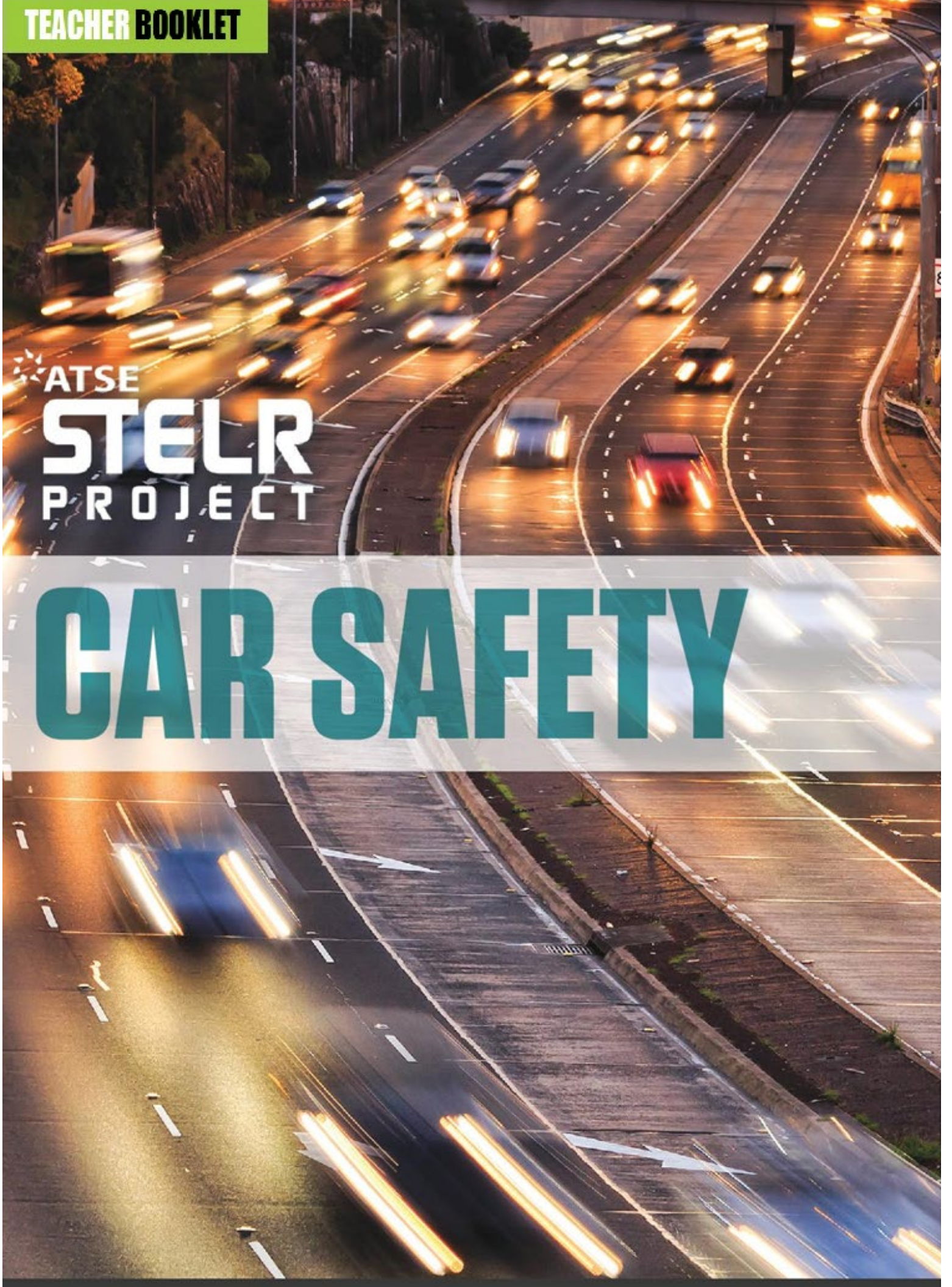
TEACHER BOOKLET



ATSE STELR PROJECT

CAR SAFETY

NAME _____ CLASS _____

TABLE OF CONTENTS

INTRODUCTION

This unit introduces Car Safety and what you can do to make informed choices as new drivers and contribute to road safety. It highlights relevant principles in science, connects to the curriculum, and focuses on the Australian context. Each module contains online learning activities, videos, simulations, small and large group discussions, and practical investigations. This unit begins with a survey to assess your prior knowledge, and also has a career section and end of unit projects.

YOUR IDEAS ABOUT ENERGY AND MOTION

- Survey: What I know about energy and motion
- Energy & Motion Word Cloud

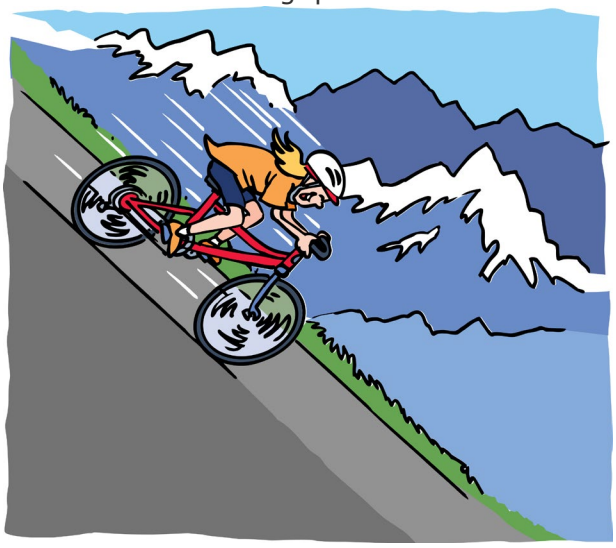
Your first task in this topic is to complete this survey, which is designed to find out what you currently know about energy and motion.

KEY IDEAS

- Energy conservation in a system can be explained by describing energy transfers and transformations.
- The motion of objects can be described and predicted using the laws of physics.
- These areas in physics help you understand principles and process related to car safety.

SURVEY: ENERGY AND MOTION

Before getting started with the activities, complete this short survey. It will help evaluate what you already know and get you thinking about the upcoming lessons. Choose the best answer to the following questions.



1. A girl is riding her bicycle down a hill without pedalling. She speeds up as she goes down the hill, and the tyres get a little warmer. What energy transformations happen while she is going down the hill?

☐ Motion energy (kinetic energy) is transformed into gravitational potential energy and thermal energy.
☐ Gravitational potential energy is transformed into motion energy (kinetic energy) and thermal energy.
☐ Gravitational potential energy is transformed only into motion energy (kinetic energy)
☐ No energy transformations are involved while she is going down the hill.
☐ I don't understand the question or I am not sure.

2. What is Sir Isaac Newton's Second Law of Motion?

☐ Objects at rest and objects in motion will remain at rest or in motion, unless they are acted upon by an unbalanced force.
☐ For every action there is an equal and opposite reaction.
☐ When a force acts on a mass, acceleration is produced.
☐ When a force acts on a mass, the mass increases.

