RECITATION-1

1- Which of the equations below are dimensionally correct? (where v is velocity, x is position, *a is* acceleration, and *t is* time)

a) $x_s = x_i + v_{xi}t + \frac{1}{2}at^2$

b) $v_{xs}^2 = v_{xi}^2 - 2a(x_s - x_i)$

① a) $X_s = X_i + v_{xi} t + \frac{1}{2} a t^2$

$$[L] = [L] + \frac{[L]}{\cancel{[T]}}\cancel{[T]} + \frac{[L]}{\cancel{[T]^2}}\cancel{[T]^2}$$

$$[L] = [L] \quad \text{TRUE}$$

b) $v_{xs}^2 = v_{xi}^2 - 2a(x_s - x_i)$

$$\frac{[L]^2}{[T]^2} = \frac{[L]^2}{[T]^2} - \frac{[L]}{[T]^2}[L]$$

$$\frac{[L]^2}{[T]^2} = \frac{[L]^2}{[T]^2} \quad \text{TRUE}$$

2-

a) By using $E = mc^2$ and $E = \frac{hc}{\lambda}$ expressions, find the dimension of the Planck contant and SI units. (ın here, E is the energy, c is the speed of light, λ is wavelengt, m is mass and h is the Planck constant)

$$mc^2 = \frac{hc}{\lambda} \rightarrow h = mc\lambda$$

m (mass) : $[M]$; c (speed of light): $\frac{x}{t}$: $[L]/[T]$

λ (wavelenght) : $[L]$

$$[h] = [M][L][T]^{-1}[L]$$

$$\boxed{[h] = [M][L]^2[T]^{-1}} \rightarrow \boxed{SI \rightarrow kg\ m^2\ s^{-1}}$$

b) The period of a simple pendulum of length "l" is given by $T = 2\pi\sqrt{\frac{l}{g}}$, where g is the accelaration due to the gravity. Show that the equation is dimensionally correct. Find its unit in SI unit system.

$$[T] = \sqrt{\frac{[L]}{\frac{[L]}{[T]^2}}} = \sqrt{[T]^2} = [T]$$

In SI unit system, its unit is second (s)

3- In a rigid body, the distance between two adjacent atoms or molecules is assumed to be approximately equal to 2 times the radius of the volume of a molecule or atom. Find the distance between two adjacent atoms for;
   a) Iron and
   b) Sodium.

(The densities of iron and sodium are given as 7,87 g/cm^3 and 1,013 g/cm^3, respectively. The atomic masses are also 9,27x10^{-26} kg and 3,82x10^{-26} kg, respectively.)

a) **Volume of an iron (Fe) atom**

$$V_{Fe} = \frac{4}{3}\pi r_{Fe}^3 = \frac{m_{Fe}}{\rho_{Fe}} \quad \text{ve yarıçapı} \quad r_{Fe} = \left(\frac{3\, m_{Fe}}{4\pi\, \rho_{Fe}}\right)^{1/3}$$

$$r_{Fe} = \left(\frac{3 \times 9{,}27 \times 10^{-26}\,\text{kg}}{4\pi \times 7{,}87\,\frac{10^{-3}}{10^{-6}}\,\frac{\text{kg}}{\text{m}^3}}\right)^{1/3} = 1{,}41 \times 10^{-10}\ \text{m}$$

Distance between two iron atom:

$$d_{Fe} = 2 \times r_{Fe} = 2{,}82 \times 10^{-10}\ \text{m} \quad \text{bulunur.}$$

b) **Distance between two sodium (Na) atom:**

$$d_{Na} = 2 \times r_{Na} = 2\left(\frac{3\, m_{Na}}{4\pi\, \rho_{Na}}\right)^{1/3}$$

$$= 2\left(\frac{3 \times 3{,}82 \times 10^{-26}\,\text{kg}}{4\pi \times 1{,}013 \times \frac{10^{-3}}{10^{-6}}\,\frac{\text{kg}}{\text{m}^3}}\right)^{1/3} = 4{,}16 \times 10^{-10}\ \text{m}.$$

4- Find the equivalent values in SI units :
1,0 g/cm^3, 980,0 cm/s^2, 9,1x10^{-37} g, 1 μm, 1,0 ms and 1,0 ft.

$$1\ g/cm^3 = 1 \times \frac{10^{-3}}{10^{-6}} \frac{kg}{m^3} = 10^3\ kg/m^3$$

$$980\ cm/s^2 = 9{,}8\ m/s^2$$

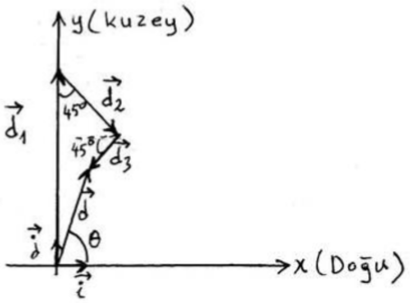
$$9{,}1 \times 10^{-27}\ g = 9{,}1 \times 10^{-30}\ kg$$

$$1\ \mu m = 10^{-6}\ m$$

$$1\ ms = 10^{-3}\ s$$

$$1\ ft = 0{,}3048\ m$$

5- A novice golfer on the green takes three strokes to sink the ball. The successive displacements are 4.00 m to the north, 2.00 m south-east, and 1.00 m west of south. Starting at the same initial point, an expert golfer could make the hole in what single displacement?



