Kingsway Regional School District

Committed to Excellence

Course Name: STEM Racing Challenge	**Grade Level(s):** 8
Department: Math	**Credits:** NA
BOE Adoption Date: October 2016	**Revision Date(s):** October 2017; October 2018; September 2022

ABSTRACT

This semester course introduces students to early hands-on engineering lessons. Using the racer challenge remote control car, students will gain an understanding of Newton's three laws of motion, acceleration, forces, work, power, and energy. As motorsports engineers do, students will learn to optimize the vehicle's performance to effectively re-engineer the car using the laws of energy, Newton's Laws of Motion, and data they collect through their hands-on activities.

The course will incorporate concepts related to physics, math, and engineering. Students will need to conceptually understand mathematical concepts in order to be able to apply them to features related to the engineering of their cars. The STEM Racing Challenge is a powerful tool for breaking down traditional subject-matter. In education today, we are often program-heavy and systems-light. The Racing Challenge curriculum and coalition is a catalyst for real change.

The course will be broken up into three major units which include:

- Motion and Forces
- Work, Power, and Energy
- Momentum and Collisions

Proficiencies and Pacing Guide:

Course Title: STEM Racing Challenge
Prerequisite(s): None

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
Unit 1: Motion and Forces	6 weeks Sept-Oct	**Mathematics:** NJSLS.8.EE.B.5, NJSLS. 8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.F.B,5, NJSLS. 8.SP.A.1, NJSLS. 8.SP.A.2, NJSLS.8.SP.A.3, NJSLS.8.SP.A.4, NJSLS. A- NJSLS.REI.10, NJSLS.F-IF.4, NJSLS.S.IC.6. **Science and engineering** NJSLS.MS-PS2-2, NJSLS. MS-ETS1-3, NJSLS.MS-ETS1-4, NJSLS.HS-PS2-1 **Interdisciplinary:** NJSLS.RST.6-8.1, NJSLS. RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 **Technology**: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1 NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4 NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3 NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3 NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 **21st Century Skills & Career Standards:** NJSLS.9.3.ST.1, NJSLS.9.3.ST.2 NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1 NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3 NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5	• Students will be able to communicate observations and information graphically, using tables, and mathematically to describe how an object's relative position, velocity, and direction of motion are affected by forces acting on the object. They will also be able to describe the proportional relationship between the acceleration of an object and the forces applied upon the object. (NJSLS.8. EE.B.5, NJSLS.8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.F.B,5, NJSLS.8.SP.A.1, NJSLS.8.SP.A.2, NJSLS.8.SP.A.3, NJSLS.8.SP.A.4, NJSLS. MS.PS2-2) (1 week) • Students will be able to analyze the relationship between velocity and acceleration and justify which of Newton's laws of motion is demonstrated when presented with an example of a force or forces interacting with an object or objects. (NJSLS.8.SP.A.1, NJSLS.A-REI.10, NJSLS.F-IF.4, NJSLS.S.IC.6. NJSLS.MS-PS2-2, NJSLS.MS-ETS1-3, NJSLS.HS-PS2-1, NJSLS.MS.PS2-2) (2 weeks) • Students will be able to analyze data using one-dimensional motion to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (NJSLS.8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.SP.A.1, NJSLS.8.SP.A.3, NJSLS.MS-PS2-2) (2 weeks) • Students will be able to use mathematical	• Collect data to compare three different methods of motion and calculate average speed for each method as well as different distances for same methods of travel. • Cite evidence to argue the fact that momentum is conserved in an elastic collision, noting the differences between elastic and inelastic collisions. • Determine what factors affect impulse and use mathematical computation and graphs to articulate the impulse. • Construct graphs from collected data, and calculate slope to interpreting graphs involving velocity and acceleration. • Relate the car's motion and speed to Newton's Laws of Motion. • Design an experiment to test Newton's 2nd law, gather data and use the date to calculate average acceleration. • Apply calculations to determine drive time and how it changes with changes in velocity.