3. What is Sir Isaac Newton's Third Law of Motion?

☐ Objects at rest and objects in motion will remain at rest or in motion, unless they are acted upon by an unbalanced force.
☐ For every action there is an equal and opposite reaction.
☐ When a force acts on a mass, acceleration is produced.
☐ When a force acts on a mass, the mass increases.

4. The speedometer in your car tells you the _____ of your car.

☐ acceleration
☐ average Speed
☐ instantaneous Speed
☐ velocity

5. The distance traveled by a race car is 7 km in 100 sec. What is its speed?

☐ 70 m/s
☐ 70 km/h
☐ 700 m/s
☐ 7 km/h

6. A family does a road trip from Melbourne to Sydney, which is about 870 km away. The total driving time took 9 ½ hours. What is the average speed the car was traveling at?

7. Most of the energy used by burning gasoline in an engine is spent as:

☐ motion
☐ light

☐ 9.5 hours
☐ 8265 m
☐ 92 km/h
☐ 97 km/h

8. A driver is traveling at 30 m/s skids to a stop in 3 s. Determine the skidding distance of the car (assume uniform acceleration).
☐ 0.1 m/s
☐ 90 m
☐ 45 m
☐ 10 m

10. A driver is approaching a pedestrian crossing moving with a velocity of +30.0 m/s. The light turns yellow, and she applies the brakes and skids to a stop just prior to the crosswalk. If her acceleration is -8.00 m/s^2, determine how far the car skids before it stops (i.e., the displacement of the car).

☐ 56.3 m
☐ 3.75 m
☐ 240 m
☐ none of the above

☐ potential
☐ heat

9. Energy transfer and transformation is never 100% efficient because:
☐ some of the energy input is always transformed into gravitational potential energy
☐ some of the energy input is always transformed into thermal energy
☐ the energy input is always less than the energy output
☐ none of the above

ENERGY WORD CLOUD

Question 1. Your task will be to create an Energy word cloud. You can use programs such as WordClouds or Word It Out, by clicking on one of the programs below. Paste your word cloud in the space below.

www.WordClouds.com
www.worditout.com

Question 2. Energy and Motion exist in our everyday lives. Construct a mind map below to help explain all the different forms of energy and motion.

DRIVING IN AUSTRALIA

- Poll: Driving in Australia

Compare your ideas about traffic accidents and injuries in this Poll.

KEY QUESTIONS

- What vehicle results in the most common transport-related fatalities?
- What is the speed limit where most fatal accidents occurred?
- How many vehicles are involved in most fatal crashes?
- What proportion of male drivers between the ages of 18-25 year old are killed in motor vehicle accidents?
- What situations affect your ability to drive safely?

POLL: DRIVING IN AUSTRALIA

Question 1. Of all transport-related fatalities, most are attributed to:

☐ airplane accidents
☐ pedal bicycle accidents
☐ motor vehicle accidents
☐ pedestrian accidents

Question 2. Most fatal accidents occurred in areas where speed limits were:

☐ 100 km/hr and above
☐ 65-90 km/hr
☐ Up to 60 km/hr

Question 3. Most fatal crashes involved:

☐ a single vehicle
☐ multiple vehicles

Question 4. The number of young drivers between the ages of 18-25 killed in motor vehicle accidents has decreased since 1987. What proportion of these drivers are male?

☐ 25%
☐ 50%
☐ 75%
☐ 95%

Question 5. The following have a strong effect on your ability to drive safely:

☐ being distracted by friends, loud music, using your phone
☐ being slightly drunk
☐ being tired
☐ all of the above

SAFE DRIVING

- Speeding has the Opposite Effect
- Braking and Reaction Times
- Real-life Scenarios

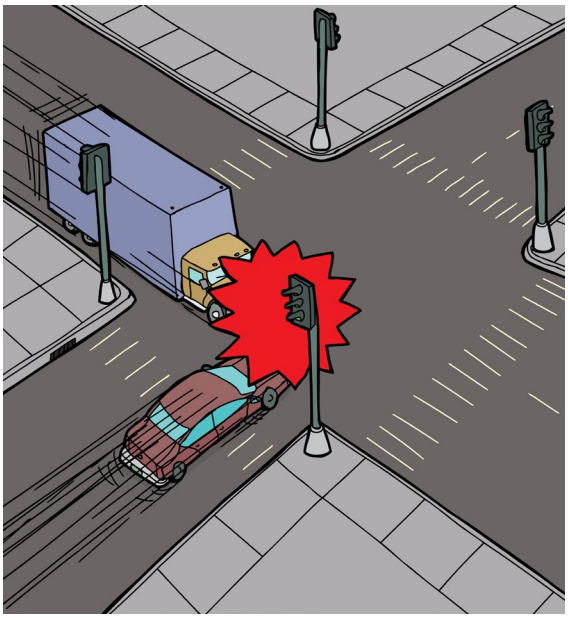
Learn about the effects of speeding on accidents, and how safer driving practices can save lives.

KEY IDEAS

- Everyday motion is created by forces and can be measured by distance, time, speed, force, mass and acceleration.
- Speed limits are set to improve road safety. As speed increases, so does the amount of energy; thus, speeding is directly related to increased crash occurrences and severity.
- The two key results of speeding that affect crash avoidance are reaction time and braking distance.

SPEEDING HAS THE OPPOSITE EFFECT

Speed is measured as the amount of distance travelled in a certain time. Whether on a bicycle or in a car, it is typically measured as kilometers (i.e., distance) per hour (i.e., time). From a theoretical perspective, the faster you go, the sooner you will get there. However, in the real world, whether it is on a racetrack, on a country road, or in city traffic, there are several other factors to consider, such as road conditions, the weather, quality of tires, and most importantly, the risk of injury to others. Regardless of the factors, research in road safety consistently shows that with increased speed, the number of crashes and severity of injury increases.



ROLE PLAY ON SPEEDING

This activity requires an open space in the classroom or outdoors. Begin by marking out an area, either by using tape or a string, of about 1.5 metre by 1.5 meter squared.

Activity:

1. 1. Have four (4) students position themselves on the boundary of the square.
2. 2. While playing music, students walk slowly around the square.
3. 3. When the music stops, students stop walking.
4. 4. Stop the music.
5. 5. Observe and compare how students are positioned in the area in relation to one another.
6. 6. While playing music again, students increase their speed and walk faster.
7. 7. Stop the music.
8. 9. Observe and compare how students are positioned in the area in relation to one another.
9. 10. Answer the questions below and discuss with the class.

Note: this activity is based on Toyota's Teen Drive 365 for School Resources

Toyota's Teen Drive 365 for School
https://www.teendrive365inschool.com/safe-driving-resources/educators

Question 1. How were the students positioned in the area when they were walking slowly? Sketch a diagram or paste a photo.

Question 2. How were the students positioned in the area when they were walking quickly? Sketch a diagram or paste a photo.

