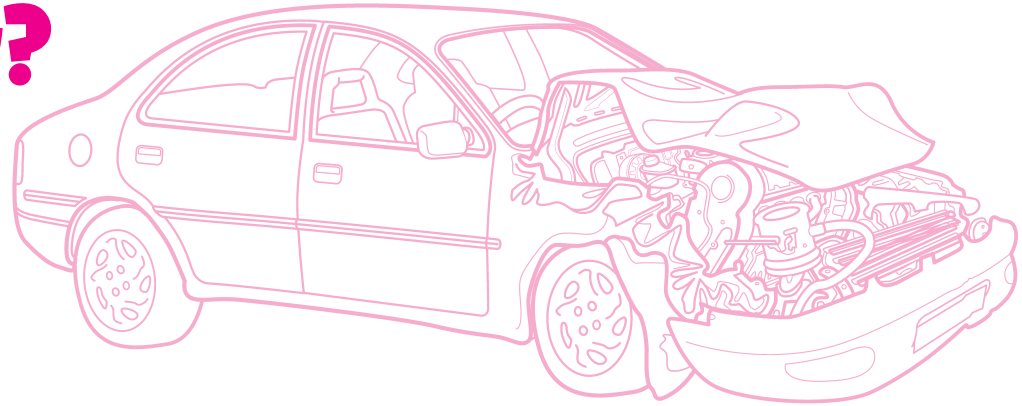
2 Car Crashes

Did you know?

- 95% of road crashes are caused or partly caused by human error
- Being on a mobile phone can slow a driver's reaction time by an extra 50%.



Discussion Points

Car crashes are complicated events. Most are caused by a combination of:

- **human behaviour**
- **the environment (including road, time of day and weather)**
- **the vehicle.**

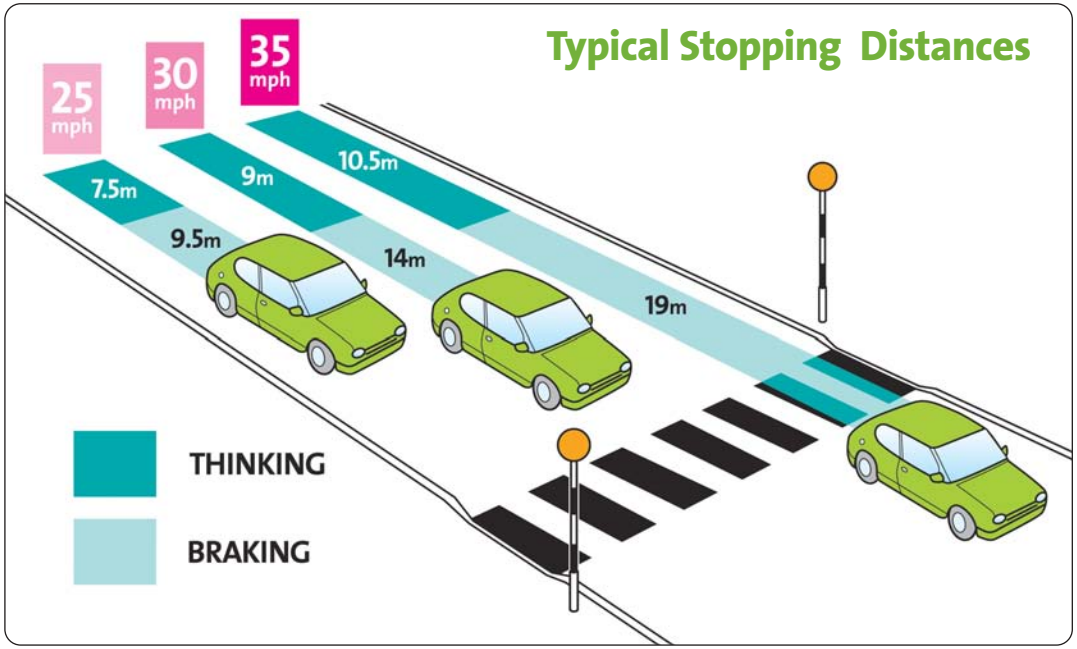
Each of these has an influence before, during and after a crash. This can be illustrated in a grid, known as a Haddon Matrix *(right)*.

