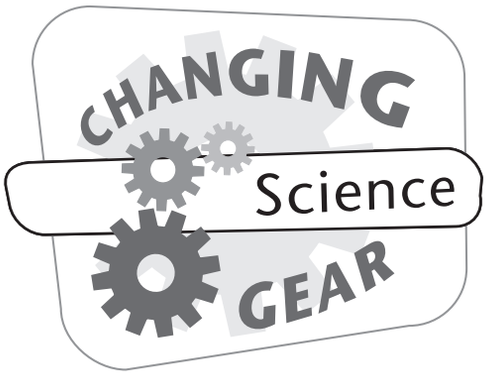


# Acknowledgements

## *Road Safe* Series

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| | |
|---|---|
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# Contents

# Part A Introduction

## The *Road Safe* Series

***Changing Gear*** is the junior secondary programme in the Police ***Road Safe*** Series.

This is a co-ordinated, integrated series of programmes beginning in the primary school and concluding in the senior secondary school. The intention is that young people learn road safety skills and knowledge at each level of their schooling and are given the opportunity to practise and reinforce these.

The programmes are:

| | |
|---|---|
| ***Stepping Out*** | Years 0-3 |
| ***Riding By*** | Years 4-6 |
| ***Out and About*** | Year 7-8 |
| ***Changing Gear*** | Year 9-10 |
| ***Safe Wheels*** | Years 11-13 |

# Aim of *Changing Gear*

Students will be empowered to participate safely as responsible road users, aware of their own place in traffic, as well as that of others.

# General Objectives

- Students have a basic understanding of road rules and laws as they affect them.
- Students are aware of their rights and responsibilities as road users.
- Students can explain what can happen when road rules are broken.
- Students can identify risks and the consequences of risky behaviour, and will respond to risks in safe ways.
- Students can illustrate safe responses to social pressures to be an unsafe road user.
- Students can identify road hazards and respond to them in sensible, safe ways.
- Students can identify their own personal skills and deficiencies as road users.
- Students can behave in rational ways on or near the road.
- Students can explain how social messages can affect road safety.
- Students can make sensible and safe decisions in a road safety context.
- Students know how speed affects safety, and understand the forces and energy involved in movement on the road.
- Students can list the attributes of a safe driver.
- Students can explain the process and requirements for getting a driver licence.



# Messages

The following messages will become part of students' thinking as a result of working through activities in ***Changing Gear***. It is not the intention that they be handed out to students as a list, although the list could be presented to the parents/caregivers during consultation.

- All my actions have consequences.
- I am responsible for my own road user behaviour and safety.
- I have a responsibility to help keep other road users safe.
- Safe road use requires rational behaviour.
- There are legal consequences when road rules are broken.
- There are strategies I can use to manage road risk.
- I can make safe decisions as a road user.
- Safe drivers are sensible drivers.
- A crash at high speed causes much more damage than a crash at a slow speed.
- As a road user I must obey road rules.
- Road rules and regulations are there for the safety of all road users.

# Using the Programme

**School Policy**

Before beginning teaching any ***Road Safe*** programme, a school should check that it has a road safety policy, and decide whether the policy needs reviewing.

Suggested points to cover in the policy are:

- Legal requirements for wearing cycle helmets.
- Legal requirements for use of skateboards.
- Legal requirements for students on restricted and learner licences.
- How to handle the situation when students have unsafe cycles or cycle helmets.
- Parking and safety of students' vehicles at school.
- Drink/driving issues.
- Safety on school buses.
- Respecting traffic rules and laws.
- Parking of parents' and teachers' vehicles inside and outside the school grounds.
- School trips
- Road safety education - where, when, how
- Transporting students on outings

# An Integrated Programme

***Changing Gear*** has been designed to be integrated into a number of Essential Learning Areas of the New Zealand Curriculum Framework. Activities have been developed for Social Studies, Health, Science, Maths, English and Technology. Each curriculum area has its own teaching guide and required resources.

Care has been taken to ensure that these activities link closely with Achievement Objectives and Essential Skills of the New Zealand Curriculum Framework.

The intention is that students will have school road safety education reinforced in a range of subjects, over a period of time. International research shows there is a need for ongoing reinforcement.

*"Road Safety Education (RSE) is best used as a real and relevant context within which much of the curriculum may be delivered. To be effective, and for progression to be achieved, RSE needs to be drip fed throughout the curriculum, with pupils receiving small but regular inputs which give purpose and meaning to their work."* Transport Research Laboratory, Department of Transport, UK

Schools may leave the decision of when to introduce road safety activities up to the individual subject teachers or Heads of Department. Alternatively, a school may decide to run a school road safety week, with road safety material being taught right across the curriculum.

It is recommended that a school appoint a **school road safety co-ordinator**, who can liaise between departments and co-ordinate activities.

# The Role of the Police Education Officer

The police education officer has the important role of making the school aware of the ***Road Safe*** Series, and, in particular, ***Changing Gear*** and ***Safe Wheels***, the two secondary programmes produced by the Police Youth Education Service. Roles of the police education officer include:

- Making a brief presentation about ***Changing Gear*** at a whole staff meeting.
- Arranging in-depth meetings with Heads of Department.
- Providing the teaching materials.
- Assisting with planning.
- Teaching in partnership as decided at the planning meeting.
- Taking part in evaluation.

Other police may be used as resource people, for example to discuss road and hazard markings.

# Parent/Caregiver Involvement

It should be of concern to every parent/caregiver that their young people are safe on the road as pedestrians, passengers, cyclists and drivers.

Both school and family have a role in teaching appropriate road safety skills, knowledge and attitudes.

The school should consult with parents/caregivers about the needs of students, and keep them informed about road safety programmes being run at school. Parents can then reinforce the road safety messages. Parents and teachers should also be aware of the importance of modelling safe road safety practices.

In ***Changing Gear***, some opportunities have been provided for parents to be involved and informed. A letter should be sent home before road safety work begins.

This should cover such things as:

- An outline of the ***Changing Gear*** programme.
- Time frame for teaching.
- Proposed learning outcomes.
- Ways parents/caregivers can be involved.
- Issues that could be discussed at home.
- Importance of role modelling by parents/caregivers.
- Process for parents/caregivers to voice queries or concerns.

