

Working with Vectors in the Plane

Grade 12 – Precalculus math · Worksheet · Standards: N-VM.A.1, N-VM.A.2, N-VM.A.3, N-VM.B.4, N-VM.B.5

Name: _____ Date: _____ Class: _____

These 20 problems cover component form, magnitude and direction, vector addition and subtraction, scalar multiples, unit vectors, velocity and force problems and the dot product. They train standards N-VM.A.1 through N-VM.A.3, N-VM.B.4 and N-VM.B.5. The last six problems use work, a glider in a wind, rope tension, trails and a drone flight path.

Standards: N-VM.A.1, N-VM.A.2, N-VM.A.3, N-VM.B.4, N-VM.B.5 · **Level:** Grade 12 Precalculus

Problem 1 Component Form from Two Points (easy)

Find the component form and the magnitude of the vector from $A(-3, 5)$ to $B(4, 1)$. Give the magnitude to the nearest hundredth.

Problem 2 Magnitude and Direction Angle (easy)

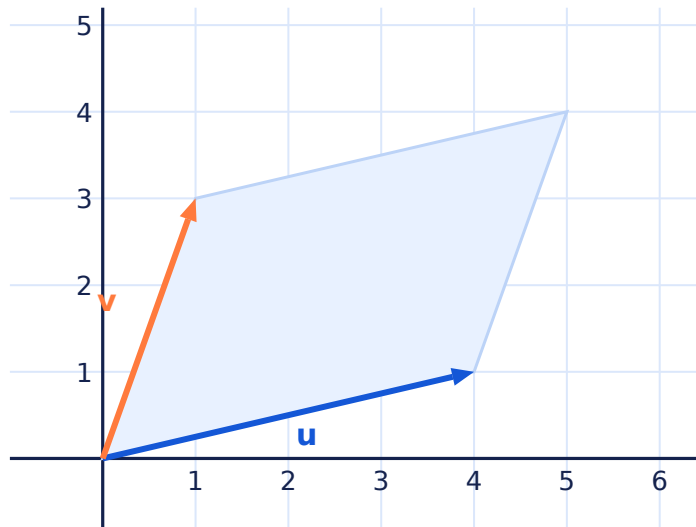
Find the magnitude and the direction angle ($0^\circ \leq \theta < 360^\circ$) of each vector. (a) $\langle -7, 7 \rangle$ (b) $\langle 9, -4 \rangle$

Problem 3 Components from Magnitude and Angle (easy)

Write each vector in component form to the nearest hundredth. (a) magnitude 18, direction 40°
(b) magnitude 25, direction 215°

Problem 4 Add and Subtract from a Figure (easy)

The figure shows $\mathbf{u}$ and $\mathbf{v}$ from the origin. Read their components, then find $\mathbf{u} + \mathbf{v}$ and $\mathbf{u} - \mathbf{v}$.



Vectors $\mathbf{u}$ and $\mathbf{v}$.

Problem 5 Scalar Multiples (easy)

For $\mathbf{v} = \langle -3, 8 \rangle$, find $5\mathbf{v}$, $-\frac{1}{4}\mathbf{v}$ and the magnitude of $5\mathbf{v}$.

Problem 6 Find a Unit Vector (easy)

Find the unit vector in the direction of $\mathbf{v} = \langle 2, -5 \rangle$. Give decimals to three places.

Problem 7 Linear Combination of Vectors (medium)

Let $\mathbf{u} = \langle -1, 4 \rangle$ and $\mathbf{v} = \langle 3, -2 \rangle$. Find $2\mathbf{u} - 3\mathbf{v}$ and its magnitude.

Problem 8 Angle Between Two Vectors (medium)

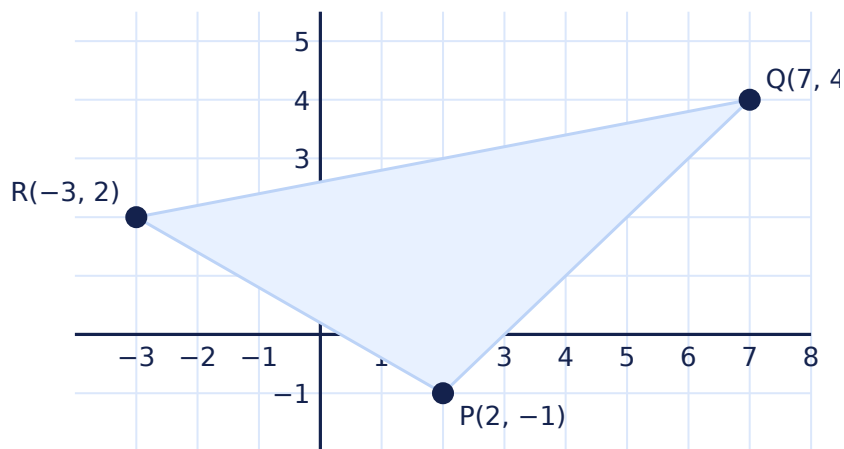
Find the dot product of $\mathbf{u} = \langle 6, 1 \rangle$ and $\mathbf{v} = \langle -2, 5 \rangle$, and the angle between them to the nearest tenth of a degree.

Problem 9 Perpendicular Vectors (medium)

(a) Find k so that $\langle k, 6 \rangle$ is perpendicular to $\langle 9, -4 \rangle$. (b) Are $\langle 2, 7 \rangle$ and $\langle -7, 2 \rangle$ perpendicular?