Question 3. Explain how this Role Play Activity relates to speeding. Discuss other factors that might impact the distance between cars when you are speeding.

MEASURING SPEED

Use the Measuring Speed simulation to learn the relationship with speed, distance, and time, and answer the question below:
http://lrrpublic.cli.det.nsw.edu.au/lrrSecure/Sites/Web/skoool/phys/sim/Measuring%20Speed/index.htm

Question 4. Show how you can rearrange the equation used in the simulation to find out the speed and the distance.

WHERE DOES SPEEDING GET YOU?

Use the Where Does Speeding Get You? simulation to investigate the difference between speed and velocity. Your task is to measure speed and velocity over the shortest path from start to finish. Begin by selecting the finish point, then click on start and select your speed using the "slower" and "faster" buttons.

Where does speeding get you?
www.scootle.edu.au/ec/viewing/L53/index.html

Question 5. Record your results in the table provided and answer the questions that follow.

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Shortest Distance to Finish (metres)						
Actual Distance Travelled (metres)						
Displacement (metres)						
Direction (degrees)						
Time (seconds)						
Speed (m/s)						
Velocity (m/s at a given angle)						

Question 6. Explain the results for your simulation.

Question 7. Describe the difference between speed and velocity

SPEEDING: A LITTLE IS A LOT

Watch the video below and answer the following questions.

The Science of Low Level Speeding
www.youtube.com/watch?v=y5cVvHAwwCg

Question 8. Explain the cumulative effects when people speed, even if they are speeding a few km/h over the limit.

Question 9. Explain how a small increase in speed increases the *chance* of a crash.

Question 10. Explain how a small increase in speed affects the *severity* of a crash.

BRAKING AND REACTION TIMES

Try the RED Light GREEN Light Reaction Time Test to measure your average reaction time when the light turns green and answer the following questions.

https://faculty.washington.edu/chudler/java/redgreen.html

Question 1. Compare your average reaction time with those of your classmates

Question 2. Discuss factors that might influence your reaction time.

SIMULATION: GIVE ME A BRAKE

Try the Give me a Break simulation to investigate how different vehicles and road conditions affect braking distances. Begin by choosing your speed, selecting your vehicle, the tires, road type, and weather conditions, then click on "start" and "brake" buttons.

Give me a Break

www.scootle.edu.au/ec/viewing/L52/index.html

Question 3. Record your results in the table provided and answer the questions that follow.

Speed	Vehicle	Tires	Road	Weather	Braking Distance (m)	Distance from Target (m)

Question 4. Describe the relationship between speed and stopping/braking distance.

Question 5. In this simulation, which factor has the strongest effect on braking distance?

The **Queensland Government** has organized some information about speeding on their website, to help educate drivers. Click on the link below and navigate the menu to find the answer the following questions.
www.tmr.qld.gov.au/Safety/Driver-guide/Speeding.aspx

Question 6. What is the average reaction time for drivers?

☐ 1 second
☐ 1.5 seconds
☐ 2 seconds
☐ none of the above

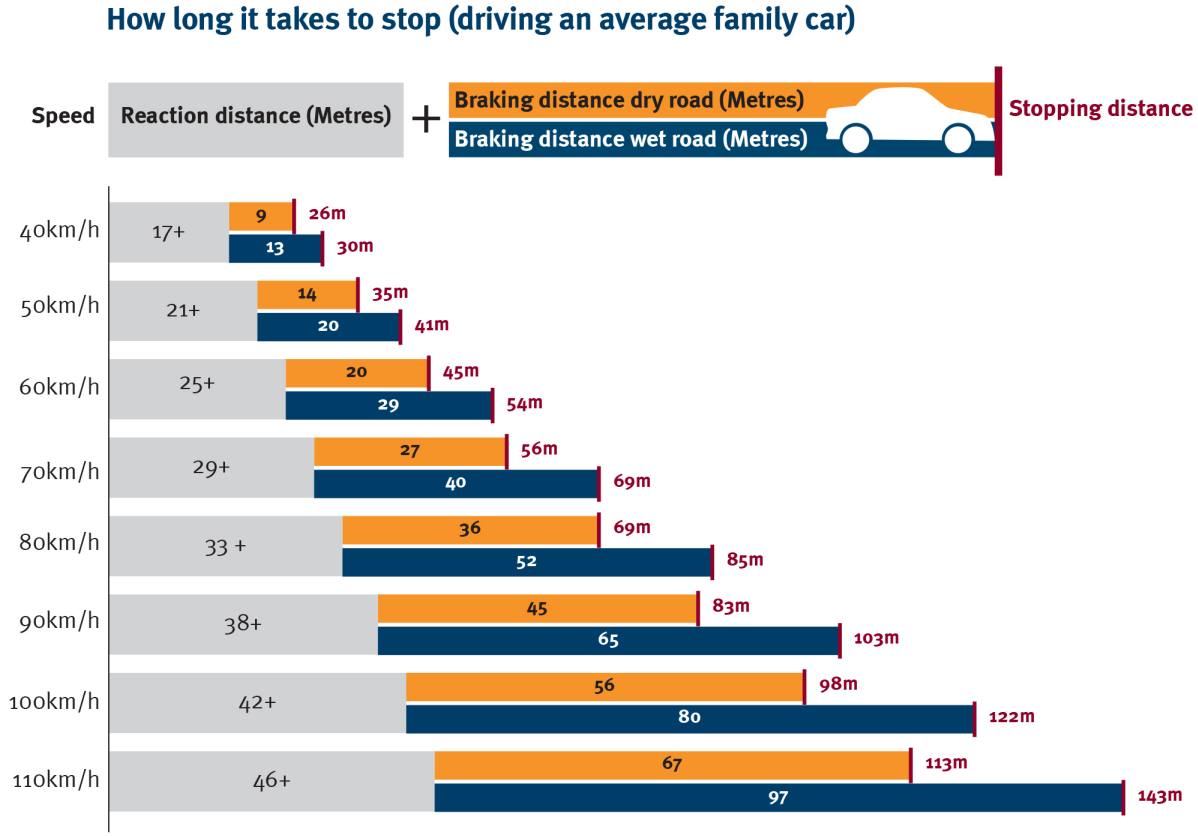
Question 7. Some of the social costs to speeding include:

☐ health care costs
☐ loss of productivity in the school or workplace
☐ injury or loss of a friend or family member
☐ the cost of using emergency services
☐ all of the above

Question 8. Explain 3 factors that influence how speed limits are set.

Question 9. Of the entire driver, vehicle, and environmental factors that affect stopping distances, list 3 that you have personally experienced and discuss with another student.

Refer to the graph below: **"How long it takes to stop"** to answer the following questions.



Question 10. If you are driving 50 km/h, what is the difference in total stopping distance between wet and dry road conditions?

☐ 6 m
☐ 14 m
☐ 20 m
☐ 21 m

Question 11. If you are driving 110 km/h in a 100 km/h zone, how much longer is your total stopping distance on wet road conditions?

