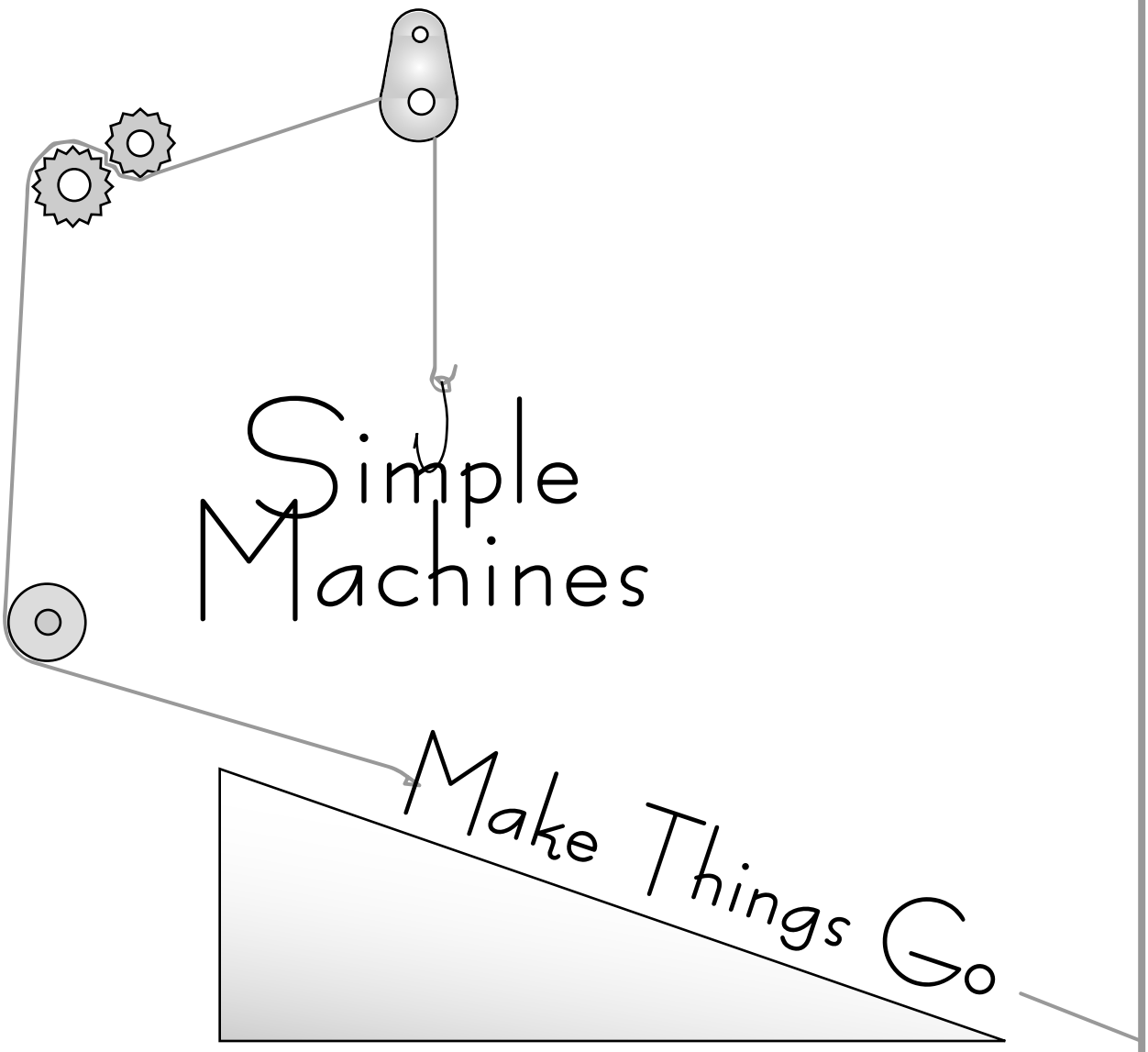


Simple Machines

Make Things Go

by Adelina Bellantino and Jill Russell

CSC
www.curriculum.org

Simple Machines Make Things Go

Acknowledgement

This resource was developed through support from the The Curriculum Foundation's Grants for Teachers program (See **www.curriculum.org** for more details.)

Simple Machines Make Things Go

Simple Machines Make Things Go supports a study of the structures and mechanism strand in the Science curriculum. It presents interesting approaches for students to use in applying concepts, and for recording the results of their explorations and investigations during the study. For example, students design, construct, and test a vehicle, recording relevant observations in writing, graphs, and in oral presentations.

This resource includes five booklets in which students record the activities they complete. Teachers may choose to use all or some of the booklets or to modify them to suit the needs of their students and the approach they are taking with the curriculum.

Simple Machines Workbook

Investigating and Exploring
Students discuss how to make work easier. They investigate and discover that six simple machines separately or in combination, help to make work easier. They are introduced to the basic concepts of each simple machine, followed by an exploration of multi-step inventions. Through observation and investigation, students identify characteristics and movements of simple machines.

Applying and Recording
Students apply and review what they learn by completing the tasks in the Simple Machines Workbook.

Mission Possible Agent Portfolio

Students review their understanding of simple machines by completing home assignments that reinforce the connections to the world outside the classroom. After learning about each simple machine, they complete a number of tasks at home and record their responses in the Mission Possible Agent Portfolio. It serves as an ongoing record of their learning and as home-school connection.

Wonder Wheels Workbook

Investigating and Exploring
Students design and construct their own vehicle based on the knowledge and skills they have learned through their investigations. They plan, design, and construct a vehicle from a block of wood, wheels, and axles. Cross-curricular connections are made with language, visual art, and mathematics as students talk about, measure, and assemble their vehicles.

Applying and Recording
Students work through a variety of activities in the Wonder Wheels Workbook that support their thinking during the vehicle project. There are opportunities for collaborative work with senior students in the actual construction of the vehicles.

Roadster Rallies Booklet

Investigating and Exploring
Students apply the basic concepts of simple machines by constructing a ramp that they use to test their vehicle. They investigate the effects that different run-out surfaces have on the motion of their vehicle. During the tests, students engage in critical thinking and problem solving as they hypothesize, investigate probability, and draw conclusions.

Applying and Recording
Students record their planning for and results of their vehicle tests in the Roadster Rallies Booklet. They create and interpret displays of data and present and discuss the information to their peers.

Activity Centre Booklet

Students review and apply their knowledge of simple machines by participating in the Simple Machines Activity Centres. They record their responses to the tasks in the Activity Centre Booklet. As part of their reflection on their work, students use written language to convey their observations and knowledge of simple machines.