# Youth Education Service Internet Site

Further information for teachers is available on the YES internet site **www.police.govt.nz/service/yes**

Teachers can also use this site or the following address to contact the YES office in the Office of the Commissioner of Police. Questions and comments are welcome. **yes@xtra.co.nz**

# Road Safety Objectives

- Students can identify road hazards and respond to them in sensible, safe ways.
- Students can make sensible, safe decisions in a road safety context.
- Students can identify risk and the consequences of risky behaviour, and will respond to risk in safe ways.
- Students will know how speed affects safety, and understand the forces and energy involved in road movement.



# Links with the New Zealand Curriculum

**Essential Learning Areas**

***Changing Gear*** will help teachers and students meet requirements of ***Science in the New Zealand Curriculum***. Detail of these links are given at the beginning of each unit.

## Essential Skills

(see Appendix pages 36-38)

***Changing Gear*** will enable students to further develop the following essential skills.

Communication 1

Numeracy 1,3,4,5

Information 2,3

Problem-solving 5,6

Social and Co-operative 1,2,5

Work and Study 1,2

# Using this Resource

- Each unit is designed as a basic activity that could be incorporated into an existing school science programme with extension activities.
- The entire package could be used as a unit of work in the context of road safety or Transport Science.
- Though the underlying message is one of safe road use, the intention is to deliver this message as secondary to the immediate learning of the class. Thus the class will cover a 'science' lesson but there is a road safety twist to the follow-up questions which makes the science more relevant.

# Overview

| Units | Context | Content | Learning Outcomes |
|---|---|---|---|
| 1 **Snapped** | Speed cameras | Distance/time<br>Speed | **1** Process data on vehicle speed.<br>**2** Recognise vehicle speed as a hazard to road use.<br>**3** Relate the principles of reflection to radar operation. |
| 2 **Night Lights** | Street lighting<br>Perception of colours | Vision<br>Light<br>Colour | **1** Relate how well different coloured objects or materials show up in different coloured lights.<br>**2** Explain some of the problems of seeing and being seen on the road.<br><br>**Extension**<br>**1** Describe the effect 'fog' has on how colours show up.<br>**2** Describe the effect different coloured lights have on how reflectors and reflective clothing show up. |
| 3 **Slippery when Wet** | Road surfaces | Friction | **1** Describe the effect of friction on motion.<br>**2** Describe the ways in which friction can be increased and reduced.<br>**3** Relate fictional forces to road use as a pedestrian, cyclist and driver.<br>**4** Carry out practical investigations into the effects of surfaces on frictional forces. |
| 4 **Smash Palace** | Collisions | Force<br>Inertia<br>Safety | **1** Describe the relationship between collision, speed and force.<br>**Extension**<br>Describe how some safety devices are used to reduce the force of a collision (on the passengers). |

# Copysheets

# Unit 1: *Snapped*

## Summary

***Investigating speed detection devices.***

## Links with the Curriculum

**Making Sense of the Physical World**

**Level 5.1** Carry out practical investigations, with control of variables, into common physical phenomena, and relate their findings to scientific ideas.

**Level 5.4** Investigate how physical devices or systems can be used to perform specific functions.

## Possible Teaching Contexts

Road safety

Speed (motion, transport)

Light/sound/waves

Technology

## Learning Outcomes

By the end of this unit students should be able to:

- Process data on vehicle speed.
- Recognise vehicle speed as a hazard to road use.
- Relate the principles of reflection to radar operation.

## Materials and preparation

Stop watches

Copysheet 1 **Candid Camera** page 14

Copysheet 2 **Road Runner** page 15

Copysheet 3 **Pretty Flash** page 16

Copysheet 4 **Operation of a Speed Camera** pages 17-19

Police officer authorised to use the laser gun

*Note: Contact your local police well in advance of the anticipated need, to ensure availability. The police officer will provide access to the speed/ laser gun/ radar detector and will be able to explain and demonstrate their use to students.*

## Time

1 lesson, plus the option of a second lesson and homework.

## Teacher Notes

There are three lesson activities that could be carried out independently of each other, or together.

*Note: The first activity will be most effective if the police officer is working with small groups of students at one time, as this will enable them all to have hands-on experience with the detection device. To make this possible, the bulk of the class could be doing other work, such as* ***Road Runner*** *or* ***Pretty Flash****, with small groups withdrawn at intervals for Activity 1.*

## 1 Candid Camera

A police officer visits the class and demonstrates the use of the laser gun. The class can then work with the police officer and teacher to gather data on the speed of vehicles moving past the school. If desired, this could be carried out at different times of the day, to see if differences occur. Students use Copysheet 1 **Candid Camera** for this activity.

Students collate and process the data to show the pattern of vehicle speeds and to relate this to traffic regulations that apply to that road area.

Discussion points:

- The hazards that the traffic speeds pose to students as pedestrians, cyclists, passengers and possibly drivers.
- The hazards that the traffic speeds pose to other road users, such as younger children or the elderly.

## 2 Road Runner

Vehicle speed data can be gathered by timing the vehicles over a set distance and then calculating their speed. This could be done as an activity prior to the police education officer's visit, or as an extension. Students use Copysheet 2 **Road Runner** for this activity.

## 3 Pretty Flash

Relate the principles of reflection to the operation of the speed camera/laser gun/radar detector. Students could complete Copysheet 3 **Pretty Flash** as a class or homework activity. Copysheet 4 **Operation of a Speed Camera** is used for this.

***Sample answers for Copysheet 3***

1 Camera, flash, radar unit, computer

2 All parts need to work together to ensure that a vehicle moving into the radar beam has its speed measured, and if it is speeding, its photograph taken.

3 Radio waves

4 They are reflected from the oncoming vehicle.

5 As the vehicle is oncoming, they are shifted up in frequency (doppler shifted up).

6 BEFORE AFTER REFLECTING

# Candid Camera

***Speed***

***Excessive speed is one of the biggest killers on our roads.***

***On average, 170 people die every year in New Zealand in speed-related crashes.***

***Remember, the faster you go, the more likely you are to be killed or seriously injured if you crash.***

***Don't become a road crash statistic–slow down when you're behind the wheel!***

Official Road Code 2005

**Instructions**

- Collect and record data on the speed of vehicles on the selected road area, using the laser gun. Your teacher will instruct you on how many vehicle speeds you need.
- Collate your data into a tally table as instructed by your teacher.
- Present the information on a fully labelled graph, as instructed by your teacher.

**Questions/Tasks**

**1** What is the speed limit for the road area from which you collected your data?

**2** Use your graph to estimate what percentage of drivers exceed the speed limit in your area.

**3** Describe how speeding vehicles on this chosen strip of road might affect:

a) a cyclist

b) a pedestrian

c) a passenger

d) a driver

Remember that you could be some, or all of the above!