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1 NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4 **Career Ready Practices:** CLKS.1, CRP2, CRP4, CLKS.4, CRP7, CLKS.5	representations of phenomena to describe or explain how gravitational force is proportional to mass and inversely proportional to distance squared. (NJSLS.8.SP.A.1, NJSLS.8.SP.A.3, NJSLS.MS-PS2-4) (1 week)	
Unit 2: Work, Energy, and Power	6 weeks Oct-Nov	**Mathematics:** NJSLS.8.EE.B.5 , NJSLS.8.F.B.4, 8.F.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D.10, NJSLS.F-IF.4, NJSLS.A-APR.B.3, NJSLS.A-REI.C.7 **Science and engineering:** NJSLS.MS.LS2-3, NJSLS.MS.PS3-1, NJSLS.MS.PS3-2, NJSLS.MS.PS3-4, NJSLS.MS-PS3-5, NJSLS.MS.ETS1-3, NJSLS.MS.ETS1-4 **Interdisciplinary:** NJSLS.RST.6-8.1, NJSLS. NJSLS.RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 **Technology**: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1, NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4, NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3, NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3, NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 **21st Century Skills & Career Standards:**	• Students will understand how weight affects speed and power and create a mathematical model that describes the relationship between drive time and average speed and between total car weight and power. (NJSLS.8.EE.B.5, NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D10, NJSLS.MS-PS2-2, NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4) (2 weeks) • Students will be able to develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved as well as analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (NJSLS. 8.EE.B.5, NJSLS.8.SP.A.1, NJSLS.A-APR.B.3, NJSLS.A-REI.C.7, NJSLS.F-IF.B.4, NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4) (2 weeks) • Students will be able to describe various types of energy and develop an understanding of the first and second laws of energy. Students will also be able to present arguments to support the claim that when	• Relate the conservation of energy to the concept of how energy transfers from one object to another • Create a mathematical model to describe the relationship between total car weight and power • Generate a quadratic equation that describes a real-life situation • Describe efficiency and performance tradeoff • Design/construct a rubber band powered car

Unit Title:	Duration/ Month(s)	Related Standards:	Learning Goals:	Topics and Skills:
		NJSLS.9.3.ST.1, NJSLS.9.3.ST.2, NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1, NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3, NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5, NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1, NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4 **Career Ready Practices:** CLKS.1, CRP2, CRP4, CLKS.4, CRP7, CLKS.5	the kinetic energy of an object changes, energy is transferred to or from the object. (NJSLS.MS.LS1-6, NJSLS.MS.LS2-3, NJSLS.MS-PS3-5) (2 weeks)	
Unit 3: Momentum and Collisions	6 weeks/ Dec-Feb	**Mathematics:** NJSLS.8.EE.B.5 , NJSLS.8.F.B.4, 8.F.B.5, NJSLS.8.SP.A.1, NJSLS. A-REI.D.10, NJSLS.F-IF.4, NJSLS.A-APR.B.3, NJSLS.A-REI.C.7 **Science and engineering:** NJSLS.MS-PS2-1**,** NJSLS. MS-ETS1-3**,** NJSLS.MS-ETS1-4**,** NJSLS.HS-ETS1-2, NJSLS.HS-PS2-2, NJSLS.HS-PS2-3 **Interdisciplinary:** NJSLS.RST.6-8.1, NJSLS.RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7, NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 **Technology**: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1, NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4, NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3, NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3,	• Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. (NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.F-IF.4, NJSLS.A-REI.C.7, NJSLS.HS-PS2-2) (2 weeks) • Students will be able to describe the boundaries and initial conditions of a system of two macroscopic bodies moving in one dimension and use mathematical representations of the quantitative conservation of momentum and the qualitative meaning of this principle in the system. (NJSLS.8.EE.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D.10, NJSLS.HS-PS2-2) (2 weeks) • Students will be able to apply scientific and engineering ideas, qualitative evaluations, and algebraic manipulations to solve a design problem for a device that minimizes the force on a macroscopic object during a collision, taking into account possible unanticipated effects. (NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.F-IF.4, NJSLS.A-REI.C.7, NJSLS.MS-PS2-1,	• Determine what factors affect momentum and use mathematical computation and graphs to articulate the momentum. • Cite evidence to argue the fact that momentum is conserved in an elastic collision, noting the differences between elastic and inelastic collisions • Determine what factors affect impulse and use mathematical computation and graphs to articulate the impulse. • Determine whether a given design meets criteria and constraints set by society. • Design taking into consideration cost, safety, reliability, and aesthetics—and to consider social, cultural, and environmental impacts. • Design/construct a car with a

