LESSON MAKER PRO

Vector Direction Lab

Use dot products to measure direction and find projections.

HIGH SCHOOL · MA.912.NSO.3.4

MA.912.NSO.3.4 "Solve mathematical and real-world problems involving vectors in two dimensions using the dot product and vector projections."

NAME ______________________ DATE ____________

DOT, THEN PROJECT

For u=<a,b> and v=<c,d>, the dot product is u·v=ac+bd. A dot product of 0 means the vectors are perpendicular. To project u onto v, use proj_v u=((u·v)/(v·v))v.

WORKED EXAMPLE

Find proj_b a for a=<11,-13> and b=<2,7>.

1. a·b = 11(2) + (-13)(7) = -69.
2. b·b = 2^2 + 7^2 = 53.
3. proj_b a = (-69/53)<2,7> = <-138/53,-483/53>.

Answer: <-138/53,-483/53>

PRACTICE 6 problems

1 Compute <5,-3>·<-4,9>.

ANSWER ____________________

2 Compute <-6,10>·<-5,-8>.

ANSWER ____________________

3 Are <9,15> and <-5,3> perpendicular? Show the dot product.

ANSWER ____________________

4 Find proj_v u, where u=<0,15> and v=<3,4>.

ANSWER ____________________

5 Find proj_v u, where u=<20,-10> and v=<5,-5>.

ANSWER ____________________

6 Find x so that <x,4> and <3,-6> are perpendicular.

ANSWER ____________________

APPLY IT Show your work

1 At robotics club, a robot applies a force F=<6,8> newtons while moving through a displacement d=<10,5> meters. Use F·d to find the work done.

WORK SPACE

ANSWER ______________________

2 A video club drone has a wind vector w=<15,0> mph. Its planned flight direction is d=<3,4>. Find proj_d w, the part of the wind that pushes the drone along its flight direction.

WORK SPACE

ANSWER ______________________

CHALLENGE One step up

CHALLENGE

Let u=<10,15> and v=<3,4>. Write u as u_parallel+u_perp, where u_parallel is the projection of u onto v and u_perp is perpendicular to v.

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Compute <5,-3>·<-4,9>.	**-47**
2	Compute <-6,10>·<-5,-8>.	**-50**
3	Are <9,15> and <-5,3> perpendicular? Show the dot product.	**Yes. The dot product is 0.**
4	Find proj_v u, where u=<0,15> and v=<3,4>.	**<36/5,48/5>**
5	Find proj_v u, where u=<20,-10> and v=<5,-5>.	**<15,-15>**
6	Find x so that <x,4> and <3,-6> are perpendicular.	**x=8**

PART 2 · APPLY IT

1. **100 joules** Compute F·d=(6)(10)+(8)(5)=100. Since a newton times a meter is a joule, the work is 100 joules.
2. **<27/5,36/5> mph** Compute w·d=45 and d·d=25. Then proj_d w=(45/25)<3,4>=<27/5,36/5> mph.

CHALLENGE

u_parallel=<54/5,72/5> and u_perp=<-4/5,3/5>

Accept equivalent unsimplified fraction forms for projection coordinates. For the challenge, accept any correct decomposition in which the parallel component is a scalar multiple of <3,4> and the perpendicular component has dot product 0 with <3,4>.