Theme	Theme: Transportation
Unit Title	Travel safely!
Essential Question	How can we protect passengers in a car crash?
Grade Level	6-8

Unit Overview
The problem: The number of road traffic deaths continues to rise steadily, reaching 1.35 million in 2016 (WHO, 2016). Although Automotive and mechanical engineers are innovating many safety procedures to help passengers, these innovations haven't made their way into enough vehicles to reach their full potential in reducing fatal car crashes. Do you remember those days that you spent hours outlining and drawing your dream car? What are the most important aspects in automotive design? How do automotive designers build cars that are speedy and safe at the same time? Mechanical engineers, electrical engineers and industrial designers collaborate to develop and enhance motor vehicle structures, engines, and associated systems to ensure optimum wagon performance. In addition, they carry out a series of crash tests to modify their design in order to ensure optimum safety to all passengers in case of accidents. **Design challenge summary:** Students will work on developing a vehicle that would maintain passengers safety in a car accidents; additionally, the design should be within the budget of l.e 35. finally, students are also required to film the design process to be used in their presentation. **Unit summary:** This unit is divided into five phases. In the first phase, students are introduced to the topic; additionally, they understand how engineers work in their different majors and recognize the steps of the engineering design process. Each phase represents one phase of the engineering design process. Through the learning journey, students will be able to construct their knowledge of Newtons' laws of motion; moreover, they will be able to integrate their mathematical skills to calculate different features such as speed, velocity, and acceleration. On the other hand, students will have the ability to experience and enhance their soft and collaborative skills through a group-work experience. Finally, they will evaluate how to effectively use the web facilities to learn and spread the knowledge.

Goals

Transfer Goals
By the end of this unit, students will become aware of safety procedures while driving a car; moreover, they will become knowledge producers and inform other people how physics have helped in decreasing car crashes and save lives.

Knowledge and understanding:

- Recognize the impact of car safety standards on passengers' injuries.
- Identify the role of engineers in society.
- Understand the steps of the engineering design process.
- Recognize the scientific method of problem solving.
- Point out the contributions of Greek scientist in physics and formulating scientific thinking.
- Design an experimental model that will allow for the measurement of distance and time and the calculation of velocity.
- Differentiate between speed and velocity.
- Form a cohesive paragraph that answers study questions.
- Follow the scientific method of prediction.
- Differentiate between speed and velocity.
- Recognize that unbalanced forces cause changes in the speed of an object's motion.
- Identify qualities of motion including position, velocity, acceleration, and momentum, as well as forces which hinder motion, like friction.

Skills:

- Plan and execute investigations to test problems' solutions
- Analyze systems such as inputs, processes, and outputs
- Construct a valid argument depending on empirical evidence
- Follow the engineering design process and apply it to solve a problem
- Decide the reliability of the web sources.
- Select appropriate data based on their importance and relevance

- Hypothesize observations and analyze their accuracy.
- Form a cohesive paragraph that answers study questions.
- Follow the scientific method of prediction.
- Describe Newton's First, Second, and Third Laws of Motion and identify examples of these laws at work in the world around them.

Values and attitudes:
- Develop the responsibility as a passengers and driver to follow safety procedures
- Demonstrate appreciation of engineers' role in solving our problems
- Think proactively to help communities decrease injuries
- Demonstrate respect for the rules and manners of collaboration

Next Generation Science Standards (NGSS)	The Common Core State Standards (CCSS Math)	The Common Core State Standards (CCSS ELA/Literacy)	Digital Literacy Standards
MS-PS2 Motion and Stability: Forces and Interactions Students who demonstrate understanding can: MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	MP.2 Reason abstractly and quantitatively. 6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. 6.RP.A.2 Understand the concept of a unit	RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a	Safety and Security [6-8.CAS.a] 4. Describe and use safe, appropriate, and responsible practices (netiquette) when participating in online communities (e.g., discussion groups, blogs, social networking sites). 5. Differentiate between appropriate and inappropriate content on the Internet. Interpersonal and Societal Impact [6-8.CAS.c] 1. Describe current events and emerging technologies in computing and the effects they may have on

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. MS-PS3 Energy Students who demonstrate understanding can: MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. 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.	rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. 7.RP.A.2 Recognize and represent proportional relationships between quantities. 8.F.A.3 Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. 7.GR. 1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. 7.GR. 4. Solve real-world and mathematical	flowchart, diagram, model, graph, or table). WHST.6-8.1 Write arguments focused on discipline content. WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. SL.8.5 Integrate multimedia and visual displays in presentations to clarify information, strengthen claims and evidence, and add interest.	education, the workplace, individuals, communities, and global society. 5. Evaluate the bias of digital information sources, including websites. Digital Tools [6-8.DTC.a] 3. Integrate information from multiple file formats into a single artifact. 4. Individually and collaboratively, use advanced tools to design and create online content (e.g., digital portfolio, multimedia, blog, webpage). Collaboration and Communication [6-8.DTC.b] 1. Communicate and publish key ideas and details individually or collaboratively in a way that informs, persuades, and/or entertains using a variety of digital tools and media-rich resources. 2. Collaborate synchronously and asynchronously through online digital tools. 3. Demonstrate ability to communicate appropriately through various online tools (e.g., e-mail, social media, texting, blog comments). Research [6-8.DTC.c] 2. Evaluate quality of digital sources for reliability, including currency, relevancy, authority, accuracy, and purpose of digital information.

