LESSON PLAN

Lesson 1: The Safe System

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

LEVEL
Years 9-10

LESSON NUMBER
1 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **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 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).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 1: The Safe System

KEY VOCABULARY

- **safe** – not in danger or likely to be harmed
- **system** – a set of connected things or devices that operate together (etymology originating from terms for stand and together)
- **technology** – tools, devices or systems created by humans to solve problems or improve how we do things
- **brakes** – a device in a vehicle that applies friction to slow down or stop the wheels
- **speed** – the distance an object travels per unit of time (e.g. metres per second, m s-1)
- **lives lost** – the number of fatalities in a specified time period, in this context road-related fatalities

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

Teacher

- Supporting Slide Deck – as needed, display on screen or use a document camera or write on whiteboard
- TAC Video: How can Auto Emergency Braking reduce crashes? (Supporting Slide Deck Slide 2, or on YouTube)
- Vocabulary Worked Example (Resource 1.1) – as needed, display on screen or use a document camera or write on whiteboard
- Safe System Worked Example (Resource 1.2) – as needed display on screen or use a document camera or write on whiteboard

Additional/supplementary resource

- The Safe System approach fact sheet

LEARNING OBJECTIVE

- We will understand important strategies that are used to make roads safer for everyone.

SUCCESS CRITERIA

- I can explain what the safe system is.
- I can identify ways we make road travel safer and how they fit in safe system.
- I can interpret road safety data to identify safety risks to safety strategies.

TEACHING CONSIDERATIONS

- **Please note:** The Safe System approach is increasingly being referenced with a fifth pillar, *Post-Crash Care*, being incorporated into broader discussions of road safety. However, for the purposes of this unit of work, learning and assessment will focus on the traditional four Safe System pillars: Safe Roads, Safe Speeds, Safe Vehicles and Safe Road Users.
- Potential misconceptions:
  - Road Safety Strategies in the Safe System: students may identify items that are not road safety strategies, such as broader factors that may impact road safety
- Further resources: The following may be useful to supplement the material in this lesson:
  - Victorian Road Crash Data Map and Dashboard (Transport Victoria)
  - Road Safety Statistics (Transport Accident Commission)
  - Road Safety Monitor (Transport Accident Commission)
  - Crash Dash National Data

LESSON PLAN

Lesson 1: The Safe System

Structure of lesson:

1 INTRODUCTION

TIMING: 10 mins

Activate prior knowledge

- **Explain** to students that science contributes to developments in technology and engineering, and that efforts to improve the safety of roads for everyone are an example of this.
- **Show** the TAC video *How can Auto Emergency Braking reduce crashes?* to students using the Supporting Slide Deck Slide 2 or the YouTube link.
- **Instruct** students that they are to identify one message the video is communicating about how to improve safety on roads. **Repeat** the video and **ask** students to write down the message they identified.
- **Instruct** students to share the message they identified with a partner and discuss any similarities and differences. **Call on** non-volunteers to share. **Discuss** the responses with the whole class, drawing together ideas and connecting themes.
- **Enable** students using prompts connected to the messages in the video such as 'I noticed that', 'why might the video have included'.

Introduce learning objective

- **Show** the learning objective (Supporting Slide Deck Slide 1)
- **Explain** how students can achieve this through the success criteria.

Explicitly teach vocabulary

- **Show** students the definitions for safety and system. **Elaborate** on the terms.

2 ORGANISING VOCABULARY

TIMING: 10 mins

Explanation and modelling

- **Explain** to students that there is a lot of specific vocabulary used in this unit and a glossary will be used to organise this information and to help build their vocabulary.
- **Distribute** the Vocabulary Worksheet (Key Resource 3) to students (or if using the Workbook, distribute it to them and direct students to pages 3-4).
- **Show** students the worksheet and ask them to follow on their copy as you explain its contents. **Explain** that it is organised into sections: *everyday* words that have their usual meaning; *scientific* terms that have a specific meaning in physics; *road safety* terms that are specific to road safety. Emphasise that there are differences in the layout of each section, with the scientific terms having space for symbols, units and formulas.
- **Model** adding the following terms to the glossary, using the Vocabulary Worked Example (Resource 1.1) if needed: safety, system, technology, brakes, speed. **Guide** students to add these terms to their glossary.

LESSON PLAN

Lesson 1: The Safe System

3 THE SAFE SYSTEM

TIMING: 20 mins

Activate prior knowledge

- **Prompt** students to brainstorm specific things that make travel on roads safer for everyone.
- **Enable** students by providing some examples, such as seat belts, school speed limits, roadside barriers. **Extend** students by prompting them to be more specific in their responses, or to think of less well-known examples.

Explanation and modelling

- **Distribute** the Safe System Worksheet to students (or if using the Workbook, direct students to page 2).
- **Explain** that in many countries across the world, including Australia, a model called the Safe System is used to organise the strategies that we put into place to improve road safety. **Clarify** that when talking about road safety we mean for all road users including drivers, passengers, pedestrians, cyclists.
- **Show** students the partially complete Safe System Worked Example (Resource 1.2). Explain that school speed zones are a safer speeds strategy; airbags are an example of making vehicles safer; roadside safety barriers are used to improve the safety of the roads we travel on; and P-plate restrictions are a safer people strategy.

Guided and independent practice

- **Ask** students to categorise the safety features they have identified. **Enable** students by providing additional examples and prompts using the completed worked example or examples from the class.
- **Check for understanding** by asking non-volunteers to share their responses and their reasoning. **Model** organising the responses by adding them to the partial example used previously. **Provide feedback** to students and address any misconceptions or misunderstandings.

