**Dot-Product Lab Using Vector Addition Simulation** Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Construct the vectors **u** = $\left〈6, 12\right〉$and **v** = $\left〈-24, 12\right〉$. Position them so that their initial points coincide.

 You may move the vectors so that they are not at the origin to see the full vectors.

 What is the direction of **u**? \_\_\_\_\_\_\_\_\_\_ What is the direction of **v**? \_\_\_\_\_\_\_\_\_\_

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 (Hint: Subtract the two angles for the direction of **u** and **v**.)

 Multiply the horizontal components of the vectors and the vertical components of the vectors and

 add the results. What did you get? \_\_\_\_\_\_\_\_\_\_

 This is called the **dot product** and is written **u**$∙$**v =** $a\_{1}a\_{2}+b\_{1}b\_{2}$where **u =** $\left〈a\_{1},b\_{1}\right〉$and **v =** $\left〈a\_{2},b\_{12}\right〉$

2. Construct the vectors **u** = $\left〈10, -5\right〉$and **v** = $\left〈15, 30\right〉$.

 What is the direction of **u**? \_\_\_\_\_\_\_\_\_\_ What is the direction of **v**? \_\_\_\_\_\_\_\_\_\_

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

3. Construct the vectors **u** = $\left〈-8, -4\right〉$and **v** = $\left〈10, -20\right〉$.

 What is the direction of **u**? \_\_\_\_\_\_\_\_\_\_ What is the direction of **v**? \_\_\_\_\_\_\_\_\_\_

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

If the angle between two vectors, **u** and v, is 90$°$, then the dot product **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

4. Find a vector, **v**, that is perpendicular to **u** = $\left〈-16, 5\right〉 $and has a different length than **u**.

 **v** = \_\_\_\_\_\_\_\_\_\_ Construct vector **v** and **u**.

 What is the **length** of **u**? $\left|u\right|= $\_\_\_\_\_\_\_\_\_\_ What is the **length** of **v**? $\left|v\right|= $\_\_\_\_\_\_\_\_\_\_

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

5. Construct two vectors of different lengths that are perpendicular (orthogonal) to each other and

 NOT used above.

 **u** = \_\_\_\_\_\_\_\_\_\_

 **v** = \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

6. Construct the vectors **u** = $\left〈40, 0\right〉$and **v** = $\left〈16, 30\right〉$.

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

 What is the length of **u**? $\left|u\right|= $\_\_\_\_\_\_\_\_\_\_

 What is the length of **v**? $\left|v\right|= $\_\_\_\_\_\_\_\_\_\_

 What is $\frac{u∙v}{\left|u\right|\left|v\right|}$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

 (The numerator is the dot product. The denominator is the product of the lengths of the vectors.

 Be careful when grouping the denominator. Round your answer to the nearest thousandth.)

 What is $cos^{-1}\left(\frac{u∙v}{\left|u\right|\left|v\right|}\right)$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

 Does this answer agree with the angle between the two vectors that you answered on the first

 question above? \_\_\_\_\_\_\_

 Since vector **u** is has an angle measure of 0$°,$ another way of measuring the angle between the two

 vectors is to use the horizontal and vertical components of vector **v**.

 What is $tan^{-1}\left(\frac{R\_{y}}{R\_{x}}\right)$ for vector **v**? \_\_\_\_\_\_\_\_\_\_ Show your work here.

7. Construct the vectors **u** = $\left〈12, -8\right〉$and **v** = $\left〈36, 20\right〉$.

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

 What is the length of **u**? $\left|u\right|= $\_\_\_\_\_\_\_\_\_\_

 What is the length of **v**? $\left|v\right|= $\_\_\_\_\_\_\_\_\_\_

 What is $\frac{u∙v}{\left|u\right|\left|v\right|}$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

 What is $cos^{-1}\left(\frac{u∙v}{\left|u\right|\left|v\right|}\right)$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

8. Construct the vectors **u** = $\left〈-16, -10\right〉$and **v** = $\left〈32, -9\right〉$.

 What is the angle between the two vectors? \_\_\_\_\_\_\_\_\_\_

 What is the dot product? **u**$∙$**v =**  \_\_\_\_\_\_\_\_\_\_

 What is the length of **u**? $\left|u\right|= $\_\_\_\_\_\_\_\_\_\_

 What is the length of **v**? $\left|v\right|= $\_\_\_\_\_\_\_\_\_\_

 What is $\frac{u∙v}{\left|u\right|\left|v\right|}$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

 What is $cos^{-1}\left(\frac{u∙v}{\left|u\right|\left|v\right|}\right)$? \_\_\_\_\_\_\_\_\_\_ Show your work here.

9. Find the angle between **u** = $\left〈19, 14\right〉$and **v** = $\left〈0, -15\right〉$ . Show your work below.

 **u**$∙$**v =**

 $\left|u\right|= $

 $\left|v\right|= $

$$ θ=cos^{-1}\left(\frac{u∙v}{\left|u\right|\left|v\right|}\right)=$$

 Construct the vectors to check your answer.

10. Find the angle between **u** = $\left〈-16, 12\right〉$and **v** = $\left〈20, -15\right〉$ . Show your work below.

 **u**$∙$**v =**

 $\left|u\right|= $

 $\left|v\right|= $

$$ θ=cos^{-1}\left(\frac{u∙v}{\left|u\right|\left|v\right|}\right)=$$

 Construct the vectors to check your answer.