Teacher Package

Science and Technology Exemplar Task
Grade 6

Teacher Package

Title: Vehicle of the Future

Time Requirements: 240 minutes (over several class periods)

Introductory activities

- Pre-task 1: 20 minutes
- Pre-task 2: 20 minutes
- Pre-task 3: 20 minutes

Exemplar task

- Three periods of 60 minutes each

Description of the Task

Each student will be responsible for creating and designing a vehicle prototype for a fictitious automobile show. Included with the prototype will be a design portfolio containing plans, sketches, revisions, and a reflection about the student's progress.

Students will complete the worksheets provided in this package and submit them for assessment.

Scenario and Instructions for Students

See the description in Appendix 1: "Your Task".

Curriculum Expectations Addressed in the Task

Note that the codes that follow the expectations relate to the Ministry of Education's *Curriculum Unit Planner* (CD-ROM).

Students will:

1. demonstrate understanding that electrical energy can be transformed into other forms of energy (6s51);
2. design and construct a variety of electrical circuits and investigate ways in which electrical energy is transformed into other forms of energy (6s52);
3. identify uses of electricity in the home and community and evaluate the impact of these uses on both our quality of life and the environment (6s53);

4. design and construct an electrical system that operates a device in a controlled way (6s69);
5. demonstrate an understanding of different kinds of motion (linear, rotational, reciprocating, oscillating) (6s78);
6. design and make mechanical devices, and investigate how mechanisms change one type of motion into another and transfer energy from one form to another (6s79);
7. formulate questions about and identify needs and problems related to the properties or uses of electrical energy, and explore possible answers and solutions (e.g., compare some sources of electrical energy used in the past, such as coal, with sources used today, such as uranium and moving water, and evaluate the advantages and disadvantages of each) (6s61);
8. formulate questions about and identify needs and problems related to structures and mechanisms in the environment, and explore possible answers and solutions (e.g., describe how a system, such as a plumbing system, could be modified to meet different needs) (6s88);
9. plan investigations for some of these answers and solutions, identifying variables that need to be held constant to ensure a fair test and identifying criteria for assessing solutions (6s62/6s89);
10. use appropriate vocabulary, including correct science and technology terminology, in describing these investigations and observations (e.g., use terms such as *current, battery, circuit, conductor, insulator; positive* [plus] and *negative* [minus] *charges* for electrically charged materials; use terms such as *fulcrum, pivot, rack and pinion, belt*) (6s63/6s90);
11. compile data gathered through investigation in order to record and present results, using tally charts, tables, labelled graphs, and scatter plots produced by hand or with a computer (e.g., record in a journal all daily uses of electrical energy for a week, classify the various uses, and present the findings using tables and graphs; measure and record the motion of moving objects; manipulate computerized data collected from a moving object) (6s64/6s91);
12. communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, oral presentations, written notes and descriptions, drawings, and charts (e.g., draw a diagram of an electrical circuit using appropriate symbols; describe how a product was created from the first idea to the final model; produce a set of instructions to control the sequence of movements of a mechanical device) (6s65/6s92).

"Big Ideas"

Based on the expectations being assessed, the following "big ideas" have been identified for this task:

- Electrical energy can be transformed into other forms of energy (e.g., kinetic, heat, light).
- Electricity and motion are used in everyday life and in the real world.

Teacher Instructions

Prior Knowledge and Skills Required

Before attempting the task, students should have had experience with the following:

- experimenting with a motor (turning an axle, moving pulleys)
- building a simple circuit
- making a switch
- using relevant science and technology vocabulary
- identifying four types of motion – linear, rotational, reciprocating, and oscillating
- observing and explaining how one form of energy can be transformed into other forms of energy
- creating thumbnail sketches, a pre-construction sketch, and a labelled drawing

The Rubric

The rubric* provided with this exemplar task is to be used to assess students' work. The rubric is based on the achievement levels outlined on page 13 of *The Ontario Curriculum, Grades 1-8: Science and Technology, 1998*.

Introduce the task-specific rubric to students at least one day before administering the task. Copy the rubric for students or create a transparency to use with the class. You may find it useful to rephrase the rubric for students to help them in their work.

Review the elements of the rubric with students to ensure that they understand the criteria and the descriptions for achievement at each level. Allow ample class time for a thorough reading and discussion of the assessment criteria outlined in the rubric. You may also find it beneficial to create assessment criteria collaboratively with your students.

Accommodations

Accommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of the exemplar task.

Materials Needed

- wheels for vehicles
- small motors (1.5 v – 3 v)
- wooden dowels (to fit wheels)
- rubber bands
- multi-strand wire
- alligator clips with leads
- low-temperature glue gun
- low-temperature glue sticks
- motor mounting clips
- paper clips
- thumbtacks
- motor pulleys
- batteries
- battery holders
- straws
- large paper clips
- brass fasteners
- scissors
- carpenter's glue
- tape (e.g., Scotch tape, masking tape)

(Extra materials may be brought from home [e.g., tissue boxes, cans].)

