



Department of
Civil & Environmental Engineering

ROY G. PERRY COLLEGE OF ENGINEERING

PRAIRIE VIEW A&M UNIVERSITY

Course Material

CVEG 2400

STATICS & DYNAMICS

INSTRUCTOR: **Dr. Emmanuel U. Nzewi, P.E.**

Fall 2021

PRAIRIE VIEW A&M UNIVERSITY
ROY G. PERRY COLLEGE OF ENGINEERING
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

CVEG 2400 – Statics and Dynamics

Fall 2021

I. COURSE SYLLABUS IN ABET FORMAT

II. ASSESSMENT RESULTS FOR CURRENT & PAST 3 PERIODS [*COURSE NOT ASSESSED*]

- Program Outcomes Assessed in Course
- Assessment Summary of Class Semester Averages for Outcomes
- End of Semester Course Outcomes Assessment Reports

III. TESTS (03)

- Summary of Topics covered in each test

Above Average (Graded original work)
Average (Graded original work)
Below Average (Graded original work)

IV. HOMEWORK ASSIGNMENTS (03)

Comprehensive Homework Assignments

Above Average (Graded original work)
Average (Graded original work)
Below Average (Graded original work)

V. CLASSWORK [Active Learning] (06)

Classwork – Focused Topical Assignments

Above Average (Graded original work)
Average (Graded original work)
Below Average (Graded original work)

I.

ABET
COURSE
SYLLABUS

CVEG 2400 Fall 2021

Statics & Dynamics

1.	Course number and name:	CVEG 2400 - Statics and Dynamics
2.	Credits and contact hours:	4 credit hours; 4 contact hours * Subject Area: Engineering Topics
3.	Instructor's or course coordinator's name:	Dr. Emmanuel Nzewi
4.	Text book: Title:	Engineering Mechanics: Statics and Dynamics
	Author:	R. C. Hibbeler
	Publisher, Year & Edition:	Pearson Prentice Hall, 14th Ed. (2015), SBN-13: 978-0133915426; ISBN-10: 0133915425
	a. Other Supplemental material	Class Notes provided by the Instructor
5.	Specific course information	
	a. Brief description of the content of the course (catalog description)	CVEG 2400 Statics and Dynamics: 4 semester hours. Fundamental concepts; equilibrium of particles and rigid bodies; centroids; moments of inertia; friction; introduction to analysis of structures. Kinematics and Kinetics of particles and of rigid bodies; equations of motion; work and energy; impulse and momentum.
	b. Prerequisites or Co-requisites	PHYS 2325 or PHYS 2513 – Calculus-based Physics I

	c. ** Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	Required
6.	a. Specific goals for the course specific outcomes of instruction (e.g. The student will be able to explain the significance of current research about a particular topic.) <i>Students will be able to:</i>	b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course. <i>The specific goals for the course specific outcomes listed on the left column will address the following student learning outcomes:</i>
	1. Develop the ability to analyze engineering mechanics problems using the principles of science and mathematics	Outcome 7 An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
	2. Develop the ability to describe and predict the conditions of equilibrium of particles, rigid bodies, and structures	
	3. Develop the ability to determine center of gravity, centroid, and moment of inertia	
7	Brief list of topics to be covered	Course Introduction [6 hours] General Principles; Force Vectors; and Equilibrium of a Particle [8 hours] Force System Resultants; Equilibrium of a Rigid Body [8 hours] Structural Analysis [4 hours] Center of Gravity and Centroid; Moments of Inertia [6 hours] Friction [4 hours] Kinematics/Kinetics of a Particle [10 hours] Force and Acceleration [2 hours] Impulse and Momentum [2 hours] Work and Energy [2 hours] Review for Exams [4 hours] Exams [4 hours]

* For all Engineering programs, indicate subject area from the following: **Math, Basic science, Engineering topic or Other**

** **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group

II.

ASSESSMENT RESULTS

(Course is NOT
Assessed)

End of Semester Course Assessment Report

This summary contains the following Information

1. Performance Statistics

- Total number of students in class
- The class average performance (stated as %) in each course outcome assessed in this class and the two previous times course was assessed.
- The acceptable class average for the class in each outcome area as set by your Department.
- Percentage of students who scored below the expected average in each outcome.

2. Implementation Summary

- Brief summary of plans implemented during the semester based on last assessment report

3. Perceived Problems

- Instructor's critical evaluation of perceived problems that affected students' performance.

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught.

5. Overall Trend over last three assessment periods

- Instructors summary of overall performance trend for each outcome measured over the last three periods.

III.

TESTS

[03]

CVEG 2400 - Statics & Dynamics

Fall 2021

Title of Assignment: Exam 01

TOPICS COVERED IN Exam 01

Exam 01 covered the following topics:

1. Units, conversions, and significant figures
2. Determination of resultant forces, Parallelogram law, Cosine Law, Sine Law, scalars and vectors, vector components forces
3. Equilibrium of a particle; Free Body Diagram (FBD)

ABOVE
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Nzewi

Exam 01

DATE: WEDNESDAY, October 06, 2021 at 08:05 AM In-class

Submit the entire exam the order given

Name (PRINT) Maria Gonzalez

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

340

400

1. This is a **CLOSED** book exam. Please **turn off** all cell phones and mp3 players and place them in your **book bag** in front of the class. Put **AWAY ANY** wristwatches. Also put away ANY **disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator **on your person or around you** during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 75 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM.** Once the exam begins, you **must** submit your work (exam terminates) when you leave the exam to visit the restroom.
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Calculator POLICY – Allowed Calculators

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All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

Signature: [Signature] Date: 10-06-21

NAME [PRINT (Lastname, firstname)]: Gonzalez, Maria

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2 (= 32.2 \text{ ft/s}^2)$

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 m = 100 cm

1 slug = 14.59 kg

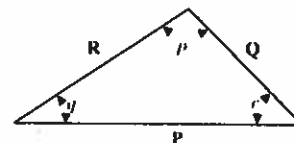
1 lb = 4.448 N

Standard atmosphere = $101.3 \text{ kPa} (= 2117 \text{ psf} = 14.7 \text{ psi})$

Gas constant for air, $R = 287 \text{ J/kg}\cdot\text{K}$

Density of water = $1000 \text{ kg/m}^3 (= 1.94 \text{ slugs/ft}^3)$ at 4°C

Specific weight of water = $9810 \text{ N/m}^3 (= 62.4 \text{ lb/ft}^3)$ at 4°C



Sine Law

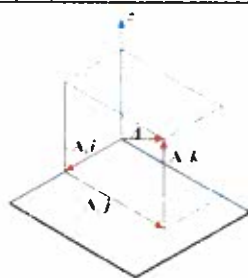
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

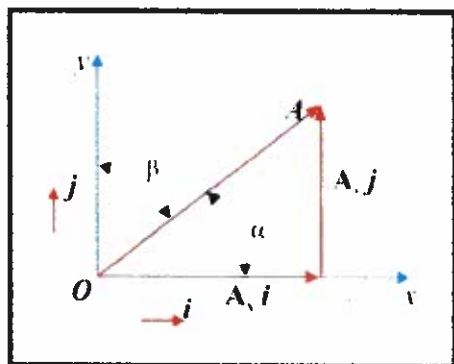
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

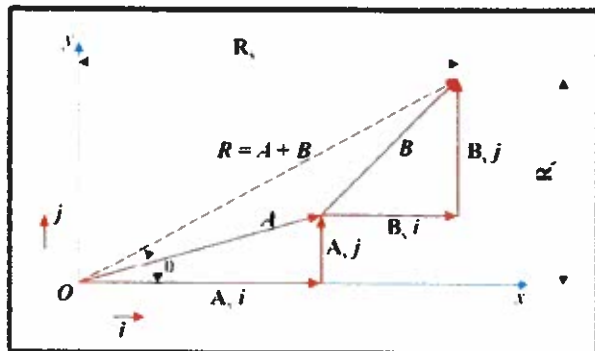


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

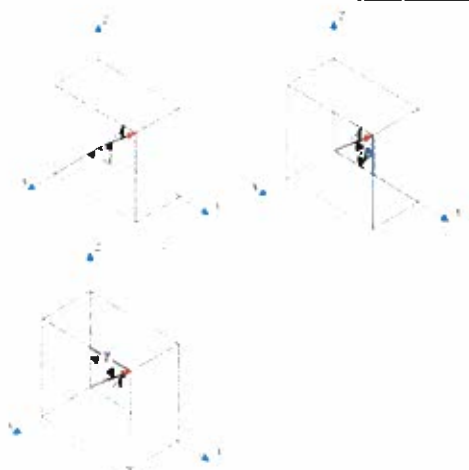
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

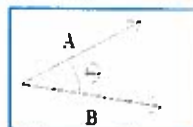
$$A = A_x i + A_y j + A_z k$$

$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$



I pledge to abide by all the rules stated for CVEG 2400 P01 Exam 01

GRADE

NAME [PRINT]: Maria Gonzalez

Signature: [Signature]

Date: 10/06/21

400

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.**Provide the answers as REQUIRED.**a) [30] Convert 100 km/hour into ft/s two significant digits

100 km	1,000 m	1 ft	1 hr	1 min
hr	1 km	0.3048 m	60 min	60 s

Velocity = 91 [ft/s]

(b)[20] Determine the equivalent of 1 MPa in psi (Hint: 1 Pa = 1 N/m² and psi stands for lb/in²).

1 N	1 lb	(0.254) ² m ²
m ²	4.448 N	1 in ²

Pressure = 1.45 x 10⁴ [psi](c)[20] Convert 60 miles/hour into m/s to three significant digits.

60 mi	5280 ft	0.3048 m	1 hr	1 min
hr	1 mi	1 ft	60 min	60 s

Speed = 26.8 m/s

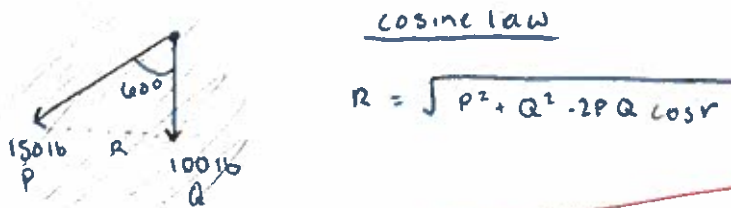
(d)[30] The density (mass/volume) of a solid is 45.4 slugs/ft³. Calculate its specific weight (weight/volume) in the SI units (N/m³) to three significant digits.Specific Weight = N/m³

-35

2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown

For the sketch provided, there are 3 forces acting on the ring as shown. Using the non-vector approach, determine the resultant force of ONLY the 150 lb and 100 lb forces. Also calculate the angle between the resultant force and the positive x-axis.

[Hint: you should begin by drawing a diagram of the 2 forces and the resultant, R.]

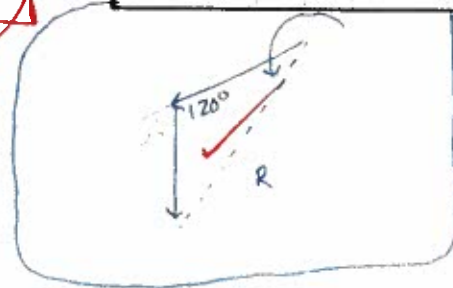
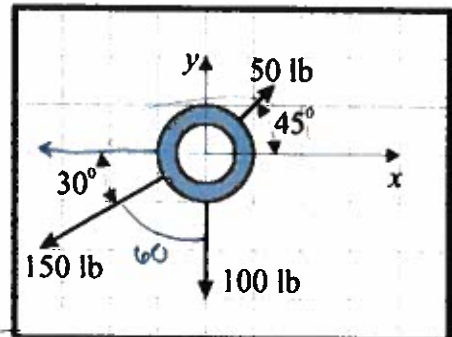


cosine law

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$

$$R = \sqrt{150^2 + 100^2 - 2(150)(100) \cos 60^\circ}$$

$$R = 217.94$$



This becomes negative

Magnitude of resultant force, $R = 218$ lb

$$R_x = 150 \cos(210^\circ)$$

$$= -130$$

$$R_x = |R| \cos \theta$$

$$-130 = 218 \cos \theta$$

$$\theta = \cos^{-1}\left(-\frac{130}{218}\right)$$

$$\theta = 120.61^\circ$$

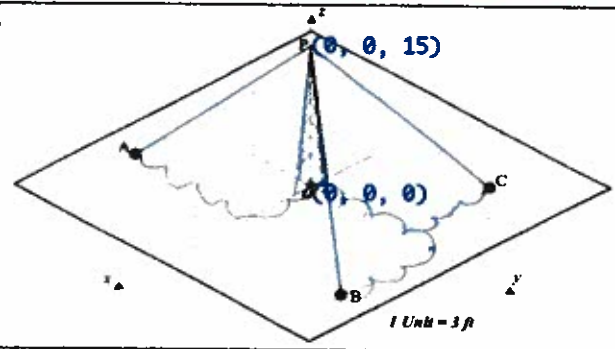
Use Force triangle
Parallelogram

Angle resultant force, R makes with positive x-axis = 127° degrees

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces.

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



a) [60] Provide the requested information below

Cable A:

$$A = (6i - 12j + 0k)$$

$$\text{Position vector for Cable A, } r_{PA} = 6i - 12j - 15k \text{ ft}$$

$$\text{Magnitude of } r_{PA} = 20.12 \text{ ft}$$

$$U_{PA}, \text{ Unit vector of } r_{PA} = \frac{0.3i - 0.6j - 0.75k}{|r_{PA}|}$$

$$|F_{PA}| = 500 \quad F_{PA} = |F_{PA}| U_{PA}$$

$$\text{Force vector for Cable A, } F_{PA} = 150i - 300j - 375k \text{ [lb]}$$

Cable B:

$$B = (9i + 12j + 0k)$$

$$\text{Position vector for Cable B, } r_{PB} = 9i + 12j - 15k \text{ ft}$$

$$\text{Magnitude of } r_{PB} = 21.21 \text{ ft}$$

$$U_{PB}, \text{ Unit vector of } r_{PB} = \frac{0.42i + 0.57j - 0.71k}{|r_{PB}|}$$

$$\vec{F}_{PB} = |F_{PB}| 0.42i + |F_{PB}| 0.57j - |F_{PB}| 0.71k$$

$$\text{Force vector for Cable B, } F_{PB} = i j k \text{ [lb]}$$

Cable C:

$$C = (-9i + 9j + 0k)$$

$$\text{Position vector for Cable C, } r_{PC} = -9i + 9j - 15k \text{ ft}$$

$$\text{Magnitude of } r_{PC} = 19.67 \text{ ft}$$

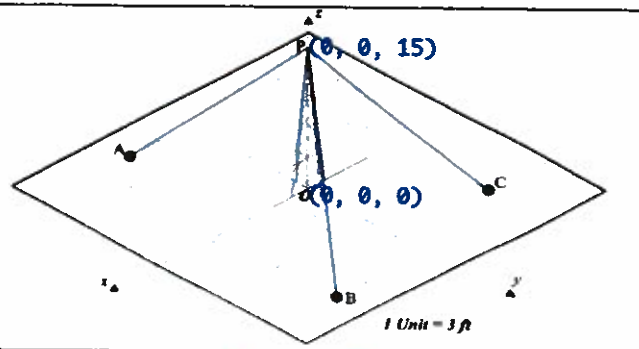
$$U_{PC}, \text{ Unit vector of } r_{PC} = \frac{-0.45i + 0.45j - 0.76k}{|r_{PC}|}$$

$$\vec{F}_{PC} = |F_{PC}| (-0.45i + 0.45j - 0.76k)$$

$$\text{Force vector for Cable C, } F_{PC} = i j k \text{ [lb]}$$

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

3b) [40] Provide the Equilibrium EQUATIONS in the X-, Y- and Z-directions below

X-DIRECTION:

$$150 + |F_{PB}| 0.42 - |F_{PC}| 0.45 = 0$$

Y-DIRECTION:

$$-300 + |F_{PB}| 0.57 + |F_{PC}| 0.45 = 0$$

Z-DIRECTION:

$$-375 - |F_{PB}| 0.71 - |F_{PC}| 0.76 + F_{OP} = 0$$

4. [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

- (a) [40] For the vector $250\mathbf{i} - 150\mathbf{j} + 200\mathbf{k}$ kN, determine its magnitude the direction, angles α , β , and γ and the unit vector.

$$|\mathbf{F}| = \sqrt{250^2 + (-150)^2 + 200^2} = 353.55$$

$$F_x = |\mathbf{F}| \cos \alpha \rightarrow \alpha = \cos^{-1} \left(\frac{F_x}{|\mathbf{F}|} \right)$$

$$\alpha = \cos^{-1} \left(\frac{250}{354} \right) = 45$$

$$\beta = \cos^{-1} \left(\frac{-150}{354} \right) = 115.1$$

$$\gamma = \cos^{-1} \left(\frac{200}{354} \right) = 55.55$$

Magnitude of Vector 354 [kN]

α 45 [degrees]

β 115.1 [degrees]

γ 55.56 [degrees]

Unit Vector, $\mathbf{U}$ $0.706\mathbf{i} - 0.424\mathbf{j} + 0.565\mathbf{k}$ []

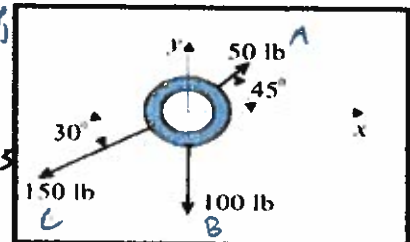
- b) [30] Using the **vector-based approach**, determine the resultant of the 3 forces on the ring shown in the accompanying figure. Label the 50 lb force A, the 100 lb force B, and the 150 lb force C. Determine the x-(i) and y-(j) components of each force first and write them out in vector format. **BE SURE TO APPLY THE CORRECT SIGNS** in your vector presentations.



$$\vec{F}_C = 150 \cos 210^\circ \mathbf{i} + 150 \cos 120^\circ \mathbf{j}$$

$$\vec{F}_B = 0\mathbf{i} - 100\mathbf{j}$$

$$\vec{F}_A = 50 \cos 45^\circ \mathbf{i} + 50 \cos 45^\circ \mathbf{j}$$



Vector A = $35\mathbf{i} + 35\mathbf{j} + 0\mathbf{k}$ [lb]

Vector B = $0\mathbf{i} - 100\mathbf{j} + 0\mathbf{k}$ [lb]

Vector C = $-130\mathbf{i} - 75\mathbf{j} + 0\mathbf{k}$ [lb]

- c) [15] Determine the resultant force, $\mathbf{R}$ of the 3 forces in **vector format**.

Resultant Force, $\mathbf{R}$ = $-95\mathbf{i} - 140\mathbf{j} + 0\mathbf{k}$ [lb]

- d) [15] Provide the **Unit vector** of the Resultant Force, $\mathbf{R}$

$$|\mathbf{R}| = 169$$

Unit Vector, $\mathbf{U}$ = $-0.56\mathbf{i} - 0.83\mathbf{j} + 0\mathbf{k}$ []

AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azemi

Exam 01

DATE: WEDNESDAY, October 06, 2021 at 08:05 AM In-class

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Signature: Danilo Edgar II

Date: 10/6/21

NAME [PRINT (Lastname, firstname)]: Edgar II, Danilo Edgar II

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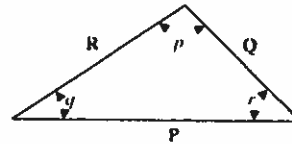
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Sine Law

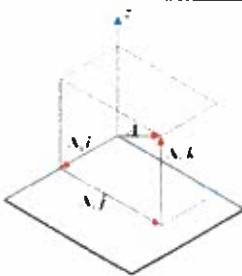
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$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

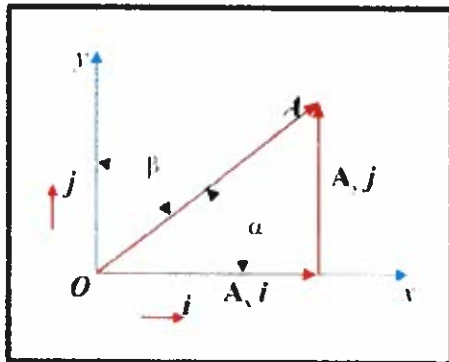
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

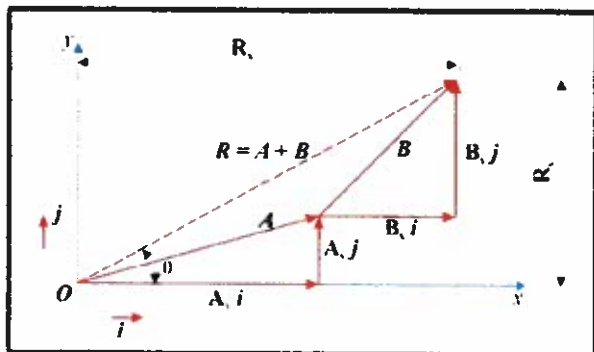


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

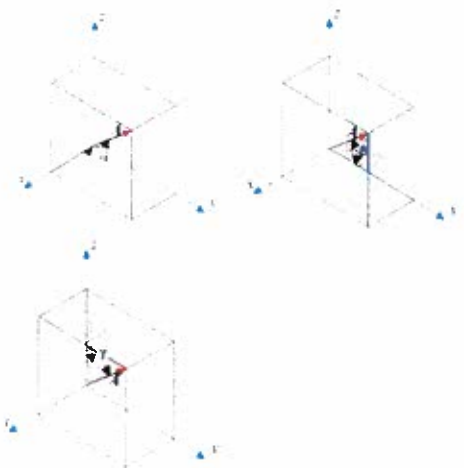
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

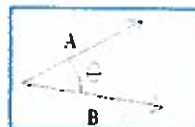
$$A = A_x i + A_y j + A_z k$$

$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$



I pledge to abide by all the rules stated for CVEG 2400 P01 Exam 01

GRADE

400

NAME [PRINT]:

Damaris Edgar II

Signature:

Damaris Edgar II

Date:

10/6/21

235

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.**Provide the answers as REQUIRED.**a) [30] Convert 100 km/hour into ft/s two significant digitsgo directly from
m → ft

100 km	1000 m	100 cm	1 in	1 ft	1 hr	1 min
1 hr	1 km	1 m	2.54 cm	12 in	60 min	60 sec

$$0.3048 \text{ m} = 1 \text{ ft}$$

$$\frac{100 \cdot 1000 \cdot 100}{(2.54)(12)(60)(60)} = 90.42 \frac{\text{ft}}{\text{s}}$$

$$(2.54)(12)(60)(60)$$

Velocity = 90 [ft/s](b)[20] Determine the equivalent of 1 MPa in psi (Hint: 1 Pa = 1 N/m² and psi stands for lb/in²).

1 MPa	1000 Pa
1 MPa	

IN sufficient

Pressure = 145.04 lb/in² [psi]You did not
show your
work(c)[20] Convert 60 miles/hour into m/s to three significant digits.

60 miles	5,280 ft	12 in	2.54 cm	1 m	1 hr	1 min
1 hr	1 mile	1 ft	1 in	1000 mm	60 min	60 sec

only
2

$$\frac{(60)(5,280)(12)(2.54)}{(1000)(60)(60)} = 2.7 \frac{\text{m}}{\text{s}}$$

Speed = 2.7 m/s(d)[30] The density (mass/volume) of a solid is 45.4 slugs/ft³. Calculate its specific weight (weight/volume) in the SI units (N/m³) to three significant digits.Specific Weight = 30 N/m³

-55

2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown

For the sketch provided, there are 3 forces acting on the ring as shown. Using the non-vector approach, determine the resultant force of ONLY the 150 lb and 100 lb forces. Also calculate the angle between the resultant force and the positive x-axis.

[Hint: you should begin by drawing a diagram of the 2 forces and the resultant, R.]

Given

$$F_1 = 150 \text{ lb}$$

$$F_2 = 100 \text{ lb}$$

Law of sines

$$\frac{100}{\sin(30)} = \frac{150}{\sin(60-\theta)}$$

$$150 \sin(30) = 100 \sin(60-\theta)$$

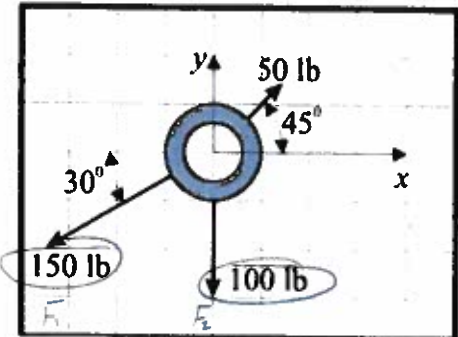
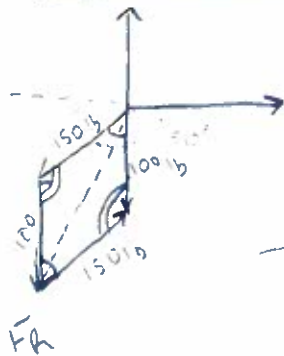
$$\frac{75}{100} = \frac{100 \sin(60-\theta)}{100}$$

$$\therefore (0.75) = \sin(60-\theta)$$

$$48.59 = 60 - \theta$$

$$\theta = 11.41^\circ$$

FBD



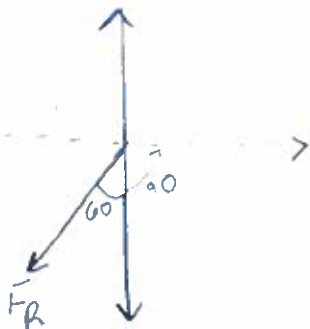
Law of Sines Continued

$$\frac{100}{\sin(30)} = \frac{|F_R|}{\sin(161.41)}$$

$$100 \sin(161.41) = |F_R| \sin(30)$$

$$31.88 = |F_R| \sin(30)$$

$$\text{Magnitude of resultant force, } R = 63.759 \text{ lb}$$



Justify your answer

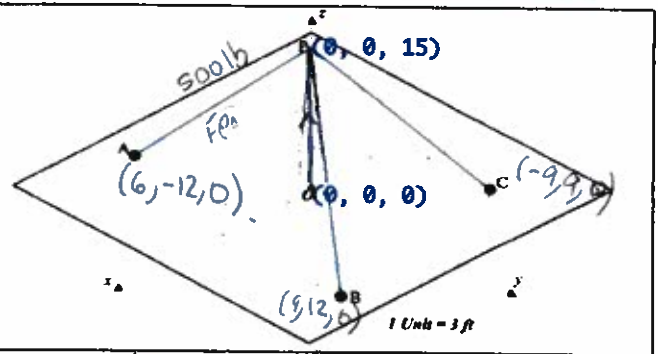
$$\text{Angle resultant force, } R \text{ makes with positive x-axis} = 150^\circ \text{ degrees}$$

145

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



a) [60] Provide the requested information below

Cable A:

$P(0,0,15)$ $\vec{r}_{PA} = (0-6)\mathbf{i} + (0+12)\mathbf{j} + (15-0)\mathbf{k}$

$A(6,-12,0)$ $\vec{r}_{PA} = -6\mathbf{i} + 12\mathbf{j} + 15\mathbf{k}$

Position vector for Cable A, $\vec{r}_{PA} = -6\mathbf{i} + 12\mathbf{j} + 15\mathbf{k}$ ft

$A(6,-12,0)$ Magnitude of $\vec{r}_{PA} = 16.957$ ft $|\vec{r}_{PA}| = \sqrt{(-6)^2 + (12)^2 + (15)^2}$

$U_{PA} = \frac{\vec{r}_{PA}}{|\vec{r}_{PA}|} = \frac{-6\mathbf{i} + 12\mathbf{j} + 15\mathbf{k}}{16.957}$ U_{PA} , Unit vector of $\vec{r}_{PA} = -0.128\mathbf{i} + 0.256\mathbf{j} + 0.958\mathbf{k}$

$\vec{F}_{PA} = |\vec{F}_{PA}| \cdot U_{PA} = 500(-0.128\mathbf{i} + 0.256\mathbf{j} + 0.958\mathbf{k})$ Force vector for Cable A, $\vec{F}_{PA} = -64\mathbf{i} + 128\mathbf{j} + 479\mathbf{k}$ [lb]

Cable B:

$P(0,0,15)$ $\vec{r}_{PB} = (0-9)\mathbf{i} + (0-12)\mathbf{j} + (15-0)\mathbf{k}$