**4** How might fast vehicles affect other road users, such as:

a) the elderly

b) young school children?

**5** How might the speed of vehicles on this road be controlled to comply with the speed limit?

# Road Runner

**Instructions**

**1** Collect your equipment from your teacher.

**2** Follow your teacher's instructions carefully; you will be working alongside the road and you need to keep yourself, and others, safe at all times.

**3** Measure the distance between two fixed points, such as telegraph poles (e.g. 100 metres).

**4** Position one person at the beginning of the measured zone with a flag or other marker. They will indicate when each vehicle enters the measured zone.

**5** Position another person at the other end of the measured zone with a stop watch.

**6** The timekeeper measures the time it takes for a vehicle to cover the (100m) distance.

**7** Record the results for the required number of vehicles.

**8** Back in class, use your data to calculate the speed for each vehicle, using the equation:

**speed = distance/time**

**9** Collate your results and present them in a tally table as instructed.

**10** Graph your results as instructed by your teacher.

**Questions/Tasks**

**1** What is the speed limit for the road area from which you collected your data?

**2** Use your graph to estimate what percentage of drivers exceed the speed limit in your area.

**3** List the implications the fast vehicles have for you as a:

**a)** pedestrian

**b)** cyclist

**c)** passenger

**4** How could the speed of vehicles on this road be controlled to comply with the speed limit?

# Pretty Flash


Official Road Code 2005

## Instructions

Read the information on Copysheet 4 ***The Operation of a Speed Camera*** and use this to answer the questions.

## Questions/Tasks

**1** What are the parts of the speed camera device?

**2** Why do the parts need to work together?

**3** What type of waves does the speed camera produce?

**4** What happens to these waves when they meet the oncoming vehicle?

**5** How are the returning waves different to the waves that go out?

**6** Draw diagrams to show the waves going out and the waves returning.
State <u>one</u> difference between the waves.

**7** How effective do you think speed cameras are in encouraging drivers to reduce their speed?

## Above and Beyond

<u>Radar</u> detection devices can make use of the Doppler effect. Find out what this is and how it is used in speed cameras.

<u>Sonar</u> uses a similar idea to radar detectors, but in water. Find out what sonar stands for and how it is used in water safety.

# The Operation of a Speed Camera

## RADAR – BASIC PRINCIPLES

Radar is an important and effective means of establishing vehicle speed. It is not the only means available, and it may not be the best means in certain cases, but it has numerous advantages that make it perhaps the most widely used method. In recent decades radar technology has been advanced significantly. Its cost effectiveness has made a major contribution to our speed enforcement capability.

### Fundamental Concepts

The word 'radar' is an abbreviation of the phrase Radio Detection And Ranging. This acronym implies that all radars are capable of finding a target (detection) and calculating its distance (range). The acronym, as defined, does not exactly fit the description of police traffic radars. Police traffic radars can provide a speed reading on a detected target, but they cannot measure the range of the target.

It is important to recognise that many types of radars exist. Some are complex, while others, like the police units are simpler. Even though there are many variations and different features among types and families of radars, the underlying principle remains the same: radio frequency energy is generated by a transmitter: an antenna forms the energy into a beam: and the beam is transmitted into space. When the energy, or signal, strikes an object, a small amount is reflected back to the antenna. From the antenna it is sent to the receiver, where, if the signal is strong enough, it is detected.

The way that the energy reflected from the target is processed by the receiver determines what information will be available to the operator. If the radar is to compute range to the target, timing circuits in the set will time the round trip travel period of the signal – starting at the time the signal is transmitted and ending when the receiver detects the reflected signal. Timing circuits are made possible by the fact that radio energy always travels at 186,000 miles per second – the speed of light. The speed of radio energy is therefore a constant in all computations performed in any radio set.

Police traffic radars use another characteristic of radio energy to measure speed. A radio signal's frequency (waves per second) is changed when the signal is reflected from a target that is moving at a speed different from that of the radar set. This change or shift in frequency is known as the Doppler shift.

### Doppler Shift

Christian Johan Doppler, an Austrian physicist, is credited with having discovered that relative motion causes the frequency of a signal to change. We now honour his memory by referring to this basic scientific fact as the Doppler Principle. Doppler actually studied sound waves but it was later found that the principle applies to all wave energy, including light waves and radio waves.

Almost everyone has had the opportunity to hear how the Doppler Principle affects sound waves. An observer standing by the side of a railroad track will notice that an approaching train makes a high-pitched sound (pitch is another word for frequency). As the train passes the observer, an immediate drop in pitch occurs. The frequency of the wavelengths that carry the trains sound has changed because of the train's motion, relative to the observer. The same thing can be heard alongside a road listening to the sound of passing cars and trucks.

***The Doppler Principle can be expressed as follows:***

- When there is a relative motion between two objects, one which is transmitting wave energy, the frequency of the signal as received by the other object changes due to relative motion.

- If the relative motion brings the objects closer together, the frequency will be increased.

- If the relative motion takes the objects further apart, the frequency will be decreased.

- How much the frequency is increased or decreased is determined by the exact speed of the relative motion.

What is most important about the Doppler Principle is that the frequency change happens only when there is a relative motion between the objects. If both objects are standing still, there is no relative motion, and the received signal has the same frequency as the transmitted signal. There is also no relative motion between two objects if they are moving in the same direction at the same speed. Relative motion requires that the distance between the transmission source and the receiver of the wave energy must be changing in some way.

***Relative motion will occur:***

- If the object receiving the energy stands still and the transmission source moves.

- If the transmission source stands still and the object receiving the energy moves.

- If both the transmission source and the object receiving the energy move, as long as they do so at different speed or in different directions (so that the difference between them changes).

In each case, the Doppler Principle says that the transmitted signal, as perceived by the receiver, will have a different frequency. Police traffic radar merely measures this change in frequency and converts it to a speed reading.

### Radar Beam

The radio wave energy transmitted by police traffic radar is concentrated into a cone shaped "beam". Most of the energy transmitted remains in the central core of the beam. The concentration of energy drops off quickly as one gets further away from or off to the side of the main beam.

Once transmitted, the length of the beam is infinite unless it is reflected, absorbed, or refracted by some object in its path. The typical objects from which the beam is reflected are made of metal. The beam is absorbed by grass, dirt, and leaves, with little energy being reflected by the antenna.

