LESSON PLAN

Lesson 2: Safer Speeds

UNIT TITLE: Safer by Design - Investigating Forces, Motion and Road Safety

LEVEL
Years 9-10

LESSON NUMBER
2 of 9

LESSON LENGTH
60 minutes

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).
- **Science as a Human Endeavour:** advances in technologies have enabled advances in science, while science has contributed to developments in technologies and engineering. (VC2S10H02).
- **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).

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 examine the relationship between science, engineering and technologies. (Level 9 & 10).
- **Mathematics:** Students analyse inferences and conclusions in the media, noting potential sources of bias. (Level 10).

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KEY VOCABULARY

- **speed** – the distance an object travels per unit of time (e.g. metres per second, m s-1)
- **energy** – the capacity to do work or make change; energy can be stored, transferred, and transformed but not created or destroyed (measured in joules, J)
- **work** – the transfer of energy that occurs when a force moves an object over a distance (measured in joules, J)
- **kinetic energy** – the energy an object has due to its motion; it depends on both the object's mass and speed
- **mass** – the amount of matter in an object (measured in kilograms, kg)

MATERIALS REQUIRED FOR THE LESSON

Student

- Safe System Worksheet (Key Resource 2) – 1 per student, printed
- Vocabulary Worksheet (Key Resource 3) – 1 per student, printed
- Speed Statistics (Resource 2.1) – 1 per student, printed
- Revisiting Key Energy Concepts (Resource 2.2) – 1 per student, printed
- Kinetic Energy Calculations (Resource 2.3) – 1 per student, printed
- Kinetic Energy Analysis (Resource 2.4) – 1 per student, printed

Teacher

- Supporting Slide Deck – as needed, display on screen or use a document camera or write on whiteboard
- Teacher Workbook – as needed for reference, including for display on screen or with a document camera

LEARNING OBJECTIVE

- We will understand why speed is an important factor in road safety.

SUCCESS CRITERIA

- I can interpret data on the impact 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.

TEACHING CONSIDERATIONS

- Potential misconceptions:
  - Forms of energy: Students may name many examples that are not scientific forms of energy. They may also use terminology that is close to accurate but not the preferred scientific term. It may be necessary to clarify scientific meanings.
- Further resources: The following may be useful to supplement the material in this lesson:
  - The How Safe is Your Car website can be used to find out the mass of specifical vehicles to (optionally) use in this lesson

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Structure of lesson:

1 INTRODUCTION

TIMING: 5 mins

Activate prior knowledge

- **Ask** students access their copy of the Safe System Worksheet (or if using the Workbook, direct students to page 2). Explain that this lesson will focus on the safer speeds part of the system.
- **Instruct** students to form pairs and share the strategies they have in the speed quadrant of the worksheet. **Ask** them to update their worksheet with any additional strategies they find from their partner.

Introduce learning objective

- **Show** the learning objective.
- **Explain** how students can achieve this through the success criteria.

Explicitly teach vocabulary

- **Show** students the definition for speed. **Elaborate** on the term.

2 SPEED AND SAFETY

TIMING: 10 mins

Explanation and modelling

- **Explain** that scientists, engineers and public policy makers use data and statistics to help improve road safety. Explain that part of this is looking at data on accidents and the speeds involved.
- **Show** students the two videos of crash tests of vehicles travelling at different speeds (Slides 15 and 16 in the Supporting Slide Deck). Explain that these are videos of standard tests, where the only variable in this case is the speed of the car.
- **Show** students the side-by-side of the two crashes (Slide 17 in the Supporting Slide Deck), where the 'after' frame is visible to allow comparison of the severity of the crashes.
- **Guide** students to predict which car was travelling faster (1 or 2) and explain their reasoning.
- **Distribute** the Speed Statistics Worksheet (Resource 2.1) to students (or if using the Workbook, direct students to page 17).
- **Model** interpreting data set 8, talking through your thinking with students.
- **Prompt** students to reflect on the patterns in the data. Use questioning prompts to model unpacking the data, such as 'is there much variation between years? Is the year-by-year comparison useful in this case' and 'which speed zones are most common, how might that impact this data?'

Guided and independent practice

- **Guide** students to interpret data set 9. **Explain** that this is not raw data, but a model was developed using data. **Prompt** students where necessary to support them to complete the interpretation, analysis and limitations sections.
- **Check for understanding** by asking non-volunteers to share their responses and their reasoning. **Provide feedback** to students and address any misconceptions or misunderstandings.