4 INTERPRETING ROAD SAFETY DATA

TIMING: 15 mins

Explanation and modelling

- **Explain** that road fatalities are the most common data we hear about related to road safety, and that this is sometimes called the 'road toll', however in most of the data you will see it referred to as 'lives lost'. Emphasis that looking at this data in more detail can help to understand what might be impacting road safety and how strategies connected to the safe system may help improve safety for all road users.
- **Distribute** the Road Safety Data Worksheet (Resource 1.3) to students (or if using the Workbook, direct students to page 2).
- **Explain** that we will use the DIAL structure to help analyse data. Show the structure to students (Slide 4 in the Supporting Slide Deck) and explain each term briefly: data, interpretation, analysis, limitations. Emphasise that the structure and the prompting questions can help us to undertake a comprehensive analysis of data.
- **Model** interpreting data set 1 with students, going through the data, interpretation, analysis and limitations. Explain that all parts of the safe system work towards improving this data – by making roads safer, the lives lost should decrease.

** continued overleaf*

Guided and independent practice

- **Think aloud** to model interpreting data set 2 with students. Ensure that you cover both what the data is clearly showing (more lives are lost in cars more than 10 years old) and limitations (having a different grouping in the data may show more nuance and detail in the trend). **Check for understanding** by providing opportunities to discuss in pairs and share their perspectives for each section. Follow-up to elaborate on thinking and address any misunderstandings. **Prompt** students to identify connections to the safe system.
- **Ask** students to look at datasets 3 to 6. **Explain** that they need to pick 2 of the remaining datasets to interpret and analyse using the prompting questions in the worksheet.
- **Enable** students by monitoring progress closely and using prompts or targeted questions to assist them to complete the activity.
- **Enable** students by using the additional/supplementary Safe system approach fact sheet.
- **Extend** students by providing access to more detailed data sets or interactive data sets which include more detail and allowing them to complete a more open-ended analysis to connect the data to the safe system.
- **Check for understanding** by calling on students to share their responses. Follow-up to elaborate on thinking and address any misunderstandings.

5 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Instruct** students to answer the following questions without referring to their notes or workbook (Slide 12 in the Supporting Slide Deck).
  - What are the four parts of the safe system? (speeds, vehicles, people, roads)
  - What were the three most significant things that you found out from analysing and interpreting the road safety data?
- **Check for understanding** by sampling student responses using mini whiteboards or choral response. **Respond** to address any errors, misunderstandings or misconceptions.

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).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 2: Safer Speeds

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

LESSON PLAN

Lesson 2: Safer Speeds

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.

LESSON PLAN

Lesson 2: Safer Speeds

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.

LESSON PLAN

Lesson 2: Safer Speeds

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.

LESSON PLAN

Lesson 2: Safer Speeds

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.

LESSON PLAN

Lesson 3: Stopping distances

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

LEVEL
Years 9-10

LESSON NUMBER
3 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects. (VC2S10U17).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 3: Stopping distances

KEY VOCABULARY

- **stopping** – coming to rest from a state of motion
- **speed** – the distance an object travels per unit of time (e.g. metres per second, m s-1)
- **distance** – how far an object has travelled (measured in metres, m)
- **time** – the measured duration between two events (measured in seconds, s)
- **acceleration** – the rate of change of velocity; how quickly an object speeds up, slows down, or changes direction (measured in m s-2)
- **reaction** – a response to a stimulus; in driving, the time between noticing a hazard and beginning to apply the brakes
- **braking** – applying the brakes to reduce a vehicle's speed
- **friction** – a force that opposes motion between two surfaces in contact
- **initial** – occurring at the start; e.g. initial speed is the speed of a vehicle before braking begins

MATERIALS REQUIRED FOR THE LESSON

Student

- Recap of describing motion (Resource 3.1) Worksheet – 1 per student, printed
- Calculating stopping distance (Resource 3.2) Worksheet – 1 per student, printed
- Analysing stopping distance (Resource 3.3) Worksheet – 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
- TAC Video: How can Auto Emergency Braking reduce crashes? (Supporting Slide Deck Slide 22, or on YouTube)

LEARNING OBJECTIVE

- We will analyse vehicle stopping distances in different conditions.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- Further resources: The following may be useful to supplement the material in this lesson:
  - It's a drag - stopping distances online simulator (ESA, Scootle)
  - Creating safe distances (Vic Roads, MyLearners)

ADDITIONAL RESOURCES

- Road to Zero Physics challenge

LESSON PLAN

Lesson 3: Stopping distances

Structure of lesson:

1 INTRODUCTION

TIMING: 5 mins

Activate prior knowledge

- **Show** students the warm up question on Slide 22 of the Supporting Slide Deck. **Ask** them to select the best answer without looking at their notes or workbooks. **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

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 stopping. **Elaborate** on the term.

2 REVISITING DESCRIBING MOTION

TIMING: 10 mins

Explicitly teach vocabulary

- **Show** students the definitions for speed, distance, time and acceleration. **Elaborate** on the terms.

Explanation and modelling

- **Distribute** the Recap of Describing Moton Worksheet (Resource 3.1) to students (or if using the Workbook, direct students to page 25).
- **Explain** that we can use our knowledge of describing motion to calculate the distance it will take a vehicle to stop. Explain that to do this we need to be confident in our use of motion terminology and performing calculations.
- **Model** use of the formula for speed to calculate speed using the worked example provided in Part 1.

Guided and independent practice

- **Guide** students to complete the speed calculations using the worked example in Part 1 to help them as needed.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

Explanation and modelling

- **Explain** that when we want to calculate distance, we can rearrange the relationship for speed. **Model** this for students, using a think aloud.
- **Model** calculating distance using the worked example provided in Part 2.

** continued overleaf*

ROAD SAFETY EDUCATION VICTORIA

Lesson 3: Stopping distances

Guided and independent practice

- **Guide** students to complete the distance calculations using the worked examples in Part 2 to help them as needed.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

Explanation and modelling

- **Explain** that we will often encounter speeds, distances and times that are in other units. Ask students to recall that we practiced converting speeds in the previous lesson. Explain to students that we want to be using consistent units in our calculations. That normally means metres and seconds.
- **Model** unit conversions for distance, time and speed using the worked example provided in Part 3.

