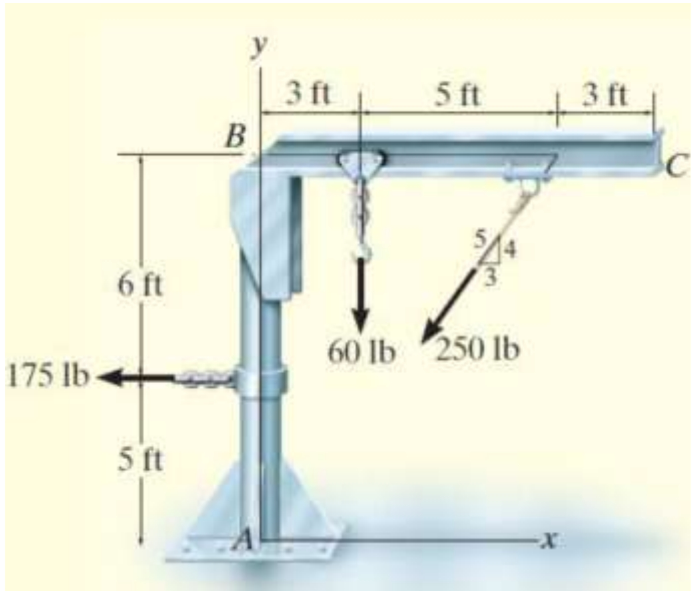
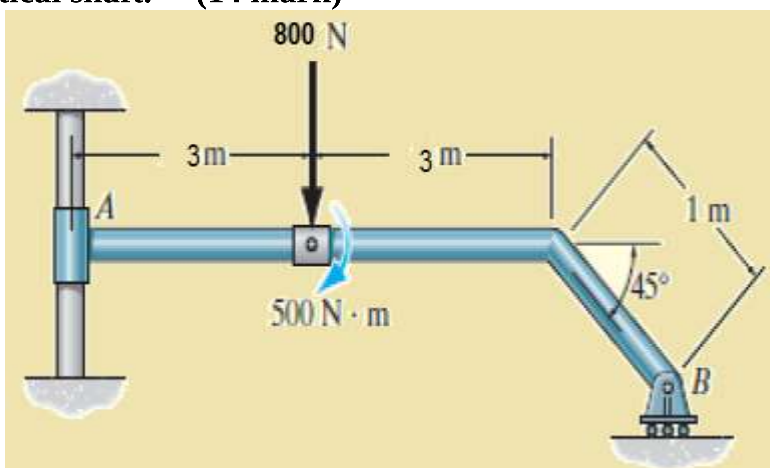
Benha University **Faculty of Engineering – Shoubra** **Engineering Mathematics and Physics department** **Preparatory year**		**Midterm Exam (A)** **Date: Tues. 21/11/2018** **Course title: Mechanics** **Course code: EMP 012** **Duration: 1 hour**

Name:…………………………………………… Section:……… Mark:………………..

1- **Replace the system by a force and couple moment at A. Then find the intersection of a single resultant force with the column AB and BC. (18 mark)**



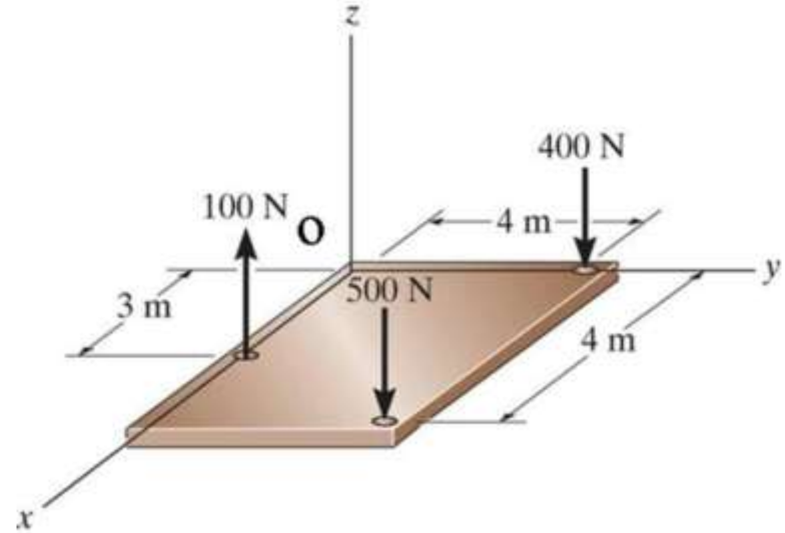
2- **Determine the support reactions on the member. The collar at A is fixed to the member and can slide vertically along the vertical shaft. (14 mark)**



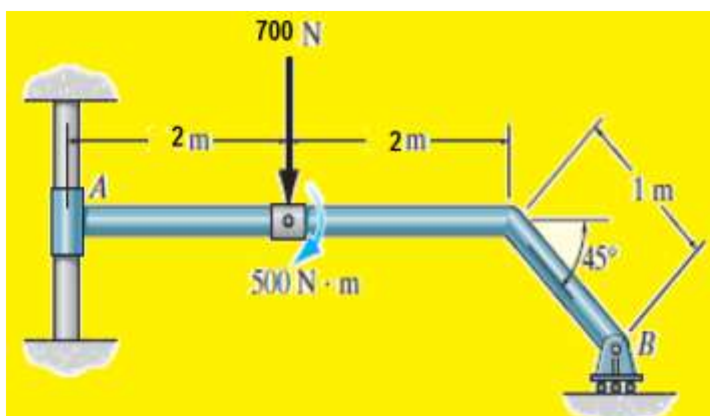
Benha University Faculty of Engineering – Shoubra Engineering Mathematics and Physics department Preparatory year		Midterm Exam (B) Date: Tues. 21/11/2018 Course title: Mechanics Course code: EMP 012 Duration: 1 hour

Name:…………………………………………… Section:……… Mark:………………..

1- **Reduce the system to a force and couple moment at the origin O. Also find the location (x, y) of the single equivalent resultant force. (18 mark)**



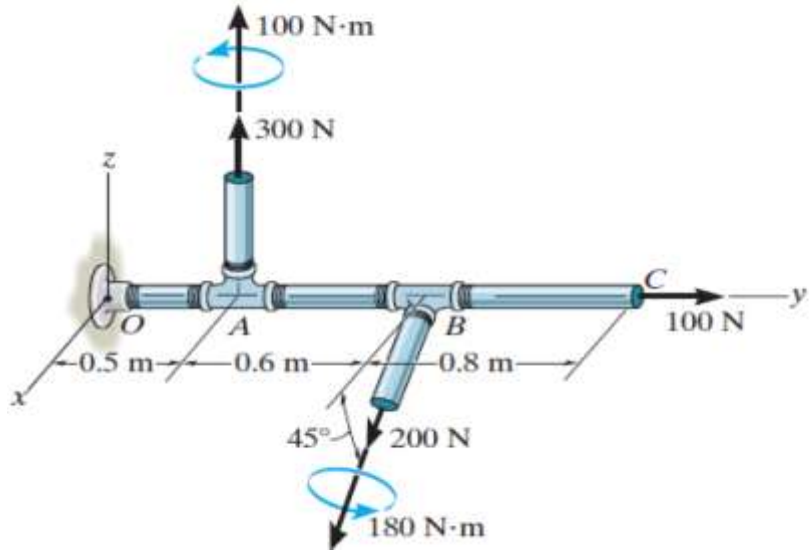
2- **Determine the support reactions on the member. The collar at A is fixed to the member and can slide vertically along the vertical shaft. (14 mark)**