$$\vec{d}_1 = 4\vec{j}\ (m)$$

$$\vec{d}_2 = 2\cos 45° \vec{i} - 2\sin 45° \vec{j}$$

$$\vec{d}_3 = -1.\cos 45 \vec{i} - 1.\sin 45° \vec{j}$$

$$\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3 = \frac{\sqrt{2}}{2}\vec{i} + \left(4 - \frac{3}{2}\sqrt{2}\right)\vec{j}$$

$$|\vec{d}| = \sqrt{\frac{2}{4} + 16 - 12\sqrt{2} + \frac{9}{2}} \cong 2m$$

$$\tan\theta = \frac{4 - \frac{3}{2}\sqrt{2}}{\frac{\sqrt{2}}{2}} = 2{,}69 \qquad \theta = 69{,}6°$$

6- Two vectors are given as: $\vec{a} = 4\hat{\imath} - 3\hat{\jmath} + \hat{k}$ and $\vec{b} = -\hat{\imath} + \hat{\jmath} + 4\hat{k}$. Find

a) $\vec{a} + \vec{b}$ vector and its magnitude
b) $\vec{a} - \vec{b}$ vector and its magnitude
c) Find a vector $\vec{c}$ that $\vec{a} - \vec{b} + \vec{c} = 0$

a) $\vec{c} = \vec{a} + \vec{b} = (4\,\hat{\imath} - 3\hat{\jmath} + \hat{k}) + (-\,\hat{\imath} + 1\hat{\jmath} + 4\hat{k}) = 3\hat{\imath} - 2\hat{\jmath} + 5\hat{k}$

$$|\vec{c}| = \sqrt{3^2 + (-2^2) + 5^2} = \sqrt{38}$$

b) $\vec{c} = \vec{a} - \vec{b} = (4\,\hat{\imath} - 3\hat{\jmath} + \hat{k}) - (-\,\hat{\imath} + 1\hat{\jmath} + 4\hat{k}) = 5\,\hat{\imath} - 4\hat{\jmath} - 3\hat{k}$

$$|\vec{c}| = \sqrt{5^2 + (-4)^2 + (-3)^2} = \sqrt{50}$$

c) $\vec{a} + \vec{b} + \vec{c} = 0$

$$(4\,\hat{\imath} - 3\hat{\jmath} + \hat{k}) - (-\,\hat{\imath} + 1\hat{\jmath} + 4\hat{k}) + (c_x\hat{\imath} + c_y\hat{\jmath} + c_z\hat{k}) = (0\hat{\imath} + 0\hat{\jmath} + 0\hat{k})$$

$$c_x = -5, \qquad c_y = 4, \qquad c_z = 3$$

7- **A**, **B** and **C** are defined as vectors and their components are given as: $A_x=3$, $A_y=-2$ and $A_z=2$, $B_x=0$, $B_y=0$, $B_z=4$, $C_x=2$, $C_y=-3$ adn $C_z=0$. Find

a) $\vec{A}\,.(\vec{B} + \vec{C})$

$$\vec{B} + \vec{C} = 2\hat{\imath} - 3\hat{\jmath} + 4\hat{k}$$
$$\vec{A}.(\vec{B}+\vec{C}) = (3\hat{\imath} - 2\hat{\jmath} + 2\hat{k}).(2\hat{\imath} - 3\hat{\jmath} + 4\hat{k})$$
$$\vec{A}.(\vec{B}+\vec{C}) = 6 + 6 + 8 = \boxed{20}$$

b) $\vec{A}\,x\,(\vec{B} + \vec{C})$

$$\vec{A} \times (\vec{B}+\vec{C}) = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 3 & -2 & 2 \\ 2 & -3 & 4 \end{vmatrix} = \hat{\imath}(-8+6) - \hat{\jmath}(12-4) + \hat{k}(-9+4) = \boxed{-2\hat{\imath} - 8\hat{\jmath} - 5\hat{k}}$$

c) $\vec{A}\,.(\vec{B}\,x\,\vec{C})$

$$\vec{B} \times \vec{C} = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 0 & 0 & 4 \\ 2 & -3 & 0 \end{vmatrix} = \hat{\imath}(0+12) - \hat{\jmath}(0-8) + \hat{k}(0-0) = 12\hat{\imath} + 8\hat{\jmath}$$
$$\vec{A}.(\vec{B} \times \vec{C}) = (3\hat{\imath} - 2\hat{\jmath} + 2\hat{k}).(12\hat{\imath} + 8\hat{\jmath}) = 36 - 16 = \boxed{20}$$

d) $\vec{A}\,x\,(\vec{B}\,x\,\vec{C})$

$$\vec{A} \times (\vec{B} \times \vec{C}) = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 3 & -2 & 2 \\ 12 & 8 & 0 \end{vmatrix} = \hat{\imath}(0-16) - \hat{\jmath}(0-24) + \hat{k}(24+24) = \boxed{-16\hat{\imath} + 24\hat{\jmath} + 48\hat{k}}$$

8- Three displacement vectors of a croquet ball are shown in Figure, where $|A| = 20.0$ units, $|B| = 40.0$ units, and $|C| = 30.0$ units. Find (a) the resultant in unitvector notation and (b) the magnitude and direction of the resultant displacement.