☐ 4 m
☐ 21 m
☐ 122 m
☐ 143 m

The **Transport Accident Commission** of Victoria State assists people who have been in accidents and promotes road safety. They maintain a database of fatalities and injuries related to motor vehicle accidents (i.e., Searchable Road Trauma Statistics). Click on the link below to access this database and answer the following questions.

http://reporting.tacsafety.com.au/s/search.html?clive=tac-fatalities-xml¤t-step=2&collection=tac-xml-meta

Question 12. How many fatalities occurred in Melbourne for all road users in the last 12 months?

Question 13. From your answers, what broad trends can you identify? Explain how this many influence any decisions you make as a driver, or any advice you would give to a driver who is a friend or family member.

The **Monash University Accident Research Centre** has an advanced Driving Simulator that helps us understanding the relationship between speed and breaking distance. The engineers there follow mathematical formulas for motion, in this case: $\mathbf{v^2 = u^2 + 2ax}$ (where ***v*** stands for final velocity - in this case zero, ***u*** stands for initial velocity, ***a*** stands for constant acceleration, and ***x*** is the distance travelled). This equation was rearranged to show how stopping distance is affected by speed: $\mathbf{d = u^2/2a}$ where ***d*** stands for stopping distance. Watch the video below.

VIDEO **Math Delivers! Braking Distance**
https://careers.amsi.org.au/car-braking-distances/

The **Australian Mathematical Sciences Institute** used the above formulas to develop a table showing how braking distance is affected by speed. Refer to the table and answer the following questions.

Question 14. In a 60 km/h speed zone, how fast was is the speeding car that was going 65 km/h still going after the driver has been braking for a distance of 14 m?

Speed of car while braking from 60 km/h and 65 km/h

Distance travelled	Speed	
0 m	**60 km/h**	**65 km/h**
5 m	48 km/h	54 km/h
10 m	32 km/h	40 km/h
12 m	22 km/h	33 km/h
13 m	15 km/h	29 km/h
14 m	stationary	24 km/h
15 m	stationary	18 km/h

Question 15. Based on your answer to Question 14, use the internet to find out the impact of a collision at that speed on a pedestrian or cyclist.

The **Queensland Government** created a video about safe following distances. Watch the video to find out the answers to the question below.

Safe Following Distances
https://www.youtube.com/watch?v=mXmqnSNRWQo

Question 16. Write down the recommended safe following distance (in seconds) for each of the scenarios below.

Scenario	Safe following distance (in seconds)
Regular vehicle and good road conditions	
Towing a trailor	
Heaving vehicle	
Poor weather conditions	

ACTIVITY: REAL-LIFE SCENARIOS

There are 6 real-life scenarios presented that relate to choices you may face as a young driver or passenger.

In your group, discuss your scenario and how you would respond it. Record your thoughts in the space below. Share your scenario with the whole class and discuss your responses.

Scenario 1: A friend drives you to a party and promises not to drink so you can get a drive home. But you notice him smoking marijuana during the party. Should you mention this to him? How would you approach this situation?

Scenario 2: Your friend is driving a group of you to school footy game and you are running late. Everyone is talking excitedly in the car and you notice a couple things about the driver: she is also enjoying the conversation and she has been driving over the speed limit. Would you say anything? How would you respond given that everyone is having fun and no one else is noticing?

Scenario 3: You are going to a party on the weekend that is about 10 km from home and it is likely that your friends will also be drinking. You know there is no public transport is available after midnight, so what are your options?

Scenario 4: Your friend has his probationary license and picks you up to go to a party. The restrictions on this license include zero blood alcohol levels, but he is a 181 cm tall and says he'll only have one beer early on. How would you respond to this?

Scenario 5: Your best friend finally has her first level probationary license, which limits the number of passengers aged 16-22 years to one other person. She offered to drive you to the school fete. As soon as she picks you up, you receive a text from another friend who wants to join you and has no other way to get to the event. How do you respond to this situation?

Scenario 6: You and your friend are driving home from a late movie. It has been raining for the past few hours but there is not much traffic on the road except for the car behind you.

As you come to a stop light at an intersection, you scan your rear view mirror and notice the car behind you seems to be going too fast into the red light. The next thing you notice is a loud booming sound and your car is thrown forward into the intersection. Both you and your friend are wearing seatbelts and seem to be okay. You look at each other and confirm you are okay. What do you do next?

DESIGNING CARS

- Designing for Safety
- How Safe is Your Car?
- Practical Session: Crash Test Cars
- Crumple Zones
- Practical Session: Crumple Zones

Learn how physics is used to inform the design features and safety ratings in vehicles.

KEY IDEAS

- Vehicles are designed with safety features that reduce the amount and severity of crashes.
- There is an international system in place to rate the safety of all vehicles.
- Energy is transferred during a collision.
- The kinetic energy of an object is directly proportional to the square of its speed.

DESIGNING FOR SAFETY

There are a number of features in a car that are designed to improve safety. Seatbelts and airbags are easy to identify. Additional features that are not as obvious address traction, braking and car stability, the type of materials used to construct the car, and ways to make the driving experience more comfortable for the driver.

In this Jigsaw activity, you will work in one of 5 groups to investigate how modern cars are designed to address key safety features. Click on the links below, investigate one of the following areas: *Crash Avoidance, Crash Protection and Driver Features, Driver Education, Infographic Interpretation*, *and Young Driver Factbase* and record your answers below or in your notebook. When everyone in your group is finished answering their questions, everyone will share their answers with other group members. When all answers are complete, take the quiz at the end of the webpage and prepare to discuss you answers in class.

For ***Crash Avoidance, Crash Protection and Driver Features, Driver Education, Infographic Interpretation***, click on **Designs for Car Safety**
https://www.science.org.au/curious/technology-future/death-defying-designs-car-safety

Click here for ***Young Driver Factbase***.
www.youngdriverfactbase.com
At the end of the Jigsaw presentations, complete the QUIZ at the bottom of the webpage.

GROUP ACTIVITY 1: CRASH AVOIDANCE

Question 1. In your own words, briefly describe each of the features below and answer the following question.

Features	Description
Electronic Stability Control	
Traction Control	
Auto Emergency Braking	
Anti-lock Brakes	

GROUP ACTIVITY 2: CRASH PROTECTION AND DRIVER FEATURES

In your group, discuss the cars used in your respective families and which of these **crash protection features** they have. You may need to look up the make, model, and year online to find the information, or review the drivers manual that came with the car.

Question 1. Summarize your findings below.

Features	Description
Crumple Zones	
Seatbelts	
Airbags	
Driver Features	

Question 2. For Crumple Zones, Seatbelts, and Air Bags, identify which of Newton's Laws of Motion each address. Briefly describe each in the table below.

Features	Newton's Laws of Motion
Crumple Zones	
Seatbelts	
Airbags	

GROUP ACTIVITY 3: SAFER CARS STILL AREN'T PERFECT

Question 1. Review the Infographic provided and summarize the key messages below. In your group, discuss the most compelling message and explain how it influences the choices you make when driving (in) a car.

