International Baccalaureate
Baccalauréat International
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3D Science Unit Planner

Marietta City Schools

MARIETTA CITY SCHOOLS

Grade & Course: Physical Science	**Topic: Forces and Motion**	**Duration: S2 5 weeks**
Teachers: Physical Science PLC		

Georgia Standards and Content:

SPS8. Obtain, evaluate, and communicate information to explain the relationships among force, mass, and motion.

a. Plan and carry out an investigation to analyze the motion of an object using mathematical and graphical models. *(Clarification statement: Mathematical and graphical models could include distance, displacement, speed, velocity, time and acceleration.)*

b. Construct an explanation based on experimental evidence to support the claims presented in Newton's three laws of motion. *(Clarification statement: Evidence could demonstrate relationships among force, mass, velocity, and acceleration.)*

c. Analyze and interpret data to identify the relationship between mass and gravitational force for falling objects.

d. Use mathematics and computational thinking to identify the relationships between work, mechanical advantage, and simple machines.

Topics to Cover: Part 1: Forces and Motion Part 2: Newton's Laws and Gravity Part 3: Mechanical Advantage

Lesson Content:

Part 1: Forces and Motion
Lesson 1: Motion - velocity/acceleration / distance/displacement

Lesson 2: speed/average speed s=distance/time / velocity/average velocity v=displacement/time / Acceleration (a = Vf - Vi/t)
Graphs- distance/time - velocity/time

Part 2: Newton's Laws and Gravity (Falling objects)

Lesson 3: Newton's Laws (1st, 2nd, 3rd)

Lesson 4: Relationships between mass and gravitational force for falling objects

Part 3: Mechanical Advantage
Lesson 5: Work/Power - (effort/resistance force and displacement) and Simple Machines (lever and inclined plane families)

Narrative / Background Information

Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)

Units 1-3 Atomic Structure and Nuclear Reactions, Periodic Table, Chemical Bonding and Chemical Reactions, and Atomic & Molecular 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 not been exposed to the 8th Science GSE that lay 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 sometimes working with right triangles.
Basic knowledge of forces and acceleration
Basic F=ma calculation (using triangle method)
Basic overview of Newton's 3 laws

Unit Phenomena (LEARNING PROCESS)

Part1: The swirling motion continues even after you have stopped stirring your coffee or tea.

Part 2: Seatbelts and airbags make use of Newton's Laws to prevent serious injury.

Part 3: Changes in limb posture affect muscle forces by altering the mechanical advantage of the ground reaction force.

Inquiry Statement: Scientific and technological modeling allow for identification of consequences and effects of movement to identify relationships.

Global Context/Exploration:
Scientific and Technical Innovation

Science & Engineering Practices:

- **Planning and carrying out investigations**
- **Analyzing and Interpreting data**
- **Using Mathematical and Computational Thinking**
- **Constructing Explanations and Designing Solutions**
- NOS Connection: Science models, Laws, and Mechanisms, and Theories Explain Natural Phenomena

Disciplinary Core Ideas: (KNOWLEDGE & SKILLS)

PS2.A: Forces and Motion

● For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first but in the opposite direction (Newton's third law).

● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change.

● The greater the mass of the object, the greater the force needed to achieve the same change in motion.

● For any given object, a larger force causes a larger change in motion.

● Forces on an object can also change its shape or orientation.

● All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame.

● Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. In any system, total momentum is always conserved.

SPS2.B: Types of Interactions

● Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—for example, Earth and the sun. Long-range gravitational interactions govern the evolution and maintenance of large-scale systems in space, such as galaxies or the solar system, and determine the patterns of motion within those structures.

● When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. For example, when energy is transferred to an Earth-object system as an object is raised, the gravitational field energy of the system increases. This energy

Crosscutting Concepts: (KNOWLEDGE & SKILLS)

Patterns
Cause and Effect
Systems and System models

Key and Related Concepts:

Key: Relationships
Related: Consequences/Effects and Movement

Approaches to Learning (ATLs):

Communication

I. Communication skills: Exchanging thoughts, messages and information effectively through interaction

- Organize and depict information logically
- Make inferences and draw conclusions

Research

VI. Information literacy skills: Finding, interpreting, judging and creating information

- Collect, record, and verify data
- Practice analyzing and attributing causes for failure

ATL's need to be taught explicitly using a noncontent example then move into using them directly with content.

