UNIT 5.4 Newton's Second Law

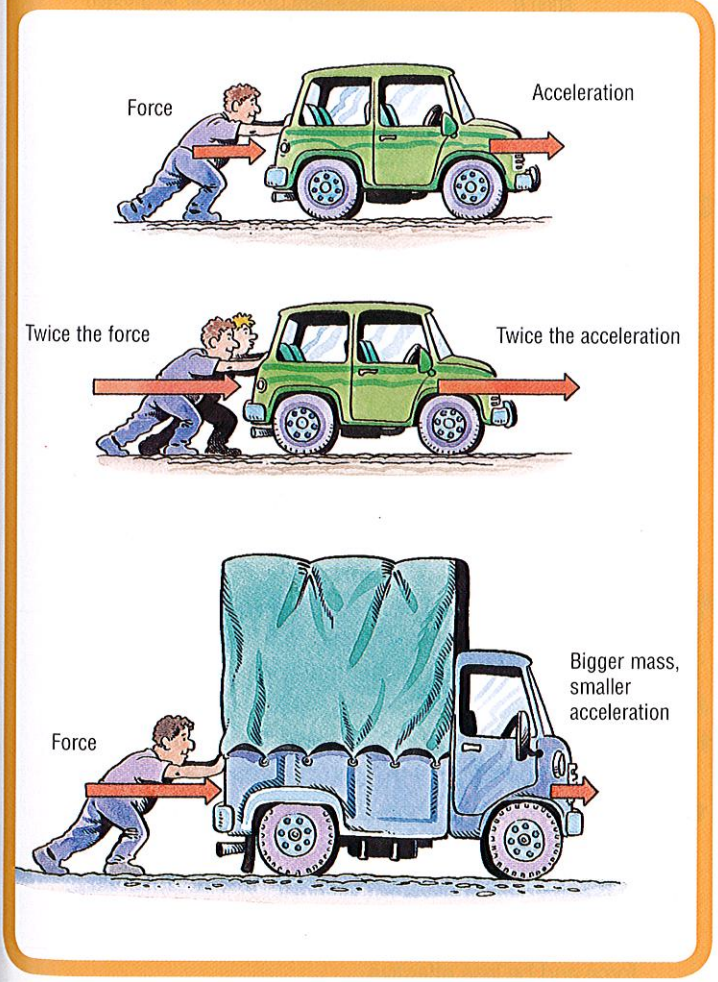
context When you ride a bike, you have to apply a force to the pedals to get the wheels turning. The larger the force applied, the faster you accelerate. When you want to stop you have to apply a force, using the brakes, to slow you down. The harder you squeeze the brakes, the faster you slow, or decelerate. This is Newton's Second Law! Too easy ...

Acceleration

Acceleration applies to any change in velocity. This may be a change in speed (e.g. from 10 to 20 m/s) or a change in direction (e.g. from north to east).

All acceleration requires a force. The bigger the force, the greater the acceleration. Two people pushing a car will be more effective than just one person pushing it. But if the car is a big one, the acceleration will be less: mass affects acceleration. **Mass** is the amount of matter in an object. It never changes unless you remove a bit from it or add more to it. A 2 kg mass stays as 2 kg regardless of where it is in the universe.

Fig 5.4.1 Acceleration depends on mass and the force applied.



Physics facts

Mass

Symbol in formulas: m
Unit: kilograms
Unit abbreviation: kg

Science Focus

Crumpling crashes

The force that you experience in an accident depends not on your speed, but the rate at which you come to a stop. If you decelerate more slowly, then the impact force is less. Modern cars are designed to extend the time you take to stop in a collision. Crumple zones slow the crash, and seatbelts and airbags allow you to decelerate with the car. Without this protection you will strike something hard. Deceleration and impact force will then be high.

Newton's Second Law

Newton's **Second Law** states:

> **Something will happen if a force is applied: the object will accelerate and the acceleration will depend on the mass of the object.**

$$\text{force} = \text{mass} \times \text{acceleration}$$

or $F = ma$

This formula can also be arranged to give:

$$m = F/a \quad \text{and} \quad a = F/m$$

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