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UNIT NARRATIVE

Students will start off this unit by observing a skater on a vert ramp and asked to describe the motion of the skater. This activity will be followed by a brief history of Galileo who was the first person to describe inertia. Students will then be introduced to Newton's First Law of Inertia. Students will then explore what motion is and the effect of balanced and unbalanced forces. Students will distinguish between speed and velocity in linear motion, calculate average speed and describe the motion of an object using distance time graphs. Finally, students will apply all of the learning from the unit to building roller coasters. This will expand on the roller coasters the students built in 6th grade. Students will analyze the speed and acceleration of the marble at various locations on their roller coasters.

CONTENT STANDARDS

Below are the standards **taught** and **assessed** in this unit.

Readiness Standards
7.7 Force, motion, and energy. The student describes the cause-and-effect relationship between force and motion. The student is expected to: **7.7A calculate average speed using distance and time measurements from investigations.** **7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;** **7.7C measure, record, and interpret an object's motion using distance-time graphs;** 7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.

UNDERSTANDINGS AND QUESTIONS

Important big ideas and processes for the unit.

Key Understandings
• Inertia is the tendency of an object to resist a change in its state of motion until some force causes its speed or direction to change. Friction is a force that slows down or opposes motion. Without friction, objects would keep on moving at the same speed without slowing down. • Unbalanced forces cause changes in the motion of an object. • If the net force on an object is zero, in other words, the forces are balanced, an object at rest will stay at rest, and a moving object will continue moving in a straight line with constant speed. • Direction describes the line or course that an object is traveling or is aimed to travel. • Distance is a description of how far an object travels between two points. • Displacement is the direction and the distance, in a straight line, from the initial starting point to the ending point. • Average speed is the total distance traveled by an object over a total amount of time. • Instantaneous speed is the speed of an object at a particular moment in time. • A distance vs. time graph shows the distance an object travels over time. They are also referred to as speed graphs because the average speed of an object can de be determined from these types of graphs. • Speed is the rate of change in the distance traveled by an object over a given amount of time. So, speed = distance/time. • Velocity can be defined as the rate of change of an object's position (displacement) over a given amount of time So, velocity = displacement/time. • Acceleration occurs because unbalanced forces act upon an object, causing the object to change its speed or direction

Key Questions
• What is inertia? • What is friction? • In what ways do unbalanced forces affect the motion of an object? • Why can an object with balanced forces still be in motion? • How can you determine if an object is in motion? • How do reference points help us identify if an object is in motion? • What is the difference in distance and displacement? • What is the difference between average speed and instantaneous speed? • How do we calculate average speed? • What information can you obtain from a distance-time graph? • How are speed and velocity similar? How are they different? • What causes an object to accelerate?

ROADMAP

Suggested daily guide for instruction in this unit.

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Lesson 1: Unit Introduction: Inertia, Friction, and Galileo	**SWBAT** describe the principle of inertia and explain how friction affects inertia of motion. **TEKS** 7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object ~~using Newton's First Law of Motion.~~	• Students will observe a skater on a vert. ramp and brainstorm what causes the skater's motion to stop. • Students will explore mass, gravity, and friction on motion using the PhET simulation Energy Skate Park to determine which one stops the motion of the skater. • Students will then engage in a short video about Galileo's Concept of Inertia and a discussion of how friction affects the inertia of motion. • Students will complete an exit ticket in which they are asked to describe the principle of inertia and explain how friction affects the inertia of motion. <u>Vocabulary</u> Inertia Friction	Lesson 1: Unit Introduction: Inertia, Friction, and Galileo

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Lesson 2: Newtons First Law of Motion	**SWBAT** describe how balanced and unbalanced forces change an object's state of motion **TEKS** 7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.	• Students will review net force calculations from 6th grade. • Students will complete a station lab where they see examples of Newton's first law of Motion in action and make observations. • Students will complete a Reading to Learn to acquire more information about Newton's first law of motion. • Students will apply the knowledge they learned in the reading to the station lab to give examples of Newton's First Law. <u>Vocabulary</u> Kinetic friction Net force Normal force Static friction Unbalanced force	Lesson 2: Newton's First Law of Motion
Lesson 3: The 3 Ds of Motion	**SWBAT** differentiate between distance and displacement and describe the motion of an object in terms of distance, displacement, and direction. **TEKS** 7.7B distinguish between ~~speed and velocity in linear motion in terms of~~ distance, displacement, and direction;	• Students will describe the motion of an object in relation to a reference point. • Students will explore the motion of a mealworm and observe and describe the mealworm's distance and displacement. • Students will analyze diagrams and measure and record the direction, distance, and displacement of objects in the diagrams. • Students will analyze diagrams to differentiate between distance and displacement and describe the motion of an object in terms of distance, displacement, and direction. <u>Vocabulary</u> Distance Direction Displacement Motion Reference Point	Lesson 03: The 3 Ds of Motion