- Use thinking maps to show students how to organize information thinking-maps-overview-71525044.jpeg
- Provide students with an example of how to make inferences and draw conclusions Making Inferences & Drawing Conclusions
- Demonstrate how to collect, record and verify data from a very practical easy investigation
- Give students a data set to analyze and then take the steps to determine strengths and weaknesses of the investigation used to collect the data

Thinking

VIII. Critical-thinking skills

- Analyzing and evaluating issues and ideas
- Troubleshoot systems and applications

IX. Creative-thinking skills

- Generating novel ideas and considering new perspectives

	is released as the object falls; the mechanism of this release is the gravitational force. **PS3.A: Definitions of Energy** ● "Mechanical energy" generally refers to some combination of motion and stored energy in an operating machine. ● Machines are judged as efficient or inefficient based on the amount of energy input needed to perform a particular useful task. Inefficient Machines are those that produce more waste heat while performing a task and thus require more energy input.	● Design improvements to existing machines, media and technologies X. Transfer skills ● Using skills and knowledge in multiple contexts ● Combine knowledge, understanding and skills to create products or solutions

Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)
Some of the common ones that you will find include:

Part 1: Forces and Motion
That motion implies force and acceleration is always the direction of motion
Difference between scalar and vector forms of measurements (distance vs displacement, speed vs velocity)
The constant/average velocity equation cannot be used to solve for an instantaneous velocity to substitute into a kinematic equation (involving acceleration).
Meaning of slope of different motion graphs and how to find it. Many students simply divide the final x,y coordinate instead of calculating the slope.
Deceleration should be thought of as a negative acceleration if the initial direction of motion is declared positive. This has large consequences for solving kinematic equations.

Part 2: Newton's Laws
Newton's 3rd law causes forces to cancel out making objects not move.
Cannot correctly identify reaction forces.
Identifying Normal Force.
Misconception: Mass and weight are the same thing.

Part 3: Mechanical Advantage
Power is the same as force or work.
How the mechanics of the machine affects the efficiency of the machine

Content/Key Vocabulary: (KNOWLEDGE & SKILLS)
Split the unit into Part 1 Forces and Motion, Part 2 Newton's Laws, and Part 3 Mechanical Advantage

Part 1 Forces and Motion	Part 2 Newton's Laws	Part 3 Mechanical Advantage
scalar vector motion displacement distance speed constant speed meters/second average speed instantaneous speed coordinate systems	force Joule (J) Newton (N) unbalanced forces net force normal force friction static friction sliding friction rolling friction gravity The Law of Universal Gravitation	work machine simple machine compound machine efficiency mechanical advantage mechanical disadvantage moment arm parallel force perpendicular force applied force

x- axis y-axis position time 1 dimensional motion distance time graph velocity momentum relative motion velocity acceleration velocity time graphs horizontal motion vertical motion	gravitational field mass weight Newton's 1st law inertia Newton's 2nd law Newton's 3rd law air resistance terminal velocity free fall centripetal force law of conservation of momentum propulsion	horizontal force vertical force lever wheel and axle pulley inclined plane wedge screw input work output work

These questions are related directly to the key concepts, related concepts, and global context and statement of inquiry. These are taking a step further from the content questions.

Inquiry Questions:

Factual -

What is the difference between constant velocity, average velocity, and instantaneous velocity?

What does the slope and area under displacement-time, velocity-time, and acceleration-time graphs mean?

What is the acceleration of gravity?

What force attracts all masses together?

What is Inertia?

What is equilibrium?

Conceptual –

When do directions (+, -) need to be assigned?

How can the fall time of an object be determined?

How can the stopping distance of a car be determined?

What is the difference between mass and weight?

What factors affect the force of friction?

Debatable -

Who would win a race between a person and a car?

How can a car be designed to be safer in a collision?

MYP A https://docs.google.com/document/d/1Y89kT1wQ-9CtHgxcydMmfNRIsqps4VO04FsR3r1Jurw/edit?usp=sharing Students assessed on their knowledge and comprehension of	**Formative Assessments:** **CFA 1 SPS8a** **Forces and Motion** **CFA1 - Part 1** **CFA 2 SPS8bc**	**Summative assessment** **CSA over Parts 1,2,3** **Relationship between summative assessment task(s) and statement of inquiry:** **Students were assessed over the concepts and the relationships of how kinematics can be used to model and interpret the motion of objects.**

distance, displacement, speed, and velocity through interpretation of distance time graphs. MYP B and C (TBD) More explicit summary of assessments and how they are used	**CSA SPSabcd**	

Unit Objectives: Obtain, evaluate, and communicate information to explain the relationship among force, mass and motion.

