

Your teacher may watch to see if you can...

- follow instructions carefully.

## Aim

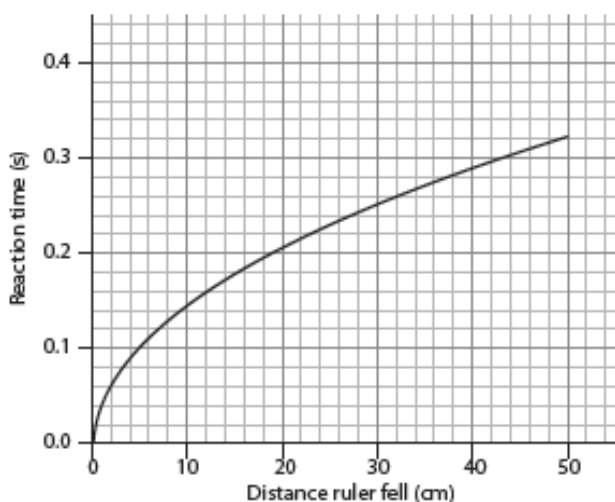
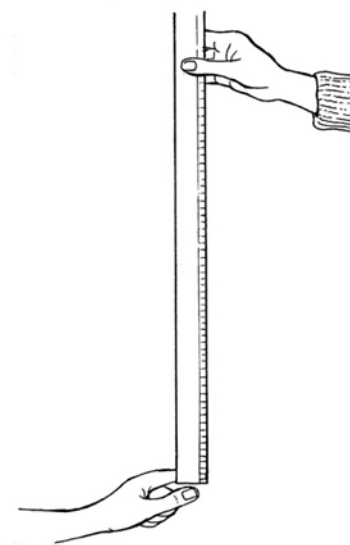
To compare two methods of measuring human **reaction time**.

## Method 1 – Using a ruler

- Take a metre ruler and get your partner to hold it so that 0 cm is nearest the floor.
- Place your thumb and first finger just underneath the end of the ruler.
- As soon as your partner lets go, catch the ruler using your thumb and first finger.
- Read the distance that the ruler fell (use the number just above the top side of your thumb).
- Do this three times for practice.
- Do this three more times and record your results in a table. Use the graph below to work out your reaction times.

### Apparatus

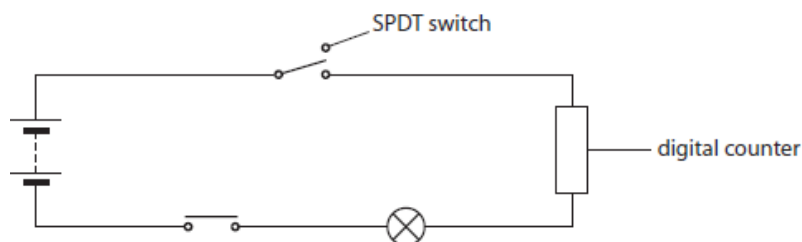
- metre ruler



- Now calculate your mean reaction time for the three tries.

## Method 2 – Using a circuit

A Set up your circuit like this.



### Apparatus

- push button switch
- single pole double throw (SPDT) switch
- power pack
- digital counter
- connecting wires
- bulb and holder

- B The person whose **reaction times** are being tested should hold down the push-button switch.
- C The other person should hide the SPDT switch so that the person being tested cannot see the switch.
- D The tester closes the SPDT switch to light the bulb. As soon as the person being tested sees the bulb light, he or she should stop pushing on the push-button switch.
- E Read the time off the counter. Do this three times for practice.
- F Do it three more times, recording your results in your table.
- G Work out the mean reaction time for your three attempts.

## Recording your results

1 Draw a table like this for your results.

	Method 1		Method 2
	Distance (cm)	Reaction time (s)	Reaction time (s)
1st go			
2nd go			
3rd go			
Mean			

## Considering your results

2 What are your reaction times measured by the two different methods?

## Evaluation

- 3 Which method was the simpler? Try to give a reason.
- 4 What variables did you keep the same in each experiment?
- 5 a Which set of results do you think was the more accurate?  
b Why do you think this?
- 6 a Which method produced the more reliable evidence?  
b How do you know this?
- 7 a What results would you predict if you did these tests with someone before and after they drank alcohol?  
b Explain your predictions.

**S1** List the factors that affect **stopping distance**. State whether each factor affects the **thinking distance** or the **braking distance**, and how they affect this distance.