The term refraction refers to the radio waves that may pass completely through some substance and continue on infinitely. As they do, though, their direction or velocity may be changed slightly. Almost all forms of glass and many plastics will refract the radar beam. (An example of light waves being refracted can be seen when a straight object that has been put part way into water appears suddenly to be bent).

## Vehicle Speed Measurement And Verification With Auto Patrol Speed Cameras

### Speed Measurement

As the front of the vehicle enters the radar beam a continuous Doppler signal originating from the radar unit is reflected off the target vehicle and received by the centre control unit. Actual

measuring of the target vehicle begins after the front of the target vehicle has moved a few inches into the radar beam. The central control unit continuously analyses the Doppler signal frequency being received and makes approximately twenty speed measurements per foot of travel. Those measurements are analysed and compared to expected cosine decay and if the analysis is successful then the speed is used.

### Camera Activation

If the speed measurements received by the central control unit indicate a pattern of successful measurement, and the observed speed is equal to or greater than a threshold speed set for that particular site, then the camera is activated (a photograph is taken). The photograph has to be taken at this time so that the vehicle will still be in the photograph. At this point the camera shutter has been actuated and a photograph taken, but there is a delay before the information is recorded on the bottom of the photograph to allow further evaluation of the speed as the vehicle completes its pass through the radar beam.

### Verification

The main objective of verification is to determine whether the target vehicle is, in fact, moving through the radar beam. Deviations of more than plus or minus three percent from the original measured value indicate that more than one vehicle is moving through the beam, and will result in the cancellation of the measurement and voiding of the photograph.

### Infringement Record

Assuming a good measurement has been made and verified, the Doppler signal is converted to a speed value in Km/h and is displayed on the operational unit when the vehicle leaves the radar beam. The speed and other deployment data are recorded on the film as it advances, and the unit is ready for the next photograph.

# Unit 2: *Night Lights*

## Summary

***Investigating coloured light.***

## Curriculum Links

**Making Sense of the Physical World**

**Level 5.1** Carry out practical investigations, with control of variables, into common physical phenomena, and relate their findings to scientific ideas.

**Level 5.2** Describe various ways that energy can be transformed and transferred in our every-day world.

**Level 5.4** Investigate how physical devices or systems can be used to perform specific functions.

## Possible Teaching Contexts

Light and vision

Clothing and fabrics

Road safety

Design

## Learning Outcomes

By the end of this unit students should be able to:

- Relate how well different coloured objects or materials show up in different coloured lights.
- Explain some of the problems of seeing and being seen on the road.

**Extension**

- Describe the effect 'fog' has on how colours show up.
- Describe the effect different coloured lights have on how reflectors and reflective clothing show up.

## Materials and Preparation

Light source (ray box kit)

Coloured filters

Darkened room or cardboard box/tunnel –one for each group

Set of Colour Cards–one for each group (supplied)

Road Code - reference copy or access to the Land Transport New Zealand website www.landtransport.govt.nz

Copysheet 5 **Night Lights** page 22

**Extension**
Dry ice for 'fog'

Copysheet 6 **Night Lights Extension** page 23

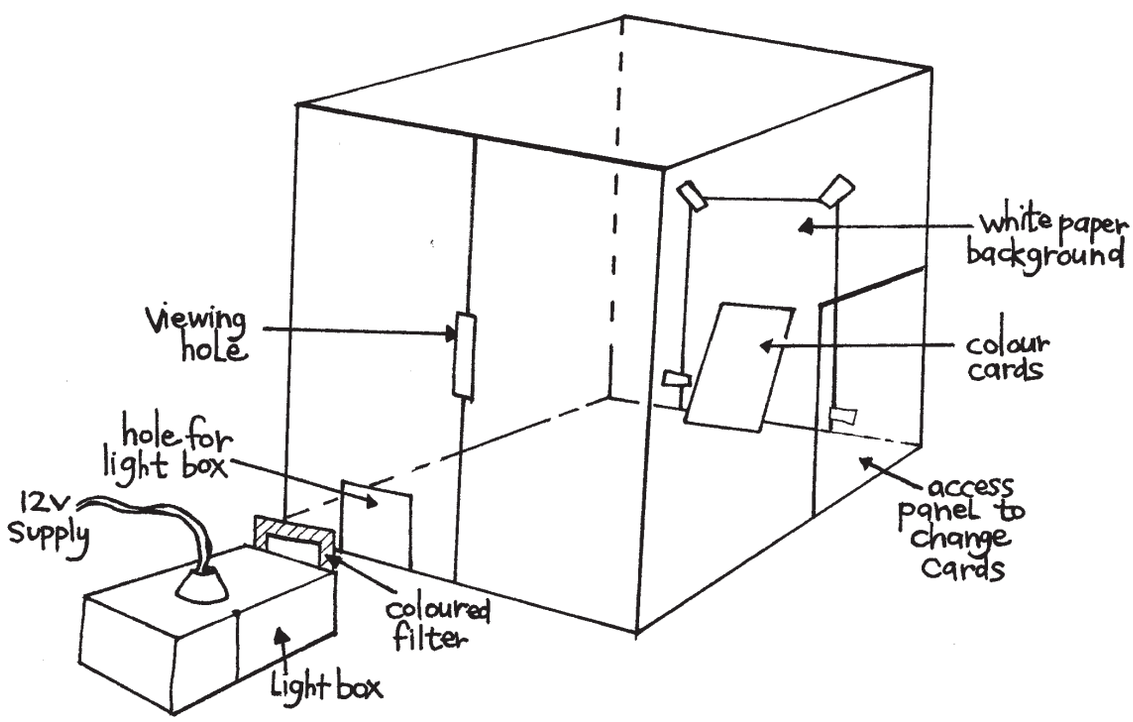
## Time

| | |
|---|---|
| Basic activity | 1 hour |
| Extension Activity | up to 3 hours |

## Teacher Notes

You will need a darkened room or a darkened area of the room, if you are working with the whole class. Alternatively, students could work in groups, each with their own darkened area, such as a large cardboard box. The box should be something like the one drawn in the diagram below. Try to exclude as much background (white) light as possible so that only the coloured light shines on the card.

Students use Copysheet 5 **Night Lights**, for this activity.




**Extension**
Students use Copysheet 6 **Night Lights Extension** for these activities.

Fog: Use a small beaker of hot water with 2-3 pellets of dry ice placed in the path of the light, and get students to describe the effect on visibility of different colours against the background in different coloured lights.