MS-ETS1 Engineering Design Students who demonstrate understanding can: MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities	problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.		3. Gather, organize, and analyze information from digital sources by quoting, paraphrasing, and/or summarizing. Modeling and Simulation [6-8.CT.e] 1. Create a model of a real-world system and explain why some details, features and behaviors were required in the model and why some could be ignored. 3. Select and use computer simulations, individually and collaboratively, to gather, view, analyze, and report results for content-related problems (e.g., migration, trade, cellular function).

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.			

Integrated Concepts		
Science	Engineering & Technology	Maths
• Force • Motion • Velocity and speed • Acceleration • Friction • Newtons' laws	• Engineering design process • Automotive safety features	• Drawing graphs • Calculate rate • Scale drawing • Proportional division
Literacy/ Language Arts	Social Studies	Citizenship

• Writing reflection • Identifying main points • Writing report	• Greek history	Participate in knowledge transfer
Digital Literacy		
Evaluate digital data Creating blog		

Performance Assessment	Other assessment evidence
• Goal: Have students design, build, and modify a device to prevent the egg shell from cracking • Role: Students will work in groups to test, evaluate, and modify their designs. • Audience: The teacher and the rest of the class. • Situation: Improving passengers safety procedures. • Product: Safe car design. • Standards for success: The egg shell doesn't crack when the car collides with an object after moving on a ramp 60c.m incline.	Writing reflection Blog KWL Lab sheet EDP template Students' journals

Learning Plan Overview			
Phase	Phase Questions	Learning Objectives	Assessment Evidence

Phase 1 Problem identification	Why do passengers get injured in a car crash? How can passengers be safe in a car crash? How do engineers work? What are the steps engineers follow to solve a problem?	• Recognize the impact of car safety standards on passengers' injuries. • Identify the role of engineers in society. • Follow the engineering design process and apply it to the challenge • Identify the steps of the engineering design process.	• Poster design. • Reflection sheet • Engineering design template
Phase 2 Define	How can we make our web search more reliable? How can we identify the reliability of resources? How can we conduct an experiment? Are there certain steps for the scientific inquiry? How do you know an object is in motion? How do you measure how fast an object is moving? What do you need to know in order to find velocity? What variables might affect the velocity of an object over a given time? What can be done to increase the reliability of experimental data? How did the car race show each of Newton's laws in action?	• Decide the reliability of the web sources. • Select appropriate data based on their importance and relevance. • Describe Newton's First, Second, and Third Laws of Motion and identify examples of these laws at work in the world around them. • Know that unbalanced forces cause changes in the speed of an object's motion. • Understand qualities of motion including position, velocity, acceleration, and momentum, as well as forces which hinder motion, like friction. • Describe properties of the cuboid such as corners, vertices, faces, and ages.	Group presentation Jigsaw reading Flow chart Reflection KWL Word wall Lab sheet

		● Find the Lateral surface area and total surface area of the cuboid. ● Use the knowledge of drawing scale in a real-life context.	
Phase 3 Try possible options	How can we decrease injuries in car accidents? What are the feasible solutions for the problem? How studying physics can save more lives?	● Work collaboratively, use advanced tools to design and create online content. ● Describe current events and emerging technologies in computing and the effects they may have on education	Simulation Blog
Phase 4 Prototype	What are the materials needed for the design? How my design look like? What is the cost of my design? How can I choose my materials?	● Use the knowledge of Newton's laws of motion to create a device that can protect passengers in a car crash. ● Follow the engineering design process.	Budget worksheet
Phase 5 Test	How can I check the success of my device? What are the implications of the design? How can I modify my design within the budget? What is my audience feedback? And which design was the most efficient and why?	Develop a prototype of the design solution. Test solution for efficiency. Make necessary modifications to the prototype. Develop and build the final version of the solution. Present and communicate the design solution idea. Reflect on the design process.	Presentation

Phase 1 Identify the Problem or Need: In this phase, students will be introduced to the different causes of injuries in a car crash; additionally, they will brainstorm ideas on how to maintain passengers' safety in a car crash. Moreover, they will be able to differentiate between the majors of engineers; additionally, they will identify the different steps engineers go through to solve a problem. Finally, the teacher will introduce the grand challenge which is to design a safe car that prevents an egg from cracking when it collides with an object.		
Activity 1: Activity 1: the effect of car's safety procedures on passengers		
Activity Duration: 50 minutes	Activity type: group work	Resources: https://www.youtube.com/watch?v=3YF34gzwiaQ&feature=youtu.be
Activity objectives: ● Recognize the impact of car safety standards on passengers' injuries.		
Materials needed: The following video discusses the safety procedures in car and that airbags do not provide the maximum safety standards. https://www.youtube.com/watch?v=3YF34gzwiaQ&feature=youtu.be Internet access. Procedures: ● The teacher divides the students into groups of four students. Before watching the video, the teacher asks the students to answer the following questions: Why do passengers get injured in a car crash? How can passengers be safe in a car crash? ● Students will have 5-10 minutes to discuss and write their answers. ● After watching the video, students will take another 5-10 minutes to revisit their answers and share them with the rest of the class.		

