PHYS 101: General Physics | KOÇ UNIVERSITY | Spring Semester 2016

College of Arts and Sciences

Section 2 | Quiz 1 | 12 September 2016

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes
First Name: **Last name:** **Student ID:** **Signature:**

Find a unit vector that lies in the xy plane and is perpendicular to the vector:

$$4\hat{\imath} + 5\hat{\jmath}$$

We are looking for a vector that lies in xy plane. In the most general form, it can be expressed as:

$$a\hat{\imath} + b\hat{\jmath}.$$

We also need it to be perpendicular to $4\hat{\imath} + 5\hat{\jmath}$. Therefore:

$$(a\hat{\imath} + b\hat{\jmath}) \cdot (4\hat{\imath} + 5\hat{\jmath}) = 0$$

should be satisfied. Since we need it to be a unit vector, it should satisfy:

$$a^2 + b^2 = 1.$$

Now we can solve for a and b.

$$(a\hat{\imath} + b\hat{\jmath}) \cdot (4\hat{\imath} + 5\hat{\jmath}) = 0 \Rightarrow 4a + 5b = 0 \Rightarrow b = -\frac{4a}{5}$$

$$a^2 + b^2 = a^2 + \frac{16a^2}{25} = \frac{41a^2}{25} = 1 \Rightarrow a = \pm\frac{5}{\sqrt{41}}, \quad b = \mp\frac{4}{\sqrt{41}}.$$

There are two solutions:

(i) $\frac{5}{\sqrt{41}}\hat{\imath} - \frac{4}{\sqrt{41}}\hat{\jmath}$

(ii) $-\frac{5}{\sqrt{41}} + \frac{4}{\sqrt{41}}\hat{\jmath}$

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Section 1 | Quiz 1 | 12 February 2016

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Quiz duration: 10 minutes

First Name: Last name: Student ID: Signature:

Find a unit vector that is perpendicular to both $2\hat{\imath} + 3\hat{k}$ and $4\hat{\imath} + 5\hat{\jmath}$.

Cross product of two vectors is perpendicular to both vectors.

$$(2\hat{\imath} + 3\hat{k}) \times (4\hat{\imath} + 5\hat{\jmath}) = (2\hat{\imath} \times 4\hat{\imath}) + (2\hat{\imath} \times 5\hat{\jmath}) + (3\hat{k} \times 4\hat{\imath}) + (3\hat{k} \times 5\hat{\jmath})$$

$$= 0 + 10\hat{k} + 12\hat{\jmath} - 15\hat{\imath}$$

$$= -15\hat{\imath} + 12\hat{\jmath} + 10\hat{k}.$$

The solution is not complete yet. We need to find a unit vector. To make its length one, we need to divide our solution by its length.

$$\frac{-15\hat{\imath} + 12\hat{\jmath} + 10\hat{k}}{\sqrt{(-15)^2 + (12)^2 + 10^2}} = \frac{-15\hat{\imath} + 12\hat{\jmath} + 10\hat{k}}{\sqrt{469}} \quad //$$

There is another solution which could be obtained if we reversed the order of cross product!

$$\frac{+15\hat{\imath} - 12\hat{\jmath} - 10\hat{k}}{\sqrt{469}} \quad //$$

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Section 3 | Quiz 1 | 12 February 2016

Closed book. No calculators are to be used for this quiz.

Quiz duration: 10 minutes

First Name: **Last name:** **Student ID:** **Signature:**

Use direct substitution and evaluate $\vec{\mathbf{A}} \times (\vec{\mathbf{B}} \times \vec{\mathbf{C}})$ and $\vec{\mathbf{B}}(\vec{\mathbf{A}} \cdot \vec{\mathbf{C}}) - \vec{\mathbf{C}}(\vec{\mathbf{A}} \cdot \vec{\mathbf{B}})$ for the vectors $\vec{\mathbf{A}} = 2\hat{\imath} + \hat{\jmath}$, $\vec{\mathbf{B}} = \hat{\jmath}$, and $\vec{\mathbf{C}} = \hat{\boldsymbol{k}}$. Hint: You should obtain the same result for both expressions.

$$\vec{A} \times (\vec{B} \times \vec{C}) = (2\hat{\imath} + \hat{\jmath}) \times (\hat{\jmath} \times \hat{k})$$
$$= (2\hat{\imath} + \hat{\jmath}) \times \hat{\imath}$$
$$= (2\hat{\imath} \times \hat{\imath}) + (\hat{\jmath} \times \hat{\imath}) = 0 - \hat{k} = -\hat{k}$$

$$\vec{B}(\vec{A} \cdot \vec{C}) - \vec{C}(\vec{A} \cdot \vec{B}) = \hat{\jmath}\left[(2\hat{\imath} + \hat{\jmath}) \cdot \hat{k}\right] - \hat{k}\left[(2\hat{\imath} + \hat{\jmath}) \cdot \hat{\jmath}\right]$$
$$= \hat{\jmath}(2\hat{\imath} \cdot \hat{k} + \hat{\jmath} \cdot \hat{k}) - \hat{k}(2\hat{\imath} \cdot \hat{\jmath} + \hat{\jmath} \cdot \hat{\jmath})$$
$$= \hat{\jmath}(0 + 0) - \hat{k}(0 + 1)$$
$$= -\hat{k}$$