Mansoura University
Faculty of Engineering
Mid Term Exam

BME Program
Level 000
Course Name: **Mechanics 1**
Course Code: **MATH002**

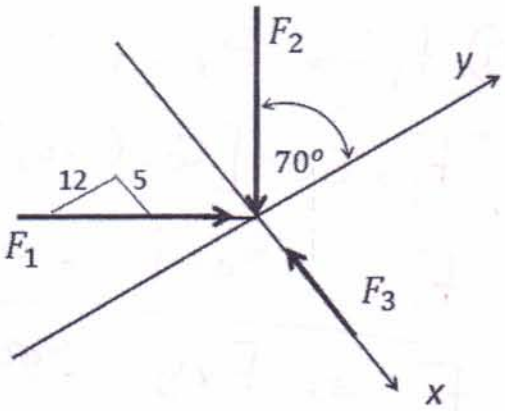
Total marks: 20
Allowed Time: **1 Hours**
Exam Date: **28-11-2018**

الإسم (رباعي): نموذج اجابة	
Section:	
Group:	
يتكون الإمتحان من أربعة أسئلة في اربع صفحات. **The Exam consists of 4 questions in 4 pages.**	

/20

Question 1:	
Question 2:	
Question 3:	
Question 4:	
Total Marks:	/40

[Q. 1] [**6 marks**] If $F_1 = 52$ N, $F_2 = 20$ N and $F_3 = 60$ N, choose the correct answer of the following:



(i) The Cartesian vector form of $\mathbf{F_1}$ is [**2 marks**]

a) $20\,\mathbf{i} + 48\,\mathbf{j}$

b) $48\,\mathbf{i} - 20\,\mathbf{j}$

c) $-20\,\mathbf{i} + 48\,\mathbf{j}$

d) $48\,\mathbf{i} + 20\,\mathbf{j}$

(ii) The Cartesian vector form of $\mathbf{F_2}$ is [**2 marks**]

a) $-18.8\,\mathbf{i} - 6.8\,\mathbf{j}$

b) $18.8\,\mathbf{i} - 6.8\,\mathbf{j}$

c) $18.8\,\mathbf{i} + 6.8\,\mathbf{j}$

d) $-18.8\,\mathbf{i} + 6.8\,\mathbf{j}$

(iii) The resultant force, **R**, of $\mathbf{F_1}$, $\mathbf{F_2}$ and $\mathbf{F_3}$ has a magnitude and angle with the positive x-axis as [**2 marks**]

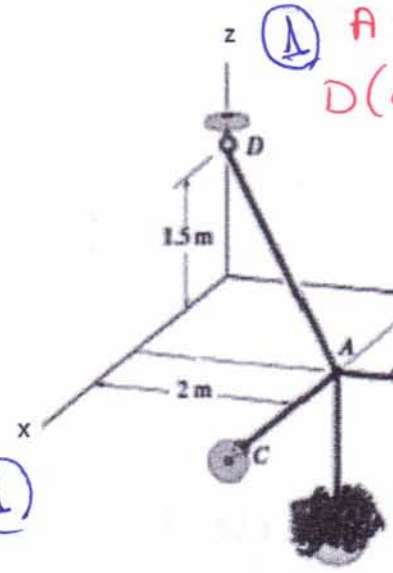
a) $R = 46.3$ N, and $\theta = 117.2^o$

b) $R = 46.3$ N, and $\theta = 62.8^o$

c) $R = 46.3$ N, and $\theta = -62.8^o$

d) $R = 46.3$ N, and $\theta = 242.8^o$

[Q. 2] [**10 marks**] Determine the maximum mass of the supported crate so that the tension developed in any cable shown does not exceed 5 kN.