- The teacher will ask students to imagine that they are engineers and try to draw a safe car that keeps passengers safe in a car crash.
- Students draw it and list their safety procedures for accessing the web.
- Groups will switch their models and evaluate the other group's model. Students will have the opportunity to defend their design; finally, the teacher will ask students to share their expectations and knowledge on how engineers work on a poster.

Activity 2: The role of engineers		
Activity duration: 40 minutes	Activity type: Whole class discussion/ design teams	Resources: Video: https://www.youtube.com/watch?v=D9I35Rqo04E

Activity objectives:

- Identify the role of engineers in society.
- Follow the engineering design process and apply it to the challenge

Procedures:

- The teacher divides students into groups of 4; the same students within the group will work together throughout the unit.
- Students watch the video that demonstrates the different types of engineers and their work.
- Teacher should ask the students to take notes while watching to be able to answer the video sheet (attached below) appendix 1
- The teacher should introduce the challenge; students should try to answer the three questions they already filled in the sheet but this time concerning the revealed challenge.

An Introduction to Engineering Design Process		
Duration: 45 minutes	Activity type: (Group Work/ Design teams)	Resources: https://www.youtube.com/watch?v=fxJWin195kU
Objectives: ● Understand the steps of the engineering design process.		
Procedures: Teacher asks the students if engineers follow certain steps when they approach a problem? Students respond differently. Teacher can refer to any day to day situation that requires an engineer solution. She/ he may refer to the High Dam: ● What was the problem? Answers should include a reference to the flood of the River Nile or the electricity shortage. ● Did the engineers do research? Answers should include reference to reading books or finding information from other countries who were successful in designing dams ● Did they have different designs? They should have had ● How did they choose the current design? They had tried prototypes and the current one is the best regarding the type of soil, and other factors ● Was it successful from the first trial? Sure, there were some modifications they made Students will watch a video that introduces them to the Engineering design steps and its application to real life situations. https://www.youtube.com/watch?v=fxJWin195kU Think- Pair - Share Students shall fill a flowchart that shows the steps they are going to follow to design their prototype and test it (appendix 2). Extension to the next phase: While students are filling the EDP template, answers should include motion, forces, speed, velocity, and measuring distances. Meanwhile, the teacher will hold a discussion to evoke students' curiosity about these concepts (students will be familiar with some of these concepts, and the teacher will ask them to do further research about things they need to learn.		

Phase 2 Learn the Basics By the beginning of this phase, the teacher will ask students to record all the knowledge they will learn, search, obtain, and practice in the group journal including the 2 appendices for the EDP. Therefore, students understand how to find reliable data; additionally, they will differentiate between speed and velocity. Moreover, they will be able to relate acceleration of objects to motion. This phase will focus on the second and third steps of the EDP.		
Activity 1: Reliability of resources		
Activity Duration:50 minutes	Activity type: groups of 4	Resources: https://www.cerias.purdue.edu/education/k-12/teaching_resources/lessons_presentations/SITECREDIBILITY2.pdf
Activity objectives: ● Decide the reliability of the web sources. ● Select appropriate data based on their importance and relevance.		
Materials needed: Computers or any device or smartphone that might be connected to the internet. Paper and pencils. Procedures: ● In the previous stage, students were gathering information related to the topics they need to learn. The teacher will ask the students to present the knowledge they have gathered. ● Students explain what search words and engines were used to collect this information. ● The teacher will ask the students to evaluate their data and exclude any knowledge which they feel irrelevant. ● The teacher will ask students to defend why they have excluded this information. ● Students will show the sources they have used and display them in front of the class. ● Each student must have a rule in the group (each member will present a part). ● The teacher will display the reliable sources rubric and ask students to re-evaluate their data using this rubric https://www.cerias.purdue.edu/education/k-12/teaching_resources/lessons_presentations/SITECREDIBILITY2.pdf		

• Students can now include the collected data in their journals.

Activity 2: follow the scientific method (a journey through the history)		
Activity duration: 45 minutes	Activity type: jigsaw (groups of 4) and whole class discussion	Resources: https://channayousif.files.wordpress.com/2011/06/glencoe-science-motion-forces-and-energy_0078617707.pdf p.2-5
Activity objectives: • Recognize the scientific method of problem solving. • Point out the contributions of Greek scientist in physics and formulating scientific thinking. • Hypothesize observations and analyze their accuracy.		
Materials needed: Students journals Printed book section		

NATURE OF SCIENCE

Physical Science

The study of motion, forces, and energy is part of physical science. Physical scientists also learn about elements, atoms, electricity, sound, and more.

Like all scientists, they use experimentation and careful observation to answer questions about how the world works. Other scientists learn about these experiments and try to repeat them. In this way, scientists eliminate the flaws in their work and participate in the search for answers.

Scientific Methods

1. **Identify a question.** Determine a question to be answered.
2. **Form a hypothesis.** Gather information and propose an answer to the question.
3. **Test the hypothesis.** Perform experiments or make observations to see if the hypothesis is supported.
4. **Analyze results.** Look for patterns in the data that have been collected.
5. **Draw a conclusion.** Decide what the test results mean. Communicate your results.

Scientists use scientific methods to answer questions about motion.

Scientific Methods

The understanding of motion was undertaken by philosophers such as Descartes and scientists such as Galileo. Their efforts led to the creation of procedures, called scientific methods, which scientists use to investigate the world. Scientific methods generally include several steps.