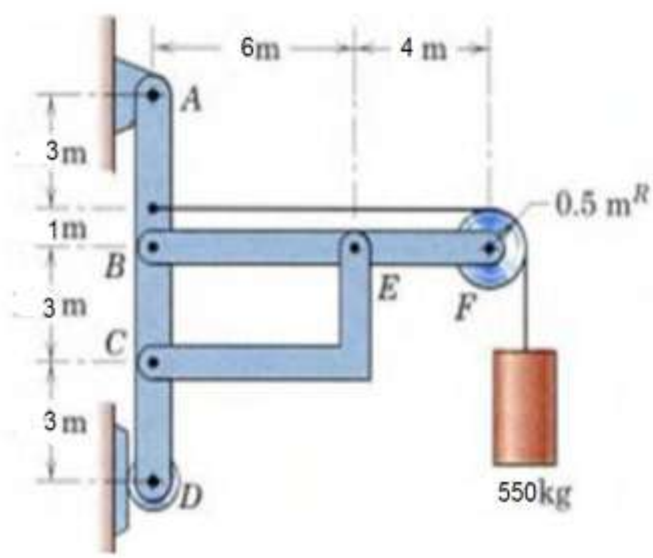
Benha University **Faculty of Engineering – Shoubra** **Engineering Mathematics and Physics department** **Preparatory year**		**Midterm Exam (C)** **Date: Tues. 21/11/2018** **Course title: Mechanics** **Course code: EMP 012** **Duration: 1 hour**

Name:…………………………………………… Section:……… Mark:………………..

1- Replace the system by a force and couples at o .Then replace the force and couple by a wrench (central axis and strength). (18 mark)



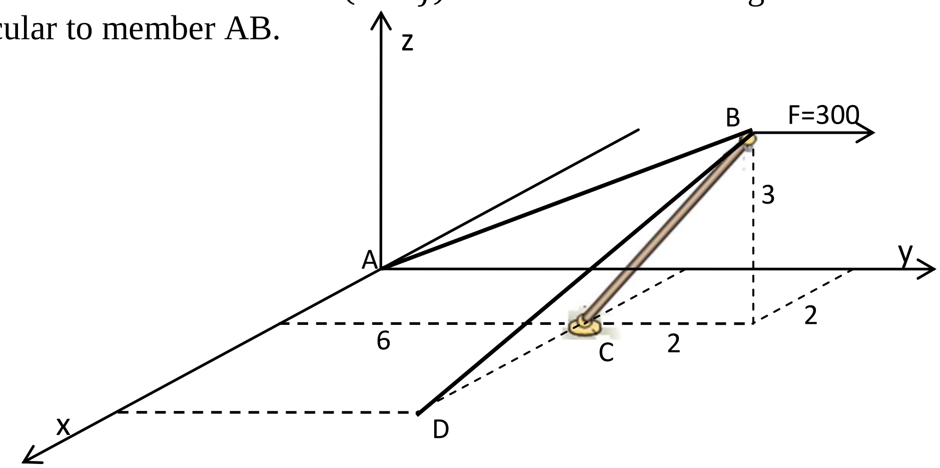
2- The frame supports the weight, Determine the reactions at A & D. (14 mark)



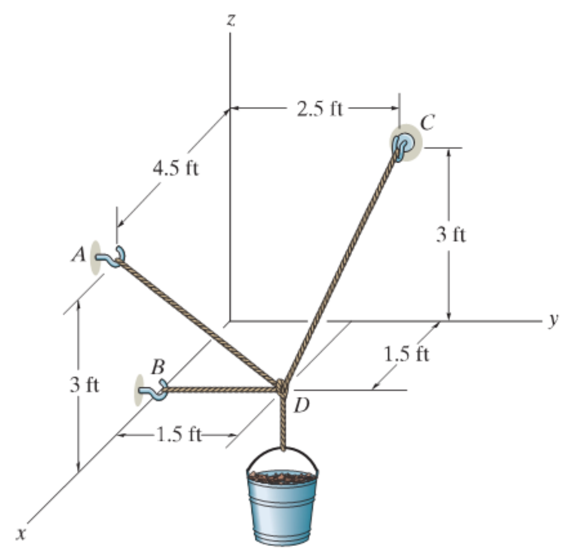
Benha University		**Midterm Exam (C)**
Faculty of Engineering – Shoubra		**Date: Tues. 07/11/2017**
Engineering Mathematics and		**Course title: Mechanics**
Physics department		**Course code: EMP 012**
Preparatory year		**Duration: 1 hour**

Name:……………………………………………………..   Section:………………..

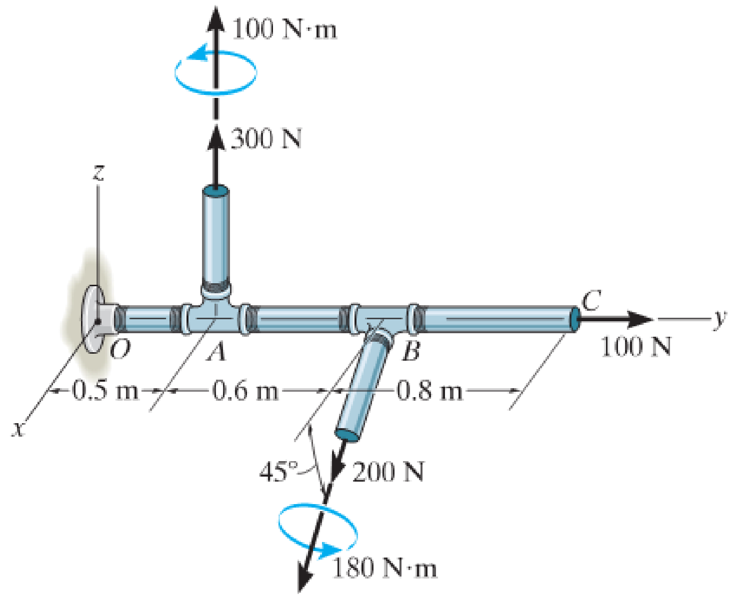
1.a- The rod shown is subjected to a horizontal force $\vec{F} = (300\,\hat{j})\ N$. Determine the magnitude of this force parallel and perpendicular to member AB.



1.b- If the bucket and its content have a total weight of 20 lb, determine the force in the supporting cables DA, DB and DC.