Unit: 1 Motion and Forces			**Recommended Duration: 6 Weeks– Sept-Oct**	
Unit Description: In unit one, students will work with Newton's Laws of Motion. Using RC cars students will develop an understanding of velocity, acceleration, and the forces acting on objects. Students will also learn about Business plans, marketing, and public relations as they design their own team identity.				
Unit Title:	**Duration/ Month(s)**	**Related Standards:**	**Learning Goals:**	**Topics and Skills:**
		NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 **21st Century Skills & Career Standards:** NJSLS.9.3.ST.1, NJSLS.9.3.ST.2, NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1, NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3, NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5, NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1, NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4 **Career Ready Practices:** CLKS.1, CRP2, CRP4, CLKS.4, CRP7, CLKS.5	NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4, NJSLS.HS-PS2-3, NJSLS.HS-ETS1-2) (2 weeks)	restraint and bumper system to protect an egg in a collision

Essential Questions:	**Enduring Understandings:**
• What methods does a car GPS use to predict the driver's estimated time of arrival?	• Students will be able to determine what factors affect momentum and use mathematical computation and graphs to articulate the momentum. • Students will be able to cite evidence to argue the fact that momentum is conserved in an elastic collision, noting the differences between elastic and inelastic collisions • Students will be able to determine what factors affect impulse and use mathematical computation and graphs to articulate the impulse • Students will be able to relate 70Unde that Newton's Laws are applicable to everyday life. • Understand that an imbalance of force results in a change of motion. • Laws are statements or descriptions of the relationships among observable phenomena.

Essential Questions:	Enduring Understandings:
	• Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects. • Newton's second law accurately predicts changes in the motion of macroscopic objects.

Relevant Standards:	Learning Goals:	Learning Objectives:
Mathematics: NJSLS.8.EE.B.5 Understand the connections between proportional relationships, lines, and linear equations. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. NJSLS.8.F.A.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. NJSLS.8.F.A.2 Compare properties (e.g. rate of change, intercepts, domain and range) of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change. NJSLS.8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the	• Students will be able to communicate observations and information graphically, using tables, and mathematically describe how an object's relative position, velocity, and direction of motion are affected by forces acting on the object. They will also be able to describe the proportional relationship between the acceleration of an object and the forces applied upon the object. (NJSLS.8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.F.B,5, NJSLS.8.SP.A.1, NJSLS.8.SP.A.2, NJSLS.8.SP.A.3, NJSLS.8.SP.A.4, NJSLS.MS.PS2-2)(1 week) • Students will be able to analyze the relationship between velocity and acceleration and justify which of Newton's laws of motion is demonstrated when presented with an example of a force or forces interacting with an object or objects. (NJSLS.8.SP.A.1, NJSLS.A-REI.10, NJSLS.F-IF.4, NJSLS.S.IC.6, NJSLS.MS-PS2-2, NJSLS.MS-ETS1-3, NJSLS.HS-PS2-1, NJSLS.MS.PS2-2) (2 weeks) • Students will be able to analyze data using one-dimensional motion to support the claim that Newton's second law of motion	• Collect data to compare three different methods of motion and calculate average speed for each method as well as different distances for same methods of travel • Cite evidence to argue the fact that momentum is conserved in an elastic collision, noting the differences between elastic and inelastic collisions • Determine what factors affect impulse and use mathematical computation and graphs to articulate the impulse. • Construct graphs from collected data, and calculate slope to interpreting graphs involving velocity and acceleration • Relate the car's motion and speed to Newton's Laws of Motion • Design an experiment to test Newton's 2nd law, gather data and use the date to calculate average acceleration • Apply calculations to determine drive time and how it changes with changes in velocity

Relevant Standards:	Learning Goals:	Learning Objectives:
situation it models, and in terms of its graph or a table of values. NJSLS.8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. NJSLS.8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. NJSLS.8.SP.A.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit (e.g. line of best fit) by judging the closeness of the data points to the line. NJSLS.8.SP.A.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height. NJSLS.8.SP.A.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your	describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. (NJSLS.8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.SP.A.1, NJSLS.8.SP.A.3, NJSLS.MS-PS2-2) (2 weeks) • Students will be able to use mathematical representations of phenomena to describe or explain how gravitational force is proportional to mass and inversely proportional to distance squared. (NJSLS.8.SP.A.1, NJSLS.8.SP.A.3, NJSLS.MS-PS2-4) (1 week)	

Relevant Standards:	Learning Goals:	Learning Objectives:
class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores? NJSLS.A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). NJSLS.F-IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. S.IC.6. Evaluate reports based on data. **Science and engineering:** NJSLS.MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. NJSLS.MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. NJSLS.MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. NJSLS.HS-PS2-1 Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.		