Identifying a Question

The first step in a scientific method is to identify a question to be answered. For example, Aristotle wanted to know what causes motion. The answer to one question often leads to others. Aristotle wondered how an object's weight affects the speed at which it falls. After Galileo showed that an object's weight does not affect its falling speed, Newton wanted to know how fast objects fall, regardless of their weight.

Forming a Hypothesis

The next step is to form a hypothesis. A hypothesis is a possible answer to the question that is consistent with available information. A hypothesis can result from analyzing data or from observations. For example, data show that lung cancer occurs more frequently in smokers than in nonsmokers. A hypothesis might be that smoking causes lung cancer. Observations of falling objects might lead to the hypothesis that heavier objects fall faster than lighter ones.

Testing a Hypothesis

A hypothesis must be testable to see if it is correct. This is done by performing experiments and measuring the results. Galileo tested Aristotle's hypothesis by rolling balls of differing weight down an inclined plane to see which, if either, rolled faster. Since a well-designed experiment is crucial, Galileo made sure the inclined plane was smooth and the balls were released in the same way.

Analyzing Results

Scientists collect information, called data, which must be analyzed. In order to organize, study, and detect patterns in data, scientists use graphs and other methods.

Collecting data requires careful measurements. Many experiments of the past were flawed because the measuring devices were inaccurate. Because Galileo needed precise timing, he used a water clock to measure the time for a ball to roll down the inclined plane. If his clock had been inaccurate, Galileo's results would have been less useful.

Figure 5 These students are conducting an experiment to learn how objects move.

Drawing a Conclusion

The last step in a scientific experiment is to draw a conclusion based on results and observations. Sometimes the data does not support the original hypothesis and scientists must start the process again, beginning with a new hypothesis. Other times, though, the data supports the original hypothesis. If a hypothesis is supported by repeated experiments, it can become a theory—an idea that has withstood repeated testing and is used to explain observations. Scientists, however, know that nothing is certain. A new idea, a new hypothesis, and a new experiment can alter what is believed to be true about the world.

You Do It

A ball may fall, but will it bounce back? What determines how high and how fast it will bounce? Make a list of possible factors that affect the way a ball bounces. Choose one of these and form a hypothesis about it. Think of experiments you could do to test your hypothesis.

Image source: https://channayousif.files.wordpress.com/2011/06/glencoe-science-motion-forces-and-energy_0078617707.pdf

Procedures:

- The teacher will divide the class into groups of 4.
- For each group, each student has to read a page from page 2 up to page 5 and they will be named A, B, C, and D.
- Each student will have 10-15 minutes to read the page and highlight the main ideas.
- All students who are A will sit together for 5-10 minutes to discuss the main ideas as well as debate similarities and differences between their individual understanding, and the same for other students.
- Students will return back to their original groups.
- Students will discuss the main ideas in the book section and draw a flowchart for the steps of the scientific method.
- A whole class discussion will take place, and the teacher will clarify any misconceptions.
- The steps will be used throughout all the experiments

Activity 3: speed and velocity		
Activity duration: 60 minutes	Activity type: groups of 5	Resources: https://www.youtube.com/watch?v=RlonB4d2Wgc

Activity objectives:

- Design an experimental model that will allow for the measurement of distance and time and the calculation of velocity.
- Differentiate between speed and velocity.
- Form a cohesive paragraph that answers study questions.
- Follow the scientific method of prediction.

Materials needed:

- Bricks
- Small rocks
- Measuring tape
- Stopwatch
- Recording table
- Graph paper

Procedures for the experiment (40 minutes):
In this activity, the teacher will show students a simulation of the experiment, then will ask them to form hypothesis for the essential question and write the first two steps of the scientific method in their journal (mentioned later).

- This activity can be done in the school playground.
- Put the brick on the ground.
- Use the measuring tape to measure 5 meters from the brick location.
- Place another brick at the end of the spot (another participant will stand there with a stopwatch).
- Place another brick 5 meter away from the third brick on 90 degrees perpendicular on the first brick (another participant will also stand with a stopwatch).
- Ask the same participant from each group to run from the first brick to the second and record the time.
- Ask them to run from the first point to the second and then the third.
- Take in consideration that after the participant run from the first to the second point, he should rest for 2 min. in order for his pulse rate to return to normal before he proceeds and run from the second point to the third point.
- Ask the participants to run in different directions and record the time and the distance in a table.
- Small rocks can be placed randomly; students can run from a spot to the other and record the time and distance and each time.
- Students need to record the time and distance at each time.
- By the end of the trial students in groups plot the data recorded in the table in a graph using a broken line.
- The teacher will ask the students to analyze the difference between speed and velocity.

Further application (20 minutes):
Students can write a short paragraph in their journals to reflect on their experiment. The aim of this paragraph is to answer the following essential questions (they can be presented before the activity).

1. How do you know an object is in motion?
2. How do you measure how fast an object is moving?
3. What do you need to know in order to find velocity?
4. Can you differentiate between speed and velocity?
5. What variables might affect the velocity of an object over a given time?
6. What can be done to increase the reliability of experimental data?
7. How can we improve the accuracy experiment?

