Physical Sciences

Energy, Force and Motion

Year 4 Unit of Inquiry

Planeteers Game-based Learning Platform

Science and Technology, Arts, Math and Engineering

Email: education@steamcraftedu.com

Outcomes and Content

Science & Technology

Curriculum Content Code: ACSSU076

Learning Outcomes

Observes qualitatively how speed is affected by the size of a force

Standards: Energy, Force and Motion

1. How is motion affected by force?
2. What materials are needed to make your vehicle move faster?
3. How can understanding various physical properties about motion be useful in understanding everyday occurrences?
4. How do we measure the speed of objects using time and distance?
5. What are the factors that affect the speed of an object?
6. What materials should be used to sustain or recharge a vehicle's energy?
7. How can one be responsible in using energy?

- Recognises that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect
- Compare and contrast the effect of friction on different surfaces, such as tyres and shoes on a range of surfaces
- Describe the motion of an object by tracing and measuring its change in position (distance traveled) over a period of time
- Describe motion according to a frame of reference and recognize that movement is observed according to a point or a frame of reference

Engineering

STEAM Curriculum Code: EN1.1 | EN1.2

Learning Outcomes

Identifies and creates simple or complex machines

Standards: Design Process for Innovation

1. How will you design or create a fast and an efficient rescue vehicle?
2. What are the basic materials needed to create a simple machine or vehicle?

- Identify and use appropriate materials in creating a high speed land rover
- Demonstrate how a certain materials contribute to the motion or movement of the vehicle

Arts & Mathematics

Learning Outcomes

Constructs 3-D simple and complex machines or vehicles using geometric shapes/blocks, polygon, space, and repetition of colors to show balance of the structure and shape

Standards: Elements of Design and Geometry

1. What shapes and materials should be used to create a simple or a complex vehicle?

- Demonstrate understanding of lines, colors, space and harmony through creating simple and complex machines with the use of 3D objects, and the right proportions of parts.
- Visualize, name, and describe polygons with 5 or more sides
- Construct polygons, circles, and solid figures

Social Studies

Learning Outcomes

Creates a simple project that exemplifies the culture of different regions

Standards: Regions and Culture

1. How do we instill resilience among people through product creation, especially in times of flooding?
2. How do we encourage the community to help prevent flooding in their area?

- Develop an awareness campaign about flood prevention and safety
- Describe ways to prevent flooding in the community

Unit Summary

Grade:
4

Subject:
Science, Technology, Arts and Math

Duration:
1 week (50 minutes/day)

Syllabus Mapping:
- Energy, Force and Motion
- Elements of Design
- Geometry
- Design Process for Innovation
- Making

Integration:
- Science
- Mathematics
- Arts
- Engineering
- Technology

Outcomes:
ACSSU076

Inquiry and Focus Questions:

Driving Question:

How do we create a rescue land rover or any vehicle that is sustainable, efficient and effective in times of emergencies?

Science & Technology Inquiries:
- How is motion affected by force?
- What materials are needed to make your vehicle move faster?
- How can understanding various physical properties about motion be useful in understanding everyday occurrences?
- How do we measure the speed of objects using time and distance?
- What are the factors that affect the speed of an object?
- What materials should be used to sustain or recharge your vehicle's energy?
- How can one be responsible in using energy?

Engineering Inquiries:
- How will you design or create a fast and an efficient rescue vehicle?
- What are the basic materials needed to create a simple machine or vehicle?

Social Studies Inquiries:
- How do we instill resilience among people through product creation, especially in times of flooding?
- How do we encourage the community to help prevent flooding in their area?

Learning across the Curriculum:

Cross-curriculum priority
- Sustainability

General Capabilities
- Teamwork & Collaboration
- Critical & Creative Thinking
- ICT Capability
- Numeracy
- Literacy
- Disaster preparedness

Skills Focus:

Working Scientifically
- Communicating
- Questioning and predicting

Design and Production
- Researching and planning
- Design and innovation
- Producing, implementing, testing, refining

Skills Focus:

This unit of investigation explores concepts from the core science standards for energy, force and motion, with a focus on speed and sustainable energy. Students use an individual inquiry-based approach to explore solutions to a multi-layered real-world question. They experiment with a number of in-game tasks to test and refine the effectiveness of their design and construction, while minimizing the environmental and financial cost. They learn about sustainable practices in rescuing their community during emergencies. They take action to improve their own and others' social and environmental wellness.