Cat's Eyes: Students can investigate how different reflectors, and reflective garments behave in different coloured light.

# Night Lights

## Instructions

**1** Follow your teacher's instructions to set up your cardboard viewing box.

**2** Write a hypothesis about the investigation you are about to do.

**3** Allocate roles within your group. One person is the viewer. They will report how each colour behaves under the different light sources. One person is responsible for changing the colour cards. One person is responsible for changing the light filters. One person is responsible for recording the findings. Try to make sure that the viewer doesn't see the colour cards in white light.

**4** Choose a colour filter for your light. Place a series of different coloured cards, one at a time, in this light and ask the viewer to describe the colour they see each time AND how easily they can be distinguished from the background.

**5** Make a 'league table' of most visible to least visible colours, in each colour of light. Write a conclusion based on your findings.

## Questions

**1** What effect does the colour of light have on each of the coloured cards?

**2** What colour do you think has the greatest visibility over all?

**3** What advice would you give to someone deciding what colour car, or cycle to buy?

**4** What advice would you give to drivers about visibility of other vehicles?

**5** What coloured street lights are used in the vicinity of the school?

**6** How visible is your school uniform under different street lights?

**7** How could your uniform be altered to improve pedestrian visibility?

# Night Lights Extension

## Fog

### *Dip Your Headlamps in Fog*

***If you drive with your headlamps on full beam in fog, the light will reflect back on you. Dip your lights. It will be much easier to see.***

***Don't just turn your parklamps on. They are hard for oncoming drivers to see. It is also illegal to drive with just your parklamps on.***

***Front fog lamps may also be used. These have a wide, low beam and produce either white or yellow light.***

***Rear fog lamps, which produce a high-intensity red light, should only be used when visibility is very bad.***

***Fog lamps should be switched off as driving conditions improve.***

Official Road Code 2005

## Fog

**Instructions**

**1** Read the information above.

**2** Place a small beaker of hot water with 2-3 pellets of dry ice in the path of the light, in your cardboard viewing box.

**3** Place the colour cards in the light, one at a time, as per activity *Night Lights.*

**4** Describe the visibility of each colour in these 'foggy' conditions.

**5** Report on your findings.

## Questions

**1** What advice would you give to each of the following concerning moving in foggy weather?

**a)** pedestrian

**b)** cyclist

**c)** driver

**d)** skateboarder

# Cats' Eyes

### Instructions

**1** Investigate how different reflectors (for example from a bicycle) behave in different coloured light.

**2** Look at reflective garments in different coloured lights.

**3** Report on the findings to your investigations.

### Questions/Tasks

**1** Find out what the Road Code says about reflectors on cycles.

**2** Research the type of reflective clothing or equipment available to road users.

**3** Which road users do you think should use such clothing or equipment?

# Above and Beyond

### Car Colours – Research Topics

**1** What is the most popular colour of passenger vehicles?

**2** What colour cars are involved in most vehicle crashes?

**3** What colours are emergency vehicles, and how do the vehicles increase their visibility?

**4** Why are sodium vapour lamps becoming more popular as street lights?

**5** What other types of street lights are available besides sodium vapour?

**6** What are the advantages and disadvantages of each type of street light?

# Unit 3: *Slippery when Wet*

## Summary

***Investigating frictional forces.***

## Curriculum Links

### Making Sense of the Physical World

**Level 5.1** Carry out practical investigations, with control of variables, into common physical phenomena, and relate their findings to scientific ideas.

**Level 5.3** Investigate and describe the patterns associated with physical phenomena.

**Level 5.4** Investigate how physical devices or systems can be used to perform specific functions.

### Making Sense of the Material World

**Level 5.4** Research and describe how selected materials are manufactured and used in every-day goods and technology.

## Possible Teaching Contexts

Road safety

Friction (forces, motion)

Materials

## Learning Outcomes

By the end of this unit students should be able to:

- Describe the effect of friction on motion.
- Describe the ways in which friction can be increased and reduced.
- Relate frictional forces to road use as a pedestrian, cyclist and driver.
- Carry out practical investigations into the effects of surfaces on frictional forces.

## Background

This activity is suitable for investigating friction and would follow some prior teaching of forces. It could also be used to investigate the use of selected equipment.

## Materials and Preparation

A range of different surfaces to be placed over the friction blocks. Examples could be different grades of sandpaper, glass, carpet, acetate, painted surface.

Force meter

Wooden friction block

Copysheet 7 **Slippery when Wet** page 27

## Extension Materials

Surfaces as above

Plank or ramp

Toy friction cars; Lego vehicles or similar; dynamics trolley

Sand or grit

Water

Grease

Ruler

Photopack **Tyre Types**

Copysheet 8 **Set-up Diagrams for Unit 3** page 29

## Time

1 basic lesson with 1-3 extension lessons

## Teacher Notes

This activity has been written using the basic system of friction block and force meter on a range of surfaces. As an alternative, the following variations could be used:

a) use shoes instead of the friction block;

b) use toy cars or motorised vehicles and measure the distance they can move UP an inclined plane at different angles;

c) measuring the angle/height of slopes for a fixed wheel vehicle/block to slide down the surface.

Students use Copysheet 7 **Slippery when Wet** and Copysheet 8 **Set-up Diagrams for Unit 3** for this activity.

# Slippery when Wet

## Aim

To determine how surface type affects the force required to slide a wooden block.

## Instructions

**1** Set up the equipment as shown on diagram 1 of Copysheet 8.

**2** Pull the wooden block along the surface and record the force required to slide the block along.

**3** Repeat the above, but using a range of surfaces, such as different grades of sandpaper, carpet, bench top, timber, concrete, OHP acetate.

**4** Collate and present your results to show any pattern in your data, as instructed by you teacher.

**5** Write a clear conclusion to your investigation.

## Questions/Tasks

**1** Which surface produced the greatest friction? Suggest reasons to explain this.

**2 a** Write a list of specifications for a good tyre for each of the following – family car, racing car, 4WD, motor cycle, light van.

Look at the pictures of tyre types.

**b** Which tyres match up to your description of a good tyre?

**c** Which tyres do you think would be best for each of the following – adhesion, noise, grip, smoothness of ride?

**d** What differences do you notice between the motor cycle tyres and the four wheel vehicle tyres? What do you think is the reason for this?

