When a vector has a magnitude of 1, it is called a **Unit Vector**.

Vector $\hat{i}$ is **The Unit vector in the Positive x Direction**.

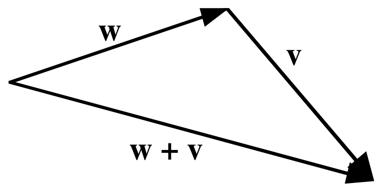
Vector $\hat{j}$ is **The Unit vector in the Positive y Direction**.

Vector $\hat{k}$ is **The Unit vector in the Positive z Direction**.

Basic Vector Operations:

Vector Addition is performed by adding the horizontal components and adding the vertical components.

<3,-4> + <-5, 1> = <-2, -3> Graphically, to find **w** + **v**, take the Tail of one **v** and place it at the Head of **w**, then draw a vector from the the Tail of **w** to the head of **v**.



The **Scalar Multiple** of the Real Number -3 times the vector: -3<3, -5> = <-9, 15> .

Vectors **u** and **v** are **oirthogonal** if **u** • **v** = 0

Dot Product:

$\langle a,b\rangle \bullet \langle c,d\rangle = \langle ac,bd\rangle$

u · v = v · u The Dot Product is a commutative operation.

u · v = $\|u\|\,\|v\|\cos\theta$ Knowing a Dot Product can help find the Angle Between 2 Vectors.

If **u · v** = 0, then the vectors are orthogonal (perpendicular), and vice versa.

u = <3, -5>, **v** = <5, 7>

1. Find **u** • **v**

   15 – 35 = $\boxed{-20}$

2. Find ||**u**||

   $\sqrt{3^2 + (-5)^2}$

   $\boxed{\sqrt{34}}$

3. Find ||**v**||

   $\sqrt{5^2 + 7^2}$

   $\boxed{\sqrt{74}}$

4. Find the angle between **u** and **v** in degrees.

   u • **v** = $\|u\|\,\|v\|\cos\theta$,

   $$\cos\theta = \frac{u \bullet v}{\|u\|\,\|v\|}$$

   $$\theta = \arccos\left(\frac{u \bullet v}{\|u\|\,\|v\|}\right)$$

   $$\theta = \arccos\left(\frac{-20}{\sqrt{(34)(74)}}\right)$$

   $$\theta = \boxed{113.499^\circ}$$

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Exer. 1-4: Use the vectors **u** = <2,2>, **v** = <-3,4>, and **w** = <1,-4> to find the indicated quantity. State whethe the result is a vector or a scalar.

1. **u . u**
2. **v** · **w**
3. **u** · **2v**
4. (**u .** 2**v**)**w**

Exer. 5-10: Use vectors u = <2, 2>, **v** = <-3, 4>, and **w** = <1, -4> to find the indicated quantity.

5. **u** · **u**
6. **v** · **w**
7. **u** · 2**v**
8. 4**u** · **v**
9. (3**w** · **v**)**u**
10. (**u** · 2**v**)**w**

Exer. 11-16: Find the magnitude of **u**.

11. **u** = <-5, 12>
12. **u =** <2 -4>
13. **u** = 20**i** + 25**j**
14. **u** = 6**i** – 10**j**
15. **u** = -4**j**
16. **u** = 9**i**

Exer. 17-24: Find the angle θ (in degrees 17-22, in radians 23-24) between the 2 vectors.

17. **u** = <-1, 0>, **v** = <0, 2>
18. **u** = <4, 4>, **v** = <-2, 0>
19. **u** = 3**i** + 4**j**, **v** = -2**i** + 3**j**
20. **u** = 2**i** – 3**j**, **v** = **i** – 2**j**
21. **u** = 2**i**, **v** = -3**j**
22. **u** = 4**j**, **v** = -3**j**
23. $\mathbf{u} = \cos\frac{\pi}{3}\mathbf{i} + \sin\frac{\pi}{3}\mathbf{j},\ \mathbf{v} = \cos\frac{3\pi}{4}\mathbf{i} + \sin\frac{3\pi}{4}\mathbf{j}$
24. $\mathbf{u} = \cos\frac{\pi}{4}\mathbf{i} + \sin\frac{\pi}{4}\mathbf{j},\ \mathbf{v} = \cos\frac{2\pi}{3}\mathbf{i} + \sin\frac{2\pi}{3}\mathbf{j}$

Exer. 25-26: Find **u** · **v**, where θ is the angle between **u** and **v**.

25. $\|u\| = 9 \quad \|v\| = 16 \quad \theta = \frac{3\pi}{4}$
26. $\|u\| = 4 \quad \|v\| = 12 \quad \theta = \frac{\pi}{3}$