Physics in crash avoidance or crash protection

Internal assessment resource. Physics.

Supports internal assessment against:

Achievement Standard 90936: Demonstrate understanding of the physics of an application

2 credits

This resource:

- clarifies the requirements of the assessment standard
- supports good assessment practice
- should be subjected to the school's usual assessment quality assurance process
- should be modified to make the context relevant to students in their school environment and to ensure that submitted evidence is authentic.

Teacher guidelines

The following guidelines are designed to enable teachers to carry out valid and consistent assessment using this internal assessment resource.

Teachers need to be thoroughly familiar with the outcome being assessed by Achievement Standard 90936. The achievement criteria and the explanatory notes contain information, definitions and requirements that are crucial when interpreting the achievement standard and assessing students against it.

Authenticity of evidence

Using this assessment resource without modification may mean that students' work is not authentic.

Teachers must manage authenticity for any assessment from a public source because students may have access to the assessment schedule or student exemplar material.

The teacher may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform.

Values that underpin this task	Key competencies that underpin this task	Key understanding
Excellence Innovation Diversity Equity **Community and Participation** Ecological Sustainability Integrity **Respect**	**Thinking** Managing self Participating and contributing Relating to others **Making meaning from language, symbols and text**	Physics helps keep our friends, family and whānau safe around roads.

Context

In this assessment activity students must prepare a report on the physics involved in applications for crash avoidance or crash protection and explain how the phenomenon works in this context. It is not sufficient to state the physics principle being used.

The application the students are researching should be appropriate to Level 6 of the curriculum.

Examples include seat belts, airbags, rumble strips, safety cages, disc brakes, anti-lock brakes (ABS), tyre pressure, tread and grip, crash barriers, and headrests.

If an application involves only one aspect of physics it may not, by itself, allow the student to show sufficient knowledge and understanding of physics concepts to satisfy the requirements of the standard. In this situation the student should choose more than one application.

The following are possible road safety applications:

- use of inertia in car seat belts
- use of weight and pressure in tyre grip
- use of accelerometers in airbags
- use of audio tactile profiled road markings
- use of friction in disc brakes
- use of deformable materials in crash barriers
- use of resistant materials in safety cages in cars.

Set the scope of the research by:

- choosing the topic to research or assisting students in their selection and approving that topic. It is important that the student has already received instruction in the physics of the topic chosen. It is unlikely that the student will be able to acquire the depth of understanding required for merit and excellence from the research material they find
- providing a planning template, e.g. Resource 1
- directing students to perform independent research outside the classroom, on a selected application of physics principles
- indicating how students should present their information, including in a bibliography or list of links.

Conditions

Refer to Conditions of Assessment for comments on developing and practising the skills required, use of modelling and scaffolded practice, assembling evidence, and independent student work:

Physics subject resources

The timeframe of the assessment will depend on the selected application. Set time appropriately.

Assessment is not restricted to a written report. Clarify for students the approved formats of the report; for example, written, visual, oral or simulation format.

Students should conduct their research independently.

Although students will conduct their research outside of the classroom, supervise the report writing.

The standard does not require the students' research to be assessed. They should only be assessed on the report they produce.

A standardised policy unifies referencing requirements across subject areas. Insufficient referencing does not now preclude achievement, unless the achievement criteria of the standard specifically include it. Thus, requirements for referencing are not shown in the assessment schedule.

Resource requirements

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 events, and discretion is advised.

Suggested materials on the physics in crash avoidance and crash protection

Volvo safety features

Accelerometers

Electronic stability control (NZ Ministry of Transport)

How electronic stability control works

How anti-lock brakes work

Horrifying Sculpture Depicts a Human Evolved to Survive a Car Crash

Want to meet our crash test dummy family? (ANCAP)

Lane Departure Warning

The safety effectiveness of the audio tactile profiled markings programme

Nigel Latta – Big old car vs small new car

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

Embrace Life – Always Wear Your Seat Belt (YouTube)

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

What is a force?

What forces are acting on you?

ForceMan

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 of motion (Khan Academy)

Newton's third law of motion (Khan Academy)

Assessment resources

- The standard
- Conditions of assessment
- Assessment schedule
- Sufficiency statements and exemplars

Possible local adaptation

When they adapt this resource to fit with local requirements, teachers and schools should:

- check that the adapted assessment validly assesses the achievement standard
- check the copyright status of any material imported into the assessment
- comply with all internal and external quality assurance requirements.