**3** Why do you think grit is spread on ice covered road surfaces?

**4** How do you think road surfaces could be improved to reduce skidding or slipping?

## Over and Above

**1** Do some research to find out the three most common types of road surfaces used in New Zealand, and the advantages and disadvantages of each.

**2** Locate and record where examples of these road surfaces are in your local area.

## Extension

**1** Repeat the investigation ***Slippery when Wet***, but change each surface by covering it with one of the following:

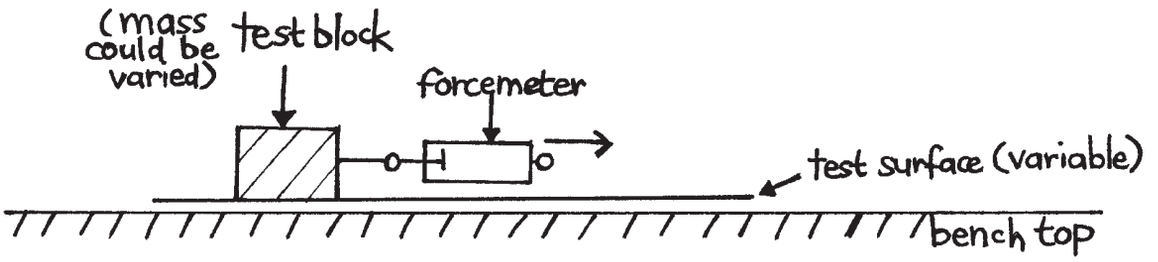
**a** water

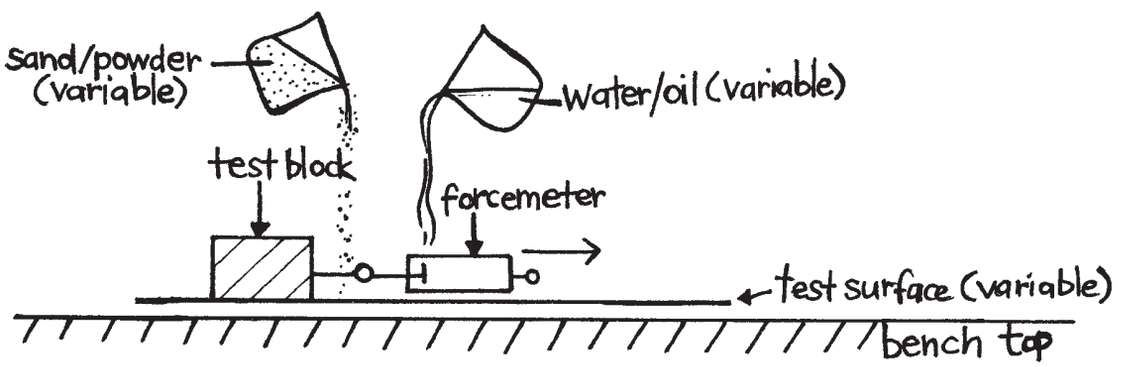
**b** oil or grease

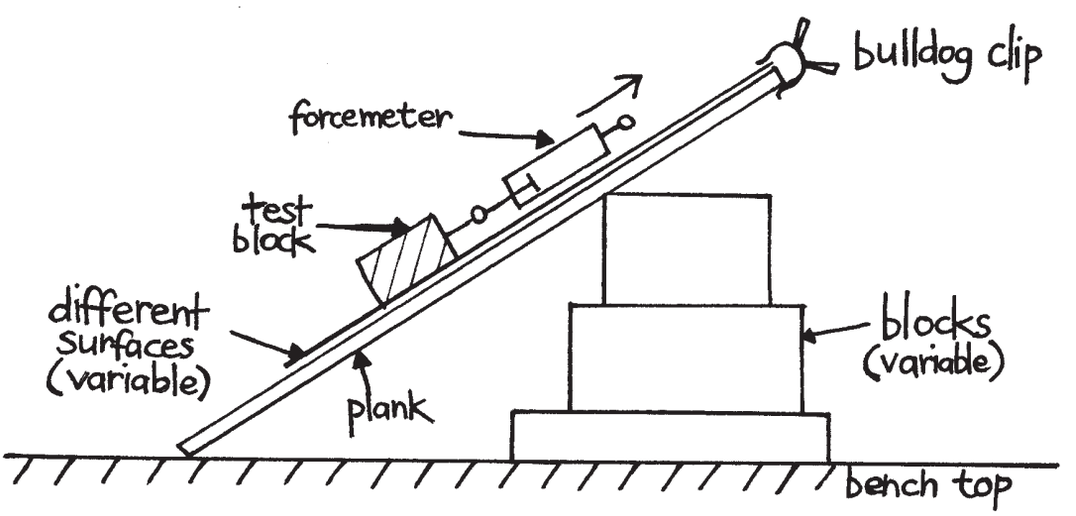
**c** sand/powder/grit

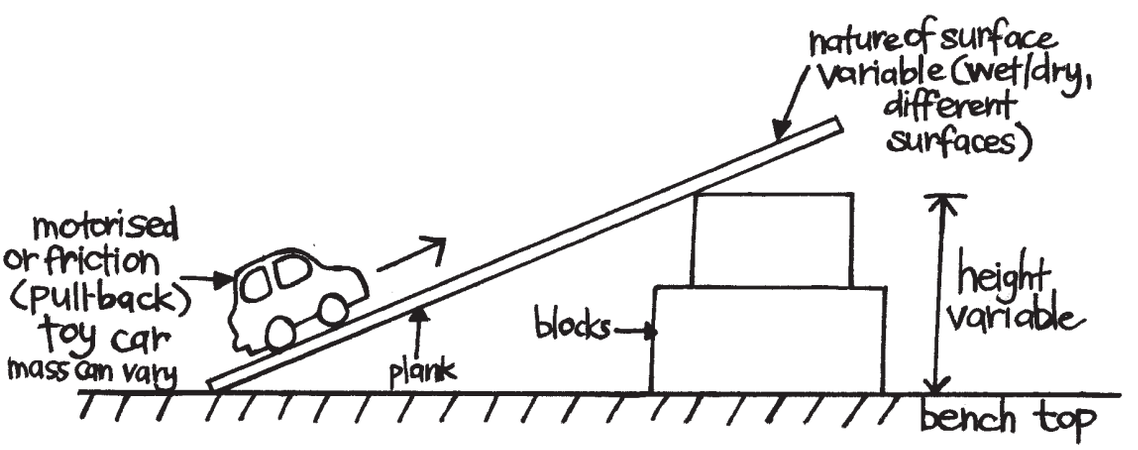
**2** Repeat the investigation, but change the gradient of the surface, as shown in diagrams 2-4 on Copysheet 8. Use the ramp to support the different surfaces.