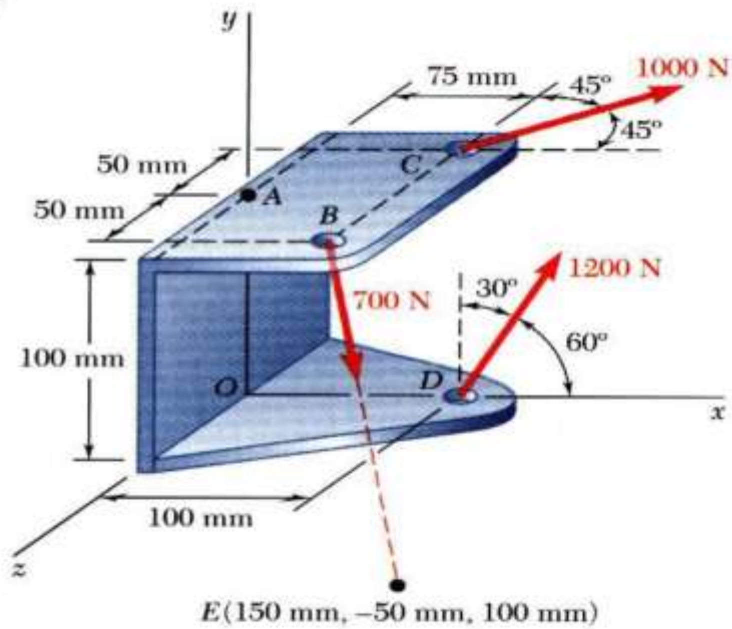
2- Replace the system of forces and couples by a wrench (Specify the vector equation of its axis and its pitch).



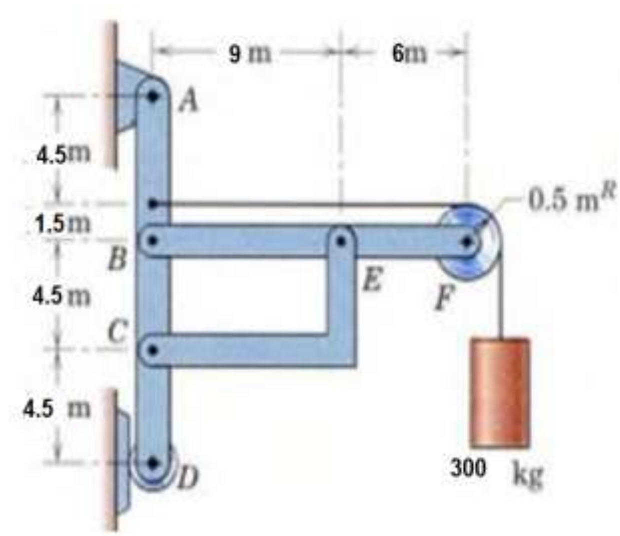
Benha University **Faculty of Engineering – Shoubra** **Engineering Mathematics and Physics department** **Preparatory year**		**Midterm Exam (D)** **Date: Tues. 21/11/2018** **Course title: Mechanics** **Course code: EMP 012** **Duration: 1 hour**

Name:…………………………………………… Section:……… Mark:………………..

1- Replace The Forces With a Force and Couple moment at A. (18 mark)



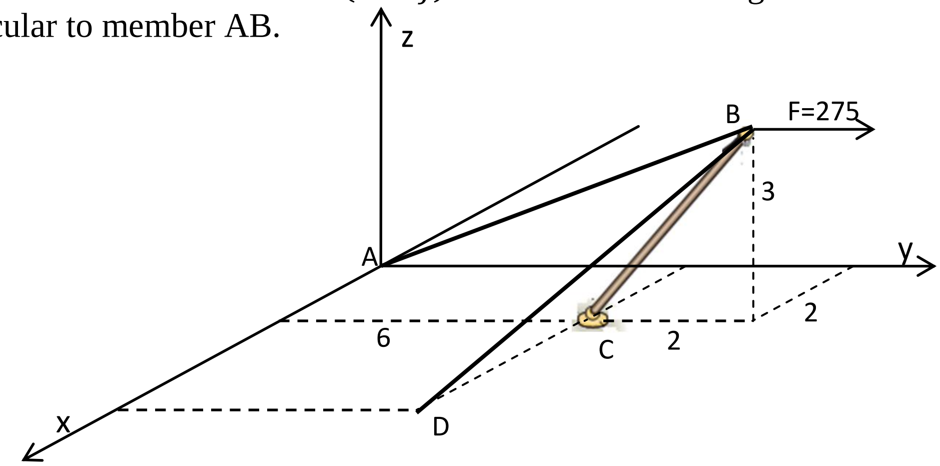
2- The frame supports the weight, Determine the reactions at A & D. (14 mark)



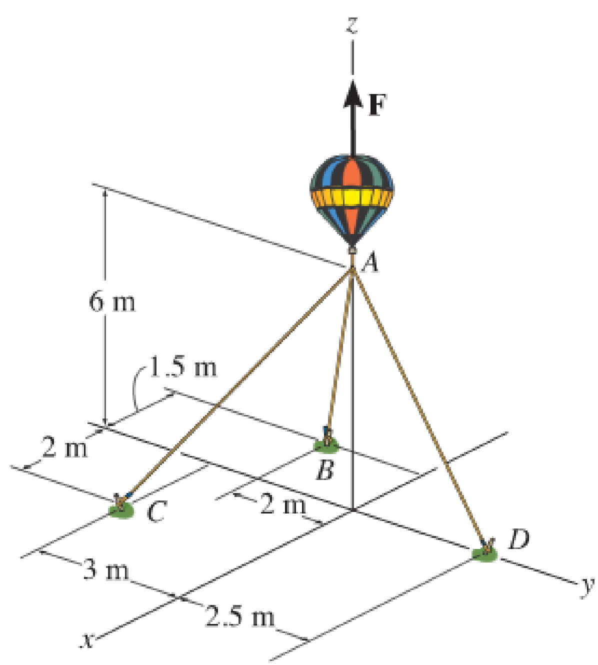
Benha University **Faculty of Engineering - Shoubra** **Engineering Mathematics and Physics department** **Preparatory year**		**Midterm Exam (D)** **Date: Tues. 07/11/2017** **Course title: Mechanics** **Course code: EMP 012** **Duration: 1 hour**

Name:………………………………………………….. Section:………………..