GROUP ACTIVITY 4: DRIVER EDUCATION

Question 1. Research the Driver Education Programs in your area, and include a brief description of the following: types of programs, curriculum, how to get a learner's permit, and how to get a probationary license.

GROUP 5: YOUNG DRIVER DATABASE.

The Georgia Institute is a Health and Medical Research Institute that provides information on young drivers safety.

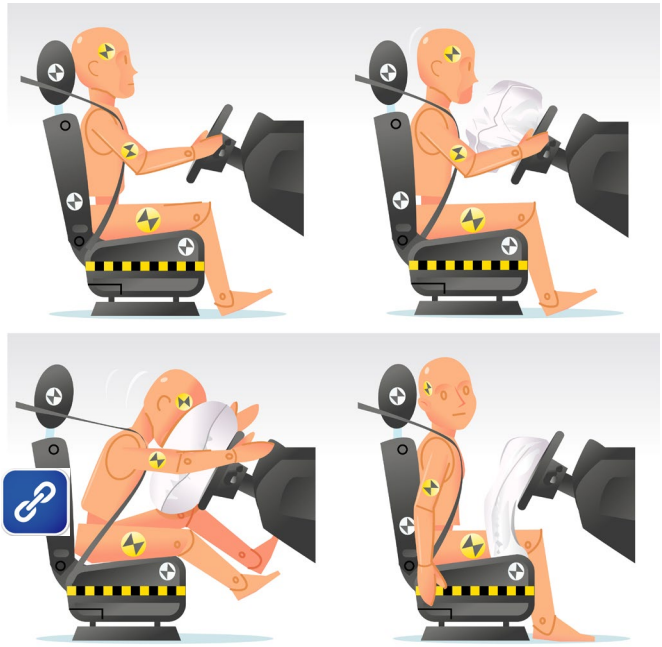
Navigate the webpage to investigate the following questions.

Question 1. From **THE ISSUES** tab, choose any three driver behaviours that are strongly linked to having an impact on young driver safety. For each, explain the key issues and how they are relevant in your community.

Question 2. From the **KEY STATISTICS** tab, choose any three statistics that are relevant in your community. Explain how they might influence your choices as a driver or passenger.

Question 3. Discuss how scientific research can be used to inform policy.

HOW SAFE IS YOUR CAR?



Now that you are familiar with key safety features in cars, you will learn how vehicles are rated. The Australasian New Car Assessment Program developed a safety rating system for all vehicles based on protective devices such as seatbelts, and also on how the car reacts in certain conditions

Click on the link below to find how safe the car you are in the most is (e.g. family car, friends car) Then answer the following questions.

How Safe is Your Car?
www.howsafeisyourcar.com.au

Question 1. The key safety tests are described in the following link and identified in the table below. In your own words, write a brief description for each and provide an example of this situation in real life.

ANCAP
http://howsafeisyourcar.com.au/Rating-Process/What-is-ANCAP/

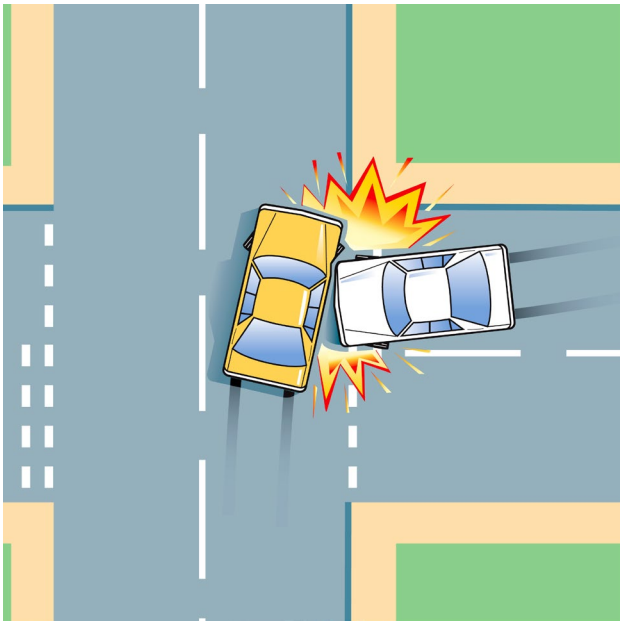
Test	Description of the Test	Example in Real-life
Frontal Offset Test		
Side Impact Test		
Pole Impact Test		
Pedestrian Impact Test		
Whiplash Test		
Sat Assessment		

Question 2. Kinetic energy is the energy of motion. The equation for Kinetic Energy, **KE =1/2mv^2** where ***m*** is the mass of the object and ***v*** is the speed of the object, and the unit

for **KE** is measured in ***Joules*** (1 Joule = 1 kg * m^2/s^2). This equation shows the relationship between energy and speed. Describe how **KE** changes if speed is doubled. Explain how this relates to car safety.

Question 3. For the Side impact test, calculate the Kinetic Energy at impact based on the following formula: KE=1/2mv2. Remember to convert to the correct units.

Question 4. Transferable kinetic energy is the energy of motion from one object to another. For the ***side impact*** scenario, given that energy is neither created or destroyed, what happens to the Kinetic Energy in the collision? Which of Newton's Laws of Motion does this relate?



PRACTICAL ACTIVITY: CRASH TEST CARS

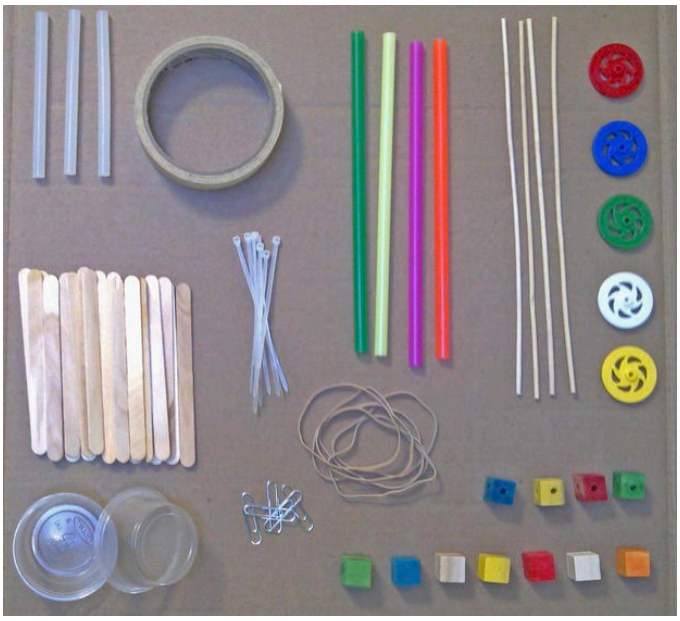
Based on the classic *egg-drop* challenge, this activity looks to keeping "eggs" safe in a moving vehicle. Using the material provided, each group will design a car in such a way to keep an egg intact as it rolls down a ramp and crashes into a wall.

