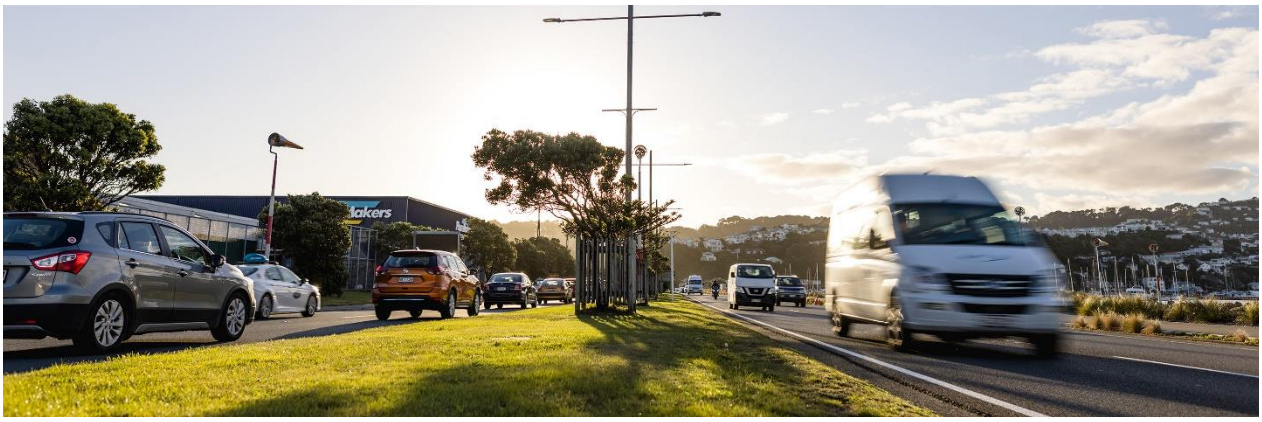

The science of safe stopping

Updated 2023

Teacher notes

Introduction

These 6 lesson plans develop a key science understanding:

- Forces cause change in motion and change in shape.

The context is safe stopping of vehicles: How do we use forces to make crashes survivable?

Students will:

1. Describe a road safety device designed to use forces to change motion.
2. Explain the causes of a change in motion (or the consequences of a change in motion) related to the use of a road safety device.
3. Create road safety messages using physics concepts to encourage others to minimise their exposure to sudden changes in motion.

Curriculum background

Learning area: Science.

Values: Community and participation.

Key competencies: Thinking, Making meaning from language, symbols and text.

Achievement objectives

Physical World Level 5

Physical inquiry and physics concepts

- Identify and describe the patterns associated with physical phenomena found in simple everyday situations involving movement, forces, electricity and magnetism, light, sound, waves, and heat. For example, identify and describe energy changes and conservation of energy, simple electrical circuits, and the effect of contact and non-contact on the motion of objects.

Using physics

- Explore a technological or biological application of physics.

Learning intentions

Schools will have their own criteria for developing learning intentions. Highlight the learning intentions that best match the abilities of your students. You can use these to write your WALTs.

Describe the forces acting on a vehicle.

Describe the forces acting on a person in a vehicle.

Sequence the forces acting on a vehicle or the person.

Classify forces (push and pull, contact and non-contact, magnetic, elastic, weight due to gravity, action and reaction, balanced and unbalanced etc).

Classify the forces acting on a person in a vehicle.

Compare and contrast the forces acting on a vehicle or the person.

Explain the causes of the forces acting on a vehicle or the person in a vehicle.

Explain the effect of these forces.

Analyse, predict or model the forces acting on a vehicle.

Describe the motion of a vehicle.

Sequence the motion of a person riding on a vehicle.

Compare and contrast different motions of a vehicle.

Explain the causes of the motion and effects of the motion of a vehicle.

Analyse, predict or model the motion of a person in a vehicle.

Describe a technological application of physics in a road safety device.

Sequence the actions of a road safety device.

Sequence the design history of a road safety device.

Explain why we need a road safety device, how it works, and its effects.

Evaluate the effectiveness of a road safety device.

Reflect on the use of a road safety device (technological application of physics).