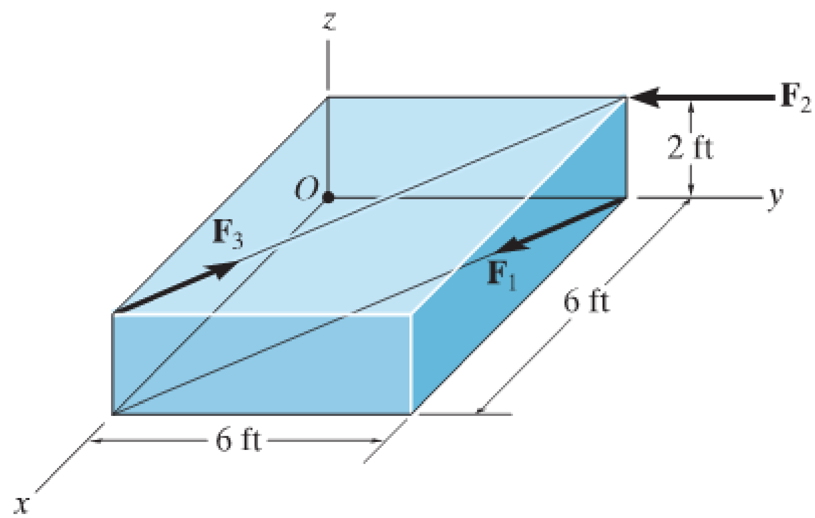
1.a- The rod shown is subjected to a horizontal force $\vec{F} = (275\,\hat{j})\ N$. Determine the magnitude of this force parallel and perpendicular to member AB.



1.b- If cable AD is subjected to a tension force 450 N, determine the force in cables AC and AB and the force F needed for equilibrium.

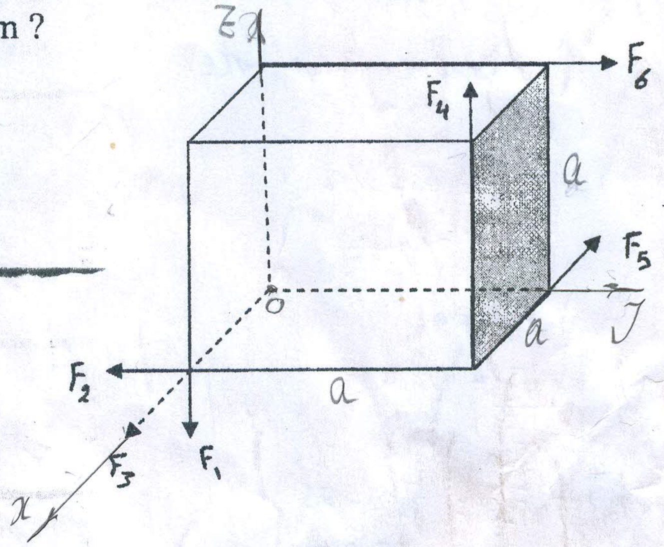


2- A rectangular block is acted upon by three forces as shown (F_2=F_3= 10 lb, F_1=20 lb), reduce the system of forces to a wrench (Specify the vector equation of its axis and its pitch).



Benha University **Faculty of Engineering at Shoubra** **Mathematical and physical Dept** **Time 1 hour**	**Mechanics**	**Mid Term Exam** ~~**Mar 2011**~~ Nov 2012

1- Six forces act in the vertices of a cube in the directions of its sides as in the figure. What are the conditions that the forces $\mathbf{F_1}$, $\mathbf{F_2}$, $\mathbf{F_3}$, $\mathbf{F_4}$, $\mathbf{F_5}$, $\mathbf{F_6}$ must satisfy to be in equilibrium ?



Sol:

The conditions of equilibrium are:

$\sum \vec{F} = \vec{0}$ and $\sum \vec{M} = \vec{0}$ about any point

* 1st Condition: $(\sum \vec{F} = \vec{0})$

$\sum F_x = 0$

$F_3 - F_5 = 0 \longrightarrow F_3 = F_5$ ---(1)

$\sum F_y = 0$

$F_6 - F_2 = 0 \longrightarrow F_6 = F_2$ ---(2)

$\sum F_z = 0$

$F_4 - F_1 = 0 \longrightarrow F_4 = F_1$ ---(3)

* 2nd Condition: $(\sum \vec{M} = \vec{0})$

Take moment about O:

$\sum M_x = 0$

$F_4 * a - F_6 * a = 0 \longrightarrow F_4 = F_6$ ---(4)

$\sum M_y = 0$

$-F_4 * a + F_1 * a = 0 \longrightarrow F_4 = F_1$ ---(5)

$\sum M_z = 0$

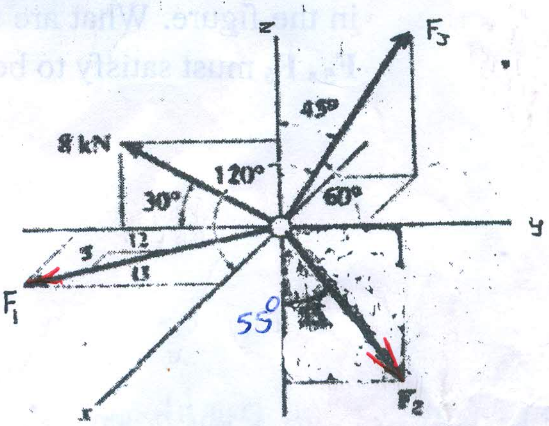
$F_5 * a - F_2 * a = 0 \longrightarrow F_5 = F_2$ ---(6)

Comparing (4) and (3) $\longrightarrow F_6 = F_1 = F_4$

Comparing (6) and (2) $\longrightarrow F_6 = F_2 = F_5$

So All the forces are equal

2- Determine the magnitudes of F_1 , F_2 , and F_3 for equilibrium of the particle.



Sol:

1st Resolve each force:

* F_1:

$F_{1x} = F_1 * 5/13$

$F_{1y} = -F_1 \frac{12}{13}$

$F_{1z} = 0$

* F_2:

$F_{2x} = 0$

$F_{2y} = F_2 \sin 55$

$F_{2z} = -F_2 \cos 55$

* F_3:

$F_{3x} = F_3 \cos 120$

$F_{3y} = F_3 \cos 60$

$F_{3z} = F_3 \cos 45$

* 8 kN

$X = 0$

$Y = -8\cos 30$ kN

$Z = 8 \sin 30$ kN

2nd Due to equilibrium

$\Sigma F_x = 0 \longrightarrow F_1 \frac{5}{13} + F_3 \cos 120 = 0$ --- (1)

$\Sigma F_y = 0 \longrightarrow -F_1 \frac{12}{13} + F_2 \sin 55 + F_3 \cos 60 - 8\cos 30 = 0$ --- (2)

$\Sigma F_z = 0 \longrightarrow -F_2 \cos 55 + F_3 \cos 45 + 8 \sin 30 = 0$ --- (3)

From (1) $F_1 = 1.3 F_3$ --- (4)

From (3) $F_2 = 1.233 F_3 + 6.974$ --- (5)

substitute by (4) and (5) in (2) to get F_3

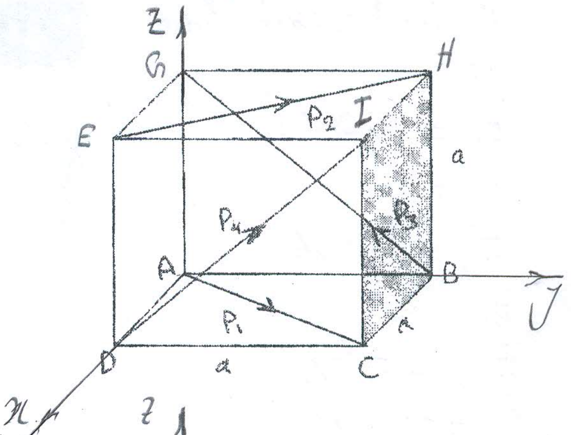
$-1.3 \times \frac{12}{13} F_3 + 1.233 F_3 \sin 55 + 6.974 \sin 55 + F_3 \cos 60 - 8\cos 30 = 0$

$F_3 = 3.921$ kN

substitute in (4) and (5) $\longrightarrow F_1 = 5.0968$ kN and $F_2 = 11.808$ kN.

