



Forces and Acceleration

1. **Acceleration** is the **rate** of **change** of **velocity**
2. It can be calculated using the equation $a = \frac{v-u}{t}$,
where a is the acceleration (m/s²), v is the final velocity (m/s), u is the initial velocity (m/s) and t is the time taken (s)
3. An object falling through a **fluid** initially accelerates due to the force of gravity
4. Eventually the **resultant force** will be **zero** and the object will move at its **terminal velocity**
5. Opening a parachute decreases the terminal velocity because the **surface area** of the parachute is larger than the person so air resistance increases more quickly
6. Newton's Second Law states that the **acceleration** of an object is **proportional** to the **resultant force** acting on it and **inversely proportional** to its **mass**.
7. This can be written as the equation $F = ma$,
where F is the resultant force (N), m is the mass (kg) and a is the acceleration (m/s²)
8. Acceleration can also be calculated using the equation $v^2 - u^2 = 2as$,
where v is the final velocity (m/s), u is the initial velocity (m/s), a is the acceleration (m/s²) and s is the distance travelled (m).
9. *Inertial mass is a measure of how difficult it is to change the velocity of an object*
10. *It is defined as the ratio of force over acceleration*

Stopping Distance

11. The **stopping distance** of a vehicle is the **sum** of the **distance** the vehicle travels during the **driver's reaction time** (thinking distance) and the **distance** it travels under the **braking force** (braking distance).
12. Thinking distance can be calculated using the equation $s = vt$,
where s is the distance or displacement (m), v is the velocity (m/s) and t is the time taken (s).
13. For a given braking force the **greater** the **speed** of the vehicle, the **greater** the **stopping distance**.
14. When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel **reduces** the **kinetic energy** of the vehicle and the **temperature** of the **brakes increases**.
15. The greater the speed of a vehicle the greater the braking force needed to stop the vehicle in a certain distance.
16. The greater the braking force the greater the deceleration of the vehicle. **Large decelerations** may lead to brakes **overheating** and/or **loss of control**.
17. Thinking distance is affected by the driver's reaction time
18. A driver's **reaction time** can be affected by **tiredness**, **drugs** and **alcohol**. **Distractions** may also affect a driver's ability to react.
19. Reaction times vary from person to person. Typical values range from 0.2 s to 0.9 s.
20. Simple methods such as the **ruler drop** can be used to measure reaction time.
21. The **braking distance** of a vehicle can be affected by **adverse road** and **weather** conditions and poor condition of the vehicle.





22. Adverse road conditions include **wet** or **icy** conditions. Poor condition of the vehicle describes the state of the vehicle's **brakes** or **tyres**.
23. The distance required for a vehicle to stop depends on its **speed**.
24. **Both thinking distance** and **braking distance** are affected by **speed**

Momentum (HT only)

25. **Momentum** is defined as the **product** of an object's **mass** and **velocity**
26. It can be calculated using the equation $\text{momentum} = \text{mass} \times \text{velocity}$, or $p = mv$,
Where p is the momentum (kg m/s), m is the mass (kg) and v is the velocity (m/s)
27. The **greater** the **mass** of an object, the **more momentum** it has
28. The **greater** the **velocity** of an object, the **more momentum** it has
29. The more momentum an object has, the harder it is to change the velocity of the object
30. In a **closed system**, the total momentum before an event is equal to the total momentum after the event. This is called **conservation of momentum**.
31. A closed system is one in which there are no external force acting
32. Conservation of momentum can be seen in **collisions** and **explosions**

Change in Momentum (Physics only)

33. When a **force** acts on an object that is moving, or able to move, a **change in momentum** occurs.
34. The equations $F = ma$ and $a = \frac{v - u}{t}$
35. combine to give the equation $F = \frac{m \Delta v}{\Delta t}$
36. where $m \Delta v$ = change in momentum (i.e. force equals the rate of change of momentum).

37. Safety features such as: air bags, seat belts, gymnasium crash mats, cycle helmets and cushioned surfaces for playgrounds work by **increasing the time taken** for a body to stop, thereby **decreasing the rate of change of momentum**.

Work Done by Forces

38. When a **force** causes an object to move through a **distance** **work** is **done** on the object. So a force does work on an object when the force causes a displacement of the object.
39. The work done by a force on an object can be calculated using the equation:
 $\text{work done} = \text{force} \times \text{distance moved along the line of action of the force}$,
or $W = Fs$
40. One joule of work is done when a force of one newton causes a displacement of one metre. 1 joule = 1 newton-metre
41. **Work done against** the **frictional** forces acting on an object causes a rise in the **temperature** of the object.

Forces and Deformation

42. Forces can be used to **stretch**, **bend** or **compress** objects.
43. **Elastic** objects can return to their original shape after deformation, **inelastic** objects cannot.
44. The **extension** of an elastic object is directly proportional to the force applied, within the limit of proportionality.
45. This can be represented by the equation $F = ke$,
where F = the force applied (N), k is the spring constant of the spring (N/m) and e is the extension (m).



- 46. The extension of a spring is the difference between the final length and the initial length.
- 47. This relationship also applies to the compression of an elastic object, where e would be the compression of the object.
- 48. A force that stretches or compresses a spring does work and **elastic potential** energy is stored in the spring. If the spring is not inelastically deformed, the work done on the spring is equal to the elastic potential energy stored.
- 49. **Work done** in stretching (or compressing) a spring (up to the limit of proportionality) can be calculated using the equation: $E_e = \frac{1}{2}ke^2$,
Where E_e is the elastic potential energy (J), k is the spring constant (N/m) and e is the extension of the spring (m).

Turning Effects of Forces (Physics only)

- 50. A force or a system of forces may cause an object to **rotate**.
- 51. The **turning effect** of a force is called the **moment** of the force.
- 52. The size of the moment is defined by the equation: $M = Fd$,
Where M is the moment of the force (Nm), F is the force applied (N) and d is the perpendicular distance from the line of action of the force to the pivot (m).
- 53. If an object is **balanced**, the **total clockwise moment** about a pivot equals the **total anticlockwise moment** about that pivot.
- 54. A simple lever and a simple gear system can both be used to **transmit** the **rotational effects** of forces by increasing the distance from the pivot and therefore increasing the moment.