Draw your own Haddon Matrix. For each box in the grid, list things that influence the likelihood of crashes occurring and how severe they will be.

In groups/pairs, pick an example of each factor (Human, Environment, Vehicle) and decide what influence it could have 'Before the Crash', 'During the Crash' and 'After the Crash'. Then consider what measures could be taken to reduce the likelihood of the factors you've chosen causing an accident, then present your conclusions to the rest of the class or group.

	Before the Crash	During the Crash	After the Crash
Human Factors	The driver is tired which means he is much more likely to crash.	The driver has fallen asleep, and so does not brake or swerve. This makes the crash very severe.	One of the occupants was elderly and less likely to recover from his injuries.
Environment Factors	It was a motorway in the early hours of the morning. The road surface was wet.	The crash was high speed as it was on a motorway and so more severe. But the crash barrier stopped the car crossing onto the other side of the road.	As the crash occurred on a motorway at night when there was little traffic, the emergency services were able to reach the scene quickly.
Vehicle Factors	The tyres were close to the legal minimum tread depth. This also made the crash more likely.	A passenger in the rear was not wearing his seat belt, and was thrown forward into the driver, causing fatal injuries to both.	The car's occupant compartment withstood the impact quite well and so the emergency services were able to extricate the casualties quickly.

The stopping distance of a vehicle is made up of the thinking distance and the braking distance as shown in the picture.

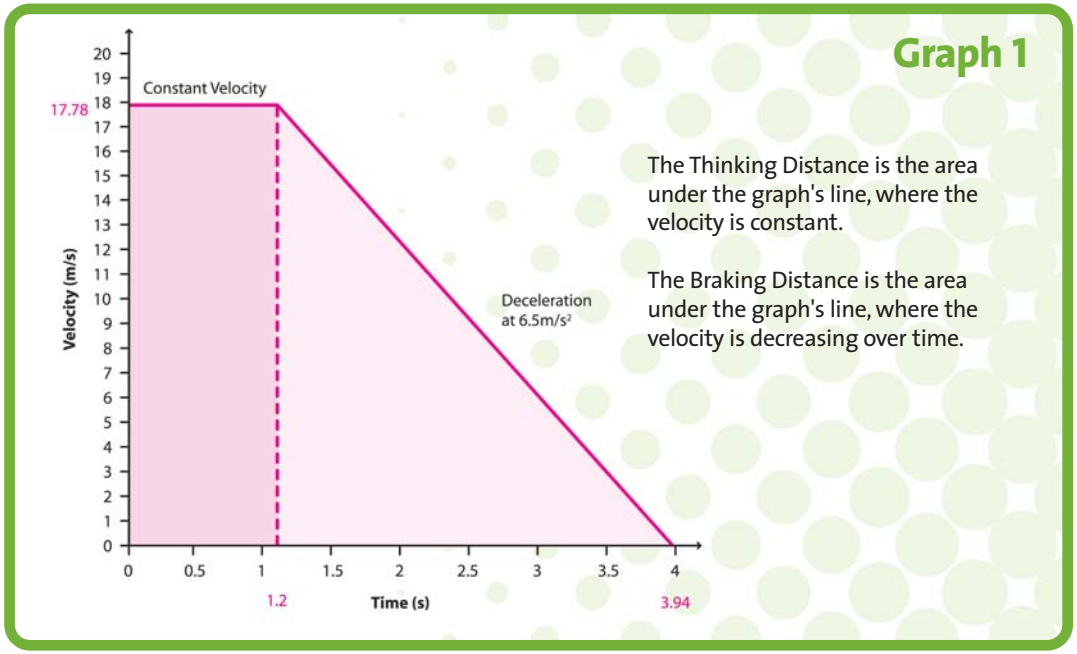


Activities

1. **Imagine a driver is travelling down an inner city road. The driver had been drinking the night before and still has alcohol in his body. The speed limit is 30mph but the driver is exceeding it and is travelling at 40mph (17.78 metres per second). A 15-year old is texting on his phone, and steps out into the road without spotting the car. The car is 30 metres away. It takes the driver 1.2 seconds to spot him and apply the brakes (the thinking distance). After applying the brakes, the car decelerates at 6.5m/s² before coming to a stop (the braking distance).**

