Physics 5: Forces

Section 1: Key terms

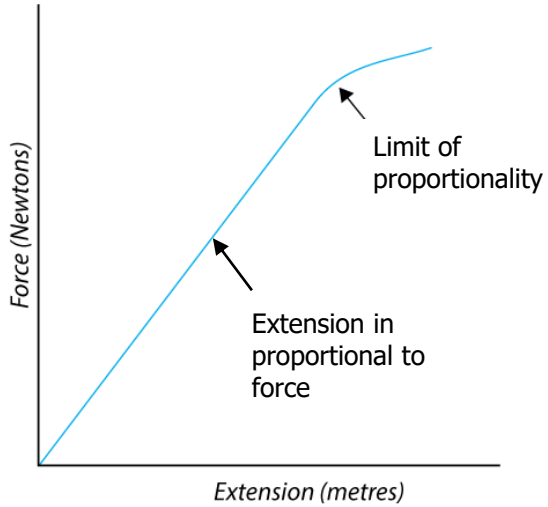
1 Scalar	A value with **magnitude (size) only,** e.g. **speed, distance.**
2 Vector	A value with **magnitude (size)** and **direction,** e.g. **all forces, displacement, velocity.**
3 Contact force	Force between objects that are **touching** e.g. friction, air resistance.
4 Non-contact force	Force between **separate objects** e.g. gravitational force, magnetic force.
5 Weight	The **force of gravity** acting **on an object's mass**. Measured using a **newtonmeter**.
6 Centre of mass	The **single point** at which the **object's weight appears to act**.
7 Resultant force	A resultant force is a **single force** that has the **same effect as all the forces** acting on an object.
8 Work done	Work is done when an **object is moved through a distance**. When work is done **against friction** there is a **temperature rise**.
9 Momentum (HT)	Moving objects with mass have momentum. Momentum is "**mass in motion**".
10 Conservation of momentum (HT)	In a closed system, the **total momentum before an event is equal to the total momentum after the event**.

Section 2: Equations to learn

	Equation	Symbol equation	Units
11	Weight = mass x gravitational field strength	W = m g	Weight – newtons (N) Mass – kilograms (kg) GFS – newtons per kilogram (N/kg)
12	Work done = force x distance	W = F s	Work done – joules (J) Force – newtons (N) Distance – metres (m)
13	Force = spring constant x extension	F = k e	Force – newtons (N) Spring constant – newtons per metre (N/m) Extension – metres (m)
14	Distance = speed x time	s = v t	Distance – metres (m) Speed – metres per second (m/s) Time – seconds (s)
15	Acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$	Acceleration = metres per second squared (m/s^2) Velocity = metres per second (m/s) Time = seconds (s)
26	Resultant force = mass x acceleration	F = m a	Force – newtons (N) Mass – kilograms (kg) Acceleration = metres per second squared (m/s^2)
17 (HT)	Momentum = mass x velocity	p = m v	Momentum – kilograms metres per second (kg m/s) Mass – kilograms (kg) Velocity = metres per second (m/s)

Section 3: Elasticity

18 Elastic deformation	Occurs when a **spring is stretched** and can then **return to its original length.**
19 Inelastic deformation	Occurs when a **spring is stretched** and its **length is permanently altered.**
20 Limit of proportionality	The **length** a spring can be **stretched before it no longer is able to return to its original length**. Beyond the limit of proportionality, a force-extension graph is curved.