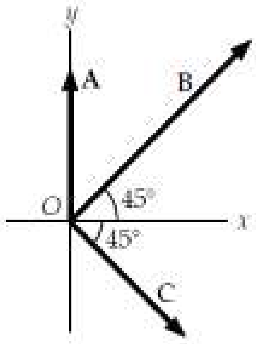
(a) $R_x = 40.0\cos 45.0° + 30.0\cos 45.0° = 49.5$

$R_y = 40.0\sin 45.0° - 30.0\sin 45.0° + 20.0 = 27.1$

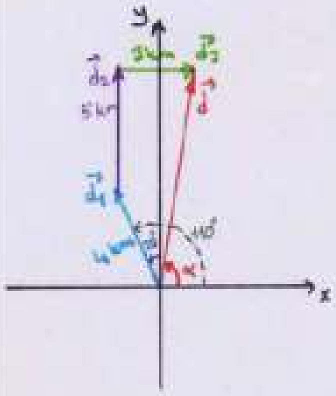
$\mathbf{R} = \boxed{49.5\hat{\mathbf{i}} + 27.1\hat{\mathbf{j}}}$

(b) $|\mathbf{R}| = \sqrt{(49.5)^2 + (27.1)^2} = \boxed{56.4}$

$\theta = \tan^{-1}\left(\dfrac{27.1}{49.5}\right) = \boxed{28.7°}$



9- A person going for a walk and follows the path: First walks through northwest 4 km which makes 20 degree with the north. Then, 5 km in the way of north and lastly 3 km through the east. At the end of the walk, what is the person's resultant displacement measured from the starting point?



$\vec{d}_1 = 4(\cos 110\,\hat{i} + \sin 110\,\hat{j})$

$\vec{d}_1 = 4(-0{,}342\,\hat{i} + 0{,}939\,\hat{j})$

$\vec{d}_1 = -1{,}368\,\hat{i} + 3{,}758\,\hat{j}$ (km)

$\vec{d}_2 = 5\hat{j}$ (km)

$\vec{d}_3 = 3\hat{i}$ (km)

$\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$

$\vec{d} = (-1{,}368 + 3)\,\hat{i} + (3{,}758 + 5)\,\hat{j}$

$\boxed{\vec{d} = 1{,}632\,\hat{i} + 8{,}758\,\hat{j} \text{ (km)}}$

$|\vec{d}| = \sqrt{(1{,}632)^2 + (8{,}758)^2}$

$\boxed{|\vec{d}| = 8{,}907 \text{ km}}$

$\tan\alpha = \dfrac{8{,}758}{1{,}632} = 5{,}366$

$\alpha = \tan^{-1}(5{,}366)$

$\boxed{\alpha = 79{,}44°}$

10- A proton with velocity $\vec{v} = 1{,}0.10^6\,\hat{\imath} + 2{,}0.10^6\,\hat{\jmath} - 2{,}0.10^6\,\hat{k}$ in a magnetic filed which is given by $\vec{B} = 0{,}2\,\hat{\imath} - 0{,}3\,\hat{\jmath} + 0{,}4\,\hat{k}$. Find the force on proton using $\vec{F} = q\vec{v}x\vec{B}$ expression. ($q = 1{,}6\ x\ 10^{-19}$ C).

a) $\vec{V} = 1{,}0.\,10^6\,\hat{\imath}\ (m/s) + 2{,}0.10^6\,\hat{\jmath}\ (m/s) - 2{,}0.\,10^6\,\hat{k}\ (m/s)$

$\vec{B} = 0{,}2\,\hat{\imath}\ (T) - 0{,}3\,\hat{\jmath}\ (T) + 0{,}4\,\hat{k}\ (T)$

$$\boxed{\vec{F} = q\,\vec{V} \times \vec{B}}$$

$$\vec{V} \times \vec{B} = (0{,}2\,\hat{\imath} - 0{,}8\,\hat{\jmath} - 0{,}7\,\hat{k}).10^6$$

$$\vec{F} = 1{,}6.10^{-19}\,(0{,}2\,\hat{\imath} - 0{,}8\,\hat{\jmath} - 0{,}7\,\hat{k}).10^6$$

$$\vec{F} = 0{,}32.10^{-13}\,\hat{\imath} - 1{,}28.10^{-13}\,\hat{\jmath} - 1{,}12.\hat{k}.10^{-13}\ (N)$$

$$\boxed{\vec{F} = (32\,\hat{\imath} - 128\,\hat{\jmath} - 112\,\hat{k}).10^{-15}\ (N)}$$