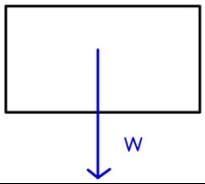
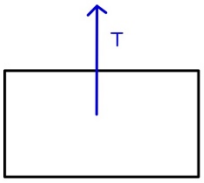
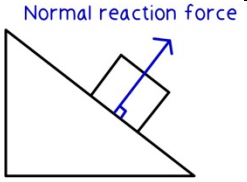
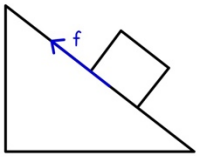
- Part I: Forces
- Types of Forces

Contact Forces

Forces exists when the two objects are in contact.

Weight	Tension	Normal reaction force	Friction / Air resistance
			
Vertically downwards from centre of gravity	Against weight of object	Perpendicular to surface	Againsnt motion of object / body

Non-contact Forces

Forces that exist but do not require object to be in contact. e.g. gravitational force, electric force, magnetic force.

- Effects of Forces

Forces can **move a stationary object**.
Forces can **change the direction** in which an object is moving.
Forces can **change the speed** of a moving object.
Forces can **stop a moving object**.

- Part II: Vector Diagrams

When there can be more than one vector acting on an object with differing magnitudes and direction, vector diagrams can be used to find the resultant vector. (Note: Vector diagrams can be used for other vectors such as velocity)

A vector quantity is represented by an **arrow**. The **length** of the arrow is proportional to the **magnitude** of the vector. The direction of the arrow indicates the direction of the vector.

Condition	Line
Object at equilibrium ($F_R = 0$)	Draw "connecting" line with single head as there is no start and end point – lines keep going in circles.
Moving object ($F_R \neq 0$)	Draw "connecting" line with double head as there is a start point and end point.

- Addition of parallel vectors

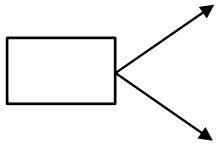
Resultant vector is indicated by a double-headed arrow.

- Addition of non-parallel vectors

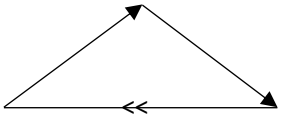
1. Tip-to-tail method (recommended)

Move the tail of an arrow to the tip of the other arrow.

Method:
A character needs a clear straightforward path to walk.
Rearrange arrows to do so!



Character does not have a straightforward path to walk.

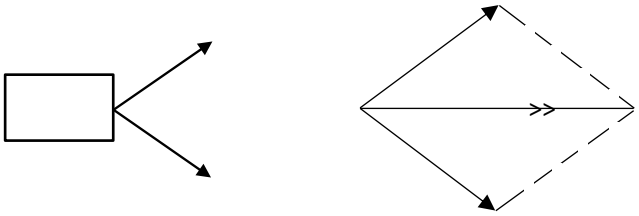


Character has a straightforward path to walk.

Checklist

1. Scale
2. Magnitude
3. Arrowheads
4. Angle

2. Parallelogram method
   Drawing duplicate lines to form a parallelogram.



Checklist
1. Scale
2. Magnitude
3. Arrowheads
4. Angle

- Part III: Newton's First Law of Motion
  Newton's First Law of Motion (also known as law of inertia) states that every body **continues** in its **state of rest** or **uniform motion in a straight line** unless an **external force acts on it**.

  When forces are balanced → $F_R = 0N$ → $a = 0ms^{-2}$ (remain at rest or remain in constant velocity)

- Part IV: Newton's Second Law of Motion
  Newton's Second Law of Motion states that when a **resultant force** acts on an object of a **constant mass**, the object will **accelerate in the direction** of the resultant force. The product of the force and the acceleration of the object gives the resultant force**.**

  Formula
  $$F = m \cdot a$$

  When force is constant, acceleration is inversely proportional to mass. $\boldsymbol{a \propto \frac{1}{m}}$
  When mass is constant, acceleration is directly proportional to force. $\boldsymbol{a \propto f}$

Note!
$F_R =$ exerted force $-$ drag force, where drag force is a force opposing the object.
When there is a resultant (unbalanced) force, an object produces acceleration.
$F_R \neq 0N$ → $a \neq 0ms^{-2}$ (start moving from rest or its velocity changes)

- Part IV: Newton's Third Law of Motion
  Newton's Third Law of Motion states that if **Body A** exerts a force $\boldsymbol{F_{AB}}$ on **Body B**, then Body B will **exert an equal and opposite force** F_{BA} on Body A.

  F_{AB} and F_{BA} will **always occur as a pair**. Each pair is made up of an action and reaction.

- Condition for action-reaction pair
  1. Equal in magnitude
  2. Act in opposite directions
  3. Act on mutually opposite bodies

Examples (action-reaction pairs)
Gravitational force that earth acts on object and gravitational force that object acts on earth.
Friction that floor acts on object and friction that object acts of floor.
Contact force that stool acts on floor and contact force that floor acts on stool.

- Part V: Friction
  Friction is the contact force that opposes or tends to oppose motion between surfaces in contact.