Teaching, Learning & Assessment Activities

NOTE: 'Quest Game Activity' describes activities that happen in-game while 'Unplugged' occur outside the game

Lesson 1: Project Orientation and Research

Summary: Teacher explains the importance of energy, force and motion (ie. speed, time, distance) in our daily lives. As part of the project based lesson, the teacher relates emergency-preparedness and sustainability within the context of Australia. Students are tasked with researching about emergency-preparedness, and disaster-readiness vehicular solutions based on their understanding of energy, force and motion.

Assessment*: Quiz about energy, force and motion (10 minutes)*

Unplugged Activity: *Driving Question (15 minutes) – Brainstorm (Guided)*

Begins with a discussion about motion, specifically for measuring speed using time and distance.

Teachers says "Forces in nature produce many different types of motion. Sir Isaac Newton was the first person to describe the physical laws that explain how objects around us move. Over the centuries, engineers have used their understanding of motion and forces to build many tools and machines that are useful to us."

Teacher poses driving questions for the students to investigate and discover possible solutions:

Q. How do we create a rescue land rover or any vehicle that is sustainable, efficient and effective in times of emergencies?

Science & Technology Inquiries:

- How is motion affected by force?
- What materials are needed to make your vehicle move faster?
- How can understanding various physical properties about motion be useful in understanding everyday occurrences?
- How do we measure the speed of objects using time and distance?
- What are the factors that affect the speed of an object?
- What materials should be used to sustain or recharge your vehicle's energy?
- How can one be responsible in using energy?

Engineering Inquiries:

- How will you design or create a fast and efficient rescue vehicle?
- What are the basic materials needed to create a simple machine or machine?

Social Studies Inquiries:

- How do we instill resilience among people through product creation, especially in times of flooding?
- How do we encourage the community to help prevent flooding in their area?

Lesson 1: Project Orientation and Research

Project Orientation (5 minutes)

- Teacher introduces the project and relates it to the discussion outcomes
- Teacher divides the class in research groups (recommend 4-6)
- Provides project guide and overview of the timeline of activities and assessments to students (organized by lesson)

Research and Design Journal (20 minutes)

- Students research and watch documentary videos about energy, force and motion and different types of high speed vehicles used for emergencies.

Science & Technology Inquiries:

- How is motion affected by force?
- What materials are needed to make your vehicle move faster?
- How can understanding various physical properties about motion be useful in understanding everyday occurrences?
- How do we measure the speed of objects using time and distance?
- What are the factors that affect the speed of an object?
- What materials should be used to sustain or recharge your vehicle's energy?
- How can one be responsible in using energy?

Engineering Inquiries:

- How will you design or create a fast and efficient rescue vehicle?
- What are the basic materials needed to create a simple machine or machine?

Social Studies Inquiries:

- How do we instill resilience among people through product creation, especially in times of flooding?
- How do we encourage the community to help prevent flooding in their area?

- Students brainstorm, draft their design and plans on a sheet of paper or project journal**

** If teachers run out of time in the lesson to meaningfully allocate time for this exercise, students can be given the design plan during extra time.

Lesson 1 Assessment Ideas

Teachers should consider different assessment options throughout the project phases, including for example:

1. Quiz on energy, force and motion
2. Quality of student research and project journal
3. Design thinking and reasoning, problem solving
4. Group skills, time management, collaboration
5. Project works (later lessons)
6. Photo Essay (later lessons)

Lesson 2: Prototyping a Rescue Land Rover

Introduction to the Lesson

Teacher guides the students in identifying essential parts of a rescue vehicle. Based on their design plan from lesson 1, students can start their prototype within the game. They should be able to explain the usefulness of those materials based on functions, properties and how these affect the motion and speed of the rover. The students should consider vehicle parts that would allow for their rovers to use sustainable energy.