a. In the 1.2 seconds that it takes the driver to see the 15-year old and brake, how far does the car travel? What distance does this leave between the car and the 15-year old?

b. Using graph paper, draw the velocity-time graph shown to the right. The flat line indicates the thinking time, before the driver starts to brake. The sloping line is the deceleration of the car as it slows down.



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c. Using the graph that you have drawn, work out how far the car travels during braking before it comes to a stop.

d. Add the thinking distance and the braking distance together to get the driver's overall stopping distance.

Did the driver hit the 15-year old?

e. The equation $v^2 = u^2 + 2as$ can be used to calculate the speed of a vehicle at a point during its deceleration, where:

v is the speed at which the car hits the pedestrian

u is the speed that the car is travelling just before it starts to brake

a is the acceleration of the car

s is the distance between the car and the 15 year old, at the point the car starts to brake (see your answer to part 'a')

Using the equation, calculate the speed that the car is travelling when it hits the 15 year old.

Knowing the chances of survival at different speeds below, roughly what is the 15 year old's chance of being killed?

- Hit by a car at 30 mph, 2 out of 10 pedestrians will be killed
- Hit by a car at 35 mph, 5 out of 10 pedestrians will be killed
- Hit by a car at 40 mph, 9 out of 10 pedestrians will be killed

f. Use your velocity-time graph and your answer from part 'e' to find out how long it takes the car to reach the 15 year old.

Activities

2. Imagine a similar scenario, this time the driver is obeying the posted speed limit and is travelling at 30mph (13.41 metres per second). The driver had not been drinking and is concentrating on the road.

The 15-year old steps out 30 metres in front of the car. This time it takes the driver 0.7 seconds to spot him and apply the brakes. The car decelerates at 6.5m/s² after the driver applies the brakes, until it comes to rest.

a. What is the thinking distance?

b. Plot another velocity-time graph, representing the second scenario using the new numbers from above. What is the braking distance this time?

c. Adding the thinking distance to the braking distance. What is the overall stopping distance?

Did the driver hit the 15 year old?

d. For the stopping distances in the two scenarios, work out the distances in car lengths. An average car length is 4 metres, and so for example, a thinking distance of 7.5 metres is roughly 2 car lengths.

To illustrate the two scenarios, measure out the distances using a measuring wheel in the playground. Get someone to stand at a point and measure out the two stopping distances in both of the activities, getting another pupil to stand where the vehicle stops. An unimpaired driver will typically stop in 53 metres from 50mph. Measure this distance out and compare it with the answers from activity 1 and 2.

Discussion Points

Recent road safety campaigns have highlighted the effects of a car hitting a pedestrian at different speeds. Look at the advert called 'It's 30 for a reason' on **www.thinkroadsafety.gov.uk**. This illustrates the 'life and death' difference of someone being hit by a car which was travelling between 40mph and 30mph.

Take it further...

Find out how tyres are manufactured.

Braking distances can increase as the tread of tyres wears down. Using the tyre safety fact sheets at: **www.rospa.com/roadsafety/advice/motorvehicles**, find out the difference in stopping distances in the wet for a car with new tyres and one with tyres with a 1.6mm tread depth. If the two scenarios above took place on a wet road and the tyres of the car had 1.6mm tread depth, what would have been the stopping distances? Is the outcome of the accident the same in each case?

Did you know?

The minimum legal requirement for a car tyre's tread is 1.6mm.