1- Find the simple Resultant of this system of forces knowing that

$$P_1 = P_2 = P_3 = P_4 = P$$



Sol:

$\vec{AC} = a(\hat{i}+\hat{j})$

$\vec{EH} = a(-\hat{i}+\hat{j})$

$\vec{BG} = a(-\hat{j}+\hat{k})$

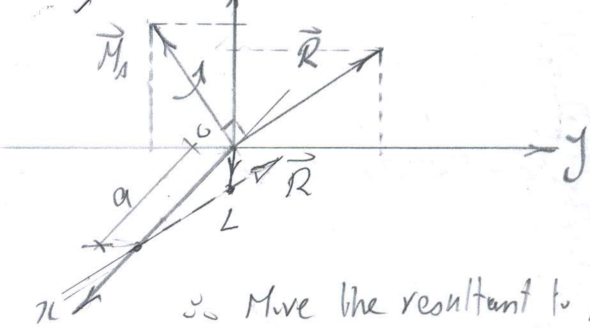
$\vec{DI} = a(\hat{j}+\hat{k})$

$\therefore \vec{P_1} = P\frac{\vec{AC}}{|\vec{AC}|} = \frac{Pa(\hat{i}+\hat{j})}{a\sqrt{2}} = \frac{P}{\sqrt{2}}(\hat{i}+\hat{j})$

$\vec{P_2} = P\frac{\vec{EH}}{|\vec{EH}|} = \frac{P}{\sqrt{2}}(-\hat{i}+\hat{j})$

$\vec{P_3} = P\frac{\vec{BG}}{|\vec{BG}|} = \frac{P}{\sqrt{2}}(-\hat{j}+\hat{k})$

$\vec{P_4} = P\frac{\vec{DI}}{|\vec{DI}|} = \frac{P}{\sqrt{2}}(\hat{j}+\hat{k})$



$\therefore$ Move the resultant to point $(a,0,0)$

Move the system to point A:

1st The resultant force:

$\vec{R} = \vec{P_1}+\vec{P_2}+\vec{P_3}+\vec{P_4} = \frac{P}{\sqrt{2}}(2\hat{j}+2\hat{k}) = \sqrt{2}P(\hat{j}+\hat{k})$

2nd The resultant moment due to movement:

$\vec{M_A} = \vec{AD}\times\vec{P_4} + \vec{AB}\times\vec{P_3} + \vec{AE}\times\vec{P_2}$

$\vec{M_A} = a\hat{i}\times\frac{P}{\sqrt{2}}(\hat{j}+\hat{k}) + a\hat{j}\times\frac{P}{\sqrt{2}}(-\hat{j}+\hat{k}) + a(\hat{i}+\hat{k})\times\frac{P}{\sqrt{2}}(-\hat{i}+\hat{j})$

$\vec{M_A} = \frac{Pa}{\sqrt{2}}\left[(\hat{k}-\hat{j})+(0+\hat{i})+(0+\hat{k}-\hat{j}-\hat{i})\right]$

$\vec{M_A} = \frac{Pa}{\sqrt{2}}(-2\hat{j}+2\hat{k}) = \sqrt{2}Pa(-\hat{j}+\hat{k})$

To check if $\vec{M_A}$ and $\vec{R}$ are perpendicular or not:

$\vec{M}\cdot\vec{R} = \sqrt{2}Pa(-\hat{j}+\hat{k})\cdot\sqrt{2}P(\hat{j}+\hat{k}) = 2P^2a(-1+1) = \text{zero}$

$\therefore$ $\vec{R}$ and $\vec{M}$ are perpendicular $\Longrightarrow$ The system can be reduced to a single force

Let the position of the single force $\vec{R}$ be at point L

$\therefore \vec{M_A} = \vec{OL}\times\vec{R}$

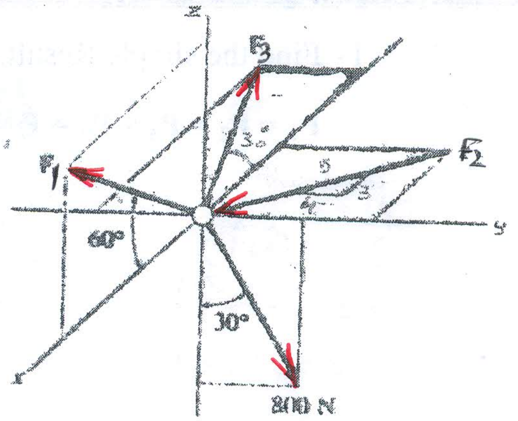
$$\sqrt{2}Pa(-\hat{j}+\hat{k}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ 0 & 1 & 1 \end{vmatrix}\sqrt{2}P = (y-z)\hat{i} - x\hat{j} + x\hat{k}$$

$\therefore$ $y - z = 0 \longrightarrow y = z$

$-x = -a \longrightarrow x = a$

$x = a$

2- Determine the magnitudes of $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$ for equilibrium of the particle.



sol:

1st Resolve each force

F_1:

$F_{1x} = F_1 \cos 60$

$F_{1y} = 0$

$F_{1z} = F_1 \sin 60$

F_2:

$F_{2x} = +F_2 (3/5)$

$F_{2y} = -F_2 (4/5)$

$F_{2z} = 0$

F_3:

$F_{3x} = -F_3 \cos 30$

$F_{3y} = -F_3 \sin 30$

$F_{3z} = 0$

800 N:

$X = 0$

$Y = 800 \sin 30$

$Z = -800 \cos 30$

2nd Due to equilibrium:

$\Sigma F_x = 0 \longrightarrow F_1 \cos 60 + F_2\left(\frac{3}{5}\right) - F_3 \cos 30 = 0$ --- (1)

$\Sigma F_y = 0 \longrightarrow -F_2\left(\frac{4}{5}\right) - F_3 \sin 30 + 800 \sin 30 = 0$ --- (2)

$\Sigma F_z = 0 \longrightarrow F_1 \sin 60 - 800 \cos 30 = 0 \longrightarrow F_1 = 800\ N$

Substitute in (1) $\longrightarrow F_2 = \frac{5}{3} F_3 \cos 30 - 800 \cos 60$ --- (3)

Substitute by (3) in (2)

