10.3
Notes

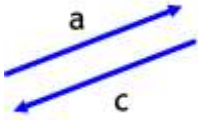
VECTORS: A GEOMETRIC APPROACH

OBJECTIVES: 1) Draw a vector in the coordinate plane and compute its magnitude (two different ways).
2) Determine the resultant of two forces.
3) Find the horizontal and vertical components of a vector.

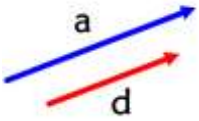
VECTOR BASICS

Many physical quantities such as length, area, volume, or speed can be completely specified by a single real number, which we call **scalar quantities**. Other quantities, such as velocities and forces require for their complete specification both a magnitude and a direction, which we call **vector quantities.**

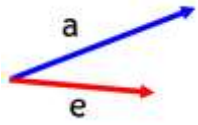
Same magnitude and direction: **a**=**b**



Same magnitude, directions are not the same: **a** ≠ **b**



Same direction, magnitudes are not the same: **a** ≠ **d**



Neither magnitude nor direction are the same: **a** ≠ **e**

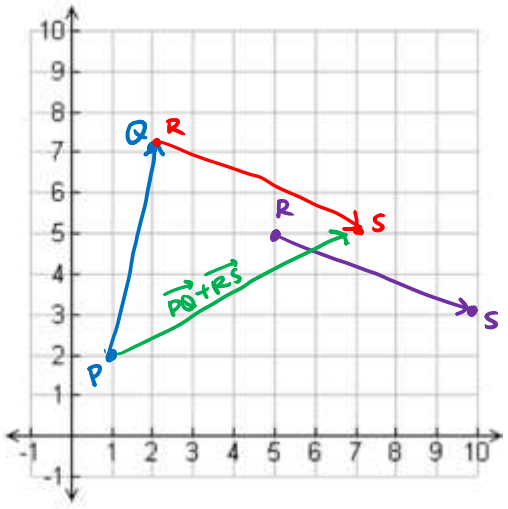
VECTOR ADDITION

Two different approaches:

Given the following points, draw the vector $\overrightarrow{PQ}+\overrightarrow{RS}$ and compute its magnitude.

$P(1,2)\quad Q(2,7)\quad R(5,5)\quad S(10,3)$

HEAD-TO-TAIL RULE



$\overrightarrow{PS}$ $P(1,2)$ $S(7,5)$

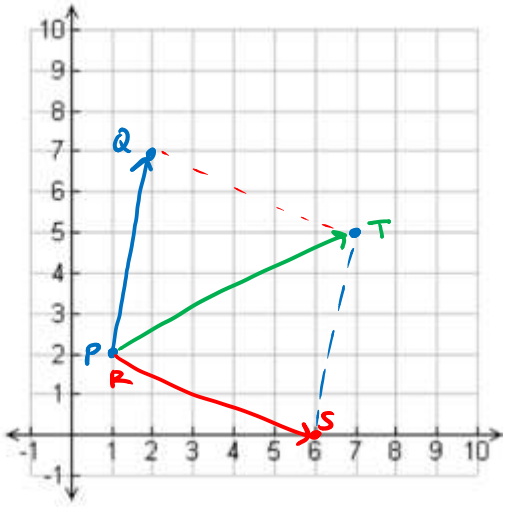
$|\overrightarrow{PQ}+\overrightarrow{RS}| = \sqrt{(1-7)^2+(2-5)^2}$

$= \sqrt{36+9}$

$= \sqrt{45}$

$= 3\sqrt{5}$

PARALLELOGRAM RULE

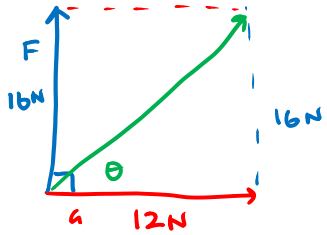


$\overrightarrow{PT}$ $P(1,2)$ $T(7,5)$

$|\overrightarrow{PT}| = |\overrightarrow{PQ}+\overrightarrow{RS}| = 3\sqrt{5}$

THE RESULTANT OF TWO PERPENDICULAR FORCES

Two forces **F** and **G** act on an object. **G** acts horizontally to the right with a magnitude of 12 N (newtons, 1N ≈ 0.2248 lb.). **F** acts vertically upward with a magnitude of 16 N. Determine the magnitude and direction of the resultant force.



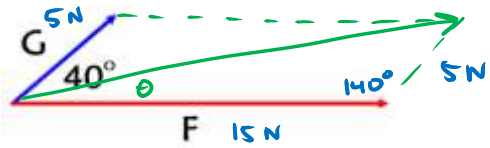
$|F+G| = \sqrt{12^2+16^2} = \sqrt{400} = 20\text{ N}$

$\tan\theta = \frac{16}{12}$

$\theta = \tan^{-1}\left(\frac{16}{12}\right) \quad \theta \approx 53.1°$

THE RESULTANT OF TWO FORCES

Force **F** acts on an object horizontally to the right with a magnitude of 15 N. Force **G** acts on the object as indicated in the diagram with a magnitude of 5N. Determine the resultant of the two forces.



$|F+G| = \sqrt{5^2+15^2-2(5)(15)\cos 140°}$

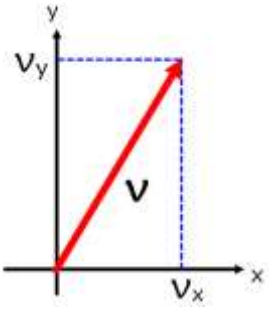
$|F+G| \approx 19.1\text{ N}$ STORE THIS!

$\frac{\sin\theta}{5\text{N}} = \frac{\sin 140°}{19.1\text{ N}}$ ← STORE!

$\sin\theta = \frac{5\sin 140°}{19.1}$

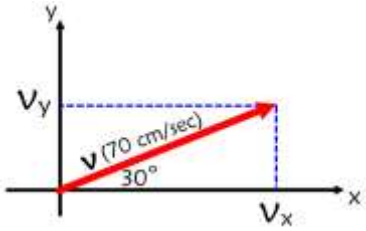
$\theta = \sin^{-1}\left(\frac{5\sin 140°}{19.1}\right)$

$\theta \approx 9.7°$



FINDING HORIZONTAL AND VERTICAL COMPONENTS

Determine the horizontal and vertical components of the velocity vector in the figure below.



$\sin 30° = \frac{v_y}{70}$ $\quad \cos 30° = \frac{v_x}{70}$

$v_y = 70\sin 30°$ $\quad v_x = 70\cos 30°$

$v_y = 35\text{ cm/sec}$ $\quad v_x = 70\cdot\frac{\sqrt{3}}{2}$

$v_x = 35\sqrt{3}\text{ cm/sec}$