THE MATHEMATICAL ASSOCIATION OF VICTORIA

MATHEMATICS IN CAREERS

Investigation - How safe is a vehicle?

Key career focus for this investigation: Engineer and design
Related career areas: Auto mechanics

THINKING ABOUT CAREERS

- Brainstorm information technology professions you can think of where maths is frequently used.
  Use https://joboutlook.gov.au to explore engineering related career pathways that include use of mathematics. *How is maths used in these scenarios? What maths is used in these scenarios?*
- This task focuses on how maths is used in engineering through investigating car safety.
- Explore careers such as mechanical engineering to discover how maths is used in these. For a more extensive list of careers related to this task, with a maths / science focus, refer to the table at the end of the task and explore the maths used in these jobs.

MATHEMATICS IN EVERYDAY LIFE AND CAREERS

Mathematical focus for this investigation

- Represent worded problem with simple linear equations and solve them to answer questions.
- Solving simple equations arising from formulas
- Calculate speed, time, and distance
- Comparing and analysing data to draw conclusions

A formula is a mathematical relationship expressed in variables. Many people use formulas every day to calculate unknown values. Formulas can be used to calculate or convert different values such as Celsius degrees to Fahrenheit or currency exchange rates.

Brainstorm and share scenarios where this mathematics may be used in engineering to solve problems.

MATHEMATICAL INVESTIGATION
HOW SAFE IS A VEHICLE?

INVESTIGATION BACKGROUND

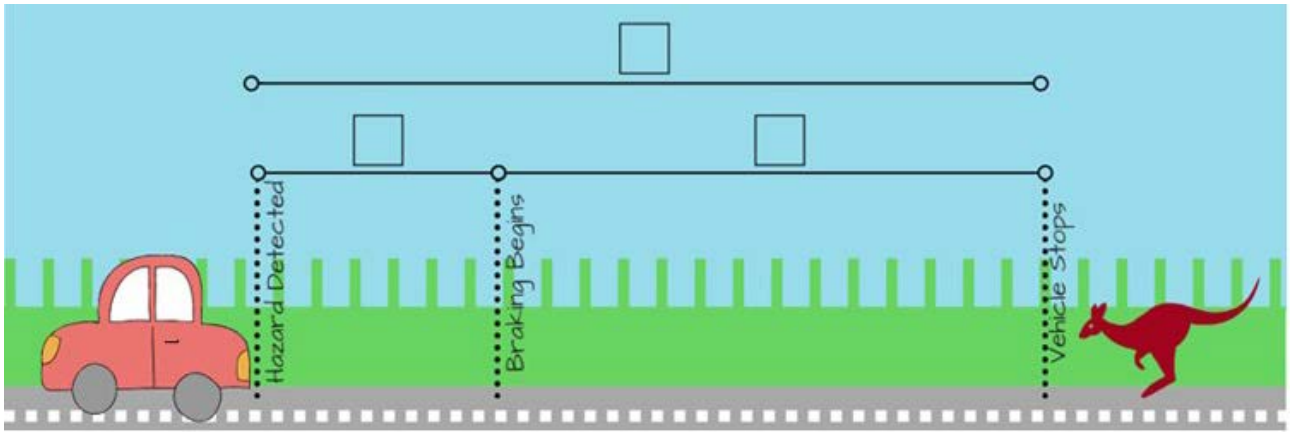
The EuroNCAP is a rating system to help customers understand how safe their vehicles are. The vehicle is rated out of five stars based on four key categories – Adult Occupant, Child Occupant, Safety Assist and Vulnerable Road Users (VRU).

YOUR INVESTIGATION

As Future Ford Driver Assist Technologies (DAT) engineers, your task is to compare 3 vehicles and rank them in terms of their safety for vulnerable road users. You are then to provide a recommendation of what you would do to improve the performance of the vehicle in terms of VRU protection.

PART 1

Label the missing distances on the below diagram:



The missing variables are:
R = Reaction distance in meters
B = Vehicle Braking distance in meters
T = Total stopping distance in meters

PART 2: HOW SAFE IS YOUR VEHICLE?

