Spectrum Physical Science Textbook

Work and Energy Textbook Chapter (Sections 2-3)
https://drive.google.com/file/d/1ileCCV7DvbY5R8OG2flTwJWTjCJKpbdG/view?usp=sharing

Thermal Energy Textbook Chapter
https://drive.google.com/file/d/1pJCRVzGStsndyiqnmKCSBjPSketqhq82/view?usp=sharing

Energy Sources and the Environment Textbook Chapter

https://drive.google.com/file/d/1Maa_beog6lOq_ymcShCXY2uY_zh6FBQU/view?usp=sharing

Group Schoology Resources

Other Sites for Interactives and Practice:
Positive Physics
The Physics Classroom
Phet Simulations
GSE Website for Physical Science
https://www.georgiastandards.org/Georgia-Standards/Pages/Science-Physical-Science.aspx

Reflection: Considering the planning, process and impact of the inquiry

Prior to teaching the unit	During teaching	After teaching the unit
After teaching the units as written last year, nuclear should be moved to this unit and not in the chemistry section of the course. Find engaging ways for students to explore heat transformations	Revisit previous units - spiral concepts and vocabulary that were introduced earlier Examples: Isotopes, phase change, molecular motion	Incorporate some of the optional content so students are aware of the energy resources and their impacts on the environment