Guided and independent practice

- **Guide** students to complete the unit conversions in Part 3.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

3 CALCULATING STOPPING DISTANCE

TIMING: 15 mins

Explicitly teach vocabulary

- **Show** students the definitions for reaction and braking. **Elaborate** on the terms. Clarify that the reaction has a number of meanings, even in science; as appropriate acknowledge and explain that the reaction we are talking about here is different to a reaction force in the sense of Newton's Third Law.

Explanation and modelling

- **Distribute** the Calculating Stopping Distance Worksheet (Resource 3.2) to students (or if using the Workbook, direct students to page 28).
- **Explain** that stopping distance is a combination of reaction distance and braking distance.
- **Explain** that reaction distance is how far a vehicle travels while the driver reacts to what has occurred, up until they respond by applying the brakes. During this time the vehicle speed can be assumed to remain constant.
- **Model** the calculation of reaction distance using the worked example in Part 1. Provide additional instructional examples if needed.

Guided and independent practice

- **Guide** students to complete the reaction distance calculations using the worked examples in Part 1 to support them.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

** continued overleaf*

Lesson 3: Stopping distances

Explanation and modelling

- **Explain** that during braking, the friction force from the road on the tyres causes an acceleration opposing the forwards motion of the vehicle. This acceleration can be assumed to be constant for the purposes of estimating braking distance.
- **Explain** that we can derive a relationship for braking distance, and that it depends on the initial speed of the vehicle and the acceleration provided by the friction during braking. Show students the formula and explain what each term represents. Explain that students will learn how to derive this formula in VCE Physics, and that it is only for straight line motion at a constant acceleration. Explain that this formula has been specifically derived and simplified for braking distance scenarios and takes in the magnitude of the initial speed and acceleration (no negative signs).
- **Model** the calculation of braking distance using the worked example in Part 2. Provide additional instructional examples if needed. Explain that we need to choose a positive direction, and that is normally the direction that the vehicle is moving. The acceleration will be in the opposite direction, so it will have a negative sign.

Guided and independent practice

- **Guide** students to complete the braking distance calculations using the worked examples in Part 2 to support them.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.
- **Guide** students to recall stopping distance is a combination of reaction distance and braking distance. Explain that these two calculations can be combined into a single relationship for stopping distance.
- **Ask** students to complete the stopping distance calculations using the worked examples in Part 3 to support them.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

4 ANALYSING STOPPING DISTANCE

TIMING: 20 mins

Explanation and modelling

- **Distribute** the Analysing Stopping Distance Worksheet (Resource 1.10) to students (or if using the Workbook, direct students to page 31).
- **Explain** that we can analyse how different factors effect stopping distance using the relationships that we have just practiced doing calculations with. Explain that this requires some assumptions, so we will assume a reaction time of 1.5 seconds and keep this constant.
- **Explain** that the road conditions effect the friction force between the tyres and the road, which in turn effects the acceleration during braking. For dry roads assume an acceleration of 6 m s-2. Wet roads provide less friction, so assume a lower acceleration value of 4.5 m s-2.
- **Model** the calculation of stopping distance for these assumptions using the worked example in Part 1.
- **Explain** to students that **to compare different scenarios it is useful to create a visual comparison**. **Model** how to create the stopping distance visualisation at the end of the worked example in Part 1.

** continued overleaf*

Lesson 3: Stopping distances

Guided and independent practice

- **Guide** students to calculate the stopping distances for the different scenarios given in Part 2, using the space available to show their working and recording their results in the table. Explain that they can used the worked example in Part 1 to assist them.
- **Guide** students to represent their results in the visualisation at the end of Part 2. **Check for understanding** by sampling the completed visualisations.
- **Ask** students to reflect on how the different variables effected stopping distance. **Facilitate** discussion of what made a difference (speed, road conditions), and to what extend (changing speed leads to a large increase in stopping distance as it is a squared term in the calculation).

5 CONCLUSION

TIMING: 10 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Ask** students access their copy of the Safe System Worksheet (or if using the Workbook, direct students to page 2). **Guide** students to reflect on how stopping distances connect to different parts of the safe system. Use prompting questions such as 'which parts of the system can effect reaction distance?', 'how might safer vehicles effect braking distance?', 'what are some of the choices that a driver makes that effect stopping distance?', or similar.
- **Show** students the graphic on the three second rule on Slide 24 of the Supporting Slide Deck. Briefly explain the 3 second rule to students. **Guide** students to think-pair-share their answers to the question on the slide about the connection between stopping distances and the 3 second rule. Ensure that students have adequate solo thinking time first, that the sharing in pairs is focussed and both get a turn to share.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

LESSON PLAN

Lesson 4: Reaction times (experiment)

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

LEVEL
Years 9-10

LESSON NUMBER
4 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects. (VC2S10U17).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 4: Reaction times (experiment)

KEY VOCABULARY

- **distraction** – anything that draws attention away from the task at hand, such as a phone while driving
- **attention** – the mental focus directed toward a specific task or object
- **stimulus** – something in the environment that triggers a response (plural: stimuli); e.g. a red traffic light
- **field of view** – the total area visible to a person at any given moment without moving their head
- **variables** – factors in an experiment that can change; the independent variable is deliberately changed, the dependent variable is predicted to change and is measured, control variables are kept constant
- **fair test** – an experiment in which only one variable is changed at a time while all others are kept the same

MATERIALS REQUIRED FOR THE LESSON

Student

- Reaction Times Experiment Worksheet (Resource 4.1) – 1 per student, printed
- Rulers – one between two, at least 30 cm long, up to 1 m can be used