Rubric for the writing:

	Outstanding	Emerging	Needs improvement

Word count and answer of the study questions	Writing is within the range of the word count (150-200). All study questions are answered	The paragraph is from 100 and less than 150 words. Three or four study questions are answered	The paragraph is less than 100 words. Most of the study questions are not answered
Cohesion	Writing is cohesive, and ideas are smoothly connected	Writing is sometimes cohesive and ideas are smoothly connected	Writing is not cohesive and ideas are sometimes connected
Evidence- based	Answers to the essential questions are supported with evidence	Most answers to the essential questions are supported with evidence	2 answers of the study questions are supported with evidence

- Finally, students will complete the steps of the scientific method and compare their predictions with the conclusion.

Activity (4) Assess the knowledge		
Activity Duration: 20 minutes	Activity type: whole class discussion	Resources

Activities objectives:
- Complement prior knowledge on Newtons' laws of motion

Procedures:
- The teacher will use KWL to assess students' knowledge on the laws of motion.
- Word Wall: Place the following words on large index cards or print in large font: inertia, force, acceleration, gravity, speed (average and constant), slope, friction, net force, Newtons (N), rate, velocity, distance, kinetic energy, potential energy and work. Place on a wall or bulletin board that is easily seen by students. Also include cards with formulas that will be used during the lesson. Ask students to mention definitions for each term and fill the KWL

Activity 5: motion learning stations		
Activity duration: 60-80 minutes	Activity type: group activity	
Activity objectives: ● Identify Newton's First, Second, and Third Laws of Motion and demonstrate examples of these laws at work in the world around them. ● Conclude that unbalanced forces cause changes in the speed of an object's motion. ● Differentiate between qualities of motion including position, velocity, acceleration, and momentum, as well as forces which hinder motion, like friction.		
Learning stations: Station 1 materials: ● Toy car ● Coins ● Graph sheet ● Measuring tape ● Stop watch ● Ramp ● Science lab sheet ● Books Procedures: ● The teacher will ask the students the following question: ● If, we placed a car on a ramp once when it is empty, and once when we add more mass. How this will affect the speed, and velocity of the car? ● What if we have changed the slope, why would this affect velocity? ● Students will start forming hypotheses. ● Students will start simulating the experiment with 4 trials. In the first trial, they will place the car empty on the ramp and calculate the distance, time and speed. ● In the second trial, they will add more mass (coins) and measure the distance,time and speed. ● The teacher will ask the students to repeat the two trials, but this time place different forces to push the car.		

- The teacher should remind the students that in each trial the students measure the distance ,they should start from the same starting point on the ramp in order to be fair.
- Students will record the distance and time taken in each trial in a table. Then plot a graph of the distance and time.
- Ask the students to fill the science lab sheet and compare their predictions with their findings.

Station 2 materials:

- Toy car
- Coins
- Curved ramp
- Sand papers
- Graph sheet
- Measuring tape
- Stop watch
- Science lab sheet

Procedures:

The teacher will ask students the following questions:

How changing the car direction affects its velocity?

When we add sand paper once and mass once, would that affect the cars' safety? Justify your answer.

1. Students will start forming hypothesis (scientific prediction).
2. Students will start simulating the experiment with 4 trials. In the first trial, they will place the car empty on the ramp and calculate the distance, and time.
3. In the second trial, they will add more mass (coins) and measure the distance,time and speed.
4. The teacher will ask the students to repeat the two trials, but this time by applying different forces on the car to investigate how unbalanced forces affect the car speed.
5. Students will record the speed each time. Then graph the distance and time.
6. The students will repeat the experiment from step 2 till 6 but this time by putting a sand paper on the ramp.
7. Ask the students to fill the science lab sheet and compare predictions with findings.

Extension for activity 1:

The teacher will discuss the factors that affect speed, and distance covered and relate them to Newtons' laws of motion.

Then the students can conclude how forces like friction could affect the speed of the car. The students can conclude that the friction force has an impact on the speed of the car.

Activity 6: Application of Newtons' law in real life

Activity duration: 30 minutes	Activity type: Design teams	Resources: https://www.lakeshorelearning.com/assets/media/product_guides/DD354.pdf Watch the video through this link https://youtu.be/zcHLdCI3Ygw?t=49
Activity objectives: By the end of this activity Students will be able to: ● Relate Newton's First, Second, and Third Laws of Motion to everyday life applications ● Conclude that unbalanced forces cause changes in the speed of an object's motion.		
Rocket racer: Review Newton's Laws of Motion and discuss how a rocket is a good example of this law. Tell the class that they will make their own balloon rockets so they can see how Newton's Third Law of Motion works. Materials: • Balloons • Tape measure • Compass or circle pattern Flexible straws • Marking pen • Styrofoam trays Masking tape • Scissors Procedures: Divide the class into groups of four or five students each. The materials for this experiment can be set up at a science center for the		

groups to rotate through, or all of the groups can do the experiment at the same time.
Make sure that each group has a person to operate the stopwatch during each trial. Have students record the results on their log sheets.

- Have students trace the parts of the car on the Styrofoam tray. Draw 1 rectangular car body and 4 circular wheels.
- Cut all the parts out of the tray.
- Inflate the balloon, and then let out the air. Tape the balloon to the short end of a flexible straw.
- Tape the straw and balloon to the rectangular car body.
- Use pins to attach the wheels to the car body.
- Demonstrate how to operate the race car: Blow air into the straw to inflate the balloon and squeeze the tip of the straw to hold in the air. When the tip is released, the car zooms forward.

