Name: STANFORD Date:

**NV Physics Quiz 2 - Vectors**

Answer all of the following multiple-choice questions. Each is worth 5 points.

1. Find **C** = **A** + **B**, where **A** = -3**i** + 4**j** and **B** = -**i** + -3**j**.

(a) **C** = -4**i** + **j**

b) **C** = -2**i** + 7**j**

c) **C** = -2**i** + 1**j**

d) **C** = 2**i** + **j**

e) **C** = 2**i** - 7**j**

$\vec{C} = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$

$\vec{C} = (-3-1)\hat{i} + (4-3)\hat{j}$

$\vec{C} = -4\hat{i} + \hat{j}$

2. What is the magnitude of the vector **A** = **i** + **2j** - 2**k** ?

a) 1

b) 2

(c) 3

d) 5

e) 9

$|\vec{A}| = \sqrt{1^2 + 2^2 + (-2)^2}$

$= \sqrt{9} = 3$

3. **A** is a vector that lies between the –x and –y axes. **B** is parallel to –**k**. In what direction is the vector **C** = **A** x **B** ?

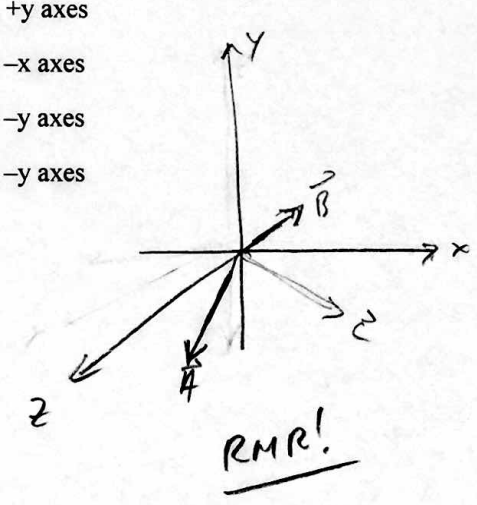
a) parallel to **k**

b) between +x and +y axes

c) between +y and –x axes

d) between –x and –y axes

(e) between +x and –y axes




RMR!

4. Find **C** = **A** • **B** where **A** = 1**i** + **2j** + 3**k** and **B** = 2**i** - **3j** + **k**

a) -5

(b) -1

c) 6

d) 11

e) 14

$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$

$= 2 - 6 + 3 = -1$

5. Find **C** = **A** - 2**B** where **A** = 2**i** – 3**j** and **b** = -**i** + **2j**

a) **C** = 3**i** - 7**j**

b) **C** = 3**i** - 5**j**

(c) **C** = 4**i** -7**j**

d) **C** = 4**i** - 5**j**

e) **C** = 4**i** - 1**j**

$2\hat{i} - 3\hat{j}$

$-(-2\hat{i} + 4\hat{j})$

$4\hat{i} - 7\hat{j}$

6. Find **A** • **B** where **A** = 2**i** + **j** - 2**k** and **B** = -**i** + **3j** -**k**

a) -3

b) -1

c) 1

(d) 3

e) 7

$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$

$= -2 + 3 + 2 = 3$

7. The direction of vector **C = A x B**, where **A = -2 i + j** and **B = i - 5j** is given by:

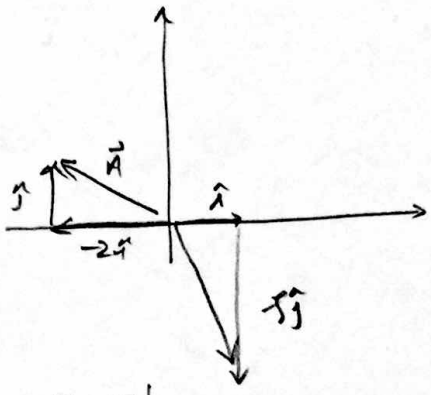
a) **C = i**

b) **C = - j**

c) **C = j**

d) **C = - k**

e) **C = k**




RMR!

Check:

$$\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 1 & 0 \\ 1 & -5 & 0 \end{vmatrix} = 0\hat{i} + 0\hat{j} + (10-1)\hat{k} = 9\hat{k}$$

8. Find **C = 2A - 3B** where **A = -i + 2j - k** and **B = -2i - j – k**

a) **C = -8i + j + k**

b) **C = -8i + 7j -5k**

c) **C = 4i + j + k**

d) **C = 4i + 7j - 5k**

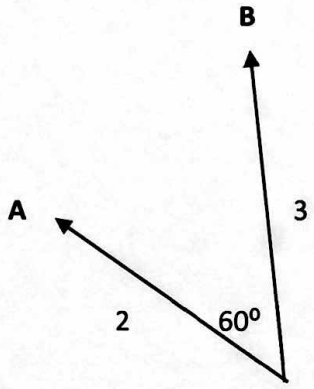
e) **C = 4i + 7j + k**

$$2\vec{A} = -2\hat{i} + 4\hat{j} - 2\hat{k}$$

$$-(3\vec{B}) = -(-6\hat{i} - 3\hat{j} - 3\hat{k})$$

$$\vec{C} = 4\hat{i} + 7\hat{j} + \hat{k}$$

9. Find **A • B** where **A** and **B** are vectors as shown below:




$$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos 60^\circ \quad (\cos 60^\circ = \tfrac{1}{2})$$

$$= (2)(3)\left(\tfrac{1}{2}\right) = 3$$

a) -3

b) $3\sqrt{3}$

c) $2\sqrt{3}$

d) 3

e) 7

10. **A = -3i** and **C = -6√2k**. If **C = A x B**, which of the following is a possible expression of the vector **B?**

a) **B = 2i + 2j**

b) **B = -2i + 4j**

c) **B = -2√2i + 2√2j**

d) **B = 4i + 2j**

e) **B = -4i + 2j**

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -3 & 0 & 0 \\ B_x & B_y & 0 \end{vmatrix}$$

must be 0 by RMR!

$$C_z = -6\sqrt{2} = -3B_y + 0B_x$$

$$B_y = 2\sqrt{2},\ B_x = \text{anything!}$$

$$\vec{B} = B_x\hat{i} + 2\sqrt{2}\hat{j}$$

**Part 2: Free – Response.** There are two questions in this part, each worth 25 points. Show all your work and circle or box your answers.

