The physical world: collisions
Collisions: Accident investigation

V/O: Accident investigation is looking at the physical evidence that has been left at the scene of a collision and establishing what has actually happened in the collision itself.

JON NEADES V/O: OK let's have a look at the marks that we've got. I'm Jon Neades and I'm an ex-police officer and I now I teach accident investigation to police officers.

JON NEADES, Ai TRAINING SERVICES LTD: What is actually happening in the collision, what's happened to the various objects, why we have marks on the road surface, why a vehicle behaves in a particular way, and it's all based on the laws of physics.

PRESENTER: In a skid you may be out of control but the laws of physics aren't. Behind the chaos and confusion of a crash is the order and certainty of nature. If you understand these rules you can work backwards and discover just how the metal got mangled.

PRESENTER: It's over a hundred years since the first person was killed in a road accident in Britain. This car may look lovely but it's also deadly. Both car and driver were being written off in a crash.

MAN: I think that if we look at what's happened in the whole development of the cars we can say that by understanding how energy is absorbed this has enabled us to move forward so that in the unhappy event that you have an accident then there's a much better chance that you'll be protected in that accident. And without our understanding of physics we would never have got to that point.

PRESENTER: To unpick the chaos of a car crash scientists need some rules they can always rely on. One thing physicists learned to bank on is the reliability of energy. Energy can't be created or destroyed, it has to go somewhere. If I don't burn off the energy in these chips it will be stored as fat. Energy doesn't miraculously disappear. Unfortunate for slimmers, great news for scientists. They can be sure that although energy can change from one form to another the total amount has to remain the same.

FRANK CLOSE, CERN: Energy is a quantity that stays the same, it can change from one form to another but overall it stays the same. A familiar example – if I've got this piece of snow here and I hold it above the ground and I don't let go, it's got potential energy, it's go the potential to change into motion. It turned into motion, it hit the ground, as it hit the ground sound was emitted, so all these forms of energies were changing from one to another, but the total of them all stayed the same throughout, and is the principal that energy is conserved, preserved.

MAN: If we're looking at energy we have energy, we have kinetic energy if anything's moving. Of course when two cars crash into each other they have a lot of kinetic energy and we have to absorb that kinetic energy in the front structure of the car. If we don't absorb it in the front structure of the car it'll have to be absorbed somewhere and it'll be absorbed by collapse of the passenger compartment. So we want to have the softest front structure that you can have but would absorb sufficient on impact energy. You could design a car that would have its front end that would be like a spring so that when cars collided they crushed and then recovered. The problem there is that the cars would then bounce back and so the change in velocity on the cars would be much greater. There's no point in stopping somebody and then saying I'm now going to accelerate you backwards and increase your
injuries. Now you can't do that perfectly. Cars will recover but the ideal is cars which collapse and stay collapsed.

V/O: So car designers have a stark choice. In a crash the energy either deforms the car or the people. Energy always has to go somewhere, it can't just disappear. That what crumple zones are about. They allow the energy to go into bending metal, the front of the car crumples so the people don't.

PRESENTER: The total amount of energy in the Universe always remains the same, it's conserved. Nature's law on the conservation of energy is never broken. Scientists rely on it absolutely. But energy isn't the only thing that obeys the law of conservation.
Motion is the key to understanding crashes. If my toy car were travelling at the same velocity as a real car, the real car would do you a lot more damage. That's because it's got more momentum and momentum is the velocity of a vehicle multiplied by its mass. If two vehicles are travelling at the same velocity the one with more mass has more momentum.

MAN: When we consider two cars hitting each other then the first thing we have to consider is the momentum, so if you have one car that is twice the mass of the other car, then the momentum that that car has is its mass times its velocity. Both the cars are going at the same velocity, then one car has twice as much momentum as the other car. If you were to imagine something like a Mini hitting a truck, a very extreme example, you can see the very simple situation is if a truck is coming along at 30 mph into a Mini at 30 mph the Mini will basically be going back at nearly 30 mph, so it's had a change of velocity of something like 60 mph, and the truck will be going along still at almost 30 mph, so it's had a velocity change of virtually nothing.