$B(9,12,0)$

Position vector for Cable B, $\vec{r}_{PB} = -9\mathbf{i} - 12\mathbf{j} + 15\mathbf{k}$ ft

Magnitude of $\vec{r}_{PB} = 17.34$ ft $|\vec{r}_{PB}| = \sqrt{(-9)^2 + (-12)^2 + (15)^2}$

$U_{PB} = \frac{\vec{r}_{PB}}{|\vec{r}_{PB}|} = \frac{-9\mathbf{i} - 12\mathbf{j} + 15\mathbf{k}}{17.34}$ U_{PB} , Unit vector of $\vec{r}_{PB} = -0.190\mathbf{i} - 0.253\mathbf{j} + 0.949\mathbf{k}$

$\vec{F}_{PB} = |\vec{F}_{PB}| \cdot U_{PB} =$ Force vector for Cable B, $\vec{F}_{PB} = -17.1\mathbf{i} - 22.4\mathbf{j} + 179\mathbf{k}$ [lb]

Cable C:

$P(0,0,15)$ $\vec{r}_{PC} = (0+9)\mathbf{i} + (0-9)\mathbf{j} + (15-0)\mathbf{k}$

$C(-9,9,0)$

Position vector for Cable C, $\vec{r}_{PC} = 9\mathbf{i} - 9\mathbf{j} + 15\mathbf{k}$ ft

Magnitude of $\vec{r}_{PC} = 17.65$ ft $|\vec{r}_{PC}| = \sqrt{(9)^2 + (-9)^2 + (15)^2}$

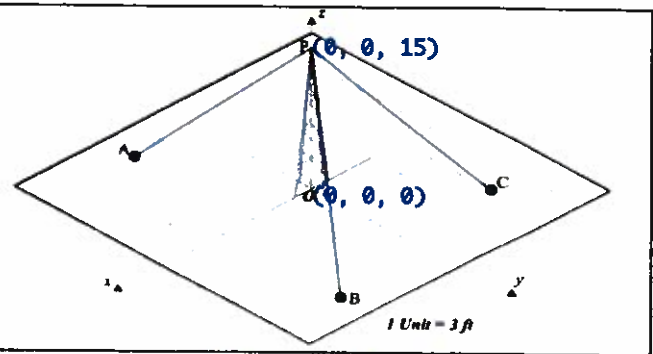
$U_{PC} = \frac{\vec{r}_{PC}}{|\vec{r}_{PC}|} = \frac{9\mathbf{i} - 9\mathbf{j} + 15\mathbf{k}}{17.65}$ U_{PC} , Unit vector of $\vec{r}_{PC} = 0.192\mathbf{i} - 0.192\mathbf{j} + 0.962\mathbf{k}$

$\vec{F}_{PC} = |\vec{F}_{PC}| \cdot U_{PC} =$ Force vector for Cable C, $\vec{F}_{PC} = 17.1\mathbf{i} - 17.1\mathbf{j} + 179\mathbf{k}$ [lb]

-380

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

3b) [40] Provide the Equilibrium EQUATIONS in the X-, Y- and Z-directions below

X-DIRECTION:

Y-DIRECTION:

$$-64 - |F_{PB}|(-0.190) + |F_{PC}|(0.192) = 0$$

OK method

Z-DIRECTION:

$$128 + |F_{PB}|(-0.253) + |F_{PC}|(-0.192) = 0$$

$$479 + |F_{PB}|(0.949) + |F_{PC}|(-0.192) = 0$$

+ F_{OP} -5

-5

4.100] CLEARLY SHOW ALL WORK AND provide the answers as shown

(a) [40] For the vector $250\mathbf{i} - 150\mathbf{j} + 200\mathbf{k}$ kN, determine its magnitude the direction, angles α , β , and γ and the unit vector.

$$\text{magnitude} = \sqrt{(250)^2 + (-150)^2 + (200)^2} = 353.553 \text{ kN}$$

$$\mathbf{U} = \frac{250\mathbf{i} - 150\mathbf{j} + 200\mathbf{k}}{353.553} = 0.707\mathbf{i} - 0.424\mathbf{j} + 0.566\mathbf{k}$$

Magnitude of Vector 353.553 [kN] α 45.009° [degrees] β 115.087° [degrees] γ 124.71° [degrees]

$$A_x = |A| \cos \alpha \quad A_y = |A| \cos \beta \quad A_z = |A| \cos \gamma$$

$$250 = 353.553 \cos \alpha \quad -150 = 353.553 \cos \beta$$

$$0.707 = \cos \alpha$$

$$\alpha = \cos^{-1}(0.707)$$

$$\beta = \cos^{-1}(-0.424)$$

$$\gamma = \cos^{-1}(0.566)$$

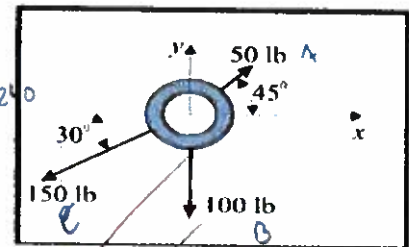
Unit Vector, $\mathbf{U}$ 0.707 $\mathbf{i}$ - 0.424 $\mathbf{j}$ + 0.566 $\mathbf{k}$ []

b) [30] Using the vector-based approach, determine the resultant of the 3 forces on the ring shown in the accompanying figure. Label the 50 lb force A, the 100 lb force B, and the 150 lb force C. Determine the x- (i) and y- (j) components of each force first and write them out in vector format. BE SURE TO APPLY THE CORRECT SIGNS in your vector presentations.

$$\begin{array}{c} \text{A} \\ \text{50 lb} \\ \text{50 cos } 45^\circ \quad \text{50 cos } 45^\circ \end{array}$$

$$\begin{array}{c} \text{B} \\ \text{100 lb} \\ \text{100 cos } 90^\circ \quad \text{100 cos } 180^\circ \end{array}$$

$$\begin{array}{c} \text{C} \\ \text{150 lb} \\ \text{150 cos } 150^\circ \quad \text{150 cos } 240^\circ \end{array}$$

Vector A = 35.355 $\mathbf{i}$ + 35.355 $\mathbf{j}$ + 0 $\mathbf{k}$ [lb]Vector B = 0 $\mathbf{i}$ - 100 $\mathbf{j}$ + 0 $\mathbf{k}$ [lb]Vector C = -129.904 $\mathbf{i}$ - 75 $\mathbf{j}$ + 0 $\mathbf{k}$ [lb]

c) [15] Determine the resultant force, R of the 3 forces in vector format.

Resultant Force, $\mathbf{R}$ = -94.549 $\mathbf{i}$ - 139.645 $\mathbf{j}$ + 0 $\mathbf{k}$ [lb]

d) [15] Provide the Unit vector of the Resultant Force, R

$$\mathbf{U}_R = \frac{-94.549\mathbf{i} - 139.645\mathbf{j} + 0\mathbf{k}}{168.64}$$

$$|\mathbf{R}| = \sqrt{(-94.549)^2 + (-139.645)^2 + 0^2} = 168.64$$

Unit Vector, $\mathbf{U}$ = -0.574 $\mathbf{i}$ - 0.828 $\mathbf{j}$ + 0 $\mathbf{k}$ []

BELOW
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azizi

Exam 01

DATE: WEDNESDAY, October 06, 2021 at 08:05 AM In-class

Submit the entire exam the order given

Name (PRINT)

Nakaela Malone

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

65

400

1. This is a **CLOSED** book exam. Please **turn off all cell phones and mp3 players** and place them in your **book bag** in front of the class. Put **AWAY ANY wristwatches**. Also put away **ANY disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator **on your person or around you** during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 75 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM.** Once the exam begins, you **must** submit your work (exam terminates) when you leave the exam to visit the restroom.
9. You are required to solve **ALL** problems.

Calculator POLICY – Allowed Calculators

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name)

All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

Signature:

Nakaela Malone

Date:

10/06/2021

NAME [PRINT (Lastname, firstname)]:

Malone Nakaela

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2$ ($= 32.2 \text{ ft/s}^2$)

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 m = 100 cm

1 slug = 14.59 kg

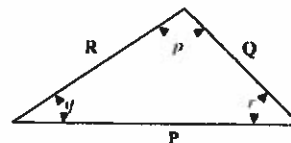
1 lb = 4.448 N

Standard atmosphere = 101.3 kPa ($= 2117 \text{ psf} = 14.7 \text{ psi}$)

Gas constant for air, $R = 287 \text{ J/kg.K}$

Density of water = 1000 kg/m^3 ($= 1.94 \text{ slugs/ft}^3$) at 4°C

Specific weight of water = 9810 N/m^3 ($= 62.4 \text{ lb/ft}^3$) at 4°C



Sine Law

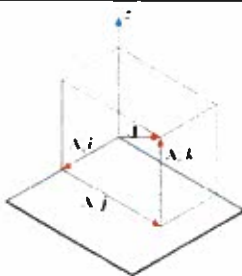
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

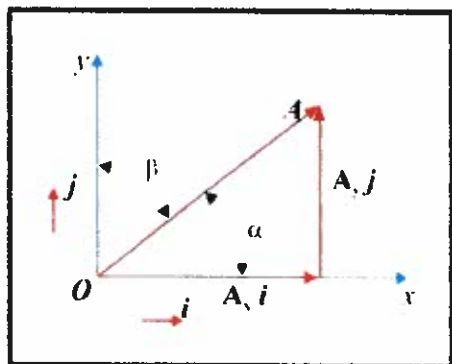
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

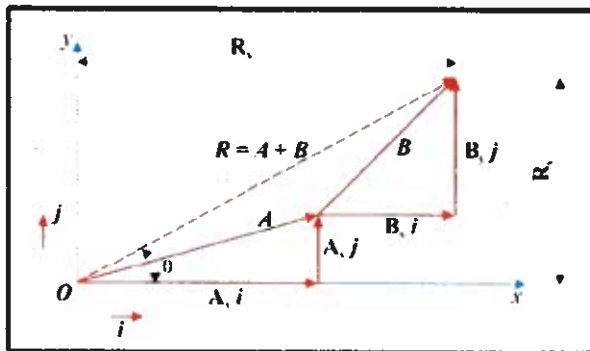


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

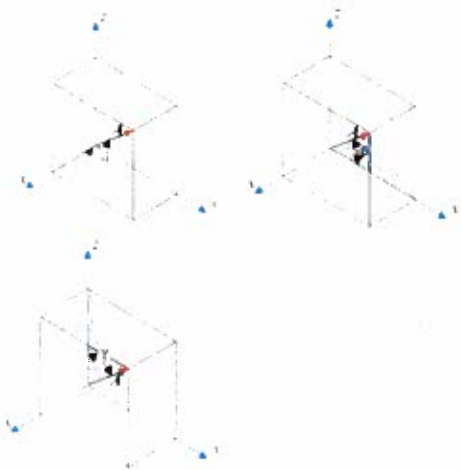
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} \mathbf{R} &= \mathbf{A} + \mathbf{B} = (A_x \mathbf{i} + A_y \mathbf{j}) + (B_x \mathbf{i} + B_y \mathbf{j}) \\ &= (A_x + B_x) \mathbf{i} + (A_y + B_y) \mathbf{j} \\ &= R_x \mathbf{i} + R_y \mathbf{j} \end{aligned}$$

$$|\mathbf{R}| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{\mathbf{A}}{|\mathbf{A}|}$$

$$= \frac{A_x}{|\mathbf{A}|} \mathbf{i} + \frac{A_y}{|\mathbf{A}|} \mathbf{j} + \frac{A_z}{|\mathbf{A}|} \mathbf{k}$$

$$u_A = \cos \alpha \mathbf{i} + \cos \beta \mathbf{j} + \cos \gamma \mathbf{k}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\mathbf{F} = F_x \mathbf{i} + F_y \mathbf{j} + F_z \mathbf{k}$$

$$\mathbf{r} = r_x \mathbf{i} + r_y \mathbf{j} + r_z \mathbf{k}$$

$$\mathbf{U}_r = \frac{r_x \mathbf{i} + r_y \mathbf{j} + r_z \mathbf{k}}{|\mathbf{r}|}$$

$$\mathbf{F}_r = |\mathbf{F}| \cdot \mathbf{U}_r$$

$$|\mathbf{r}| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

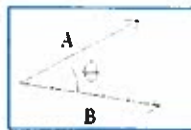
$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

$$\mathbf{B} = B_x \mathbf{i} + B_y \mathbf{j} + B_z \mathbf{k}$$

$$\cos \theta = \frac{\mathbf{A} \cdot \mathbf{B}}{|\mathbf{A}| |\mathbf{B}|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|\mathbf{A}| |\mathbf{B}|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|\mathbf{A}| |\mathbf{B}|} \right)$$



I pledge to abide by all the rules stated for CVEG 2400 P01 Exam 01

NAME [PRINT]: Nakaela MaloneSignature: Nakaela MaloneDate: 10/06/2021

GRADE

400

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.**Provide the answers as REQUIRED.**a) [30] Convert 100 km/hour into ft/s two significant digits

$$100 \frac{\text{km}}{\text{hr}} \cdot \frac{1 \text{ hr}}{60 \text{ s}} \cdot \frac{1 \text{ m}}{5280 \text{ ft}} ?$$

$$1 \text{ meter} = \frac{1}{0.3048} \text{ ft}$$

$$100 \cdot 5280 / 60$$

Velocity = 88 [ft/s](b)[20] Determine the equivalent of 1 MPa in psi (Hint: 1 Pa = 1 N/m² and psi stands for lb/in²).Pressure = 15 [psi](c)[20] Convert 60 miles/hour into m/s to three significant digits.

$$60 \frac{\text{mi}}{\text{hr}} \cdot \frac{1 \text{ hr}}{60 \text{ s}} ?$$

Speed = 360 m/s(d)[30] The density (mass/volume) of a solid is 45.4 slugs/ft³. Calculate its specific weight (weight/volume) in the SI units (N/m³) to three significant digits.

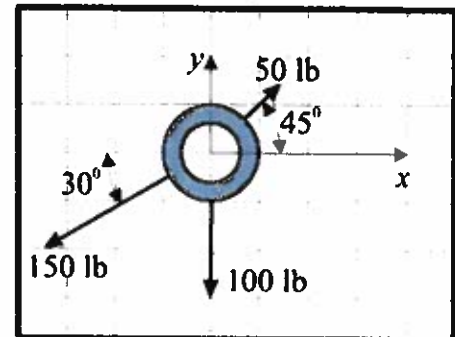
$$45.4 / 1000$$

Specific Weight = 0.045 N/m³

2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown

For the sketch provided, there are 3 forces acting on the ring as shown. Using the non-vector approach, determine the resultant force of ONLY the 150 lb and 100 lb forces. Also calculate the angle between the resultant force and the positive x-axis.

[Hint: you should begin by drawing a diagram of the 2 forces and the resultant, R.]



$$|R| = \sqrt{r_x^2 + r_y^2}$$

$$|R| = \sqrt{100^2 + 100^2} = 180.28$$

Not adequate
Draw force triangle
+ Parallelogram

35

Magnitude of resultant force, $R =$ 180.28 lb

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$

$$\tan^{-1} \left| \frac{100}{150} \right| = 33.69$$

35

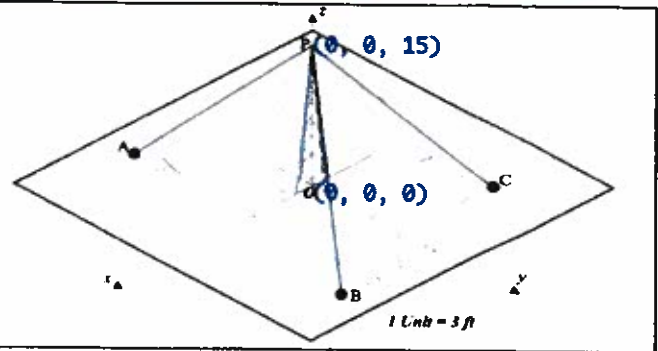
Angle resultant force, R makes with positive x-axis = 33.69 degrees

70

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



a) [60] Provide the requested information below

Cable A:

$$6^2 + 12^2 + 15^2 = 405$$

$$6 + 12 + 15 = 33$$

Magnitude of $r_{PA} =$ 33 ft

Position vector for Cable A, $r_{PA} =$ $6i + 12j + 15k$ ft

U_{PA} , Unit vector of $r_{PA} =$ $\frac{6}{33}i + \frac{12}{33}j + \frac{15}{33}k$

Force vector for Cable A, $F_{PA} =$ $83.3i + 41.6j + 33.3k$ [lb]

Cable B:

Magnitude of $r_{PB} =$ 15 ft

Position vector for Cable B, $r_{PB} =$ $9i + 12j + 15k$ ft

U_{PB} , Unit vector of $r_{PB} =$ $\frac{9}{15}i + \frac{12}{15}j + \frac{15}{15}k$

Force vector for Cable B, $F_{PB} =$ $i + j + k$ [lb]

Cable C:

Magnitude of $r_{PC} =$ 15 ft

Position vector for Cable C, $r_{PC} =$ $9i + 0j + 15k$ ft

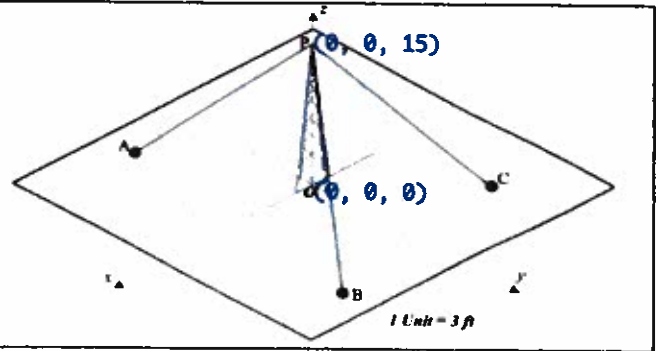
U_{PC} , Unit vector of $r_{PC} =$ $\frac{9}{15}i + 0j + \frac{15}{15}k$

Force vector for Cable C, $F_{PC} =$ $3i + 0j + 3k$ [lb]

-55

A 15 ft tall pole is supported by three cables. The pole is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, F_{PA} is 500 lb, PROVIDE the REQUESTED information about the tension in the cables. The force exerted by the pole on joint P is F_{OP} and points upwards in the z-direction. The force in the cable PA is F_{PA} , the force in the cable PB is F_{PB} and the force in the cable PC is F_{PC} .

Note that 1 unit = 3 ft. HINT: First find the Unit vector for each cable and then the force vector for each one.



CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

3b) [40] Provide the Equilibrium EQUATIONS in the X-, Y- and Z-directions below

X-DIRECTION:

Y-DIRECTION:

Z-DIRECTION:

-40

4 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

- (a) [40] For the vector $250\mathbf{i} - 150\mathbf{j} + 200\mathbf{k}$ kN, determine its magnitude the direction, angles α , β , and γ and the unit vector.

$$250\mathbf{i} - 150\mathbf{j} + 200\mathbf{k} \text{ kN}$$

$$\alpha = \cos$$

$$\beta = \cos$$

$$\gamma = \cos$$

$$\frac{250^2 - 150^2 + 200^2}{300}$$

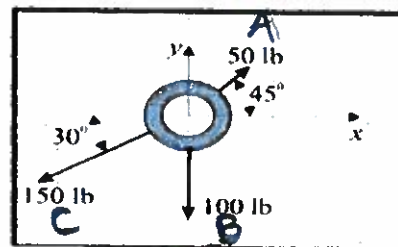
Magnitude of Vector ~~300~~ [kN] α ~~70~~ [degrees] β ~~30~~ [degrees] γ ~~20~~ [degrees]Unit Vector, $\mathbf{U} = \underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} []$

- b) [30] Using the vector-based approach, determine the resultant of the 3 forces on the ring shown in the accompanying figure. Label the 50 lb force A, the 100 lb force B, and the 150 lb force C. Determine the x- (i) and y- (j) components of each force first and write them out in vector format. BE SURE TO APPLY THE CORRECT SIGNS in your vector presentations.

$$A = 50$$

$$B = -100$$

$$C = 150$$

Vector A = $\underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} [lb]$ Vector B = $\underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} [lb]$ Vector C = $\underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} [lb]$

- c) [15] Determine the resultant force, R of the 3 forces in vector format.

Resultant Force, $\mathbf{R} = \underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} [lb]$

- d) [15] Provide the Unit vector of the Resultant Force, R

Unit Vector, $\mathbf{U} = \underline{\hspace{1cm}} \mathbf{i} \underline{\hspace{1cm}} \mathbf{j} \underline{\hspace{1cm}} \mathbf{k} \underline{\hspace{1cm}} []$

CVEG 2400 - Statics & Dynamics

Fall 2021

Title of Assignment: Exam 02

TOPICS COVERED IN Exam 02

Exam 02 covered the following topics:

- 1) Equilibrium of a Particle),
- 2) Equilibrium of a Rigid Body
- 3) Structural Analysis & Trusses
- 4) Center of Gravity and Centroids

ABOVE
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Vezoi

Exam 02

DATE: WEDNESDAY, November 17, 2021 at 08:05 AM In-class

Submit the entire exam the order given

Name (PRINT)

Kennedy Dent

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

385

400

1. This is a **CLOSED** book exam. Please **turn off all cell phones and mp3 players** and place them in your **book bag** in front of the class. Put **AWAY ANY** wristwatches. Also put away **ANY disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator **on your person or around you** during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 80 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM. Once the exam begins, you must submit your work (exam terminates) when you leave the exam to visit the restroom.**
9. You are required to solve **ALL** problems.

Calculator POLICY – Allowed Calculators

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name.)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name.)

All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

Signature:

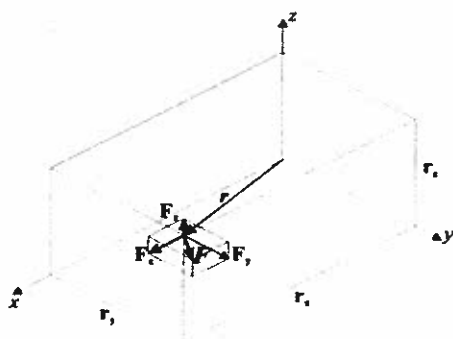
Kennedy Dent

Date:

11/17/21

NAME [PRINT (Lastname, firstname)]:

Dent, Kennedy



Vector Moment of a Force **[F]** about a point with Position Vector **[r]**

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = 2b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$
	$A = bh/2$ $x_c = (a + b)/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = [bh(b^2 - ab + a^2)]/6$ $I_{x_c} = bh^3/12$ $I_{y_c} = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$ $I_{x_c} = bh^3/3$ $I_{y_c} = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

$$I_x = I_{x'} + Ad_y^2$$

$$I_y = I_{y'} + Ad_x^2$$

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2 (= 32.2 \text{ ft/s}^2)$

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 mile = $5280 \text{ feet} = 1760 \text{ yards}$; 1 acre = $43,560 \text{ ft}^2$

1 m = 100 cm

1 slug = 14.59 kg

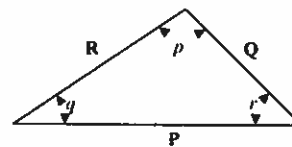
1 lb = 4.448 N

Standard atmosphere = $101.3 \text{ kPa} (= 2117 \text{ psf} = 14.7 \text{ psi})$

Gas constant for air, $R = 287 \text{ J/kg}\cdot\text{K}$

Density of water = $1000 \text{ kg/m}^3 (= 1.94 \text{ slugs/ft}^3)$ at 4°C

Specific weight of water = $9810 \text{ N/m}^3 (= 62.4 \text{ lb/ft}^3)$ at 4°C



Sine Law

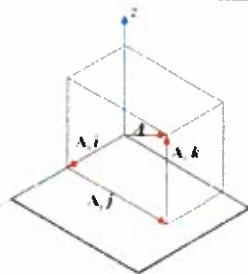
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

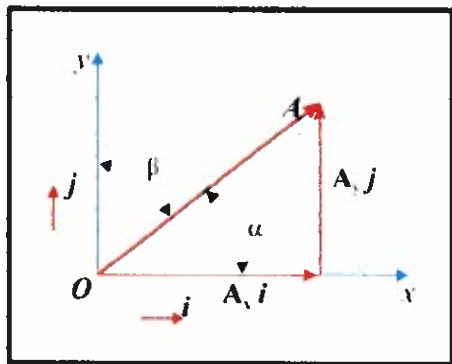
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

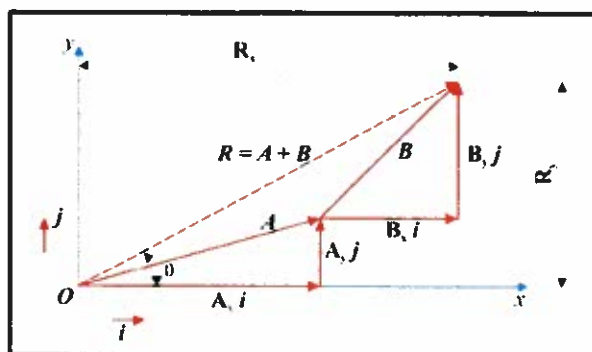


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$\cos^2 \alpha + \cos^2 \beta = 1$$



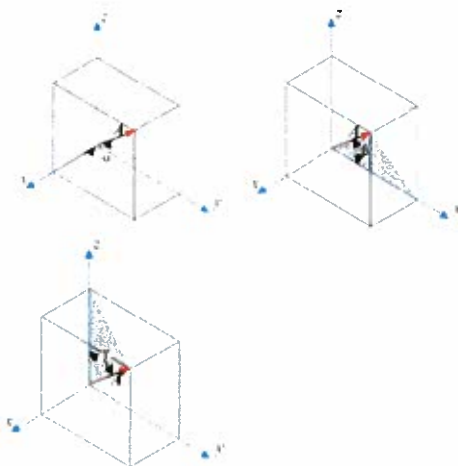
$$R = A + B = (A_x i + A_y j) + (B_x i + B_y j)$$

$$= (A_x + B_x) i + (A_y + B_y) j$$

$$= R_x i + R_y j$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

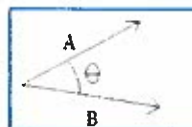
$$A = A_x i + A_y j + A_z k$$

$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$



I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

NAME [PRINT]:

Kennedy Dent

Signature:

Kennedy Dent

Date:

11/17/21

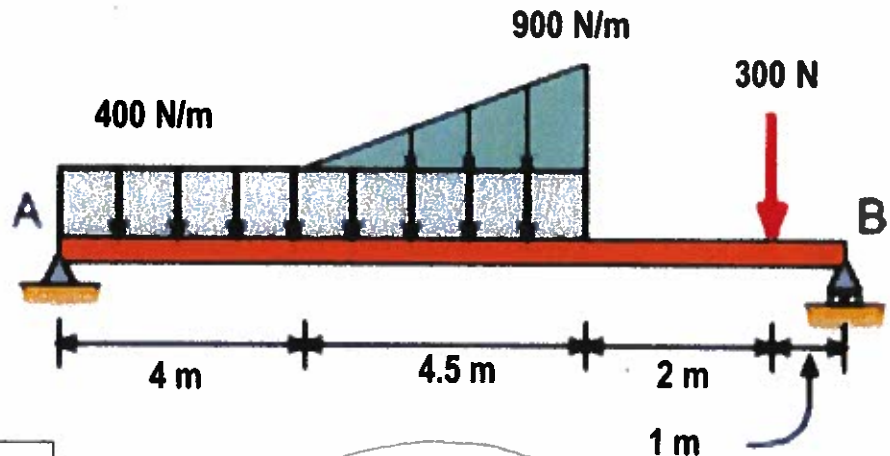
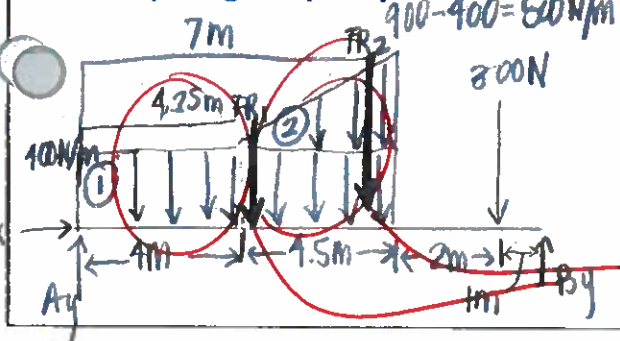
GRADE

400

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.**Provide the answers REQUIRED.**

a) [50] Determine the reactions at the supports, A and B. First, determine the equivalent load [kN] as required below and provide the location of each one from A [m]. The distributed load equivalents MUST be ONLY 2.