Suggested materials for the main frame of the vehicle

- foam plates
- cardboard
- toilet-paper rolls
- small boxes (e.g., tissue boxes, milk cartons)
- wood
- paper cups
- plastic containers (e.g., mustard containers, pop bottles)

Note: Many of the materials (e.g., motors, batteries) can be reused once the vehicles have been shared and assessed.

Safety Considerations

- Supervise students when using low-temperature glue guns.
- Ensure that students understand that thin copper wire will become very hot if connected to both the positive and negative terminals at the same time.
- Remind students to follow established safety procedures when working with batteries.

General Notes

Weight Considerations of the Structure

- If a student's battery or structure is too heavy for the vehicle, the student may need to use the battery as a hand-held remote control or use lighter batteries (e.g., two AAA or two AA batteries).

Written Responses

- Students are not limited to the space provided. Encourage them to use the backs of the pages if necessary.

**The rubric is reproduced on pages 62–63 of this document.*

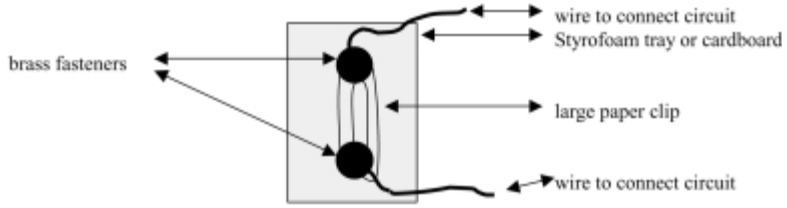
Student-Made Switches

To make an on-off switch, students will need a large paper clip, wires, two brass fasteners, and a small Styrofoam tray or piece of cardboard to hold the circuit/switch. They should then:

- attach the two brass fasteners to the Styrofoam tray or piece of cardboard (see accompanying diagram);
- wrap a large paper clip around one of the fasteners;
- attach the wires as shown on the accompanying diagram.

When the paper clip is moved to connect the two fasteners, a closed circuit will be made.

Diagram of Student-Made Switch



The following are examples of some of the science and technology vocabulary required for this task:

- circuit – series, parallel
- conductor/insulator
- current
- drive belt
- electrical energy
- friction
- pulley
- structure
- switches
- system
- wheel and axle

Definitions of Some Key Terms Related to the Task

kinetic energy. All moving objects have kinetic energy, the energy of motion.

linear motion. Motion along a straight line (e.g., a car moving along the road).

post-construction drawing. A drawing of the model that the student built. The student should produce a detailed diagram, including labels using appropriate science and technology vocabulary, measurements (height, width, and length), circuit drawings, and design details. The final drawing will differ from the pre-construction sketch as a result of modifications made throughout the actual design and construction process.

pre-construction sketch. A sketch based on one of the thumbnail sketches. A thumbnail sketch should include sufficient detail for construction (including labels using appropriate science and technology vocabulary and estimates of height, width, and length). Although this sketch will assist the student with the hands-on building phase, modifications are to be expected.

rotational motion. Motion along a curved path or in a circle (e.g., the wheels of a car turning).

thumbnail sketch. A rough pencil sketch of three different ideas for the design, each of which should include the basic design structure (e.g., in the case of the prototype electric car, the location of the wheels, motor, switch, and batteries).

Task Instructions

Introductory Activities

The pre-tasks are designed to ensure that students have the prior knowledge and skills required to complete the exemplar task. These activities review and reinforce the skills and concepts that students will be using in the task.

Pre-task 1: Setting the Stage

1. Read and discuss the student scenario (see Appendix 1) as a class, along with the task-specific rubric.
2. Have the class brainstorm environmentally friendly modes of transportation. Record, or have a student record, the results of the brainstorming.
3. Introduce the design challenge (the student scenario) and discuss the criteria of the project that students will complete.
4. Discuss the design portfolio booklet (the Student Package) with the class.

Pre-task 2: Draw and Build a Circuit

1. Review with students how to draw a simple circuit and a parallel circuit.
2. Have students draw and label examples of both circuits (the drawings should include appropriate vocabulary and electrical symbols).

Pre-task 3: Types of Motion

1. Review with the class the different types of motion (linear, rotational, reciprocating, oscillating).
2. Review the design process with students as outlined in the rubric: identifying the problem/need, making the plan, executing the plan, and evaluating the plan.

Exemplar Task

The worksheets "My Challenge", "Thumbnail Sketches", "Pre-Construction Sketch", "Trials and Modifications Recording Sheet", "Explanation of Procedures", "Post-Construction Drawing", and "Design Reflection" (see Appendices 2-8) are to be submitted for marking.