Watch the video below, in your group, gather the materials, and design a car that can withstand an accident and keep your egg intact! Answer the following questions after every group has had a chance to debut their design.

VIDEO **Crash Test Cars** www.youtube.com/watch?v=smYRfuXJd6s

Materials (select from any of these or add as needed):

- Wheels
- Skewers
- Straws
- Craft sticks
- Wood cubes
- Rubber bands
- Plastic or styrofoam cups
- Glue
- Cardboard to protect work surface
- Eggs (raw, plastic, hard boiled)
- Downhill ramp (made from folding tables)



Activity:

- Draw a design of your car, and then build it.
- Set up a ramp, and determine the start line and the length of the run (the finish line should be a wall or similar barrier)
- Prepare to video the activity and begin the trial runs.

Question 1. Which car(s) has the best design (i.e., the egg was the most intact after the crash)? Describe they key features that contributed to the successful design.

Question 2. Compare the key features of your design with those actually found in real cars. Explain the similarities and differences.

Question 3. Identify the control and experimental variables in this activity. Explain whether this activity follows a fair test. Describe how you would design this activity based on an experimental approach in science.

Question 4. Draw a diagram or create a video showing how your design performed in the car crash activity.

CRUMPLE ZONES

View the videos below on **crumple zones** and answer the following questions.

Crumple Zones
www.youtube.com/watch?v=zS_Gk7vjmOg

Side Impact Protection System
www.youtube.com/watch?v=onkNWGfcO8M

Describe three key features in the design of the crumple zone that help reduce personal injury in a car crash, and how science and/or mathematics was used to inform the design.

PRACTICAL ACTIVITY: CRUMPLE ZONES

Materials for each group:

- 1 hard-boiled egg (no cracks)
- Adhesive tape
- 5 plastic or paper drinking straws
- 2 sheets of A4 paper
- 1 metre ruler
- Aluminium foil (30 cm sheet)
- 2 Plastic or styrofoam cups
- Other materials as needed (Note: no parachutes are allowed for this activity as we are simulating a road test).

Challenge 1: Construct a vehicle that will enable you to drop a hard-boiled egg onto a floor from a height of 1 m without cracking the egg.
Challenge 2 (optional): Construct a vehicle that will enable you to drop a hard-boiled egg onto a floor from a height of 2 m without cracking the egg.

ACTIVITY

10. Draw the design of your vehicle.
11. Build the vehicle using the material provided.
12. Prior to the experiment, explain how your vehicle will protect your egg.
13. Prepare to video each of your trials.
14. Put the egg into the vehicle and drop it from the required height. Perform more than one trial as needed.

Question 1. Did your egg survive without being cracked? Explain your results.

Question 2. By what distance did your vehicle crumple when it hit the ground?

Question 3. The speed of the vehicle when it hits the ground can be found using this equation:$v=\sqrt{20h}$, Where ***v*** stands for the speed of the egg in metres per second and ***h*** stands for height in metres that the egg is dropped. How fast is your vehicle travelling when it hits the ground?

Question 4. Draw a diagram or paste a photograph of your vehicle and egg and/or a video of how it performed in the crumple zone activity.

CAREERS

This section features an Interview with Laurie Budd, Research Officer for the Data Analysis team at the Monash University Accident Research Centre, and a research activity to find out more about career possibilities in car safety.

KEY QUESTIONS

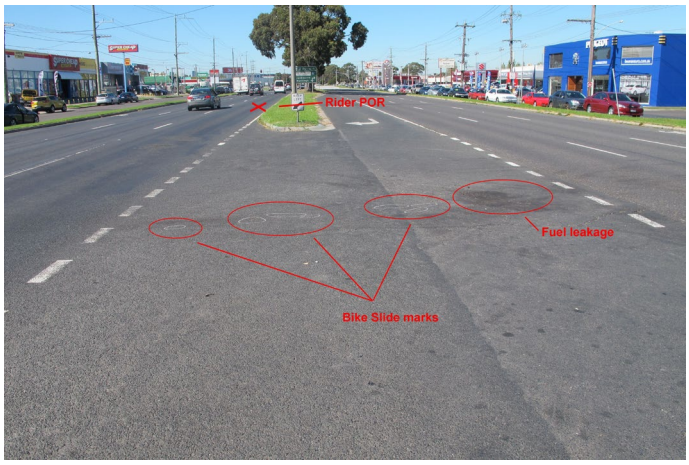
- What is the work of the data analysis team at Monash University Accident Research What are the possible careers in car safety?
- What do car safety professionals do?
- What kind of work do scientists and engineers do that is related to car safety?

A CAREER IN FOCUS

There are diverse career possibilities in the area of car safety. In this interview, we introduce **Laurie Budd**, a research officer for the Data Analysis team at the Monash University Accident Research Centre.

Who do you work for? The Monash Injury Research Institute (MIRI) at the Monash University Accident Research Centre in Melbourne: https://www.monash.edu/muarc/research/research-areas/transport-safety

What does your job involve? I usually take Police-reported crash data and use it to evaluate (with respect to crashes) road safety programs such as red light speed cameras, all road safety cameras, and road improvements. I also use the data to project casualty and serious casualty crash changes that may occur if safety features or designs were mandated in passenger or heavy vehicles or vehicle sectors such as taxis or corporate fleet vehicles. I do work on the data and statistical analysis of other projects within the institute.



Why did you choose to work in this sector? I originally trained and worked as a Chemist (not a Pharmacist) for industry. I have my Dip.Ed. and did some high school teaching as well, in QLD, NSW and Vic. I think there will always be a shortage of Science/Maths teachers so I have always found it easy to get employment in that field -- so the Dip Ed has served me well.

After taking time off to raise children, I decided to give up Chemistry and re-train as a Biostatistician. Although this job fits within the broad area of Public Health, it is not a Biostatistics job. I found it difficult to find work in this area (due to age bias and limited work experience), so had to widen my choice of statistical job applications. Hence I fell into this sector.

What is the most rewarding part of your current job? The area of road safety is really popular in the media so it is great to hear/read in media discussions around statistics that I produced. It is also great to know that policy recommendations from my work are being taken up and that my work does save lives. On the personal side of things it is also very rewarding to work in an environment flexible to the needs of families.

What has been one of your recent achievements? The most recent would be influencing the current push for mandating of autonomous emergency brake systems in new cars.

What is the most challenging part of your current job? Probably there are two: writing the syntax to do the analyses that I want in an efficient way, and keeping the clients happy.

What do you hope to do in the future? I'd like to continue in my the area of data analysis, and now that I have more experience, I am able to use these skills in any field. As statistics is looking at numbers, it really doesn't matter what the numbers are from. It makes you employable in any field. I think that in the future, big data may surpass statistical sampling and analysis of sub-sets in many fields, so I am trying to keep up to date with the new methods being developed to analyse big data to stay relevant.