Physics in crash avoidance or crash protection

Internal assessment resource

Student instructions

Achievement standard Physics 90936 version 1: Demonstrate understanding of the physics of an application

Credits: 2

This achievement standard involves understanding the underlying physics of a chosen application.

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the physics of an application.	Demonstrate in-depth understanding of the physics of an application.	Demonstrate comprehensive understanding of the physics of an application.

Introduction

This assessment activity requires you to research the physics in a road safety application and to produce a report that demonstrates understanding of the physics used in the application for crash avoidance or crash protection. It is not sufficient to simply state the physics principle being used in the application.

To produce the report you will need to:

1. Identify an application of physics in a road safety application and check with your teacher that you have been given sufficient teaching on the physics involved for you to be able to give the required explanations.

2. Collect information about the use of physics in the application from a range of primary or secondary sources. Use the planning template provided (Resource 1: Planning template).

3. Process this information by explaining how the physics information relates to the application.

4. Produce a report that clearly demonstrates your understanding of the physics of an application and its use.

The report could be in one or more of the following formats:

- written (a report, blog post or webpage)
- visual (a poster, infographic, short film, digital essay)
- oral (a formal speech, a podcast)
- or simulation (for example, use of software to build working 2-D models).

Resource 1: Planning template

Put your research question here. You will need to form one or more questions that explore the application, the physics involved and the use of the physics in the application. Keep this sheet so that you can show the questions to your teacher.

Research question:

Source	**Information** [text, images, graphs, tables, diagrams, screen grabs etc]	**Key words** [important words that describe the topic]	**In your own words**
Paste URL or write bibliographic reference details here.	Paste or write information from sources here. Include only what you need.	List the key words in this box. Use individual words, not sentences. There may be many key words.	Take your key words and make new sentences. Use them to help answer your question.

Summary:

Summarise your new sentences here. Your summary should answer your question(s). If your plan is more than one page long, write your summary on the last page. When your summary is complete, ask your teacher for their feedback and signature. Keep this sheet as evidence of your research.

Planning template

Research question:			
Source	**Information** [text, images, graphs, tables, diagrams, screen grabs etc]	**Key words** [important words that describe the topic]	**In your own words**
Summary:			

Assessment schedule

Assessment schedule summary

Physics 90936 v1: Physics in Crash Avoidance or Crash Protection

2 credits

A	M	E
Identifies an application and links it to road safety.	Identifies an application and links it to road safety.	Identifies an application and links it to road safety.
Describes the key physics principles used in the application.	Describes the key physics principles used in the application.	Describes the key physics principles used in the application.
Demonstrates understanding of **how** the physics principles are used in the road safety application.	Demonstrates deep understanding of **how and why** the physics principles are used in the road safety application.	Demonstrates comprehensive understanding of the **integration** of physics principles in the road safety application.

Assessment schedule: Physics 90936 v1 Physics in Crash Avoidance or Crash Protection

Evidence/judgements for Achievement	Evidence/judgements for Achievement with Merit	Evidence/judgements for Achievement with Excellence
The student's report: • identifies the road safety application and the context in which it is used • demonstrates understanding by describing how key physics ideas (in terms of phenomena, concepts, principles and/or relationships) are used in the road safety application.	The student's report: • identifies the road safety application and the context in which it is used • demonstrates deep understanding by explaining why key physics ideas (in terms of phenomena, concepts, principles and/or relationships) are used in the road safety application.	The student's report: • identifies the road safety application and the context in which it is used • demonstrates comprehensive understanding by analysing the key physics ideas (in terms of phenomena, concepts, principles and/or relationships) integrated into the road safety application.
*For example, the text framework for an Achievement report on the use of **seat belts** would describe the key physics ideas used:*	*For example, the text framework for a Merit report on the use of **seat belts** would extend the Achievement report with explanation (give reasons):*	*For example, the text framework for an Excellence report on the use of **seat belts** would extend the Merit report with analysis and evaluation to integrate the key physics:*
Objects will keep moving at the same speed and in the same direction unless acted on by an unbalanced force. This is Newton's second law. This means that whatever the car crashes into stops the car, but doesn't stop the people inside the car. If seat belts are not worn the people will continue to move forward and will crash into the structure of the car. If this happens the force that stops them from moving will be large and may cause injury.	Objects will keep moving at the same speed and in the same direction unless acted on by an unbalanced force. This means that whatever the car crashes into stops the car, but doesn't stop the people inside the car. If seat belts are not worn the passengers will continue to move forward and will crash into the structure of the car. *The time it takes them to stop is likely to be much less than the time it took the car to stop, so their deceleration, and hence force acting on them (F = ma), would be greater. OR: *The energy they lose will be the same with or without seatbelts, but the work done to make them lose this energy will be over a much shorter	Objects will keep moving at the same speed and in the same direction unless acted on by an unbalanced force. This means that whatever the car crashes into stops the car, but doesn't stop the people inside the car. If seat belts are not worn the passengers will continue to move forward and will crash into the structure of the car. *The time it takes them to stop is likely to be much less than the time it took the car to stop, so their deceleration, and hence force acting on them (F = ma), would be greater. OR: *The energy they lose will be the same with or without seatbelts, but the work done to make them lose this energy will be over a much shorter