One for the **rectangular** distribution (FR_1) and the other for the **triangular** distribution (FR_2). PROVIDE the FBD

CLEARLY SHOW ALL WORK.**Free-body Diagram [FBD]**

$$FR_1 = A = b(h) = 8.5m(400N/m)$$

$$FR_1 = 3400N = 3.4kN$$

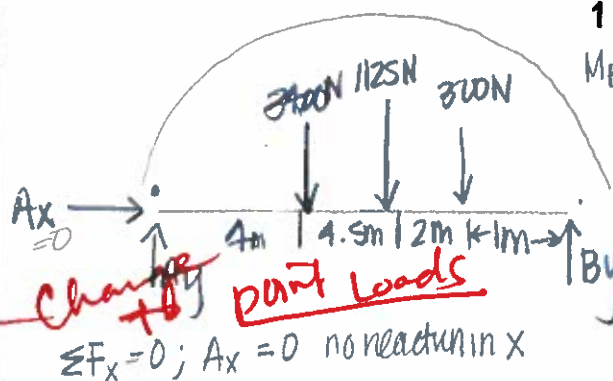
$$\bar{x}_1 = \frac{1}{2}(8.5) = 4.25 \text{ from A}$$

$$FR_2 = A = \frac{1}{2}bh = \frac{1}{2}(4.5)(500N/m)$$

$$FR_2 = 1125N = 1.125kN$$

$$\bar{x}_2 = \frac{2}{3}(4.5) + 4m (\text{from A})$$

$$= 7m \text{ from A}$$



$$\sum F_x = 0; A_x = 0 \text{ no reaction in } x$$

$$\sum M_A = 3400N(4.25) + 1125(7m) + 300N(10.5m) - B_y(11.5m)$$

$$B_y = \frac{25475N \cdot m}{11.5m} = 2215.2N = 2.215$$

$$\sum F_y = A_y - 3400N - 1125N - 300N + 2215.2N$$

$$A_y = 2609.8N \checkmark = 2.61kN$$

$$FR_1 = 3.4 \checkmark [kN]; \text{ Location from A} = 4.25 \checkmark m$$

$$FR_2 = 1.125 \checkmark [kN]; \text{ Location from A} = 7m \checkmark m$$

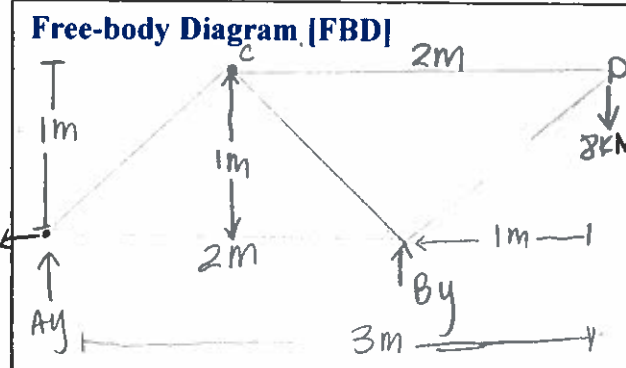
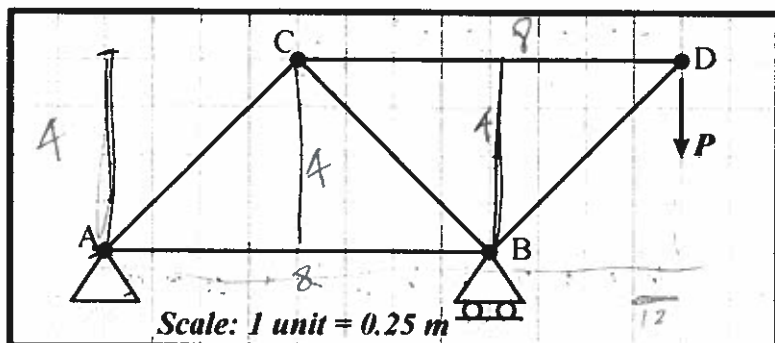
$$\text{Reaction1 (if present - specify } [A_x] \text{), at A} = A_x = 0 \checkmark [kN]$$

$$\text{Reaction2 (if present - specify } [A_y] \text{), at A} = 2.61 \checkmark [kN]$$

$$\text{Reaction1 (if present - specify } [B_x] \text{), at B} = \text{None} \checkmark [kN]$$

$$\text{Reaction2 (if present - specify } [B_y] \text{), at B} = 2.215 \checkmark [kN]$$

1(b)[50] Determine the reactions at A and B in the truss, and the forces in the members at JOINT A ONLY!
 $P = 8 \text{ kN}$.



$$\sum F_x = 0; A_x = 0$$

$$\sum M_A = 0 \Rightarrow \sum M_A = 8 \text{ kN} (3 \text{ m}) - B_y (2 \text{ m}) = 0$$

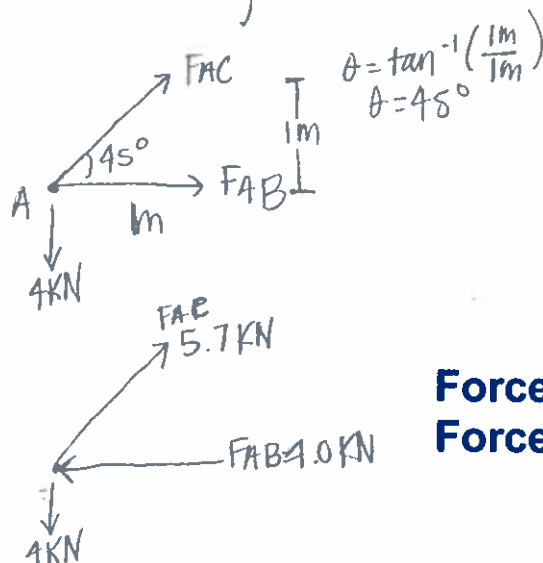
$$B_y = 12 \text{ kN}$$

$$\sum F_y = A_y - 8 \text{ kN} + 12 \text{ kN}$$

$$A_y = -4 \text{ kN} \downarrow$$

$$\text{or } \sum M_B = -A_y (2 \text{ m}) - 8 \text{ kN} (1 \text{ m})$$

$$A_y = -4 \text{ kN} \downarrow$$



Reaction1 (if present - specify [A_x]), at A = 0 [kN]
 Reaction2 (if present - specify [A_y]), at A = -4 [kN]

Reaction1 (if present - specify [B_x]), at B = None [kN]
 Reaction2 (if present - specify [B_y]), at B = 12 [kN]

Excellent

$$\sum F_y = 0; -4 \text{ kN} + F_{AC} \sin 45^\circ = 0$$

$$F_{AC} = 5.7 \text{ kN Tension}$$

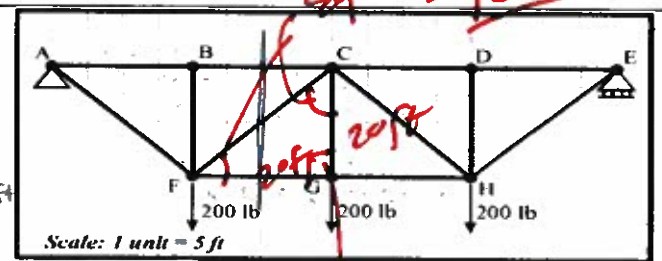
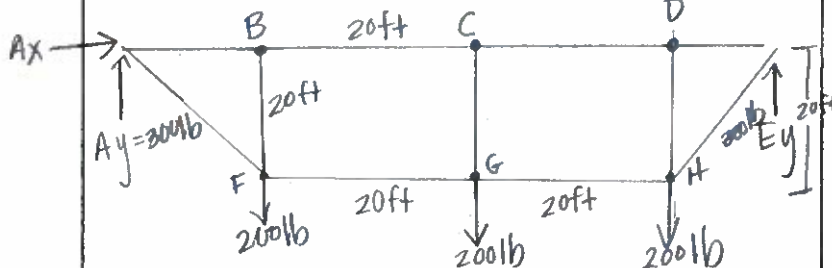
$$\sum F_x = 5.7 \text{ kN} (\cos 45^\circ) + F_{AB}$$

$$F_{AB} = -4.0 \text{ kN compression}$$

Force, AC 5.7 [kN]; Compression/Tension circle
 Force, AB 4.0 [kN]; Compression/Tension circle

2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown

For the truss below, answer the associated questions

a) [20] Provide the **free body diagram** of the truss that includes the reactions in the area belowb) [30] Determine the force **reactions** at the supports A and E [lb]

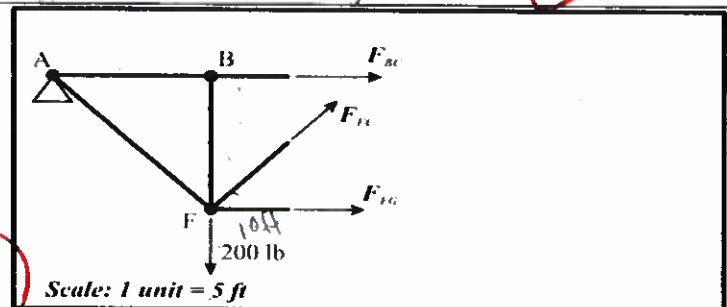
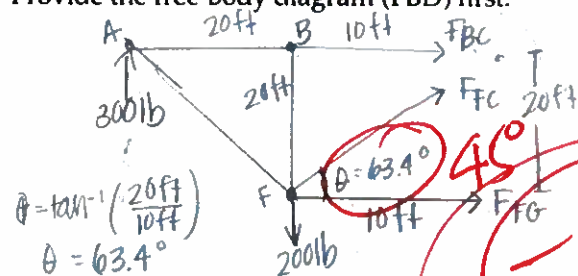
$$\sum F_x = 0, A_x = 0$$

$$\sum M_A = -E_y(80\text{ ft}) + 200\text{ lb}(60\text{ ft}) + 200\text{ lb}(40\text{ ft}) + 200\text{ lb}(20\text{ ft})$$

$$E_y = 300\text{ lb}$$

$$\sum F_y = -200\text{ lb} - 200\text{ lb} - 200\text{ lb} + 300\text{ lb} + A_y$$

$$A_y = 300\text{ lb}$$

Reaction1 (if present - specify [Ax]), at A = 0 [lb]Reaction2 (if present - specify [Ay]), at A = 300 lb [lb]Reaction1 (if present - specify [Ex]), at E = None [lb]Reaction2 (if present - specify [Ey]), at E = 300 lb [lb]c) [50] Using the **Method of Sections**, determine the forces [lb] **FBC**, **FFC** and **FFG**. Provide the free-body diagram (FBD) first.

$$\sum F_y = 0; 300\text{ lb} - 200\text{ lb} + F_{FC} \sin 63.4^\circ$$

$$F_{FC} = -111.8\text{ lb (compression)}$$

$$\sum M_C = 300\text{ lb}(30\text{ ft}) - F_{FG}(20\text{ ft}) + 200\text{ lb}(10\text{ ft})$$

$$F_{FG} = 550\text{ lb Tension}$$

$$\sum F_x = 550 - 111.8 \cos 63.4^\circ + F_{BC}$$

$$F_{BC} = -500\text{ lb (compression)}$$

$$F_{BC} = \underline{500 \text{ compression}} \text{ [lb]}$$

$$F_{FC} = \underline{112 \text{ compression}} \text{ [lb]}$$

$$F_{FG} = \underline{550 \text{ tension}} \text{ [lb]}$$

-5

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

Determine the **moment vector** (M_B) due to force vector, $F = 50i + 20j - 50k$, acting at **D** about the point **B**

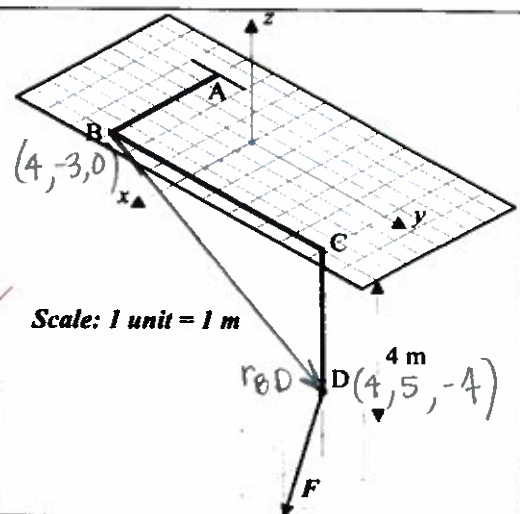
(a) [30] Provide the **position vector** (r_{BD}) necessary for calculating the moment vector, M_B

Be sure to clearly show how you determined the position vector.
(Draw the position vector in the diagram and add the necessary coordinates to the diagram)

$$r_{BD} = D - B = \{ (4-4)i + (5-3)j + (-4-0)k \} \text{ m}$$

$$= 0i + 8j - 4k$$

Position vector, $r_{BD} =$ 0 i + 8 j - 4 k



b) **[50]** Provide the calculations for determining the **moment vector** in the space below. Also provide the value of M_B

$$M_B = r_{BD} \times F$$

$$= \{ 0i + 8j - 4k \} \times 50i + 20j - 50k$$

$$= \begin{vmatrix} i & j & k \\ 0 & 8 & -4 \\ 50 & 20 & -50 \end{vmatrix} = \begin{vmatrix} i & j & k \\ 0 & 8 & -4 \\ 50 & 20 & -50 \end{vmatrix}$$

$$= \{ (8 \cdot -50) - (-4 \cdot 20) \} i - \{ (0 \cdot -50) - (-4 \cdot 50) \} j + \{ (0 \cdot 20) - (8 \cdot 50) \} k$$

$$= -320i - 200j - 400k$$

Moment Vector, $M_B =$ -320 i - 200 j - 400 k

(c)[20] What is the **magnitude** of the Moment Vector, M_B ?

$$|M_B| = \sqrt{(-320)^2 + (-200)^2 + (-400)^2}$$

$$= 549.9$$

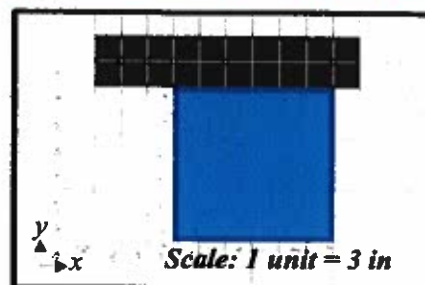
$$\text{or } 550$$

Magnitude of $M_B =$ 550

4.100 CLEARLY SHOW ALL WORK AND provide the answers in slots shown

a) [50] Determine the COMPOSITE centroid of the 2 sections (**black** and **blue**), using (x, y) shown in the figure as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.



Part	Dimensions [inches]	Area [square in]	x-centroid $\bar{x}$ [in]	y-centroid $\bar{y}$ [in]	$x_i A_i$ [in ³]	$y_i A_i$ [in ³]
Black (Top) ①	30 in × 6 in	180	33	24	5940	4320
Blue (Bottom) ②	18 in × 18 in	324	24	12	7776	3888
		504			13716	8208

$$\bar{x}_1 = \frac{1}{2}(30\text{ in}) + 18\text{ in} = 33\text{ in}$$

$$y_1 = \frac{1}{2}(6\text{ in}) + 21\text{ in} = 24$$

$$\bar{x}_2 = \frac{1}{2}(18) + 15\text{ in} = 24$$

$$y_2 = \frac{1}{2}(18) + 3\text{ in} = 12\text{ in}$$

$$\bar{x} = \frac{13716}{504} = 27.2$$

$$\bar{y} = \frac{8208}{504} = 16.3$$

$$x\text{-Centroid} = 27.2 \text{ [in]}$$

$$y\text{-Centroid} = 16.3 \text{ [in]}$$

b) [50] Determine the COMPOSITE Moment of Inertia [I_{ol}] of the 2 sections (**black** and **blue**), using (x, y) shown as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.

Part	$I_{x'}$ [in ⁴]	$I_{y'}$ [in ⁴]	$d_x = \bar{x} - \bar{x}_i$ [in]	$d_y = \bar{y} - \bar{y}_i$ [in]	$A d_x^2$ [in ⁴]	$A d_y^2$ [in ⁴]
Black (Top)	540	13500	-5.8	-3.2	6055.2	1843.2
Blue (Bottom)	8748	8748	7.7	-4.3	19209.96	5990.76
	9288	22248			25265.16	7833.96

$$I_{x'} = b(h)^3/12$$

$$I_{y'} = b^3(h)/12$$

$$I_{x'_1} = 30(6)^3/12 = 540 \quad I_{x'_2} = 8748$$

$$I_{y'_1} = 30^3(6)/12 = 13500 \quad I_{y'_2} = 8748$$

$$I_x = I_{x'} + A d_y^2$$

$$I_y = I_{y'} + A d_x^2$$

$$I_{dx} = 17121.96$$

$$I_{dy} =$$

$$x\text{-Moment of Inertia, } I_x = 17121.96 \text{ [in}^4\text{]}$$

$$y\text{-Moment of Inertia, } I_y = 47813.16 \text{ [in}^4\text{]}$$

1-5

AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azemi

Exam 02

DATE: WEDNESDAY, November 17, 2021 at 08:05 AM In-class

Submit the entire exam the order given

Name [PRINT] Maria Gonzalez

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

168
400

1. This is a **CLOSED** book exam. Please **turn off all cell phones and mp3 players** and **place them in your book bag** in front of the class. Put **AWAY ANY wristwatches**. Also put away **ANY disallowed** calculators in your book bags.
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All necessary formulas/tables have been provided.

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Signature: _____ Date: _____

NAME [PRINT (Lastname, firstname)]: _____

Unless otherwise stated or implied, assume the following:

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1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 mile = 5280 feet = 1760 yards; 1 acre = 43,560 ft²

1 m = 100 cm

1 slug = 14.59 kg

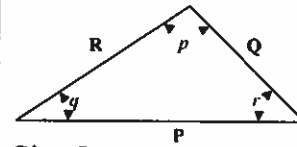
1 lb = 4.448 N

Standard atmosphere = 101.3 kPa (= 2117 psf = 14.7 psi)

Gas constant for air, $R = 287 \text{ J/kg}\cdot\text{K}$

Density of water = $1000 \text{ kg/m}^3 (= 1.94 \text{ slugs/ft}^3)$ at 4°C

Specific weight of water = $9810 \text{ N/m}^3 (= 62.4 \text{ lb/ft}^3)$ at 4°C



Sine Law

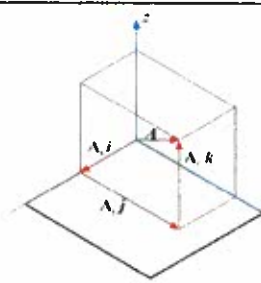
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

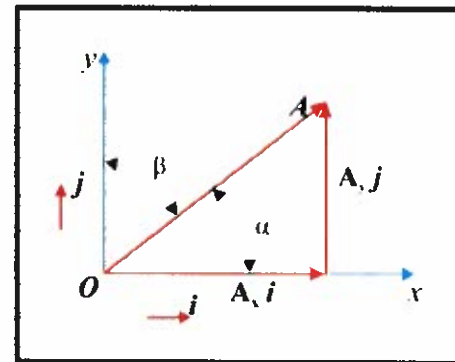
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

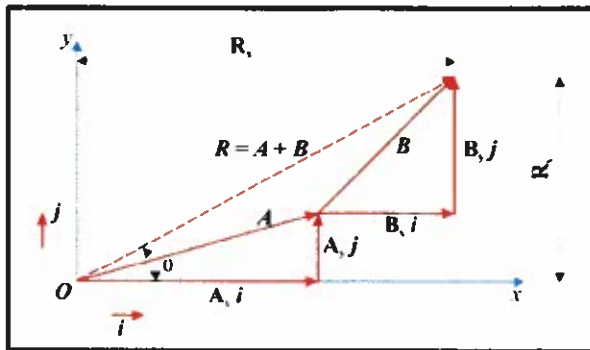


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

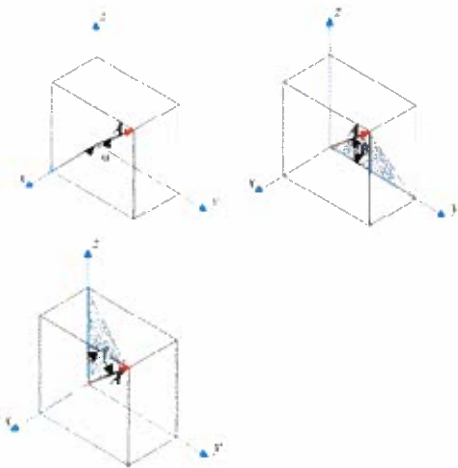
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

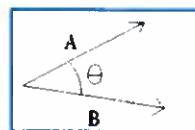
$$A = A_x i + A_y j + A_z k$$

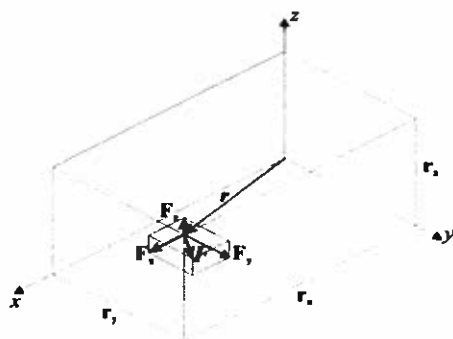
$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$





Vector Moment of a Force $[F]$ about a point with Position Vector $[r]$

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = 2b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/4$
	$A = bh/2$ $x_c = (a+b)/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = [bh(b^2 - ab + a^2)]/6$ $I_{x_c} = bh^3/12$ $I_{y_c} = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$ $I_{x_c} = bh^3/3$ $I_{y_c} = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

$$I_x = I_{x'} + Ad_y^2$$

$$I_y = I_{y'} + Ad_x^2$$

I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

NAME [PRINT]: M. G.

Signature: _____

Date: _____

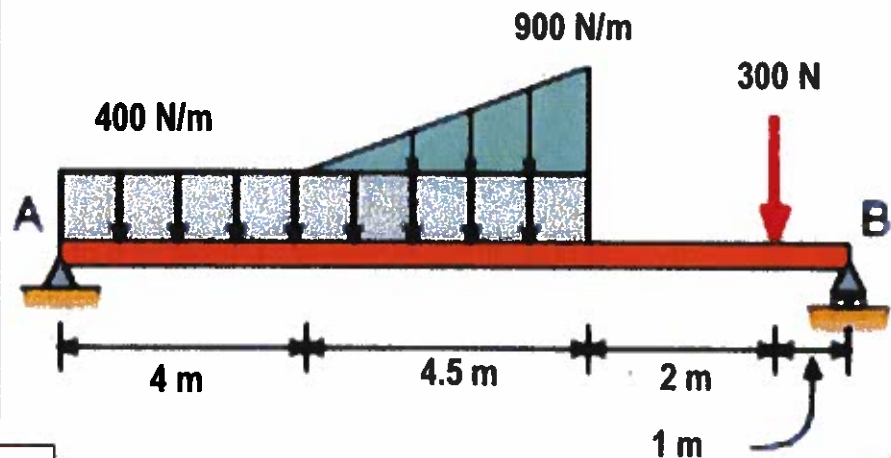
GRADE

400

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.

Provide the answers REQUIRED.

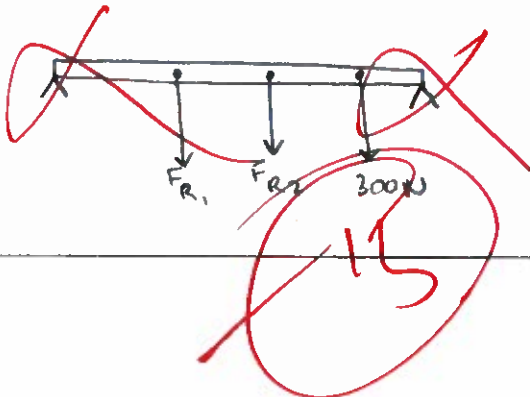
a) [50] Determine the reactions at the supports, A and B. First, determine the equivalent load [kN] as required below and provide the location of each one from A [m]. The distributed load equivalents MUST be ONLY 2. One for the **rectangular** distribution (FR_1) and the other for the **triangular** distribution (FR_2). PROVIDE the FBD **CLEARLY SHOW ALL WORK.**



$$(400 \text{ N/m}) (8.5 \text{ m}) = 3400 \text{ N} \quad \checkmark$$

$$(900 \text{ N/m}) (4.5 \text{ m}) = 4050 \text{ N} \quad \times$$

Free-body Diagram [FBD]



FR_1 3.4 [kN]; Location from A = 4.25 m

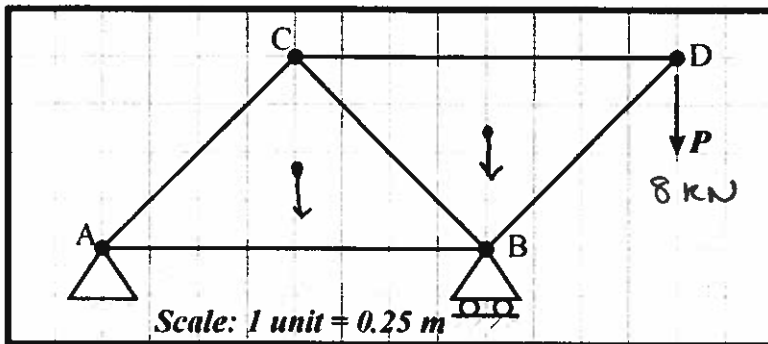
FR_2 4.05 [kN]; Location from A = 7 m

Reaction1 (if present - specify []), at A = _____ [kN]
Reaction2 (if present - specify []), at A = _____ [kN]

Reaction1 (if present - specify []), at B = _____ [kN]
Reaction2 (if present - specify []), at B = _____ [kN]

1-40

1(b)[50] Determine the reactions at A and B in the truss, and the forces in the members at JOINT A ONLY!
 $P = 8 \text{ kN}$.