The science of safe stopping

Year 9-10 unit plan

Context: This series of lessons allows students to meet achievement objectives at Level 5 of Science – Physical World in The New Zealand Curriculum. Problem solving, experiments and activities help students develop conceptual understanding of force and motion through the context of technologies used for road safety and safe stopping.

Note: Be aware that this unit may involve the discussion of road crashes. It is likely there will be students in your class with first-hand experience of such issues, and discretion is advised.

Lesson 1: what is a force?

Before the lesson – set the scene

1. Watch video footage of crash test results.

Nigel Latta – Big old car vs small new car

2009 Chevy Malibu vs 1959 Bel Air Crash Test | Consumer Reports

2. Visit a panel beating or crash repair workshop to see the effects of unbalanced forces on motor vehicle panels. Observe how the panel beater uses hammers and dollies for planishing – creating unbalanced forces to change the shape of the damaged panels back to their factory state after an unbalanced force has caused a rapid change in motion or collision. Alternatively invite a panel beater to give a demonstration to students at school.

3. Read the summary of young driver crash statistics

Safety – young drivers (Ministry of Transport)

Make an infographic from the facts and statistics you find.

Examples:

Road Safety (CDC)

Infographics on global road safety (WHO)

Road traffic injuries are a global killer (The Lancet)

4. Discuss a newspaper article about a recent car crash. Describe what happened and the people who were directly involved in the crash. Explain the reasons for the crash. Explain the consequences of the crash (short, medium and long term). Generalise about steps you could take to avoid this type of crash.

5. Ask student to write their 'known unknown' questions about forces, motion and road safety onto strips of card. Collect these questions and make them available to all students. Display the questions on a wall in the classroom.

Make connections with what they already know about forces

Discuss previous learning experiences with forces (at intermediate and primary schools and in everyday life).

Be alert to the learner perspectives of forces that students will bring to the secondary science classroom. Think carefully about the strategies you will adopt to confront their science misconceptions. Refer to:

Physics misconceptions

Form groups of approximately 5 students. Ask groups of students to brainstorm ideas on forces. Use these group ideas to make a class pre-topic definition of forces.

‘We think a force is …’

Establish two key ideas from their previous science learning.

- Force is a push or a pull.
- Forces change an object’s motion or its shape.

Observe and use forces

Set up a circuit of force-related learning experiences around the room and outside. Ask students to work in pairs to complete each activity. The following are some activities you could set up.

- Rub a plastic ruler on a piece of wool then hold the ruler next to small torn pieces of paper.
- Push a bath-toy duck under the water.
- Hold a magnet near an iron nail.
- Put a laptop on a table.
- Kick a rugby ball.
- Glide a paper aeroplane.
- Stretch a rubber band and use it to fire a small wad of paper.
- Shove a billiard ball across a pool table.
- Squeeze the juice from a citrus fruit.
- Throw a creme egg at a hard surface.

Observe the forces in action (push or pull) at each station.

Describe how each unbalanced force changes an object’s motion or changes an object’s shape.

Record observations on a ‘Forces response sheet’ as shown below.

Squeeze the juice from a lemon. What changes?	Hit a nail with a hammer. What changes?
Pull a heavy weight using a rope. What changes?	Push a bath-toy duck under the water. What changes?
Drop a rugby ball. What changes?	Glide a paper aeroplane. What changes?
Hold a magnet near an iron nail. What changes?	Put a brick on a table. What changes?
Rub a plastic ruler on a piece of wool then hold the ruler next to small torn pieces of paper. What changes?	Stretch a rubber band and use it to fire a small wad of paper. What changes?

Alternatively go for a slow walk around the school grounds looking for forces in action. Log or photograph any evidence you observe on your walk.

Categorise (classify) the force/s involved in each situation above as one or more of the following:

- contact forces (push with hand, pull with rope)
- non-contact forces (magnetic, gravitational, electrical forces)
- friction force (contact force)
- weight force (gravity)
- action and reaction forces.

So … what is a force?

Break the class into groups of 3 students. Each group views one of the following video clips:

What is a force?

What forces are acting on you?