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3 REVISITING KEY ENERGY CONCEPTS

TIMING: 10 mins

Activate prior knowledge

- **Explain** that one way to understand the important role speed plays in road safety is to use our scientific understanding of energy. **Explain** that to do this we need to revisit what we have previously learnt about energy.
- **Instruct** students to write down names they can think of for different types of energy. **Ask** non-volunteers to share their responses. **Organise** their responses into examples and non-examples, providing brief explanation on what responses do or do not fit with our scientific meaning of energy. **Provide feedback** to students and address any misconceptions or misunderstandings.
- **Enable** students by prompting them with examples of energy forms. **Extend** students by prompting them to make connections between the types of energy they may identify, such as thermal and kinetic

Explanation and modelling

- **Distribute** the Revisiting Key Energy Concepts Worksheet (Resource 2.2) to students (or if using the Workbook, direct students to page 19).
- **Explain** to students that this resource will help to revise what they already know about energy.

Guided and independent practice

- **Guide** students to use the worked examples provided to complete the worksheet.
- **Check for understanding** by asking non-volunteers to share their responses and their reasoning. **Provide** feedback to students and address any misconceptions or misunderstandings.
- **Enable** students by breaking the task into smaller parts as required or by providing prompts using the completed example in the Teacher Workbook.

4 KINETIC ENERGY CALCULATIONS AND ANALYSIS

TIMING: 10 mins

Explanation and modelling

- **Distribute** the Kinetic Energy Calculations Worksheet (Resource 2.3) to students (or if using the Workbook, direct students to page 20).
- **Explain** to students that this resource will help to practice kinetic energy calculations and unit conversions.

Guided and independent practice

- **Guide** students to use the worked examples in Part 1 of the worksheet to calculate kinetic energy.
- **Check for understanding** by asking non-volunteers to share their responses and their reasoning. **Provide feedback** to students and address any misconceptions or misunderstandings.
- **Enable** students by using the worked examples provided for a think aloud, explaining your thinking as you work through how to complete the calculation.
- Repeat these steps for Part 2 on unit conversion and Part 3 on combined calculations.
- **Extend** students by providing the option to complete the questions without looking at the worked examples and use them instead for error checking and correction.

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5 REVISITING KEY ENERGY ANALYSIS

TIMING: 20 mins

Explanation and modelling

- **Distribute** the Kinetic Energy Analysis Worksheet (Resource 2.7) to students (or if using the Workbook, direct students to page 23).
- **Explain** to students that this resource will help to compare the kinetic energy of vehicles travelling at different speeds, and that this will help us to understand why the data we looked at earlier in the lesson showed that increasing speed led to increased frequency and severity of accidents.
- **Model** the steps to be taken using the worked examples in Part 1 of worksheet. Explain that to produce a simple graphical visualisation for comparing data, we will use each square of the grid to represent 10 kJ of kinetic energy. Explain that this means it is necessary to round the energy values to the nearest 10 kJ as part of the calculation.
- **Check for understanding** throughout the modelling, ensuring that students are following along as you model the calculation and process.

Guided and independent practice

- **Explain** to students that they will now complete their own analysis in Part 2 of the worksheet.
- **Instruct** students to select a vehicle mass from the four options provided (or allocate a specific mass to each student) and to fill it into the empty mass box for each scenario (A,B,C,D,E).
- **Extend** students by having them use the mass of their family car. This information can be sourced from the How Safe is Your Car website.
- **Guide** students to complete the calculation and visualisation for scenario A. Use the solutions in the Teacher Workbook to check for understanding.
- **Enable** students by providing additional explanation or modelling in response to the check for understanding.
- **Instruct** students to complete the remaining examples.
- **Extend** students by asking them to create an additional scenario for comparison in box F in the worksheet. Explain that they need to justify why they selected the scenario to compare to the others.
- **Guide** students through a comparison of the results for the whole class. Ensure that this highlights that speed has a very significant impact on kinetic energy, more than increasing mass, and that this relates to the formula for kinetic energy. Quantify this by explaining that doubling mass simply doubles the kinetic energy, whilst doubling the speed increases the kinetic energy by a factor of 4.
- **Explain** that while the mass of the car is mostly determined by the car we choose, the speed is determined by the speed limits and the choices made by the driver.
- **Explain** that more kinetic energy meaning that more work must be done to stop a vehicle in the event of an accident. Connect this to the impact of increasing speed, and how this is reflected in the safety statistics considered at the start of the lesson.

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6 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Instruct** students to complete the following sentences. Use Slide 20 in the Supporting Slide Deck.
  - Research into vehicle safety has shown that increasing the speed that a vehicle travels at ___*(increases)*___ the severity of an accident
  - Road safety data from Victoria shows the highest number of lives are lost in the ___*(100 km h-1)*___ speed zone
  - Kinetic energy of a moving object depends on its ___*(mass)*___ and ___*(speed)*___.
  - Increasing kinetic energy means that more ___*(work)*___ needs to be done to stop a vehicle in the event of an accident, which can mean that the accident is ___*(more)*___ severe.
- **Check for understanding** by sampling student responses using mini whiteboards or choral response. **Respond** to address any errors, misunderstandings or misconceptions.