Cross-curricular Activities

In addition to the cross-curricular experiences students have during the activities, they can demonstrate their learning by:

- writing fictional stories about adventures with their vehicles;
- learning the meaning of vocabulary related to simple machines and using it in their recordkeeping and discussions;
- writing poetry about their vehicles for a class book;
- creating media works such as advertisements for their vehicles;
- working together to create a class newsletter that highlights the knowledge, skills and projects that evolved from the study of simple machines.

Home – School Connection

During the study, encourage participation from the home through regular communication:

- Send a note home explaining the Simple Machines study.
- Request volunteers to assist with some classroom activities.
- Encourage at-home reading and research on simple machines.
- Send a vocabulary list home and encourage discussion about the meaning of the terms.
- Provide activities to be completed with help from family members (see Mission Possible Agent Portfolio).
- As a class, produce a newsletter showcasing the students' work.

Showcasing Simple Machines in the Classroom

- Throughout the study have available a variety of resources, e.g., books, videos, software, for students to use in learning about simple machines.
- Display objects and pictures that contain the simple machines students are studying. Encourage them to add to the display throughout the study.
- Provide a variety of simple machines for students to sort and classify – items that represent a lever, screw, a pulley system, a wedge, an inclined plane (an adjustable ramp) and a wheel and axle.
- Plan a celebration of the work and invite guests to students' presentations of their work. These can be oral presentations, exhibits of their booklets and inventions, carousels, … .
- Produce an end-of-study newsletter that features each student's favourite piece of work. Guide them in their selection of what to include: illustrations, pictures of their vehicles or multi-step inventions, graphs, reports, stories, poems, assignments, ….

Simple Machines Workbook

Students complete the activities in this workbook to reinforce basic concepts about each simple machine after they have opportunities to observe, investigate, build, and discuss simple machines.

Introducing Simple Machines

A video that examines work and making work easier can be an effective introduction to simple machines.
Begin a word wall of the relevant vocabulary that students can add to throughout the study. Students can make their personal word lists to share at home.

Pre-activities

Students should engage in a variety of activities prior to completing the simple machines worksheets. Activities to accompany the study of each simple machine are suggested below.

Levers

- Demonstrate how *load*, *effort*, and *fulcrum* relate to levers, e.g., using a broom, hockey stick, or can opener.
- Have students sort and classify different levers, e.g., envelopes, flip top bottles, bottle openers.
- Ask students to investigate different fulcrum positions; using a ruler, a pencil as the fulcrum, and a weight.
- Together, design and make a storage container with a levered top.

Inclined Planes

- As a class, walk around the school looking for examples of inclined planes, e.g., playground equipment, ramps.
- Find examples of inclined planes in magazines and catalogues to make a class collage.
- Create a context for students to solve a problem, using an inclined plane, e.g., moving a heavy object up the stairs.
- Use an adjustable ramp as an example of an inclined plane to demonstrate visually changes in the slope.

Wedges

- Discuss, and record on a class chart, different things wedges can do: wedges can cut – knife, wedges can split – axe, wedges can tighten – door stop, and wedges can hold – nail.
- Find pictures of wedges to add to a class bulletin board.

Screws

- Demonstrate the various things that screws are used for.
- Have students sort and classify a variety of different screws, depending on their function.

Wheels and Axles

- Explain the relationship between a wheel and an axle and demonstrate the wheel without the axle to help students understand the importance of the axle.
- Investigate and explore items that contain wheels and axles, e.g., paint roller, inline skates.
- Find examples of wheels and axles to add to the classroom simple machines display or bulletin board.
- Design and make a simple spinning top.

Pulleys

- Provide examples of objects with pulleys for students to explore.
- Demonstrate how a load is lifted using a pulley system.
- Create a context for students to solve a problem using a pulley system, e.g., design a pulley system to lift a bucket of water.

Multi-step Inventions

Students combine simple machines to create multi-step inventions that identify various simple machines used to complete a task. Students design and build a multi-step invention within an identified context, e.g., cooking a hotdog, answering the telephone.

As a further application of their knowledge, students can work cooperatively or independently to create a multi-step invention that includes the six simple machines they studied. (See the worksheets in the Simple Machines Workbook and the Mission Possible Agent Portfolio.)

SIMPLE MACHINES WORKBOOK

Name: _____

Simple Machines

What is work?

_____

_____

What is force?

_____

_____

What is a load?

_____

_____

What is a machine?

_____

_____

Draw a picture to show a machine, the load, the force, and the work. Label your picture.

Making Work Easy

How can you make work easy?

_____

_____

_____

Write about machines that make work easier. Tell what they do.
Draw or find a picture of each machine.
Machines that:
cut

_____

_____

_____

lift

_____

_____

_____

dig

_____

_____

_____

move objects

_____

_____

_____

Levers

A lever has 3 parts:

_____ _____ _____

A load is _____.

Effort is _____.

Fulcrum is _____.

Two parts of a lever that move are: _____ and

_____.

The _____ does not move.

A load can be moved or lifted in different ways. How you move a load depends on what kind of lever you use.

Levers

Draw a different lever in each box. Name it.

Levers

Choose the best lever to use when lifting or moving the following loads.

Loads		Levers
Moving a load of dirt.	What kind?	☐ 1st class ☐ 2nd class ☐ 3rd class
Lifting a child up and down in the park.	What kind?	☐ 1st class ☐ 2nd class ☐ 3rd class
Sweeping the dirt off the porch.	What kind?	☐ 1st class ☐ 2nd class ☐ 3rd class

Levers

There are 3 kinds of levers:

_____ _____ _____

Name and draw a first class lever.

_____

Name and draw a second class lever.

_____

Name and draw a third class lever.

_____

Levers can be joined together by a fulcrum.
Name and draw a double lever.

_____

Inclined Planes

An inclined plane is a simple machine that helps to make work easier.

An inclined plane looks like a _____.

It has a _____.

Draw a picture of an inclined plane. Explain how it makes work easier.

_____

_____

_____

_____

_____

_____

_____

_____

Inclined planes are found everywhere.
Fill in the chart with examples of inclined planes.

Work	Fun	Home

Wedges

A wedge can be used to _____.

Complete the chart with examples of wedges that:

Cut	Split	Tighten	Hold

Draw a picture of a wedge at work. Explain what it is doing.

Screws

A screw is used to _____

_____.

Draw and label the parts of a screw.

Complete the chart with examples of screws.

What it Does?	Kind of Screw	Picture
Fasten		
Drills		
Moves		

Screws

Screws can be used to join, cut, lift, or push.

Find or draw pictures of screws and label them with words that describe what they do.

Wheels and Axles

A wheel is _____

_____.

A wheel can be used by itself or together with other wheels to carry heavy loads.

Wheels need _____.