ForceMan

Each group takes turns to explain the main ideas in its allocated video to the rest of the class.

Note: Mass and weight are different. The mass of an object is how much matter it contains. The weight of an object is the force caused by gravity pulling down on the mass.

Review the class definition of forces. Is there anything we should add, delete, re-phrase or change? Continue to revisit this definition throughout the unit.

Lesson 2: what is motion?

Motion is a change in the position of an object with time

Observe motion and moving objects in everyday situations –in real life or on YouTube.

For example, observe a person jogging, a cricket ball falling, an inflatable shark flying, a car braking, a skateboarder doing a kick lift, a hawk diving on prey, bubbles rising in a thermal pool, a triathlon runner in the sprint for the finish line, a drag racer slowing down, a surfer wiping out, a monster truck driving at constant speed on the motorway, or a greyhound racing.

Describe the motion of each object with annotated pictures, diagrams, annotations, video and stop frame animation.

Example

A hawk diving on prey experiences a force due to gravity pulling it down. It will move in a straight line unless it applies a force with its wings, changing direction. Classify the motions above using the following terms:

- stationary (at rest)
- moving at constant speed
- moving at increasing speed (accelerating)
- moving at decreasing speed (decelerating)
- forwards, backwards, upwards, downwards.

Create a 'motion' mind-map to categorise motion and give examples from everyday life. Use simple mapping software to annotate motions. Form a class definition that answers the question 'What is motion?'

Forces - balanced and unbalanced

Distinguish between balanced and unbalanced forces. For example, balanced forces involve no change in motion (stationary or constant velocity) or shape, unbalanced forces involve a change in shape or motion (acceleration or deceleration).

Observe unbalanced forces changing an object's motion or shape in everyday situations. For example, visit a school playground, local garage, a bridge, pizza parlour, amusement park or local road. Observe forces changing an object's motion or shape on movies and YouTube.

Describe the forces at work and any change in motion or shape. Draw simple diagrams with arrows representing the magnitude and direction of the forces acting on the objects.

Extend the motion concept map above to include information on the forces involved. Summarise the use of forces to change motion in everyday life.

Update your definitions of 'forces' and 'motion'.

Show your new learning about forces and motion in one of the following ways.

- Make a 'forces are everywhere' picture book, slide show or comic strip for five-year-olds. showing them how forces change motion and shape in their everyday lives.
- Create a comic strip describing the motion of a car at different parts of the trip – stationary, moving forward, accelerating, decelerating, moving at constant speed. Draw the forces acting on a car at each of these stages of motion.
- Create an animation (or flip book) describing the motion of a car and passenger at different parts of the trip – stationary, accelerating, decelerating, moving at constant speed.
- Make a presentation showing objects in different states of motion – stationary, accelerating, decelerating, moving at constant speed. Take your own images or video or use copyright-free images or video from YouTube.

Lesson 3: describing motion

Motion is a change in the position of an object with time

Describe motion by using …

1. Distance travelled

Describe the motion of [an object] by using the distance (d) travelled from the starting point to finish point. Use centimetres (cm), metres (m) or kilometres (km).

- Observe objects in motion, such as a dog running, a person walking, a triathlete biking or a vehicle driving between two locations.
- Estimate the distance (d) travelled from the starting point to the finish point.
- Measure the distance travelled in cm, m or km.
- Measure the distance on a map using a ruler, tape measure, or on the ground using a pedometer or odometer.
- How did your prediction compare with the actual distance travelled?

2. Time taken

Describe the motion of [an object] by using the time (t) taken from starting point to finish point. Use seconds (s), minutes (min) or hours (h).

- Observe objects in motion, such as a dog running, a person walking, a triathlete biking or a vehicle driving between two locations.
- Estimate the time taken from the starting point to the finish point.
- Measure the time taken in s, min or h.
- Measure the time taken using a stopwatch, wristwatch or freeze frame animation.
- How did your prediction compare with the actual time taken?

3. Average speed

Describe the motion of [an object] by using a measure of the average speed. Speed measures how far something travels in a certain time, e.g. the number of metres travelled in one second (m/s) or the number of kilometres travelled in one hour (km/h). Use a motion sensor, speed gun, speed camera, ticker timer or odometer.