# Set-up Diagrams for Unit 3



# Unit 4: *Smash Palace*

## Summary

***Investigating forces in collisions***

## Curriculum Links

**Making Sense of the Physical World**

**Level 5.1** Carry out simple investigations, with control of variables, into common physical phenomena, and relate their findings to scientific ideas.

**Level 5.3** Investigate and describe the patterns associated with physical phenomena.

## Possible Teaching Contexts

Forces and motion

Newton's Laws (1st and 2nd)

Road Safety

Materials use

Safety devices

## Learning Outcomes

By the end of this unit students should be able to:

- Describe the relationship between collision, speed and force.

**Extension**

- Describe how some safety devices are used to reduce the force of a collision (on the passengers).

## Materials and Preparation

School physics dynamics trolley

Empty matchbox

Sellotape

Masses (could be sand or known masses such as brass weights)

Sloping smooth surface about 1m in length

Copysheet 9 **Smash Palace** page 32

The police education officer or local Plunket could bring in examples of child restraints.

**Extension**

Rubber bands

A4 paper sheets

Eggs

String

Drawing pins

Paper clips

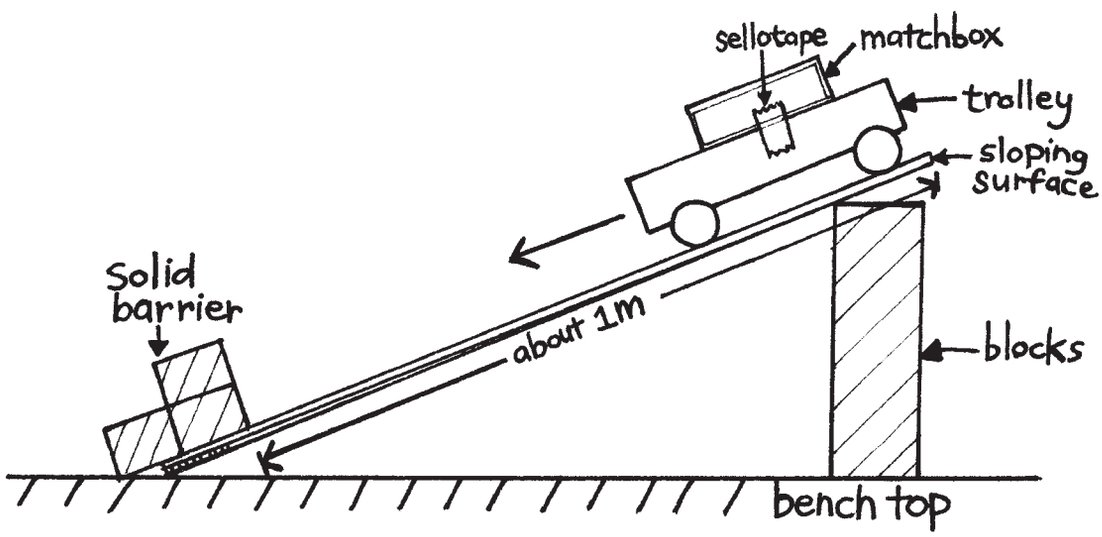
Foam rubber blocks

Copysheet 10 **Smash Palace Extension** page 34

## Teacher Notes

Students use Copysheet 9 **Smash Palace** to set up and carry out this activity.

The basic set up is shown in the diagram below.




For the **Above and Beyond** section, the police education officer or Plunket could be invited to class to bring examples of child restraints and discuss their use.

Extension activities are provided on Copysheet 10 **Smash Palace Extensions**.

# Smash Palace

## *Safety Belts and Child Restraints*

***Safety belts and child restraints protect people by holding them in their seats when there is a crash. If you don't wear a safety belt and you're involved in a crash, you could be thrown out of your vehicle.***

***Always remember to fasten your safety belt before you drive off.***

Official Road Code 2005

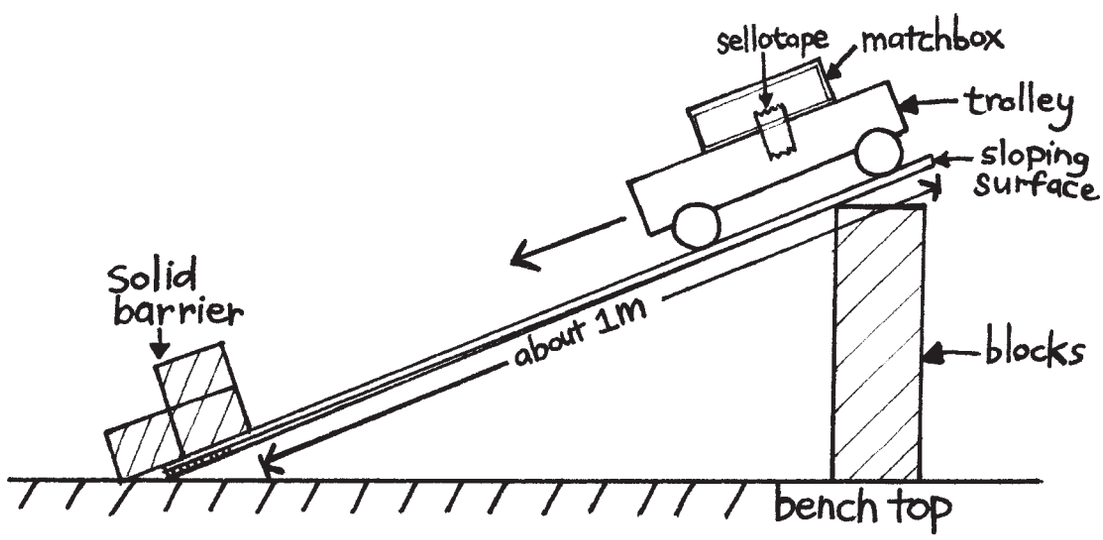
## Instructions

**1** Sellotape an empty matchbox to a dynamics trolley, so that the drawer can slide freely in and out of the casing.

**2** Put a mass in the drawer and slide it closed.

**3** Set up a sloping surface (start with a small slope first). Place a fixed barrier at the bottom end of the slope, to stop the trolley.

The above three steps are shown in the diagram below.