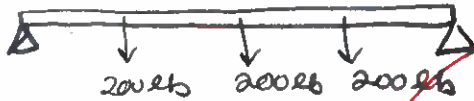
Free-body Diagram [FBD]

Reaction1 (if present – specify []), at A = _____ [kN]
 Reaction2 (if present – specify []), at A = _____ [kN]
 Reaction1 (if present – specify []), at B = _____ [kN]
 Reaction2 (if present – specify []), at B = _____ [kN]

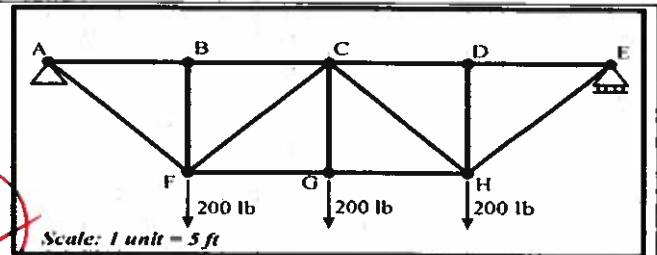
Force, AC _____ [kN]; Compression/Tension circle
 Force, AB _____ [kN]; Compression/Tension circle

2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown

For the truss below, answer the associated questions

a) [20] Provide the **free body diagram** of the truss that includes the reactions in the area belowmust show
~~the truss~~

more



b) [30] Determine the force reactions at the supports A and E [lb]

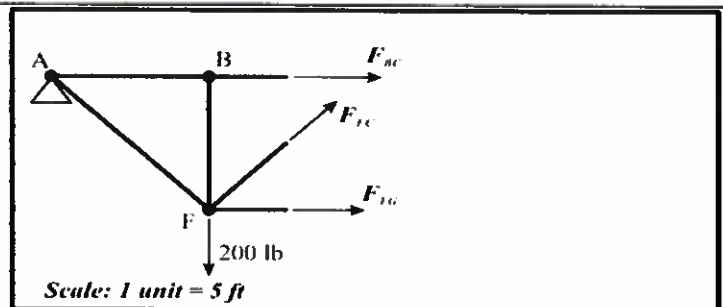
Not just beam

Reaction1 (if present - specify []), at A = [] [lb]

Reaction2 (if present - specify []), at A = [] [lb]

Reaction1 (if present - specify []), at E = [] [lb]

Reaction2 (if present - specify []), at E = [] [lb]

c) [50] Using the **Method of Sections**, determine the forces [lb] F_{BC} , F_{FC} and F_{FG} . Provide the free-body diagram (FBD) first. $F_{BC} =$ [] [lb] $F_{FC} =$ [] [lb] $F_{FG} =$ [] [lb]

95

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

Determine the moment vector (M_B) due to force vector, $F = 50i + 20j - 50k$, acting at D about the point B

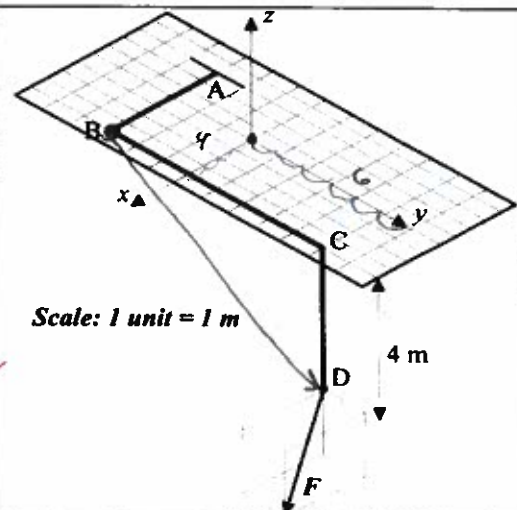
(a) [30] Provide the position vector $[r_{BD}]$ necessary for calculating the moment vector, M_B

Be sure to clearly show how you determined the position vector. (Draw the position vector in the diagram and add the necessary coordinates to the diagram)

$$D = 4i + 6j - 4k$$

$$- B = 4i - 3j + 0k$$

Position vector, $[r_{BD}] = 0i + 9j - 4k$



b) [50] Provide the calculations for determining the moment vector in the space below. Also provide the value of M_B

$$M_B = r_{BD} \times F$$

$$M_B = \begin{vmatrix} i & j & k \\ 0 & 9 & -4 \\ 50 & 20 & -50 \end{vmatrix}$$

$$\rightarrow M_B = ((9 \cdot -50) - (-4 \cdot 20))i -$$

$$((0 \cdot -50) - (-4 \cdot 50))j + ((0 \cdot 20) - (9 \cdot 50))k$$

$$M_B = (450 + 80)i - (0 + 200)j + (0 - 450)k$$

ok method - 3

$$\text{Moment Vector, } M_B = 530i - 200j - 450k$$

(c)[20] What is the magnitude of the Moment Vector, M_B ?

$$\sqrt{(530)^2 + (200)^2 + (450)^2}$$

ok method - 0

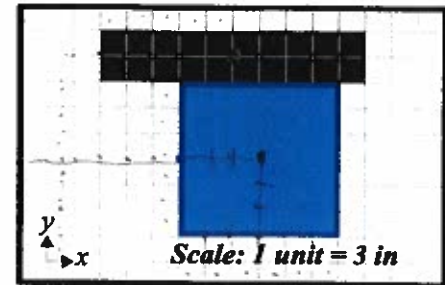
$$\text{Magnitude of } M_B = 723.46$$

-10

4 [100] CLEARLY SHOW ALL WORK AND provide the answers in slots shown

a) [50] Determine the COMPOSITE centroid of the 2 sections (**black** and **blue**), using (x, y) shown in the figure as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.



Part	Dimensions [inches]	Area [square in]	x-centroid $\bar{x}$ [in]	y-centroid $\bar{y}$ [in]	$x_i A_i$ [in ³]	$y_i A_i$ [in ³]
Black (Top)	30 in × 6 in	180	21	24	3,780	4,320
Blue (Bottom)	36 in × 36 in	1,296	24	12	31,104	15,552
		1,476			34,884	19,872

$$\div 1,476$$

$$x\text{-Centroid} = 23.63 \text{ [in]}$$

$$y\text{-Centroid} = 13.46 \text{ [in]}$$

b) [50] Determine the COMPOSITE Moment of Inertia [Mol] of the 2 sections (**black** and **blue**), using (x, y) shown as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.

Part	$I_{x'}$ [in ⁴]	$I_{y'}$ [in ⁴]	$d_x = \bar{x} - \bar{x}_i$ [in]	$d_y = \bar{y} - \bar{y}_i$ [in]	$A d_x^2$ [in ⁴]	$A d_y^2$ [in ⁴]
Black (Top)	90	450	-2.63	10.54	1,245.04	19,996.49
Blue (Bottom)	3,888	3,888	0.37	-1.46	177.42	2,762.55
	3,978	4,338			1,422.46	22,759.04

$$I_x = I_{x'} + A d_y^2$$

$$I_y = I_{y'} + A d_x^2$$

$$x\text{-Moment of Inertia, } I_x = 26,177.04 \text{ [in}^4\text{]}$$

$$y\text{-Moment of Inertia, } I_y = 5,760.46 \text{ [in}^4\text{]}$$

45

BELOW
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azawi

Exam 02

DATE: WEDNESDAY, November 17, 2021 at 08:05 AM In-class

Submit the entire exam the order given

Name [PRINT] CISSE

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~~070~~

400

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Signature: [Signature] Date: November 17, 2021

NAME [PRINT (Lastname, firstname)]: Richa Cisse

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1 mile = $5280 \text{ feet} = 1760 \text{ yards}$; 1 acre = $43,560 \text{ ft}^2$

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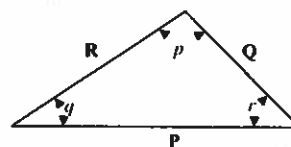
1 lb = 4.448 N

Standard atmosphere = $101.3 \text{ kPa} (= 2117 \text{ psf} = 14.7 \text{ psi})$

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Sine Law

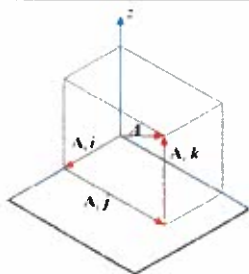
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

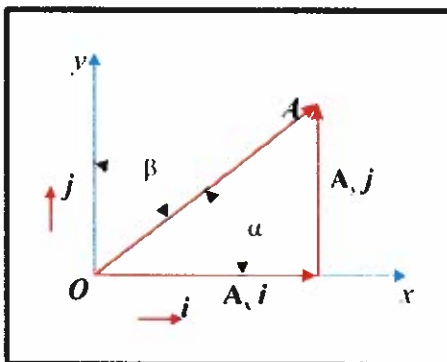
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

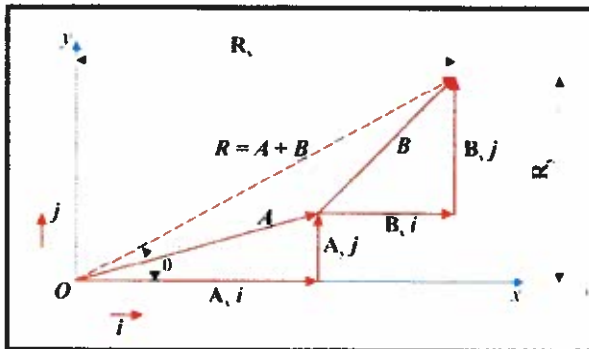


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$\cos^2 \alpha + \cos^2 \beta = 1$$



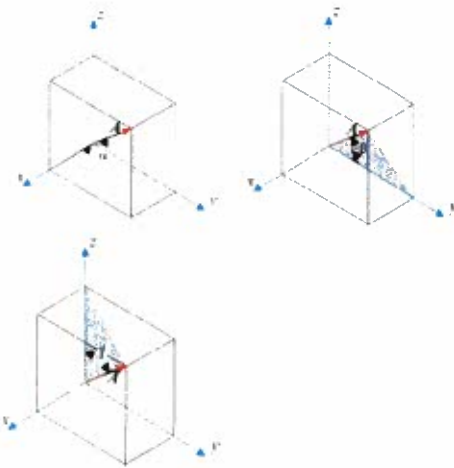
$$R = A + B = (A_x i + A_y j) + (B_x i + B_y j)$$

$$= (A_x + B_x) i + (A_y + B_y) j$$

$$= R_x i + R_y j$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

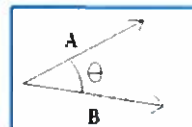
$$A = A_x i + A_y j + A_z k$$

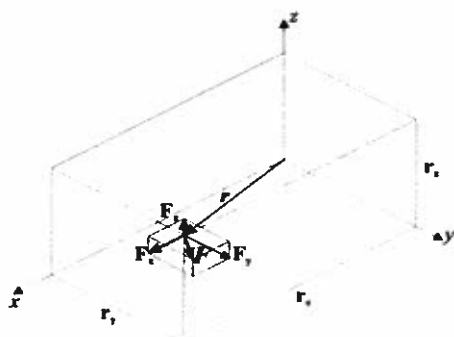
$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$





Vector Moment of a Force **[F]** about a point with Position Vector **[r]**

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

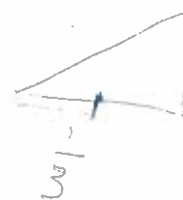
Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = 2b/3$ $y_c = h/3$	$I_x = bh^3/36$ $I_y = b^3h/36$ $I_c = bh^3/12$ $I_y = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_x = bh^3/36$ $I_y = b^3h/36$ $I_c = bh^3/12$ $I_y = b^3h/12$
	$A = bh/2$ $x_c = (a+b)/3$ $y_c = h/3$	$I_x = bh^3/36$ $I_y = [bh(b^2 - ab + a^2)]/36$ $I_c = bh^3/12$ $I_y = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_x = bh^3/12$ $I_y = b^3h/12$ $I_c = bh^3/3$ $I_y = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

$$I_x = I_{x'} + Ad_y^2$$

$$I_y = I_{y'} + Ad_x^2$$



I pledge to abide by all the rules stated for this CVEG 2400 P01 Exam

NAME [PRINT]: _____ Signature: _____ Date: _____

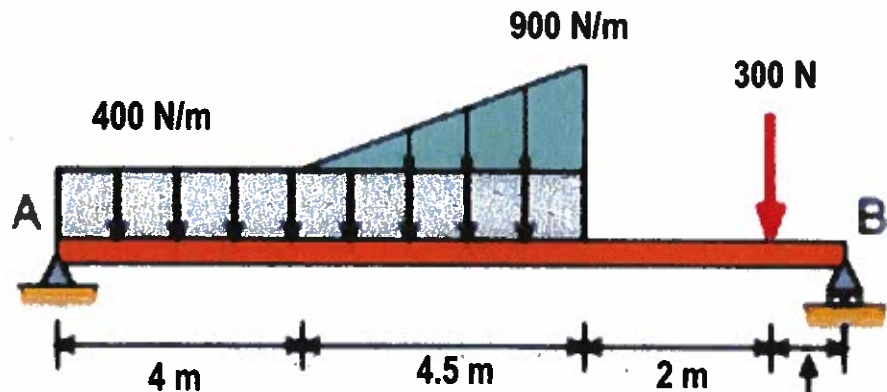
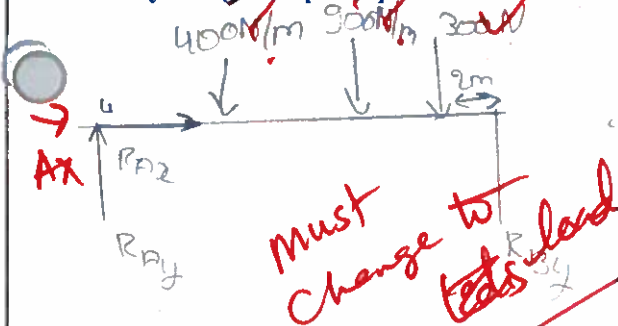
GRADE

400

1[100] CLEARLY DETAILED WORK. NO detailed work, NO credit.**Provide the answers REQUIRED.**

a) [50] Determine the reactions at the supports, A and B. First, determine the equivalent load [kN] as required below and provide the location of each one from A [m]. The distributed load equivalents MUST be ONLY 2.

One for the **rectangular** distribution (FR_1) and the other for the **triangular** distribution (FR_2). PROVIDE the FBD

CLEARLY SHOW ALL WORK.**Free-body Diagram [FBD]**

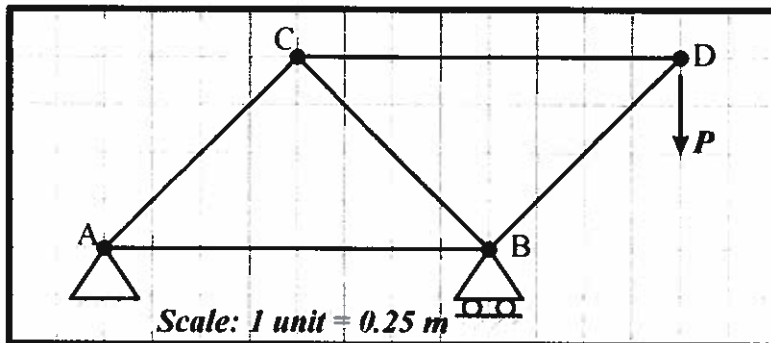
let's find the cent mid of the triangle:
 $\frac{2}{3} \times 4.5 = 3$
 for the rectangle

 ~~FR_1 [kN]; Location from A = _____ m~~ ~~FR_2 [kN]; Location from A = _____ m~~~~Reaction1 (if present - specify [], at A = _____ [kN]~~~~Reaction2 (if present - specify [], at A = _____ [kN]~~~~Reaction1 (if present - specify [], at B = _____ [kN]~~~~Reaction2 (if present - specify [], at B = _____ [kN]~~

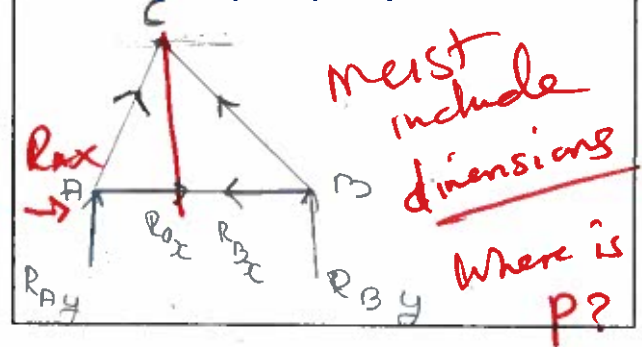
45

45

1(b)[50] Determine the reactions at A and B in the truss, and the forces in the members at JOINT A ONLY!
 $P = 8 \text{ kN}$.



Free-body Diagram [FBD]



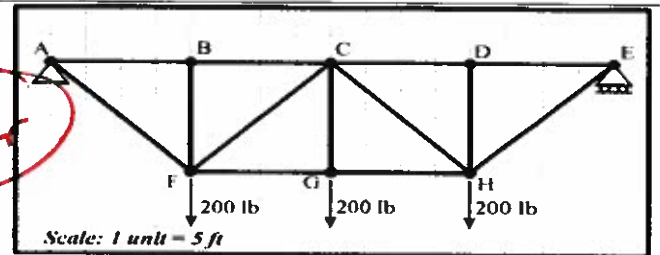
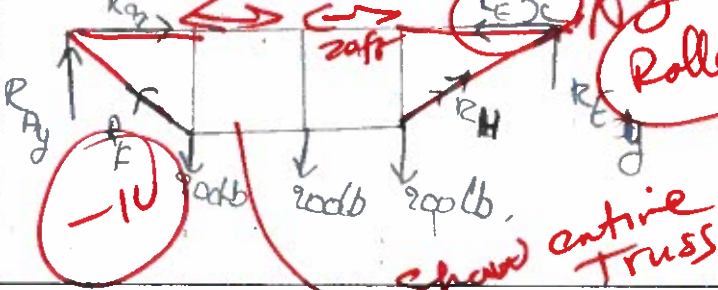
at the equilibrium, $\sum \vec{F} = 0$ $\sum \vec{M} = 0$ $\sum \vec{F} = 0$
 $\sum F_x = 0 \Rightarrow R_{Ax} - R_{Bx} + 0 = 0$
 $R_{Ax} = R_{Bx}$
 $R_A = (0.5 \sin 45^\circ \times 2)$
~~45~~

Reaction1 (if present - specify []), at A = [kN]
 Reaction2 (if present - specify []), at A = [kN]

Reaction1 (if present - specify []), at B = [kN]
 Reaction2 (if present - specify []), at B = [kN]

Force, AC [kN]; Compression/Tension circle
 Force, AB [kN]; Compression/Tension circle

-45

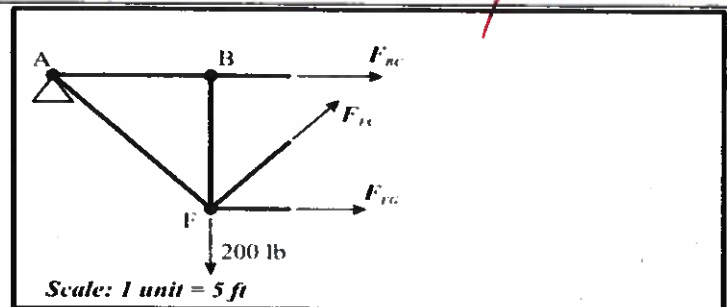
2[100] CLEARLY SHOW ALL WORK AND provide the answers as shown**For the truss below, answer the associated questions**a) [20] Provide the **free body diagram** of the truss that includes the reactions in the area below

b) [30] Determine the force reactions at the supports A and E [lb]

-30

Reaction1 (if present - specify []), at A = [lb]
 Reaction2 (if present - specify []), at A = [lb]

Reaction1 (if present - specify []), at E = [lb]
 Reaction2 (if present - specify []), at E = [lb]

c) [50] Using the **Method of Sections**, determine the forces [lb] F_{BC} , F_{FC} and F_{FG} . Provide the free-body diagram (FBD) first.

$F_{BC} =$ [lb]
 $F_{FC} =$ [lb]
 $F_{FG} =$ [lb]

-90

3[100] CLEARLY SHOW ALL WORK AND provide the answers in designated spaces

Determine the **moment vector** (M_B) due to force vector, $F = 50i + 20j - 50k$, acting at **D** about the point **B**

(a) [30] Provide the **position vector** [r_{BD}] necessary for calculating the moment vector, M_B

Be sure to clearly show how you determined the position vector. (Draw the position vector in the diagram and add the necessary coordinates to the diagram)

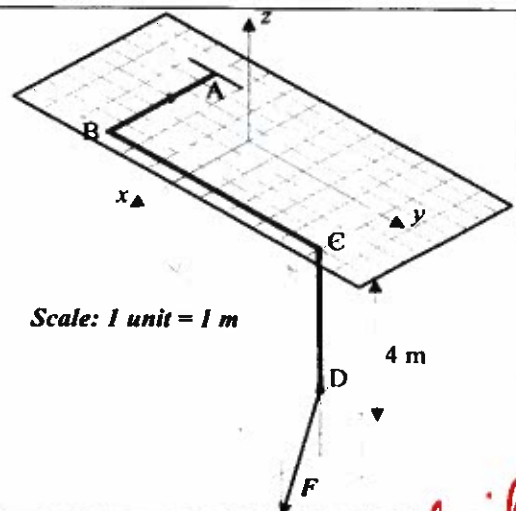
$$B(4, -3, 0)$$

$$D(0, 5, -4)$$

$$r_{BD} = (0 - 4)i + (5 - (-3))j + (-4 - 0)k$$

$$r_{BD} = -4i + 8j - 4k$$

$$\text{Position vector, } [r_{BD}] = -4i + 8j - 4k$$



b) [50] Provide the calculations for determining the **moment vector** in the space below. Also provide the value of M_B

Let's calculate the magnitude of the position vector and the unit vector

$$|r_{BD}| = \sqrt{(-4)^2 + 8^2 + (-4)^2} = 6.403$$

The unit vector

$$u = \frac{-4}{6.403}i + \frac{8}{6.403}j - \frac{4}{6.403}k$$

$$= -0.625i + 0.46j - 0.625k$$

The moment m_B will be:

$$m_B = [(3)(50) - (-4)(20)]i -$$

$$[(-4)(50) - (-4)(50)]j + [(-4)(20) - (3)(50)]$$

$$= [150 + 80]i - [200 + 200]j + [-20 - 150]$$

$$= 230i - 400j - 170k$$

$$\text{Moment Vector, } M_B = 230i - 400j - 170k$$

(c)[20] What is the **magnitude** of the Moment Vector, M_B ?

The magnitude of the moment m_B will be

$$|M_B| = \sqrt{(230)^2 + (-400)^2 + (-170)^2}$$

$$= 466.69$$

$$\text{Magnitude of } M_B = 466.69$$

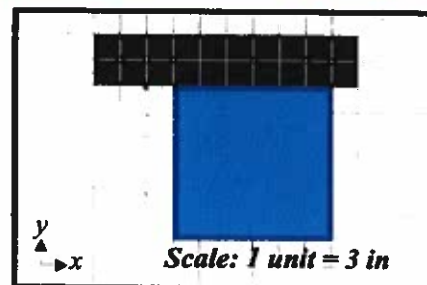
all method

$$= 0$$

4.100 CLEARLY SHOW ALL WORK AND provide the answers in slots shown

a) [50] Determine the COMPOSITE centroid of the 2 sections (**black** and **blue**), using (x, y) shown in the figure as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.



Part	Dimensions [inches]	Area [square in]	x-centroid $\bar{x}$ [in]	y-centroid $\bar{y}$ [in]	$x_i A_i$ [in ³]	$y_i A_i$ [in ³]
Black (Top)	6 in $\times$ 3 in	72 in ²	X	X	X	X
Blue (Bottom)	6 in $\times$ 6 in	36 in ²	X	X	X	X

~~45~~

x-Centroid = ~~X~~ [in]

y-Centroid = ~~X~~ [in]

b) [50] Determine the COMPOSITE Moment of Inertia [Mol] of the 2 sections (**black** and **blue**), using (x, y) shown as the origin and the reference.

Provide your solution by completing the table provided below and any other calculations.

Part	$I_{x'}$ [in ⁴]	$I_{y'}$ [in ⁴]	$d_x = \bar{x} - \bar{x}_i$ [in]	$d_y = \bar{y} - \bar{y}_i$ [in]	Ad_x^2 [in ⁴]	Ad_y^2 [in ⁴]
Black (Top)	X	X	X	X	X	X
Blue (Bottom)	X	X	X	X	X	X

~~50~~

x-Moment of Inertia, I_x = ~~X~~ [in⁴]

y-Moment of Inertia, I_y = ~~X~~ [in⁴]

~~95~~

CVEG 2400 - Statics & Dynamics

Fall 2021

Title of Assignment: Final Exam

TOPICS COVERED IN Final Exam

Final Exam covered the following topics:

- 1) Determination of resultant forces, force vectors, Cartesian vectors
- 2) Equilibrium of a particle; Free Body Diagram (FBD), force systems
- 3) Equilibrium of a Particle, Equilibrium of a Rigid Body; Structural Analysis & Trusses
- 4) Center of Gravity and Centroids
- 5) Kinematics of A Particle; Kinetics of a Particle

ABOVE
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Vezoni

Final Exam

DATE: MONDAY, December 06, 2021 at 07:00 AM INENR 137I

Submit the entire exam the order given

Name [PRINT] Kayla Freeman

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

510
600

1. This is a **CLOSED** book exam. Please **turn off all cell phones and mp3 players** and place them in your **book bag** in front of the class. Put **AWAY ANY wristwatches**. Also put away ANY **disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator on your person or around you during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 110 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM.** Once the exam begins, you must submit your work (exam terminates) when you leave the exam to visit the restroom.
9. You are required to solve **ALL** problems.

Calculator POLICY – Allowed Calculators

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name.)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name.)

All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all stated Exam stipulations:

Signature: Kayla Freeman Date: 12-6-21

NAME [PRINT (Lastname, firstname)]: Freeman, Kayla

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2 (= 32.2 \text{ ft/s}^2)$

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 mile = 5280 feet = 1760 yards; 1 acre = 43,560 ft²

1 m = 100 cm

1 slug = 14.59 kg

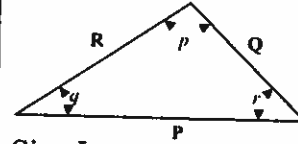
1 lb = 4.448 N

Standard atmosphere = $101.3 \text{ kPa} (= 2117 \text{ psf} = 14.7 \text{ psi})$

Gas constant for air, $R = 287 \text{ J/kg.K}$

Density of water = $1000 \text{ kg/m}^3 (= 1.94 \text{ slugs/ft}^3)$ at 4°C

Specific weight of water = $9810 \text{ N/m}^3 (= 62.4 \text{ lb/ft}^3)$ at 4°C



Sine Law

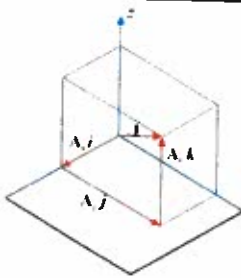
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

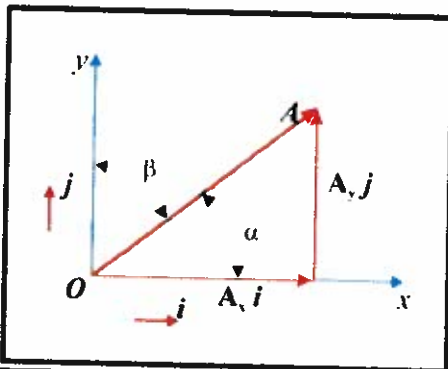
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

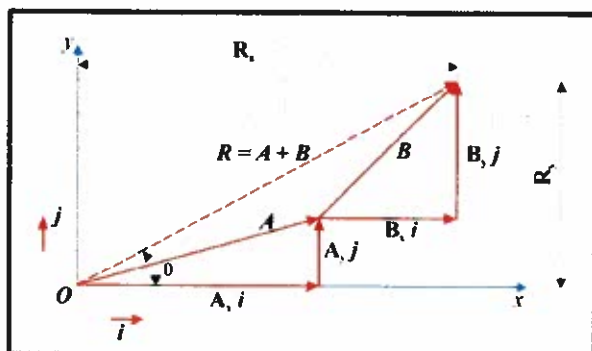


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

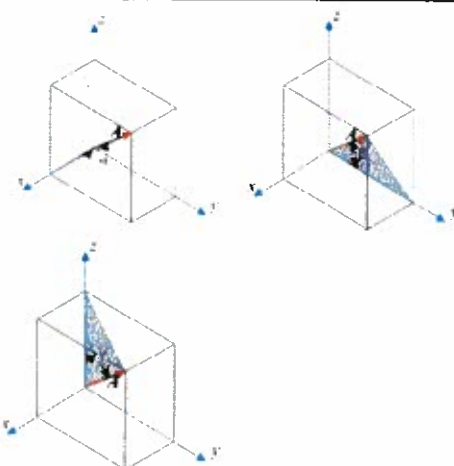
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

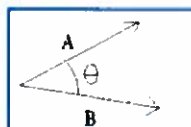
$$A = A_x i + A_y j + A_z k$$

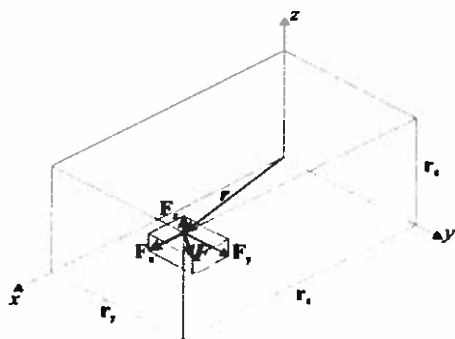
$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$





Vector Moment of a Force $[F]$ about a point with Position Vector $[r]$

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = 2b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$
	$A = bh/2$ $x_c = (a + b)/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = [bh(b^2 - ab + a^2)]/36$ $I_{x_c} = bh^3/12$ $I_{y_c} = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$ $I_{x_c} = bh^3/3$ $I_{y_c} = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

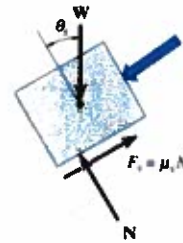
$$I_x = I_{x'} + Ad_{y'}^2$$

$$I_y = I_{y'} + Ad_{x'}^2$$

Friction

Friction is defined as a force of resistance acting on a body which prevents or resists the slipping of a body relative to a second body.

$$F_s = \mu_s N$$



Kinematics

$$v = \frac{ds}{dt} \quad a = \frac{dv}{dt}$$

Acceleration

$$v = ds/dt; \quad a = dv/dt \quad \text{or} \quad a = v dv/ds$$

Constant Acceleration Formulas:

$$v = v_0 + a_c t \quad \text{Equation 12-4}$$

$$s = s_0 + v_0 t + (1/2) a_c t^2 \quad \text{Equation 12-5}$$

$$v^2 = (v_0)^2 + 2a_c(s - s_0) \quad \text{Equation 12-6}$$

VERTICAL MOTION

$$v_y = v_{oy} - g t$$

$$y = y_0 + (v_{oy}) t - \frac{1}{2} g t^2$$

$$v_y^2 = v_{oy}^2 - 2 g (y - y_0)$$

Special cases of motion:

- 1) The particle moves along a **straight line**.

$$\rho \rightarrow \infty \Rightarrow a_n = v^2/\rho = 0 \Rightarrow a = a_t = \dot{v}$$

The **tangential component** represents the **time rate of change** in the **magnitude** of the **velocity**.