Teacher-Led Unplugged Activity (10 minutes)

- Teacher gives an overview of lesson goals, and reiterates the driving question.
- Teacher gives students the opportunity to ask questions before beginning their prototype.

Game Sandbox Activity (30 minutes)

In-Game Prototype:

1. Use the Builder Tool to make an inventory of blocks and basic parts in building a rover.
2. Use the Builder tool to create a rescue land rover that uses sustainable energy.
    - Ideally, the rover should include essential parts: blocks, wheels, cockpit, steering wheel, engine, and battery.
    - Students should consider changing the properties of the blocks (i.e. metal, carbon fiber, etc.) in order to strengthen the foundation or add weight to the rover.
    - The rover should be big or spacious enough to accommodate enough people inside.
    - Ideally, the rover should include solar panels for sustainable energy and they should consider adding booster or propeller to it for speed.

Documentation using Game Camera:

- Using the Camera, students should take pictures of their prototype at different stages of construction.
- Later, in lesson 5, the photos will be used in their reflection and presentation i.e. they will create a photo essay and present their project in class.

Lesson 2 Assessment Ideas

Teachers should consider different assessment options throughout the project phases, including for example:

1. Quality of student research and project journal
2. Design thinking and reasoning, including material uses and reasoning in relation to energy, force, and motion
3. Engineering approach, including aspect, size and safety of the vehicle, speed by the rover based on materials added, and other considerations students should explain
4. Time management, collaboration, problem-solving skills

Lesson 3: Testing and Refining

Introduction to the Lesson

Students test and refine their rover by discovering different textures in the Builder tool, trying out vehicle parts to affect speed and motion, adjusting the size and height of their rover. With consideration of social and environmental emergency they want to address in the community, students should consider strategies to effectively rescue people or even animals from impending danger. For example, a mountain rover can be used to rescue people or animals from forest fire.

Teacher-Led Unplugged Activity (10 minutes)

- Teacher gives an overview of lesson goals, and reiterates the driving question.
- Teacher gives students the opportunity to ask questions before refining their prototype.

Game Sandbox Activity (30 minutes)

Refining and Testing the Prototype:

1. Using the game's Builder Tool, the students spend time in finishing their rovers.
2. When their basic prototype is completed, students should test different strategies to increase speed of their rovers, for effective rescue.
3. They should use pen and paper to measure and compare speed based on the added materials or changed properties.
4. After their analysis, they can refine their design based on initial observations and opportunities for improvement.
5. Students should explain their reasoning behind refining the design in their project journal.

Pen and Paper Analysis:

1. Using their basic rover, they have to try out different adjustments to test out speed:
    - Use tracks versus wheels
    - Use propeller versus booster
    - Adjust size, length of rover
    - Change properties of materials or blocks
2. For each modification, measure the speed by:
    - Mark off a "test track" in game (e.g. set a flag or block)
    - Estimate the length (distance of the track)
    - Using a stopwatch, measure how long it takes for the rover to travel the length of the track
    - Calculate the speed for each trial by dividing the distance by the time
    - Record three (3) speeds per modification or trial
    - After performing 3 trials per modification, calculate an average speed from the results by adding them and dividing by three

Lesson 3: Testing and Refining (continued)

Documentation using Game Camera

1. Students should take pictures of their prototype at different stages of construction.
2. They should take photos to illustrate how they refined their designs after their pen and paper analysis.
3. Later, in lesson 5, the photos will be used in their reflection and presentation i.e. they will create a photo essay and present their project in class.

Lesson 3 Assessment Ideas

Teachers should consider different assessment options throughout the project phases, including for example:

1. Quality of student research and project journal
2. Design thinking and reasoning, including material uses and reasoning in relation to energy, force, and motion
3. Engineering approach, including aspect, size and safety of the vehicle, speed by the rover based on materials added, and other considerations students should explain
4. Time management, collaboration, problem solving skills
5. And specifically for Lesson 3:
   - Students analysis of the vehicle parts used based on function (e.g big wheels for mountains, tracks for ice/polar cap)
   - Design changes to improve their effectiveness and safety in rescuing people or animals
   - Their reasoning and explanation for making these changes
   - Some guide questions:
     - Describe any changes in each rover's speed during each trial
     - Why is it better to average the speeds rather than choose one?
     - Which modification reaches the highest speed?

