Chapter 7 - Mechanics

Applications of Forces

Chapter Overview

1. Static Particles
2. Modelling with Statics
3. Friction and Static Particles
4. Static Rigid Bodies
5. Dynamics and Inclined Planes
6. Connected Particles

Topics	What students need to learn:		
	Content		Guidance
8 **Forces and Newton's laws**	8.1	**Understand the concept of a force; understand and use Newton's first law.**	**Normal reaction, tension, thrust or compression, resistance.**
	8.2	**Understand and use Newton's second law for motion in a straight line (restricted to forces in two perpendicular directions or simple cases of forces given as 2-D vectors);** extend to situations where forces need to be resolved (restricted to 2 dimensions).	**Problems will involve motion in a straight line with constant acceleration in scalar form, where the forces act either parallel or perpendicular to the motion.** Extend to problems where forces need to be resolved, e.g. a particle moving on an inclined plane. **Problems may involve motion in a straight line with constant acceleration in vector form, where the forces are given in i – j form or as column vectors.**

	8.3	**Understand and use weight and motion in a straight line under gravity; gravitational acceleration, *g*, and its value in S.I. units to varying degrees of accuracy.**	**The default value of *g* will be 9.8 m s^{-2} but some questions may specify another value, e.g. *g* = 10 m s^{-2}** **The inverse square law for gravitation is not required and *g* may be assumed to be constant, but students should be aware that *g* is not a universal constant but depends on location.**
	8.4	**Understand and use Newton's third law; equilibrium of forces on a particle and motion in a straight line; application to problems involving smooth pulleys and connected particles;** resolving forces in 2 dimensions; equilibrium of a particle under coplanar forces.	**Connected particle problems could include problems with particles in contact e.g. lift problems.** Problems may be set where forces need to be resolved, e.g. at least one of the particles is moving on an inclined plane.
	8.5	Understand and use addition of forces; resultant forces; dynamics for motion in a plane.	Students may be required to resolve a vector into two components or use a vector diagram, e.g. problems involving two or more forces, given in magnitude-direction form.
8 **Forces and Newton's laws** *continued*	8.6	Understand and use the $F \leq \mu R$ model for friction; coefficient of friction; motion of a body on a rough surface; limiting friction and statics.	An understanding of $F = \mu R$ when a particle is moving. An understanding of $F \leq \mu R$ in a situation of equilibrium.
9 **Moments**	9.1	Understand and use moments in simple static contexts.	Equilibrium of rigid bodies. Problems involving parallel and non-parallel coplanar forces, e.g. ladder problems.

In this chapter, we will bring together everything that we have learned about forces: friction, resolving forces into components, Newton's 2nd law, inclined planes and connected particles, for different, common types of problems.

1. Static Particles

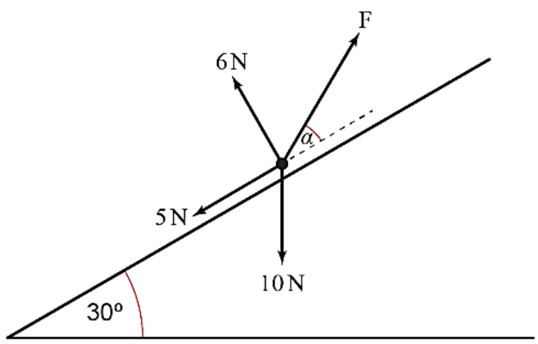
If a particle is in equilibrium, the resultant of all forces is 0 and the particle remains at rest.

- Always draw a diagram
- Resolve the forces, horizontal and vertical, or parallel and perpendicular if on an inclined plane
- In each direction, sum of components = 0
- Solve the resulting equations to find unknown forces

For particles in equilibrium, you can also use a triangle of forces.

Example

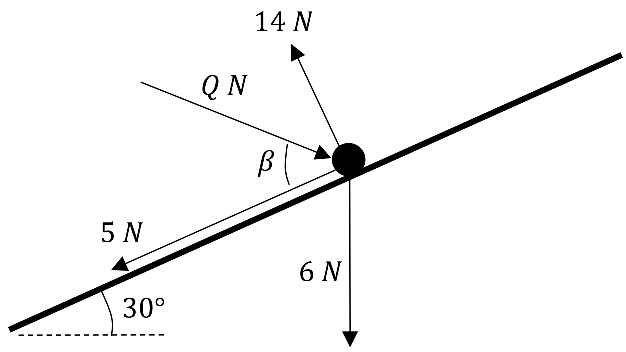
The diagram shows a particle in equilibrium under the action of four forces as shown in the diagram below. The particle rests on an inclined plane which is set at an angle of 30° to the horizontal.



Find the magnitude of force *F* and the size of the angle, α, in degrees giving both answers to two significant figures.

Test Your Understanding

The diagram shows a particle in equilibrium on an inclined plane under the forces shown. Find the magnitude of the force Q and the size of the angle β.



Hint: Redraw the Q N force

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