- 1 Complete the sentences to show how different factors affect the stopping distance of a car. Choose words from the box.

braking	thinking	longer	shorter
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- a Stopping distance is made up of a \_\_\_\_\_ distance and a \_\_\_\_\_ distance.
- b Mass: the greater the mass of a vehicle the \_\_\_\_\_ the \_\_\_\_\_ distance.
- c Speed: the greater the speed, the greater the \_\_\_\_\_ and the \_\_\_\_\_ distances.
- d **Reaction time:** the shorter the driver's reaction time the \_\_\_\_\_ the \_\_\_\_\_ distance.
- e If the brakes are worn the \_\_\_\_\_ distance will be \_\_\_\_\_.
- f If the road is slippery the \_\_\_\_\_ distance will be \_\_\_\_\_.
- g If there is a lot of friction between the tyres and the road the \_\_\_\_\_ distance will be \_\_\_\_\_.

- 2 Complete these sentences about reaction times using words from the box. You can use each word once, more than once or not at all.

0.001 seconds	0.25 seconds	2 seconds	alcohol	brake	coffee
decreased	fast	increased	distracted	longer	road
	slow	<b>stimulus</b>	stopping	thinking	time

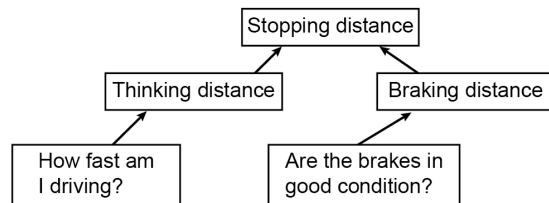
- a A person's reaction \_\_\_\_\_ is the time it takes them to react to a \_\_\_\_\_. For a driver, the \_\_\_\_\_ could be a person running into the \_\_\_\_\_ in front of them, or a car turning into their path.
- b For an average person, the reaction time is about \_\_\_\_\_.
- c The reaction time affects the \_\_\_\_\_ distance, which is the distance the car travels between the hazard occurring and the driver pressing the \_\_\_\_\_ pedal.
- d A person with a \_\_\_\_\_ reaction time will have a shorter \_\_\_\_\_ distance than a person with \_\_\_\_\_ reaction time.
- e Reaction times are \_\_\_\_\_ if the person is tired or ill. Drinking \_\_\_\_\_ or taking some drugs increases the reaction time.

- 1 Think about these questions. Jot down the answers and an explanation for each one if you can.
  - a Does fog affect the **thinking distance**?
  - b Does fog affect the **stopping distance**?
  - c On a clear day, how far away could a driver spot a hazard on a straight road? (Choose from: a few metres, 100 metres, a kilometre.)
  - d How far away could a driver spot a hazard when it is foggy?
  - e A car is being driven at 80 km/h. The stopping distance at this speed is 53 m. What will happen if the driver spots a hazard 30 m in front of the car?
  - f What would be a safe speed to drive if hazards can only be spotted 30 m ahead?

**E1** Write a paragraph for a road-safety website to explain why fog can be a hazard on the roads, and what drivers can do to avoid crashing in foggy conditions.

2 Use your answers to question 1 to help you to write a paragraph in answer to question **E1** above.

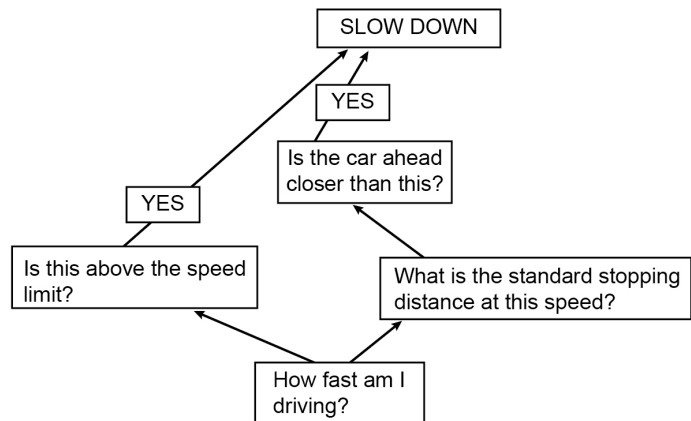
3 Draw a concept map to show the different factors that affect stopping distance. You could start your chart like this:



4 Draw another chart that shows how drivers could decide whether or not their speed is safe.

The diagram shows one way in which you could start to lay out your chart.

Other questions you could include on your chart concern how far you can see, the state of the road, the state of the vehicle and how fit you are to drive.



Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

- 1 Tick the boxes to show if each of these statements is true or false. For the false statements, write a corrected version underneath. For the true statements, try to explain why they are true.