- 2) The particle moves along a curve at **constant speed**.

$$a_t = \dot{v} = 0 \Rightarrow a = a_n = v^2/\rho$$

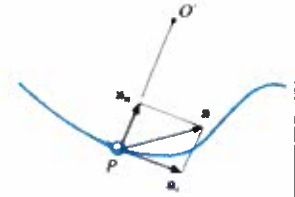
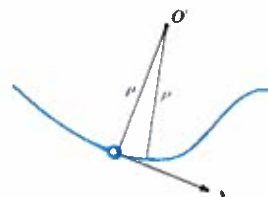
The **normal component** represents the **time rate of change** in the **direction** of the velocity.

Chain Rule

$$\dot{y} = \frac{dy}{dt} = \frac{dy}{dx} \frac{dx}{dt}$$

VELOCITY & ACCELERATION IN THE n-t COORDINATE SYSTEM

Velocity & Acceleration



Velocity

$$\mathbf{v} = v \mathbf{u}_t \quad \text{where} \quad v = s = ds/dt$$

v is the **magnitude** of the velocity (speed) and $\mathbf{u}_t$ defines the **direction** of the velocity vector.

Acceleration

Components of the **acceleration vector**:

$$\mathbf{a} = a_t \mathbf{u}_t + a_n \mathbf{u}_n = \dot{v} \mathbf{u}_t + (v^2/\rho) \mathbf{u}_n$$

$$a_t = \dot{v} \quad \text{or} \quad a_t ds = v dv;$$

$$a_t = \dot{v} = dv/dt = (dv/ds) (ds/dt) = v(dv/ds)$$

The **normal** or **centripetal component** is: $a_n = v^2/\rho$

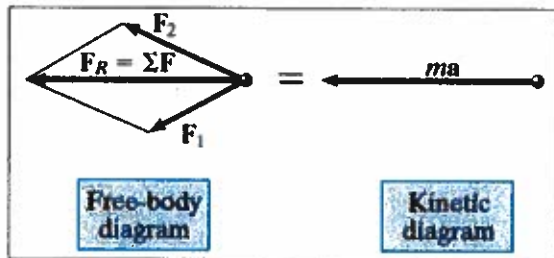
The **magnitude** of the acceleration vector is

$$a = \sqrt{(a_n)^2 + (a_t)^2}$$

For a particle moving along a path expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

Kinetics



Equations (Newton's 2nd Law)

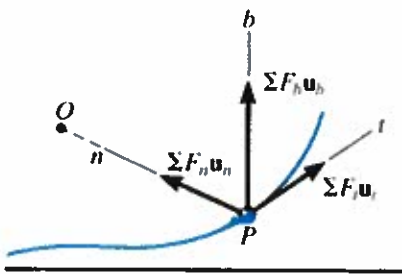
$$\Sigma \mathbf{F} = \mathbf{F}_R = m\mathbf{a}$$

$$\Sigma \mathbf{F} = m\mathbf{a} \text{ or}$$

$$\Sigma F_x \mathbf{i} + \Sigma F_y \mathbf{j} + \Sigma F_z \mathbf{k} = m(a_x \mathbf{i} + a_y \mathbf{j} + a_z \mathbf{k})$$

$$\Sigma F_x = ma_x, \Sigma F_y = ma_y, \text{ and } \Sigma F_z = ma_z$$

NORMAL & TANGENTIAL COORDINATES



$$\Sigma F_t u_t + \Sigma F_n u_n = ma_t + ma_n$$

scalar equations: $\Sigma F_t = ma_t$ and $\Sigma F_n = ma_n$

Acceleration

tangential acceleration, $a_t = dv/dt$

normal acceleration, $a_n = v^2/\rho$

For a particle moving along a path expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

I pledge to abide by all Final exam rules stated

NAME [PRINT]: Kayla Freeman

Signature: Kayla Freeman

Date: 12-6-21

GRADE

600

1 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

- (a) [70] The relative position vector $\mathbf{r}$ is defined by beginning and end coordinates, $(x,y,z) = (4,3,2)$ m and $(-6, 0, 5)$ m, respectively. For the force vector $\mathbf{F}$ given below, determine the angle and the magnitude of the force along the position vector. And determine the force vector along the position vector.

$$\mathbf{F} = (30\mathbf{i} + 50\mathbf{j} + 20\mathbf{k}) \text{ N}$$

$$(-6-4)\mathbf{i} + (0-3)\mathbf{j} + (5-2)\mathbf{k}$$

$$= \sqrt{10^2 + 3^2 + 3^2} = 10.9$$

$$\sqrt{30^2 + 50^2 + 20^2} = 61.6$$

$$|\mathbf{F}| = 61.6$$

$$\text{Position vector along, } \mathbf{r} = -10\mathbf{i} - 3\mathbf{j} + 3\mathbf{k} \text{ [m]}$$

$$\cos^{-1} \left(\frac{(30 \times -10) + (50 \times -3) + (20 \times 3)}{10.9 \times 61.6} \right) = \cos^{-1} \left(\frac{\mathbf{r} \cdot \mathbf{F}}{|\mathbf{r}| |\mathbf{F}|} \right)$$

$$\text{Angle between } \mathbf{r} \text{ and } \mathbf{F} = 126^\circ \text{ [degrees]}$$

$$\cos^{-1} \left(\frac{-300 + -150 + 60}{10.9 \times 61.6} \right) = 125.5 \approx 126^\circ$$

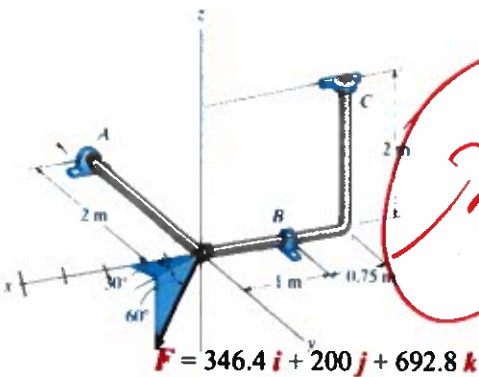
$$\sqrt{56.5^2 + 16.7^2 + 16.9^2} = 61.3$$

$$\text{Magnitude of Force ALONG Position Vector} = 61.3 \text{ [N]}$$

$$\mathbf{u}_r = \frac{-10}{10.9}\mathbf{i} + \frac{-3}{10.9}\mathbf{j} + \frac{3}{10.9}\mathbf{k} = -0.917\mathbf{i} - 0.275\mathbf{j} + 0.275\mathbf{k}$$

$$\text{Force vector along, } \mathbf{r} = -56.5\mathbf{i} - 16.9\mathbf{j} + 16.9\mathbf{k} \text{ [N]}$$

- b) [30] Using the vector method (Cross Product), determine the moment vector at point A of the force, $\mathbf{F}$ [kN].



$$\text{Force Vector, } \mathbf{F} = 0\mathbf{i} + 200\mathbf{j} + 0\mathbf{k} \text{ kN}$$

$$\text{Position Vector, } \mathbf{r}_A = 0\mathbf{i} + 2\mathbf{j} + 0\mathbf{k} \text{ m}$$

$$\mathbf{O} = 0, 0, 0$$

$$\mathbf{A} = 0, 2, 0$$

$$(0\mathbf{i} - 2\mathbf{j} + 0\mathbf{k})$$

$$\mathbf{u}_A = 1\mathbf{j}$$

$$\mathbf{F}(\mathbf{u}_A)$$

* ran out of time

$$M_A = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 0 & -2 & 0 \\ 0 & 200 & 0 \end{vmatrix} = 0$$

$$\text{Moment Vector, } \mathbf{M}_A = 0\mathbf{i} + 0\mathbf{j} + 0\mathbf{k} \text{ kN.m}$$

-30

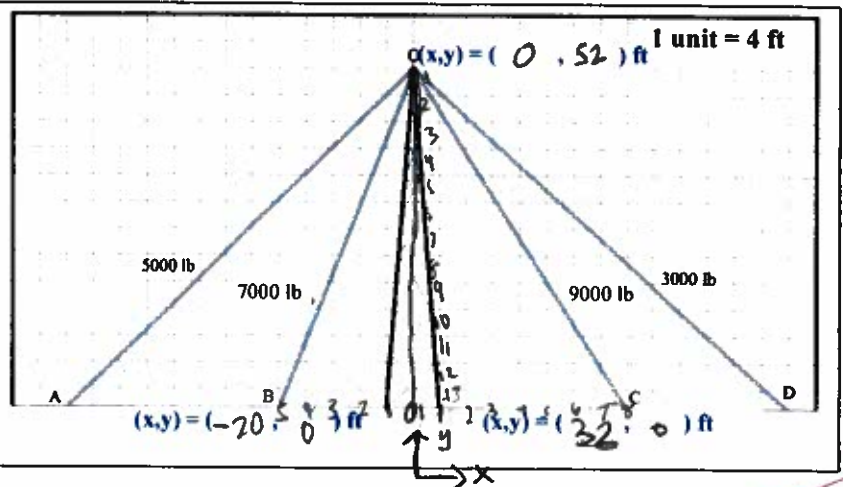
2 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

A pole is stabilized in a plane using four cables. The tension in each cable is shown in the figure. Determine the combined force vector on the pole due to cables B and C ONLY.

Note that 1 unit = 4 ft.

Provide the coordinates of O, B and C (x, y) ft. First find the Unit vector for each cable and then the force vector for each one.

$$r_B = (-20 - 0)i + (0 - 52j)$$



$$r_B = \sqrt{20^2 + 52^2} = 55.71$$

Position vector for Cable B, $r_B = -20i - 52j + 0k$ ft

$$\frac{-20}{55.71} = -0.359i$$

Unit vector of $r_B = -0.359i - 0.933j + 0k$

$$\frac{-52}{55.71} = -0.933$$

Force vector Cable B, $F_B = -2513i - 6551j + 0k$ lb
 $7000 \text{ lb} (U_{r_B}) = 7000(-0.359i - 0.933j)$

$$r_C = (32i - 52j)$$

Position vector for Cable D, $r_C = 32i - 52j + 0k$ ft

$$\sqrt{32^2 + 52^2} = 61.1$$

Unit vector of $r_C = 0.524i - 0.851j + 0k$

$$9000(0.524i - 0.851j)$$

Force vector Cable C, $F_C = 4716i - 7659j + 0k$ lb

$$\frac{32}{61.1} = 0.524i$$

$$(4716 + (-2513))i + (-7659 + (-6551))j = 2203i - 14190j$$

$$\frac{-52}{61.1} = -0.851$$

Combined Force vector (by cables B & C) on pole $F_{POLE} = 2203i - 14190j + 0k$ lb

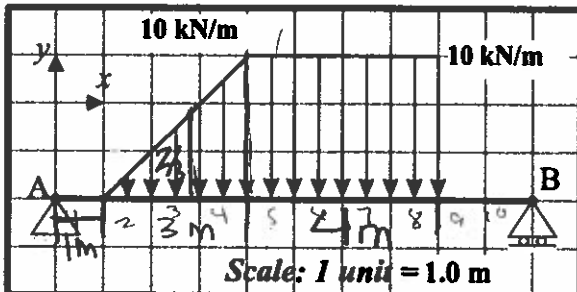
$$\sqrt{2203^2 + (14190)^2} = 14359.98 \approx 14360 \text{ lb}$$

Magnitude of combined Force on pole $F_{POLE} = 14360$ lb

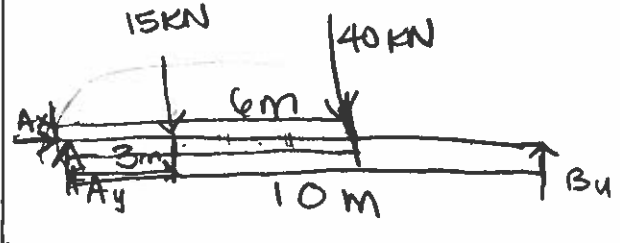
3 [100]

a) [50] Determine the reactions at the supports. First, determine the equivalent point load [kN] and provide the location of each one from A [m], respectively. **Draw the FBD first.** The distributed load point load equivalents MUST be ONLY 2. One for the **rectangular** distribution (FR_1) and the other for the **rectangular** distribution (FR_2).

CLEARLY SHOW ALL WORK AND provide the answers in the spaces provided



Provide the Free-body Diagram [FBD] here



$$FR_1 = 10 \times 4 = 40 \text{ kN}$$

$$x = 0.5 \times 4 = 2 \text{ m} + 3 + 1 = 6 \text{ m} \quad \sum F_x = 0$$

$$FR_2 = \frac{1}{2} (10) (3) = 15 \text{ kN}$$

$$x = \frac{2}{3} (3) + 1 = 3 \text{ m}$$

$$\sum F_y = 0$$

$$A_y + (-15) - 40 + 28.5 = 0$$

$$A_y - 26.5 = 0 \Rightarrow A_y = 26.5$$

[rect] $FR_1 = 40$ [kN]; Location from A = 6 m

[tri] $FR_2 = 15$ [kN]; Location from A = 3 m

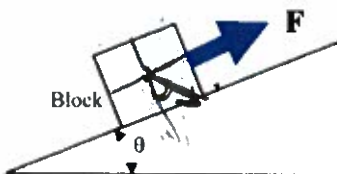
Reaction at A (x-direction) [if any] = 0 [kN]

Reaction at A (y-direction) [if any] = 26.5 [kN]

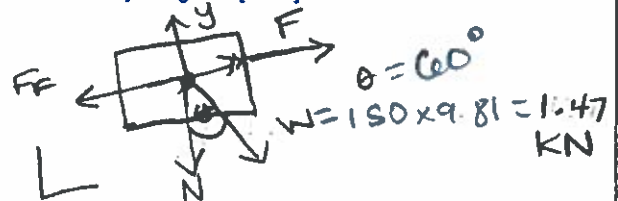
Reaction at B (x-direction) [if any] = 28.5 [kN]

Reaction at B (y-direction) [if any] = 28.5 [kN]

b) [50] The block shown below has a mass of 150 kg and is being pulled UP the incline. The angle $\theta = 60^\circ$ and the coefficient of dry friction between the block and the surface, $\mu = 0.25$. Determine the force, F [N] required for impending motion up the incline. **Draw the FBD first.**



Provide the Free-body Diagram [FBD] here



$$\sum F_y = 0$$

$$N - W \cos 60 = 0$$

$$N = 1.47 (\cos 60) = 0.735 \text{ kN}$$

$$F_f = 0.25 (0.735) = .183 \text{ kN}$$

$$\sum F_x = 0$$

$$-.183 \text{ kN} + 1.47 \sin 60 + F = 0$$

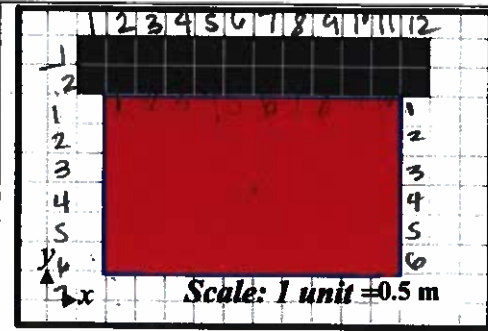
Force, $F = -1.09$ [kN]

$F = -1.09$ kN is should be in opposite direction

-10

4 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [50] Determine the COMPOSITE centroid of the T section by completing the table below. The (x, y) shown is the origin and the reference for the centroid values [m]. Please fully justify your answer.



Part	Dimensions	Area [m ²]	x-centroid, x _i [m]	y-centroid, y _i [m]	x _i A _i [m ³]	y _i A _i [m ³]
Top - A (Black)	6 m × 1 m	6	3.5	4	21	24
Bottom - B (Red)	5 m × 3 m	15	3.5	2	52.5	30
		21	6.5		73.5	54

$$\bar{x} = \frac{\sum x_i A_i}{\sum A_i} = \frac{73.5}{21} = 3.5$$

$$\bar{y} = \frac{\sum y_i A_i}{\sum A_i} = \frac{54}{21} = 2.57$$

$$x\text{-Centroid} = \cancel{3.5} \text{ [m]}$$

$$y\text{-Centroid} = \cancel{2.57} \text{ [m]}$$

b) [50] Determine the COMPOSITE Moment of Inertia [Mol] of the 2 sections (BLACK and RED), using (x, y) shown as the origin and the reference point. Provide your solution by completing the table provided below and any other calculations.

Part	I _{x'} [m ⁴]	I _{y'} [m ⁴]	d _x = $\bar{x} - \bar{x}_i$ [m]	d _y = $\bar{y} - \bar{y}_i$ [m]	Ad _x ² [m ⁴]	Ad _y ² [m ⁴]
Top - A (Black)	2	72	0	-1.43	0	18.26
Bottom - B (Red)	45	125	0	0.57	0	4.87
	47	197				17.1

$$I_x = \frac{bh^3}{3}$$

$$I_y = \frac{b^3h}{3}$$

$$\frac{6(1)^3}{3} = 2$$

$$\frac{6^3}{3} = 72$$

$$I_x = I_{x'} + Ad_y^2$$

$$47 + 17.13$$

$$I_y = 197 + 0$$

$$x\text{-Moment of Inertia, } I_x = \cancel{64.1} \text{ [m⁴]}$$

$$y\text{-Moment of Inertia, } I_y = \cancel{197} \text{ [m⁴]}$$

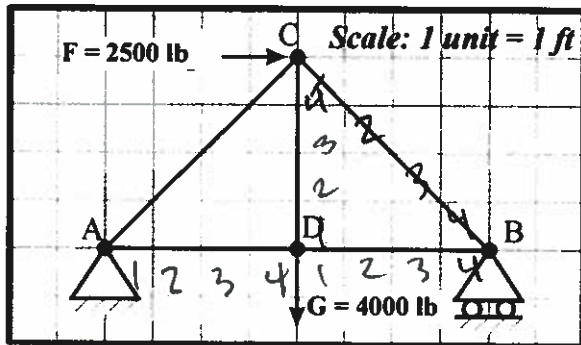
$$I_{x \text{ Red}} = \frac{5 \times 3^3}{3} = 45$$

$$I_{y \text{ Red}} = \frac{5^3 \times 3}{3} = 125$$

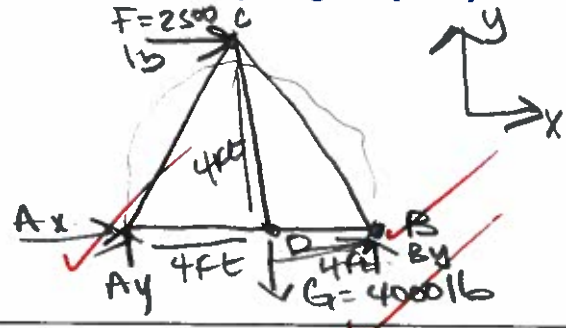
5 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [30] Determine the reactions at the supports. Draw FBD first.

CLEARLY SHOW ALL WORK.



Provide the Free-body Diagram [FBD] here



$$\sum F_y = A_y + 3250 - 4000$$

$$A_y = 750$$

$$\sum M_A = 2500(4\text{ft}) - B_y(8\text{ft}) + (4000)(4) = 0$$

$$16000 - B_y(8) = 0$$

$$B_y = 2000$$

$$\sum F_x = 0$$

$$2500\text{ lb} + A_x = 0$$

$$A_x = -2500$$

opposite direction of FBD

Reaction at A (x-direction) [if any] = -2500 [lb]

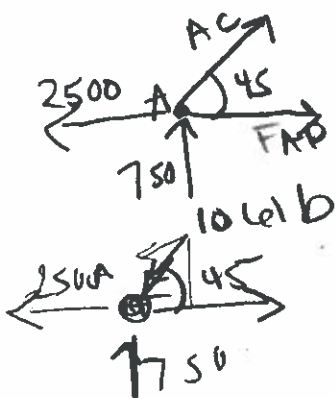
Reaction at A (y-direction) [if any] = 750 [lb]

$$B_y = 3250$$

Reaction at B (x-direction) [if any] = 3250 [lb]

Reaction at B (y-direction) [if any] = 0 [lb]

b) [70] Determine the loads in members: AC, AD, DC and BC using the Method of Joints. Fully justify your answer.



$$\sum F_x = 0$$

$$-2500 + FAD - FAC \cos 45 = 0$$

$$-2500 + FAD - 1061 \cos 45 = 0$$

$$\sum F_y = 750 + FAC \sin 45 = 0$$

$$FAD = 3250$$

$$FAC \sin 45 = -750$$

$$FAC = -1061$$

Joint C



$$\sum F_x = 2500 - 1061 \sin 45 - FCB \sin 45 = 0$$

$$1749.75 - FCB \sin 45 = 0$$

$$FBC = 2475$$

Load in member AC = 1061 [lb]

Load in member AD = 3250 [lb]

Load in member DC = 2500 [lb]

Load in member BC = 2475 [lb]

$$FCD - 2500.32 = 0$$

$$FCD = 2500$$

-15

6 [100] CLEARLY SHOW ALL WORK AND provide answers in spaces provided

- a) [55] A projectile travels along a fixed path, $y = 8x^2$ into the air (assume zero drag force) at a velocity (in the x-direction) $= (3t + 5)$ ft/s at $t = 4$ s. Assume that at $t = 0$ s, the projectile is a point $(x, y, z) = (0, 0, 0)$ ft.

i) [15] How far [ft] will the projectile travel in the x-direction after traveling for 4 seconds?

$$v = \frac{ds}{dt} \rightarrow \int_0^4 (3t + 5) dt = s \rightarrow \frac{3t^2}{2} + 5t$$

$$24 + 20 = 44 \text{ ft}$$

X-direction travel in 4 s = 44 ft [ft]

ii) [15] Provide the velocity vector of the projectile at $t = 4$ s

$$v_x = 3(4) + 5 = 17i$$

Chain rule for y: $= 8(2)x \rightarrow 16x(v_x) =$

$$16(44 \text{ ft}) (3(4 \text{ s}) + 5) = 704(17)$$

Velocity vector at $t = 4$ s = 17 i 1968 j 0 k ft/s

ii) [25] Provide the acceleration in the y-direction of the projectile at $t = 4$ s

Product Rule $= f(x)(g'(x)) + f'(x)(g(x))$

$$(16x)(3t + 5) \quad 16x(3) + 16(3t + 5)$$

$$16(44)(3)$$

$$2112 + 16(17) = 2384$$

Acceleration in y-direction at $t = 4$ s = 2384 ft/s²

- b) [45] A prototype Tesla Model S car is being tested around a circular race track (radius = 500 m) with increasing velocity, $v = 0.0125t^3$ m/s.

i) [10] Determine the tangential velocity at $t = 20$ s

$$0.0125(20^3) = 100$$

Tangential Velocity at $t = 20$ s = 100 m/s

ii) [10] Determine the tangential acceleration at $t = 20$ s

$$0.0125(3)t^2$$

Tangential acceleration at $t = 20$ s = 15 m/s²

ii) [15] Determine the Normal acceleration at $t = 20$ s

$$a_n = \frac{100^2}{500} = 20$$

Normal acceleration at $t = 20$ s = 20 m/s²

ii) [10] Determine the magnitude of acceleration at $t = 20$ s

$$\sqrt{20^2 + 15^2}$$

magnitude of acceleration at $t = 20$ s = 25 m/s²

FS

AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. A. Nzewi

Final Exam

DATE: MONDAY, December 06, 2021 at 07:00 AM (NENR 137)

Submit the entire exam the order given

Name [PRINT] Hunter Evans

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

290
600

1. This is a **CLOSED** book exam. Please **turn off all cell phones and mp3 players** and **place them in your book bag in front of the class. Put AWAY ANY wristwatches.** Also put away ANY **disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator **on your person or around you** during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 110 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM. Once the exam begins, you must submit your work (exam terminates) when you leave the exam to visit the restroom.**
9. You are required to solve ALL problems.

Calculator POLICY – Allowed Calculators

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name.)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name.)

All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all stated Exam stipulations:

Signature: Hunter Evans Date: 12/6/21

NAME [PRINT (Lastname, firstname)]: Evans, Hunter

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2$ ($= 32.2 \text{ ft/s}^2$)

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 mile = 5280 feet = 1760 yards; 1 acre = 43,560 ft²

1 m = 100 cm

1 slug = 14.59 kg

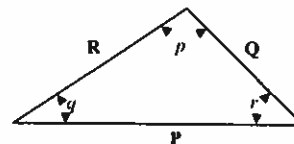
1 lb = 4.448 N

Standard atmosphere = 101.3 kPa ($= 2117 \text{ psf} = 14.7 \text{ psi}$)

Gas constant for air, $R = 287 \text{ J/kg.K}$

Density of water = 1000 kg/m^3 ($= 1.94 \text{ slugs/ft}^3$) at 4°C

Specific weight of water = 9810 N/m^3 ($= 62.4 \text{ lb/ft}^3$) at 4°C



Sine Law

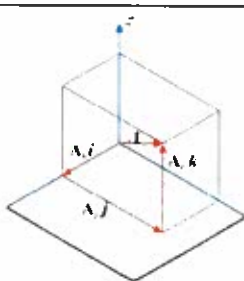
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j} + A_z \mathbf{k}$$

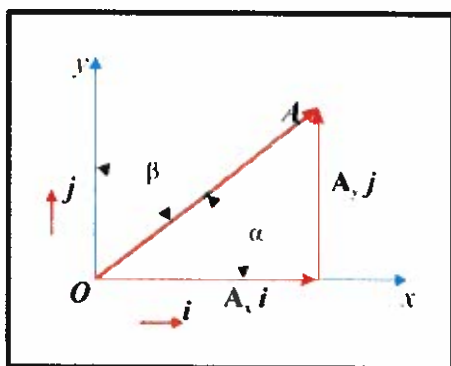
$$|\mathbf{A}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

$$A_z = |\mathbf{A}| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

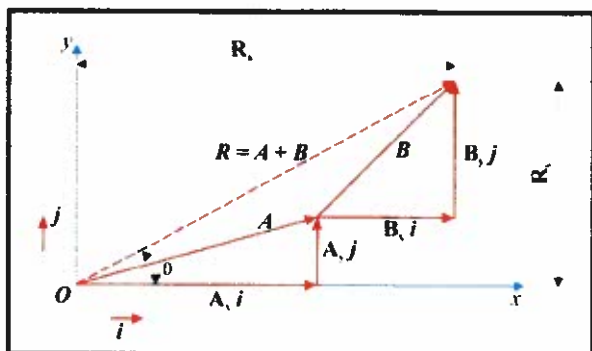


$$\mathbf{A} = A_x \mathbf{i} + A_y \mathbf{j}$$

$$A_x = |\mathbf{A}| \cos \alpha$$

$$A_y = |\mathbf{A}| \cos \beta$$

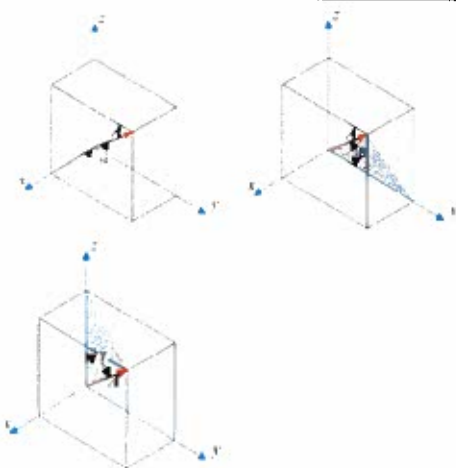
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

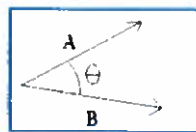
$$A = A_x i + A_y j + A_z k$$

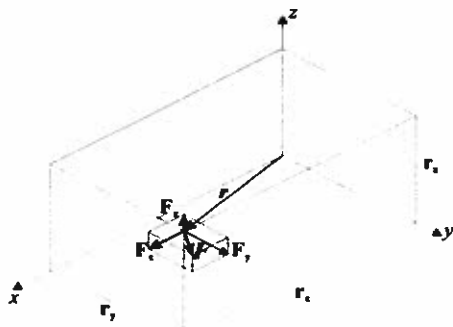
$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$





Vector Moment of a Force $[F]$ about a point with Position Vector $[r]$

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = 2b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_b} = bh^3/12$ $I_{y_b} = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_{x_b} = bh^3/12$ $I_{y_b} = b^3h/12$
	$A = bh/2$ $x_c = (a+b)/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = [bh(b^2 - ab + a^2)]/36$ $I_{x_b} = bh^3/12$ $I_{y_b} = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$ $I_{x_b} = bh^3/3$ $I_{y_b} = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

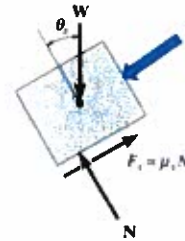
$$I_x = I_{x'} + Ad_{y'}^2$$

$$I_y = I_{y'} + Ad_{x'}^2$$

Friction

Friction is defined as a force of resistance acting on a body which prevents or resists the slipping of a body relative to a second body.

$$F_s = \mu_s N$$



Kinematics

$$v = \frac{ds}{dt} \quad a = \frac{dv}{dt}$$

Acceleration

$$v = ds/dt; \quad a = dv/dt \quad \text{or} \quad a = v \, dv/ds$$

Constant Acceleration Formulas:

$$v = v_0 + a_c t \quad \text{Equation 12-4}$$

$$s = s_0 + v_0 t + (1/2) a_c t^2 \quad \text{Equation 12-5}$$

$$v^2 = (v_0)^2 + 2a_c(s - s_0) \quad \text{Equation 12-6}$$

VERTICAL MOTION

$$v_y = v_{oy} - g t$$

$$y = y_0 + (v_{oy}) t - \frac{1}{2} g t^2$$

$$v_y^2 = v_{oy}^2 - 2 g (y - y_0)$$

Special cases of motion:

- 1) The particle moves along a **straight line**.

$$\rho \rightarrow \infty \Rightarrow a_n = v^2/\rho = 0 \Rightarrow a = a_t = \dot{v}$$

The **tangential component** represents the **time rate of change** in the **magnitude** of the **velocity**.