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
Pre-Assessment , Teacher	Unit test, Extended constructed	How Fast is Fast, Are we There Yet,	How Fast is Fast, Are we There Yet,

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
Observation, Class Participation, Warm Ups, Homework, Exit Slips, Status Checks, Popsicle Sticks, Thumbs Up/Thumbs Down, Stomp on Three, Student Progress Charts & Reflections	response questions, Quizzes, Student logbook, Team Presentations	What is Acceleration, Under Pressure	What is Acceleration, Under Pressure, Unit Test

Possible Assessment Modifications /Accommodations:
Word Banks, Calculators, Bold Key Words within Questions, Reduce Answer Choices

Instructional Strategies (*Robert Marzano's* 41 Elements):
Chunking Content into Digestible Bites, Recording and Representing Knowledge, Reviewing Content, Using Homework, Examining Similarities and Differences, Examining Errors in Reasoning, Practicing Skills, Strategies and Processes, Engaging Students in Cognitively Complex Tasks Involving Hypothesis Generation and Testing

Possible Instructional Modifications /Accommodations:
Instructional Scaffolds, "Interleave"-style Homework Assignments (solutions are made available to students at home to utilize as references for homework assignments), Calculators, Small Group Review of Pre-Requisite Skills (such as measurement, units of measure, and properly reading a stopwatch and tape measure), Review and Re-teaching of Difficult Concepts

Unit Vocabulary:
Essential: Newton's First Law of Motion, Newton's Second Law of Motion, Newton's Third Law of Motion, Acceleration, equilibrium, force, inertia, mass, speed, velocity, scatter plot, independent variable, dependent variable, x-axis, y-axis, gravity, normal force **Non-Essential:** significant figure, scientific theory, precision, accuracy, displacement, free fall, projectile motion

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
E/LA: NJSLS.RST.6-8.1, NJSLS.RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7	Technology:	____ Global Awareness ____ Civic Literacy	_x__ Creativity & Innovation ____ Media Literacy

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
Mathematics: NJSLS.8.F.A.1, NJSLS.8.F.A.2, NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.8.SP.A.1, NJSLS.8.SP.A.2, NJSLS.8.SP.A.3, NJSLS.8.SP.A.4, NJSLS.A-REI.10, NJSLS.F-IF.4, NJSLS.S.IC.6. Science: NJSLS.MS.LS1-6, NJSLS.MS.LS2-3, NJSLS.MS.PS1-6, NJSLS.MS.PS3-1, NJSLS.MS.PS3-2, NJSLS.MS-PS3-5, NJSLS.HS-ETS1-2 Technology: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1, NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4, NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3, NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3, NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 21st Century Life and Careers: NJSLS.9.3.ST.1, NJSLS.9.3.ST.2 NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1 NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3 NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5 NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1 NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4		____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	__x_ Critical Thinking and Problem Solving _x__ Life and Career Skills ____ Information & Communication Technologies Literacy _x__ Communication & Collaboration ____ Information Literacy

Resources:	
Texts/Materials: Ten80 website, YouTube video clips, and Solidworks Student Edition	

Resources:	
Unit: 2 Work, Energy, and Power	**Recommended Duration:**
Unit Description: In unit two, students will work with the laws of energy. Using RC cars, they will study the different types of energy and develop an understanding of energy transfer. They will investigate how weight affects speed, work, and power as it pertains to the RC cars as they try and find the optimal weight of their RC car. Students will also learn about Business plans, marketing, and public relations as they design their own team identity.	
Essential Questions:	**Enduring Understandings:**
• How does the Law of Conservation of Energy impact the amount of energy that is available on our planet? • Why do engineers constantly try to modify designs to improve the efficiency of a car engine?	• Understand the difference between kinetic and potential energy • Understand that no energy transfer is 100% efficient • Understand that energy can neither be created nor destroyed • Proportional relationships among different types of quantities provide information about the magnitude of properties and processes. • When the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. • Kinetic energy may take different forms (e.g., energy in fields, thermal energy, and energy of motion).

