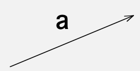
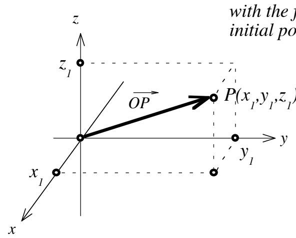
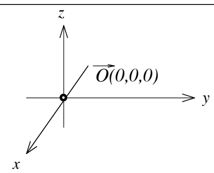
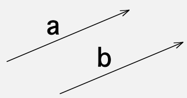
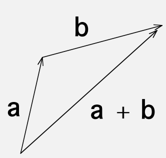
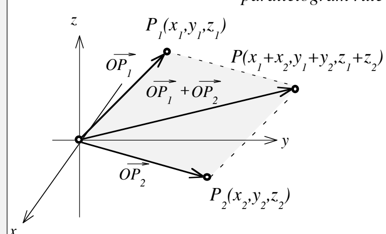
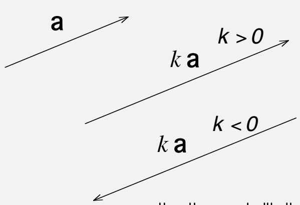
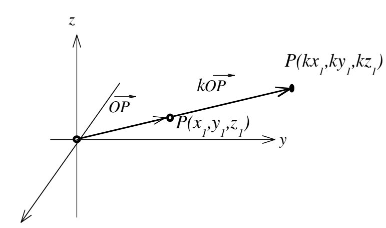
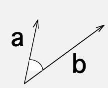
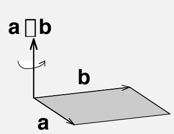
Vectors in Euclidian Space

free vector	**position vector**	**coordinate vector**	**1^{st} order tensor**
	*directed segment with the fixed initial point* 	*triple of real numbers* $\mathbf{a} = <a_1,a_2,a_3>$	a_i *with index convention:* $i = 1,2,3$ *and summation convention:* $a_j b_j = a_1 b_1 + a_2 b_2 + a_3 b_3$ $\delta_{ij} a_j = a_1 + a_2 + a_3$
zero vector ∘ *any point*		$\mathbf{0} = <0,0,0>$	0
norm $\lVert \mathbf{a} \rVert$ = *length of segment*	$\lVert \vec{OP} \rVert = \sqrt{x_1^2 + y_1^2 + z_1^2}$	$\lVert \mathbf{a} \rVert = \sqrt{a_1^2 + a_2^2 + a_3^2}$	$\sqrt{\delta_{ij} x_i x_j}$
equality $\mathbf{a} = \mathbf{b}$ *two vectors are equal if they have the same norm and direction*	$\vec{OP_1} = \vec{OP_2} \Leftrightarrow$ $x_1 = x_2$, $y_1 = y_2$, $z_1 = z_2$	$\mathbf{a} = \mathbf{b} \Leftrightarrow$ $a_1 = b_1$, $a_2 = b_2$, $a_3 = b_3$	$a_i = b_i$
summation 	*parallelogram rule* 	$\mathbf{a} + \mathbf{b} = <a_1 + b_1, a_2+b_2, a_3+b_3>$	$a_i + b_i$
multiplication by a scalar $\lVert k\mathbf{a} \rVert = \lvert k \rvert \lVert \mathbf{a} \rVert$		$k\mathbf{a} = <ka_1,ka_2,ka_3>$	ka_i
dot product $\mathbf{a} \cdot \mathbf{b} = \lVert \mathbf{a} \rVert \lVert \mathbf{b} \rVert cos(\mathbf{a},\mathbf{b})$	$\vec{OP_1} \cdot \vec{OP_2} = x_1 x_2 + y_1 y_2 + z_1 z_2$	$\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$	$a_i b_i$
cross product 	$\vec{OP_1} \times \vec{OP_2} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \end{vmatrix}$	$\mathbf{a} \times \mathbf{b}$ $= \langle a_2 b_3 - a_3 b_2, a_3 b_1 - a_1 b_3, a_1 b_2 - a_2 b_1 \rangle$	$(\mathbf{a} \times \mathbf{b})_i = a_j b_k - a_k b_j$ i,j,k is cyclic permutation of 1,2,3