- 2) The particle moves along a curve at **constant speed**.

$$a_t = \dot{v} = 0 \Rightarrow a = a_n = v^2/\rho$$

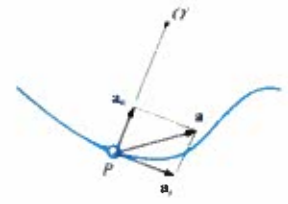
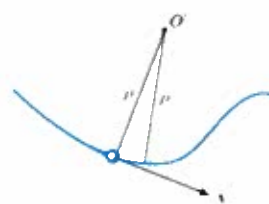
The **normal component** represents the **time rate of change** in the **direction** of the velocity.

Chain Rule

$$\dot{y} = \frac{dy}{dt} = \frac{dy}{dx} \frac{dx}{dt}$$

VELOCITY & ACCELERATION IN THE n-t COORDINATE SYSTEM

Velocity & Acceleration



Velocity

$$\mathbf{v} = v \mathbf{u}_t \quad \text{where} \quad v = s = ds/dt$$

v is the **magnitude** of the velocity (speed) and $\mathbf{u}_t$ defines the **direction** of the velocity vector.

Acceleration

Components of the **acceleration vector**:

$$\mathbf{a} = a_t \mathbf{u}_t + a_n \mathbf{u}_n = v \mathbf{u}_t + (v^2/\rho) \mathbf{u}_n$$

$$a_t = \dot{v} \quad \text{or} \quad a_t ds = v dv;$$

$$a_t = \dot{v} = dv/dt = (dv/ds) (ds/dt) = v(dv/ds)$$

The **normal** or **centripetal component** is: $a_n = v^2/\rho$

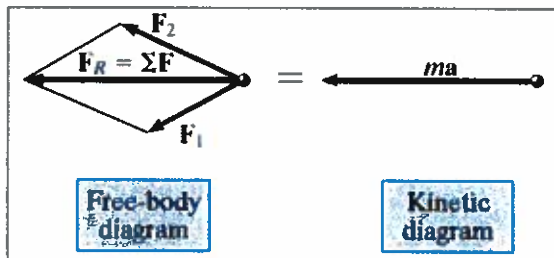
The **magnitude** of the acceleration vector is

$$a = \sqrt{(a_n)^2 + (a_t)^2}$$

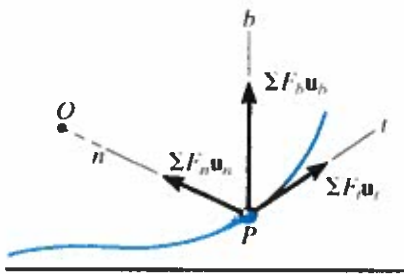
For a particle moving **along a path** expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

Kinetics



NORMAL & TANGENTIAL COORDINATES



$$\Sigma F_t u_t + \Sigma F_n u_n = ma_t + ma_n$$

scalar equations: $\Sigma F_t = ma_t$ and $\Sigma F_n = ma_n$

Acceleration

tangential acceleration, $a_t = dv/dt$

normal acceleration, $a_n = v^2/\rho$

For a particle moving along a path expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

Equations (Newton's 2nd Law)

$$\Sigma \mathbf{F} = \mathbf{F}_R = m\mathbf{a}$$

$$\Sigma \mathbf{F} = m\mathbf{a} \text{ or}$$

$$\Sigma F_x \mathbf{i} + \Sigma F_y \mathbf{j} + \Sigma F_z \mathbf{k} = m(a_x \mathbf{i} + a_y \mathbf{j} + a_z \mathbf{k})$$

$$\Sigma F_x = ma_x, \Sigma F_y = ma_y, \text{ and } \Sigma F_z = ma_z$$

I pledge to abide by all Final exam rules stated

NAME [PRINT]: Hunter Evans

Signature: Hunter Evans

Date: 12/6/21

GRADE

600

1 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

- (a) [70] The relative position vector $\mathbf{r}$ is defined by beginning and end coordinates, $(x,y,z) = (4,3,2)$ m and $(-6, 0, 5)$ m, respectively. For the force vector $\mathbf{F}$ given below, determine the angle and the magnitude of the force along the position vector. And determine the force vector along the position vector.

$$\mathbf{F} = (30\mathbf{i} + 50\mathbf{j} + 20\mathbf{k}) \text{ N}$$

$$\mathbf{r} = (x_2 - x_1)\mathbf{i} + (y_2 - y_1)\mathbf{j} + (z_2 - z_1)\mathbf{k}$$

$$(-6 - 4)\mathbf{i} + (0 - 3)\mathbf{j} + (5 - 2)\mathbf{k}$$

$$-10\mathbf{i} - 3\mathbf{j} + 3\mathbf{k}$$

Position vector along, $\mathbf{r}$ $-10\mathbf{i} - 3\mathbf{j} + 3\mathbf{k}$ [m]

$$|\mathbf{r}| = \sqrt{10^2 + 3^2 + 3^2}$$

$$r = |\mathbf{r}| = \sqrt{118}$$

Angle between $\mathbf{r}$ and $\mathbf{F}$ -0.580 [degrees]

$$\theta = \cos^{-1} \left(\frac{-10 \cdot 30 + -3 \cdot 50 + 3 \cdot 20}{\sqrt{118} \cdot 61.64} \right)$$

Magnitude of Force ALONG Position Vector 658.71 [N]

$$|\mathbf{F}| = \sqrt{30^2 + 50^2 + 20^2} = 61.64 \text{ N}$$

$$F_r = |\mathbf{F}| \cdot \cos \theta$$

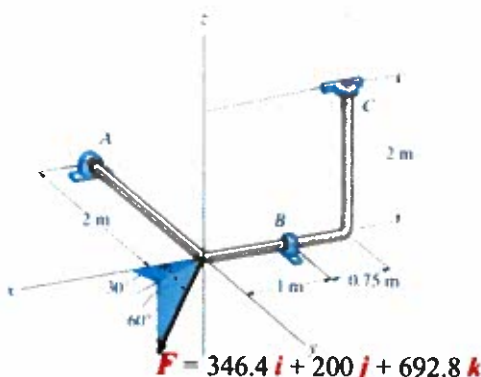
$$\frac{F_x}{|\mathbf{F}|}$$

$$\frac{F_y}{|\mathbf{F}|}$$

$$\frac{F_z}{|\mathbf{F}|}$$

Force vector along, $\mathbf{r}$ $-0.92\mathbf{i} - 0.27\mathbf{j} + 0.27\mathbf{k}$ [N]

- b) [30] Using the vector method (Cross Product), determine the moment vector at point A of the force, $\mathbf{F}$ [kN].

Force Vector, $\mathbf{F} = 346.4\mathbf{i} + 200\mathbf{j} + 692.8\mathbf{k}$ kNPosition Vector, $\mathbf{r}_A = 0\mathbf{i} + 2\mathbf{j} + 0\mathbf{k}$ m

$$(\mathbf{F}_y \cdot 0 - 692.8 \cdot 2)\mathbf{i} - (346.4 \cdot 0 - 692.8 \cdot 0)\mathbf{j} + (346.4 \cdot 2 - 1385.6)\mathbf{k}$$

$$-1385.6\mathbf{i} - 0\mathbf{j} + (-692.8)\mathbf{k}$$

Moment Vector, $\mathbf{M}_A = -1385.6\mathbf{i} - 0\mathbf{j} - 692.8\mathbf{k}$ kN.m

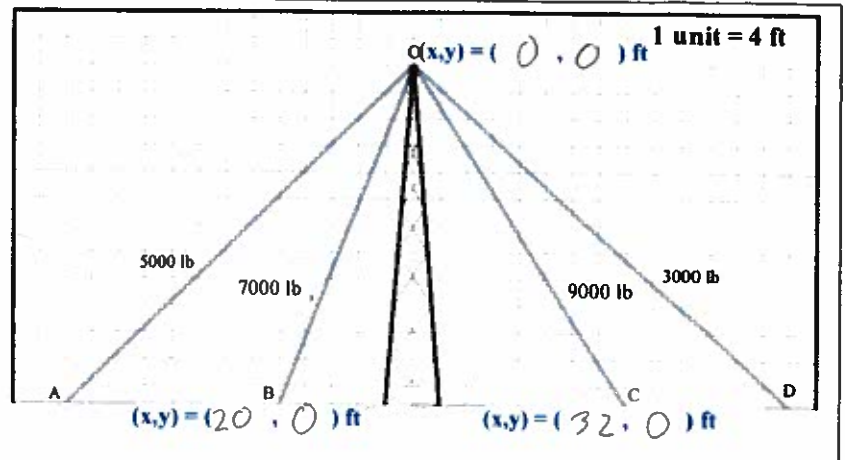
-40

2 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

A pole is stabilized in a plane using four cables. The tension in each cable is shown in the figure. Determine the **combined force vector** on the pole due to **cables B and C ONLY**.

Note that 1 unit = 4 ft.

Provide the **coordinates** of O, B and C (x, y) ft. First find the **Unit vector** for each cable and then the **force vector** for each one.



Position vector for Cable B, $r_B = 20 \mathbf{i} + 0 \mathbf{j} + 0 \mathbf{k}$ ft

$|r_B| = \sqrt{20^2} = 20$
 $u_B = \frac{r_B}{|r_B|} = \frac{20}{20} \mathbf{i}$

Unit vector of $r_B = 1 \mathbf{i} + 0 \mathbf{j} + 0 \mathbf{k}$

Force vector Cable B, $F_B = \frac{7000}{2000 \cdot 1} \mathbf{i} + \frac{0}{0 \cdot 0} \mathbf{j} + \frac{0}{0 \cdot 0} \mathbf{k}$ lb

Position vector for Cable C, $r_C = 32 \mathbf{i} + 0 \mathbf{j} + 0 \mathbf{k}$ ft

$|r_C| = \sqrt{32^2} = 32$

$u_C = \frac{r_C}{|r_C|} = \frac{32}{32} \mathbf{i}$

Unit vector of $r_C = 1 \mathbf{i} + 0 \mathbf{j} + 0 \mathbf{k}$

Force vector Cable C, $F_C = \frac{9000}{9000 \cdot 1} \mathbf{i} + \frac{0}{0 \cdot 0} \mathbf{j} + \frac{0}{0 \cdot 0} \mathbf{k}$ lb

Combined Force vector (by cables B & C) on pole $F_{POLE} = 16000 \mathbf{i} + 0 \mathbf{j} + 0 \mathbf{k}$ lb

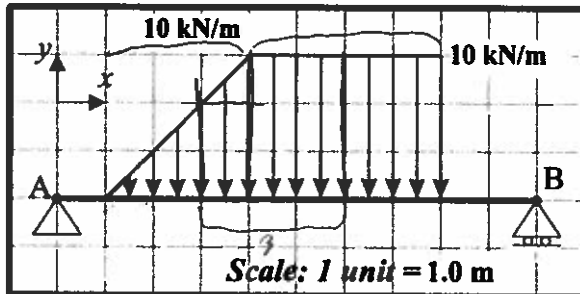
$\sqrt{16000^2} = 16000$

Magnitude of combined Force on pole $F_{POLE} = 16000$ lb

3 [100]

a) [50] Determine the reactions at the supports. First, determine the equivalent point load [kN] and provide the location of each one from A [m], respectively. **Draw the FBD first.** The distributed load point load equivalents MUST be ONLY 2. One for the **rectangular** distribution (FR_1) and the other for the **triangular** distribution (FR_2).

CLEARLY SHOW ALL WORK AND provide the answers in the spaces provided



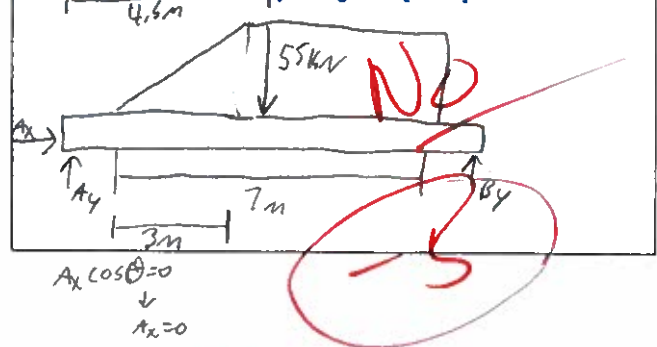
$$\frac{3}{2} = 1.5$$

$$4 \cdot 10 = 40$$

$$\frac{1}{2}(3)10 = 15$$

$$A_y + B_y = 55 \text{ kN}$$

Provide the Free-body Diagram [FBD] here



[rect] $FR_1 = 40$ [kN]; Location from A = 4 m

[tri] $FR_2 = 15$ [kN]; Location from A = 1.5 m

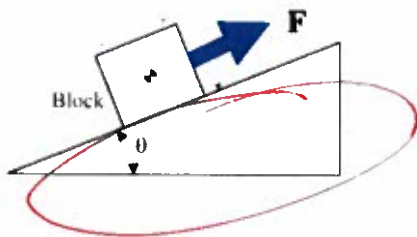
Reaction at A (x-direction) [if any] = 0 [kN]

Reaction at A (y-direction) [if any] = 0 [kN]

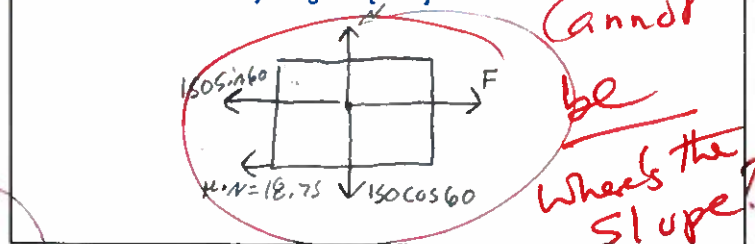
Reaction at B (x-direction) [if any] = N/A [kN]

Reaction at B (y-direction) [if any] = 55 [kN]

b) [50] The block shown below has a mass of 150 kg and is being pulled UP the incline. The angle $\theta = 60^\circ$ and the coefficient of dry friction between the block and the surface, $\mu = 0.25$. Determine the force, F [N] required for impending motion up the incline. **Draw the FBD first.**



Provide the Free-body Diagram [FBD] here



$$N = 150 \cos 60 = 75$$

$$F_f = \mu N = 0.25 \cdot 75 = 18.75$$

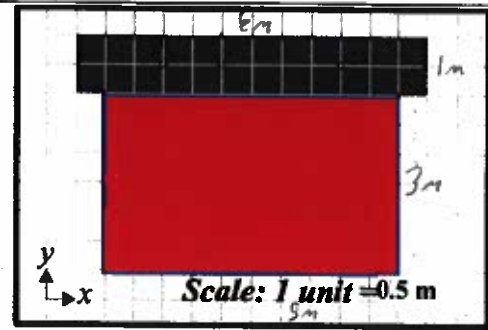
$$F = 150 \sin 60 - 18.75$$

Force, $F = 111.15$ [kN]

111.15

4 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [50] Determine the COMPOSITE centroid of the T section by completing the table below. The (x, y) shown is the origin and the reference for the centroid values [m]. Please fully justify your answer.



Part	Dimensions	Area [m ²]	x-centroid, x _i [m]	y-centroid, y _i [m]	x _i A _i [m ³]	y _i A _i [m ³]
Top - A (Black)	1 m × 6 m	6	3.5	4	24.5	28
Bottom - B (Red)	3 m × 5 m	15	3.5	2	52.5	30
		22			77	58

x-Centroid = ~~3.5~~ [m]

y-Centroid = ~~2~~ [m]

b) [50] Determine the COMPOSITE Moment of Inertia [Mol] of the 2 sections (BLACK and RED), using (x, y) shown as the origin and the reference point. Provide your solution by completing the table provided below and any other calculations.

Part	I _{x'} [m ⁴]	I _{y'} [m ⁴]	d _x = $\bar{x} - \bar{x}_i$ [m]	d _y = $\bar{y} - \bar{y}_i$ [m]	Ad _x ² [m ⁴]	Ad _y ² [m ⁴]
Top - A (Black)	72	2	3.5	2	85.75	28
Bottom - B (Red)	125	49	3.5	4	183.75	240
	197	47			269.5	268

$$i_x = bh^3/12$$

$$i_y = b^3h/12$$

$$I_{xc} = i_x + Ad_y^2$$

$$I_{yc} = i_y + Ad_x^2$$

$$197 + 268$$

$$47 + 269.5$$

x-Moment of Inertia, I_x = ~~465~~ [m⁴]

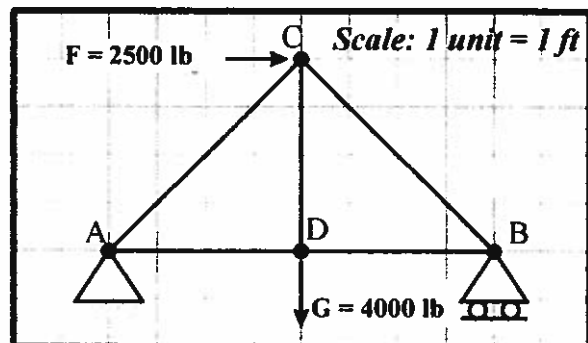
y-Moment of Inertia, I_y = ~~316.5~~ [m⁴]

-50

5 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [30] Determine the reactions at the supports. Draw FBD first.

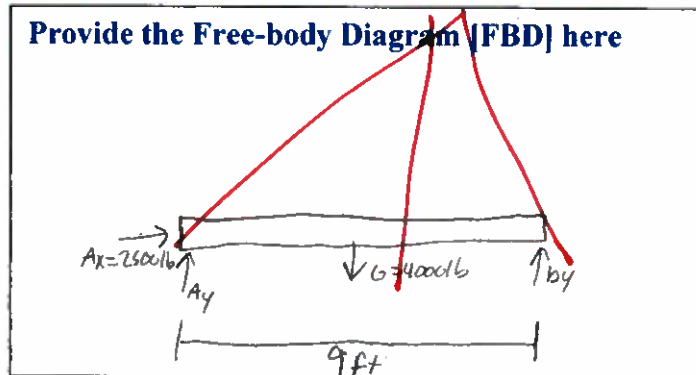
CLEARLY SHOW ALL WORK.



$$A_x + 2500 = 0$$

$$A_x = -2500 \text{ lb}$$

Provide the Free-body Diagram [FBD] here

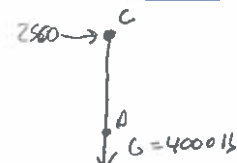
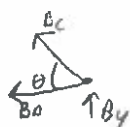
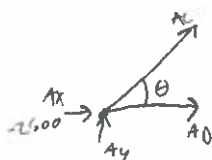


$$\sum F_y = 0 \rightarrow A_y + B_y = 4000$$

-15

- Reaction at A (x-direction) [if any] = -2500 [lb] ✓
- Reaction at A (y-direction) [if any] = ~~X~~ [lb]
- Reaction at B (x-direction) [if any] = N/A [lb] ✓
- Reaction at B (y-direction) [if any] = ~~X~~ [lb]

b) [70] Determine the loads in members: AC, AD, DC and BC using the Method of Joints. Fully justify your answer.



?

-55

Show work

How?

- Load in member AC = ~~X~~ lb
- Load in member AD = ~~X~~ lb
- Load in member DC = ~~X~~ lb
- Load in member BC = ~~X~~ lb

-70

6 [100] CLEARLY SHOW ALL WORK AND provide answers in spaces provided

- a) [55] A projectile travels along a fixed path, $y = 8x^2$ into the air (assume zero drag force) at a velocity (in the x-direction) $= (3t + 5)$ ft/s at $t = 4$ s. Assume that at $t = 0$ s, the projectile is a point $(x, y, z) = (0, 0, 0)$ ft.

i) [15] How far [ft] will the projectile travel in the x-direction after traveling for 4 seconds?

$$x = 3(4) + 5 = 17$$

ii) [15] Provide the velocity vector of the projectile at $t = 4$ s

X-direction travel in 4 s = 17 [ft]

$$\frac{d}{dt}(3t+5) = 3$$

$$\frac{d}{dx}(3t+5) = 3 \cdot 16(4)$$

Velocity vector at $t = 4$ s = $3 \mathbf{i} + 192 \mathbf{j}$ ft/s

ii) [25] Provide the acceleration in the y-direction of the projectile at $t = 4$ s

$$\rho = \frac{(1 + (\frac{dy}{dx})^2)^{3/2}}{d^2y/dx^2}$$

$$\frac{(1 + 16(4)^2)^{3/2}}{16}$$

$$a_n = v^2/\rho = \frac{17^2}{16390}$$

$$a_n = 0.017$$

$$\dot{v} = \sqrt{3^2 + 192^2} = 192$$

$$\frac{d}{dx}(8x^2)$$

$$\frac{d^2}{dx^2} = 16$$

$$a = \sqrt{a_n^2 + a_t^2} = \sqrt{0.017^2 + 192^2}$$

Acceleration in y-direction at $t = 4$ s = 192 ft/s²

- b) [45] A prototype Tesla Model S car is being tested around a circular race track (radius = 500 m) with increasing velocity, $v = 0.0125t^3$ m/s.

i) [10] Determine the tangential velocity at $t = 20$ s

$$v = 0.0125t^3$$

$$v = 100$$

Tangential Velocity at $t = 20$ s = 100 m/s

ii) [10] Determine the tangential acceleration at $t = 20$ s

$$a = a_t = \frac{dv}{dt} = \frac{d}{dt}(0.0125t^3) = 0.0375t^2$$

Tangential acceleration at $t = 20$ s = 15 m/s²

ii) [15] Determine the Normal acceleration at $t = 20$ s

$$a_n = v^2/\rho = \frac{100^2}{500} = 20$$

Normal acceleration at $t = 20$ s = 20 m/s²

ii) [10] Determine the magnitude of acceleration at $t = 20$ s

$$|a| = \sqrt{a_n^2 + a_t^2} = \sqrt{20^2 + 15^2}$$

magnitude of acceleration at $t = 20$ s = 25 m/s²

-35

BELOW
AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azizi

Final Exam

DATE: MONDAY, December 06, 2021 at 07:00 AM (ENR 137)

Submit the entire exam the order given

Name (PRINT) Aicha Linné

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

195
600

1. This is a **CLOSED** book exam. Please **turn off** all cell phones and mp3 players and place them in your **book bag** in front of the class. Put **AWAY ANY** wristwatches. Also put away ANY **disallowed** calculators in your book bags.
2. If you have a cell phone/mp3 player/wristwatch/disallowed calculator on your person or around you during the exam, it will constitute dishonesty and you will automatically be assigned a grade of zero (0.00), in addition to other possible penalties. **ANY CHEATING WILL BE PENALIZED.**
3. You have **ONLY 110 minutes** to complete this exam.
4. There shall be **NO SHARING** of resources!
5. Please turn in your work on time.
6. Provide enough detail for each problem you solve. You earn points based on the details you provide.
7. You must work independently.
8. **IF YOU NEED TO USE THE RESTROOM, DO SO BEFORE OPENING THIS EXAM.** Once the exam begins, you must submit your work (exam terminates) when you leave the exam to visit the restroom.
9. You are required to solve **ALL** problems.

Calculator POLICY – Allowed Calculators

- **Casio:** All fx-115 and fx-991 models (Any Casio calculator must have "fx-115" or "fx-991" in its model name.)
- **Hewlett Packard:** The HP 33s and HP 35s models, but no others
- **Texas Instruments:** All TI-30X and TI-36X models (Any Texas Instruments calculator must have "TI-30X" or "TI-36X" in its model name.)

All necessary formulas/tables have been provided.