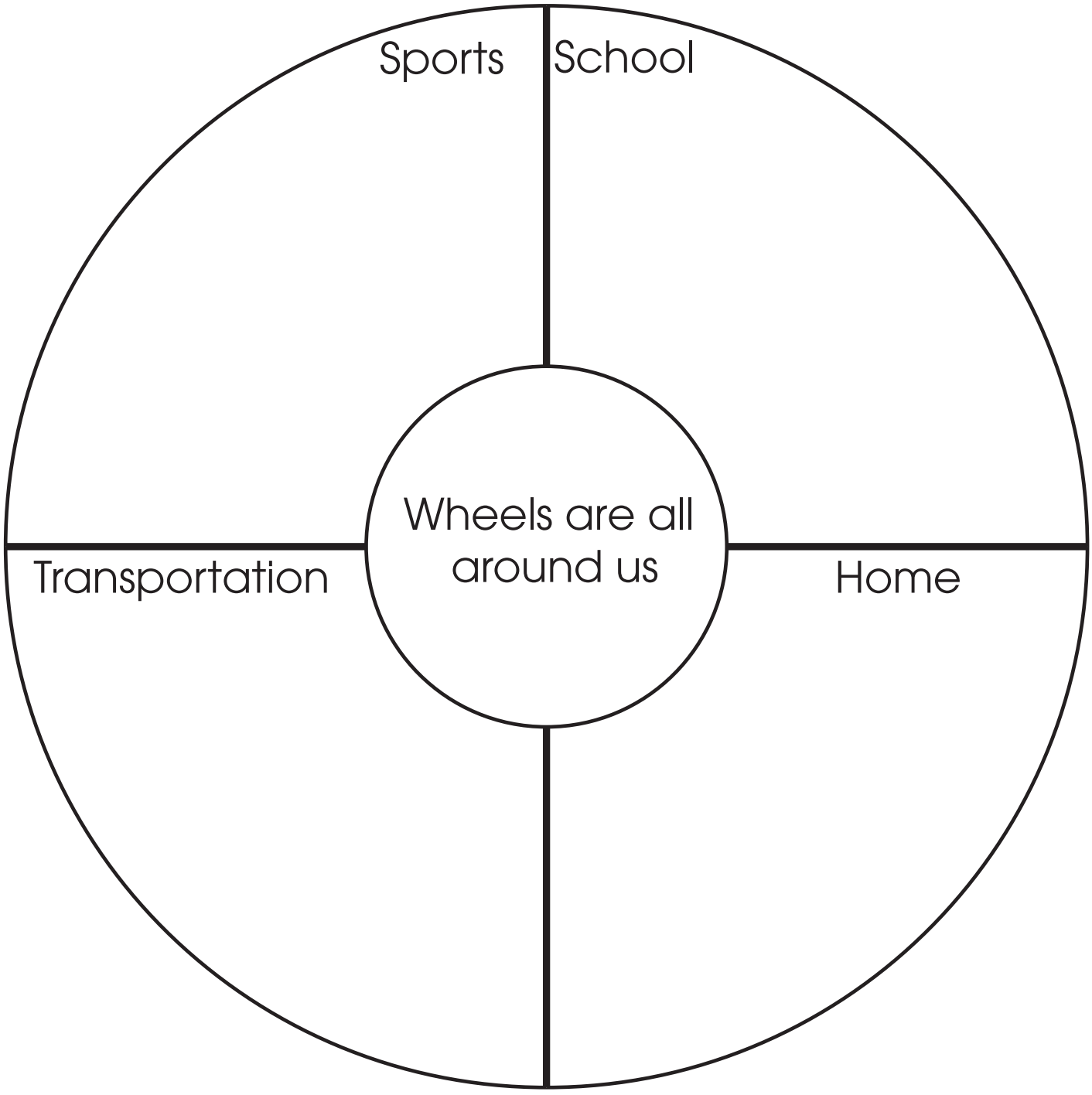
An axle is _____.

It helps the wheel remain in its place while it turns.

Draw something that has a wheel and axle. Label the wheel (w) and the axle (a)

Wheels and Axles

Draw and label ways wheels are used:



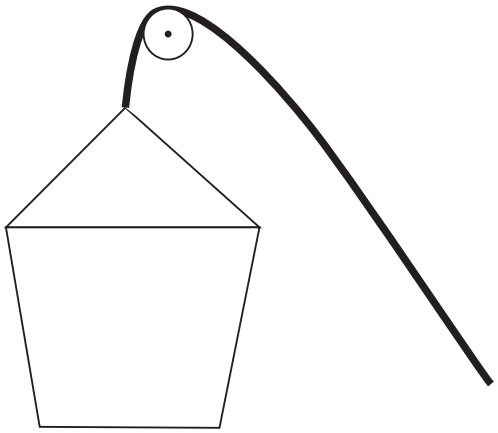
Pulleys

A pulley is a simple machine that _____

_____.

A pulley looks like a _____.

