

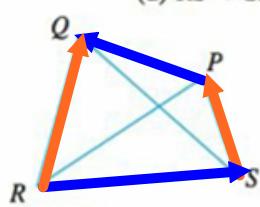
4. Write each combination of vectors as a single vector.

(a) $\vec{PQ} + \vec{QR}$

(c) $\vec{QS} - \vec{PS}$

(b) $\vec{RP} + \vec{PS}$

(d) $\vec{RS} + \vec{SP} + \vec{PQ}$



(a) $\vec{PQ} + \vec{QR} = \vec{PR}$

(b) $\vec{RP} + \vec{PS} = \vec{RS}$

(c) $\vec{QS} - \vec{PS} = \vec{QP}$

(d) $\vec{PS} + \vec{SP} + \vec{PQ} = \vec{RQ}$

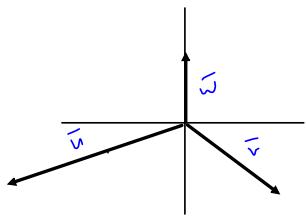
5. Copy the vectors in the figure and use them to draw the following vectors.

(a) $\vec{u} + \vec{v}$

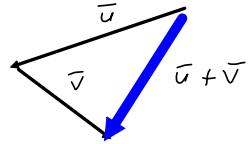
(b) $\vec{u} - \vec{v}$

(c) $\vec{v} + \vec{w}$

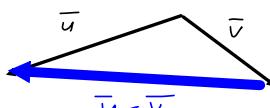
(d) $\vec{w} + \vec{v} + \vec{u}$



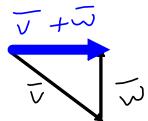
(a) $\vec{u} + \vec{v}$



(b) $\vec{u} - \vec{v}$

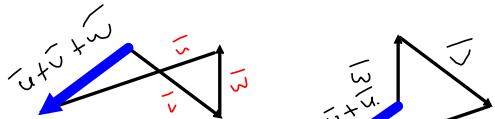


(c) $\vec{v} + \vec{w}$



(d) $\vec{u} + \vec{v} + \vec{w}$

$\vec{w} + \vec{u} + \vec{v}$

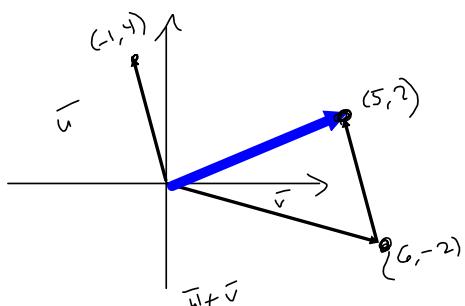
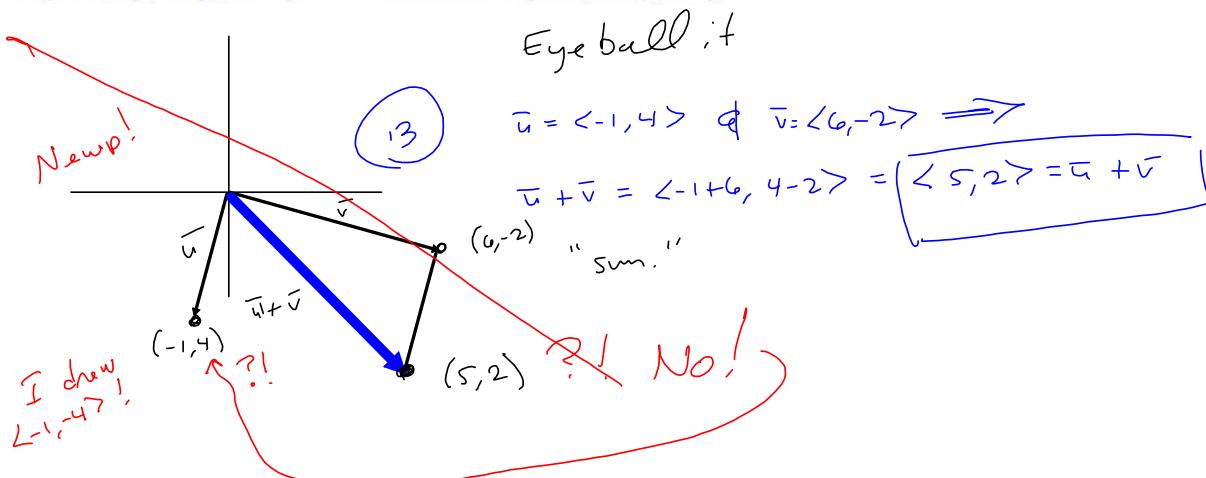