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 conduct a simple experiment to explore factors that affect human reaction times.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- Further resources: The following may be useful to supplement the material in this lesson:
  - Conversation article on touch screens in cars
  - Conversation article on driver distractions

LESSON PLAN

Lesson 4: Reaction times (experiment)

Structure of lesson:

1 INTRODUCTION

TIMING: 5 mins

Activate prior knowledge

- **Show** students Slide 26 of the Supporting Slide Deck. **Explain** that these are just some examples of articles in the media focussed on the dangers of drivers being distracted. **Emphasise** that distraction is really a lack of attention, or attention being focussed on things other than driving the car. **Ask** students to work in pairs to answer the questions on the slide. **Check for understanding** by sampling all student responses. Use questioning to support students to elaborate on their thinking and make connections. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

Introduce learning objective

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

2 CONDUCTING THE EXPERIMENT

TIMING: 30 mins

Explanation and modelling

- **Distribute** the Reaction Times Experiment Worksheet (Resource 4.1) to students (or if using the Workbook, direct students to page 34).
- **Explain** that we are going to conduct an experiment to explore factors that affect human reaction times. Referring to the worksheet, explain to students the background, aims and equipment that will be used in the experiment. Preview that the experiment involves one person dropping a ruler, and the other reacting to catch it.
- **Show** students Slide 27 of the Supporting Slide Deck. With reference to the slide and the worksheet, explain the simple theoretical model of what happens when we react. Provide students with opportunities to respond to ensure they are engaged.
- **Explain** the process for calculating reaction time from the ruler drop using the explanation provided in the worksheet. Model the calculation using the worked example provided. **Check for understanding** by having students complete the calculation for a 15cm drop in the space provided. Ensure that you sample all student responses, and address errors or misconceptions, including reteaching if necessary.
- **Ask** students to turn to the method and results section of the worksheet and read it through once independently. Guide students through the method by thinking aloud as you read through it. **Check for understanding** frequently to ensure all students know what is required and how to conduct the experiment.

** continued overleaf*

ROAD SAFETY EDUCATION VICTORIA

Lesson 4: Reaction times (experiment)

Guided and independent practice

- **Instruct** students to work in pairs to collect the required equipment and conduct the experiment.
- **Monitor** student progress by circulating the room frequently, observing how students are working and using questioning to check in on their progress with the experiment.
- **Ensure** students are clear on the amount of time available for the experiment, providing a reminder 5 minutes before completion.
- **Enable** students by prompting them to revisit the details in the worksheet where applicable.
- **Extend** students by promoting them to consider a range of possible variables for part 4, and to justify their selection of a variable to test that is highly relevant to likely distractions drivers may encounter.

3 ANALYSING AND EVALUATING THE RESULTS

TIMING: 20 mins

Explanation and modelling

- **Explain** to students that they need to calculate the average ruler drop distance for each set of trials. Enable students by providing an example of an average calculation if necessary.

Guided and independent practice

- **Instruct** students to complete the calculations to fill out the last two rows of the results table. **Ask** them to complete their calculations individually and check their results with their partner. **Explain** that they should also check if their results are reasonable and feasible, and that this may help uncover any calculation errors.
- **Guide** students in the collation of whole class results into the data collation table. Explain that this process will allow us to see what the distribution of results look like for the whole class, and how that compares across the different conditions.
- Use a suitable method for collating results such as students adding their data to a table on the whiteboard, talking through the table and using hands up to count how many results fall into each range, or using a digital tool. Ensure that students simply collate a count of how many results in each range, not the actual numbers, to keep the process straightforward.
- Only collate the results for part 4 if all students tested the same additional variable.

Explanation and modelling

- **Explain** to students that having completed the data collection and calculations, they can then analyse the data and reflect on the experiment. Instruct students to work independently through the analysis, reflection and discussion prompts in the Reaction Times Experiment Worksheet.

Guided and independent practice

- **Monitor** progress while students complete the worksheet, circulating the room as applicable. Prompt students with additional questioning and address any errors or misconceptions that you notice.

LESSON PLAN

Lesson 4: Reaction times (experiment)

4 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Show** students Slide 29 of the Supporting Slide Deck which repeats the question prompts in the discussion section of the Reaction Times Experiment Worksheet. Guide students in a whole class discussion of their responses to these questions. Use a range of suitable techniques to ensure that you sample responses from all students. Prompt students to elaborate or extend their thinking, and to make connections to what others have shared. Address any errors or misconceptions.

LESSON PLAN

Lesson 5: Vehicle safety features

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

LEVEL
Years 9-10

LESSON NUMBER
5 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

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

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science:** Students examine the relationship between science, engineering and technologies. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 5: Vehicle safety features

KEY VOCABULARY

- **active safety** – vehicle features that help prevent a crash from occurring (e.g. automatic emergency braking, lane-keeping assist)
- **passive safety** – vehicle features that protect people if a crash occurs (e.g. seatbelts, airbags, crumple zones)
- **assistance** – support provided to help a person or system complete a task
- **autonomous** – able to operate independently without human input; a fully autonomous vehicle drives itself
- **ADAS** – advanced driver assistance systems

MATERIALS REQUIRED FOR THE LESSON

Student

- Active and Passive Safety (Key Resource 4) – 1 per student, printed
- Advanced Driver Assistance Systems Jigsaw Worksheet (Resource 5.1) – 1 per student, printed (including printed copies of the resource sets for each jigsaw group)

Teacher

- Video on Collision Avoidance Technologies from ANCAP available on Vimeo and also on the ANCAP website
- 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 how active safety features improve vehicle safety.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- Further resources: The following may be useful to supplement the material in this lesson:
  - ADAS assist website

LESSON PLAN

Lesson 5: Vehicle safety features

Structure of lesson:

1 INTRODUCTION

TIMING: 5 mins

Activate prior knowledge

- **Show** students Slide 31 of the Supporting Slide Deck. **Instruct** students to complete a quick write in response to the prompt provided. Ensure students are clear that this involves writing down their thinking for a period of 2 minutes, without editing or correction.
- **Instruct** students to share their responses with a partner. **Check for understanding** by sampling student responses using a suitable mode of response. Use questioning to support students to elaborate on their thinking and make connections.