Note: The faster something goes, the further it travels in a certain time. 1m/s = 3.6km/h.

- Observe objects in motion, e.g. a dog running, a person walking, a triathlete biking or a vehicle driving between two locations.
- Estimate the average speed (m/s) of an identified object.
- Measure the distance travelled and the time taken.
- Calculate the average speed of the object.

Use the formula:

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}} \qquad v = \frac{d}{t}$$

Create motion problems for other students to solve. Get them to calculate the speed, distance or time taken for the motion of objects you describe.

4. Balanced and unbalanced forces

Describe the motion of [an object] by referring to unbalanced and balanced forces and inertia.

Inertia is the tendency for an object to resist any change in its state of motion.

Newton's First Law (Law of Inertia): if the forces acting on an object are balanced, then the object will remain stationary or carry on at the same speed at the same direction (constant velocity).

Identify a body in a state of motion when all forces acting on it are balanced. This body may be:

- stationary
- moving at constant speed.

Sketch (or video) different bodies in situations where all forces acting on them are balanced. Represent the forces acting on the body with arrows.

List examples of inertia in action from everyday life.

View the following web resources:

What is a force (BBC Bitesize)

Egg Experiment to Demonstrate Inertia

Newton's Laws

What is Newton's first law? (Khan Academy)

Newton's Second Law: if unbalanced forces act on an object, then the object will accelerate in the direction in which the net force acts.

Identify a body in a state of motion when the forces acting on it are unbalanced. This body may be:

- moving at increasing speed (accelerating);
- moving at decreasing speed (decelerating);
- moving forwards, backwards, upwards or downwards.

Sketch (or video) different bodies in situations where unbalanced forces are acting on them. Annotate the diagram or video with descriptions of the state of motion of each body. Represent the unbalanced forces acting on each body with arrows.

View the following videos:

Newton's second law of motion (Khan Academy)

Newton's third law of motion (Khan Academy)

Belt yourself into a stationary car holding a full cup of water. Describe what happens to the water as the driver starts the car and accelerates. Use Newton's Law of Inertia (resistance to change in state of motion) to explain what happens to the water when the road provides an unbalanced force on the spinning wheels, causing the car to accelerate from rest.

Describe what happens to the water in the cup when the car brakes to stop the car. For example, the unbalanced force of the road on the locked wheels changes the car's state of motion. The forces acting on the cup of water are balanced. The car stops but the water continues moving in the same speed and the same direction.

Identify an example of a technological device from everyday life that has been designed to provide unbalanced forces to protect us from the effects of inertia.

Lesson 4: modelling motion

Construct a simple marble run (optional)

Observe different marble runs on YouTube. Design a cut-down marble ramp run on a 1m-by-1m sheet of stiff card or board. The challenge is to design a run that controls the marble's motion, so it takes longer to complete the trip. Keep a log or blog describing and explaining the decisions made during the construction and testing process.

Plan a plank trip for a plasticene doll

Rethink the strategies you used for your marble run design and use this experience to design the ultimate plank trip for a plasticene doll.

1. Put a small plasticene doll on a trolley car on a flat surface. Describe the motion of the doll and the trolley car (stationary).

2. Draw a diagram to show the forces acting on the doll and the trolley car. (Gravitational force pulls downward on the trolley and an equal and opposite force – the bench force – pushes upwards on the trolley.)

[Newton's First Law (Law of Inertia): if the forces acting on an object are balanced, then the object will remain stationary or carry on at the same speed at the same direction (constant velocity).]

3. Use a force meter (or stretched rubber band) to put a constant pull force on the trolley. Describe the motion of the doll and the trolley on a flat surface (accelerating in the direction of the net force).

4. Draw a diagram to show the forces acting on the doll and the trolley when a constant pull force is pulling the trolley.

[Newton's Second Law: if unbalanced forces act on an object, then the object will accelerate in the direction in which the net force acts.]