**4** Write a hypothesis about the investigation you are about to do.

**5** Let the trolley roll down the slope into the barrier. Measure how far the drawer of the matchbox slides forward.

**6** Repeat step 5, varying the amount of the slope. Record your results.

**7** Write a conclusion based on your results.

## Extension

Repeat the experiment with different masses in the matchbox.

What effect does this have?

## Questions

**1** What effect did increasing the slope have on the collision speed of the trolley?

**2** What effect did the collision speed have on the distance travelled by the matchbox drawer?

**3** How could this information be put to use in everyday life?

## Over and Above

Use the Road Code, or the Land Transport New Zealand website **www.landtransport.govt.nz** to check out what the law says about safety belts and child restraints.

# Smash Palace Extension

## Car Collisions

## Instructions

You have seen the effect of speed on a matchbox 'passenger'. Now you are asked to try to reduce the effect of the collision, by adding 'safety devices' to the trolley.

### Safer Trolley

- Design and add structures to the front of the trolley to reduce the effect of a collision. You could use foam, paper or other materials if they are available.
- Test the effectiveness of these structures and record your findings.

### Matchbox

- What changes could be made to the matchbox to prevent the drawer from sliding forward?
- Test the effectiveness of these and record your findings.

### A Safer 'Passenger'

- What happens to the solid mass in the collision?
- Does the starting position of the mass make any difference in the collision?
- Test the effectiveness of different starting positions for the mass, and record your findings.

### A Safer Barrier

- What difference does the barrier make to the collision?
- Change the material of the barrier into which your trolley crashes, and record your findings.

## Questions

**1** Find out how force is related to acceleration on a mass.

**2** What advantage is there in modifying a barrier compared to modifying a vehicle?

**3** What advantage is there in modifying the vehicle and not the barrier?

**4** List some of the design features that are incorporated into modern vehicles to reduce the force of an impact on a passenger in a collision.

**5** Try to find out the force on a 50kg person in a $50km/H^{-1}$ collision.

**6** Look at cycle helmets. Why are they lined with polystyrene, rather than just being a hard shell?

# Above and Beyond

**Technology Challenge** **Egg Drop**

Design and produce a container for a raw hen's egg that will protect the egg when dropped from a height of 3m onto a hard surface such as concrete.

The materials you may use will be listed by your teacher.

# Appendix

# The Essential Skills

### Communication Skills

**Students will:**

**1** communicate competently and confidently by listening, speaking, reading, and writing, and by using other forms of communication where appropriate;

**2** convey and receive information, instruction, ideas and feelings appropriately and effectively using a range of different cultural, language and social contexts;

**3** develop skills of discrimination and critical analysis in relation to media, and to aural and visual messages from other sources;

**4** argue a case clearly and logically, and convincingly;

**5** become competent in using new information and communication technologies, including augmented communication for people with disabilities.

### Numeracy Skills

**Students will:**

**1** calculate accurately;

**2** estimate proficiently and with confidence;

**3** use calculators and a range of measuring instruments confidently and competently;

**4** recognise, understand, analyse, and respond to information which is presented in mathematical ways, for example, in graphs, tables, charts, or percentages;

**5** organise information to support logic and reasoning;

**6** recognise and use numerical patterns and relationships.

### Information Skills

**Students will:**

**1** identify, locate, gather, store, retrieve and process information from a range of sources;

**2** organise, analyse, synthesize, evaluate and use information;

**3** present information clearly, logically, concisely, and accurately;

**4** identify, describe, and interpret different points of view, and distinguish fact from opinion;

**5** use a range of information-retrieval and information-processing technologies confidently and competently.

**Problem-solving Skills**

**Students will:**

**1** think critically, creatively, reflectively and logically;

**2** exercise imagination, initiative, and flexibility;

**3** identify, describe, and redefine a problem;

**4** analyse problems from a variety of different perspectives;

**5** make connections and establish relationships;

**6** inquire and research, and explore, generate and develop ideas;

**7** try out innovative and original ideas;

**8** design and make;

**9** test ideas and solutions, and make decisions on the basis of experiences and supporting evidence;

**10** evaluate processes and solutions.

**Self-management and Competitive Skills**

**Students will:**

**1** set, evaluate, and achieve realistic personal goals;

**2** manage time effectively;

**3** show initiative, commitment, perseverance, courage, and enterprise;

**4** adapt to new ideas, technologies, and situations;

**5** develop constructive approaches to challenge and change, stress and conflict, competition, and success and failure;

**6** develop the skills of self-appraisal and self-advocacy;

**7** achieve self-discipline and take responsibility for their own actions and decisions;

**8** develop self-esteem and personal integrity;

**9** take increasing responsibility for their own health and safety, including the development of skills for protecting the body from harm and abuse;

**10** develop a range of practical life skills, such as parenting, budgeting, consumer, transport, and household maintenance skills.

**Social and Co-operative Skills**

**Students will:**

**1** develop good relationships with others, and work in co-operative ways to achieve common goals;

**2** take responsibility as a member of a group for jointly decided actions and decisions;

**3** participate appropriately in a range of social and cultural settings;

**4** learn to recognise, analyse, and respond appropriately to discriminatory practices and behaviours.

**5** acknowledge individual difference and demonstrate respect for the rights of all people;

**6** demonstrate consideration for others through qualities such as integrity, reliability, trustworthiness, caring or compassion (aroha), fairness, diligence, tolerance, (rangimarie), and hospitality or generosity (manaakitanga);

**7** develop a sense of responsibility for the well-being of others and for the environment;

**8** participate effectively as responsible citizens in a democractic society;

**9** develop the ability to negotiate and reach consensus.

**Physical Skills**

**Students will:**

**1** develop personal fitness and health through regular exercise, good hygiene, and healthy diet;

**2** develop locomotor, non-locomotor, and manipulative skills;

**3** develop first aid skills;

**4** develop specialised skills related to sporting, recreational, and cultural activities;

**5** learn to use tools and materials efficiently and safely;

**6** develop relaxation skills.

**Work and Study Skills**

**Students will:**

**1** work effectively, both independently and in groups;

**2** build on their own learning experiences, cultural backgrounds, and preferred learning styles;

**3** develop sound working habits;

**4** take increasing responsibility for their own learning and work;

**5** develop the desire and skills to continue learning throughout life;

**6** make career choices on the basis of realistic information and self-appraisal.

*Taken from* ***The New Zealand Curriculum Framework*** *Ministry of Education 1993.*