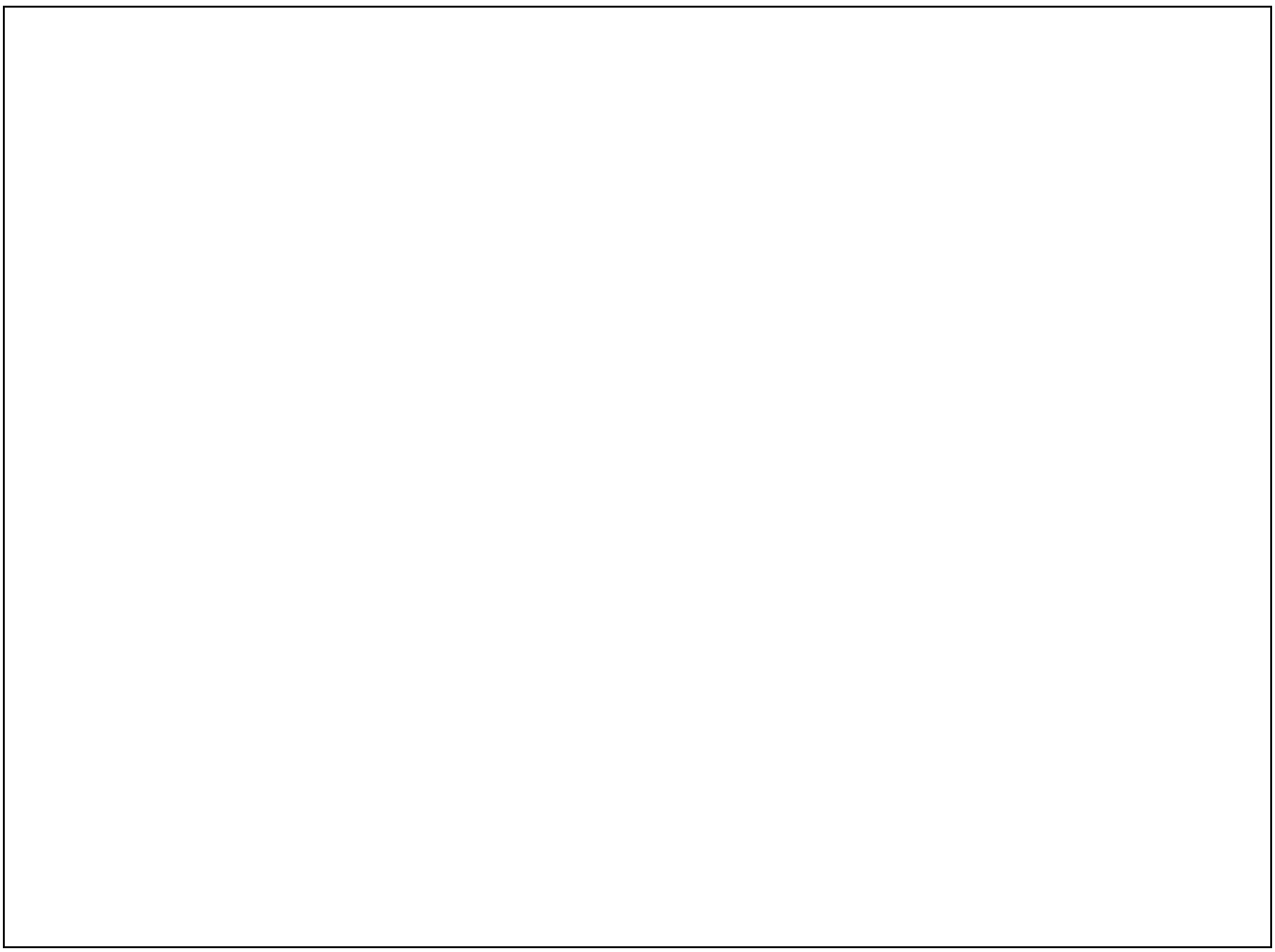
The wheel of a pulley turns on an axle. It has a grooved track so the rope will not slide off.



Design a pulley system to lift a bucket of water.

My Multi-step Invention

Design a multi-step invention.
Draw a picture of it.
Explain how it works.



_____

_____

_____

_____

_____

_____

Mission Possible Agent Portfolio

To increase students' interest, set up a portfolio as assignments for special agents, e.g., a Mission Possible Agent Portfolio. This booklet provides a home-school connection with the students completing the assignments at home to relate what they have learned to the world outside the classroom. Students develop the portfolio as they study each simple machine. The tasks serve as review and reinforcement of the concepts learned about a particular simple machine.

Preparing for the Assignments

- Students fill out special agent identification cards that include their name, a code name, and a picture of themselves.
- Students construct a concept wheel by gluing illustrations (or drawing them) on long narrow pieces of construction paper or tag board that represent axles. They use a paper fastener to attach them to the construction paper wheel and match the definitions to the pictures. Guide the students in this construction and demonstrate how the concept wheel can be used as a reference tool when completing their assignments.
- Assign tasks after the simple machine has been discussed and class activities are completed.
- The final assignment relates to the multi-step inventions activity.

Safety Alert:
The activity with Wedges requires supervision.

Mission Possible
Agent Portfolio

Name: _____

Concept Wheel

Cut out the wheel from construction paper or tag board.

Cut the axles out of construction paper or tag paper.

Find or draw small pictures of:

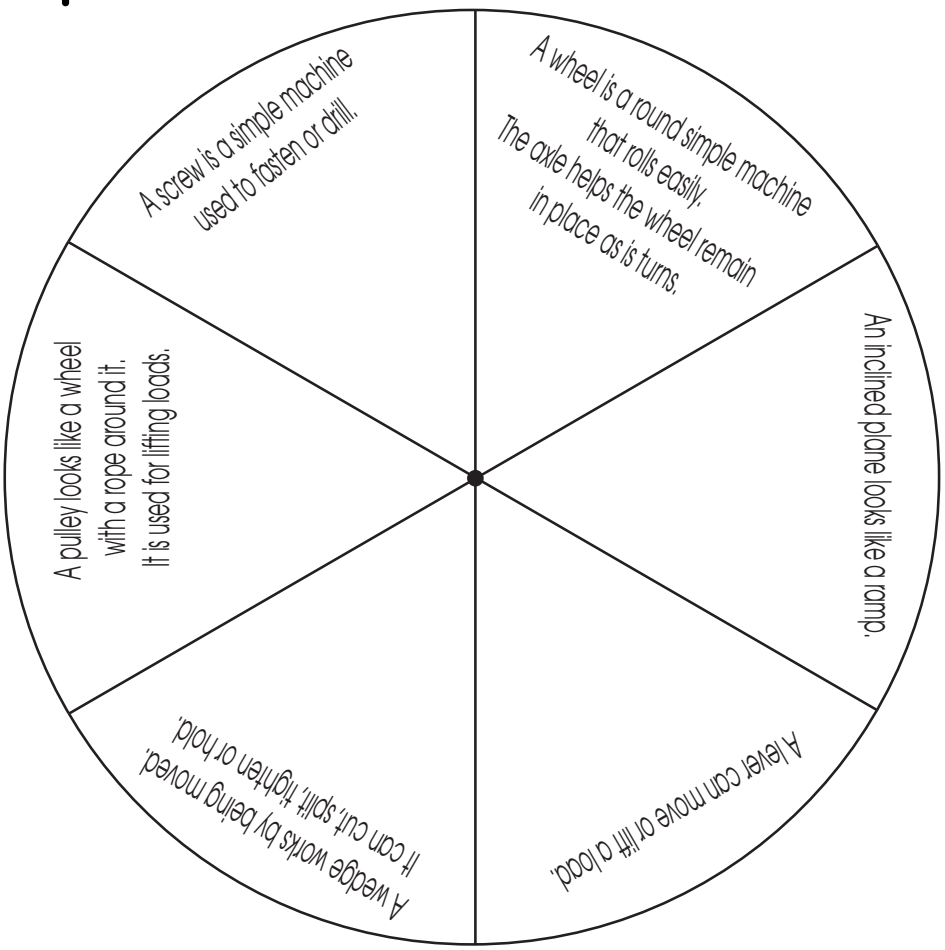
wedges	screws
inclined planes	wheels and axles
pulleys	levers

Put the pictures onto the end of each axle.