Introduce learning objective

- **Show** the learning objective.
- **Explain** how students can achieve this through the success criteria.
- **Show** students Slide 32 of the Supporting Slide Deck and explain that this lesson will focus on the safer vehicles part of the safe system.

2 ACTIVE AND PASSIVE SAFETY

TIMING: 5 mins

Explicitly teach vocabulary

- **Show** students Slide 33 of the Supporting Slide Deck with the graphic on active and passive safety. Explain that these two terms are used to describe different ways that we can make safer vehicles.
- **Distribute** the Active and Passive Safety Worksheet (Key Resource 4) to students (or if using the Workbook, direct students to page 5). Use this resource to explain to students the definitions for active safety and passive safety. **Elaborate** on the terms.

Explanation and modelling

- **Explain** that this lesson will focus on active crash protection. Refer to the Active and Passive Safety Worksheet (Key Resource 4) and use a think aloud to unpack the examples of ways that active safety systems can help to prevent crashes and reduce severity.

LESSON PLAN

Lesson 5: Vehicle safety features

3 ADVANCED DRIVER ASSISTANCE SYSTEMS

TIMING: 45 mins

Explicitly teach vocabulary

- **Show** students the Vimeo video on collision avoidance technologies from ANCAP.
- **Explain** that the acronym ADAS – advanced driver assistance systems – is commonly used to describe the many active safety features that are found in modern cars. Clarify that this is different to autonomous vehicles – self driving cars – as the ADAS systems only assist the driver and do not take full control of or responsibility for the vehicle.

Explanation and modelling

- **Distribute** the Advanced Driver Assistance Systems Jigsaw Worksheet (Resource 5.1) to students (or if using the Workbook, direct students to page 39).
- **Ask** students to read Part 1 of the worksheet. **Explain** that there are lots of different technologies in use, and that in this lesson we will use a jigsaw protocol to explore some of them in more detail
- **Explain** to students that they will work in groups of 6, with each group member being responsible for summarising and explaining one ADAS technology.
- **Assign** students to groups, and assign each student one of the 6 jigsaw topics (A. Lane Keep Assist, B. Driver Attention Detection, C. Automatic Emergency Braking (AEB), D. Intelligent Speed Assistance, E. Reversing Camera or Warning, F. Blind Spot Warning)

Guided and independent practice

- **Instruct** students to work independently on part 2 of the jigsaw worksheet. Explain that they can use the resources provided for their topic. You may provide students with only what is in the worksheet. Consider also printing out or providing access to the ADAS fact sheets on each topic as these have valuable further information.
- **Enable** students by using the videos in further resources as alternate sources of information.
- **Monitor** student progress by circulating as they complete this individual task.
- **Instruct** students to move on to part 3 of the jigsaw worksheet. **Explain** that they are to pair up with someone else who worked on the same topic and take turns sharing what they wrote in their summary. Instruct them to use this time to add to and improve their summary. Ensure that all students can pair up for this task and use a specified timeframe and prompts to ensure they remain focussed.
- **Ask** students to return to their groups of 6 for part 4 of the jigsaw.

Explanation and modelling

- **Explain** that for part 4, each student will take turns to share, and everyone else will summarise the key ideas in the space provided. **Model** what a summary might include using the example provided on Electronic Stability Control (ESC).

Guided and independent practice

- **Instruct** students compete part 4 in their groups. Monitor progress by circulating to all groups, prompting students to ensure that they are on track with the process as well as to support deeper thinking and connections.
- After the groups have worked through all the sections, **check for understanding** and facilitate whole-class sharing by sampling student responses from part 4. Prompt students to use this discussion to update and improve their summaries. Use questioning to support students to elaborate on their thinking and make connections. **Respond** by addressing errors and clarifying any misconceptions.

LESSON PLAN

Lesson 5: Vehicle safety features

4 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Instruct** students to respond to the prompts on slide 34 in the Supporting Slide Deck.
  - What is the difference between active and passive safety systems?
  - Why are ADAS systems not the same as autonomous systems or self-driving cars?
  - Explain one way that an ADAS system can 'assist' a driver that improves road safety.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

LESSON PLAN

Lesson 6: Forces and passive safety

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

LEVEL
Years 9-10

LESSON NUMBER
6 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **Science as a Human Endeavour:** advances in technologies have enabled advances in science, while science has contributed to developments in technologies and engineering. (VC2S10H02).
- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects. (VC2S10U17).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science:** Students examine the relationship between science, engineering and technologies. (Level 9 & 10).
- **Physical sciences:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 6: Forces and passive safety

KEY VOCABULARY

- **active safety** – vehicle features that help prevent a crash from occurring (e.g. automatic emergency braking, lane-keeping assist)
- **passive safety** – vehicle features that protect people if a crash occurs (e.g. seatbelts, airbags, crumple zones)
- **force** – a push or pull that can change the motion of an object (measured in newtons, N)
- **inertia** – the tendency of objects with mass to resist changes in their state of motion
- **acceleration** – the rate of change of velocity; how quickly an object speeds up, slows down, or changes direction (measured in m s-2)
- **time** – the measured duration between two events (measured in seconds, s)
- **work** – the transfer of energy that occurs when a force moves an object over a distance (measured in joules, J)
- **energy** – the capacity to do work; energy can be stored, transferred, and transformed but not created or destroyed (measured in joules, J)
- **structure** – the physical arrangement and design of parts in an object; in vehicles, some structures are engineered to absorb energy in a crash
- **seatbelt** – a safety strap that holds occupants in their seat during a crash, spreading the stopping force across the body to reduce injury
- **airbag** – an inflatable cushion that deploys rapidly in a crash to cushion the head and chest and reduce the force of impact on occupants