$\vec{u} + \vec{v} + \vec{w}$
 $\vec{v} + \vec{u} + \vec{w}$
 $\vec{w} + \vec{v} + \vec{u}$

Same, *regarding less of order*.
graphical confirmation of commutativity of vector addition.
(abelian group under addition)

13-16 Find the sum of the given vectors and illustrate geometrically.

13. $\langle -1, 4 \rangle, \langle 6, -2 \rangle$



17-20 Find $\mathbf{a} + \mathbf{b}$, $2\mathbf{a} + 3\mathbf{b}$, $\|\mathbf{a}\|$, and $\|\mathbf{a} - \mathbf{b}\|$

17. $\mathbf{a} = \langle 5, -12 \rangle, \mathbf{b} = \langle -3, -6 \rangle$

$$\bar{a} + \bar{b} = \langle 5 - 3, -12 - 6 \rangle = \boxed{\langle 2, -18 \rangle = \bar{a} + \bar{b}}$$

$$2\bar{a} + 3\bar{b}$$

$$= 2 \langle 5, -12 \rangle + 3 \langle -3, -6 \rangle$$

$$= \langle 10, -24 \rangle + \langle -9, -18 \rangle$$

$$= \boxed{\langle 1, -42 \rangle = 2\bar{a} + 3\bar{b}}$$

$$\|\bar{a}\| = \sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = \boxed{13 = \|\bar{a}\|}$$

$$\|\bar{a} - \bar{b}\| = \|\langle 5 - (-3), -12 - (-6) \rangle\| = \|\langle 8, -6 \rangle\|$$

$$= \sqrt{8^2 + 6^2} = \sqrt{64 + 100} = \sqrt{164} = \boxed{10 = \|\bar{a} - \bar{b}\|}$$

21-23 Find a unit vector that has the same direction as the given vector.

21. $-3\mathbf{i} + 7\mathbf{j}$

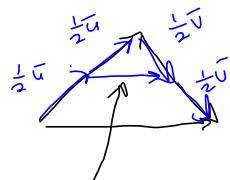
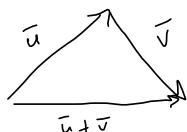
$$-3\mathbf{i} + 7\mathbf{j}$$

$$= \langle -3, 0, 0 \rangle + \langle 0, 7, 0 \rangle$$

$$= \langle -3, 7, 0 \rangle$$

$$\begin{aligned}\mathbf{i} &= \langle 1, 0, 0 \rangle \\ \mathbf{j} &= \langle 0, 1, 0 \rangle \\ \mathbf{k} &= \langle 0, 0, 1 \rangle\end{aligned}\right. \quad \left. \begin{array}{l} \text{Canonical} \\ \text{Basis for} \\ \mathbb{R}^3 \end{array} \right.$$

45. Use vectors to prove that the line joining the midpoints of two sides of a triangle is parallel to the third side and half its length.



$$\frac{1}{2}\mathbf{u} + \frac{1}{2}\mathbf{v} = \frac{1}{2}(\mathbf{u} + \mathbf{v})$$

is $\frac{1}{2}$ the length of $\mathbf{u} + \mathbf{v}$
in the direction of $\mathbf{u} + \mathbf{v}$.