Chapter 5 - Mechanics

Forces and Friction

Chapter Overview

1. Resolving Forces

2. Inclined Planes

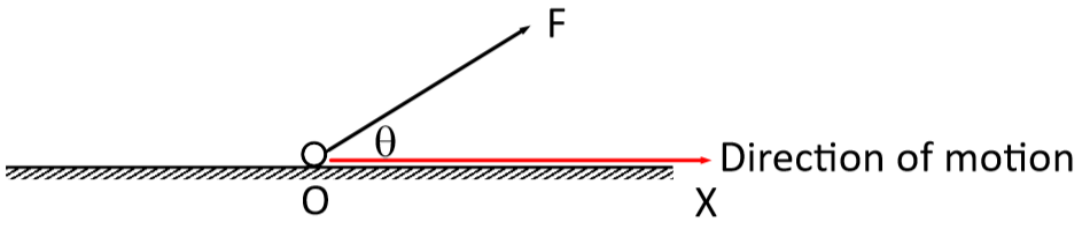
3. Friction

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.**

	8.4	**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.

1. Resolving Forces

If a force is applied at an angle to the direction of motion you can resolve it to find the component of the force that acts in the direction of motion.



The **component** of a force, F, in any given direction is the measure of the effect of the force in that direction.

In the diagram above, the magnitude of the force in the horizontal and vertical direction can be calculated using trigonometry:

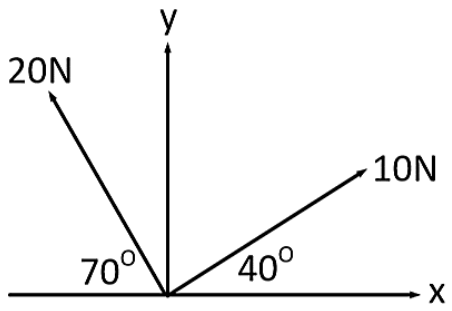
Rule of thumb:
Pull a force THROUGH an angle $\Longrightarrow \cos\theta$
Pull a force AWAY from an angle $\Longrightarrow \sin\theta$

Example

Find the sum of the components of the given forces in the direction of:

a) the x-direction

b) the y-direction

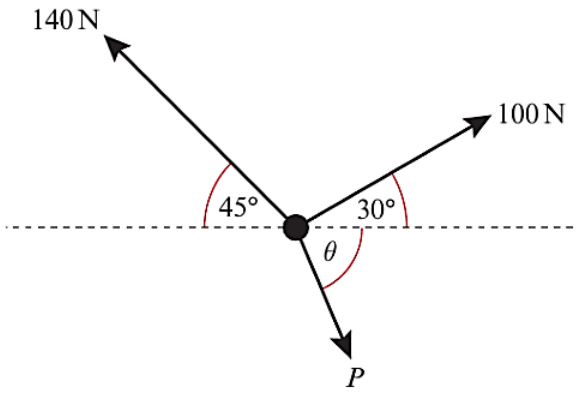


We can also draw a **triangle of forces** to solve problems for particles in equilibrium.

Example *(Textbook Page 94 Example 4)*

Three forces act on a particle as shown.

Given that the particle is in equilibrium, calculate the magnitude of P.



Applied Example

A force P is applied to a box of mass 5 kg, causing the box to accelerate at 2 m s^{-2} along a smooth, horizontal plane. Given that the force causing the acceleration is applied at 30^{o} to the plane, work out the value of P.

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