Discussion Points

In recent years, new types of electronic braking systems, such as ABS, have been developed. Research what systems are available and how they work. In the two scenarios, imagine the car had each of the systems, and describe how it might have changed the outcome of the accident. What ways do you think that drivers can be encouraged to buy vehicles with these electronic braking systems?

Did you know?

- People in cars which have a high EuroNCAP star rating are 30% less likely to suffer a serious or fatal injury in a crash than people in cars with a low EuroNCAP star rating. But the benefit is wasted if seat belts are not used.

Activities

3. **Kinetic Energy is the energy produced by the movement of a body. An increase in speed means an increase in Kinetic Energy. Kinetic Energy is measured in Joules (J)**

   When a car crashes at higher speed, there is more energy in the collision. This makes it more likely for an occupant to be injured.

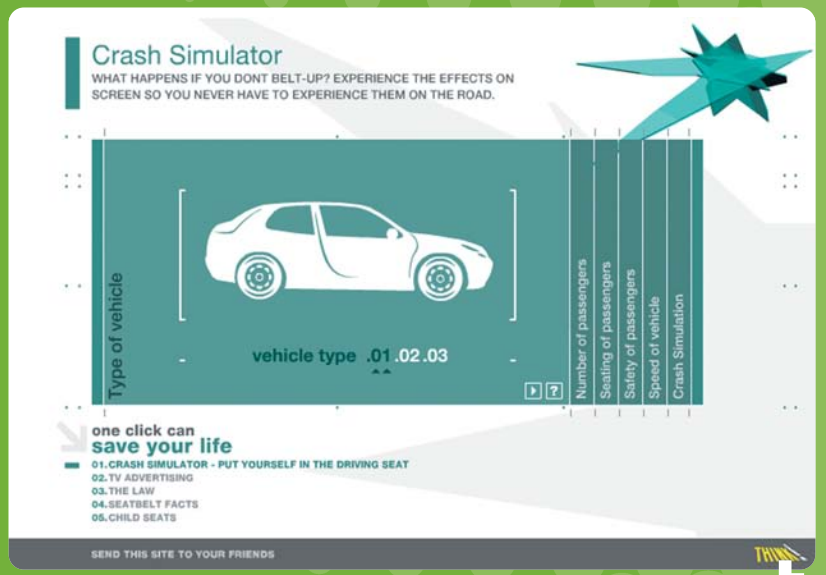
   Kinetic Energy = $^1/_2$ (mass) (velocity)^2

a. Assuming that the mass of a vehicle and its occupant is 1000kg. Calculate the Kinetic Energy of the vehicle when it is travelling at 20 mph and 40 mph. The speed has doubled, by how much has the amount of Kinetic Energy increased?

b. Work out the Kinetic Energy of the vehicle if it is travelling at 10 mph, 15mph, and 30mph.

c. Plot the points on a graph, with Kinetic Energy on the 'y' axis and the speed on the 'x' axis. Draw a line through them. What is the shape of the graph?

d. Using the crash simulator on **www.thinkseatbelts.com** (you will need Macromedia Flash Player on your computer), look at the outcomes of the collisions at different speeds, and with the car occupants wearing and not wearing seatbelts. Write a one-page sheet of advice to the public based on your findings.



e. Look at the advert called 'Backwards' on the same website. What forces are acting on the driver or one of the passengers during the crash? Would there be any difference between the forces on a belted and unbelted occupant?

Take it further...

Some vehicles now have sensors to detect other vehicles and road users. In the future, cars will monitor the actions of their driver and what is happening outside the car and, if the driver does not take appropriate action (for example, braking because the vehicle in front has slowed down) the car's computer may intervene and perform the required action for the driver (for example, by applying the brakes for the driver).

Activities Organise a class debate

Have one or two people to speak for and against the motion "This house believes that cars should drive themselves". Think about the advantages (for example, the car's computer reacts quicker than the driver) and disadvantages (the driver may not concentrate) of taking the control away from the driver. What is best for society?