Relevant Standards:	Learning Goals:	Learning Objectives:
Mathematics: **NJSLS.8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. **NJSLS.8.F.B.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its	• Students will understand how weight affects speed and power and create a mathematical model that describes the relationship between drive time and average speed and between total car weight and power. (NJSLS.8.EE.B.5, NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D10, NJSLS.MS-PS2-2, NJSLS.MS-ETS1-4, NJSLS.HS-ETS1.2) (2 weeks) • Students will be able to develop a model to generate data for iterative testing and	• Relate the conservation of energy to the concept of how energy transfers from one object to another • Students will be able to create a mathematical model to describe the relationship between total car weight and power • Generate a quadratic equation that describes a real-life situation • Describe efficiency and performance tradeoff

Relevant Standards:	Learning Goals:	Learning Objectives:
graph or a table of values. **NJSLS.8.F.B.5** Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. **NJSLS.8.SP.A.1** Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. **NJSLS.A-APR.B.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. **NJSLS.A-REI.C.7** Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x 2 + y 2 = 3. **NJSLS.A-REI.D10** Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). **NJSLS.F-IF.B.4** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. **Science** **NJSLS.MS.LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **NJSLS.MS.PS3-1** Construct and interpret graphical displays of data	modification of a proposed object, tool, or process such that an optimal design can be achieved as well as analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (8.EE.B.5, NJSLS.8.SP.A.1, NJSLS.A-APR.B.3, NJSLS.A-REI.C.7, NJSLS.F-IF.B.4, NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4) (2 weeks) • Students will be able to describe various types of energy and develop an understanding of the first and second laws of energy. Students will also be able to present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. (NJSLS.MS.LS1-6, NJSLS.MS.LS2-3, NJSLS.MS-PS3-5) (2 weeks)	

Relevant Standards:	Learning Goals:	Learning Objectives:
to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **NJSLS.MS.PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. **NJSLS.MS-PS3-4** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. **NJSLS.MS-PS3-5** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. **NJSLS.MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **Interdisciplinary:** NJSLS.RST.6-8.1, NJSLS.RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 Equity Integration (Using James Banks' Levels of Multicultural Integration): https://diversity.asee.org/deicommittee/2021/05/04/two-strategies-towards-socially-just-engineering-integration-in-high-school-science/		

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
Pre-Assessment , Teacher Observation, Class Participation, Warm Ups, Homework, Exit Slips, Status Checks, Popsicle Sticks, Thumbs Up/Thumbs Down, Stomp on Three, Student Progress Charts & Reflections	Unit test, Extended constructed response questions, Quizzes, Student logbook, Team Presentations	Potential VS Kinetic Energy, Optimal Power	Potential VS Kinetic Energy, Optimal Power, and Unit Test

Possible Assessment Modifications /Accommodations:
Word Banks, Calculators, Bold Key Words within Questions, Reduce Answer Choices

Instructional Strategies (*Robert Marzano's* 41 Elements):
Chunking Content into Digestible Bites, Recording and Representing Knowledge, Reviewing Content, Using Homework, Examining Similarities and Differences, Examining Errors in Reasoning, Practicing Skills, Strategies and Processes, Engaging Students in Cognitively Complex Tasks Involving Hypothesis Generation and Testing

Possible Instructional Modifications /Accommodations:
Instructional Scaffolds, "Interleave"-style Homework Assignments (solutions are made available to students at home to utilize as references for homework assignments), Calculators, Small Group Review of Pre-Requisite Skills (such as measurement, units of measure, and properly reading a stopwatch and tape measure), Review and Re-teaching of Difficult Concepts

Unit Vocabulary:
Essential: Energy, Kinetic Energy, Potential Energy, Work, Power, Conservation of Energy, Energy Transfer, Gravitational Potential Energy, Chemical Energy, Mechanical Energy, Electrical Energy, terminal velocity **Non-Essential:**

