

Scalars, vectors and moments

7

Scalars and vectors

Scalar: a physical-quantity that can be defined simply using magnitude

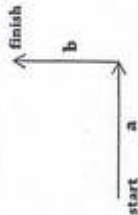
Vector: a physical quantity that is defined by both its magnitude and direction

Exam Tip!

You will be expected to calculate resultant vectors from measurements or scale drawings.

How to add vectors:

1. Draw your two vectors tip to tail.
2. Draw the resultant vector by drawing a vector from start to finish.



3. The magnitude of the vector can be determined from Pythagoras' rule:

$$a^2 + b^2 = c^2$$

4. The direction of the vector can be determined by use of trigonometry:

$$\tan \theta = \frac{b}{a}$$

where θ is the angle from north in the clockwise direction.



Examples of scalars and vectors

Scalars	Vectors
Mass	Weight
Energy	Force
Temperature	Acceleration
Distance	Displacement
Speed	Velocity

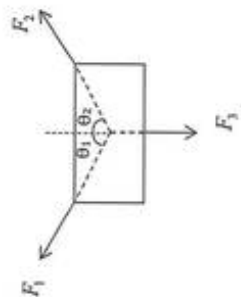
Note: You will also be expected to resolve a resultant vector back into its two original components: its horizontal and vertical components using trigonometry

Coplanar forces

Coplanar forces: forces acting in one plane

Equilibrium:

- A system is in equilibrium if the net force (the net contribution of its coplanar forces) is zero.
- If an object is in equilibrium, then the object will remain at rest or continue with constant velocity.
- Coplanar forces in **equilibrium**:



i.e.
Horizontal component of $F_1 = F_1 \cos \theta_1$
Vertical component of $F_1 = F_1 \sin \theta_1$

Moments

Moment of a force:

$$\text{moment} = F \times d$$

d = distance from point

Moment of a couple:

$$\text{moment} = F \times d$$

d = distance between forces

Moment of a force:

The moment of a force about a point is defined as the product of the force and the perpendicular distance from the line of action of the force to the point.

Couple:

A pair of equal and opposite coplanar forces acting on an object along different lines.

Moment of a couple:

The moment of a couple is defined as the product of the force and the perpendicular distance between the lines of action of the forces.

Centre of mass:

A point that indicates the average position of all the matter in a body. The position of the centre of mass in a uniform, regular object is at its centre.

Principle of moments

For equilibrium:

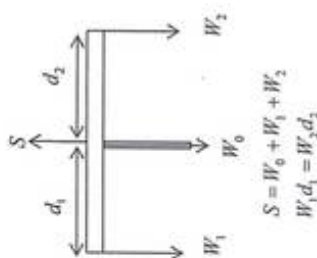


The sum of the clockwise moments = the sum of the anticlockwise moments.

$$W_1 d_1 = W_2 d_2$$

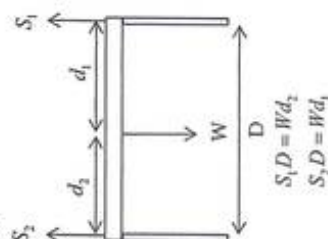
- W_1 provides the anticlockwise moment about the pivot.
- W_2 provides the clockwise moment about the pivot.

Support problems



$$S = W_0 + W_1 + W_2$$

$$W_1 d_1 = W_2 d_2$$



$$S_1 D = W d_2$$

$$S_2 D = W d_1$$