Question 1 [*25 marks*]

A man weighs 160 lb on earth. (1 lb = 4.448 N & $g_{earth} = 9.81\ m/s^2$)

a) What is his weight in Newtons?

1 lb = 4.48 N ⇒ weight (in Newtons) = 160 × 4.448 = 711.68 N

So: 712 N

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b) What is his mass in kilograms?

$W_{earth} = m \times g_{earth} \Rightarrow m = \frac{W_{earth}}{g_{earth}} = \frac{711.68\ N}{9.81\ \frac{m}{s^2}} = 72.55\ kg$

So: 72.6 kg

6/25

If the man is on the moon, where the acceleration due to gravity is 1/6th of that on earth:

c) What is his weight in pounds on the moon?

$g_{moon} = \frac{1}{6} g_{earth} \Rightarrow W_{moon} = \frac{1}{6} W_{earth} \Rightarrow W_{moon} = \frac{1}{6} \times 160\ lb = 26.67\ lb$

So: 26.7 lb

6/25

d) What is his mass in kilograms on the moon?

mass on the moon is equal to the mass on the earth,

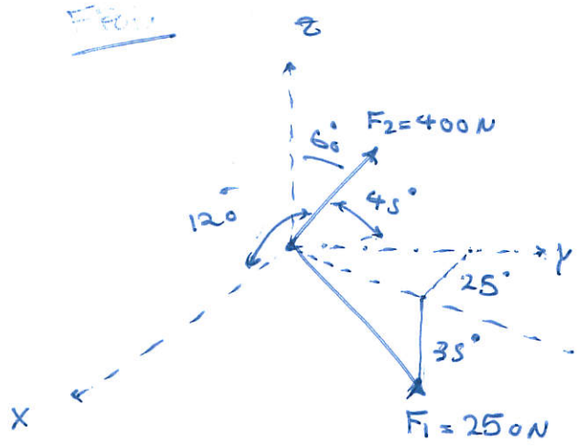
therefore: $m_{moon} = 72.55\ kg$

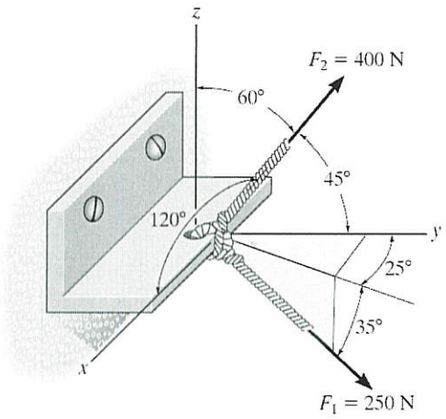
So: 72.6 kg

6/25

Question 2 [*25 marks*]

The bracket is subjected to the two forces shown. Find the resultant force (magnitude and direction).





$F_{1x} = 250 \cos 35^\circ \sin 25^\circ = 86.54\ N$ (3)

$F_{1y} = 250 \cos 35^\circ \cos 25^\circ = 185.6\ N$ (3)

$F_{1z} = -250 \sin 35^\circ = -143.4\ N$ (3)
or $F_{1z} = 250 \sin 125^\circ = -143.4\ N$

$\vec{F_1} = 86.54\,i + 185.6\,j - 143.4\,k$

$F_{2x} = 400 \cos 120 = -200\ N$ (3)

$F_{2y} = 400 \cos 45 = 282.8\ N$ (3)

$F_{2z} = 400 \cos 60 = 200\ N$ (3)

$\vec{F_2} = -200\,i + 282.8\,j + 200\,k$

$\vec{F_R} = \vec{F_1} + \vec{F_2}$

$\vec{F_R} = (86.54\,i + 185.6\,j - 143.4\,k) + (-200\,i + 282.8\,j + 200\,k) =$ (2)

$\vec{F_R} = -113.4\,i + 468.4\,j + 56.6\,k$

$|F_R| = \sqrt{(-113.4)^2 + (468.4)^2 + (56.6)^2} = 485.2\ N$ (2)

finding coordinate angles:

