BE A CRASH INVESTIGATOR AND SOLVE THE MYSTERY

LOCKERBIE ACADEMY

THE RADCLIFFE TRUST

POLICE SCOTLAND

THE ROYAL SOCIETY

Crash investigators use science to find and interpret evidence when a serious car accident happens.

Could you be a crash investigator

THE SCENARIO...

A man was hit on a quiet town road near a pub on a dark and rainy night at about 10.20pm. There were street lights. The driver fled the scene. The man is now unconscious in hospital. There were some witnesses but their reports are contradictory. Some think the pedestrian may have been drunk.

YOUR TASK...

Using the information in this booklet and the diagram and images on page 4, carefully use science techniques to find out the cause of the accident, who was responsible, and if any traffic offences were committed.

The science techniques you are to use are:

- **Observing**
  Look carefully at all the clues.
- **Hypothesising**
  What are your first impressions of what occurred?
- **Recording**
  Record what you see and any data you found during your measuring phase. This can include taking photographs.
- **Measuring**
  Measure carefully and use any scale factors you will need. The model used is 1/3 scale.
- **Calculating**
  Measure the distance it took the car to stop (see formula on page 2) and find the speed of the car when it hit the pedestrian and the speed of the car when it first braked.
- **Concluding**
  Decide what happened during the accident and if any traffic laws were broken.
- **Evaluating**
  Decide which measurements you are confident are correct and which might be interpreted differently. A defence lawyer will question your findings so be well prepared.

Before you begin, secure the scene!

Interpreting the evidence...

Crash investigators look out for certain signs and evidence on the accident scene, so they can interpret what happened.

Tyre marks

Crash investigators measure tyre marks to determine the speed of the vehicle prior to impact and when the car started to skid.

Different types of tyre marks can indicate whether a car was accelerating, decelerating (slowing down) or sliding sideways.

YOUR TASK...

Find the length of the tyre marks (displacement). Use the scale indicated in the diagram on page 4.

The coefficient of friction (μ)

To measure the speed of the vehicle at impact, you need to find out the coefficient of friction (μ). This is the value for the friction between the tyres of the vehicle and the road as it travels and when it brakes. It is an indication of how quickly a vehicle can stop and how slippery the road surface is. If the two surfaces (tyres and road) have a high coefficient of friction, the vehicle will come to a halt in a short distance. If it is low, it will take the vehicle a long distance to stop. This might mean that there is ice or diesel on the road, making it difficult for the vehicle to stop. Once you have the coefficient of friction, you will get an idea of the deceleration of the car. To establish this value, crash investigators do a skid test.

The Police Officer carrying out the skid testing first fits the test vehicle with an accelerometer and drives about 40mph on the same road and same weather conditions as the car crash. The driver applies the brakes fully to lock all four wheels and stop the vehicle. The accelerometer calculates the deceleration figure, by using the equation $a = \mu \times g$, where *a* is the deceleration, μ the kinetic coefficient of friction and *g* is the gravitational field strength or acceleration due to gravity, which is always 9.81 ms^{-2}.

This gives the rate of deceleration of the vehicle. Two of these tests are carried out; if the results are within 10% of other, investigators can go ahead with further testing.

Calculating the speed of the vehicle

The rate of deceleration is given in metres per second squared (or ms^{-2}). The crash investigators found values for the deceleration of -6.80 ms^{-2} and -7.01 ms^{-2}. The results are negative because the car decelerates. The lower result is generally used in fairness to the driver, as it gives the lowest resultant speed for any subsequent calculations made.

We can now calculate the velocity or speed of the vehicle:
1) when it started to skid, i.e. when it started to brake
2) when it collided with the pedestrian

Calculating the speed the car was travelling when it started to brake

Crash investigators use the formula: $\mathbf{v^2=u^2+2as}$.

Where
v = final velocity (in this case 0 ms^{-1}, because the car stopped in the end)
u = Initial velocity (what we are looking for)
a = acceleration = -6.80 ms^{-2}
s = displacement = _____ i.e. total length of the tyre marks

Calculating the speed the car was travelling when it collided with the pedestrian

We have to measure from the centre of the front wheels back to where the tyre marks deviate slightly, indicating where the contact took place - use the diagram on page 4 to measure this value. You can then use the same formula: $\mathbf{v^2=u^2+2as.}$

Where
v = Final velocity = 0
u = Initial velocity = ?
a = acceleration = -6.80 ms^{-2}
s = displacement = _____ (Length of tyre marks after collision with pedestrian)

Calculating
Laws of motion
Velocity

Pedestrian frontal impact

Leg/bumper contact

Hip/bonnet contact

Torso/bonnet contact

Head/windscreen contact

If the car had been travelling at the speed limit of 30mph would it still have collided with the pedestrian?