Refer to Table 1 below for vehicle information

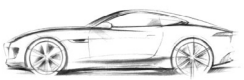
Vehicle 1	Vehicle 2	Vehicle 3
		
Vehicle style: Everyday hatchback Vehicle mass: 1,800 kg Technology: Level 1 DAT	Vehicle style: Sports car Vehicle mass: 2,000 kg Technology: None	Vehicle style: 4 x 4 off-roader Vehicle mass: 2,200 kg Technology: Level 2 DAT

Table 1. Vehicle information.

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For the two tasks below, you will also need to refer to the appendices in the reference section (See appendix 1 for the scenarios and appendix 2 for the formula sheet).

TASK 1

- Predict the success of each vehicle and use calculations to prove your hypothesis (fill in Table 2). To help with the calculations you will need to refer to the formula in the reference section.

	Scenario 1 40km/h	Scenario 2 60km/h	Scenario 3 80km/h
Everyday hatchback Tech: DAT Level 1 			
Sports car Tech: None 			
4 x 4 Off-roader Tech: DAT Level 2 			

Table 2. Comparison table of vehicles and scenarios prediction.

TASK 2

- Calculate whether each vehicle will stop and safely avoid a collision in each scenario (fill in Table 3).

	Scenario 1 40km/h	Scenario 2 60km/h	Scenario 3 80km/h
Everyday hatchback Tech: DAT Level 1 			
Sports car Tech: None 			
4 x 4 Off-roader Tech: DAT Level 2 			

Table 3.

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PART 3: GROUP DISCUSSION

- Why did some vehicles avoid a collision, and some not?
- Which vehicle is the safest, and why?

PART 4: WHAT COULD YOU CHANGE?

- Provide options to improve the performance of each vehicle to avoid a collision.
- What improvement/safety factor you are trying to achieve? (e.g just in time stop or time/distance before impact; Does your requirement depend on speed?)
- Ensure to define your independent and dependant variables (i.e. what is changing).

	Vehicle 1	Vehicle 2	Vehicle 3
			
Starting assumptions	Vehicle style: Everyday hatchback Vehicle mass: 1,800 kg Technology: Level 1 DAT	Vehicle style: Sports car Vehicle mass: 2,000 kg Technology: None	Vehicle style: 4 x 4 off-roader Vehicle mass: 2,200 kg Technology: Level 2 DAT
Option 1			
Option 2			
Option 3			

Table 4: Vehicle improvements.

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CAREERS RELATED TO THIS INVESTIGATION

GENERAL ENGINEERING

Career description	Key skills required	More information
Engineers are scientists, inventors, designers, builders, and great thinkers. Engineering covers: • Mechanics and the construction of tools and machines of all sizes • The creation of cars, trains, ships, boats, aircraft and all other vehicles • The design and production of chemical compounds • Operations of businesses and cities • Entertainment, industry, construction, transport, healthcare, and defence.	• The scientific method • Social, cultural, and economic awareness • Mathematics • Biology, chemistry, physics, and other areas of science • Creativity • Teamwork	www.engineersaustralia.org.au/For-Students-And-Educators/Engineering-Careers/What-Is-Engineering www.glassdoor.com/blog/guide/types-of-engineering-jobs/

MECHANICAL ENGINEERING

Career description	Key skills required	More information
Mechanical engineers design, develop, build, and test. They analyse their work using the principles of motion, energy, and force — ensuring that designs function safely, efficiently, and reliably, all at a competitive cost.	• Mathematics and physics • Collaboration • Good problem-solving skills • Creativity • Computer software skills	www.glassdoor.com/blog/guide/mechanical-engineering-skills/ www.mtu.edu/mechanical/engineering/

MECHANIC

Career description	Key skills required	More information
A mechanic performs maintenance, diagnostic testing, repairs, and inspections of small trucks and cars. Careers include: • Auto mechanic • Vehicle inspector • Auto body repair technician • Auto electrician	• Technical aptitude • Problem solving skills • Good work ethic • Customer service skills • Auto mechanic knowledge • Diagnostic and mechanical skills	https://careerhq.com.au/careers-database/job_details/270/light_vehicle_mechanic