	distance and because W = Fd, the force on them will be much greater.	distance and because W = Fd, the force on them will be much greater. The force that acts on the passengers is friction with the car seat. This will tend to reduce the speed of their lower body. Because of this the passenger's head is more likely to be the part of the body that hits the interior. If it is the head that hits the car's interior, the area over which the stopping force is applied is very small creating huge pressure that can do damage. A person's internal organs which are free to move, such as the lungs and brain, will also continue to move until they are stopped by part of the body structure such as ribs or skull. The greater the deceleration of the person, the greater the deceleration of these organs so the greater the force needed to stop them and hence the more likely injury will be sustained.
So what does the seat belt do? Seat belts prevent the driver and passengers from continuing to move when the car stops moving. The seat belts connect the person to the car by pinning their body to a seat bolted to the passenger compartment in the car.	**So what does the seat belt do?** Seat belts prevent the driver and passengers from continuing to move when the car stops moving. The seat belts connect the person to the car by pinning their body to a seat bolted to the passenger compartment in the car. As a consequence of wearing a seat belt the person stops with the same deceleration as the deceleration of the car.	**So what does the seat belt do?** Seat belts prevent the driver and passengers from continuing to move when the car stops moving. The seat belts connect the person to the car by pinning their body to a seat bolted to the passenger compartment in the car. As a consequence of wearing a seat belt the person stops with the same deceleration as the deceleration of the car. Whenever a force acts on an object, the object must push back with an equal force (action and reaction are equal and opposite) The injury a person might sustain depends on whether the body is able to react

		to the force that is applied to it without breaking or being squashed.
Seat belts make the stopping force on a person's body less dangerous in other ways.	Seat belts make the stopping force on a person's body less dangerous in other ways.	Seat belts make the stopping force on a person's body less dangerous in other ways.
The main way is that the seat belt anchors the passenger to the car so the deceleration of the passenger is the same as the deceleration of the car. This deceleration is most likely to be less than the deceleration the person would experience if they crashed into the structure of the car. The lower the deceleration the smaller the stopping force on the person. If a seat belt is worn the stopping force acts in places where the body is least likely to suffer damage – the rib cage and pelvis are both quite strong so are not damaged as easily as other parts of the body.	The force acts in places where the body is least likely to suffer damage – the rib cage and pelvis are both quite strong and so can push back against the seat belt without suffering damage.	The force acts in places where the body is least likely to suffer damage – the rib cage and pelvis are both quite strong and so can push back against the seat belt without suffering damage. Even with a reduced force, other softer parts of the body may not be able to provide the required reaction force and so will cave in until some other part of the body is able to provide the reaction force. By the time this happens the softer parts of the body may have been damaged.
Also, the stopping force is spread over the area of the seat belts making its effect on the parts of the body it touches experience less force.	The stopping force is spread over the area of the seat belts. This means that the parts of the body that are in contact with the seat belt feel much less pressure and so are less likely to be damaged.	The stopping force is spread over the area of the seat belts. This means that the parts of the body that are in contact with the seat belt feel much less pressure and so are less likely to be damaged.

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the achievement standard.

It is not envisaged that all the evidence suggested is required for each of the grades but there must be a reasonable attempt to describe or explain what happens when a seat belt is not worn and how the seat belt might prevent this from happening.