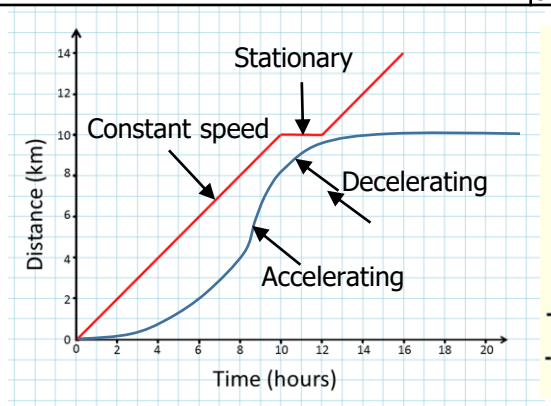
21 Force-extension graph

Section 4: Forces and Braking

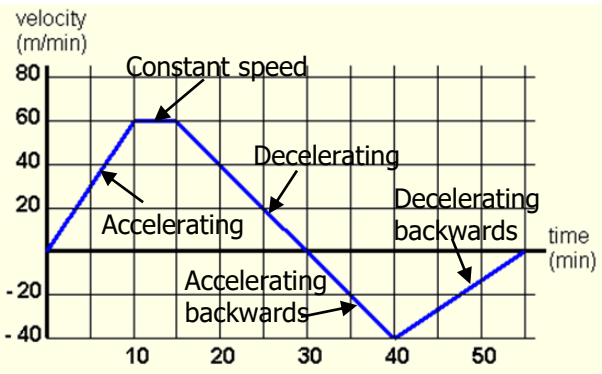
21 Stopping distance	The stopping distance of a vehicle is the **sum** of the **distance the vehicle travels** during the driver's reaction time (**thinking distance**) and the distance it travels under the braking force (**braking distance**).
22 Thinking distance	The **distance a vehicle travels** while a driver is **reacting**.
23 Reaction time	The **time it takes for a driver to react**, typically **0.2-0.9s**. Affected by **tiredness**, **drugs**, **alcohol** and **distractions**.
24 Braking distance	The **distance a vehicle travels under braking**. Affected by **weather conditions** (e.g. rain or ice) and the **conditions of the brakes** and **tyres** of a vehicle.
25 Braking force	When the brakes are pressed, **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**. The **greater the speed** of a vehicle, the **greater the force** needed to stop the vehicle. **Large declarations** may lead to **loss of control** or **overheating** of the brakes.

Section 5a: Motion	
25 Displacement	The **distance** an object moves and the **direction** in which it occurs. A **vector** quantity.
26 Velocity	The **speed** of an object in a **particular direction**.
27 Acceleration	The change of an object's speed in a certain amount of time. If an object is **falling near the surface** of the Earth its **acceleration will be 9.8m/s^2**.
28 Terminal velocity	The **maximum speed** of a moving object. Occurs when the **force moving** an object (e.g. gravity) is **balanced by frictional forces** (e.g. air resistance).
29 Circular motion (HT)	An object **moving in a circle** has **constant speed but changing velocity**. This is because the direction in which the object is moving is constantly changing, and velocity is a vector quantity that measures direction and speed.

30 Distance-time graph	31 Velocity-time graph
Constant speed - straight line	Constant speed - horizontal line
Accelerating - curved line upwards	Accelerating - straight line with velocity increasing
Decelerating - curved line going towards horizontal	Decelerating - straight line with velocity decreasing
Stationary - horizontal line	Stationary - horizontal line on x-axis (velocity = 0)
	Moving backwards - below x-axis
Gradient of line can be calculated to give speed	Gradient of line can be calculated to give acceleration or deceleration



32 Distance-time graph



33 Velocity-time graph

Section 5b: Typical Values of Speed	
32 Walking	1.5 m/s
33 Running	3 m/s
34 Cycling	6 m/s
35 Sound in air	330 m/s

Section 6: Newton's Laws	
36 Newton's First Law	The **velocity** of an object will **only change if a resultant force is acting** on the object. If there is **no resultant force** the object will: - **Remain stationary** if it was not moving. - **Continue at a constant speed** if it was already moving.
37 Newton's Second Law	The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object, i.e. Force = mass x acceleration.
38 Newton's Third Law	Whenever **two objects interact**, the **forces** they exert on each other are **equal and opposite**.
39 Inertia (HT)	The **tendency** of objects to **continue in their state of rest** or of **uniform motion**.