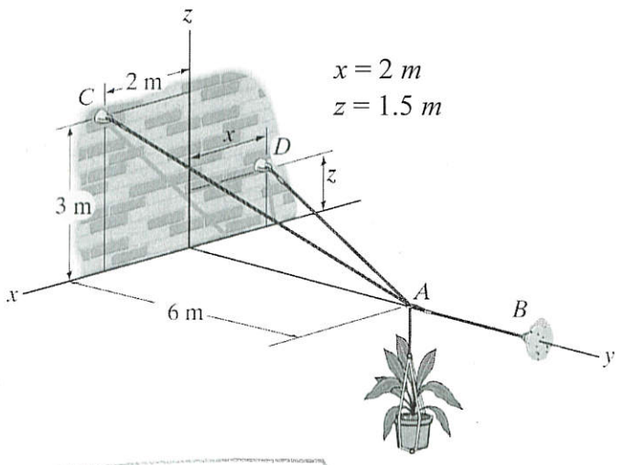
$\alpha = \cos^{-1}\left(\frac{-113.4}{485.2}\right) = 103.5^\circ$ (1)

$\beta = \cos^{-1}\left(\frac{468.4}{485.2}\right) = 15.1^\circ$ (1)

$\gamma = \cos^{-1}\left(\frac{56.6}{485.2}\right) = 83.3^\circ$ (1)

Question 3 [*25 marks*]

If the mass of the flowerpot is 50-*kg*, determine the tension developed in each wire for equilibrium.



* Coordinates

$A = (0, 6, 0)$

$C = (2, 0, 3)$

$D = (-2, 0, 1.5)$

* Position vectors

$\vec{r}_{AC} = C - A = 2\vec{i} - 6\vec{j} + 3\vec{k}$ (2)

$\vec{r}_{AD} = D - A = -2\vec{i} - 6\vec{j} + 1.5\vec{k}$ (2)

* Unit vectors

$\vec{u}_{AC} = \frac{\vec{r}_{AC}}{|r_{AC}|} = \frac{2\vec{i} - 6\vec{j} + 3\vec{k}}{\sqrt{2^2 + (-6)^2 + 3^2}}$ (2)

$= 0.2857\vec{i} - 0.8571\vec{j} + 0.4286\vec{k}$

$\vec{u}_{AD} = \frac{\vec{r}_{AD}}{|r_{AD}|} = \frac{-2\vec{i} - 6\vec{j} + 1.5\vec{k}}{\sqrt{2^2 + 6^2 + 1.5^2}}$ (2)

$= -0.3077\vec{i} - 0.9231\vec{j} + 0.2308\vec{k}$

* Forces

$\therefore \vec{F}_{AC} = F_{AC}\vec{u}_{AC}$ (2)

$= 0.2857F_{AC}\vec{i} - 0.8571F_{AC}\vec{j} + 0.428F_{AC}\vec{k}$

$\vec{F}_{AD} = F_{AD}\vec{u}_{AD}$ (2)

$= -0.3077F_{AD}\vec{i} - 0.9231F_{AD}\vec{j} + 0.2308F_{AD}\vec{k}$

* Equilibrium

$\Sigma F_x = 0$ (3)

$0.2857F_{AC} - 0.3077F_{AD} = 0$

$F_{AC} = 1.077F_{AD} \rightarrow (1)$

$\Sigma F_z = 0$ (3)

$0.4286F_{AC} + 0.2308F_{AD} - 50(9.81) = 0$

$0.4286F_{AC} + 0.2308F_{AD} = 490.5\,N \rightarrow (2)$

* Sub 1 in 2

$0.4286(1.077F_{AD}) + 0.2308F_{AD} = 490.5$

$0.6924F_{AD} = 490.5N$

$F_{AD} = 708.4 = 708N$ (1)

* From (1)

$F_{AC} = 1.077(708.4) = 762.9N$

$F_{AC} = 763N$ (1)