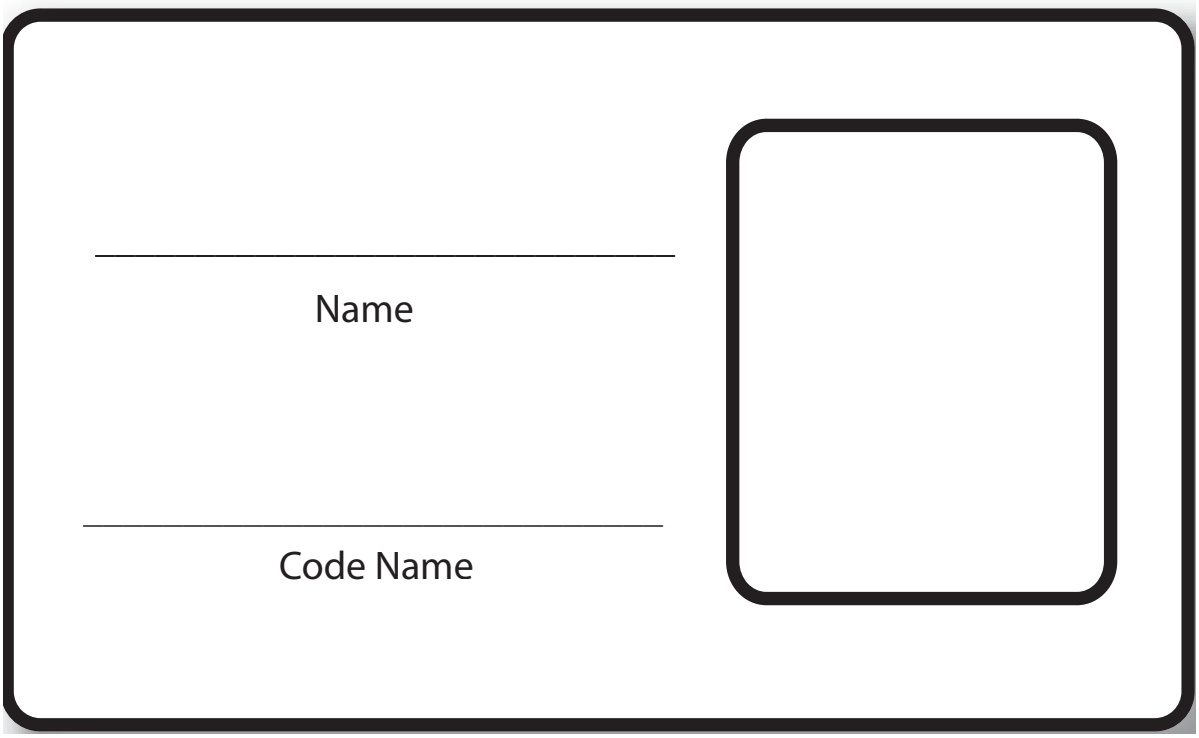
Use a paper fastener to attach the axles to the back of the wheel.

Move the axles to match the definitions with the pictures.

Concept Wheel



Special Agent Identification



Agent Assignments

Complete the following assignments by the due date.
Check your findings with your supervisors (parents/caregivers).

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Assignment: ____

____

Due Date: __________ Parent/Caregiver Signature: ______________________

Levers

Find a lever in your home.
Draw it and write about what it is used for.

Inclined Planes

Create an inclined plane by using a flat board or tray and propping one end up with an object.

Release at least 2 different objects down the board.

Raise the inclined plane higher and explain what happens when you release the objects.

Draw a picture of your experiment.

Explain what happened:

Wedges

Find a wedge in your home. Write about how it is used.

_____

_____

_____

This is a _____.

It is used to

_____

_____

_____

_____

This is a picture of a wedge in my home.

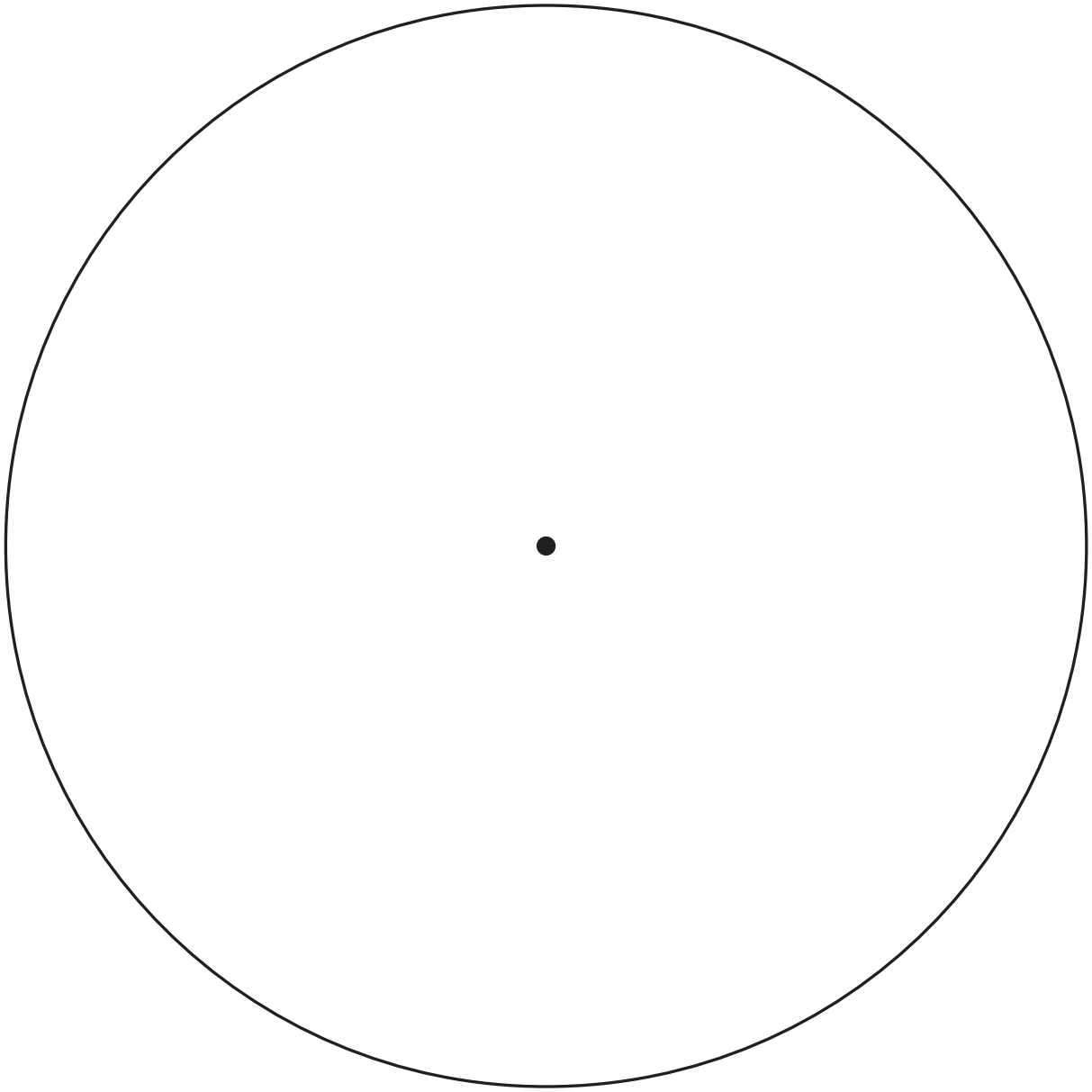
Screws

Screws are found in many places in your home.
Draw and write about a screw in each of these places:

Kitchen	Toolbox
Toy Box	Bedroom

Wheels and Axles

A pizza cutter is a simple machine.
Cut the circle and handle from construction paper or cardboard.
Draw your favourite toppings to decorate this pizza cutter.
Use a paper fastener to attach the handle to the pizza cutter.



Pulleys

Pulleys are all around us.

List 3 pulleys that you find in each place.

Simple Machines

Wheel and axle	Lever	Wedge
Inclined Plane	Screw	Pulley

Draw a picture of a multi-step machine that has at least two simple machines in it. Label your picture.

Wonder Wheels – Designing and Assembling a Vehicle

Students apply their knowledge of simple machines as they design and build a vehicle. They use inquiry and communication skills and relate their learning to the world outside the classroom.

As part of the task, students:

- select and use appropriate tools and equipment, always being mindful of safety considerations.
- use appropriate techniques to make and/or fasten components to their vehicles.
- communicate procedures and the results of their investigations and explorations through drawings, demonstrations, and oral and written descriptions.

Materials

- graph paper
- black markers
- cedar blocks – 8-10 cm long and 8 cm wide
- paint and brushes
- hammers, jigsaws, drills
- hinges with screws
- plastic wheels and steel axles

Process

- This task involves cutting out the vehicle shapes, drilling holes for the axles and for the hinges, if used. Decide on the procedure for cutting and drilling during the construction of the vehicles and who will assist the students in this task, e.g., parent volunteers, partnering with a secondary school technology class. Have students examine models of vehicles, e.g., small toys, pictures, and then discuss the differences in shape.
- Students draw an outline of their vehicle on graph paper, using a pencil. When they are satisfied with the outline, they trace it in black marker, cut it out and paste it on the page My Vehicle's Blueprint.
- Students trace their design onto their block of wood, writing "f" for the front and "b" for the back of the vehicle.
- They use the corresponding worksheets in the Wonder Wheels booklet to record their design template and to write their construction plans that include the materials they intend to use and a drawing of what their vehicle will look like.
- Discuss safety procedures in using tools.
- Students paint and decorate their vehicles. Painting can be done before the vehicle is assembled, allowing for drying time.
- They can complete the worksheet, Vehicle Interview as their reflection on the task.

Wonder Wheels Workbook

Name: _____

My Vehicle's Blueprint

This is a scale drawing of my vehicle.

My Vehicle

This is a sketch of my vehicle.

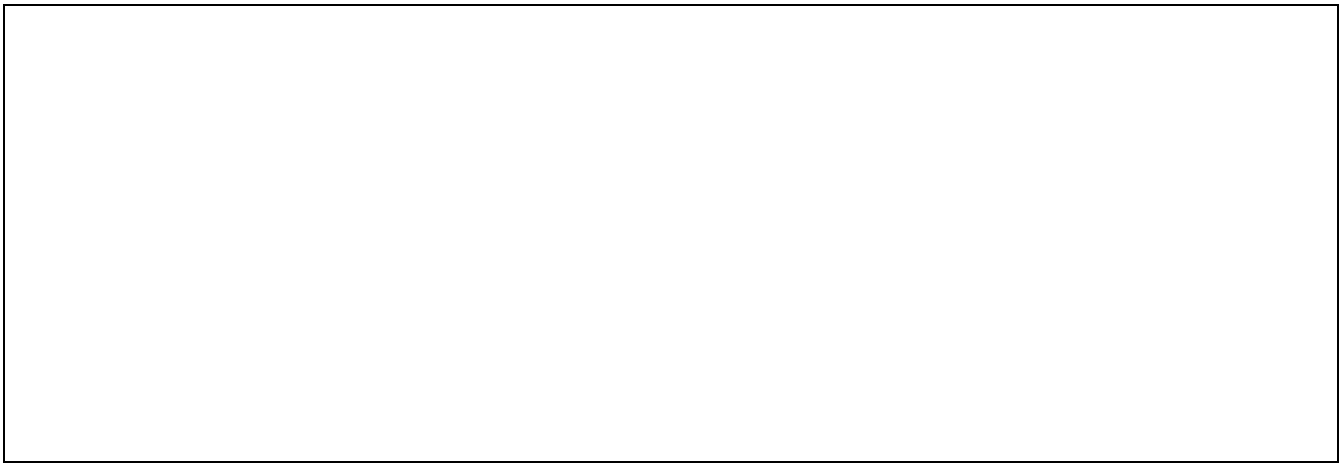
I need these materials to make my vehicle:

I want my vehicle to:

My vehicle has a hinge that:

Vehicle Interview

Draw a picture of your completed vehicle.



What did you name your vehicle?

_____

How is your vehicle different from your original design?

_____

_____

Explain why you made these changes.

_____

_____

What is the best thing about your vehicle?

_____

_____

What would you add to another vehicle that you design?

_____

_____

Roadster Rallies

Students record observations and results from testing the performance of their vehicles.

Materials

- 4 different run-out surfaces
- ramp
- vehicle with 4 wheels the same size
- metre stick
- masking tape

Conducting the Tests

- Students complete the worksheet, My Vehicle.
- Review and discuss their hypotheses to establish a purpose for the tests.
- Discuss fair testing before students begin:
  - The height of the ramp must remain consistent to secure accurate testing and results. The run-out surface is changed for each test.
  - The distance the vehicle travels in each test is measured from the edge of the ramp to the place where the vehicle stopped.
- Students complete the worksheets at each stage of the investigation.

  Note:
  A metre stick and masking tape are useful for indicating length lines. Begin from the edge of the ramp and place a tape line every metre.

- Students graph the results of their tests and orally present their findings to the class.
- Discuss additional tests that they could conduct:

  Replace the vehicle's existing wheels with larger wheels.

  Compare the distance travelled with different size wheels on the same run-out surface.

  Change the height of the ramp, keeping it consistent throughout the test.

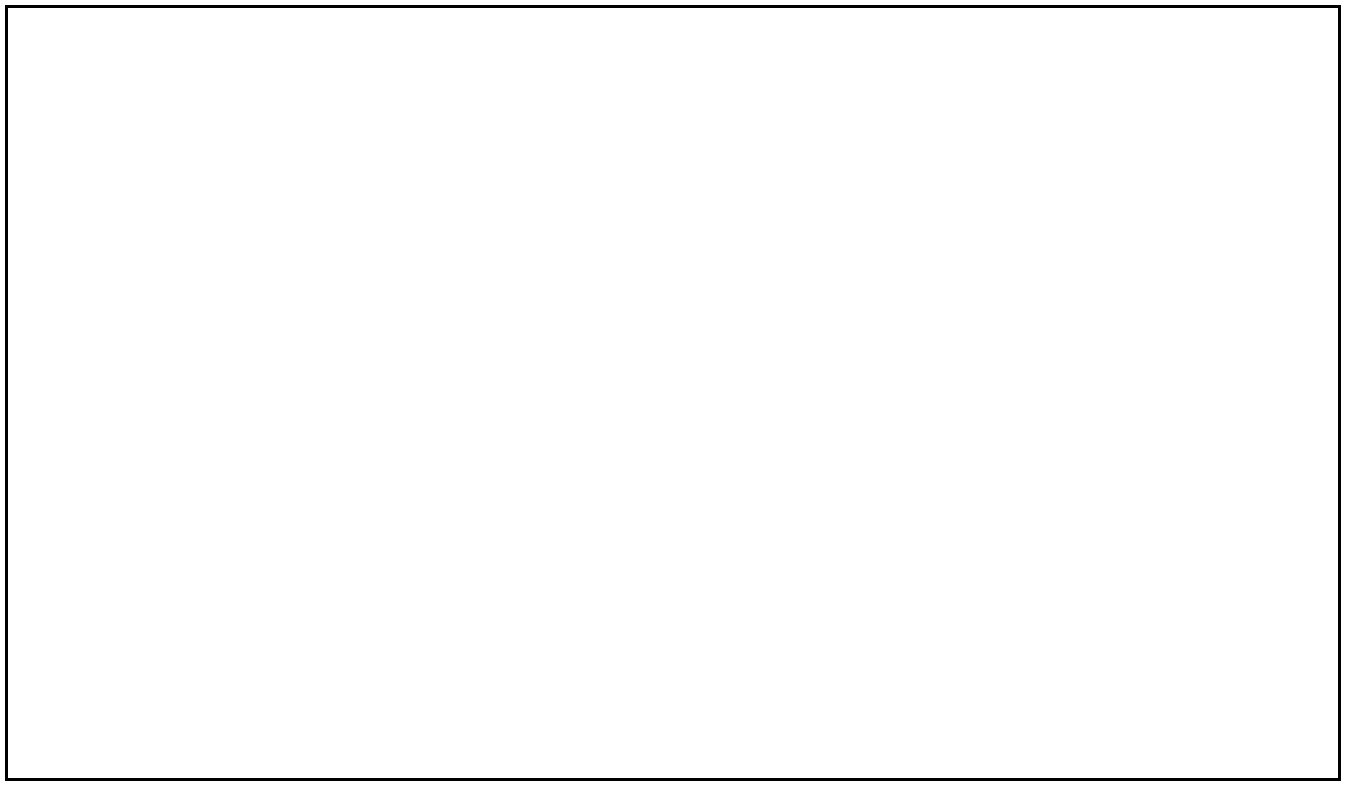
  Release two vehicles from the ramp at the same time.

  Use a stopwatch to record the time of the vehicle that crossed the finish line first. Students race at least six pairs of other vehicles. The ramp height and run-out surface remains consistent during these tests.

Roadster Rallies

Name: _____

My Vehicle



This is my vehicle.

Name of my vehicle _____

Wheel size in cm _____

My vehicle has many interesting features:

_____

_____

_____

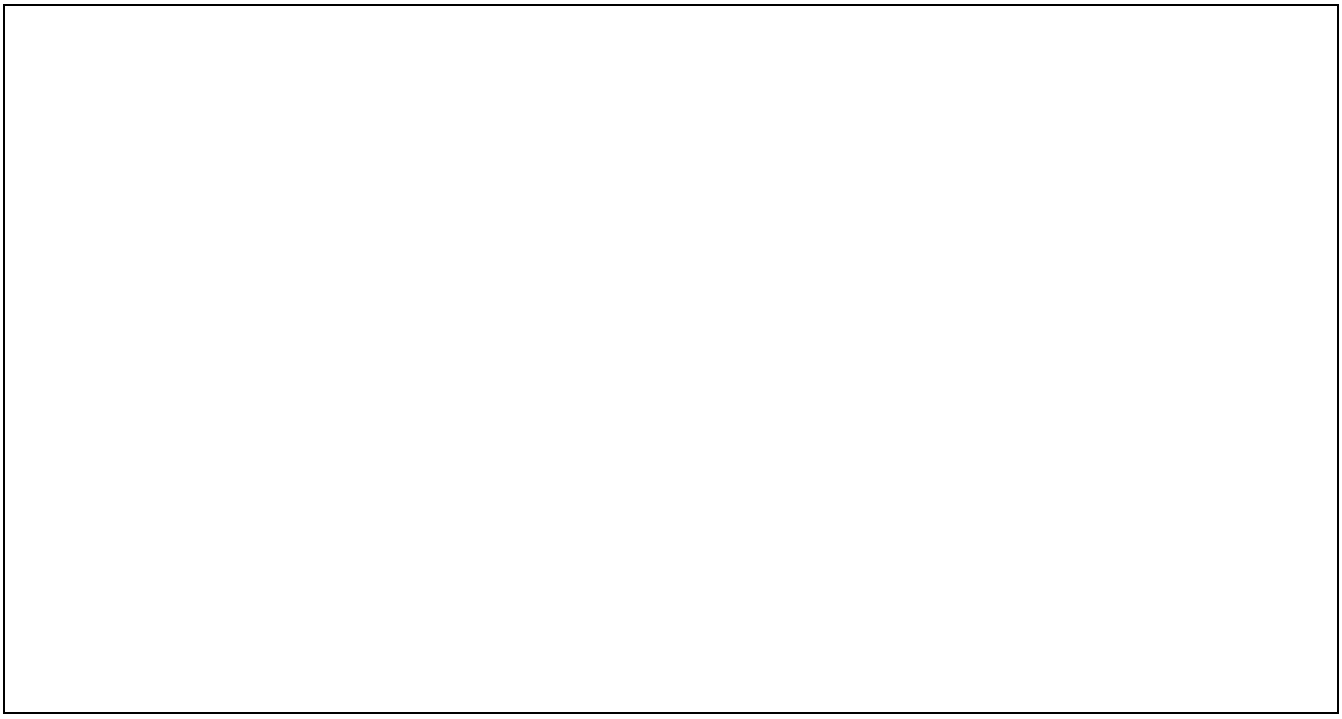
_____

_____

_____

Ramp Specifics

This is a picture of the ramp:



My hypothesis:

_____

_____

_____

_____

The ramp is made from:

_____

_____

_____

_____

The height of the ramp is: _____

Surfaces Tested

Choose 4 flooring coverings as run-out surfaces.
Complete the chart.

Floor Covering: Description: Location:	Floor Covering: Description: Location:
Floor Covering: Description: Location:	Floor Covering: Description: Location:

Vehicle Testing

Explain how you will test your vehicle.

_____

_____

_____

_____

_____

My hypothesis:

_____

_____

_____

_____

_____

Materials I Used:

_____ _____

_____ _____

_____ _____

How I will test:

_____

_____

_____

_____

Vehicle Performance

Measure the distance your vehicle travelled. Use a metre stick.
Fill in the chart with information from your vehicle test.

Floor Covering	Distance Travelled

Tell if your hypothesis was correct.

_____

_____

_____

_____

_____

_____

Results of Test

Using the information from your test, make a pictograph.
Use 1 vehicle to show 1 metre that your car travelled.

Floor Covering	Distance Travelled

Explain your pictograph.

_____

_____

_____

_____

_____

Results of Test

Were the results of the test what you expected? Explain.

How could you improve your test?

How can you change your test?

Simple Machines Activity Centres

Students apply their knowledge of simple machines as they work cooperatively at five activity centres. They explore, investigate, construct, and write about their learning experiences in the Activity Centres Booklet.

Planning the Activity Centres

- Set up the activities in a location that allows the teacher to provide guidance and assistance to the students at all the centres.
- Display and organize the materials at each centre ahead of time.
- Have parent volunteers, co-op students, or senior students act as guides or team leaders.
- Form teams of 4 to 6 students to progress through the activity centers. Naming or colour coding the team can be useful for organization and tracking the group's progress.
- Review cooperative learning skills and problem-solving strategies with the students before they begin work at the activity centres.
- Explain and demonstrate the activity at each centre and how students are to record and report their findings.
- Remind students of the safety rules for using tools, demonstrating the proper way to hold and use each tool.
- Allow the same amount of time for working at each centre, e.g., 40 minutes, and a similar amount of time to complete the reflection sheet after they have visited all of the centres.
- Explain what they can do if they complete the work at a centre ahead of the scheduled time or if they are not finished.

Activity Centres

<u>Activity 1 – Information Centre</u>

- Students review basic concepts of simple machines through literature and/or the use of computer software.
- Students use books, magazines, software, or a short DVD/video on simple machines to answer questions.
- Students can print out an activity they completed from the software and glue it into the activity booklet.
- Students write one new thing they learned.
- They release one canister at a time down the ramp, measure the distance it travelled, and record the measurement.

<u>Activity 2 – Ramp Racers</u>

- Students compare the motion of similar objects made or filled with different materials.
- Use a flat surfaced object, raising it to balance diagonally against another object for making a ramp. Remind the students that the ramp position must remain consistent for each container test to be accurate.
- Fill film canisters with sand, pennies, water, pebbles, cereal, …
- Students measure the distance the container travels after leaving the ramp.

Simple Machines Activity Centres

Activity 3 – Simple Machine Detectives

- Students identify simple machines in multi-step inventions.
- Choose a variety of everyday items that contain simple machines, e.g., pizza cutter, light bulb, toothpaste tube with the cap.
- Students identify the simple machines within the item and record their response on the worksheet.
- Students identify the simple machines in a multi-step game or invention.

Activity 4 – Pulley Power

- Students choose factors that make a load easier or heavier to move.
- Create a small single and compound pulley using a spring scale and a string and prepare loads for lifting, e.g., a film canister of pennies, a small container of erasers.
- Students use the scale to measure the weight of a load.
- Beside each load, the students record the force required for both pulley systems and then determine the best pulley system.

Activity 5 – Fantastic Fasteners

- Students select and use appropriate tools to fasten and unfasten the components of a model.
- Students examine a collection of objects containing screws. They locate the screw and use the corresponding screwdriver (e.g., Robertson, Phillips, …) to unfasten and re-fasten the object.
- Students make a paper screw using the pattern of a precut paper wedge shape and a pencil. To make the screw, the student roles the paper on a pencil, slides the pencil out and extends the roll by pulling one side. Then, they flatten the paper and glue the screw to a page in their activity booklet.

Reflection Journal

Students recall in writing their experiences at the activity centres and comment on how they felt as their team worked together at the centres.

Activity Centre Booklet

Name: _____

Activity 1 – Information Centre

Explain something that you learned from watching the video/DVD.

OR

Write about what you worked on when using the computer software program.

Printout out a page and glue it to the back of this paper. Explain what you did.

Activity 2 – Ramp Racers

Investigate how containers with different fillings roll down an inclined plane.

Step 1: Write down what is in each container.

Step 2: Roll each container down the inclined plane. Measure how far it went in centimetres, and record it in the chart.

Container	Filler	Distance (cm)
A	_____	_____
B	_____	_____
C	_____	_____
D	_____	_____
E	_____	_____
F	_____	_____

The container filled with _____ went the farthest distance.

The container filled with _____ went the shortest distance.

Why do you think this happened?

_____

_____

_____

_____

_____

_____

Activity 3 – Simple Machine Detectives

Tell what simple machines you see.

A pizza cutter has a _____.

A light bulb has a _____.

A tooth past tube with cap has a _____.

A _____ has a _____.

A _____ has a _____.

The multi-step invention has _____

_____ _____ _____

The multi-step game has _____

_____ _____ _____

Activity 4 – Pulley Power

Place the load on the scale.

Measure and record the scale value for each pulley system.

Choose the pulley system that lifts the load the easiest.

Load	Spring Scale Value Single Pulley	Spring Scale Value Compound Pulley	Circle the type of pulley that required the least force
50 pennies in a bucket			single pulley compound pulley
4 metal washers			single pulley compound pulley
a shoe			single pulley compound pulley

Activity 5 – Fantastic Fasteners

Screws can be used to join, cut, lift, and push.

A simple screw is used to join many things together. Use the screwdriver to move the screw into each item. Now, take the screw back out.

Making a Screw

A screw is an inclined plane wrapped around a rod. Wrap the paper wedge around your pencil to see how a screw is made. Glue it on this page.

Reflection Journal

Think about your experiences at the activity centres.
What was your favourite centre? Why?

How well did your team worked together?

What would you change or add to the centres?