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
E/LA: NJSLS.RST.6-8.1, NJSLS.RST.6-8.3,	Technology:	____ Global Awareness	_x__ Creativity & Innovation

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 Mathematics: NJSLS.8.EE.B.5 , NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D.10, NJSLS.F-IF.4, A-APR.B.3, NJSLS.A-REI.C.7 Science: NJSLS.MS.LS2-3, NJSLS.MS.PS3-1, NJSLS.MS.PS3-2, NJSLS.MS.PS3-4, NJSLS.MS-PS3-5, NJSLS.MS.ETS1-3, NJSLS.MS.ETS1-4 Technology: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1, NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4, NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3, NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3, NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 21st Century Life and Careers: NJSLS.9.3.ST.1, NJSLS.9.3.ST.2, NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1, NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3, NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5, NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1, NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4		____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	____ Media Literacy _x__ Critical Thinking and Problem Solving _x__ Life and Career Skills ____ Information & Communication Technologies Literacy _x__ Communication & Collaboration ____ Information Literacy

Resources:
Texts/Materials: Ten80 website, YouTube video clips, and Solidworks Student Edition

Resources:	
Unit: 3 Momentum and Collisions	**Recommended Duration: 6 Weeks– Dec-Feb**
Unit Description: In unit three, students will study the concepts of momentum, impulse, how impulse affects momentum, conservation of momentum, elastic and inelastic collisions and explosions.	

Essential Questions:	Enduring Understandings:
• Compared to the past, is the "break-away' design of car bumpers and the use of airbags justified by the laws of momentum?	• Collisions both elastic and inelastic affect momentum of an object as well as impulse. The extent to which they are affect depend on a few factors such as: mass, inertial and velocity. • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

Relevant Standards:	Learning Goals:	Learning Objectives:
Mathematics: **NJSLS.8.EE.B.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed. **NJSLS.8.F.B.4** Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. **NJSLS.8.F.B.5** Describe qualitatively the functional relationship between two quantities by analyzing a graph	• Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. (NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.F-IF.4, NJSLS.A-REI.C.7, NJSLS.HS-PS2-2) (2 weeks) • Students will be able to describe the boundaries and initial conditions of a system of two macroscopic bodies moving in one dimension and use mathematical representations of the quantitative conservation of momentum and the qualitative meaning of this principle in the system.	• Determine what factors affect momentum and use mathematical computation and graphs to articulate the momentum. • Cite evidence to argue the fact that momentum is conserved in an elastic collision, noting the differences between elastic and inelastic collisions • Determine what factors affect impulse and use mathematical computation and graphs to articulate the impulse. • Determine whether a given design meets criteria and constraints set by society. • Design taking into consideration cost, safety, reliability, and aesthetics—and

Relevant Standards:	Learning Goals:	Learning Objectives:
(e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. **NJSLS.8.SP.A.1** Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. **NJSLS.A-REI.C.7** Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x 2 + y 2 = 3. **NJSLS.A-REI.D.10** Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). **NJSLS.F-IF.B.4** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Science: NJSLS.MS-PS2-1 **Motion and Stability: Forces and Interactions. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.** **NJSLS.MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be	(NJSLS.8.EE.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D.10, NJSLS.HS-PS2-2) • Students will be able to apply scientific and engineering ideas, qualitative evaluations, and algebraic manipulations to solve a design problem for a device that minimizes the force on a macroscopic object during a collision, taking into account possible unanticipated effects. (NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.F-IF.4, NJSLS.A-REI.C.7, NJSLS.MS-PS2-1, NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4, NJSLS.HS-PS2-3, NJSLS.HS-ETS1-2) (2 weeks)	to consider social, cultural, and environmental impacts.

Relevant Standards:	Learning Goals:	Learning Objectives:
combined into a new solution to better meet the criteria for success. **NJSLS.MS-ETS1-4** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **NJSLS.HS-PS2-2** Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. **NJSLS.HS-PS2-3** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. **NJSLS.HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.		