Dishonesty and/or NOT adhering to instructions will result in a grade of ZERO (0.00)

I pledge to abide by all stated Exam stipulations:

Signature: HL

Date: 12-06-2021

NAME [PRINT (Lastname, firstname)]: _____

Unless otherwise stated or implied, assume the following:

Gravitational Acceleration, $g = 9.81 \text{ m/s}^2 (= 32.2 \text{ ft/s}^2)$

1 liter = $1000 \text{ cm}^3 = 0.001 \text{ m}^3$

1 ft = 0.3048 m

1 Pa = 1 N/m^2

1 ft³ = 7.481 gal

25.4 mm = 1 in

1 mile = 5280 feet = 1760 yards; 1 acre = 43,560 ft²

1 m = 100 cm

1 slug = 14.59 kg

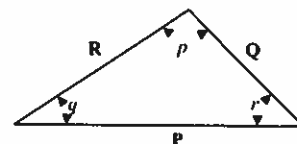
1 lb = 4.448 N

Standard atmosphere = 101.3 kPa (= 2117 psf = 14.7 psi)

Gas constant for air, $R = 287 \text{ J/kg.K}$

Density of water = $1000 \text{ kg/m}^3 (= 1.94 \text{ slugs/ft}^3)$ at 4 °C

Specific weight of water = $9810 \text{ N/m}^3 (= 62.4 \text{ lb/ft}^3)$ at 4 °C



Sine Law

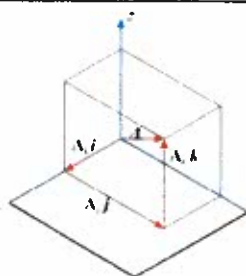
$$\frac{P}{\sin p} = \frac{Q}{\sin q} = \frac{R}{\sin r}$$

Cosine Law

$$P = \sqrt{Q^2 + R^2 - 2QR \cos p}$$

$$Q = \sqrt{P^2 + R^2 - 2PR \cos q}$$

$$R = \sqrt{P^2 + Q^2 - 2PQ \cos r}$$



$$A = A_x i + A_y j + A_z k$$

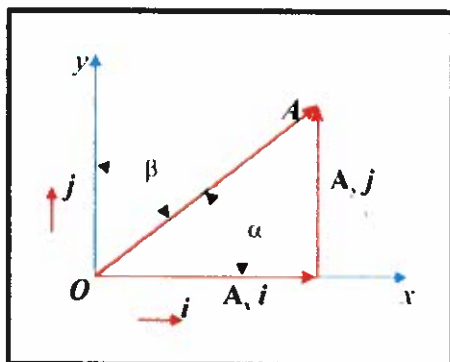
$$|A| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

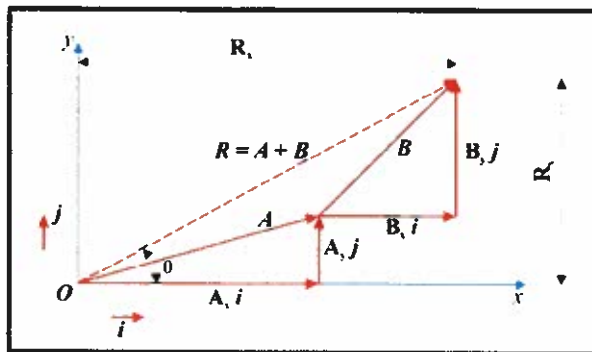


$$A = A_x i + A_y j$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

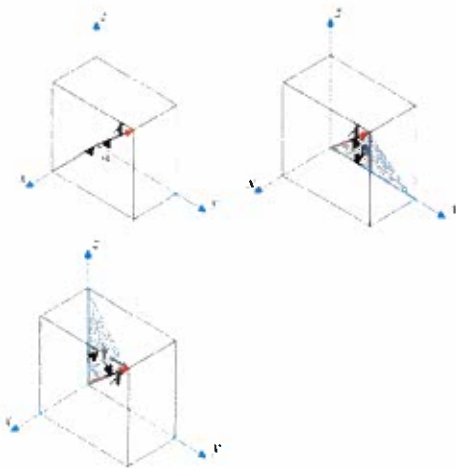
$$\cos^2 \alpha + \cos^2 \beta = 1$$



$$\begin{aligned} R &= A + B = (A_x i + A_y j) + (B_x i + B_y j) \\ &= (A_x + B_x) i + (A_y + B_y) j \\ &= R_x i + R_y j \end{aligned}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$



$$u_A = \frac{A}{|A|}$$

$$= \frac{A_x}{|A|} i + \frac{A_y}{|A|} j + \frac{A_z}{|A|} k$$

$$u_A = \cos \alpha i + \cos \beta j + \cos \gamma k$$

$$A_x = |A| \cos \alpha$$

$$A_y = |A| \cos \beta$$

$$A_z = |A| \cos \gamma$$

$$F = F_x i + F_y j + F_z k$$

$$r = r_x i + r_y j + r_z k$$

$$U_r = \frac{r_x i + r_y j + r_z k}{|r|}$$

$$F_r = |F| \cdot U_r$$

$$|r| = \sqrt{r_x^2 + r_y^2 + r_z^2}$$

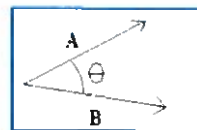
$$A = A_x i + A_y j + A_z k$$

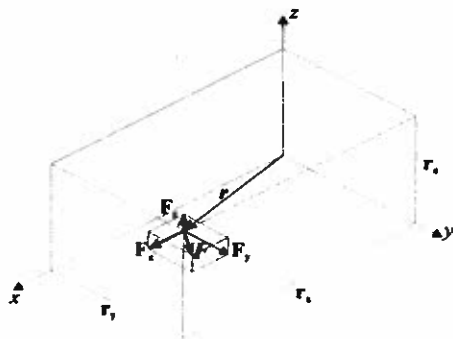
$$B = B_x i + B_y j + B_z k$$

$$\cos \theta = \frac{A \cdot B}{|A| |B|}$$

$$= \frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|}$$

$$\theta = \cos^{-1} \left(\frac{A_x B_x + A_y B_y + A_z B_z}{|A| |B|} \right)$$





Vector Moment of a Force $[F]$ about a point with Position Vector $[r]$

$$M_P = r \times F$$

$$M_P = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$M_P = (r_y F_z - r_z F_y) i - (r_x F_z - r_z F_x) j + (r_x F_y - r_y F_x) k$$

Vector Cross Product

$$A \times B = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$= i \begin{vmatrix} A_y & A_z \\ B_y & B_z \end{vmatrix} - j \begin{vmatrix} A_x & A_z \\ B_x & B_z \end{vmatrix} + k \begin{vmatrix} A_x & A_y \\ B_x & B_y \end{vmatrix}$$

$$A \times B = (A_y B_z - A_z B_y) i - (A_x B_z - A_z B_x) j + (A_x B_y - A_y B_x) k$$

$$A \times B = |A||B| \sin \theta u_c$$

where θ is the angle between the two vectors

Vector u_c is a unit vector that defines the direction of the resulting vector.

Centroids and Moments of Inertia & Parallel Axis Theorem for Moment of Inertia

Figure	Area & Centroid	Area Moment of Inertia
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_x = bh^3/12$ $I_y = b^3h/4$
	$A = bh/2$ $x_c = b/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = b^3h/36$ $I_x = bh^3/12$ $I_y = b^3h/12$
	$A = bh/2 + bh$ $x_c = (a + b)/3$ $y_c = h/3$	$I_{x_c} = bh^3/36$ $I_{y_c} = [bh(b^2 - ab + a^2)]/36$ $I_x = bh^3/12$ $I_y = [bh(b^2 + ab + a^2)]/12$
	$A = bh$ $x_c = b/2$ $y_c = h/2$	$I_{x_c} = bh^3/12$ $I_{y_c} = b^3h/12$ $I_x = bh^3/3$ $I_y = b^3h/3$ $J = [bh(b^2 + h^2)]/12$

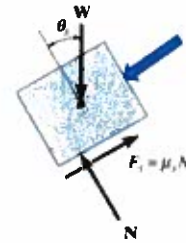
$$I_x = I_{x'} + Ad_y^2$$

$$I_y = I_{y'} + Ad_x^2$$

Friction

Friction is defined as a force of resistance acting on a body which prevents or resists the slipping of a body relative to a second body.

$$F_s = \mu_s N$$



Kinematics

$$v = \frac{ds}{dt}$$

$$a = \frac{dv}{dt}$$

Acceleration

$$v = ds/dt; \quad a = dv/dt \quad \text{or} \quad a = v \, dv/ds$$

Constant Acceleration Formulas:

$$v = v_0 + a_c t \quad \text{Equation 12-4}$$

$$s = s_0 + v_0 t + (1/2) a_c t^2 \quad \text{Equation 12-5}$$

$$v^2 = (v_0)^2 + 2a_c(s - s_0) \quad \text{Equation 12-6}$$

VERTICAL MOTION

$$v_y = v_{oy} - g t$$

$$y = y_0 + (v_{oy}) t - \frac{1}{2} g t^2$$

$$v_y^2 = v_{oy}^2 - 2 g (y - y_0)$$

Special cases of motion:

- 1) The particle moves along a **straight line**.

$$\rho \rightarrow \infty \Rightarrow a_n = v^2/\rho = 0 \Rightarrow a = a_t = \dot{v}$$

The **tangential component** represents the **time rate of change** in the **magnitude** of the **velocity**.

- 2) The particle moves along a curve at **constant speed**.

$$a_t = \dot{v} = 0 \Rightarrow a = a_n = v^2/\rho$$

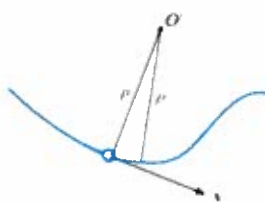
The **normal component** represents the **time rate of change** in the **direction** of the **velocity**.

Chain Rule

$$\dot{y} = \frac{dy}{dt} = \frac{dy}{dx} \frac{dx}{dt}$$

VELOCITY & ACCELERATION IN THE n-t COORDINATE SYSTEM

Velocity & Acceleration



Velocity

$$\mathbf{v} = v \mathbf{u}_t \quad \text{where} \quad v = s = ds/dt$$

v is the **magnitude** of the velocity (speed) and $\mathbf{u}_t$ defines the **direction** of the velocity vector.

Acceleration

Components of the **acceleration vector**:

$$\mathbf{a} = a_t \mathbf{u}_t + a_n \mathbf{u}_n = v \mathbf{u}_t + (v^2/\rho) \mathbf{u}_n$$

$$a_t = \dot{v} \quad \text{or} \quad a_t ds = v dv;$$

$$a_t = \dot{v} = dv/dt = (dv/ds)(ds/dt) = v(dv/ds)$$

The **normal** or **centripetal component** is: $a_n = v^2/\rho$

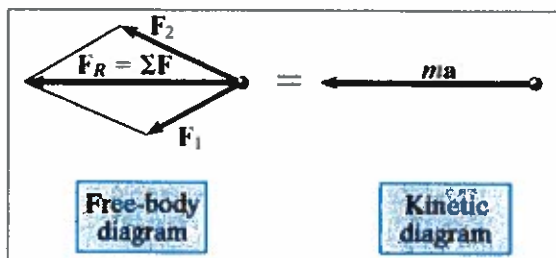
The **magnitude** of the acceleration vector is

$$a = \sqrt{(a_n)^2 + (a_t)^2}$$

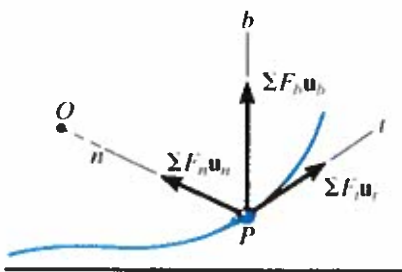
For a particle moving **along a path** expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

Kinetics



NORMAL & TANGENTIAL COORDINATES



$$\Sigma F_t u_t + \Sigma F_n u_n = ma_t + ma_n$$

scalar equations: $\Sigma F_t = ma_t$ and $\Sigma F_n = ma_n$

Acceleration

tangential acceleration, $a_t = dv/dt$

normal acceleration, $a_n = v^2/\rho$

For a particle moving along a path expressed as $y = f(x)$, the **radius of curvature**, ρ , at any point on the path can be calculated from:

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{d^2y/dx^2}$$

Equations (Newton's 2nd Law)

$$\Sigma \mathbf{F} = \mathbf{F}_R = m\mathbf{a}$$

$$\Sigma \mathbf{F} = m\mathbf{a} \text{ or}$$

$$\Sigma F_x \mathbf{i} + \Sigma F_y \mathbf{j} + \Sigma F_z \mathbf{k} = m(a_x \mathbf{i} + a_y \mathbf{j} + a_z \mathbf{k})$$

$$\Sigma F_x = ma_x, \Sigma F_y = ma_y, \text{ and } \Sigma F_z = ma_z$$

I pledge to abide by all Final exam rules stated

NAME [PRINT]: _____ Signature: _____ Date: _____

GRADE

600

1 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

- (a) [70] The relative position vector $\mathbf{r}$ is defined by beginning and end coordinates, $(x,y,z) = (4,3,2)$ m and $(-6, 0, 5)$ m, respectively. For the force vector $\mathbf{F}$ given below, determine the angle and the magnitude of the force along the position vector. And determine the force vector along the position vector.

$$\mathbf{F} = (30\mathbf{i} + 50\mathbf{j} + 20\mathbf{k}) \text{ N} \quad \mathbf{r}_{m_2} = (-6-4)\mathbf{i} + (0-3)\mathbf{j} + (5-2)\mathbf{k}$$

$$\mathbf{r} = (4, 3, 2)$$

$$\mathbf{r}_2 = (-6, 0, 5)$$

Find TR unit vector.

$$r = \sqrt{(-10)^2 + (-3)^2 + (3)^2} = 10.863$$

$$\mathbf{u} = \frac{-10}{10.863}\mathbf{i} - \frac{3}{10.863}\mathbf{j} + \frac{3}{10.863}\mathbf{k}$$

$$\mathbf{u} = -0.921\mathbf{i} - 0.276\mathbf{j} + 0.276\mathbf{k}$$

$$\text{Position vector along, } \mathbf{r} = -10\mathbf{i} - 3\mathbf{j} + 3\mathbf{k} \text{ [m]}$$

$$\text{Angle between } \mathbf{r} \text{ and } \mathbf{F} = 125.62^\circ \text{ [degrees]}$$

$$\text{Magnitude of Force ALONG Position Vector} = 31.374 \text{ [N]}$$

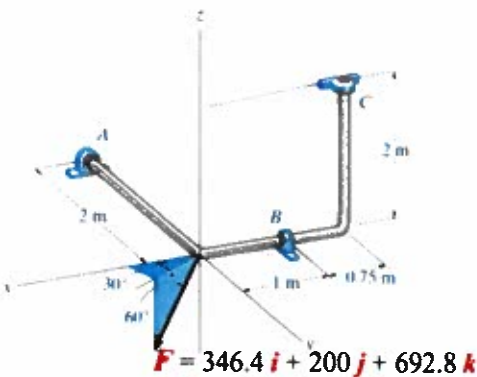
$$\mathbf{F} = (-0.921 \times 30)\mathbf{i} + (-0.276 \times 50)\mathbf{j} + (0.276 \times 20)\mathbf{k}$$

$$= -27.63\mathbf{i} - 13.8\mathbf{j} + 5.52\mathbf{k}$$

$$F = 31.374$$

$$\text{Force vector along, } \mathbf{r} = -27.63\mathbf{i} - 13.8\mathbf{j} + 5.52\mathbf{k} \text{ [N]}$$

- b) [30] Using the vector method (Cross Product), determine the moment vector at point A of the force, $\mathbf{F}$ [kN].



$$\text{Force Vector, } \mathbf{F} = \underline{\quad\quad\quad} \mathbf{i} \underline{\quad\quad\quad} \mathbf{j} \underline{\quad\quad\quad} \mathbf{k} \text{ kN}$$

$$\text{Position Vector, } \mathbf{r}_A = \underline{\quad\quad\quad} \mathbf{i} \underline{\quad\quad\quad} \mathbf{j} \underline{\quad\quad\quad} \mathbf{k} \text{ m}$$

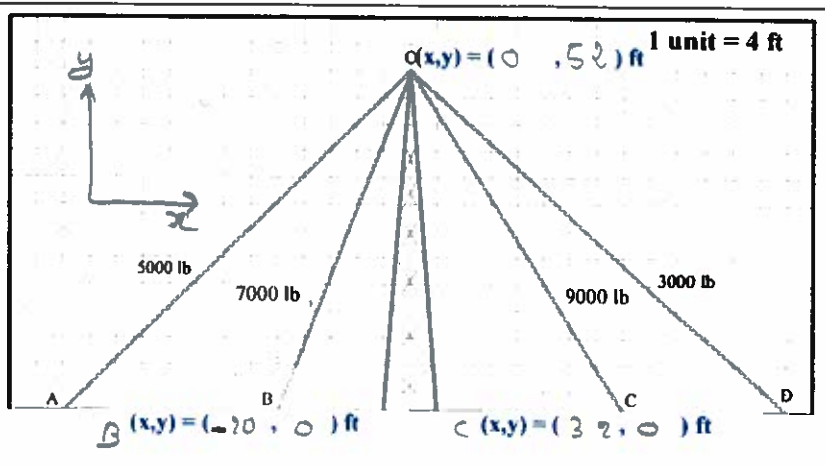
$$\text{Moment Vector, } \mathbf{M}_A = \underline{\quad\quad\quad} \mathbf{i} \underline{\quad\quad\quad} \mathbf{j} \underline{\quad\quad\quad} \mathbf{k} \text{ kN.m}$$

2 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

A pole is stabilized in a plane using four cables. The tension in each cable is shown in the figure. Determine the combined force vector on the pole due to cables B and C ONLY.

Note that 1 unit = 4 ft.

Provide the coordinates of O, B and C (x, y) ft. First find the Unit vector for each cable and then the force vector for each one.



$$\begin{aligned} & \text{B}(-20, 0) \text{ ft} \quad \text{O}(0, 52) \text{ ft} \quad \vec{r}_{OB} = (-20 - 0)\mathbf{i} + (0 - 52)\mathbf{j} + (0 - 0)\mathbf{k} \\ & \text{O}(0, 52) \text{ ft} \quad \text{B}(-20, 0) \end{aligned}$$

Position vector for Cable B, $\vec{r}_B = -20 \mathbf{i} - 52 \mathbf{j} \quad \mathbf{k} \text{ ft}$

$$r = \sqrt{r_x^2 + r_y^2 + r_z^2} = \sqrt{(-20)^2 + (-52)^2 + 0^2} = 55.7136 \text{ ft}$$

Unit vector of $\vec{r}_B = -0.359 \mathbf{i} - 0.933 \mathbf{j} \quad \mathbf{k}$

$$\hat{u} = \frac{r_x}{r} \mathbf{i} + \frac{r_y}{r} \mathbf{j} + \frac{r_z}{r} \mathbf{k}$$

Force vector Cable B, $\vec{F}_B = -2513 \mathbf{i} - 6531 \mathbf{j} \quad \mathbf{k} \text{ lb}$

$$\vec{F} = (7000 \times -0.359)\mathbf{i} + (-0.933 \times 7000)\mathbf{j} + (0)\mathbf{k}$$

$$\begin{aligned} & \text{O}(0, 52) \text{ ft} \\ & \text{C}(32, 0) \end{aligned}$$

Position vector for Cable C, $\vec{r}_C = 32 \mathbf{i} - 52 \mathbf{j} \quad \mathbf{k} \text{ ft}$

$$\vec{r}_C = (32 - 0)\mathbf{i} + (0 - 52)\mathbf{j} + (0)\mathbf{k}$$

Unit vector of $\vec{r}_C = 0.594 \mathbf{i} - 0.852 \mathbf{j} \quad \mathbf{k}$

$$r = \sqrt{32^2 + (-52)^2 + 0^2} = 61.0574 \text{ ft}$$

$$\hat{u} = \frac{32}{61.0574} \mathbf{i} + \frac{(-52)}{61.0574} \mathbf{j} + 0$$

Force vector Cable C, $\vec{F}_C = 4716 \mathbf{i} - 7668 \mathbf{j} \quad \mathbf{k} \text{ lb}$

$$\vec{F}_C = (9000 \times 0.594)\mathbf{i} + (-0.852 \times 9000)\mathbf{j} + 0$$

$$\vec{F}_B + \vec{F}_C = (-2513 + 4716)\mathbf{i} + (-6531 - 7668)\mathbf{j} + 0$$

Combined Force vector (by cables B & C) on pole $\vec{F}_{POLE} = 2203 \mathbf{i} - 14199 \mathbf{j} \quad \mathbf{k} \text{ lb}$

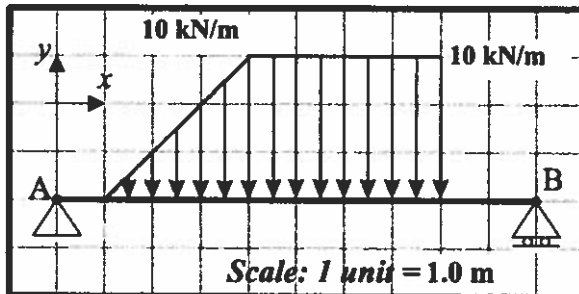
$$|\vec{F}_{BC}| = \sqrt{2203^2 + 14199^2}$$

Magnitude of combined Force on pole $F_{POLE} = 14368.38 \text{ lb}$

3 [100]

a) [50] Determine the reactions at the supports. First, determine the equivalent point load [kN] and provide the location of each one from A [m], respectively. **Draw the FBD first.** The distributed load point load equivalents MUST be ONLY 2. One for the **rectangular** distribution (FR_1) and the other for the **rectangular** distribution (FR_2).

CLEARLY SHOW ALL WORK AND provide the answers in the spaces provided



Provide the Free-body Diagram [FBD] here

[rect] $FR_1 =$ _____ [kN]; Location from A = _____ m

[tri] $FR_2 =$ _____ [kN]; Location from A = _____ m

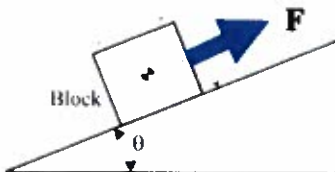
Reaction at A (x-direction) [if any] = _____ [kN]

Reaction at A (y-direction) [if any] = _____ [kN]

Reaction at B (x-direction) [if any] = _____ [kN]

Reaction at B (y-direction) [if any] = _____ [kN]

b) [50] The block shown below has a mass of 150 kg and is being pulled UP the incline. The angle $\theta = 60^\circ$ and the coefficient of dry friction between the block and the surface, $\mu = 0.25$. Determine the force, F [N] required for impending motion up the incline. **Draw the FBD first.**



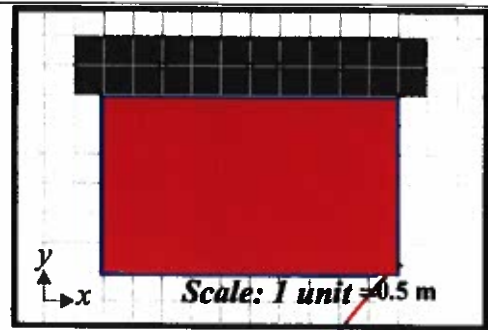
Provide the Free-body Diagram [FBD] here

Force, $F =$ _____ [kN]

-100

4 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [50] Determine the COMPOSITE centroid of the T section by completing the table below. The (x, y) shown is the origin and the reference for the centroid values [m]. Please fully justify your answer.



Part	Dimensions	Area [m ²]	x-centroid, x_i [m]	y-centroid, y_i [m]	$x_i A_i$ [m ³]	$y_i A_i$ [m ³]
Top - A (Black)	___ m × ___ m					
Bottom - B (Red)	___ m × ___ m					

x-Centroid = _____ [m]

y-Centroid = _____ [m]

b) [50] Determine the COMPOSITE Moment of Inertia [Moi] of the 2 sections (BLACK and RED), using (x, y) shown as the origin and the reference point. Provide your solution by completing the table provided below and any other calculations.

Part	$I_{x'}$ [m ⁴]	$I_{y'}$ [m ⁴]	$d_x = \bar{x} - \bar{x}_i$ [m]	$d_y = \bar{y} - \bar{y}_i$ [m]	Ad_x^2 [m ⁴]	Ad_y^2 [m ⁴]
Top - A (Black)						
Bottom - B (Red)						

x-Moment of Inertia, I_x = _____ [m⁴]y-Moment of Inertia, I_y = _____ [m⁴]

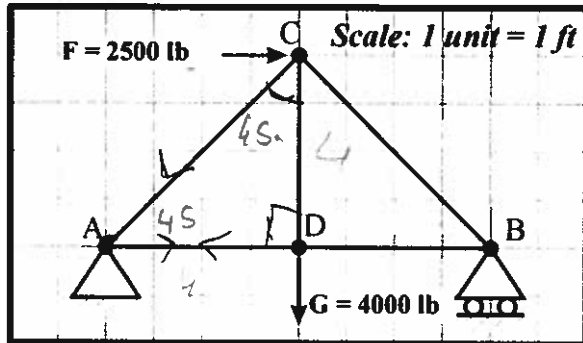
150

100

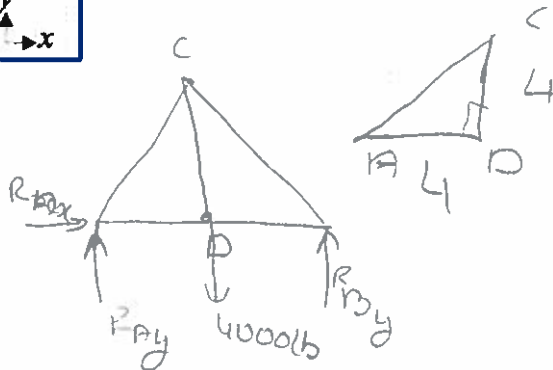
5 [100] CLEARLY SHOW ALL WORK AND provide the answers as shown

a) [30] Determine the reactions at the supports. Draw FBD first.

CLEARLY SHOW ALL WORK.



Provide the Free-body Diagram [FBD] here



$$c = \sqrt{4^2 + 4^2} = 5.657$$



Reaction at A (x-direction) [if any] = _____ [lb]

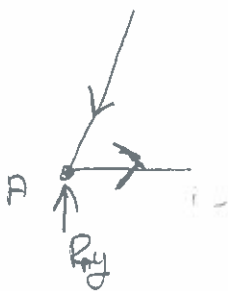
Reaction at A (y-direction) [if any] = _____ [lb]

Reaction at B (x-direction) [if any] = _____ [lb]

Reaction at B (y-direction) [if any] = _____ [lb]

b) [70] Determine the loads in members: AC, AD, DC and BC using the Method of Joints. Fully justify your answer.

if $G = 4000 \text{ lb}$, $\Rightarrow B = 2000 \text{ lb}$, $A = 2000 \text{ lb}$ for the solid to be in the equilibrium.



$$\sum F_y = 0$$

$$R_{Ay} -$$



Load in member AC = _____ lb

Load in member AD = _____ lb

Load in member DC = _____ lb

Load in member BC = _____ lb

-90

6 [100] CLEARLY SHOW ALL WORK AND provide answers in spaces provided

- a) [55] A projectile travels along a fixed path, $y = 8x^2$ into the air (assume zero drag force) at a velocity (in the x-direction) = $(3t + 5)$ ft/s at $t = 4$ s. Assume that at $t = 0$ s, the projectile is a point $(x, y, z) = (0, 0, 0)$ ft.

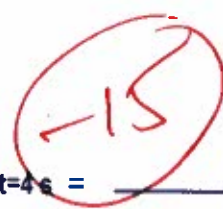
i) [15] How far [ft] will the projectile travel in the x-direction after traveling for 4 seconds?



Show work

X-direction travel in 4 s = 44 ✓ [ft]

ii) [15] Provide the velocity vector of the projectile at $t = 4$ s



Velocity vector at $t = 4$ s = i j k ft/s

ii) [25] Provide the acceleration in the y-direction of the projectile at $t = 4$ s



Acceleration in y-direction at $t = 4$ s = ft/s^2

- b) [45] A prototype Tesla Model S car is being tested around a circular race track (radius = 500 m) with increasing velocity, $v = 0.0125t^3$ m/s.

i) [10] Determine the tangential velocity at $t = 20$ s

$$v = 0.0125t^3, \text{ at } t = 20, \\ v_t = 0.0125(20)^3 = 100 \text{ m/s}$$

Tangential Velocity at $t = 20$ s = 100 ✓ m/s

ii) [10] Determine the tangential acceleration at $t = 20$ s

$$a = \frac{dv}{dt} \Rightarrow dv = 3(0.0125)t^2 \\ \text{at } t = 20, a = 3(0.0125)(20)^2$$

Tangential acceleration at $t = 20$ s = 15 ✓ m/s^2

ii) [15] Determine the Normal acceleration at $t = 20$ s

$$a_n = \frac{v^2}{r}$$



Normal acceleration at $t = 20$ s = 0.2 m/s^2

ii) [10] Determine the magnitude of acceleration at $t = 20$ s

magnitude of acceleration at $t = 20$ s = m/s^2

10
15
10
65

IV.