1. Given the following vectors:

**A** = -6i +2j -3k and **B** = 4i -3k

a) Find the magnitude of **A**.(5pts.) $|\vec{A}| = \sqrt{(-6)^2+(2)^2+(-3)^2} = 7$

b) Find the magnitude of **B**. (5pts.) $|\vec{B}| = \sqrt{4^2+(-3)^2} = 5$

c) Find **A**·**B** (5pts.) $\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$

$= (-6)(4) + 2(0) + (-3)(-3)$

$= -24 + 9 = -15$

d) Find **A** x **B** (5pts.) $\vec{A}\times\vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -6 & 2 & -3 \\ 4 & 0 & -3 \end{vmatrix} = (-6-0)\hat{i} + (-12-18)\hat{j} + (0-8)\hat{k}$

$= -6\hat{i} - 30\hat{j} - 8\hat{k}$

e) What is the angle between **A** and **B** ? You can leave your answer in terms of inverse trig functions as long as it is reduced as much as possible. (5pts.)

$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$

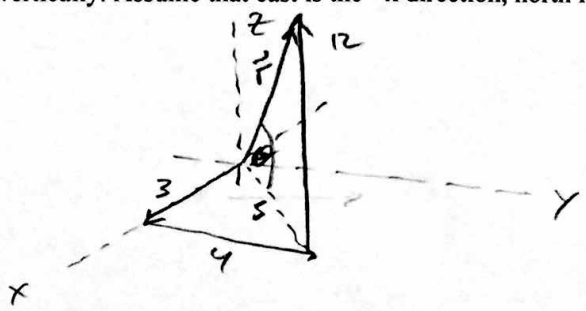
$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|} = \frac{-15}{7\cdot 5} = \frac{-5}{7}$

$\theta = \cos^{-1}\left(\frac{-5}{7}\right)$

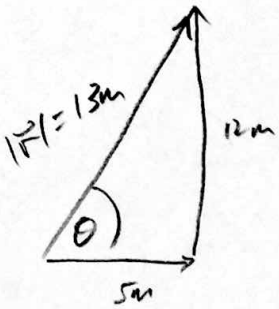
2. An insect crawls 3m eastward, then 4m northward, then 12m up a wall vertically. Assume that east is the +x direction, north is +y direction and "up" is +z direction.

a) Express his displacement vector **r** in terms of **i**, **j** and **k** (7 pts.)

$$\vec{r} = 3\hat{i} + 4\hat{j} + 12\hat{k}$$




b) Express his displacement vector **r** in terms of his distance from the origin and angle above horizontal. (8 pts.)

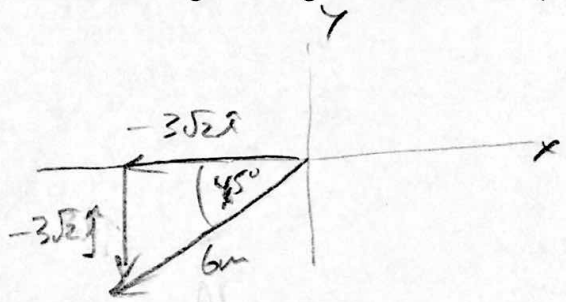



$$\theta = \tan^{-1}\left(\frac{12}{5}\right)$$

$\vec{r} = 13m$ @ $\tan^{-1}\left(\frac{12}{5}\right)$ above horizontal

c) The bug then crawls along a level ceiling a distance of 6m to the southwest (45° south of west). What is his displacement after completing this leg of his journey? Express your answer in terms of his distance from the origin and angle above horizontal. (10 pts.)

$$\Delta\vec{r} = -3\sqrt{2}\,\hat{i} - 3\sqrt{2}\,\hat{j}$$



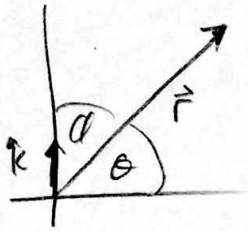

$$\vec{r} = (3-3\sqrt{2})\,\hat{i} + (4-3\sqrt{2})\,\hat{j} + 12\hat{k}$$

$$|\vec{r}| = \sqrt{(3-3\sqrt{2})^2 + (4-3\sqrt{2})^2 + 12^2}$$

$$= \sqrt{9 - 6\sqrt{2} + 18 + 16 - 24\sqrt{2} + 18 + 144}$$

$$|\vec{r}| = \sqrt{205 - 30\sqrt{2}}$$

To find angle between x-y plane and $\vec{r}$:




$$\vec{r}\cdot\hat{k} = |\vec{r}||\hat{k}|\cos\phi$$

$$\vec{r}\cdot\hat{k} = 12 = \sqrt{205 - 30\sqrt{2}}\cos\phi$$

$$\cos\phi = \frac{12}{\sqrt{205-30\sqrt{2}}}$$

$$\theta = 90 - \cos^{-1}\frac{12}{\sqrt{205-30\sqrt{2}}}$$