What are some of the benefits of your job? I spoke about the flexibility. Probably not working in the city is one for me, too. Working on a university campus is also very enjoyable as I have access to concerts and interesting talks, libraries, etc. I get to learn and apply new things all the time, which keeps it sharp and interesting. I also thrive on autonomy.

What training did you have for this job? In high school, I had to do the same six subjects for two years: English, Math (the one with probability and statistics, calculus, algebra and trigonometry), Chemistry, Biology, Physics and Art. I also took all the Science and technology subjects offered.

When I did my Bachelor of Science, I majored in Chemistry and took courses in Biochemistry (second and third year), Physiology (second year) and other 1st year subjects in first year (Microbiology, Zoology, Cell and Tissue Biology, Pure Maths, Computer Science). I did enough variety to meet the requirements for Dip. Ed. entry and followed the B.Sc. with a Dip. Ed. and honours in polymer chemistry.

I chose Computer Science because I knew nothing about computers and felt a need to learn a bit. The programming basics (it was Pascal back then!) I learned set me up for the position I have now. In fact, one of the interview questions was whether I had learned computer programming. They didn't mind what the language was. I also did some FORTRAN too as part of the honours year. Statistics uses high level programming languages in packages such as SAS, SPSS and STATA to do data cleaning and analyses. Programming knowledge, or coding as it is often called now, is adaptable to any statistical package.

The other subjects I studied I chose because I liked them. My favourite at the time was probably Biochemistry, but I took the Chemistry path as their department was better organized and had better options for post-graduate studies.

I did not study statistics in my undergraduate years, but while was working as a Chemist in Sydney I found that it was important for my job so I took some undergraduate statistics in evening classes at Macquarie University. To get my current position, I required additional training in statistics so I did a Masters of Biostatistics from the Biostatistic Collaboration of Australia.

I studied teaching as a back up, as I graduated at a time of recession and there was very high unemployment--much like the youth today are facing. I really love Chemistry and prefer it to both teaching and statistics and would still rather work in that field. I like statistics, and it pays a lot better than Chemistry but tends to be more sedentary job.

Why is mathematics important in your job? Yes, because I do statistical analyses (e.g., mostly Poisson regressions of counts of injuries or crashes but also logistic regressions and some other analyses).

What career advice would you give to school students interested in a similar career? Do what you are interested in and enjoy! The key to a happy work life is in actually enjoying your work. Be aware of future labour market demands and the salaries that go with different careers, so your expectations are realistic.

Question 1: Discuss aspects of Laurie's work that involve science and mathematics.

A CAREER IN CAR SAFETY

For this activity, you will conduct your own research to find out more about the diverse possibilities in the area of car safety.
Select one of the following options below. If possible, conduct an interview of the person you select. Alternatively, you may use the internet or other resources to find your information, including the STELR website.

Option 1: Research the career profile of someone who works in the area of car safety. His or her job can involve any aspect of the industry, such as research, manufacturing, engineering, management, technical service or marketing.

Option 2: Research the career profile of an Australian scientist or engineer whose work focuses on car safety. Their job might involve research and development, accident investigation, design of cars, or so on.

You can find sample career profiles of people on the ATSE STELR website www.stelr.org.au/career-profiles/

Questions to Research: The information you find out should include, if possible, the questions in the left hand column of the following table. Use the right hand columns to keep track of your research information. Room has been left at the bottom for you to include any questions of your own.

Question	Research Information	Reference
Name of the person being profiled		
Name of the organisation the person works for		
Brief description of what the organisation does		
Description of the position the person has in the organisation		
Question	**Research Information**	**Reference**
Subjects they studied at upper secondary school level		

Course(s) taken after leaving secondary school		
Duties involved in their job		
Why they chose this job		
The most enjoyable aspects of the job		
The challenges they face in the job		
How they think this job will change over the next decade		
Salary range of people working in this kind of job		

END OF UNIT PROJECTS

- Safety Campaign
- Design Your Own Prac on Motion

Apply your knowledge to design a safety campaign on driving safe speed limits or design your own practical investigation on motion.

KEY QUESTIONS

- What are the key components in a safety campaign that would lead to behaviour change?
- What are the key elements in an effective investigation on motion?

SAFETY CAMPAIGN

The Victoria Government has successfully convinced drivers to reduce their speed, resulting in a decline in injuries and death. Using at least three different kinds of media (e.g., diagrams, photos, videos, simulations, interviews, drawings, etc.) design a one to two minute campaign around encouraging drivers to observe the speed limit. Begin by reviewing some of the key statistics from the link below, and identifying your key messages and your target audience. You may use videos, images from the internet, or design your own electronic message. Review it with a partner to discuss how they react to your campaign and if it would be effective in changing people's behaviour.

Annual Road Toll in Victoria State
www.tac.vic.gov.au/road-safety/statistics/road-toll-annual

DESIGN YOUR OWN PRAC ON MOTION

Challenge: To design, carry out and report on an investigation on motion.
Decide what you would like to investigate (e.g,. acceleration, braking, stopping distance, safety features, factors affecting stopping distance, etc.). Of this, choose **one** factor you can vary (i.e., a variable). For this example, let's choose "colour". Your hypothesis would then be if the *colour* of the car is darker, the stopping distance will *increase*. Use the following keywords to guide to design of your investigation. Use the **table** below to organize your final report, which should be created using at least three different kinds of media (e.g., written sections, diagrams, photographs, video, Powerpoint slides) and uploaded in the **Final Report Section**.

	Explanation	Your Investigation
Title	A brief and informative title.	
Aim	Describe the purpose of your investigation.	
Hypothesis	Predict what will happen when you change a variable: If ***x*** is changed, then ***y*** will happen	
Equipment	List the materials you need for this investigation.	
Method	Determine one factor you will vary, which factors will remain constant, what you will measure, how you will measure it, your experimental design, and the roles of each of your group members.	
Safety	Describe any safety considerations.	
Results	Record your observations and results using, for example, tables, graphs, diagrams, photographs, videos, etc.	

Discussion	Interpret and summarize your results.	
Conclusion	Draft the conclusion to address: if your results support your hypothesis, any changes to your original method, how you could improve your design and method, additional experiments you might do, how your investigation relates to Newton's Laws of Motion, and how your investigation relates to the real world.	
Bibliography	Include any references you consulted for this investigation.	