Activities Pedestrian Protection

Which is more important, the protection of the occupant or the protection of pedestrians? Using '**Road Casualties Great Britain 2004**', identify pedestrian casualty statistics for the last few years. Which age group is more at risk? Why do you think this is? Produce a short fact sheet highlighting the main facts and figures about pedestrian casualties.

How would you test the front of a vehicle to assess the level of injury it is likely to cause if it hit a pedestrian? Design an experiment to test the safety of a vehicle front. What areas of the vehicle would you test? What data would you collect? How would you make the experiment repeatable? Make sure you cover at least the following headings; aim, method, and procedure. Use diagrams if you think they will help. RoSPA's Pedestrian Protection fact sheets and the website **www.euroncap.com** will give you ideas for this activity.

What do you think?

Find out about the forthcoming EU Directive on pedestrian protection. Write a summary about your findings. How does this compare with your experiment? Why do you think the legislation was defined at European level rather than in individual countries? Find out how European legislation is decided. What is the difference between a regulation and a directive? What are the advantages and disadvantages of each?

Activities

After the crash

Write down all the costs to society caused by road crashes, such as damage to vehicles and the road. Are these physical costs? Is lost time at work a cost? What about emotional costs? Write an article for a newspaper using the costs and issues you have identified to justify the need to invest public money in measures to prevent road crashes.

Discussion Points

How does improving the safety of a vehicle contribute towards sustainability? Write an article for your local newspaper based on the Society of Motor Manufacturers and Traders' 6th annual sustainability report, '**Towards Sustainability**'.

Useful Links and Publications

Useful Links

Department for Transport
www.dft.gov.uk
(Click on 'Road Safety' and/or 'Roads and Vehicles' and then 'Vehicles')
www.thinkroadsafety.gov.uk

European New Car Assessment Programme
www.euroncap.com/

Transport Research Laboratory
www.trl.co.uk

RoSPA
www.rospa.com

Tyre Manufacturers
www.driveradviser.com/

www.bridgestone-eu.com
www.conti-online.co.uk
www.dunloptyres.co.uk
www.goodyear.co.uk
www.michelin.co.uk
www.pirelli.co.uk

Institute of Transport Studies
www.its.leeds.ac.uk/index.htm

Thatcham, the Motor Insurance Repair Research Centre
www.thatcham.org/

Vehicle Safety Research Centre
www.lboro.ac.uk/research/esri/vsrc/index-std.htm

Useful Publications

(If the direct links are not working, follow the instructions in brackets to find the publications)

Road Casualties Great Britain 2004
(Go to www.dft.gov.uk, click on 'Transport Statistics', then 'Route to Data', then 'Transport Accidents and Casualties' and then 'Road Casualties Great Britain')

The Highway Code
www.highwaycode.gov.uk

Highways Economic Note 1 (HEN1)
(Go to www.dft.gov.uk, click on 'Road Safety', then 'Economic Assessment', then 'Highways Economics Notes No. 1: 2003')

Speed: Know Your Limits
(Go to www.thinkroadsafety.gov.uk, click on Road Safety Campaigns, then 'Slow Down', then 'Printed Media' and then 'Speed: Know Your Limits')

RoSPA Vehicle Safety Factsheets
(Go to www.rospa.com, click on 'Road', then 'Motor Vehicle Safety')

House of Commons Transport Committee
'Cars of the Future' Report
'Cars of the Future' Evidence
(Go to www.parliament.uk, click on 'Committees' on the left, then 'Transport Committee' (use the A-Z links), then 'Reports and Publications' on the left, then select the 2003-04 session. Scroll down to 'Cars of the Future')

'Towards Sustainability'
Society of Motor Manufacturers and Traders' 6th annual sustainability report,
Society of Motor Manufacturers and Traders – 6th annual sustainability report
(Go to www.smmt.co.uk, click on 'Publications', on the right scroll down to and click on 'ENVIRONMENT', then 'Towards Sustainability Sixth Annual Report')

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