Again using the same formula **$v^2=u^2+2as$.**

Where
v = Final velocity = 0
u = Initial velocity = 30mph = 13.4 ms^{-1}
a = acceleration = -6.80 ms^{-2}
s = displacement = ?

Compare the displacement value with the length of the tyre marks measured previously.

Pedestrian collision

Crash investigators analyse the marks on the pedestrian and on the vehicle.

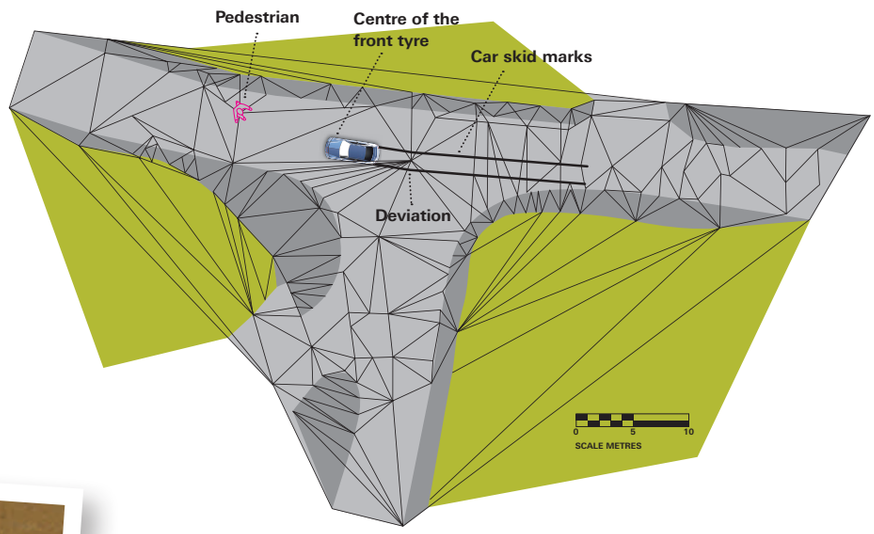
The body of the pedestrian and the car will bear different marks depending on where and how they hit each other. If the pedestrian was hit below the waist, the body is thrown upwards and the vehicle passes under the pedestrian, so the pedestrian is 'run under'. If the pedestrian is hit above the waist, they are knocked down and 'run over'.

When hit in a frontal impact (an impact where the pedestrian is struck by the front of the vehicle, other than the corners), the velocity of the pedestrian first matches the velocity of the vehicle, then is higher than the decelerating vehicle because the pedestrian is not affected by the vehicle braking. The pedestrian flies ahead of the vehicle until hitting the ground. The direction the pedestrian is projected depends on a variety of factors including: point of impact, the shape and speed of the vehicle, and the pre-impact speed and direction of the pedestrian.

Where and how far the casualty was thrown can help determine whether there was vehicle braking at impact.

SOLVE THE MYSTERY...

In our scenario the pedestrian was found at the front of the car, on the right side of the road (see diagram below). He had marks on his right leg, right hip, and right shoulder, and on the right side of his head. The car had marks on the top of its bonnet.



How do you think the pedestrian was hit

How far has he landed from the point of impact

CONCLUSION...

Based on the information included in this flyer, can you work out what happened in the accident?

- **Was the car going over the speed limit before hitting the pedestrian?**
- **Did the driver try to stop?**
- **Can you work out if the pedestrian was 'run over' or 'run under'?**

You can find the information to these questions and many more at:

- www.lockerbieacademy.com
- www.youtube.com/watch?v=MJbjKqPxUkY&list=PLoqe1SxdxO2d-EmqbAsU82nz9BbIyOEEL&index=8
- www.youtube.com/watch?v=RYGRIFcpeU&list=PLoqe1SxdxO2d-EmqbAsU82nz9BbIyOEEL&index=9
- www.your-initiatives.safety-mobility-for-all.com/school-story/road-crash-investigator