$|r_{AB}| = 1$, $\vec{r}_{AB} = \vec{j}$, $\vec{u}_{AB} = \vec{j}$

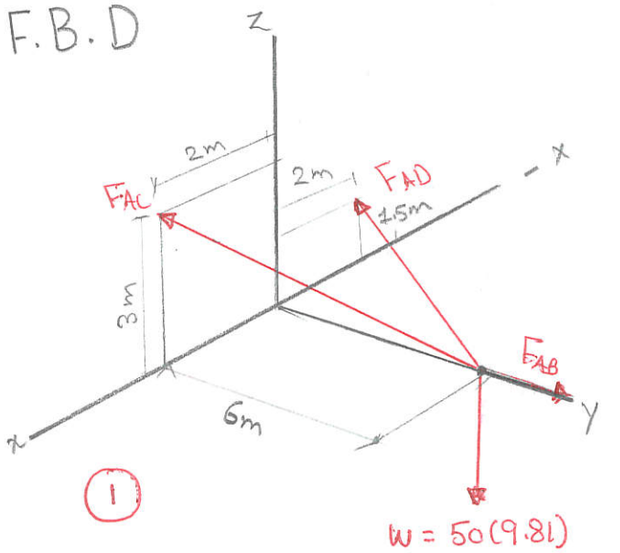
$\vec{F}_{AB} = F_{AB}\vec{j}$

$\Sigma F_y = 0$ (3)

$-0.8571(762.9) - 0.9231(708.4) + F_{AB} = 0$

$F_{AB} = 1308N = 13.1\,kN$ (1)

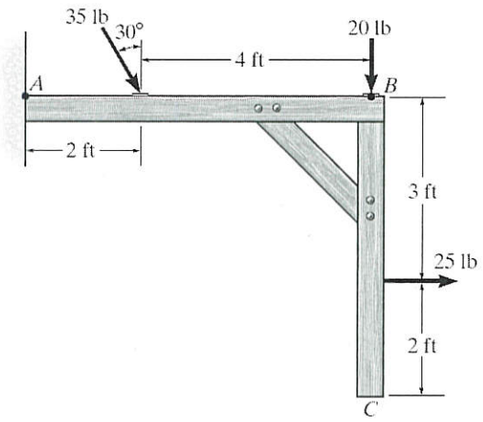
F.B.D

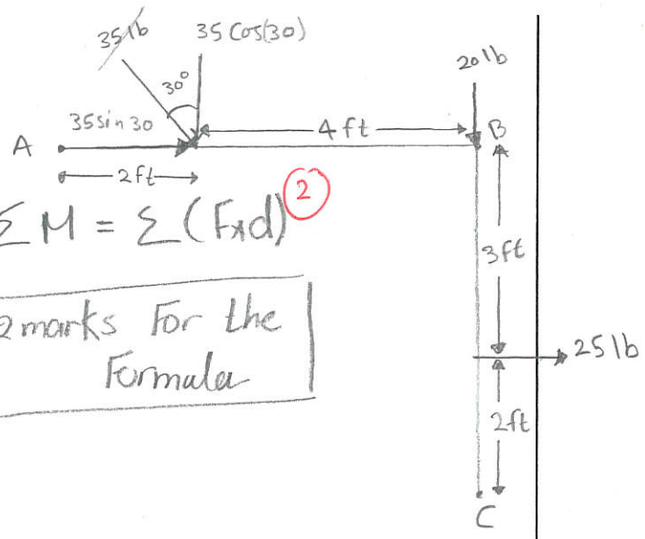


(1)

Question 4 [*25 marks*]

Determine the resultant moment produced by the forces about point *A*.





$\Sigma M = \Sigma (Fxd)$ (2)

2 marks For the Formula

$\circlearrowleft + \Sigma M_A = -[35\cos(30).(2ft)]$ (7)

$-[(20lb).(6ft)]$ (7)

$+[(25lb).(3ft)]$ (7)

21 marks = 7 marks for each correct Term

$M_A = -106\ lb\text{-}ft$

OR $M_A = 106\ lb.ft\ \circlearrowleft$ (2)

2 marks for final answer