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Lesson 4: What is Speed?	**SWBAT** describe the motion of an object in terms of average speed and instantaneous speed. **TEKS** 7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;	• Students will participate in an introductory investigation to collect motion data to being to explore speed. • Students will graph the data from the investigation and analyze the graphical representations of data and describe what story the data tells about the motion of the walkers. • Students will participate in a reading to learn and class discussion to connect the concepts from the investigation and the reading. • Students will distinguish between average speed and instantaneous speed. <u>Vocabulary</u> Average speed Instantaneous speed Rate	Lesson 4: What is Speed?
Lesson 5: Speed Investigation	**SWBAT** conduct an investigation to collect distance and time measurements **TEKS** 7.7A calculate average speed using distance and time measurements from investigations;	• Students will be collecting distance and time data to be used to calculate and graph average speed in future lessons. • Students will use toy pullback cars for this investigation. <u>Vocabulary</u> Average speed	Lesson 5: Speed Investigation
Lesson 6: Calculating Average Speed	**SWBAT** use distance and time measurements from investigation data to calculate average speed **TEKS** 7.7A calculate average speed using distance and time measurements from investigations;	• Students will review data and graphs from the Walk this Way activity. • Students will then discuss how to calculate average speed. • Students will calculate the average speed from the Toy Car Speed investigation from the previous lesson. • Students will complete practice problems where they are given distance and time and asked to calculate the average speed. <u>Vocabulary</u> Average speed	Lesson 6: Calculating Average Speed

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Lesson 7: Distance Time Graphs Part 1	**SWBAT** create distance time graphs using data collected from investigations **TEKS** 7.7C measure, record, and interpret an object's motion using distance-time graphs;	• Students will compare time and distance data of two objects and calculate the average speed of each. • Students will then analyze a graphical representation of the data and complete a I notice, and I wonder chart. The teacher will lead a class discussion around the graph. • Students will then complete a reading to learn activity that describes distance time graphs. • Students will then graph the data from the toy car investigation. • Students will be given data from an investigation and asked to complete a data table, graph, analyze the graph and calculate the average speed. <u>Vocabulary</u> Slope	Lesson 7: Distance Time Graphs Part 1
Lesson 8: Distance Time Graphs Part 2	**SWBAT** interpret and describe motion using distance time graphs **TEKS** 7.7C measure, record, and interpret an object's motion using distance-time graphs; and	• Students will use an Explore Learning Gizmo to practice creating and interpreting distance-time graphs. • Students will practice describing the motion of an object by interpreting a distance-time graph. • Students will be given a description of an object's motion and asked to create a distance-time graph that depicts the object's motions. • Students will analyze and interpret distance-time graphs to describe an object's motion.	Lesson 8: Distance Time Graphs Part 2

Lesson	Objective(s) and Standard(s)	Instructional Notes	Resources
Lesson 9: Speed vs. Velocity	**SWBAT** distinguish between speed and velocity and interpret the motion of an object on a displacement-time graph **TEKS** 7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;	• Students will review displacement from lesson 3 • Students will analyze a displacement-time graph and describe how it is different from a distance time graph. • Students will participate in a reading to learn exercise to learn how to calculate velocity and interpret a displacement time graph. • Students will practice interpreting a displacement time graph and calculating average speed and average velocity given data. • Students will compare and contrast speed and velocity and distinguish between speed and velocity when given descriptions of motion. <u>Vocabulary</u> Velocity	Lesson 9: Speed vs. Velocity
Lessons 10-12: Roller Coasters Force and Motion	**SWBAT** analyze and describe how the velocity of a marble changes as it moves through a roller coaster track and describe the unbalanced forces that cause these changes **TEKS** • 7.7A calculate average speed using distance and time measurements from investigations; • 7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction • 7.7C measure, record, and interpret an object's motion using distance-time graphs • 7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.	The Roller Coaster Force and Motion activity is allotted 3 days. (Lessons 10-12) Day 1- Introduction to acceleration, design coasters, and build. Day 2- Collect data and calculate average speed. Day 3- Graph Average Speed and complete analysis and reflection. Disassemble roller coasters. There is a thinking task and exit ticket for day 1. Teachers should create thinking tasks and exit tickets for days 2-3 based on student data in preparation for the unit assessment. <u>Vocabulary</u> Acceleration	Lessons 10-12: Roller Coasters Force and Motion
2 Flex Days			
Unit Exam			

UNPACKED STANDARDS

Focus standards for this unit.

Standards Clarification		
Standards	**Specificity**	**Notes/Explanations/Examples**
7.7A calculate average speed using distance and time measurements from investigations;	Cognition: Calculate (investigate) Content: average speed Including, but not limited to: Average speed ○ Average speed = total distance / total time ▪ $s = d_2 - d_1 / t_2 - t_1$ ▪ $s = d / t$	This TEKS was previously taught in 6th grade. The wording "from investigations" is new.
7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;	Cognition: distinguish • Speed • Average speed = total distance / total time ○ $s = d_2 - d_1 / t_2 - t_1$ ○ $s = d / t$ • Velocity is expressed by both speed and direction (e.g., 20 km/hr north)	
7.7C measure, record, and interpret an object's motion using distance-time graphs; and	Cognition: measure, record and interpret Content: objects motion Including, but not limited to: • Distance over time • Speed over time • Interpreting and comparing graph lines showing the following scenarios: ○ Constant speed ○ Increasing speed ○ Decreasing speed ○ No motion (stopped)	This TEKS was previously taught in 6th grade.
7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.	Cognition: analyze Content: the effect on balanced and unbalanced forces on the motion of an object Including, but not limited to: • Balanced forces – equal and opposite forces on an object that result in no change in position, direction, or motion; net force equals zero • Unbalanced forces – unequal forces on an object that may result in a change in position, direction, or motion; net force does not equal zero	