MATERIALS REQUIRED FOR THE LESSON

Student

- Active and Passive Safety Worksheet (Key Resource 4)
- Physics of passive safety systems (Resource 6.1)

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
- ANCAP Video on Vehicle Structure – on Vimeo or embedded in the ANCAP website
- ANCAP Video on Seatbelts – on Vimeo or embedded in the ANCAP website
- ANCAP Video on Airbags – on Vimeo or embedded in the ANCAP website

LEARNING OBJECTIVE

- We will understand how passive safety features improve vehicle safety.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- Further resources: The following may be useful to supplement the material in this lesson:
  - ANCAP website on vehicle safety

LESSON PLAN

Lesson 6: Forces and passive safety

Structure of lesson:

1 INTRODUCTION

TIMING: 10 mins

Activate prior knowledge

- **Ask** students to access their copy of the Active and Passive Safety Worksheet (Key Resource 4).
- **Explain** that we want to understand both the benefits of safety features and the scientific explanation for how they work. **Show** students the worksheet extract on slide 36 in the Supporting Slide Deck. **Model** the explanation of how anti-lock braking systems improve safety using a think aloud.
- **Instruct** students to use their notes from the previous lesson to add an explanation in the space provided for one of the active safety features from the previous lesson.
- **Check for understanding** by sampling student responses using a suitable mode of response. Use questioning to support students to elaborate on their thinking and make connections.

Introduce learning objective

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

2 PHYSICS OF PASSIVE SAFETY SYSTEMS

TIMING: 30 mins

Explanation and modelling

- **Distribute** the Physics of passive safety systems worksheet (Resource 6.1) to students (or if using the Workbook, direct students to page 48). **Explain** to students that we will work through this worksheet to explore the key physics ideas behind common passive safety features. Emphasise that the focus here is not on making calculations, but of understanding how changes in one quantity effect another.
- **Ask** students to look at Part 1 of the worksheet. **Elaborate** on the key ideas of work and energy from the worksheet using a think aloud.

Guided and independent practice

- **Prompt** students to fill in the sentence frames and make additional notes in the space provided.
- **Show** the ANCAP video on the role of vehicle structure in safety via the Vimeo link or directly from the ANCAP website. **Prompt** students to add additional relevant information from the video to their notes.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

Explanation and modelling

- **Ask** students to look at Part 2 of the worksheet. **Elaborate** on the key idea of inertia from the worksheet using a think aloud.

** continued overleaf*

ROAD SAFETY EDUCATION VICTORIA

Lesson 6: Forces and passive safety

Guided and independent practice

- **Prompt** students to fill in the sentence frames and make additional notes in the space provided.
- **Show** the ANCAP video on seatbelts via the Vimeo link or directly from the ANCAP website. **Prompt** students to add additional relevant information from the video to their notes.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

Explanation and modelling

- **Ask** students to look at Part 3 of the worksheet. **Elaborate** on the key ideas of net force and acceleration from the worksheet using a think aloud.

Guided and independent practice

- **Prompt** students to fill in the sentence frames and make additional notes in the space provided.
- **Show** the ANCAP video on airbags via the Vimeo link or directly from the ANCAP website. **Prompt** students to add additional relevant information from the video to their notes.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

3 SAFETY SYSTEMS

TIMING: 15 mins

Explanation and modelling

- **Ask** students to access their copy of the Active and Passive Safety Worksheet (Key Resource 4). Explain that we will now focus on the passive safety features on the right-hand side.
- **Model** the explanation of how seatbelts improve safety using a think aloud. Emphasise the connection to inertia.

Guided and independent practice

- **Instruct** students to use their notes from this lesson to add an explanation in the space provided for airbags and crumple zones.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

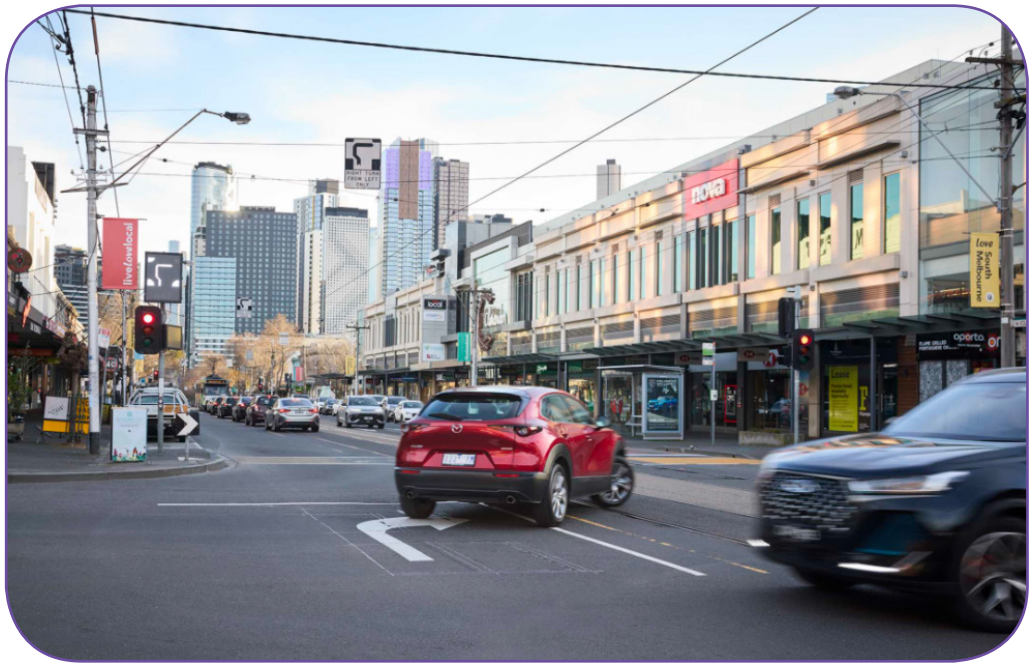
Lesson 6: Forces and passive safety

4 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Show** the learning objectives and success criteria.
- **Instruct** students to complete the following sentences. Use slide 37 in the Supporting Slide Deck.
  - Increasing the time it takes for a collision to occur will ____*(decrease)*____ the force involved.
  - How do restraints such as seatbelts and airbags relate to inertia?
  - What effect do crumple zones have on the energy involved in a collision? What is the role of work in this?
- **Check for understanding** by sampling student responses using mini whiteboards or choral response. **Respond** to address any errors, misunderstandings or misconceptions.