5 Using 1-metre long planks of wood and differing amounts of stacking blocks or books, set up a series of ramps that differ in height and send a trolley car on some plank trips under these different conditions. Measure the motion of the trolley on each plank trip with a metre rule and a stopwatch. Record your results in a table. Repeat each plank run three times and use the data to calculate the average speed of the trolley car in m/s.

Plank trip	Time (s) taken to travel 1 metre	Calculate the speed (m/s)
Trial 1		
Trial 2		
Trial 3		
Total		
Average		

Investigate motion - different ways to change the motion of the trolley car

What causes the trolley car to travel faster, further or with different motions - stationary (at rest), moving at constant speed, moving at increasing speed (accelerating), moving at decreasing speed (decelerating)?

In groups of 3-4, students select one approach to changing the motion of a trolley car. Some examples are provided below.

Approach 1. Change the slope of the plank

Use stacking blocks or books to change the starting height of the trolley car. Make a prediction about any change in the trolley car's motion before testing. Repeat your experiment 3 times, taking the average result under each condition as the speed or distance travelled. Compare this result with the prediction.

Approach 2. Change the weight force on the trolley car

Tape metal weights or washers to the trolley car body and see if increasing the weight of the trolley car by different amounts changes the motion or the distance travelled. Make a prediction about any change in the trolley car's motion before testing. Repeat your experiment up to 3 times, taking the average result under each condition as the speed or distance travelled. Compare this result with the prediction.

Approach 3. Change the frictional forces between the plank and the trolley

Cover the plank in waxy paper, corrugated cardboard, bubble wrap, sandpaper, fabric, carpet, ice, aluminium sheet etc. Make a prediction about any change in the trolley car's motion before testing. Repeat your experiment 3 times, taking the average result under each condition as the speed or distance travelled. Compare this result with the prediction.

Approach 4. Change the direction of the trolley's motion

Use small cardboard barriers to change the direction of the trolley car's motion. Make a prediction about any change in the trolley car's motion before testing. Repeat your experiment 3 times, taking the average result under each condition as the speed or distance travelled. Compare this result with the prediction.

Approach 5. Change the motion of the trolley car – by increasing its speed

Use 3 different ramp inclines. Make a prediction about which incline will change the motion (speed) of the trolley car the most. Repeat your experiment 3 times, taking the average result under each condition as the speed travelled. Compare this result with the prediction.

Approach 6. Change the motion of the trolley car – by stopping it

Change the motion from moving at increasing speed (accelerating) to stationary (at rest). Set up a series of different barricades or surfaces at the end of the ramp to stop the accelerating trolley car. Make a prediction about which intervention will change the motion of the trolley car most rapidly. Repeat your experiment 3 times, taking the average result under each condition as the time taken to change the motion to stationary. Compare this result with the prediction.

Use the experimental template below to design an experiment to test your approach. Share your experimental results and conclusions with the other groups in the class.

See: observe [multistructural]

I saw

____

Think: ask questions about what you observe [relational]

When I change ____what will happen to

____?

Wonder: form a hypothesis based on what you see and know [extended abstract]

I wonder if

____

____

Identify variables

Identify things I could change

Identify things I could measure or observe changing

Choosing variables

I will change (independent)	I will measure/observe (dependent)

I will keep these the same (controlled variables)

Equipment required

Method

Step 1:

Step 2:

Step 3:

Step 4:

Results

Record observations and data (use appropriate tables).

What did you observe ...?

What I changed (units) [Independent variable]	What I measured (units) [Dependent variable]

Analysis of results

Find patterns and trends from results (use graphs where appropriate)

Title: y-axis variable vs x-axis variable

What I measured (units)

[Dependent variable]

What I changed (units)

[Independent variable]

What happened to ______________________ (what I measured – dependent variable) when I changed

_________________________ (what I changed – independent variable)?

____

Evaluate the reliability and validity of the findings

Was the experiment a fair test?

Were my findings reliable?

Were my findings valid?

Conclusion

Make sense of the patterns in the results.

Describe, explain and justify the reliability and validity of the results.

What do the results mean? Do I accept or reject the hypothesis?

Lesson 5: adding an unrestrained passenger

Add an unrestrained plasticene doll to the trolley car

Use the experimental template below to design an experiment to answer one of the following questions.

