UNIT OVERVIEW

Safer by Design - Years 9/10
Investigating Forces, Motion and Road Safety

WHY TEACH THIS UNIT?

In this unit, students investigate the science behind road crashes — exploring how energy, forces and motion help explain why crashes happen and how their impacts can be reduced. Students apply mathematical thinking to analyse real road safety data and calculate quantities such as kinetic energy and stopping distance. They examine how vehicle safety technologies are designed and engineered, and conclude the unit by designing, building and testing their own protective structure, before communicating a road safety case to a general audience. Throughout, the unit connects learning in Science, Mathematics and Design and Technologies to a real-world problem that affects young people directly.

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ROAD SAFETY EDUCATION VICTORIA

UNIT OVERVIEW

Safer by Design: Investigating Forces, Motion and Road Safety

Victorian Curriculum 2.0 focus

The focus of this unit is on Level 9 and 10 Science understanding in the Victorian Curriculum 2.0, with a particular emphasis on physical sciences.

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **Physical sciences:** the Law of Conservation of Energy can be analysed in systems, including Earth systems, by assessing the efficiency of energy inputs, outputs, transfers and transformations (VC2S10U15).
- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects (VC2S10U17).
- **Science as a Human Endeavour:** advances in technologies have enabled advances in science, while science has contributed to developments in technologies and engineering (VC2S10H02).
- **Science inquiry:** arguments based on a variety of evidence can be constructed to support conclusions or evaluate claims, including consideration of any ethical issues and cultural protocols associated with accessing, using or citing secondary data or information (VC2S10I07)
- **Statistics:** analyse claims, inferences and conclusions of statistical reports in the media and other places, by linking claims to displays, statistics and representative data, including ethical considerations and identification of potential sources of bias (VC2M10ST04).
- **Creating designed solutions:** apply innovation and enterprise skills to generate, test, iterate and communicate design ideas, processes and solutions, using technical terms and graphical representation techniques and appropriate attributions using manual and digital tools (VC2TDE10D02).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science:** Students analyse and represent energy conservation, including efficiency, in systems, and model how different forms of energy are transformed into electrical energy. (Level 9 & 10).
- **Science:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).
- **Science:** Students examine the relationship between science, engineering and technologies (Level 9 & 10).
- **Science:** Students provide evidence-based explanations for findings and construct logical arguments based on the evaluation of multiple sources of evidence to justify conclusions and assess claims (Level 9 & 10).
- **Mathematics:** Students analyse inferences and conclusions in the media, noting potential sources of bias (Level 10).
- **Design and Technologies:** Students critique and communicate design ideas, processes and solutions to a range of audiences using technical terms, graphical representation techniques and appropriate attributions. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

UNIT OVERVIEW

Safer by Design: Investigating Forces, Motion and Road Safety

PRIOR KNOWLEDGE

This unit is strongly connected to preceding content in the physical sciences and requires students to have an understanding of describing motion, forces, work and energy. This is connected to the content at Level 7 & 8 in physical sciences.

- balanced and unbalanced forces acting on objects, including gravitational force, may be investigated and represented using force diagrams; changes in an object's motion can be related to its mass and the magnitude and direction of the forces acting on it (VC2S8U14).
- energy exists in different forms, including thermal, chemical, gravitational and elastic, and may be classified as kinetic or potential; energy transfers (conduction, convection and radiation) and transformations occur in simple systems and can be analysed in terms of energy efficiency (VC2S8U15).

ADAPTING TO CONTEXT

This unit has been designed with the intention that it is adapted to best suit your context. Potential adaptations include:

- **Standalone unit.** Running this sequence as a standalone unit that builds on students existing understanding of working with data, energy, and forces and motion.
- **Embedded unit.** Using these lessons within a larger unit on forces and motion
- **Increasing the duration and scope.** Taking the opportunity to extend the time for one or more of the lessons, and in doing so increasing the depth that students engage with the content. This would be particularly well suited to lesson 6 on forces and collisions, lesson 7 & 8 egg crash, lesson 9 road safety explainer, and the lesson 9 quiz.
- **Increasing the complexity of the practical tasks.** The practical tasks have been designed to use readily available equipment.
  - If you have more advanced equipment, such as video analysis tools, motion sensors, dynamics trolleys, these could be used to increase the detail and accuracy of the data collected.
  - If you are engaging with a local Tech School or Science Specialist Centre, they may have advanced tools and equipment that could be used to extend the design-build-test opportunity in the lesson 7 & 8 egg crash
- **Adapting the assessments.** The scope of the assessments in lesson 9 could be expanded to take more time and go into greater depth.
- **Additional assessment.** The activities in this unit could be adapted to create quiz or test style questions to provide additional assessment of learning.
- **Use of technology.** The activities have been designed to be able to be done without technology. A range of technology could be used across the sequence, including.
  - Spreadsheets for data recording and analysis.
  - Cameras for capturing data or artefacts from experiments.
  - Sensors for capturing data from experiments.

ROAD SAFETY EDUCATION VICTORIA

Safer by Design: Investigating Forces, Motion and Road Safety

ENABLING AND EXTENDING STUDENTS

Specific enabling and extending suggestions are provided within the lesson plans where applicable. Additional approaches that you could use across lessons are summarised below.

