LESSON MAKER PRO

Vector Power Moves

Use dot products and cross products in three dimensions.

HIGH SCHOOL · MA.912.NSO.3.5

MA.912.NSO.3.5 "Solve mathematical and real-world problems involving vectors in three dimensions using the dot product and cross product."

NAME _____ DATE _____

TWO VECTOR TOOLS

For u=<a,b,c> and v=<d,e,f>, the dot product is u·v=ad+be+cf. The cross product is u x v=<bf-ce, cd-af, ae-bd>; it is perpendicular to both vectors, and its magnitude gives the area of the parallelogram formed by the vectors.

WORKED EXAMPLE

Let u=<2,-3,5> and v=<4,1,-2>. Find u·v and u x v.

1. u·v=2(4)+(-3)(1)+5(-2)=-5.
2. u x v=<(-3)(-2)-5(1), 5(4)-2(-2), 2(1)-(-3)(4)>.
3. u x v=<1,24,14>.

Answer: u·v=-5; u x v=<1,24,14>.

PRACTICE 6 problems

1 Find the dot product of u=<6,-7,8> and v=<9,10,-11>.

ANSWER _____

2 Find a x b for a=<6,7,8> and b=<9,-10,11>.

ANSWER _____

3 Decide whether p=<6,8,10> and q=<8,-6,0> are perpendicular. Show the dot product.

ANSWER _____

4 Find the area of the parallelogram formed by a=<7,0,0> and b=<0,8,0>.

ANSWER _____

5 Use the dot product to classify the angle between m=<9,10,0> and n=<-11,8,0> as acute, obtuse, or right.

ANSWER _____

6 Find a normal vector to the plane determined by r=<6,0,8> and s=<0,10,0>. Use r x s.

ANSWER _____

APPLY IT Show your work

1 A virtual-reality game models a controller's force as F=<7,-8,9> newtons and its displacement as d=<10,11,12> meters. Find the work done by the force.

WORK SPACE

ANSWER _____

2 The theater club designs a parallelogram-shaped light frame. Two edge vectors from one corner are a=<9,0,12> centimeters and b=<0,15,0> centimeters. Find the area of the frame.

WORK SPACE

ANSWER _____

CHALLENGE One step up

Vectors a=<6,x,8> and b=<10,-6,0> are perpendicular. Find x. Then find a x b and the area of the parallelogram formed by a and b. Show your reasoning.

WORK SPACE AND ANSWER

ANSWER KEY

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PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	Find the dot product of u=<6,-7,8> and v=<9,10,-11>.	**-104**
2	Find a x b for a=<6,7,8> and b=<9,-10,11>.	**<157,6,-123>**
3	Decide whether p=<6,8,10> and q=<8,-6,0> are perpendicular. Show the dot product.	**Yes; p·q=0.**
4	Find the area of the parallelogram formed by a=<7,0,0> and b=<0,8,0>.	**56 square units**
5	Use the dot product to classify the angle between m=<9,10,0> and n=<-11,8,0> as acute, obtuse, or right.	**Obtuse, because m·n=-19.**
6	Find a normal vector to the plane determined by r=<6,0,8> and s=<0,10,0>. Use r x s.	**<-80,0,60>**

PART 2 · APPLY IT

1. **90 joules** Use the dot product: F·d=7(10)+(-8)(11)+9(12)=90.
2. **225 square centimeters** Find a x b=<-180,0,135>. Its magnitude is 225, which is the parallelogram's area.

CHALLENGE

x=10; a x b=<48,80,-136>; area=40sqrt17 square units

For perpendicular and angle-classification items, require dot-product evidence. Accept equivalent arithmetic work, but require the requested cross-product direction when a specific order is given.