LESSON PLAN

Lessons 7 & 8: Egg crash (design, build, test)

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

LEVEL
Years 9-10

LESSON NUMBER
7&8 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **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).
- **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).
- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects. (VC2S10U17).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **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).
- **Science inquiry:** 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).
- **Physical sciences:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lessons 7 & 8: Egg crash (design, build, test)

KEY VOCABULARY

- **design** – to plan a solution that meets a specific set of requirements
- **build** – to physically construct a design using selected materials and methods
- **test** – to trial a design under controlled conditions to see how well it performs against the requirements
- **evaluate** – to assess how well a design met the requirements and identify how it could be improved

MATERIALS REQUIRED FOR THE LESSON

Student

- Egg Crash: Design, Build, Test Worksheet (Resource 7.1)
- Permitted materials per the worksheet
- Testing equipment per the worksheet

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 apply our knowledge of safety features to design, build and test a 'mini vehicle'.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- This can be completed across two lessons or during a double lesson.
- Further resources: The following may be useful to supplement the material in this lesson:
  - Tech Schools and STEM Education Centres

LESSON PLAN

Lessons 7 & 8: Egg crash (design, build, test)

Structure of lesson:

1 INTRODUCTION

TIMING: 5 mins

Activate prior knowledge

- **Show** students Slide 39 of the Supporting Slide Deck.
- **Ask** students to work in pairs to answer the questions on the slide.
- **Check for understanding** by sampling all student responses. Use questioning to support students to elaborate on their thinking and make connections. **Respond** by addressing errors, clarifying any misconceptions and reteaching if necessary.

Introduce learning objective

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

2 DESIGN

TIMING: 25 mins

Explanation and modelling

- **Distribute** the Egg Crash: Design, Build, Test Worksheet (Resource 7.1) to students (or if using the Workbook, direct students to page 50).
- **Explain** that they are going to design, build, test and evaluate a 'mini vehicle' intended to protect its 'occupant' in a collision.
- **Ask** students to read over the entire design brief independently, annotating anything that is unclear with a question mark.
- **Model** the process of working through unpacking the entire brief with students using a think aloud. **Instruct** students to follow along and annotate their worksheet with additional information that may assist them. **Check for understanding** by asking students to summarise key aspects of the brief in their own words. Support students to ask any clarifying questions they may have or to identify anything that is unclear.
- **Organise** students into groups of 2 to 3.

Guided and independent practice

- **Instruct** students to work through the design process using the worksheet. Explain that they may spend some time discussion and brainstorming ideas, but they then must document the key features and provide a sketch of their design in the time allocated.
- **Monitor** student progress by circulating as they complete the design documentation. Use questioning to support students to elaborate on their thinking. **Respond** to any errors or misconceptions that arise.

LESSON PLAN

Lessons 7 & 8: Egg crash (design, build, test)

3 BUILD

TIMING: 30 mins

Explanation and modelling

- **Ask** students to start building their design. Emphasise that they can revise their design along the way, and it is likely that this will be necessary. **Explain** that they must ensure that the design meets the requirements in the brief.
- **Distribute** the permitted materials to students.

Guided and independent practice

- **Monitor** student progress by circulating as they complete the build.

Reflection on learning

- **Instruct** students to record the details of the three most significant design changes that they made during the build in the table Part 2 of the worksheet.

4 TEST

TIMING: 40 mins

Explanation and modelling

- **Ask** students to re-read over the test setup section in part 1 of the worksheet. **Check for understanding** by asking students to summarise key aspects of the test set up in their own words. Support students to ask any clarifying questions they may have or to identify anything that is unclear.
- **Instruct** students to read over part 3 of the worksheet. **Model** the process of working through unpacking what they need to record during testing with students using a think aloud. **Ask** students to follow along and annotate their worksheet with additional information that may assist them. **Check for understanding** by asking students to summarise key aspects of the testing process in their own words. Support students to ask any clarifying questions they may have or to identify anything that is unclear.
- **Model** the testing process using a sample set up with either a test vehicle you have built for this purpose or some other suitable wheeled object. Ensure that you emphasise correct set up, the testing process, and recording suitable observations.
- **Distribute** the testing equipment to students.

Guided and independent practice

- **Monitor** student progress by circulating as they complete the testing process.

LESSON PLAN

Lessons 7 & 8: Egg crash (design, build, test)

5 EVALUATE

TIMING: 15 mins

Explanation and modelling

- **Ask** students to re-read over the evaluate section in part 4 of the worksheet.
- **Instruct** students to use their formal and informal observations to respond to each of the evaluation questions in the worksheet.

Guided and independent practice

- **Monitor** student progress by circulating as they complete the evaluate section. Use questioning to support students to elaborate on their thinking. Clarify what is required as necessary.