	True	False
a The faster a car goes, the longer its <b>stopping distance</b> will be. _____	<input type="checkbox"/>	<input type="checkbox"/>
b If a driver is tired, the <b>thinking distance</b> will be less. _____	<input type="checkbox"/>	<input type="checkbox"/>
c If a driver has taken drugs, the thinking distance will be increased. _____	<input type="checkbox"/>	<input type="checkbox"/>
d If the road is wet, the thinking distance will be longer. _____	<input type="checkbox"/>	<input type="checkbox"/>
e A car with four passengers will have a shorter <b>braking distance</b> than a car with one passenger. _____	<input type="checkbox"/>	<input type="checkbox"/>
f Worn tyres will make the braking distance longer. _____	<input type="checkbox"/>	<input type="checkbox"/>

- 2 Road safety advice suggests that people should drive more slowly when it is raining than when it is dry. Complete the following sentences to explain this advice. Use words from the box – you can use each word once, more than once or not at all.

better	braking	closer to	decrease	further from	increase
longer	reacting	shorter	stopping	thinking	worse

If there is a hazard on the road ahead, a car travels a certain distance while the driver is \_\_\_\_\_ to the danger (the \_\_\_\_\_ distance) and while the car is slowing down (the \_\_\_\_\_ distance). The total distance is called the \_\_\_\_\_ distance. If the hazard is \_\_\_\_\_ the car than the stopping distance, the car will not stop in time and the driver will hit it.

If it is raining the driver cannot see as far as on a dry day. If they slow down their stopping distance gets \_\_\_\_\_, and so they have a \_\_\_\_\_ chance of being able to stop before they hit something.

Rain on the road will also \_\_\_\_\_ the friction between the tyres and the road. This will \_\_\_\_\_ the braking distance, so the driver also needs to slow down to compensate for this.

- 3 At 25 m/s, a car's stopping distance will be longer than when the car travels at 15 m/s. Explain why.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



Here is a table of thinking, **braking** and **stopping distances** for a vehicle at various speeds in normal conditions, with an alert driver.

Speed (m/s)	Thinking time (s)	Thinking distance (m)	Braking distance (m)	Overall stopping distance (m)
5	1	5	2	7
10	1		8	
15	1		17	
20	1			
25	1		48	
30	1		70	

- Make a copy of the table and complete the **thinking distance** column. (Remember, distance = speed × time)
- Calculate the overall stopping distance in each case to complete the last column of the table (omit the information for 20 m/s for now).
- Plot a graph of overall stopping distance against speed to show how they are connected. Speed should be on the horizontal axis. Your vertical axis should go as far as 140 m.
  - Use your graph to find the overall stopping distance at a speed of 20 m/s and use this to help you to work out the **braking distance** at that speed.
- Recalculate all of the thinking and total stopping distances for a drunk driver who takes 1.8 s to react.
- On the same axes as the graph in question 3, plot the stopping distance against speed for the drunk driver. Include a key to show what each line represents.
- Recalculate all of the braking and total stopping distances for an alert driver in a car with worn brakes. Worn brakes mean the braking distance is 20% greater at all speeds.
- Add another line to your graph to show the effect of worn brakes.
- Compare the effects of a drunk driver and worn brakes on the stopping distance.

### Extra challenge

The Highway Code instructs drivers in the rules of driving in the UK. In the section on stopping distances, there is a 'two-second rule':

'...allow at least a two-second gap between you and the vehicle in front on roads carrying faster-moving traffic and in tunnels where visibility is reduced. The gap should be at least doubled on wet roads and increased still further on icy roads.'

*From The Highway Code – Control of the Vehicle (117–126)*

This means that a driver should watch the vehicle in front as it passes a fixed object like a lamp-post and count 2 s. If they pass the lamp-post before 2 s have passed, the gap between the vehicles should be increased.

- Suggest why this rule is given to drivers.
- Why is the last sentence covering wet and icy roads included?
- Suggest why there is only one time used, 2 s, when the table above shows us that the stopping distance varies much more than this.
- Think up a slogan to help drivers to remember this rule.

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Progression questions**

Answer these questions.

1 How are human **reaction times** measured?

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2 What are typical human reaction times?

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3 What are the factors that affect the **stopping distance** of a vehicle?

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Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	1	2	3
Start	    	    	    

**Assessment**

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	1	2	3
Check	    	    	    

**Feedback**

What will you do next? Tick one box.

 strengthen my learning       strengthen then extend       extend

Note down any specific areas you need to improve.

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**Action**

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

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