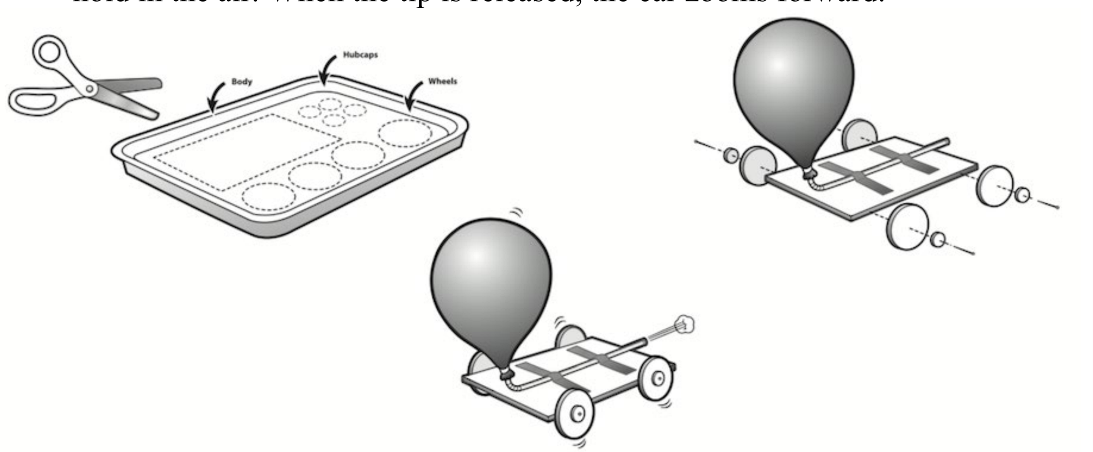

Image source: https://www.lakeshorelearning.com/assets/media/product_guides/DD354.pdf

When all the teams have completed their cars, have the class bring the cars outside or somewhere with a slick floor. Use masking tape to set up a starting line. Have students place their cars at the starting line and inflate their balloons. On your cue, have all the students let go of the straws and let the cars race.
When the race is over, discuss what happened with the class:

1. Why did the car move?
2. Why did some cars go faster?
3. How did the car race show each of Newton's laws in action

Answers to Conclusions Questions:

4. The air that was released out of the balloon was like fuel that pushed it forward on the string.
5. Answers will vary.
6. The force of the air as it came out of the back of the balloon was the "action." The reaction was that the balloon shot forward in the opposite direction.

When everyone has finished, discuss the experiment results and observations as a class. Add any new information learned to your classroom KWL Chart.

Activity 7: Ramp Design		
Activity duration: 40 minutes	Activity type: Design teams	

Activity objectives: By the end of this activity Students will be able to:

- Describe properties of the cuboid such as corners, vertices, faces, and ages.
- Find the Lateral surface area and total surface area of the cuboid.
- Use the knowledge of drawing scale in a real-life context.

Materials:

- Cardboard
- Measuring tape
- Tissues boxes (cuboid)
- Students' journals

Procedure:

- The teacher will pass one box of tissue to each group.
- Each group should identify number of faces, edges, corners.
- The teacher will ask students to find a way to calculate the total area of the shape.
- The teacher will let the students present their method and raise a discussion to deduce the rule.
- Present new vocabulary such as lateral area and total surface area.
- The teacher will ask the students to design a ramp using card board and find area; at the same time, he/she will raise and discussion to help students to identify how a cuboid without a led can be turned into a ramp.

Extension:

Assuming that you are asked to design a ramp as a civil engineer, and the total area of your ramp prototype is 120 square meters. What will be the total area of the ramp if the drawing scale is 1: 500000?

Stage 3: explore possible solutions	
Accident simulation	
Activity duration: 40 minutes	Activity type: Design teams resourcces:https://youtu.be/YKJ5bzWN7TU?t=134
Activity objectives: ● Work collaboratively, use advanced tools to design and create online content. ● Describe current events and emerging technologies in computing and the effects they may have on education ● Demonstrate the importance of seatbelts in cars. ● Prove that the seatbelt exerts a force on the driver . ● Relate the car crashes to forces and newton's law.	
Materials: Toy car Ramp Science lab sheet Colliding object Boiled eggs Cotton Balloons. Foil EDP template **Procedure:** The teacher will ask students the following questions: If the car will collide with an object(book), Why would that affect egg's safety? Explain why? How can we protect the egg? And why do you think that this is a good solution	

- Students will start forming hypotheses.
- Students will start simulating the experiment with 2 trials. In the first trial, they will push the car with the egg inside and observe the accident.
- The teacher will ask the students to repeat the trial, but this time think of a way to protect the egg from cracking by adding safety standards (cotton is an example).
- Ask the students to fill the science lab sheet and compare predictions with findings.
- Ask students to revisit their design that they have drawn at the first phase then, in the design teams they will start re-design their model based on the new knowledge.
- With the help of the students, the teacher will start filling the design rubric; therefore, students feel the ownership and responsibility of their design. Rubric might include, cost, speed, presentation, and collaboration skills.

Extension:

In this activity the students could do a research on the most advanced and reliable technological measurements used nowadays by car manufacturers to increase the car safety against car accidents then the students are asked to create a blog where each one of them will post his findings . The purpose of this blog is to highlight how Newtons' laws of motion have helped automotive engineers in designing cars' safety procedures. They will also highlight to the impact of the information superhighway on education.

The students will also start to discuss the possible solution and review their journals.