(1) $A(1.5, 2, 0)$
$D(0, 0, 1.5)$

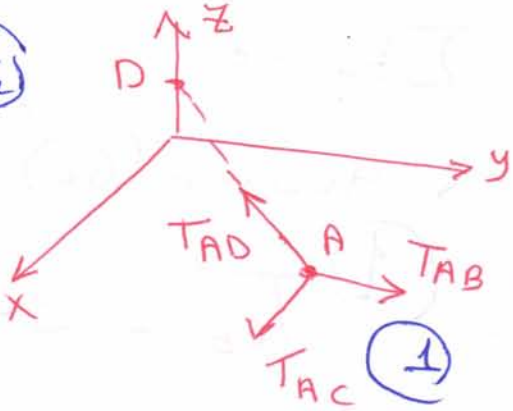
$T_{AC} = T_{AC}\,i + 0j + 0k$ (1/2)

$T_{AB} = 0i + T_{AB}\,j + 0k$ (1/2)

$T_{AD} = T_{AD}\,u_{AD}$

$= T_{AD}\left(\dfrac{-1.5i - 2j + 1.5k}{\sqrt{8.5}}\right)$ (1)

$W_{max} = 0i + 0j - W_{max}\,k$ (1/2)



(1)

F.B.D.

Equations of Equilibrium

$\sum F_x = 0 \quad T_{AC} - \dfrac{1.5}{\sqrt{8.5}} T_{AD} = 0$ (1)

$\sum F_y = 0 \quad T_{AB} - \dfrac{2}{\sqrt{8.5}} T_{AD} = 0$ (1)

$\sum F_z = 0 \quad T_{AD}\left(\dfrac{1.5}{\sqrt{8.5}}\right) - W_{max} = 0$ (1)

$T_{AD} = 1.94\,W_{max}$ (1/2) $\Rightarrow T_{AD}^{max} = 5000\ N$ (1/2)

$T_{AB} = 1.33\,W_{max}$ (1/2) $\qquad W_{max} = \dfrac{5000}{1.94}$

$T_{AC} = W_{max}$ (1/2) $\qquad$ (1/2) $= 2577\ N$

Ans- $\boxed{m_{max} = 262.7\ kg}$

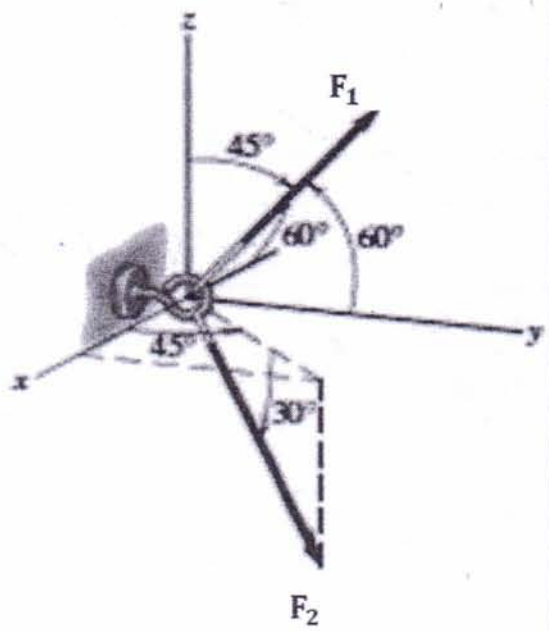
[Q. 3] [**16 marks**] Two forces $F_1 = 600$ lb, and $F_2 = 800$ lb are applied to the hook, as shown in the figure.

a) Express $\mathbf{F_1}$ and $\mathbf{F_2}$ as a Cartesian vectors. [**4 marks**]

b) Determine the unit vectors perpendicular to both of $\mathbf{F_1}$ and $\mathbf{F_2}$. [**4 marks**]

c) Determine the projections of $\mathbf{F_1}$ along the coordinate axes. [**3 marks**]

d) Determine the components of $\mathbf{F_2}$ which are parallel and perpendicular to $\mathbf{F_1}$. Express the results in Cartesian vector forms. [**5 marks**]



a) $F_1 \rightarrow \theta_x = 120^\circ,\ \theta_y = 60,\ \theta_z = 45$ (1)

$F_1 = 600[\cos(120)i + \cos(60)j + \cos(45)k]$

$F_1 = -300i + 300j + 424.26k$ (1)

$F_2 \Rightarrow F_{xy} = 800\cos(30) = 692.82$ (1)

$F_z = -800\sin(30) = -400$

$F_2 = 489.9i + 489.9j - 400k$

$F_x = 692.82\cos(45) = 489.9$ (1)

$F_y = 489.9$

b) $F_1 \times F_2 = \begin{vmatrix} i & j & k \\ -300 & 300 & 424.26 \\ 489.9 & 489.9 & -400 \end{vmatrix} = i(-327845) + j(87845) + k(293940)$ (1) (1)