- How did the stopping time influence the plasticene doll's motion during and after the change in motion to stationary?
- How did the stopping time influence the distance the plasticene doll travelled after the change in motion to stationary?
- How did the trolley's speed influence the plasticene doll's motion during and after the change in motion to stationary?
- How did the trolley's deceleration influence the distance the doll travelled after the change in motion to stationary?

Method

Seat a plasticene doll on the front of the trolley car.

Repeat one of the experimental methods used previously to change the motion of the trolley car from moving to stationary.

Observe (or video) the motion of the plasticene doll during and after the change in motion to stationary.

Share your experimental results and conclusions with the other groups in the class.

See: observe [multistructural]

I saw

____

Think: ask questions about what you observe [relational]

When I change ____what will happen to

____?

Wonder: form a hypothesis based on what you see and know [extended abstract]

I wonder if

____

____

Identify variables

Identify things I could change

Identify things I could measure or observe changing

Choosing variables

I will change (independent)	I will measure/observe (dependent)

I will keep these the same (controlled variables)

Equipment required

Method

Step 1:

___

___

Step 2:

___

___

Step 3:

___

___

Step 4:

___

___

Results

Record observations and data (use appropriate tables).

What did you observe ...?

What I changed (units) [Independent variable]	What I measured (units) [Dependent variable]

Analysis of results

Find patterns and trends from results (use graphs where appropriate)

Title: y-axis variable vs x-axis variable

What I measured (units)

[Dependent variable]

What I changed (units)

[Independent variable]

What happened to ______________________ (what I measured – dependent variable) when I changed

_________________________ (what I changed – independent variable)?

____

Evaluate the reliability and validity of the findings

Was the experiment a fair test?

Were my findings reliable?

Were my findings valid?

Conclusion

Make sense of the patterns in the results.

Describe, explain and justify the reliability and validity of the results.

What do the results mean? Do I accept or reject the hypothesis?

Create a safe plank trip for a plasticene doll

Use your new learning to create a safe plank trip for a plasticene doll.

The trolley car carrying the plasticene doll must change its state of motion at least 4 times – e.g. stationary (at rest), moving at constant speed, moving at increasing speed (accelerating) and moving at decreasing speed (decelerating).

Draw a flow chart sequencing the changes in motion on the plank trip. Compare and contrast the different motions of the vehicle at different stages of the plank trip.

Annotate your flow chart with explanations as to why the motion of your trolley car changed.

Observe when and where the plasticene doll falls off the car.

Re-design the plank trip or safety devices available so that the doll remains balanced on the trolley car for the duration of the journey. Explain what you modified and why, using concepts of force and motion.

Create a promotional interactive poster or presentation for your safe plank trip tour.

Lesson 6: experiencing forces and motion in everyday life

Set the context – road safety

List road safety devices and structures designed to help drivers and their passengers stop safely, e.g. seatbelts, airbags, crumple zones, bull bars, speed humps, road surfacing, disc brakes, anti-lock brakes (ABS), tyre pressure, tread and grip, speed limits, road signs, safety glass, paint colours, headlights, headrests.

View the video:

Understanding Car Crashes

Describe the motion of an unrestrained passenger in a car that crashes and rapidly changes its motion to stationary.

Draw a diagram using arrows to represent the direction and size of the forces (push or pull) you think may be acting on a car and on the passenger:

- before the collision (abrupt change in motion to stationary)
- during the collision
- after the collision.

Explain why an unrestrained passenger keeps their state of motion when the car they are travelling in becomes stationary. Identify 2 car safety devices designed to keep the motion of the passenger the same as that of the car.

Create a mind-map of your 'known unknown' questions about the road safety device – what you know you don't know about a road safety device.

Use the following road safety resources to answer your 'known unknown' questions, to generate more questions and to build your mind-map about an identified road safety device (and how it works).

