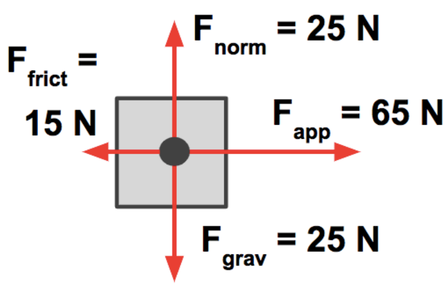
Adding and Resolving Forces

Lesson Notes

Learning Outcomes

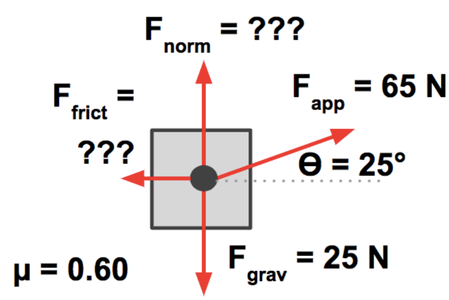
- How can force vectors be added?
- How can force vectors be resolved into components?
- What role does adding and resolving vectors have in the analysis of Physics problems?

The BIG Idea



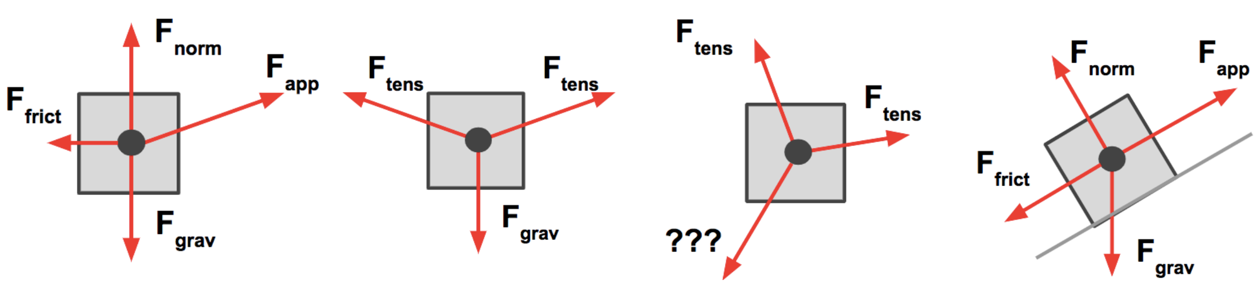
m = 2.5 kg
Determine a

The problem on the left is easy. The forces readily add because they are directed opposite each other. The problem on the right is difficult because of the angled 65 N vector. The goal is to learn to simplify complex problems by resolving angled vectors into x- and y-components.



m = 2.5 kg
Determine a

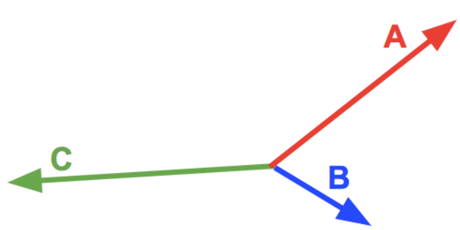
Four Complex Problem Types



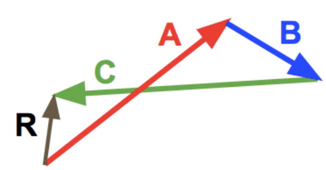
Graphical Addition of Vectors - Head-to-Tail Method

- Draw 1st vector.
- Starting at head of 1st, draw 2nd vector.
- Starting at head of 2nd, draw 3rd vector.
- Draw resultant from tail of 1st to head of 3rd vector.

Problem:
Find the vector sum (resultant) of A + B + C.

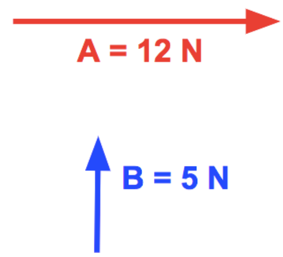


Solution:
Using the graphical method of adding vectors.

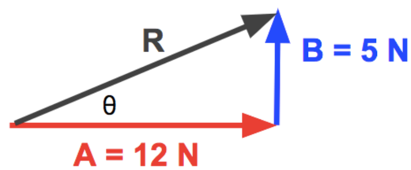


Adding Right Angle Vectors: Pythagorean Theorem and SOH CAH TOA

Problem:
Find the vector sum (resultant) of A + B.



Solution:
Using Pythagorean theorem and SOH CAH TOA.



$R^2 = A^2 + B^2 = (12)^2 + (5)^2$
$R^2 = \text{SQRT}(169) =$ **13 N**

SOH CAH TOA
sine θ = opp/hyp

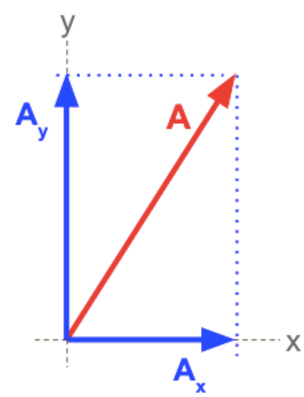
cosine θ = adj/hyp

tangent θ = opp/adj

$\Theta = \tan^{-1}(\text{opp/adj})$
$\Theta = \tan^{-1}(5/12)$
$\Theta = 25°$

Vector Components

- Vectors directed at angles to the coordinate axes can be thought of as having two parts. These parts are called **vector components**.
- A_x and A_y are the components of vector A. They are determined by projecting the vector A onto the x- and the y-axis.
- A comonent describes the effect of a vector in a given direction.



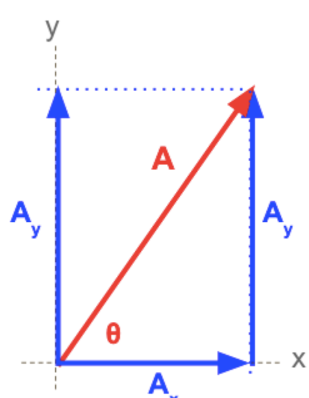
Vector Resolution

Vector resolution is the process of determining the components or parts of a vector. It relies on the use of trigonometry - SOH CAH TOA.

SOH CAH TOA
sine θ = opp/hyp

cosine θ = adj/hyp

tangent θ = opp/adj



A = hypotenuse
A_x = side adjacent θ
A_y = side opposite θ

$A_x = A \cdot \text{cosine } \theta$
$A_y = A \cdot \text{sine } \theta$