GLOSSARY

Term	Meaning

FOR TEACHERS

ANSWER KEY

Survey: 1. B 2. B 3. C 4. C 5. A 6. C 7. D 8. C 9. B 10. A (see www.assessment.aaas.org)
Driving in Australia Poll: ***1.*** *Motor vehicle accidents* ***2.*** *100 km/h and above* ***3.*** *A single vehicle* ***4.*** *75%* ***5.*** *All of the above.*
Safe Driving – Speed: ***A little is a lot. 8****. The more people speed, the great chance of a crash.* ***9.*** *Even low level speeding at 5 km/h over the limit can increase the chance of a crash twice as much. Increases in speed also affect the reaction time of the driver and the braking distance needed to stop.* ***10.*** *The energy involved in a crash follows this equation: $E = ½ mv^2$, where* ***E*** *is the energy,* ***m*** *is the mass of the car, and* ***v*** *is the speed of the car. This means for every increase in speed, the amount of energy increases exponentially.*

Braking and Reaction Times: ***6****. B* ***7****. E* ***8****. the number and configuration of traffic lanes, housing density and type of development, the amount of on-road parking, access to property arrangements, traffic signals, accident patterns that have occurred* ***10****. A* ***11****. B.* ***14****. 24 km/h* ***15****. It would have severe to fatal consequences for the pedestrian or cyclist.* ***16.*** *Regular vehicle – 2 seconds, Towing a trailer – 2 seconds plus an additional second for every 3 meters of trailer, Heavy trailer – 4 seconds, Poor weather conditions – 4 seconds or more.*

Designing for Safety:

Group 2 Question 2: *Crumple Zones - Newton's Second Law of Motion, where Force = mass x acceleration. Crumple zone decrease the acceleration, thereby decreasing the overall force from the crash. Seatbelts - Newton's First Law of Motion, where objects will remain in motion unless a force acts upon it. Thus, in a crash, the seatbelt causes the driver or passenger to decelerate at the same rate as the body of the car. The seatbelt also stretches, thus providing a greater distance for deceleration and thereby reducing the overall force, while also increasing the area over which the force acts. Airbags - Newton's Second Law of Motion, where the airbag increases the distance for deceleration thereby reducing the overall force on the driver or passenger.*

Group 3 Question 1: *Psychological distress, self-harm, risky driving behavior.* **Group 5 Question 2:** *Injury is the single biggest killer of Australian youth; more than all other causes combined; 45 per cent of all young Australian injury deaths are due to road traffic crashes; The injury death rate for Indigenous youth is 5 times greater than for non-Indigenous youth; Of all hospitalisations of young Australians, almost half are drivers involved in a road traffic crash and another quarter are passengers; Young drivers (17 – 25 years) represent one-quarter of all Australian road deaths, but are only 10 – 15% of the licensed driver population; A 17 year old driver with a P1 licence is four times more likely to be involved in a fatal crash than a driver over 26 years;The biggest killer of young drivers is speeding and around 80 per cent of those killed are male; One-third of all speeding drivers and rider in fatal crashes are males aged 17 – 25; 6 per cent are females aged 17 – 25.*

How Safe is your Car? Question 3.

Mass = 950 kg

Velocity = 50 km/h

50km x 1000/ 3600 = 50,000/3600 = 13.9m/s

KE = ½ (950)(13.9)^2

= ½ (950)(2500)

= 91774 Joules or 92 KJ of Energy

How Safe is your Car? Question 4. *The energy is transferred to the objects in the collision, including the people involved, and transformed as heat (i.e., thermal energy) and sound. This scenario is related to Newton's First and Second Laws of Motion, where the car remains in a certain speed and direction, until another force acts upon it, and the extent of the force is influenced by the objects mass and accleration, following the equation,* ***F=ma****. It also involves Newton's Third Law as both cars apply forces to each other.*

LINKS TO AUSTRALIAN CURRICULUM

YEAR 10

Physical Sciences: Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190).

- recognising that the Law of Conservation of Energy explains that total energy is maintained in energy transfer and transformation
- recognising that in energy transfer and transformation, a variety of processes can occur, so that the usable energy is reduced and the system is not 100% efficient
- comparing energy changes in interactions such as car crashes, pendulums, lifting and dropping
- using models to describe how energy is transferred and transformed within systems

The motion of objects can be described and predicted using the laws of physics (ACSU229)

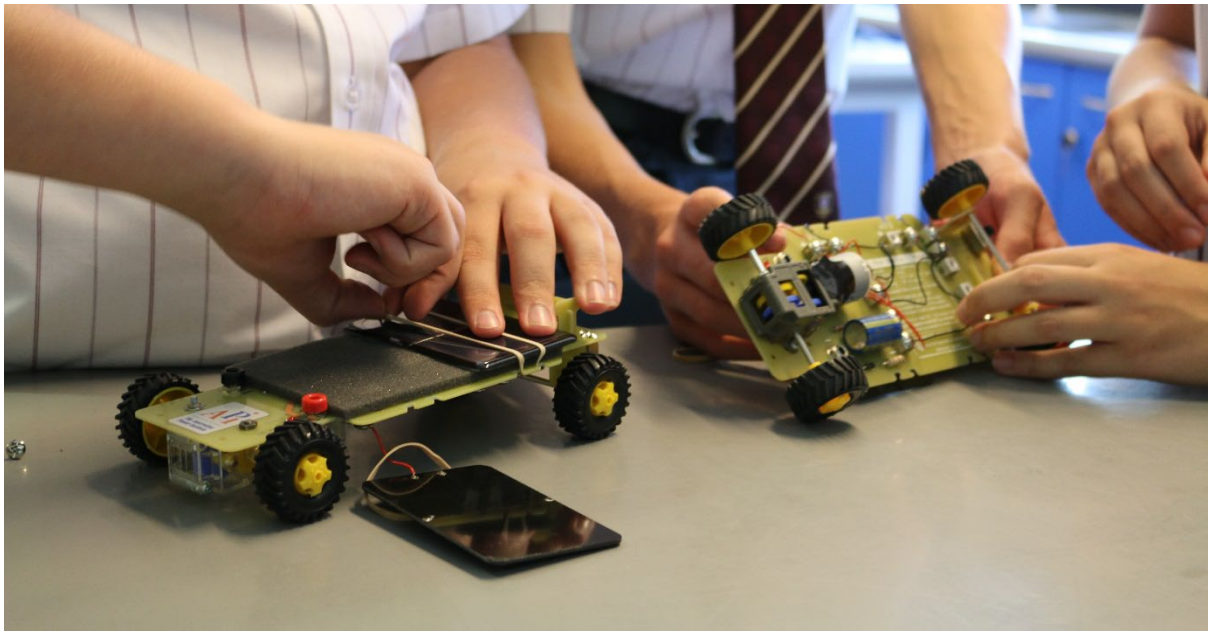
- gathering data to analyse everyday motions produced by forces, such as measurements of distance and time, speed, force, mass and acceleration
- recognising that a stationary object, or a moving object with constant motion, has balanced forces acting on it
- using Newton's Second Law to predict how a force affects the movement of an object
- recognising and applying Newton's Third Law to describe the effect of interactions between two objects

Science as a Human Endeavour: Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191); Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192); People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE194); Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities (ACSHE195); The values and needs of contemporary society can influence the focus of scientific research (ACSHE230).

Science Inquiry Skills: Formulate questions or hypotheses that can be investigated scientifically (ACSIS198); Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199); Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS200); Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS203); Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204); Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS205); Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems (ACSIS206); Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208).

GENERAL CAPABILITIES

The general capabilities addressed throughout this unit include literacy, numeracy, information and communication technology (ICT) capability, critical and creative thinking, personal and social capability, ethical understanding and intercultural understanding.



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