Embrace Life – Always Wear Your Seat Belt (YouTube)

Safer Cars, Popular Science, June 1955 page 126

How Brakes Work

Airbags (Waka Kotahi)

How front and side airbags work (IIHS)

Backyard physics – throwing eggs (experiment related to airbags)

Eggs and pizza pan (inertia demonstration)

How seat belts work

Death defying designs for car safety (Australian Academy of Science)

How crumple zones work

How Tires Work

The Physics of Speeding Cars (Australian Academy of Science)

Driving safety (Waka Kotahi)

Forces and motion

Describe a road safety device designed to keep the motion of the passenger the same as that of the car. Include diagrams and annotations in your explanation. Self-assess your description against the success criteria in the assessment rubric below.

Extended Abstract	My description of a road safety device has several relevant attributes, explains how these attributes use forces to change motion and generalises about the effectiveness of the device.
Relational	My description of a road safety device has several relevant attributes and explains how these attributes use forces to change motion.
Multistructural	My description of a road safety device has several relevant attributes.
Unistructural	My description of a road safety device has one relevant attribute.
Prestructural	I need help to describe a road safety device designed to use forces to change motion.

Sequence the design history of a road safety device. Classify road safety devices according to different criteria – ease of use, cost to implement, effectiveness etc.

Use physics concepts of force and motion to explain why we need an identified road safety device when travelling in cars. Include diagrams and annotations in your explanation.

Use physics concepts of force and motion to explain how an identified road safety device works. Include diagrams and annotations in your explanation.

Use physics concepts of force and motion to explain the effect of an identified road safety device. Include diagrams and annotations in your explanation.

Explain the causes or the consequences of a change in motion that results from the use of a road safety device. Self-assess your explanation against the success criteria in the assessment rubric below. Include diagrams and annotations in your explanation.

Extended Abstract	My explanation has several relevant causes or effects of a change in motion, gives reasons why they are relevant and generalises about the causes and effects.
Relational	My explanation has several relevant causes or effects of a change in motion and gives reasons why they are relevant.
Multistructural	My explanation has several relevant causes or effects of a change in motion.
Unistructural	My explanation has one relevant cause or one relevant effect of a change in motion.
Prestructural	I need help to explain the cause or the effect of a change in motion.

Analyse a road safety device. Identify its relevant parts and explain what each part contributes to the whole device.

Reflect on the use of a road safety device (technological application of physics).

Create a road safety message about ‘safe stopping’ using physics concepts to encourage others to minimise their exposure to sudden changes in motion.

Use your new learning about forces and motion to write a storyboard or script promoting the use of a road safety device for ‘safe stopping’ in the world of plasticene dolls.

Co-construct success criteria to include in the assessment rubric for a three-minute ‘use a safety device’ video, slide show, interactive poster or pop-up event that is designed to persuade plasticene dolls to think about:

- using safety devices for ‘safe stopping’ when going on a ‘plank trip’
- forces and motion at work when going on a ‘plank trip’.

Extended Abstract	I can make a road safety message using relevant physics concepts, I know why and when I have introduced each concept to get my message across and I seek feedback on how to improve the validity and effectiveness of my message.
Relational	I can make a road safety message using relevant physics concepts and I know why and when I have introduced each concept to get my message across.
Multistructural	I can make a road safety message using physics concepts but I am not sure why or when I should refer to the concepts.
Unistructural	I can make a road safety message using physics concepts if I am directed.
Prestructural	I need help to create a road safety message using physics concepts.

Your message should include:

- a description of a road safety device for safe stopping designed to use forces to change motion
- an explanation of the causes of a change in motion (or the consequences of a change in motion).

Create the 3 minute ‘plank trip’ video, slide show, interactive poster or pop up event.

Present your ‘use a road safety device’ message to an audience.

Share the ‘use a safety device’ messages judged most effective on YouTube or Prezi.

Reflect upon changes in your use of the language and symbols associated with science concepts of force and motion, e.g. force, motion, stationary, constant speed, acceleration, deceleration, metres (m), kilometres (km), metres per second (m/s), kilometres per hour (km/h), Newtons (N), weight force, friction force, mass.