6 CONCLUSION

TIMING: 5 mins

Reflection on learning

- **Instruct** students to respond to the prompts on slide 40 in the Supporting Slide Deck.
  - Were the safety features in your 'mini vehicle' design active or passive? Explain why.
  - How might the results have changed if you used an uncooked egg?
  - The tests did not explore the effect of the vehicle mass in detail, how do you predict having a heavier or lighter vehicle would affect the results? Explain using appropriate physics.
- **Check for understanding** by sampling all student responses using mini whiteboards or another suitable mode of response. **Respond** by prompting students to make connections and extend their thinking. Address any errors and misconceptions.

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 9: Road safety explainer (application)

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

LEVEL
Years 9-10

LESSON NUMBER
9 of 9

LESSON LENGTH
60 minutes

VICTORIAN CURRICULUM 2.0 CONTENT DESCRIPTIONS

- **Science inquiry:** communicating and justifying scientific ideas, findings and arguments for diverse audiences involves the selection of appropriate presentation formats, content, scientific vocabulary, conventions, models and other representations, and may include the use of digital tools. (VC2S10I08).
- **Physical sciences:** Newton's laws of motion can be used to quantitatively analyse the relationship between force, mass and acceleration of objects. (VC2S10U17).
- **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).

VICTORIAN CURRICULUM 2.0 ACHIEVEMENT STANDARDS

- **Science inquiry:** Students select and use appropriate presentation formats, scientific content, vocabulary, models, conventions, formulas and other representations to achieve their purpose when communicating and justifying their ideas, findings, arguments and proposals to diverse audiences. (Level 9 & 10).
- **Physical sciences:** Students use Newton's laws to describe and predict the motion of objects in a system. (Level 9 & 10).
- **Physical sciences:** 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).

ROAD SAFETY EDUCATION VICTORIA

LESSON PLAN

Lesson 9: Road safety explainer (application)

KEY VOCABULARY

- **communicate** – to share information, ideas or findings clearly with others
- **audience** – the people a message or product is intended for

MATERIALS REQUIRED FOR THE LESSON

Student

- Road Safety Explainer Poster Worksheet (Resource 9.1)
- Suitable materials for creating the poster, either in hardcopy or digitally

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 communicate the case for a specific road safety feature to a general audience.

SUCCESS CRITERIA

- 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.

TEACHING CONSIDERATIONS

- This lesson could be extended over more time to enable greater detail in the posters and more opportunities to test and reflect. It could also be adapted to make the communication element more formal or extensive – such as presenting the poster to an audience.
- Further resources: The following may be useful to supplement the material in this lesson:
  - How Safe is Your Car website
  - ADAS Assist website
  - ANCAP website

LESSON PLAN

Lesson 9: Road safety explainer (application)

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).
- **Instruct** students to spend 5 minutes adding additional examples and details to their copy. **Explain** that they should first add things they can recall from memory, then look over their workbook and notes to add additional information and finally compare with a partner to add more information.

Introduce learning objective

- **Show** the learning objective.
- **Explain** how students can achieve this through the success criteria.
- **Emphasise** that this is the final lesson in this sequence, and the focus is on applying what students have learnt to communicating key ideas about road safety to a general audience.

2 CREATING POSTER

TIMING: 30 mins

Explanation and modelling

- **Distribute** the Road Safety Explainer Poster Worksheet (Resource 9.1) to students (or if using the Workbook, direct students to page 57).
- **Ask** students to read over the details in Part 1 individually.
- **Model** the process of working through unpacking the information in Part 1 with students using a think aloud. **Instruct** students to follow along and annotate their worksheet with additional information that may assist them. **Check for understanding** by asking students to summarise key aspects of what the task requires in their own words. Support students to ask any clarifying questions they may have or to identify anything that is unclear.
- **Explain** to students that they can use all the resources from this unit to complete their poster. Emphasise that the focus is on explanation and communication rather than finding additional information.
- **Ask** students to look at the list of suggested topics at the end of the Road Safety Explainer Poster Worksheet (Resource 9.1). Instruct them select a topic from the list or allocate topics randomly to students.

Guided and independent practice

- **Instruct** students to spend the allocated time preparing their poster. Emphasise that the focus is on communication over appearance.
- **Monitor** student progress by circulating as they create their poster. Use questioning to support students to elaborate on their thinking. **Respond** to any errors or misconceptions that arise.

LESSON PLAN

Lesson 9: Road safety explainer (application)

3 TESTING AND REFLECTION

TIMING: 20 mins

Explanation and modelling

- **Ask** students to read over the details in Part 2 of the Road Safety Explainer Poster Worksheet (Resource 9.1).
- **Explain** that they are to test out their poster with their peers, obtain constructive feedback, and reflect on ways it could be further improved. Emphasise that the focus is on being as constructive as possible and learning as much as possible from the experience.

Guided and independent practice

- Form students into suitable pairs for providing feedback. Ensure pairs do not included students working on the same topic.
- **Instruct** students to work through Steps 1 and 2 of the reflection process. Emphasise that the timing is very strict.
- **Monitor** student progress by circulating as students work through the steps. **Prompt** students to move to the next step in the process to keep up with the timing.

Reflection on learning

- **Instruct** students to work through the Step 3 self-reflection.
- **Monitor** student progress by circulating around the class. **Prompt** students to ensure that they respond to the final two prompts.
- **Check for understanding** by asking students to share their highlights and next steps. Use questioning to support students to elaborate on their thinking and maintain a constructive focus.

4 CONCLUSION

TIMING: 10 mins

Reflection on learning

- **Instruct** students to respond to the prompts on slide 40 in the Supporting Slide Deck.
  - **3 most relevant things that you learnt** about road safety in this unit
  - **2 things that effect road safety** that you'd like to know more about
  - **1 top tip for being safer** that you'd share with people that have not done this unit
- **Check for understanding** by sampling all student notes using sticky notes, areas on the whiteboard, or a digital tool.
- **Respond** by summarising and acknowledging key themes in the students' responses, connecting the reflections to the importance of road safety and the many ways in which we can use our knowledge to make decisions that help to keep roads safer.