Standards Clarification		
Standards	**Specificity**	**Notes/Explanations/Examples**
	• Law of inertia – the tendency of an object to resist change in motion unless acted upon by a force ○ An object in motion will remain in motion, at a constant speed, in a straight line, until acted upon by an unbalanced force ○ An object at rest will remain at rest until acted upon by an unbalanced force ○ Relationship to mass	

VERTICAL STANDARDS

This section details the **progression** of key student expectations/standards** in the courses **before** and **after** this course. This will help you understand what **prior knowledge skills to build upon** and guide you in knowing what **skills you are preparing your students** for in the subsequent course.

Course/Grade	7th Grade	Course/Grade
	7.7A calculate average speed using distance and time measurements from investigations;	
	7.7B distinguish between speed and velocity in linear motion in terms of distance, displacement, and direction;	8.7A calculate and analyze how the acceleration of an object is dependent upon the net force acting on the object and the mass of the object using Newton's Second Law of Motion;
	7.7C measure, record, and interpret an object's motion using distance-time graphs;	

6.7A identify and explain how forces act on objects, including gravity, friction, magnetism, applied forces, and normal forces, using real-world applications; 6.7B calculate the net force on an object in a horizontal or vertical direction using diagrams and determine if the forces are balanced or unbalanced; 6.7C identify simultaneous force pairs that are equal in magnitude and opposite in direction that result from the interactions between objects using Newton's Third Law of Motion.	7.7D analyze the effect of balanced and unbalanced forces on the state of motion of an object using Newton's First Law of Motion.	8.7B investigate and describe how Newton's three laws of motion act simultaneously within systems such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

VOCABULARY GLOSSARY

Domain-specific words and definitions for this unit.

Key Content Vocabulary
List and define key vocabulary terms **Acceleration -** the rate at which an object changes its velocity (speed or direction) **Average speed** - total distance traveled by the object in a particular time interval **Distance -** how far an object travels between two points. **Direction -** the line or course that an object is traveling or is aimed to travel **Displacement** - the direction and the distance, in a straight line, from the initial starting point to the ending point **Friction** - a force that slows down or opposes motion. **Inertia** - the tendency of an object to resist a change in its state of motion until some force causes its speed or direction to change. **Instantaneous speed** - the speed of an object at a particular moment in time. **Kinetic Friction:** a force that acts between moving surfaces **Motion -** as a change in an object's position over a given period of time **Net Force:** the combination of all the forces that act on an object. **Normal Force:** is the support force exerted upon an object that is in contact with another stable object **Rate** – (rate of change) to how much one quantity changes when another quantity changes. **Reference Point -** a place or object used for comparison to determine if something is in motion **Slope** - the gradient of a line and is a number that describes both the direction and the steepness of the line **Static Friction:** friction between two or more solid objects that are not moving relative to each other **Unbalanced Force -** a force that causes a change in an object's state of motion **Velocity-** the rate of change of an object's position (displacement) over a given amount of time. *S*peed in a given direction.

Consumable Materials and Lab Supplies for Unit 1 (1 per group of 4 students unless noted)

Lesson	Commercial Vendor	Lab Supplies (Science Vendor)
Lesson 1: Unit Introduction: Inertia, Friction, and Galileo	None	Devices with internet for PhET simulation and videos
Lesson 2: Newton's First Law of Motion	**Station Lab** Station 1 • Marble • Box Station 2 • Lego Figure • Plastic Halls Carriage Station 3 • Toy Car • Penny Station 4 • Hoop (small embroidery hoop) • Hex nut Station 5 • Cup • Pennies • Index card Station 6 • Metal washers	**Station Lab** Station 3 • Small ramp or ruler • Books Station 4 • Erlenmeyer flask
Lesson 03: The 3 Ds of Motion	Mealworms Markers Small cup	Stopwatch Ruler Chart paper
Lesson 04: What is Speed?	Painter's tape	Stopwatch Meter sticks or open reel measuring tape
Lesson 05: Speed Investigations	Painter's tape Pull-back toy cars Plastic hot wheels tacks	Stopwatch app on an iPad or iPhone Balance Ruler Meter sticks or open reel measuring tape
Lesson 06: Calculating Average Speed		calculators
Lesson 07: Distance Time Graphs Part 1		Calculators Map pencils
Lesson 08: Distance Time Graphs Part 2		One-to-one device with an internet connection
Lesson 09: Speed vs. Velocity		Calculators

Lesson 10-12: Roller Coaster Force and Motion	• 2-3 pieces of foam pipe insulation cut in half lengthwise. (used in 6th grade also so campus should have these supplies) • Masking tape • Marble • plastic or paper cup	Meter stick Stopwatch