Problem 10 Vectors Between Three Points (medium)

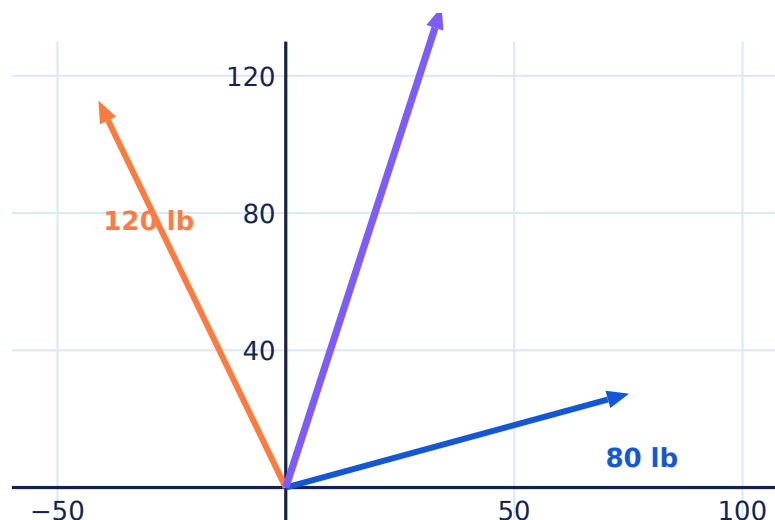
Triangle PQR has $P(2, -1)$, $Q(7, 4)$ and $R(-3, 2)$. Find the vectors $\mathbf{PQ}$, $\mathbf{PR}$ and $\mathbf{QR}$, verify that $\mathbf{QR} = \mathbf{PR} - \mathbf{PQ}$, and find the three side lengths.



Triangle PQR.

Problem 11 Two Forces on a Crate (medium)

Two forces act on a crate: 80 pounds at 20° and 120 pounds at 110° (angles measured from the positive x-axis). Find the resultant force vector, its magnitude and its direction.



Two forces and their resultant.

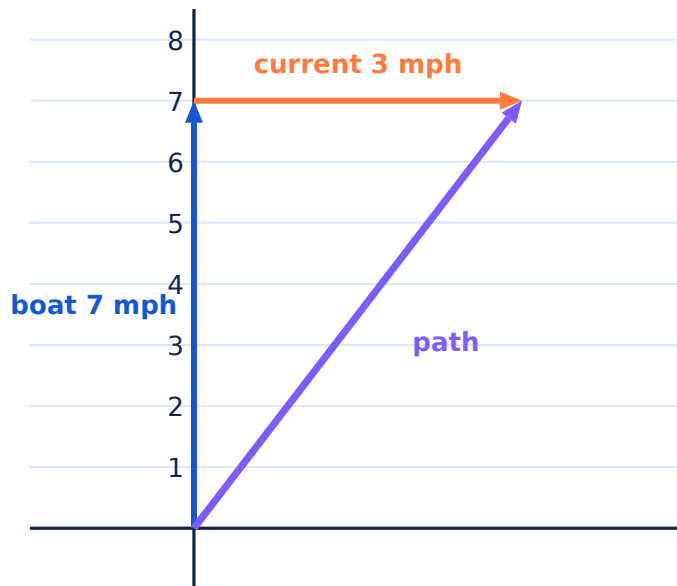
Problem 12 Plane and Crosswind (medium)

A plane heads north at an airspeed of 310 mph while a wind blows from the west at 45 mph. Find the plane's ground velocity vector, its ground speed, and the angle by which its path is east of north.

Problem 13 Boat Crossing a River (medium)

A boat aims straight across a river at 7 mph while the current flows downstream at 3 mph. Find its actual speed, the angle of its path downstream from straight across, and, for a river 0.8 mile

wide, the crossing time in minutes and the downstream drift in miles.



Boat velocity plus current velocity.

Problem 14 Force for Equilibrium (medium)

Forces $\langle 30, -12 \rangle$ and $\langle -18, 40 \rangle$ pounds act on a ring. Find the third force that keeps the ring in equilibrium, and its magnitude.

Problem 15 Diagonals of a Parallelogram (medium)

A parallelogram has side vectors $\mathbf{u} = \langle 5, 1 \rangle$ and $\mathbf{v} = \langle -2, 4 \rangle$. Find both diagonals as vectors and their magnitudes, and check that $|\mathbf{u} + \mathbf{v}|^2 + |\mathbf{u} - \mathbf{v}|^2 = 2(|\mathbf{u}|^2 + |\mathbf{v}|^2)$.

Problem 16 Work Done Pulling a Wagon (hard)

A child pulls a wagon with a force of 45 pounds at 30° above the horizontal, moving it 60 feet horizontally. Work is the dot product of the force vector and the displacement vector. Find the work in foot-pounds.

Problem 17 Glider in a Wind (hard)

A glider has an airspeed of 85 mph on a compass heading of 060° (measured clockwise from north). A 20 mph wind blows from the north. Find its ground velocity, ground speed, and the compass bearing of its path.

Problem 18 Tension in Two Ropes (hard)

A 150-pound sign hangs from two ropes that make angles of 40° and 55° with the horizontal on opposite sides. Find the tension in each rope.

Problem 19 Angle Between Two Trails (hard)

Two trails leave a lodge in the directions $\langle 8, 3 \rangle$ and $\langle 2, 7 \rangle$ (miles east, miles north). Find the angle between the trails to the nearest tenth of a degree.

Problem 20 Drone Flight Path (hard)

A drone flies from $A(0, 3)$ to $B(9, 10)$ and then to $C(15, 0)$. Find the vectors **AB**, **BC** and the total displacement **AC**, the angle at B between **BA** and **BC**, and the total distance flown.