Phase 4

Action plan

In this phase, students their work on the vehicle design with its safety procedures and apply the knowledge they have acquired. At the beginning of this phase, the teacher will revisit the EDP rubric with the design teams; furthermore, students will start building their design and review their journals. Students are also requested to film their design and testing phase.

Car design

Materials needed:

You are tasked with creating a device that keeps an egg safe inside a car moving on a ramp with 60 c.m incline.
Materials:
You can choose 12 materials from each type in the following list, price is provided:
Note: they will use books to create the ramp

Cardboard (l.e 4 per squared m)	Cotton pads (p.t 50 for the3)	Plastic wrap (p.t 30 per squared m)
Elastic bands (p.t 30 per 10)	recycled toilet rolls (p.t 40/ each)	Cotton balls (p.t 40 for piece)
Popsicle sticks – 8	Toilet papers (p.t 20 for 10)	Toothpicks (p.t 20 for 10)
Sponges (p.t 50/each)	String (p.t 20 per 30cm)	Aluminum foil (p.t 60 per square meter)
Ziploc bags (l.e 1)	Spaghetti (p.t 20 per 10)	Newspaper (p.t 15per 1 full page)
Bendy straws (p.t 20 per 5)	Balloons (p.t 30 for 2)	Masking Tape (p.t 30 for 1 meters long)
Styrofoam cup and plate (p.t 20/ unit)	Paper Plate (p.t 65 per plate)	Plastic water bottles (l.e 1/ each)
Eggs (p.t 20/egg)	Scissors (l.e 2)	Glue (l.e 1)

Source
https://pdfs.semanticscholar.org/9c44/a7d8044dba4e7b3b4c6cae6e40c95615717a.pdf

Step 1:

Finalizing the design and choosing materials:

Students will revisit their design and choose the materials to calculate the budget for their designs. Additionally, they should report why have they chosen they materials and their expectations of the challenges their might experience. They can use the following template:

Unit	Price	Standards for success
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
9)		
10)		
11)		
12)		
Total cost	……………..	

Step 2:
Car design:
Students will start to design the car that can hold the egg. The following are models of the design:

Image source: https://www.youtube.com/watch?v=69X6mRHCaI4

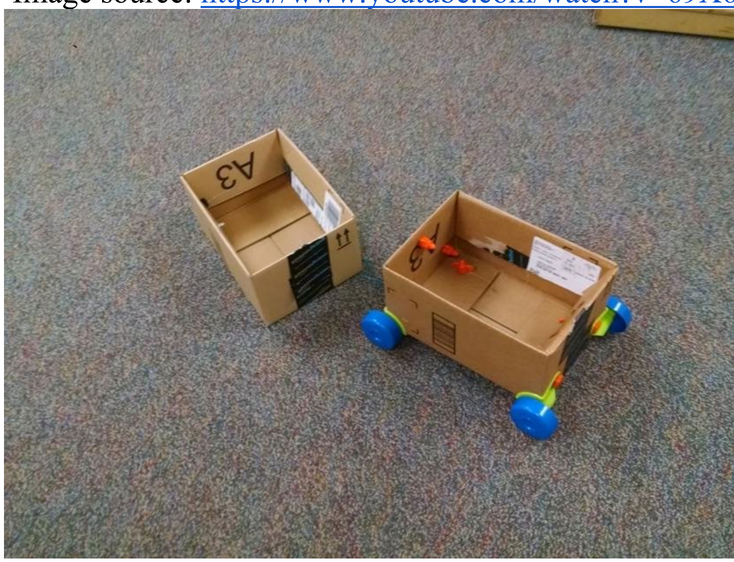

Image source: https://bellevuetoddlers.files.wordpress.com/2015/10/wpid-img_20151010_095644815.jpg

Ramp design:

Options for design:

Source:
https://alittlepinchofperfect.com/cereal-box-ramps-hands-science-activity-kids-play/

Source: https://www.sheknows.com/wp-content/uploads/2018/08/race-track-ramp_fxxw0c.jpeg
Safety model:

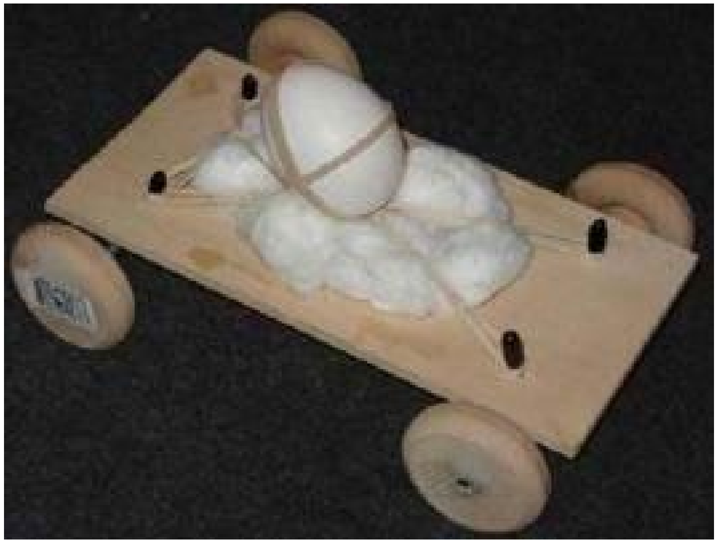

Image source: https://www.teachengineering.org/content/wpi_/activities/wpi_safety_sue/model_car.jpg