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CAREERS RELATED TO THIS INVESTIGATION

DESIGN

Career description	Key skills required	More information
An automotive designer drafts layouts of automobile components, assemblies and systems using sketches, models, and prototypes. They determine factors that may affect design proposals by using previous car models, understanding manufacturing limitations and collaborating with automotive engineers.	• Creativity • Competent software skills • Good math and physics skills • Interpersonal skills • Strong drawing and sculpting skills	www.theartcareerproject.com/become/automotive-designer/

OTHER RELATED CAREERS TO EXPLORE

https://careerswithstem.com.au/future-tech-jobs-in-australia/

- Electrical engineering
- Civil engineering
- Auto engineering

For an overview of engineering being a priority industry and sector, visit:
https://djpr.vic.gov.au/priority-industries-sectors/professional-services

MATHEMATICAL INVESTIGATION
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CAREERS ACTIVITIES

THE 10 BEST RATED JOBS OF 2021			
Rank	Career	Median salary	Projected growth
1	Data Scientist	$98 230	33%
2	Genetic Counsellor	$85 700	21%
3	Statistician	$92 270	35%
4	Medical Services Manager	$104 280	32%
5	Mathematician	$110 860	33%
6	University Professor	$80 790	9%
7	Operations Research Analyst	$86 200	25%
8	Information Security Analyst	$99 730	31%
9	Actuary	$111 030	18%
10	Software Engineer	$110 140	22%

Data from Careercast.com.

Select one of the careers, from either of the tables above, that interests you and find out:

- What are the tasks involved in this career? What may a typical day look like?
- What level of education or qualifications do you need to do this career?
- What are some other similar or related careers?
- What mathematics skills would be used in this career?
- Where does the career you have selected, to investigate, rank according to careercast.com?
- How many people in Australia are currently employed in this career (or field)?

INDUSTRY PARTNER

This project was produced collaboratively between The Mathematical Association of Victoria (MAV) and FORD

Ford Motor Company of Australia Pty Limited is a subsidiary of Ford Motor Company, founded in Geelong, Victoria, in 1925. The company designs, engineers, and imports award-winning and best-selling cars, SUVs and trucks, including Puma, Escape, Everest, Focus, Fiesta ST, Ranger, Ranger Raptor, Mustang, Mustang Mach 1 and Transit commercial vans. Australia is a key product development hub for Ford, with the company investing more than $2.5 billion in research and development in Australia between 2016-20. More than $500 million is expected to be invested in our Australian operations in 2021.

Ford is Australia's largest automotive employer, with a team of over 2,500 engineers, designers, technical, automotive and other specialists working at four locations across Victoria. Australia-based engineers and designers lead the development of award-winning vehicles sold in more than 180 markets globally, such as the Ford Ranger pickup and Ford Everest SUV.

www.ford.com.au
www.ford.com.au/about-ford/careers

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FURTHER CAREER REFERENCES

Australian Jobs Report 2021

www.nationalskillscommission.gov.au/australian-jobs-report
An overview of trends in the Australian labour market to support job seekers and employment service providers, career advisers, those considering future training and people interested in labour market issues.

Business Victoria Future Industries

https://business.vic.gov.au/grants-and-programs/future-industries
Future Industries is about supporting investment in high-growth industries through industry excellence and development projects, including establishing collaborative networks and building supply chain readiness capabilities.

Career Education

www.education.vic.gov.au/school/teachers/teachingresources/careers/Pages/default.aspx
Career Education teaching resources to help teach students to make informed career decisions and equip themselves for the world of work.

CEAV Online Learning Resources

https://ceav.vic.edu.au/media/250615/careers-in-the-construction-technology-industries-student-resource.pdf
Designed to enable students to attend a virtual Industry Immersion Experience, these online resources will help students discover more about Victoria's priority growth industries and give them the opportunity to reflect on their skills, interests and undertake career planning and exploration.