Lesson 4: Project Finalization

Introduction to the Lesson

Teacher explains the social and environmental impact of emergency-preparedness or disaster-readiness. Teacher highlights the importance of being creative and innovative in modifying existing rescue rovers in order to quickly, efficiently, and effectively save the community from impending dangers.

Teacher-Led Unplugged Activity (10 minutes)

- Teacher gives an overview of lesson goals.
- Teacher gives students the opportunity to ask questions before using game to finalize their designs/project.

Game Sandbox Activity (30 minutes)

Final Project

1. Use the *Builder tool* to make any final improvements to the rover: properties of blocks, size, length, basic and additional parts.
2. Students should finalize any and all additional design strategies in ensuring a safe, efficient and effective rescue of the community.

Documentation using Game Camera

- Students should take photos to illustrate and record their final designs for presentation.
- Later, in lesson 5, the photos will be used in their reflection and presentation i.e. they will create a photo essay and present their project in class.

Lesson 4 Assessment Ideas

Teachers should consider different assessment options throughout the project phases, including for example:

1. Quality of student research and project journal
2. Design thinking and reasoning, including material uses and reasoning in relation to energy, force, and motion
3. Engineering approach, including aspect, size and safety of the vehicle, speed by the rover based on materials added, and other considerations students should explain
4. Time management, collaboration, problem-solving skills
5. And specifically for Lesson 4:
    - Final project design, including all components based on their own merit (boosters, solar panels, etc.)
    - Their reasoning and explanation for final design, including analysis of the speed
    - Extra credit is students used the painter to color their rover, or even coded it

Lesson 5: Presentation and Reflection

Introduction to the Lesson

Teacher asks the students to write about their project, their rescue rover design, and design thinking using the game's photo essay tools.

Game Sandbox Activity (30 minutes)

Photo Essay

1. Using the game's *Mission Log*, students finalize their photo essay about the project.
2. In the photo essay, students should organize and name photos by activity and stage of project, and insert them into their essay.
3. For example, some questions students might be asked to answer in their photo essay, may include:
   - How is motion affected by force?
   - How can understanding various physical properties about motion be useful in understanding everyday occurrences?
   - How do we measure the speed of objects using time and distance?
   - What are the factors that affect the speed of an object?
   - What materials should be used to sustain or recharge your vehicle's energy?
   - How can one be responsible in using energy?
   - What emergencies or disasters could occur in your community that require quick rescue?
   - How do we instill resilience among people through product creation, especially in times of flooding?
   - How do we encourage the community to help prevent flooding in their area?
   - What is the idea behind your rescue rover?
   - What important things were you trying to achieve with your design? e.g.
     - Rescue the community (people, animals, etc.)
     - Energy-sufficient
     - Fast/speedy
   - How does your rescue rover uses sustainable energy?
   - How many blocks and what kinds of blocks were used?
   - What were the differences in design considerations and materials for each and why?
   - What changes did you make after the initial prototype and why?
   - What were the results of your analysis of your design and how did it meet requirements?
   - What else would you have done, or do differently if you had more time?

***Assessment**: Post-test about energy, force and ,motion (10 minutes)*

Final Assessment

1. Photo essay
2. Post-test about energy, force and motion (10 minutes)
3. Previous assessments made during the other lessons

Teacher Handy Links and Resources

From Us to You!

- Learn all about emergency and rescue vehicles. READ
- Learn more about the basic components of a simple and complex machines. READ
- Check out how a vehicle helps firefighters make better decisions in a flash. READ
- Learn more about Solar powers and sustainable energy. READ

Other Multimedia Resources

- Check out these facts about Newton's Laws of Motion. WATCH
- Find out more about force and motion. WATCH
- Watch how solar energy works. WATCH

Other Reference Material

- Australian Curriculum (ACARA) Science Sequence of Content F-6: Strand READ

Support & Help

Please feel free to contact the STEAM Craft Edu team for any inquiries or support needs

Email: education@steamcraftedu.com