$-\frac{4}{3} F_3 \cos 30 + 640 \cos 60 - F_3 \sin 30 + 800 \sin 30 = 0$

$F_3 = 435.124\ N$

substitute in (3) $F_2 = 228.047\ N$

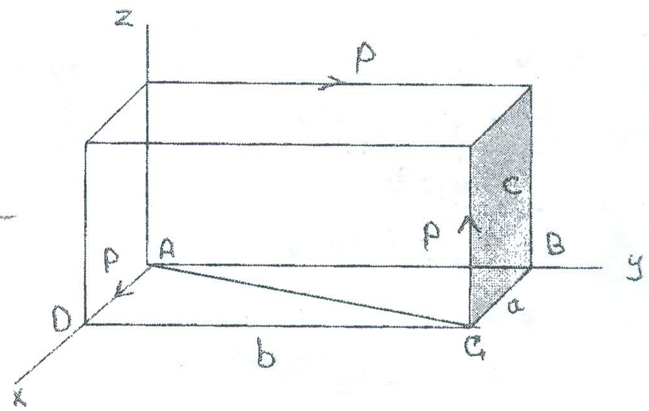
Benha University
Faculty of Engineering at Shoubra
Mathematical and physical Dept
Time 1 hour

Name:-

Mechanics

Mid Term Exam
Nov 2012

1- Find the relation between **a,b,c** to make the system of forces be a single resultant.



Sol:

The condition that a system of forces be equivalent to a single force is that the resultant force and moment of the system at any point be perpendicular.

∴ Move the system to point A

1st The resultant force:

$R_x = P$

$R_y = P$

$R_z = P$

$\vec{R} = P(\hat{i}+\hat{j}+\hat{k})$

2nd The resultant moment about A: due to movement

$M_x = P \times b - P \times c$

$M_y = -P \times a$

$M_z = 0$

$\vec{M}_A = P((b-c)\hat{i} - a\hat{j})$

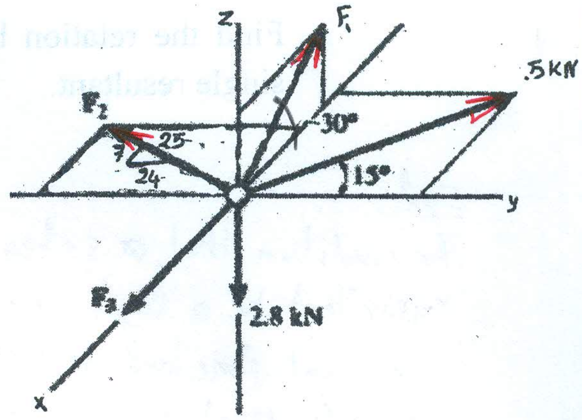
For $\vec{R}$ and $\vec{M}_A$ to be perpendicular $\vec{R} \cdot \vec{M}_A$ must equal zero

$\vec{R} \cdot \vec{M}_A = P(\hat{i}+\hat{j}+\hat{k}) \cdot P((b-c)\hat{i} - a\hat{j})$

$0 = P^2[\,b-c-a+0\,]$

∴ $b-c-a=0$ (The required relation)

2- Determine the magnitudes of $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$ for equilibrium of the particle



Sol.:

1st Resolve each force:

* F_1:

$F_{1x} = -F_1 \cos 30$

$F_{1y} = 0$

$F_{1z} = F_1 \sin 30$

* F_2:

$F_{2x} = -F_2 (7/25)$

$F_{2y} = -F_2 (24/25)$

$F_{2z} = 0$

* F_3:

$F_{3x} = F_3$

$F_{3y} = 0$

$F_{3z} = 0$

* 0.5 kN

$X = -0.5 \sin 15$ kN

$Y = 0.5 \cos 15$ kN

$Z = 0$

* 2.8 kN

$X = 0$

$Y = 0$

$Z = -2.8$ kN

2nd Due to equilibrium

$\sum F_x = 0 \longrightarrow -F_1 \cos 30 - F_2\left(\frac{7}{25}\right) + F_3 - 0.5 \sin 15 = 0$ ------ (1)

$\sum F_y = 0 \longrightarrow -F_2\left(\frac{24}{25}\right) + 0.5 \cos 15 = 0 \longrightarrow F_2 = 0.5031$ kN.

$\sum F_z = 0 \longrightarrow F_1 \sin 30 - 2.8 = 0 \longrightarrow F_1 = 5.6$ kN.

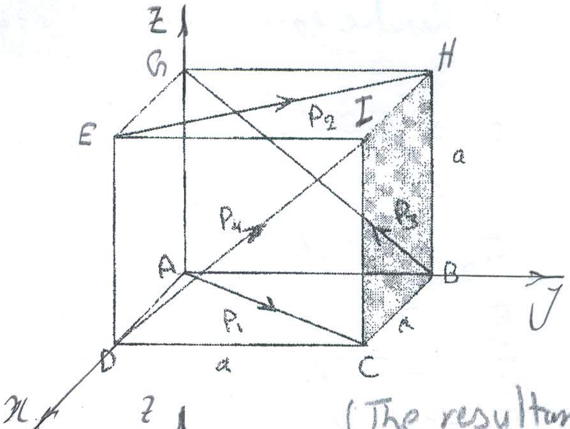
substitute by F_1 and F_2 in (1)

$F_3 = 5.12$ kN

Benha University	**Name:-**	
Faculty of Engineering at Shoubra		**Mid Term Exam**
Mathematical and physical Dept	**Mechanics**	**Nov 2012**
Time 1 hour		

1- Find the simple Resultant of this system of forces knowing that

$$P_1 = P_2 = P_3 = P_4 = P$$



Sol:

$\overrightarrow{AC} = a(\hat{i}+\hat{j})$

$\overrightarrow{EH} = a(-\hat{i}+\hat{j})$

$\overrightarrow{BG} = a(-\hat{j}+\hat{k})$

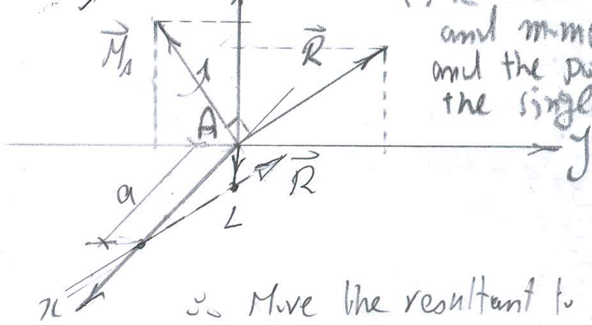
$\overrightarrow{DI} = a(\hat{j}+\hat{k})$

$\therefore \overrightarrow{P_1} = P\dfrac{\overrightarrow{AC}}{|\overrightarrow{AC}|} = \dfrac{Pa(\hat{i}+\hat{j})}{a\sqrt{2}} = \dfrac{P}{\sqrt{2}}(\hat{i}+\hat{j})$

$\overrightarrow{P_2} = P\dfrac{\overrightarrow{EH}}{|\overrightarrow{EH}|} = \dfrac{P}{\sqrt{2}}(-\hat{i}+\hat{j})$