Engineering design rubric:

	Needs improvement	Approaches expectations	Outstanding
Egg shell	The egg shell cracked	The egg shell crack but did not broke from when it collides an object with an incline 60c.m	The did not crack when it collides the other object on a ramp with incline 60 c.m
Cost	The cost of materials exceeded l.e 35	The cost of the materials exactly fit the budget	The cost of the materials is less than the budget
Brainstorm	Student uses prior knowledge and lesson content knowledge to brainstorm a clear, focused idea(s). Idea(s) are excellently aligned to the intent of the problem.	Student uses prior knowledge and/or lesson content knowledge to brainstorm a clear, focused idea(s). Idea(s) are adequately aligned to the intent of the problem.	Student uses prior knowledge and/or lesson content knowledge to brainstorm an idea(s). Idea(s) are minimally aligned to the intent of the problem and a clear connection is not readily apparent without explanation.

Design Plan	Student proposes and designs a plan that excellently aligns with the criteria, constraints, and intent of the problem. Design sketch is complete and includes exceptional, relevant details that will be referenced when building the solution to the problem.	Student proposes and designs a plan that adequately aligns with the criteria, constraints, and intent of the problem. Design sketch is complete and includes details that will be referenced when building the solution to the problem.	Student proposes and designs a plan that minimally aligns with the criteria, constraints, and intent of the problem. Design sketch is complete and a clear connection is not readily apparent without explanation.
Presentation	Presentation but no explanation of how it worked or helped in trench Presentation with description of how the tool worked and how it helped. Detailed presentation of tool, how it works, and how it helped soldiers in trench	Presentation but no explanation of how it worked or helped in trench Presentation with description of how the tool worked and how it helped. Detailed presentation of tool, how it works, and how it helped soldiers in trench	Presentation but no explanation of how it worked or helped in trench Presentation with description of how the tool worked and how it helped. Detailed presentation of tool, how it works, and how it helped soldiers in trench

Test	Accurate and detailed records are collected and an analysis of data is present.	Adequate records are collected and an analysis of data is present.	Minimal records are collected and an analysis of data is present.
Redesign	Student uses effectively data to redesign the working model into a more effective solution that aligns with the constraints.	Student uses data adequately to redesign the working model into a more effective solution that aligns with the constraints.	Student use uses data minimally to redesign the working model into a more effective solution that aligns with the constraints.

Video rubric :

	Criteria	Developing	Proficient	Exemplary
Plan	Script / Storyboard	* Sketchy script or storyboard * Shows evidence of planning for a few parts of production	* Complete script or storyboard, though not detailed * Shows evidence of planning through most parts of production	* Clearly describes each shot visually * Includes movements, narration or dialogue, and fx * Shows evidence of planning through all parts of the production

Content Objective		*Thevideoisa disconnected (or loosely connected) series of scenes with no unifying story or structure * Random or irrelevant content included	* The video tells a connected story or has a clear and complete structure * Most content relates to the storyline	* The video tells a compelling story or has a compelling structure and is expressed creatively * All content relates to the storyline * Provides fresh, interesting, or humorous insights
Footage Shoot	Video	* Sometimes in focus * Sometimes steady * No camera movement OR excessive movement (panning, zooming, trucking, etc.)	* Usually in focus * Usually steady * Pans and zooms are limited and usually purposeful * Composition usually follows the rule of thirds	* Always in focus (unless purposefully done) * Always steady * Variety of camera movements. Movements are planned, purposeful and provide impact * Variety of angles and shots (close-up to long shot)

				* Varied composition (based on rule of thirds)

Source:https://web.archive.org/web/20141127132646/http://chs.camas.wednet.edu/tech/files/2012/06/grading_rubric.pdf

Phase 5
Redesign and final presentation

Engineering Design Milestone		
Duration:	Activity type: (Group Work/ Design teams)	Resources

Objectives:

- Evaluate the efficiency and safety standards of the car
- Identify and address the design challenges
- Evaluate other teams' designs

Procedure:
The design teams will test their design and check its deficiencies. They need to check that they are fulfilling the rubric; furthermore, they can advise and receive suggestions from the other teams. Challenges may include egg crack, stability of the car on the ramp, and low speed.
Students can use teachers support sheet to evaluate and redesign their model in case of facing difficulties. After finishing the design students have to present their model and report their challenges and the criteria used to redesign the prototype.

save on broken eggs, use wooden eggs for the design and build phases.
An option if plenty of materials are available is to not charge for materials used in designs that were not tested. This encourages more experimentation. For purposes of this activity, the cost should be the finished cost (manufacturing cost) not the development cost. It should be the cost of the materials needed to make the car they dropped.

Appendices
Appendix 1

Sheet 1: Video Sheet : Solve Problem Be an engineer

What is the main job of an engineer?
……………………………………………………………………………………………………

What do all engineers have in common?
……………………………………………………………………………………………………

What are the three questions engineers ask themselves before solving problems?
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Mention as many kinds of engineers as you may remember from the video and give a description for the job of two of them?
……………………………………………………………………………………………………
……………………………………………………………………………………………………
…………………………………………………………………………………………

Question	Answer	Why is answering this question important in solving the problem?

Appendix 2

Define your problem	
Research	
Develop a possible solution	

Design your solution	

Build a prototype	

Test your prototype	

Evaluate your solution	