1. Let $N$ be an integer greater than 1. Consider the sum of $N$ vectors of equal length, each vector making an angle of $2\pi/N$ with that preceding. Then show:

$$
\cos 0 + \cos \frac{2\pi}{N} + \cos \frac{4\pi}{N} + \ldots + \cos \left( N - 1 \right) \frac{2\pi}{N} = 0
$$

that is, 

$$
\sum_{n=0}^{N-1} \cos \frac{2\pi n}{N} = 0
$$

Also show:

$$
\sum_{n=0}^{N-1} \sin \frac{2\pi n}{N} = 0
$$

2. Three vectors are given by $\vec{a} = 3\hat{i} + 3\hat{j} - 2\hat{k}$, $\vec{b} = -\hat{i} - 4\hat{j} + 2\hat{k}$, $\vec{c} = 2\hat{i} + 2\hat{j} + \hat{k}$.

Find (a) $\vec{a} \cdot (\vec{b} \times \vec{c})$, (b) $\vec{a} \cdot (\vec{b} + \vec{c})$, (c) $\vec{a} \times (\vec{b} + \vec{c})$.

(d) See if you can find two scalars $\alpha$ and $\beta$ so that $\vec{c} = \alpha \vec{a} + \beta \vec{b}$.

3. Use vector methods and find the angle between the body diagonals of a cube.

4. Find the angle $\phi$ defined by the two diagonals of a parallelogram of sides $a$ and $b$, with $b < a$. The angle $\alpha$ is the angle between the two sides of the parallelogram, as shown below and it is given. (Use the scalar product to find $\phi$).
5. Given a fixed vector $\vec{a}$, find the equation of the surface described by the end points of all position vectors $\vec{r}$ such that $\vec{r}$ is perpendicular to the vector $\vec{r} - \vec{a}$. Express your answer as an equation relating $(x, y, z)$, the components of $\vec{r}$ in a convenient coordinate frame.