- Enable students by:
  - increasing the time allocated
  - providing additional scaffolding using the worked examples and teacher resources
  - providing additional opportunities for practice, using the examples provided as a starting point
- Extend students by:
  - reducing the scaffolding provided
  - increasing the pace at which they move through the opportunities for practice, providing more challenging examples where appropriate

KEY RESOURCES

Specific enabling and extending suggestions are provided within the lesson plans where applicable. Additional approaches that you could use across lessons are summarised below.

- **Lesson Plans** – details of the learning sequence and the specifics of each lesson, including detailed teaching guidance aligned with the Victorian Teaching and Learning Model 2.0
- **Student Workbook** – complete set of worksheet materials and resources for student use for all activities
- **Teacher Workbook** – complete set of worksheet materials and resources for student use for all activities, include additional competed examples and solutions where applicable for teacher reference
- **Supporting Slide Deck** – slide deck that teachers can use to display materials from the sequence on a projector or screen as desired

ROAD SAFETY EDUCATION VICTORIA

UNIT OVERVIEW

Safer by Design: Investigating Forces, Motion and Road Safety

LESSON OVERVIEW

Lesson	Learning objective	Success criteria
Lesson #1: The safe system	We will understand important strategies that are used to make roads safer for everyone.	I can explain what the safe system is I can identify ways we make road travel safer and how they fit into the safe system I can interpret road safety data to connect safety risks to safety strategies
Lesson #2: Safer speeds	We will understand why speed is an important factor in road safety.	I can interpret data on the effect of speed on road safety I can calculate kinetic energy for objects travelling at different speeds I can explain how kinetic energy increases with speed and mass
Lesson #3: Stopping distances	We will analyse vehicle stopping distances in different conditions.	I can describe motion using speed, distance, time and acceleration I can calculate the stopping distance of a vehicle I can explain the factors that influence stopping distance
Lesson #4: Reaction times experiment	We will conduct a simple experiment to explore factors that affect human reaction times.	I can calculate reaction times using the ruler drop distance I can conduct an experiment following the method provided I can analyse and reflect on results from the reaction time experiment
Lesson #5: Vehicle safety features	We will understand how active safety features improve vehicle safety.	I can explain the difference between active and passive vehicle safety features I can interpret information on specific active safety features I can explain how specific active safety features improve safety
Lesson #6: Forces and passive safety	We will understand how passive safety features improve vehicle safety.	I can explain safety features using work and energy I can explain safety features using inertia, forces and acceleration I can elaborate on how specific safety features improve safety
Lesson #7: Egg crash (design, build)	We will apply our knowledge of safety features to design, build and test a 'mini vehicle'.	I can create a design that meets all requirements of the brief I can build and test the design I can reflect on the process and evaluate the design
Lesson #8: Egg crash (test, reflect)		
Lesson #9: Road safety explainer (application)	We will communicate the case for a specific road safety feature to a general audience.	I can explain the key details of a chosen safety feature I can explain how the feature improves safety and connect this to the safe system I can test the resource and reflect on potential improvements

ROAD SAFETY EDUCATION VICTORIA

UNIT OVERVIEW

Safer by Design: Investigating Forces, Motion and Road Safety

ASSESSMENT RUBRIC

Content Focus (Lessons)	1 Foundations	2 Acquisition	3 Fluency	4 Generalisation & Application
Safe System (Lesson 1)	Names the four components of the safe system	Sorts road safety strategies into the correct safe system component	Explains how specific strategies reduce the likelihood or severity of crashes	Connects the need for safe system strategies to road safety data
Speed & Kinetic Energy (Lesson 2)	Recalls types of energy and energy conservation	Calculates kinetic energy	Explains why small speed increases lead to large kinetic energy increases	Connects kinetic energy increases to potential crash severity
Stopping Distance (Lesson 3)	Identifies the two components of stopping distance	Calculates stopping distance from given speed and acceleration values	Explains how speed, road surface and reaction time each effect stopping distance	Predicts how changing conditions alter stopping distance
Reaction Times (Lesson 4)	Lists factors that increase reaction time	Follows a method to collect and record reaction time data	Calculates reaction times and identifies trends across conditions	Evaluates the validity of the experiment and connects findings to driver distraction
Active Safety (Lesson 5)	Distinguishes between active and passive safety features	Describes the function of a specific active safety feature	Explains how an active safety feature reduces crash risk using scientific reasoning	Connects active safety technologies to the safe system
Passive Safety & Forces (Lesson 6)	Names passive safety features found in vehicles	Describes how seatbelts, airbags or crumple zones protect occupants in a crash	Explains passive safety features using force, acceleration, work and energy	Applies Newton's laws to explain how passive features improve safety
Design, Build & Test (Lessons 7–8)	Identifies design requirements from the brief	Produces a design and constructs it according to the brief	Tests the design against brief requirements and records outcomes	Evaluates performance using test evidence and proposes justified improvements
Road Safety Communication (Lesson 9)	Identifies a road safety feature and states its purpose	Describes how a chosen feature reduces road harm for a general audience	Constructs a clear explanation of a safety feature drawing on relevant scientific understanding	Connects the feature to the safe system and makes a case for its use

ROAD SAFETY EDUCATION VICTORIA