Learning Activities and Experiences	Inquiry & Obtain: (LEARNING PROCESS)	Evaluate: (LEARNING PROCESS)	Communicate: (LEARNING PROCESS)
Part 1: Forces and Motion **Lesson 1: Motion: Velocity and Acceleration / distance and displacement**	Motion Mapper speedvelocityacceleration Tumble buggies Paper Airplane lab Motion detector graphing activity Google Slides 1D Motion https://docs.google.com/presentation/d/1Hke8BmVkvqPrAej7Q3l80fvzVkoIAg3BP1-NyNz9b_8/edit?usp=sharing	**Holt Science Spectrum Physical Science Textbook Motion** https://drive.google.com/file/d/1NqWilmxR0yMxLmf3A9z6hb3ch0NF0UXG/view?usp=sharing	CER Graphing Practice Lab+Tumble+Buggy Airplane+Velocity+Lab.pdf
Lesson 2: Speed, Velocity, and Acceleration Graphing	Unit 2 Physics in Motion - Videos used with guided notes and practice (student handouts) https://www.gpb.org/physics-in-motion PhET Activity Crash Test Phenomenon Pulling Gs phenomenon	Discovery Education Simulation Calculating safe speed vs. rollover acceleration in turning a car	Presentation forceandmotionhomework
CFA1 Forces and Motion	Schoology AMP Assessment on Forces and Motion	Discovery Education Exploration	Data Dig Discussion
Part 2: Newton's Laws and Gravity (Falling Objects) **Lesson 3: Newton's 1st, 2nd, and 3rd Laws**	Discovery Education Reading Passage	**Forces and Newton's Laws** https://drive.google.com/file/d/1-9fuRgdwgeW65CwCvKrQyyO79vU5brIO/view?usp=sharing	

Lesson 4: Relationships between mass and gravitational force for falling objects	cK-12 Activity		CER Parachute Project
CFA2 Newton's Laws and Gravity (Falling Objects)	Schoology AMP Assessment on **Newton's Laws and Gravity (Falling Objects)**		Data Dig Discussions
Part 3: Mechanical Advantage and Simple Machines **Lesson 5: Mechanical Advantage: Work, Power, & Simple Machines**	Simple Machines Internet Lab (1)	**Work and Energy (Section 1)** **https://drive.google.com/file/d/10HV3hWx9fHyHIBI8oucRBhVmzvrvvTwH/view?usp=sharing** Simple Machines Project	Gallery Walk Feedback
CSA Unit 4 SPS8abcd	Schoology AMP Assessment over Parts 1-3 Cumulative		Data Dig Discussions

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.

Unit 4: Google Drive Resources
https://drive.google.com/drive/folders/1RWDfFooJ5YpQr81CT1iKXUtF3HFS9hhF?usp=sharing

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

Discovery Education: Chemistry Science Techbook
Holt Science Spectrum Physical Science Textbook
Motion
https://drive.google.com/file/d/1NqWilmxR0yMxLmf3A9z6hb3ch0NF0UXG/view?usp=sharing

Forces and Newton's Laws
https://drive.google.com/file/d/1-9fuRgdwgeW65CwCvKrQyyO79vU5brIO/view?usp=sharing

Work and Energy
https://drive.google.com/file/d/10HV3hWx9fHyHIBI8oucRBhVmzvrvvTwH/view?usp=sharing

Student Resources
https://drive.google.com/file/d/1NN2OCNKH42kwSedtmhHF9XzIY6lxsEaY/view?usp=sharing

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
General DE Chapter Resources:
Interactive Periodic Table
Interactive Glossary
Engage & Explore Activities
Explorations
Virtual Labs
Skill Builders
Video Segments
CK12 High School Chemistry Flexbook/Adaptive Practice
Shared Physical Science Resources
https://marietta.schoology.com/group/4621413779/materials?f=231800526#/group/4621413779/materials

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

Prior to teaching the unit	During teaching	After teaching the unit
Decided order and split up into parts to make the unit more manageable for both students and teachers Resources were collected and organized before the beginning of the unit to ensure that the PLC had all resources to set up and teach the unit effectively	Scaffolding with all problems will be used. Examples: GUESS method -G = givens U = Unknown E = Equation S = Substitute S = Solve Variable Bank/Formula/Plug and Chug Tumble Buggies and Airplane lab were very useful in helping the students gather data, analyze data, model and graph data to show understanding of distance, displacement, speed, velocity, and acceleration.	