PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Spring Semester 2015**

College of Arts and Sciences

Section **Quiz 1-1** **February 2014**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

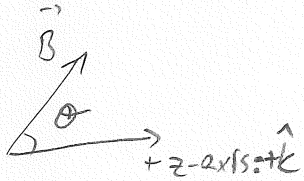
Name: **Student ID:** **Signature:**

Given two vectors $\vec{A} = 2\hat{\imath} - \hat{\jmath}$, and $\vec{B} = -\hat{\imath} + b\hat{\jmath} + c\hat{k}$, where b and c are some constants. If $|\vec{B}| = 3$ and $\vec{A}$ and $\vec{B}$ are perpendicular, find the angle the vector $\vec{B}$ makes with the positive z-axis (you can give your result in terms of inverse trigonometric functions)

$|\vec{B}| = 3 \Rightarrow |\vec{B}|^2 = \vec{B}\cdot\vec{B} = 1 + b^2 + c^2 = 9 \Rightarrow b^2 + c^2 = 8$

$\vec{A}\cdot\vec{B} = -2 - b = 0 \Rightarrow b = -2 \Rightarrow 4 + c^2 = 8 \Rightarrow c^2 = 4$

$c = \pm 2$



$\vec{B}\cdot\hat{k} = |\vec{B}|\,|\hat{k}|\cos\theta$

$c = 3 \cdot 1 \cdot \cos\theta \Rightarrow \cos\theta = \pm\frac{2}{3}$

$\theta = \arccos(\pm 2/3)$

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Section **Quiz 1-2** **February 2015**

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Name: **Student ID:** **Signature:**

Two perpendicular unit vectors $\hat{u}$ and $\hat{v}$ satisfy $\hat{u} \times \hat{v} = \frac{1}{\sqrt{2}}(\hat{\imath} - \hat{\jmath})$. If $\hat{u}$ has no x-component, find $\hat{v}$.(Hint: write $\hat{u}$ and $\hat{v}$ as three dimensional vectors unknown components and determine the components of $\hat{v}$)

$\hat{u} = u_1\hat{\imath} + u_2\hat{\jmath} + u_3\hat{k}$

$\hat{v} = v_1\hat{\imath} + v_2\hat{\jmath} + v_3\hat{k}$

$u_1 = 0$ (no x-component)

$\hat{u} \cdot \hat{v} = 0$ (perpendicular)

$u_2 v_2 + v_3 u_3 = 0$

$$\hat{u} \times \hat{v} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 0 & u_2 & u_3 \\ v_1 & v_2 & v_3 \end{vmatrix} = (u_2 v_3 - u_3 v_2)\hat{\imath} + (u_3 v_1)\hat{\jmath} + (u_2 v_1)\hat{k}$$

$\hat{u} \times \hat{v} = \frac{1}{\sqrt{2}}\hat{\imath} - \frac{1}{\sqrt{2}}\hat{\jmath}$

$u_3 v_3 = 0$

$\Downarrow$

$v_3 = 0$

$\Rightarrow u_2 v_1 = 0$ $\quad u_3 v_1 = \frac{-1}{\sqrt{2}}$ $\quad u_2 v_3 - u_3 v_2 = \frac{1}{\sqrt{2}}$

$u_2 = 0$ $\quad u_3 \neq 0$ $\quad v_1 \neq 0$

$u_3 v_2 = -1/\sqrt{2}$

$u_3 v_1 = -1/\sqrt{2}$

$|\hat{u}| = 1 \Rightarrow u_3 = \pm 1$

$\Downarrow$

$v_1 = -v_2 = \pm 1/\sqrt{2}$ $\quad v_3 = 0$

$\hat{v} = \pm \frac{1}{\sqrt{2}}(\hat{\imath} + \hat{\jmath})$

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Section **Quiz 1-3** **February 2015**

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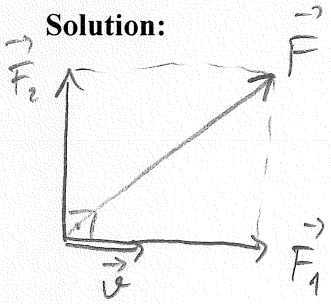
Name: **Student ID:** **Signature:**

At an instant the velocity of a particle is given as $\vec{v} = 3\hat{\imath} - \hat{\jmath}$ (m/s). The force acting on the particle is $\vec{F} = \hat{\imath} + \hat{\jmath} - \hat{k}$ (N). If we consider the force vector as the sum of two vectors $\vec{F} = \vec{F}_1 + \vec{F}_2$ such that $\vec{F}_1$ is parallel to $\vec{v}$ and $\vec{F}_2$ is perpendicular to $\vec{v}$, determine the magnitude of $\vec{F}_2$.(Hint: Consider the geometrical interpretation of the scalar product of two vectors).

Solution:



$$\vec{F}\cdot\vec{v} = (\vec{F}_1+\vec{F}_2)\cdot\vec{v} = \vec{F}_1\cdot\vec{v} + \underbrace{\vec{F}_2\cdot\vec{v}}_{=0}$$

$$\vec{F}\cdot\vec{v} = 3-1 = 2 = \vec{F}_1\cdot\vec{v} = F_1 v \underbrace{\cos\theta}_{=1} \quad \text{as } \vec{F}_1 \parallel \vec{v}$$

$$v = \sqrt{9+1} = \sqrt{10}$$

$$\Rightarrow F_1 = \frac{2}{\sqrt{10}} \qquad \vec{F}_1 = F_1\hat{F}_1 = F_1\hat{v} = \frac{2}{\sqrt{10}}\cdot\frac{1}{\sqrt{10}}(3\hat{\imath}-\hat{\jmath})$$

$$\vec{F}_1 = \frac{3}{5}\hat{\imath} - \frac{1}{5}\hat{\jmath}$$

$$\vec{F}_2 = \vec{F} - \vec{F}_1 = \frac{2}{5}\hat{\imath} + \frac{6}{5}\hat{\jmath} - \hat{k}$$