Extended Abstract	I use the language and symbols associated with the science concepts of force and motion when relevant. I seek feedback on my use of scientific language and symbols so that I can clarify my meaning.
Relational	I use the language and symbols associated with the science concepts of force and motion when relevant. I know why and when to use them.
Multistructural	I use the language and symbols associated with the science concepts of force and motion but I am not sure if I am using them correctly. I make mistakes.
Unistructural	I can use the language and symbols associated with the science concepts of force and motion if directed.
Prestructural	I need help to use the language and symbols associated with the science concepts of force and motion.

Assessment

Learning area

The following assessment rubrics use SOLO Taxonomy to categorise the different levels of achievement. Replace the categories with your own marking guide in the left-hand column of each rubric if you prefer.

Describe a road safety device designed to use forces to change motion.

Extended Abstract	My description of a road safety device has several relevant attributes, explains how these attributes use forces to change motion and generalises about the effectiveness of the device.
Relational	My description of a road safety device has several relevant attributes and explains how these attributes use forces to change motion.
Multistructural	My description of a road safety device has several relevant attributes.
Unistructural	My description of a road safety device has one relevant attribute.
Prestructural	I need help to describe a road safety device designed to use forces to change motion.

Explain the causes of a change in motion or the consequences of a change in motion.

Extended Abstract	My explanation contains several relevant causes or effects of a change in motion, gives reasons why they are relevant and generalises about the causes and effects.
Relational	My explanation contains several relevant causes or effects of a change in motion and gives reasons why they are relevant.
Multistructural	My explanation contains several relevant causes or effects of a change in motion.
Unistructural	My explanation contains one relevant cause or one relevant effect of a change in motion.
Prestructural	I need help to explain the cause or the effect of a change in motion.

Create a road safety message using physics concepts to encourage others to minimise their exposure to sudden changes in motion.

Extended Abstract	I can make a road safety message using relevant physics concepts, I know why and when I have introduced each concept to get my message across and I seek feedback on how to improve the validity and effectiveness of my message.
Relational	I can make a road safety message using relevant physics concepts and I know why and when I have introduced each concept to get my message across.
Multistructural	I can make a road safety message using physics concepts but I am not sure why or when I should refer to the concepts.
Unistructural	I can make a road safety message using physics concepts if I am directed.
Prestructural	I need help to create a road safety message using physics concepts.

Key competency

Making meaning from language, symbols and texts.

Using the language and symbols associated with science concepts of force and motion, e.g. force, motion, stationary, constant speed, acceleration, deceleration, metres (m), kilometres (km), metres per second (m/s), kilometres per hour (km/h), Newton (N), weight force, friction force, mass.

Extended Abstract	I use the language and symbols associated with the science concepts of force and motion when relevant. I seek feedback on my use of scientific language and symbols so that I can clarify my meaning.
Relational	I use the language and symbols associated with the science concepts of force and motion when relevant. I know why and when to use them.
Multistructural	I use the language and symbols associated with the science concepts of force and motion but I am not sure if I am using them correctly. I make mistakes.
Unistructural	I can use the language and symbols associated with the science concepts of force and motion if directed.
Prestructural	I need help to use the language and symbols associated with science concepts of force and motion.

Thinking resources

These are suggested thinking frameworks based on a range of strategies.

Think Pair Share

See Think Wonder

Mind Mapping

SCAMPER

Plus Minus Interesting

Brainstorming

What if questions

Use these for class and group discussion or writing.

What if cars were like ski lifts and never stopped moving?

What if people wore airbags?

What if the speed limit was 30km/h?

What if all roads were one way?

What if we banned music and conversation in cars?

What if all passengers wore a body harness like racing drivers wear?

What if there was no speed limit?

What if clothes had crumple zones?

What if overtaking was banned?

Student-led inquiry scenario

Investigate the introduction of road safety devices in cars. Create an annotated timeline for the invention and introduction of road safety devices.

Investigate the effect of increasing the incline of a plank trip on the speed of the trolley and the impact of any subsequent collision.

Investigate the effect of increasing the incline of a plank trip on the stopping distance of a trolley and its effect on a plasticene passenger on the trolley.

Design a safety device to transport an egg (creme egg or chicken egg) down a plank.

Refer to Design an Egg Car:

Crash test eggs

Design a prototype safety device to transport plasticene dolls on adventure sport 'plank trips'.