WJEC (Eduqas) Physics GCSE

4.3: Safety in Public Transport

Detailed Notes

(Content in **bold** is for higher tier **only**)

Stopping Distances

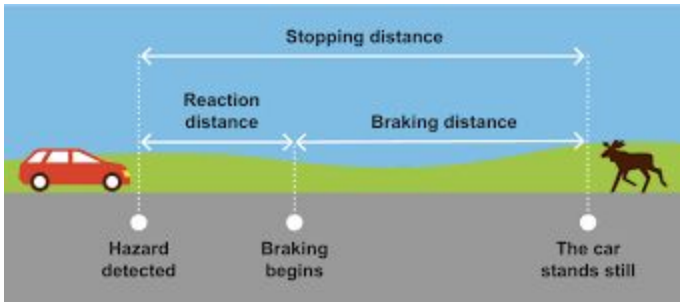
The velocity of a vehicle can affect how safely the vehicle can stop. Stopping distances are made up of two separate distances:

1. **Thinking distance** - the distance travelled **before** the driver reacts.
2. **Braking distance** - the distance travelled **whilst** the driver is reacting and **braking**.

The thinking distance is affected by the **speed** of the car and **reaction time**. The reaction time of the driver is affected by tiredness, concentration or the influence of drugs and alcohol.

The braking distance is affected by **speed** and **physical factors** such as poor road conditions, condition of the car (balding tyres, worn brake pads etc.) and weight of the car (number of passengers).

The overall stopping distance is the **sum** of the thinking distance and braking distance.



Vehicle stopping distances (korkortonline.se).

Deceleration and Forces

When a vehicle experiences a large deceleration, the principles of Newton's 2nd Law apply. A large change in velocity over a short space of time (such as emergency braking or a collision) means a large force is experienced.

$$F = ma = \frac{m(v-u)}{t}$$

F is force in Newtons (N), m is mass in kg, v is final velocity in m/s, u is initial velocity in m/s and t is time in s. Other units may be used.

To reduce the force experienced, by increasing the time of the impact or distance travelled during it.

Vehicle Safety

When braking hard, there is a **large deceleration**. Therefore, a **large force** is exerted on the passengers and the vehicle which can be dangerous, as the force experienced can cause injuries such as whiplash. These impacts of dangerous forces can be **reduced** through several **safety measures**:

Seatbelts

Seatbelts strap you in, but also **stretch slightly** under large forces. This stretching **increases the distance** moved for passengers to stop which decreases the magnitude of the acceleration, **reducing the force** experienced.

Without these, when braking hard you will keep moving and not decelerate (momentum), causing you to fly through the windshield.

Crumple Zones

Softer areas at the front of the car, which crumple upon impact absorb energy to deform and compact. This **increases the time** taken for the car to stop, **reducing the acceleration** and force on passengers.

Without these, the car acts as a **solid metal block**, which would immediately stop during a crash, transferring all of the momentum to people in the car.

Air Bags

Air bags inflate **automatically** upon a crash. Your head hits the bag and slows down. Therefore the time taken for the head to stop moving is **increased**, reducing the force on the neck.

Without these your head would **whip forward** during a crash, hitting the steering wheel or backwards causing serious neck injuries.