$\overrightarrow{P_3} = P\dfrac{\overrightarrow{BG}}{|\overrightarrow{BG}|} = \dfrac{P}{\sqrt{2}}(-\hat{j}+\hat{k})$

$\overrightarrow{P_4} = P\dfrac{\overrightarrow{DI}}{|\overrightarrow{DI}|} = \dfrac{P}{\sqrt{2}}(\hat{j}+\hat{k})$



(The resultant force and moment and the position of the single force)

$\therefore$ Move the resultant to point $(a,0,0)$

Move the system to point A:

1st The resultant force:

$\overrightarrow{R} = \overrightarrow{P_1}+\overrightarrow{P_2}+\overrightarrow{P_3}+\overrightarrow{P_4} = \dfrac{P}{\sqrt{2}}(2\hat{j}+2\hat{k}) = \sqrt{2}P(\hat{j}+\hat{k})$

2nd The resultant moment due to movement:

$\overrightarrow{M_A} = \overrightarrow{AD}\times\overrightarrow{P_4} + \overrightarrow{AB}\times\overrightarrow{P_3} + \overrightarrow{AE}\times\overrightarrow{P_2}$

$\overrightarrow{M_A} = a\hat{i}\times\dfrac{P}{\sqrt{2}}(\hat{j}+\hat{k}) + a\hat{j}\times\dfrac{P}{\sqrt{2}}(-\hat{j}+\hat{k}) + a(\hat{i}+\hat{k})\times\dfrac{P}{\sqrt{2}}(-\hat{i}+\hat{j})$

$\overrightarrow{M_A} = \dfrac{Pa}{\sqrt{2}}\left[(\hat{k}-\hat{j})+(0+\hat{i})+(0+\hat{k}-\hat{j}-\hat{i})\right]$

$\overrightarrow{M_A} = \dfrac{Pa}{\sqrt{2}}(-2\hat{j}+2\hat{k}) = \sqrt{2}Pa(-\hat{j}+\hat{k})$

To check if $\overrightarrow{M_A}$ and $\overrightarrow{R}$ are perpendicular or not:

$\overrightarrow{M}\cdot\overrightarrow{R} = \sqrt{2}Pa(-\hat{j}+\hat{k})\cdot\sqrt{2}P(\hat{j}+\hat{k}) = 2P^2a(-1+1) = \text{zero}$

$\therefore \overrightarrow{R}$ and $\overrightarrow{M}$ are perpendicular $\Longrightarrow$ The system can be reduced to a single force

Let the position of the single force $\overrightarrow{R}$ be at point L

$\therefore \overrightarrow{M_A} = \overrightarrow{OL}\times\overrightarrow{R}$

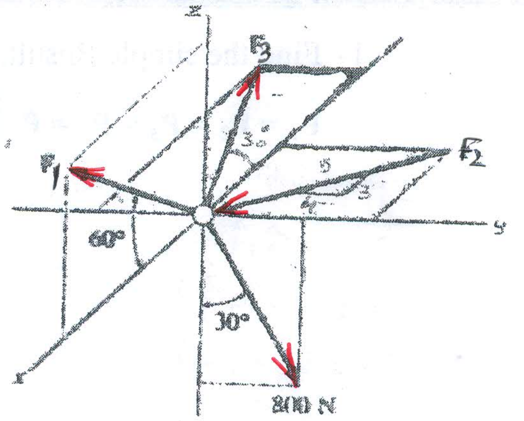
$$\sqrt{2}Pa(-\hat{j}+\hat{k}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ 0 & 1 & 1 \end{vmatrix} \sqrt{2}P = (y-z)\hat{i} - x\hat{j} + x\hat{k}$$

$\therefore\ y-z=0 \longrightarrow y=z$

$-x=-a \longrightarrow x=a$

$x=a$

2- Determine the magnitudes of $\vec{F}_1$, $\vec{F}_2$, and $\vec{F}_3$ for equilibrium of the particle.



sol:

1st Resolve each Force

F_1:

$F_{1x} = F_1 \cos 60$

$F_{1y} = 0$

$F_{1z} = F_1 \sin 60$

F_2:

$F_{2x} = +F_2 (3/5)$

$F_{2y} = -F_2 (4/5)$

$F_{2z} = 0$

F_3:

$F_{3x} = -F_3 \cos 30$

$F_{3y} = -F_3 \sin 30$

$F_{3z} = 0$

800 N:

$X = 0$

$Y = 800 \sin 30$

$Z = -800 \cos 30$

2nd Due to equilibrium:

$\Sigma F_x = 0 \longrightarrow F_1 \cos 60 + F_2\left(\frac{3}{5}\right) - F_3 \cos 30 = 0 \quad --(1)$

$\Sigma F_y = 0 \longrightarrow -F_2\left(\frac{4}{5}\right) - F_3 \sin 30 + 800 \sin 30 = 0 \quad --(2)$

$\Sigma F_z = 0 \longrightarrow F_1 \sin 60 - 800 \cos 30 = 0 \longrightarrow F_1 = 800\ N$

Substitute in (1) $\longrightarrow F_2 = \frac{5}{3} F_3 \cos 30 - 800 \cos 60 \quad --(3)$

Substitute by (3) in (2)

$-\frac{4}{3} F_3 \cos 30 + 640 \cos 60 - F_3 \sin 30 + 800 \sin 30 = 0$

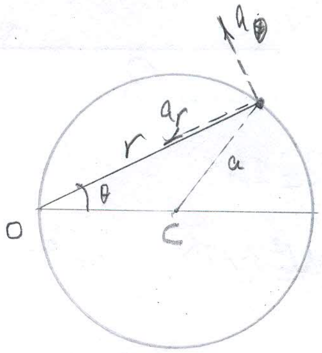
$F_3 = 435.124\ N$

substitute in (3) $\quad F_2 = 228.047\ N$

Benha University **Faculty of Engineering at Shoubra** **Mechanics** **Time 1 hour**	**Mid Term Exam** **April 2013**

1- A particle moves along a circle r = 2a Cos θ in such a way that its acceleration towards the origin is always zero – prove that

$$d^2 \theta/dt^2 = - 2 \cot \theta . \dot{\theta}^2$$



Sol:

Given: $r = 2a\cos\theta$

$a_r = 0$ (radial component of the acceleration)

$\therefore \ddot{r} - r\dot{\theta}^2 = 0$ - - - (1)

* $\dot{r} = -2a\dot{\theta}\sin\theta$

$\ddot{r} = -2a\ddot{\theta}\sin\theta - 2a\dot{\theta}^2\cos\theta$

subistitute in equn (1)

$-\cancel{2a}\ddot{\theta}\sin\theta - \cancel{2a}\dot{\theta}^2\cos\theta - \cancel{2a}(\cos\theta)\dot{\theta}^2 = 0$

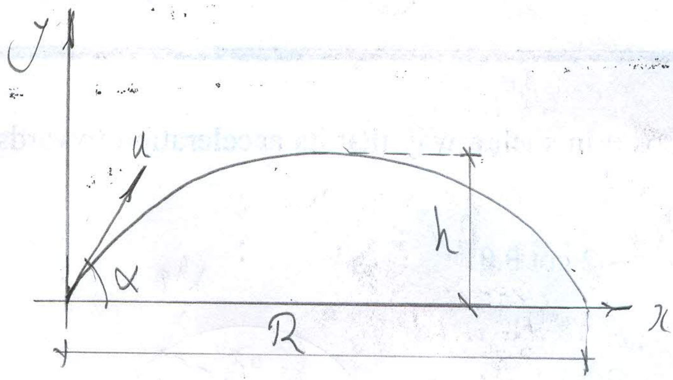
$-\ddot{\theta}\sin\theta - 2\dot{\theta}^2\cos\theta = 0$

$\therefore \ddot{\theta} = -2\dot{\theta}^2\cot\theta$ Hence the prove.

2- A particle is projected with velocity u so that its range on the horizontal plane is twice the greatest height attained. Prove that the range is

$$4\,v^2 / 5g$$

Sol:



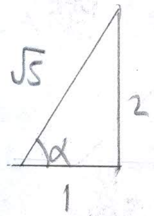
Given: $R = 2h$

$\because R = \frac{u^2 \sin 2\alpha}{g}$ and $h = \frac{u^2 \sin^2\alpha}{2g}$

$\therefore \frac{u^2 \sin 2\alpha}{g} = 2\,\frac{u^2 \sin^2\alpha}{2g}$

$2\sin\alpha\cos\alpha = \sin^2\alpha$

$\tan\alpha = 2$



$\therefore \sin\alpha = \frac{2}{\sqrt{5}}$ and $\cos\alpha = \frac{1}{\sqrt{5}}$

$\therefore R = \frac{u^2 \sin 2\alpha}{g} = \frac{2u^2 \sin\alpha\cos\alpha}{g}$

$R = \frac{2u^2}{g}\,\frac{2}{\sqrt{5}}\,\frac{1}{\sqrt{5}}$

$R = \frac{4u^2}{5g}$

Hence the prove

Benha University
Faculty of Engineering at Shoubra
Mechanics
Time 1 hour

Mid Term Exam
April 2013

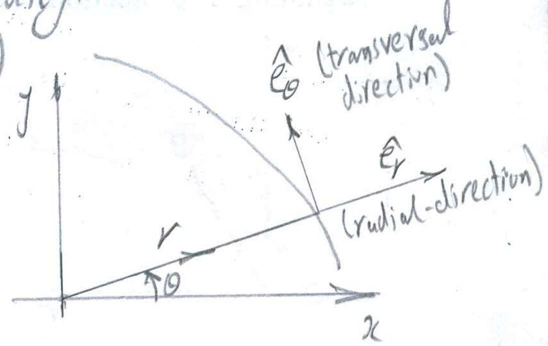
1- Find the radial and transverse components for a particle moves such that

$$r = a\,(1 + \sin t) \quad , \theta = 1 - e^t$$

Sol:

1st The radial and transversal components for the velocity.

$V_r = \dot{r}$ (radial) and $V_\theta = r\dot{\theta}$ (transversal)



$\dot{r} = a\cos t$

$\dot{\theta} = -e^t$

$\therefore V_r = a\cos t$ and $V_\theta = -a(1+\sin t)e^t$ —— ×

2nd The radial and transversal components for the acceleration

$a_r = \ddot{r} - r\dot{\theta}^2$ (radial) and $a_\theta = 2\dot{r}\dot{\theta} + r\ddot{\theta}$ (transversal)

$\ddot{r} = -a\sin t$

$\ddot{\theta} = -e^t$

$\therefore a_r = -a\sin t - a(1+\sin t)(-e^t)^2$

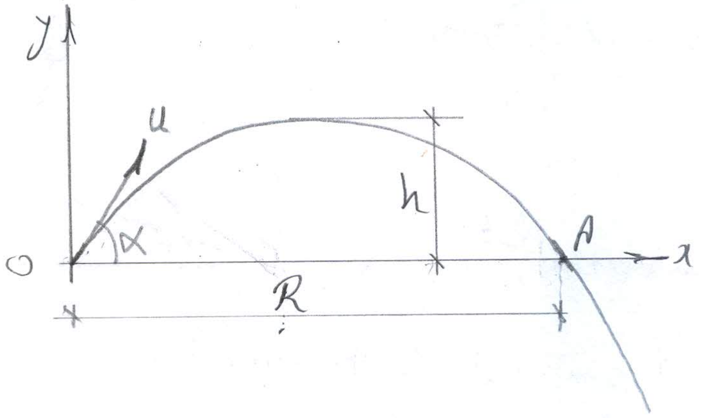
$= -a\sin t - ae^{2t} - ae^{2t}\sin t$

$a_r = -a\left((1+\sin t)e^{2t} + \sin t\right)$ —— ✱

and $a_\theta = 2a(\cos t)(-e^t) + a(1+\sin t)(-e^t)$

$a_\theta = -ae^t\left(2\cos t + 1 + \sin t\right)$ —— ✱

2- A particle is projected from a certain point. It is noticed that It's range on the horizontal plane which passes through the point of projection is equal to three times the maximum height above the point of projection and its velocity after two seconds from the time of projection is equal to the velocity of projection: find the velocity of projection, find also the position of projection after 5 second from the beginning of projection.



Sol:

Given: $R = 3h$ and at $t = 2$ sec $\longrightarrow v = u$

$\therefore$ At $t = 2$sec $v = u$

$\therefore$ The time $t = 2$sec is the time from $O \longrightarrow A$ i.e. the time of flight

$\therefore T = \frac{2u\sin\alpha}{g}$

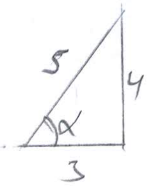
$\therefore 2 = \frac{2u\sin\alpha}{g} \longrightarrow u = \frac{g}{\sin\alpha}$ --- (1)

To get α: $\because R = 3h$ and $R = \frac{u^2\sin 2\alpha}{g}$ and $h = \frac{u^2\sin^2\alpha}{2g}$

$\therefore \frac{\cancel{u^2}\sin 2\alpha}{\cancel{g}} = \frac{3\cancel{u^2}\sin^2\alpha}{2\cancel{g}}$

$\cancel{2}\sin\alpha\cos\alpha = \frac{3\sin^2\alpha}{2}$

$\tan\alpha = \frac{4}{3}$



$\therefore u = \frac{g}{4/5} = \frac{5g}{4} = 12.263$ m/sec

* The position of the projectile after 5sec (i.e. x and y coordinates)

$x = ut\cos\alpha = 12.263 * 5 * \frac{3}{5} = 36.788$ m

$y = ut\sin\alpha - \frac{1}{2}gt^2 = 12.263 * 5 * \frac{4}{5} - \frac{1}{2} * 9.81 (5)^2 = 73.575$ m