Jobs Victoria

www.jobs.vic.gov.au

JobOutlook

www.joboutlook.gov.au
Relevant and current labour market trends and career information.

MyFuture

www.myfuture.edu.au
A database of over 600 careers.

National Careers Institute

www.dese.gov.au/nci
The National Careers Institute (NCI) ensures Australians have access to reliable and accurate careers information, resources, and support.

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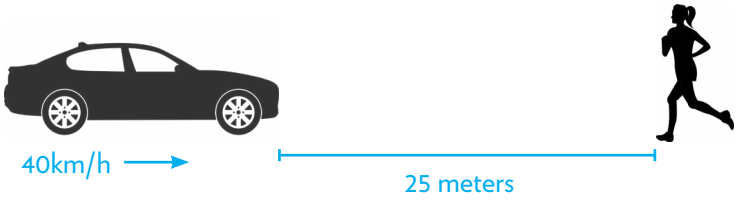
REFERENCE MATERIAL

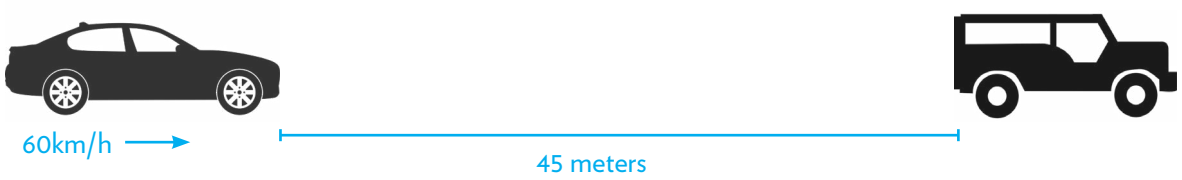
Scenario 1

You are driving 40km/h down a busy street. There's a school nearby and there are pedestrians everywhere, school must have just finished. A 12 year old girl runs onto the road just 25 meters in front of you.



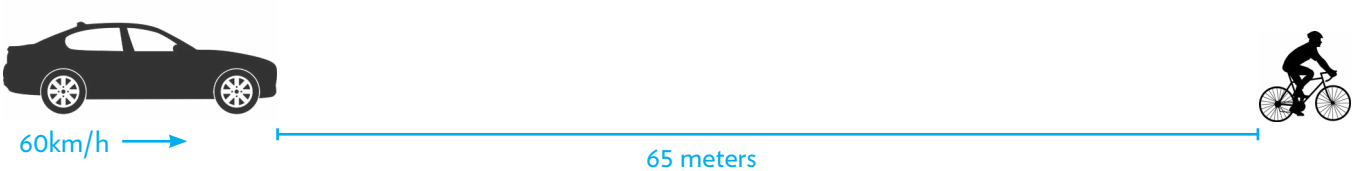
Scenario 2

You're going 60km/h in your when a car stops suddenly in front of you. It's an older car, and their brake lights don't work. By the time you notice, the vehicle is stationary, 45 menters in front of you.



Scenario 3

You're on a highway with a bike lane travelling at 80km/h. The bike lane finishes suddenly, and the cyclist swerves across into your land just 65 meters ahead, stopping abruptly to avoid hitting another vehicle.



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REFERENCE MATERIAL

Formula sheet

HUMAN/MACHINE REACTION TIMES		
Human	DAT Level 1	DAT Level 2
1.5 seconds	1.0 seconds	0.8 seconds

BRAKING DISTANCES				
Mass	**40km/h**	**60km/h**	**80km/h**	**100km/h**
1800 kg	10m	20m	35m	55m
2000 kg	11m	22m	39m	64m
2200 kg	12m	24m	50m	78m

EQUATIONS	
$R = s \times t$	$T = R + B$
s = speed in meters/sec	
t = reaction time in seconds	
R = reaction distance in metres	
B = vehicle braking distance in metres	
T = total stopping distance in metres	

Images on pages 3, 9 and 10 by Pixabay.