$u_\perp = \pm \dfrac{F_1 \times F_2}{|F_1 \times F_2|} = \pm[-0.73i + 0.196j + 0.655k]$ (1)

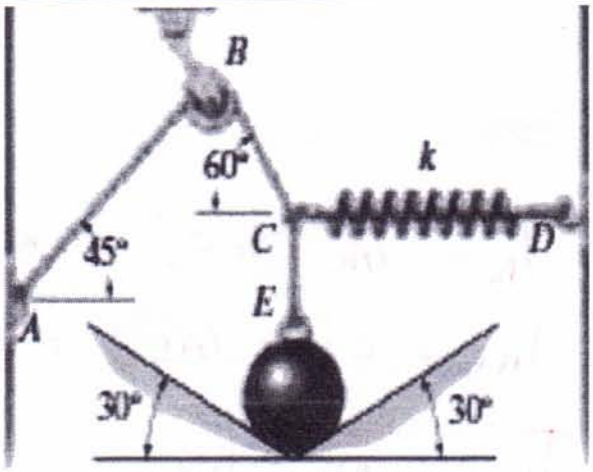
c) $F_{1x} = |-300|$ (1) $F_{1y} = 300$ (1), $F_{1z} = 424.26$ (1)

d) $|F_{2\parallel F_1}| = F_2 \cdot u_{F_1} = (489.9i + 489.9j - 400k) \cdot (-\frac{1}{2}i + \frac{1}{2}j + \frac{1}{\sqrt{2}}k) = -282.84$ (1)

$F_{2\parallel} = (-282.84)[-\frac{1}{2}i + \frac{1}{2}j + \frac{1}{\sqrt{2}}k] = 141.42i - 141.42j - 200k$ (1)

$F_{2\perp} = F_2 - F_{2\parallel} = 348.48i + 631.32j - 200k$ (1) (1)

[Q. 4] [**8 marks**] The 800 N sphere is supported by two smooth inclined planes, spring *CD*, and two cables *ABC* and *CE*. Determine the forces of the smooth planes on the sphere. If the tensile force of the cable *ABC* is 400 N.

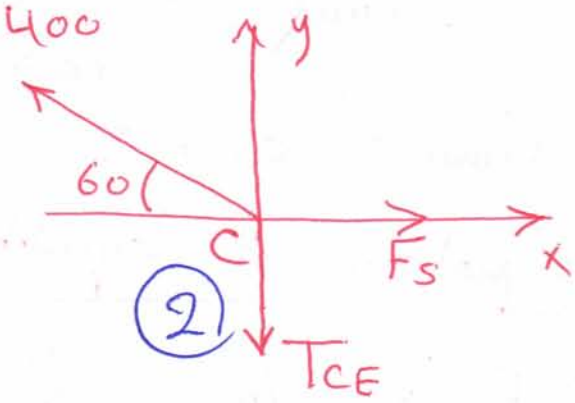


On Particle C

$\sum F_y = 0$

$400 \sin(60) = T_{CE}$

(1) $T_{CE} = 346.41$ N



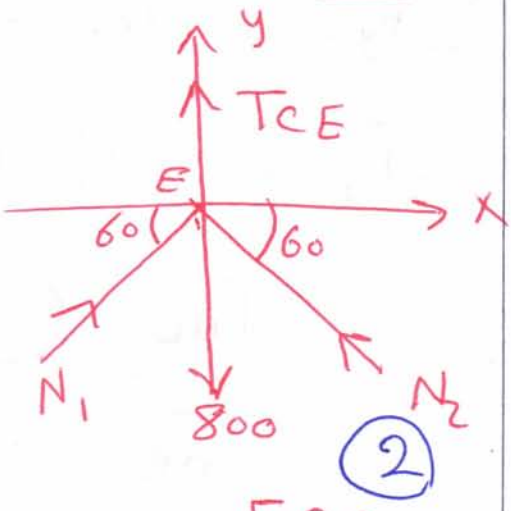
F.B.D.

On Particle E

$\sum F_x = 0 \qquad N_1 = N_2 = N$ (1)

$\sum F_y = 2N_1 \sin(60) + T_{CE}$

(1) $= 800$



F.B.D.

(1) $\boxed{N_2 = N_1 = 261.88 \text{ N}}$ Ans.