Part 1: Identifying the Problem/Challenge and Making the Plan

1. Review the student scenario with students (see Appendix 1).
2. Have students identify the problem and make their plans by completing the "My Challenge", "Thumbnail Sketches", and "Pre-Construction Sketch" worksheets in the student package (see Appendices 2, 3, and 4).

Part 2: Executing the Plan (Construction and Testing)

1. Remind students of safety precautions.
2. Have each student begin construction after you have approved his or her completed pre-construction sketch.
3. When their prototype vehicles are complete, ask students to test their vehicles, recording the results of each trial run and the modifications they made as a result on the "Trials and Modifications Recording Sheet" of the Student Package (see Appendix 5).

Part 3: Evaluating the Plan and Communicating (Design Reflection)

Have students complete the "Explanation of Procedures", "Post-Construction Drawing", and "Design Reflection" worksheets (see Appendices 6, 7, and 8).

Appendix 1

Your Task!

You have been invited to the annual "Vehicles of the Future" auto show. This auto show will feature student-built vehicles that:

- transform electrical energy into the energy of moving objects;
- create linear motion;
- are environmentally friendly.

Representatives of the top ten car manufacturers of the world will be attending the auto show. The selected designer will be featured on the cover of *Vehicles of the Future* magazine.

Your task is to:

- design a prototype of an electrical vehicle that can travel a distance of at least one metre;
- make an on-off switch to activate your vehicle;
- complete a design portfolio.

Your vehicle must include the following:

- a battery
- a motor
- a switch
- a circuit
- wheels

Your design portfolio will include the following:

- three thumbnail sketches (planning sketches and ideas)
- a pre-construction concept sketch (a drawing based on one of your thumbnail sketches)
- a post-construction drawing (a detailed, labelled drawing of your completed design including the electrical circuit drawings and measurements)
- a written explanation outlining how your vehicle was constructed
- any design changes that you would make in the future

Appendix 2

My Challenge

After reading the description of your task, explain the challenge in your own words.

My challenge is _____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 3

Thumbnail Sketches

Using the sheet provided:

- **draw three different thumbnail sketches of your vehicle design.**
- **choose one of the sketches which you believe will work best.**
- **explain in words why you have chosen to test this design in box #4.**

Remember, a thumbnail sketch is a rough pencil sketch of 3 different ideas for the design. This should include the basic structure design (e.g., location of wheels, motor, switch, and batteries).

Design #1.	Design #2.
Design #3.	I have chosen to test design #_____ because:

Appendix 4

Pre-Construction Sketch

A *pre-construction sketch* is a design based on one of your thumbnail sketches. It should include enough detail to help build your vehicle. Your pre-construction sketch should include:

- location of the main parts (wheels, axle, pulley)
- electrical circuit drawing (wires, power source, motor, switch)
- measurements (height, width, and length)
- appropriate science and technology vocabulary

Although this drawing will assist you with the hands-on building phase, changes in your design of your vehicle are to be expected as you build it. You may find it helpful to identify the parts of your vehicle; however, labelling your drawing is not necessary. Use pencil please.

List materials, tools and equipment you need to create your vehicle. Use your pre-construction drawing to help you. Use scientific/technological vocabulary when listing your materials.

Appendix 5

Trials and Modifications Recording Sheet

When the construction of your final design is complete, test your vehicle. Each time you test your vehicle, you must fill in the following observation chart.

	Distance Travelled in cm	Observations	Problem	Solution
Trial 1				
Trial 2				
Trial 3				

* If necessary, use the back of the sheet to record more trials.

Appendix 6

Explanation of Procedures

Using the appropriate scientific/technological vocabulary, list the steps you followed to build your vehicle.

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

*If necessary, use the back of the page.

Appendix 7

Post-Construction Drawing

On this page, you must include a detailed diagram of your vehicle including labels. Use scientific/technological vocabulary to describe the mechanical and electrical systems that you have used to make your vehicle move. Don't forget to add the necessary measurements and design details.

The final drawing may be different from your pre-construction sketch due to possible modifications you have made throughout the actual design process.

*Use pencil for your drawing.

Appendix 8

Design Reflection

Answer the following questions using complete sentences. Remember to use appropriate scientific/technological vocabulary when describing your ideas.

1. Describe how the vehicle was able to move using **electrical energy and kinetic energy to produce linear motion.** Use the appropriate scientific/technological vocabulary to explain the process.

2. Writers from the *Vehicles of the Future* magazine need some ideas for an upcoming article on how to make today's vehicles "environmentally friendly". List as many suggestions as you can to help them.

3. List some of the advantages and disadvantages of battery-operated vehicles in real life:

Advantages	Disadvantages

4. What do you think the design challenges would be when building a full-sized electrically powered vehicle? List as many as you can.

5. If I were to do this project again, I would: