Contents

To the Teacher

This is one in a series of hands-on science activity books for secondary-school students. A survey of students of that age group found that:

- more than half listed science as their favourite subject
- more than half wanted more hands-on activities
- 90 per cent said the best way for them to learn science was to do experiments themselves

The books in this series seek to capitalise on these findings. These books are not texts but supplements. They offer hands-on, fun activities that will turn some students on to science. Most of these activities can be done in school, and some of them can be done at home. Most of the authors are teachers who have field-tested the activities in a public secondary school.

Students will need only basic, standard scientific equipment that can be found in most high-school science laboratories. The activities range from the simple (examining Newton's first law) to the difficult (exploring the concept of ballistics). There is something for every student.

The activities can be used:

- to provide hands-on experiences pertaining to textbook content
- to give verbally limited children a chance to succeed
- as the basis for class or school science projects or for other science competitions
- to involve students in science-club undertakings
- as homework assignments
- to involve parents in their child's science education and experiences

Students can learn important scientific principles from carrying out these activities. Some examples include key concepts in conservation of energy, the laws of motion that govern all moving objects, and the important but sometimes overlooked force of friction.

Each activity has a Teacher Resource section that includes—besides helpful hints and suggestions—a scoring rubric, as well as Internet connections for those students who wish to go further and carry out the Follow-Up Activities.

These activities are designed to stand alone as supplements to your instruction. While the activities can be performed in any order according to your teaching plans, please note that some activities are similar in concept to others. For example, *Activity 8: Friction* and *Activity 9: Work (the Physics Kind)* discuss similar aspects of Newton's laws. It will reinforce student understanding to perform them in conjunction with each other. Also, the setup procedures for *Activity 1: Making Vectors* are very similar to those of *Activity 2: Adding Vectors*. If you choose to do both activities, you will save time and effort by doing them together.

5. Newton's Second Law: The Effect of Force

TEACHER RESOURCE PAGE

Instructional Objectives

Students will be able to:

- describe Newton's second law
- demonstrate the effects of mass and force on acceleration
- record data in a table
- draw conclusions based on data

Science Benchmark

Years 7–8

Content description
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Motions and forces
Transfer of energy
Abilities of technological design
Understandings about science and technology
Science as a human endeavour

Years 9–10

Content description
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry
Motions and forces
Abilities of technological design
Science as a human endeavour

Years 7–8

National Science Curriculum
Students investigate the effects of forces supporting or opposing each other; for example speeding up and slowing down
Students practise safe, responsible and ethical behaviour when conducting investigations using standard equipment
Students plan and conduct scientific investigations in ways that lead to the collection, interpretation and presentation of valid data
Students describe examples of how different forms of energy cause change in simple systems

Years 9–10

National Science Curriculum
Students plan experimental procedures which include the accurate control and measurement of variables
They identify inconsistencies in results and suggest reasons for uncertainty in data.
They use scientific language and representations when communicating their results and ideas
Students explain trends and patterns in data, identify discrepancies in experimental results and suggest improvements to their investigations
They use relationships between force, mass and acceleration to predict changes in the motion of objects

Vocabulary

- **acceleration:** the measure of change in velocity in a given amount of time
- **force:** generally a push or pull exerted on an object
- **mass:** the measure of the amount of matter in an object
- **newton:** the SI unit of force
- **Newton's second law:** states that the acceleration (a) of an object is proportional to the force (F) applied to it and inversely proportional to the object's mass (m)

5. Newton's Second Law: The Effect of Force

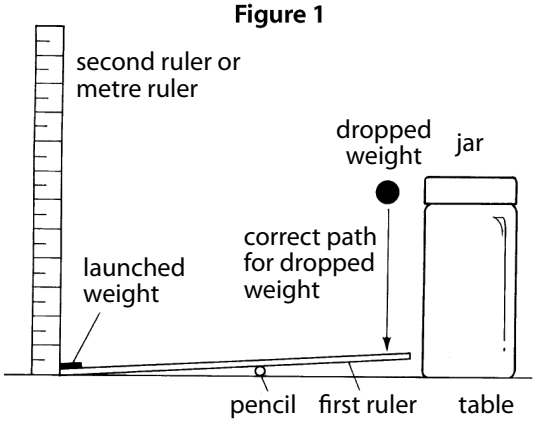
TEACHER RESOURCE PAGE

Materials

For each team:

- 15 counters or tiles of similar size and weight , glued or taped together into packs of 2, 3, 4 and 5 counters, and one single counter
- pencil
- two wooden or strong plastic 30-centimetre rulers (one may be a one-metre ruler)
- transparent tape or white glue
- jar, box or other object 15 to 20 cm tall
- table or bench
- calculator (optional)
- graph paper (extension activity)

Figure 1



Helpful Hints and Discussion

Time frame: 40 minutes, or one class period
Structure: pairs
Location: in class or at home

Since it is difficult to measure acceleration without special equipment, this activity uses an indirect approach. A counter is launched upward by the impact of a weight dropped from a standard height. The height reached by the counter depends on its initial upward speed. This initial upward speed depends on the acceleration provided by the ruler, which depends on the counter's mass and on the force exerted by the weight dropped onto the raised end of the ruler. Good results require practice and care in dropping the weight consistently from the same height and onto the same spot on the ruler. The ruler/pencil seesaw converts the downward motion of the dropped weight into upward motion. Taping the packs of counters together is acceptable, but gluing is preferred. Preparing these packs the day before the activity will allow the glue time to dry. Packs of counters glued with white glue can be separated by soaking them in water overnight.

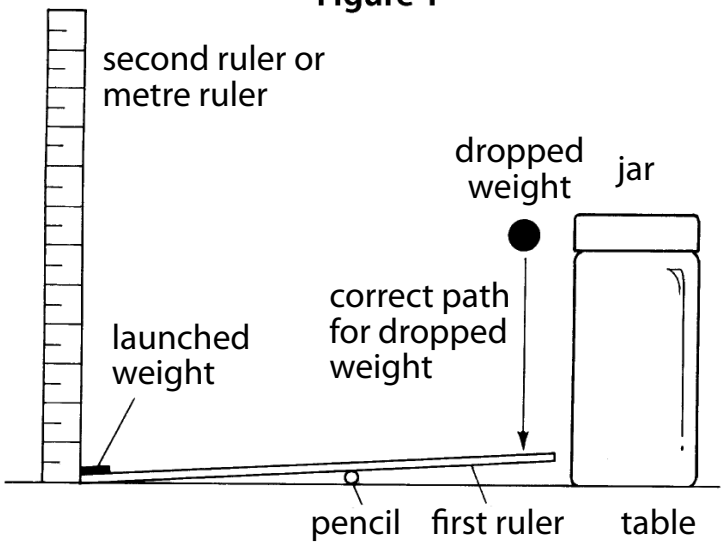
Name _____ Date _____

5. Newton's Second Law: The Effect of Force

STUDENT ACTIVITY PAGE

1. Using glue or tape to join the counters, make a pack with 2 counters, a pack with 3 counters and a pack with 5 counters. (If this step is done the day before the main activity, use a drop of white glue between the counters. If this step is done during the main activity, use transparent tape—as little as possible—to hold the counters together in a pack.)
2. Now you will prepare the launcher. Set the pencil on the table.
3. Place the 30-centimetre ruler on top of and perpendicular to the pencil, with the pencil at the 18-centimetre mark of the ruler. The end of the long side of the ruler should be resting on the table. The other end should be raised.
4. Set the jar near the raised end of the ruler. The top of the jar will be used as a standard height from which to drop a pack of counters onto the raised end.
5. Prop up or tape the second ruler or one-metre ruler to stand vertically behind and near the end of the long side of the first ruler. The second ruler will be used to estimate the height reached by the launched packs.
6. One team member should stand where he or she can see both the metre ruler and the launched counters.
7. The other team member should stand where he or she can release the dropped pack of counters onto the raised end of the ruler correctly and consistently. See Figure 1.

Figure 1



8. Place a single counter on the end of the long side of the ruler resting on the table.
9. One partner will hold the 2-counter pack directly above the raised end of the ruler at the height of the top of the jar.
10. The partner standing next to the vertical one-metre ruler needs to be ready to observe how high the launched counter goes into the air. He or she will estimate this by comparing the launched counter to the vertical one-metre ruler.