Formative Assessments	Summative Assessments:	Performance Assessments:	Major Activities/ Assignments (required):
Pre-Assessment , Teacher Observation, Class Participation, Warm Ups, Homework, Exit Slips, Status Checks, Popsicle Sticks, Thumbs Up/Thumbs Down, Stomp on Three, Student Progress Charts & Reflections	Unit test, Extended constructed response questions, Quizzes, Student logbook, Team Presentations	Egg Car Design	Egg Car Design and Unit Test

Possible Assessment Modifications /Accommodations:
Word Banks, Calculators, Bold Key Words within Questions, Reduce Answer Choices

Instructional Strategies (*Robert Marzano's* 41 Elements):
Chunking Content into Digestible Bites, Recording and Representing Knowledge, Reviewing Content, Using Homework, Examining Similarities and Differences, Examining Errors in Reasoning, Practicing Skills, Strategies and Processes, Engaging Students in Cognitively Complex Tasks Involving Hypothesis Generation and

Instructional Strategies (*Robert Marzano's* 41 Elements):
Testing

Possible Instructional Modifications /Accommodations:
Instructional Scaffolds, "Interleave"-style Homework Assignments (solutions are made available to students at home to utilize as references for homework assignments), Calculators, Small Group Review of Pre-Requisite Skills (such as measurement, units of measure, and properly reading a stopwatch and tape measure), Review and Re-teaching of Difficult Concepts

Unit Vocabulary:
Essential: Momentum, Impulse, Conservation of Momentum, Collisions Elastic & Inelastic, Collisions, Explosions, Recoil, Angular Momentum **Non-Essential:** Work, Kinetic Energy, Potential Energy, Conservation of Energy, Machine, Mechanical Advantage, Efficiency, and Power

Interdisciplinary Connections (Applicable Standards):	**Integration of Technology:**	**21st Century Themes:**	**21st Century Skills:**
E/LA: NJSLS.RST.6-8.1, NJSLS.RST.6-8.3, NJSLS.RST.6-8.7, NJSLS.RST. 6-12.4, NJSLS.RST.6-12.7 NJSLS.WHST.6-8.1, NJSLS.WHST.6-8.7 Mathematics: NJSLS.8.EE.B.5, NJSLS.8.F.B.4, NJSLS.8.F.B.5, NJSLS.8.SP.A.1, NJSLS.A-REI.D.10, NJSLS.F-IF.4, NJSLS.A-APR.B.3, NJSLS.A-REI.C.7 Science: NJSLS.MS-PS2-1, NJSLS.MS-ETS1-3, NJSLS.MS-ETS1-4, NJSLS.HS-ETS1-2, NJSLS.HS-PS2-2, NJSLS.HS-PS2-3 Technology: NJSLS.9.4.8.TL.4, NJSLS.8.1.IC.1, NJSLS.8.1.8.ED.1, NJSLS.8.1.8.AP.7, NJSLS.8.1.8.ETW.2, NJSLS.8.1.8.ETW.1,	Technology:	____ Global Awareness ____ Civic Literacy ____ Financial, Economic, Business, & Entrepreneurial Literacy ____ Health Literacy	_x__ Creativity & Innovation ____ Media Literacy _x__ Critical Thinking and Problem Solving _x__ Life and Career Skills ____ Information & Communication Technologies Literacy ____ Communication & Collaboration ____ Information Literacy

Interdisciplinary Connections (Applicable Standards):	Integration of Technology:	21st Century Themes:	21st Century Skills:
NJSLS.8.1.8.ED.4, NJSLS.9.3.HL-THR.4, NJSLS.8.2.8.ED.5, NJSLS.8.2.8.NT.3, NJSLS.8.2.8.ETW.1, NJSLS.8.2.8.ED.3, NJSLS.8.2.8.ED.6, NJSLS.8.2.8.ETW.3 21st Century Life and Careers: NJSLS.9.3.ST.1, NJSLS.9.3.ST.2, NJSLS.9.3.ST.3, NJSLS.9.3.ST-ET.1, NJSLS.9.3.ST-ET.2, NJSLS.9.3.ST-ET.3, NJSLS.9.3.ST-ET.4, NJSLS.9.3.ST-ET.5, NJSLS.9.3.ST-ET.6, NJSLS.9.3.ST-SM.1, NJSLS.9.3.ST-SM.2, NJSLS.9.3.ST-SM.4			

Resources:
Texts/Materials: Ten80 website, YouTube video clips, and Solidworks Student Edition