HOMework ASSIGNMENTS

[03]

CVEG 2400

Statics & Dynamics

Fall 2021

HOMework

01

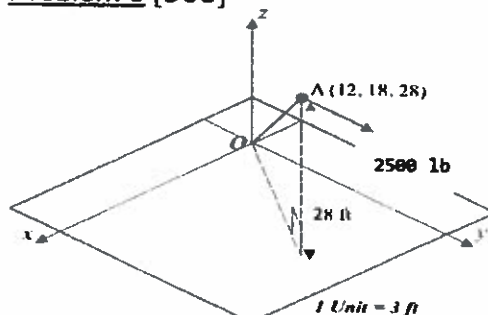
ABOVE
AVERAGE

CVEG 2400P01
Statics & Dynamics
Fall 2021
Dr. Veen
Homework 01
Assigned: 09/10/2021
Due: Wed. Sep. 15, 2021 at 7:30 AM (Canvas) & 8:00 AM (In-Class)
Chapters 01, 02 & 03
SUBMIT THIS as cover sheet with your work
Name [PRINT]
Laury Mengue
Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE =>

990
~~980~~
1000

Problem 1
[50] Textbook Problem 1-4
Problem 2
[50] Textbook Problem 1-16
Problem 3
[100] Textbook Problem 2-12
Problem 4
[100] Textbook Problem 2-24
Problem 5
[100] Textbook Problem 2-80
Problem 6
[150] Textbook Problem 2-88
Problem 7
[150] Textbook Problem 3-48
Problem 8 [300]


For the setup in the figure, the force, F (2500 lb) acts solely in the y -direction and the structural member OA is oriented as shown. As such, the following applies (r_A = relative position vector of the member OA):

$$r_A = 12i + 18j + 28k \text{ ft}$$

$$F = 2500j \text{ lb}$$

Find the components of the force, F along and perpendicular to structural member OA by doing the following:

- [40] Find the magnitude of the position vector, r_A
- [60] Find the angle, θ , between the force, F and the member, OA
- [50] Find the magnitude of the force ALONG the position vector, r_A
- [50] Find the magnitude of the force NORMAL to the position vector, r_A
- [50] Find the force vector, F_1 , ALONG the position vector, r_A
- [50] Find the force vector, F_2 , NORMAL to the position vector, r_A

930
+ 50 Canvas

980
+ 10 Excellence

990

Problem 1Excellent layout

a) Convert 200 lb.ft to N.m

$$200 \text{ lb.ft} \times \frac{1 \text{ lb}_f}{1 \text{ lb}} \times \frac{1 \text{ N}}{0.225 \text{ lb}_f} \times \frac{1 \text{ m}}{3.28 \text{ ft}}$$

Answer: 271 N.m ✓b) Convert 350 lb/ft³ to KN/m³

$$350 \frac{\text{lb}}{\text{ft}^3} \times \frac{1 \text{ lb}_f}{1 \text{ lb}} \times \frac{1 \text{ N}}{0.225 \text{ lb}_f} \times \frac{1 \text{ kN}}{10^3 \text{ N}} \times \frac{3.28^3 \text{ ft}^3}{1^3 \text{ m}^3}$$

Answer: 54.9 kN/m³ ✓

c) 8 ft/h to mm/s

$$\frac{8 \text{ ft}}{\text{h}} \times \frac{1 \text{ m}}{3.28 \text{ ft}} \times \frac{1 \text{ mm}}{10^{-3} \text{ m}} \times \frac{1 \text{ h}}{3600 \text{ s}}$$

Answer: 0.678 mm/s ✓Problem 2Convert $\frac{1 \text{ N}}{\text{m}^2}$ to lb/ft²

$$\frac{1 \text{ N}}{\text{m}^2} \times \frac{0.225 \text{ lb}_f}{1 \text{ N}} \times \frac{1 \text{ lb}}{1 \text{ lb}_f} \times \frac{1 \text{ m}^2}{3.28^2 \text{ ft}^2}$$

$$\frac{1 \text{ N}}{\text{m}^2} = 0.0209 \frac{\text{lb}}{\text{ft}^2}$$

$$1 \text{ Pa} = \frac{1 \text{ N}}{\text{m}^2} = 0.0209 \frac{\text{lb}}{\text{ft}^2} \times \frac{1 \text{ ft}^2}{144 \text{ in}^2} = 1.45 \times 10^{-4} \frac{\text{lb}}{\text{in}^2}$$

Therefore

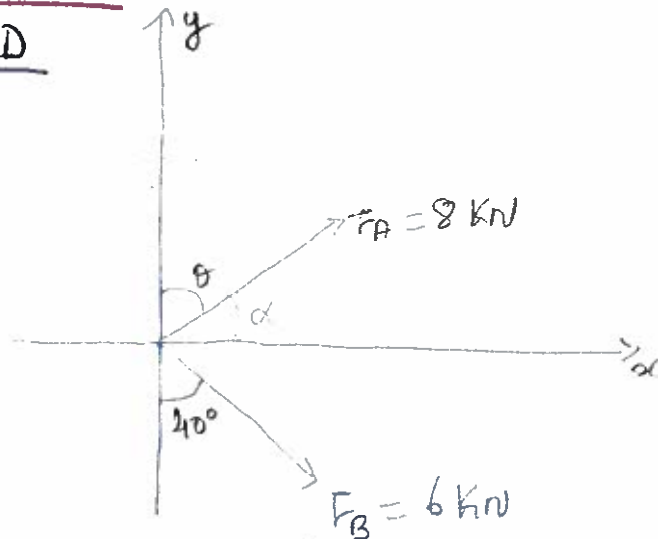
$$\frac{1 \text{ Pa}}{1.45 \times 10^{-4} \text{ lb.in}^{-2}} \times 14.7 \text{ lb.in}^{-2} = \boxed{101,379 \text{ Pa}}$$

Page 1

EXcellent presentation of Work

+10

-0

Problem 3FBD

Given: We know the resultant force

$F = F_A + F_B$ is horizontally to the right

Therefore: $F_y j = F_{Ay} j + F_{By} j = 0$

$$\vec{F}_B = 6 \cos 50^\circ i + 6 \cos 140^\circ j = 3.86 i - 4.6 j$$

$$F_{Ay} j + F_{By} j = 0 \Rightarrow F_{Ay} j - 4.6 j = 0$$

$$\Rightarrow F_{Ay} j = 4.6 j$$

$$F_{Ay} = |F| \cos \theta \Rightarrow \cos \theta = \frac{F_{Ay}}{|F|} = \frac{4.6}{8} = 0.575$$

$$\theta = \cos^{-1}(0.575) = \boxed{54.9^\circ}$$

$$\cos^2 \alpha + \cos^2 \beta = 1 \Rightarrow \cos^2 \alpha = 1 - \cos^2 \beta \Rightarrow 1 - (0.575)^2 = 0.67$$

$$\cos \alpha = \sqrt{0.67} = 0.81 \Rightarrow \alpha = \cos^{-1}(0.81) = \boxed{35.1^\circ}$$

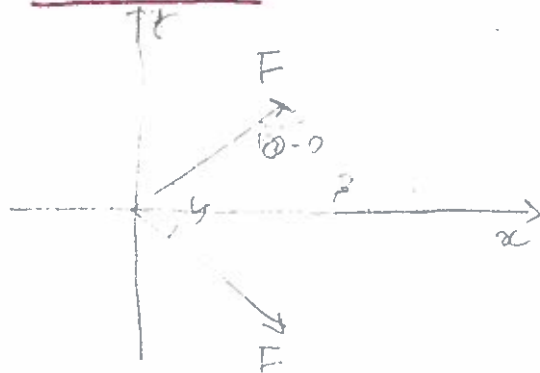
• Resultant Force $\vec{F} = \vec{F}_A + \vec{F}_B$

We know $F_y j = 0$

$$\text{So } \vec{F} = \vec{F}_{Ax} i + \vec{F}_{Bx} i = 8 \cos 35.1^\circ i + 6 \cos 50^\circ i$$

$$|\vec{F}| = \sqrt{10.4^2} = \boxed{10.4} \text{ kN}$$

✓

Problem 4

According to sin rule

$$\frac{F}{\sin \beta} = \frac{F}{\sin(\theta - \beta)}$$

$$\sin \beta = \sin(\theta - \beta)$$

$$\beta = \theta - \beta$$

$$2\beta = \theta$$

$$\boxed{\beta = \frac{\theta}{2}}$$

Therefore:

$$F_R = \sqrt{F_1^2 + F_2^2 - 2 \times F_1 \times F_2 \times \cos(180 - \theta)} \quad F_1 = F_2 = F$$

$$= \sqrt{2F^2 - 2F^2 \cos(180 - \theta)}$$

$$= \sqrt{2F^2(1 - \cos(180 - \theta))} \quad \cos(180 - \theta) = -\cos \theta$$

$$= \sqrt{2F^2(1 + \cos \theta)}$$

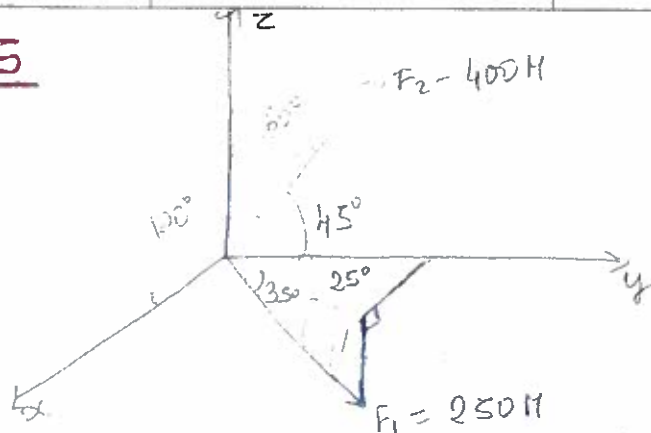
$$F_R = F\sqrt{2} \times \sqrt{1 + \cos \theta}$$

Also, $\cos \frac{\theta}{2} = \sqrt{\frac{1 + \cos \theta}{2}}$ ✓

Then $F_R = \sqrt{2} F (\sqrt{2} \times \cos \frac{\theta}{2})$

$$\boxed{F_R = 2F \cos \frac{\theta}{2}}$$
 ✓

Diagram to show β ?

Problem 5

$$\vec{F}_1 = F_1 \cos 35^\circ \sin 25^\circ \vec{i} + F_1 \cos 35^\circ \cos 25^\circ \vec{j} + \cos 125^\circ \vec{k}$$

$$\vec{F}_1 = 250 \times 0.346 \vec{i} + 250 \times 0.742 \vec{j} - 250 \times 0.5735 \vec{k}$$

$$\vec{F}_1 = 86.5 \vec{i} + 185.5 \vec{j} - 143.37 \vec{k}$$

$$\vec{F}_2 = F_2 \cos 120^\circ \vec{i} + F_2 \cos 45^\circ \vec{j} + F_2 \cos 60^\circ \vec{k}$$

$$\vec{F}_2 = 400 \times (-0.5) \vec{i} + 400 \times 0.707 \vec{j} + 400 \times 0.5 \vec{k}$$

$$\vec{F}_2 = -200 \vec{i} + 282.84 \vec{j} + 200 \vec{k}$$

$$\vec{F} = \vec{F}_1 + \vec{F}_2 = (86.5 - 200) \vec{i} + (185.5 + 282.84) \vec{j} + (-143.37 + 200) \vec{k}$$

$$\vec{F} = -113.5 \vec{i} + 468.34 \vec{j} + 56.63 \vec{k}$$

$$|\vec{F}| = \sqrt{(-113.5)^2 + (468.34)^2 + (56.63)^2}$$

$$|\vec{F}| = 485.21 \text{ N}$$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2 + F_{Rz}^2}$$

Direction angles

$$\alpha = \cos^{-1} \left(\frac{-113.5}{485.21} \right) = 103.5^\circ$$

$$\beta = \cos^{-1} \left(\frac{468.32}{485.21} \right) = 15.15^\circ$$

$$\gamma = \cos^{-1} \left(\frac{56.63}{485.21} \right) = 83.29^\circ$$

Explain

$$\frac{F_{Rx}}{|\vec{F}_R|}$$

S

FS

Problem 6

$$A \begin{pmatrix} 0 \\ 4 \\ 0 \end{pmatrix} \quad B \begin{pmatrix} 2 \\ 0 \\ -6 \end{pmatrix} \quad C \begin{pmatrix} -2.5 \\ 0 \\ 6 \end{pmatrix}$$

must provide
a diagram
-15

$$\bullet \vec{AB} \begin{pmatrix} 2-0 \\ 0-4 \\ -6-0 \end{pmatrix} \Rightarrow \vec{AB} \begin{pmatrix} 2 \\ -4 \\ -6 \end{pmatrix} \quad |\vec{AB}| = \sqrt{2^2 + (-4)^2 + (-6)^2} = 7.48 \text{ ft}$$

$$\text{Unit vector } U_{AB} = \frac{2}{7.48} i - \frac{4}{7.48} j - \frac{6}{7.48} k$$

$$U_{AB} = 0.267 i - 0.535 j - 0.802 k \quad \checkmark$$

$$\bullet \vec{AC} \begin{pmatrix} -2.5-0 \\ 0-4 \\ 6-0 \end{pmatrix} \Rightarrow \vec{AC} \begin{pmatrix} -2.5 \\ -4 \\ 6 \end{pmatrix} \quad |\vec{AC}| = \sqrt{-2.5^2 + (-4)^2 + 6^2}$$

$$|\vec{AC}| = 7.63 \text{ ft}$$

$$\text{Unit vector } U_{AC} = \frac{-2.5}{7.63} i - \frac{4}{7.63} j + \frac{6}{7.63} k$$

$$U_{AC} = -0.328 i - 0.524 j + 0.786 k$$

We know that Force = Magnitude $\times$ Unit Vector

$$\vec{F}_2 = |\vec{F}_2| \times U_{AB}$$

$$\vec{F}_2 = 50 (0.267 i - 0.535 j - 0.802 k)$$

$$\vec{F}_2 = 13.363 i - 26.726 j - 40.089 k$$

$$\vec{F}_1 = |\vec{F}_1| \times U_{AC}$$

$$\vec{F}_1 = 80 (-0.328 i - 0.524 j + 0.786 k)$$

$$\vec{F}_1 = -26.205 i - 41.928 j + 62.892 k$$

$$\bullet \vec{F}_A = \vec{F}_1 + \vec{F}_2$$

$$= (13.363 - 26.205) i - (26.726 + 41.928) j + (-40.089 + 62.892) k$$

$$\vec{F}_A = -12.842 i - 68.654 j + 22.803 k \quad \checkmark$$

$$|F_R| = \sqrt{(-12.842)^2 + (-68.654)^2 + (22.803)^2}$$

$$|F_R| = 73.473 \text{ lb}_f$$

• Direction angles

~~dir~~

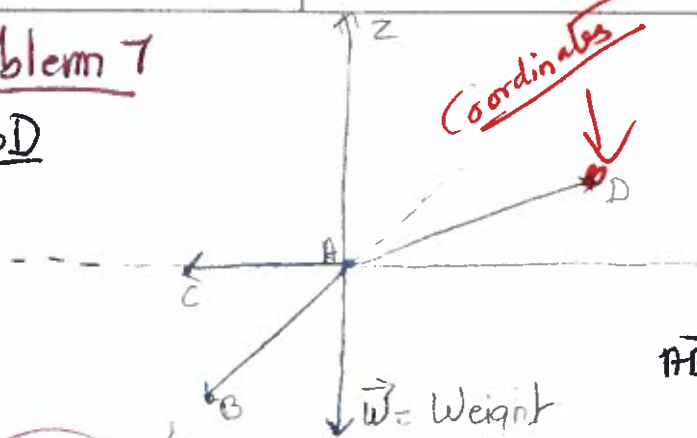
$$\alpha = \cos^{-1} \left(\frac{-12.842}{73.473} \right) = \boxed{100.06^\circ}$$

$$\beta = \cos^{-1} \left(\frac{-68.654}{73.473} \right) = \boxed{159.13^\circ}$$

$$\gamma = \cos^{-1} \left(\frac{22.803}{73.473} \right) = \boxed{71.92^\circ}$$

Problem 7

FBD



$A \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \quad B \begin{pmatrix} 2.5 \\ 0 \\ 0 \end{pmatrix}$

$C \begin{pmatrix} 0 \\ -2 \\ 0 \end{pmatrix} \quad D \begin{pmatrix} 2 \\ 2 \\ 1 \end{pmatrix}$

$\vec{AB} \begin{pmatrix} 2.5-0 \\ 0-0 \\ 0-0 \end{pmatrix} \Rightarrow \vec{AB} \begin{pmatrix} 2.5 \\ 0 \\ 0 \end{pmatrix}$

$|\vec{AB}| = \sqrt{2.5^2 + 0^2 + 0^2} = 2.5$

$\vec{AC} \begin{pmatrix} 0-0 \\ -2-0 \\ 0-0 \end{pmatrix} \Rightarrow \vec{AC} \begin{pmatrix} 0 \\ -2 \\ 0 \end{pmatrix} \quad |\vec{AC}| = \sqrt{0^2 + (-2)^2 + 0^2} = 2$

$\vec{AD} \begin{pmatrix} 2-0 \\ 2-0 \\ 1-0 \end{pmatrix} \Rightarrow \vec{AD} \begin{pmatrix} 2 \\ 2 \\ 1 \end{pmatrix} \quad |\vec{AD}| = \sqrt{(2)^2 + 2^2 + 1^2} = 3$

Unit vector $U_{AB} = \frac{2.5 \hat{i}}{2.5} = \hat{i}$

Unit Vector $U_{AC} = \frac{-2 \hat{j}}{2} = -\hat{j}$

Unit Vector $U_{AD} = -\frac{2}{3} \hat{i} + \frac{2}{3} \hat{j} + \frac{1}{3} \hat{k}$

$T_{AB} = |T_{AB}| \times U_{AB} \Rightarrow T_{AB} \hat{i}$

$T_{AC} = |T_{AC}| \times U_{AC} = -T_{AC} \hat{j}$

$T_{AD} = |T_{AD}| \times U_{AD} = T_{AD} \left(-\frac{2}{3} \hat{i} + \frac{2}{3} \hat{j} + \frac{1}{3} \hat{k} \right)$

According to the equilibrium equation:

$\sum F_i = 0$

$T_{AB} - \frac{2}{3} T_{AD} = 0 \quad (\text{Eq 1})$

$\sum F_j = 0$

$-T_{AC} + \frac{2}{3} T_{AD} = 0 \quad (\text{Eq 2})$

$\sum F_k = 0$

$\frac{1}{3} T_{AD} - W = 0 \quad (\text{Eq 3})$

Express as vector

$\vec{r}_{AC} = 0\hat{i} + 2\hat{j} + 0\hat{k}$

and etc

-0

$$\text{Weight} = mg = 9.81 \times 100 = \boxed{981 \text{ N}}$$

$$T_{AD} = 9.81 \times 3 = \boxed{2943 \text{ N}}$$

By substituting value of T_{AD} in Eq 1, we have

$$T_{AB} - \frac{2}{3} \times 2943 = 0 \Rightarrow T_{AB} = \boxed{1962 \text{ N}}$$

By doing the same thing with Eq 2, we have

$$-T_{AC} + \frac{2}{3} \times 2943 = 0 \Rightarrow -T_{AC} = -1962 \text{ N}$$

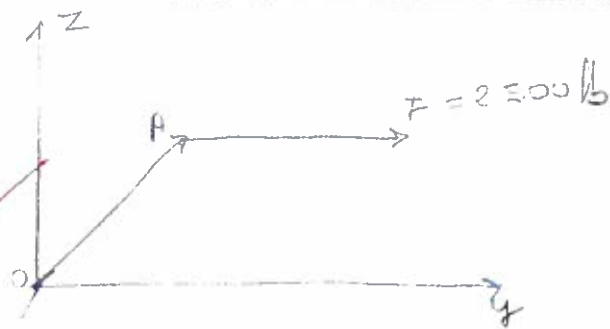
$$T_{AC} = \boxed{1962 \text{ N}}$$

Problem 8

a) $r_A = 12i + 18j + 28k$

$$|r_A| = \sqrt{12^2 + 18^2 + 28^2}$$

$$|r_A| = 35.38 \text{ lb}$$



b) According to the Dot Product formula:

$$\vec{F} \cdot \vec{r}_A = |\vec{F}| |\vec{r}_A| \cos \theta$$

$$\cos \theta = \frac{\vec{F} \cdot \vec{r}_A}{|\vec{F}| |\vec{r}_A|}$$

Given: $\vec{F}$ only acts along the y direction, therefore:

$$\vec{F} = 2500 \vec{j}$$

$$\vec{F} \cdot \vec{r}_A = (0 \times 12 + 2500 \times 18 + 0 \times 28) = 45000$$

$$\cos \theta = \frac{45000}{2500 \times 35.38} = 0.5087$$

$$\theta = \cos^{-1}(0.5087) = 59.42^\circ$$

c) Force along position vector r_A

$$F = |\vec{F}| \cos \theta = 2500 \times \cos 59.42^\circ = 1250 \text{ lb}$$

d) Force normal to the position vector r_A .

$$F_n = F \sin \theta = 2500 \times \sin 59.42^\circ = 2100 \text{ lb}$$

e) Force vector F along position vector r_A .

$$\text{Unit vector } \vec{r}_A = \frac{12}{35.38} i + \frac{18}{35.38} j + \frac{28}{35.38} k$$

$$\vec{U}_{r_A} = 0.339i + 0.508j + 0.791k$$

-30

$$\vec{F} = 508.7 (0.339\vec{i} + 0.508\vec{j} + 0.791\vec{k})$$

$$\vec{F} = 172.45\vec{i} + 258.42\vec{j} + 402.38\vec{k}$$

f) Vector $\vec{F}_2$, normal to the position vector $\vec{r}_A$.

Let's assume $\vec{n}$ vector normal to $\vec{r}_A$.

Dot Product $\vec{n} \cdot \vec{r}_A = 0$

$$(x_n \vec{i} + y_n \vec{j} + z_n \vec{k}) \cdot (12\vec{i} + 18\vec{j} + 28\vec{k}) = 0.$$

$$12x_n + 18y_n + 28z_n = 0.$$

If $x_n = y_n = 1$, we have z_n equal to

$$12(1) + 18(1) + 28z_n = 0.$$

$$30 + 28z_n = 0.$$

$$z_n = -\frac{30}{28}$$

$$z_n = -\frac{15}{14}$$

So $\vec{n} = \begin{pmatrix} 1 \\ 1 \\ -\frac{15}{14} \end{pmatrix}$ is a vector normal to $\vec{r}_A$.

$$|\vec{n}| = \sqrt{1^2 + 1^2 + \left(-\frac{15}{14}\right)^2} = 1.774$$

$$\text{Unit vector } U_n = \frac{1}{1.774}\vec{i} + \frac{1}{1.774}\vec{j} - \frac{15}{14 \times 1.774}\vec{k}$$

$$U_n = 0.563\vec{i} + 0.563\vec{j} - 0.604\vec{k}$$

$$\vec{F}_2 = 860.94 (0.563\vec{i} + 0.563\vec{j} - 0.604\vec{k})$$

$$\vec{F}_2 = 484.7\vec{i} + 484.7\vec{j} - 519.97\vec{k}$$

AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Homework 01

MID

Assigned: 09/10/2021

Due: Wed, Sep 15, 2021 at 7:30 AM (Canvas) & 8:00 AM (in Class)

Chapters 01, 02 & 03

SUBMIT THIS as cover sheet with your work

Name [PRINT] Hunter Evans

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE $\Rightarrow$
840
1000

Problem 1

[50] Textbook Problem 1-4

Problem 2

[50] Textbook Problem 1-16

Problem 3

[100] Textbook Problem 2-12

Problem 4

[100] Textbook Problem 2-24

Problem 5

[100] Textbook Problem 2-30

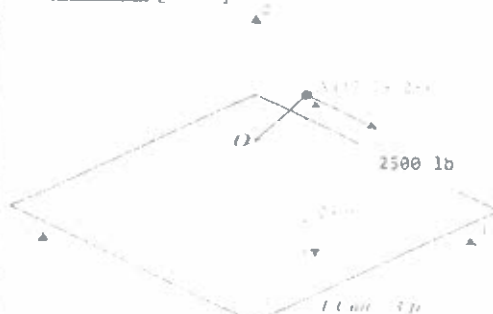
Problem 6

[150] Textbook Problem 2-88

Problem 7

[150] Textbook Problem 3-48

Problem 8 [300]



For the setup in the figure, the force, F (2500 lb) acts solely in the y -direction and the structural member OA is oriented as shown. As such, the following applies (r_A = relative position vector of the member OA).

$$r_A = 12i + 18j + 28k \text{ ft}$$

$$F = 2500j \text{ lb}$$

Find the components of the force, F along and perpendicular to structural member OA by doing the following:

- [40] Find the magnitude of the position vector, r_A
- [60] Find the angle, θ , between the force, F and the member, OA
- [50] Find the magnitude of the force ALONG the position vector, r_A
- [50] Find the magnitude of the force NORMAL to the position vector, r_A
- [50] Find the force vector, F_1 , ALONG the position vector, r_A
- [50] Find the force vector, F_2 , NORMAL to the position vector, r_A

+ 790
590 Canvas
840

Convert 200 lb-ft to $\text{N}\cdot\text{m}$, 350 lb/ft^2 to kN/m^2 , 8 ft/h to mm/s

a) to convert 200 lb-ft multiply it by 1.3558

$$1 \text{ ft}\cdot\text{lb} = 1.3558 \text{ N}\cdot\text{m}$$

so

$$200 \cdot 1.3558 = \boxed{271.16 \text{ N}\cdot\text{m}}$$

271 sig figs

b) to convert 350 lb/ft^2 multiply it by 0.157087

$$1 \text{ lb/ft}^2 = 0.157087 \text{ kN/m}^2$$

so

$$350 \cdot 0.157087 = \boxed{54.98 \text{ kN/m}^2}$$

55.0

Not quite $8\frac{1}{2} \times 11$

c) to convert 8 ft/h multiply it by 0.084666

$$1 \text{ ft/h} = 0.084666 \text{ mm/s}$$

so

$$8 \cdot 0.084666 = 0.677 \text{ mm/s}$$

5

Convert $1 \text{ Pa} = 1 \text{ N/m}^2$ to lb/ft^2 . ($P_{\text{atm}} = 14.7 \text{ lb/in}^2$), How many Pascals is this?

a)

$$1 \text{ lbf} = 4.44822 \text{ N}$$

$$1 \text{ in} = 0.0254 \text{ m}$$

b)

$$\frac{1 \text{ lbf/in}^2}{1 \text{ lbf}} \cdot \frac{4.44822 \text{ N}}{1 \text{ lbf}} \cdot \frac{0.0254 \text{ m}^2}{1 \text{ in}^2} = 6895 \text{ N/m}^2$$

$$c) 1 \text{ lbf/in}^2 = 6895 \text{ Pa}$$

$$1 \text{ Pa} = \frac{1}{6895} \text{ lbf/in}^2$$

$$1 \text{ Pa} = \left(\frac{1}{6895} \text{ lbf/in}^2 \right) \left(\frac{144 \text{ in}^2}{1 \text{ ft}^2} \right)$$

$$1 \text{ Pa} = 0.0209 \text{ lbf/ft}^2$$

d)

$$1 \text{ lbf/in}^2 = 6895 \text{ Pa}$$

$$1 \text{ atm} = 14.7 \text{ lbf/in}^2$$

$$= 14.7 \cdot 6895$$

$$1 \text{ atm} = 101357 \text{ Pa}$$



~~A~~ 3?

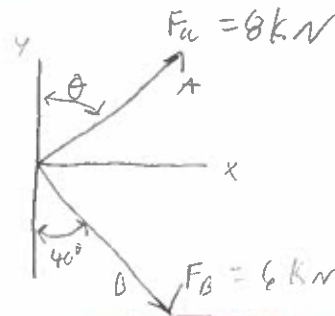
a) Resultant force is horizontal,
Vertical force = 0

b) $8 \cos \theta - 6 \cos 40 = 0$

$\theta = \cos^{-1} \left(\frac{6 \cos 40}{8} \right)$

$\theta = 54.93$

explain



Force Triangle?

c) resultant force

$8 \sin(54.93) + 6 \sin(40)$

$= 10.4 \text{ kN}$

NO

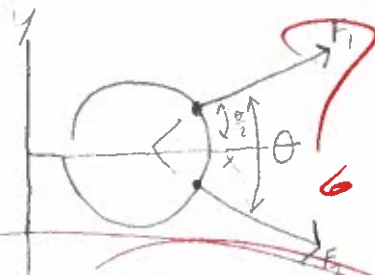
-35

ONLY on
1 SIDE
of sheet

You need to provide
sufficient detail in
your solutions

-35

a) $F_1 = F_2 = F$



B) Since F_1 and F_2 equal each other they can be separated equally on the x-axis.

C) $\text{angle} = \frac{\pi}{2}$

Need to show math. calculations

30

D) $F_x = f \cos(\frac{\theta}{2}) + f \cos(\frac{\theta}{2})$

$f_y = f \sin(\frac{\theta}{2}) - f \sin(\frac{\theta}{2})$

$F_x = 2f \cos(\frac{\theta}{2})$

$f_y = 0$

Not enough detail

25

E) $F_R = F_x$

$F_R = 2f \cos(\frac{\theta}{2})$ - magnitude

55

a) $F_1 = 250 \text{ N}$, $F_2 = 400 \text{ N}$

b) F_1 in cartesian form is

$$\vec{F}_1 = 250((\cos 35^\circ \sin 25^\circ)\mathbf{i} + (\cos 35^\circ \cos 25^\circ)\mathbf{j} + (-\sin 35^\circ)\mathbf{k})$$

$$\vec{F}_1 = 86.5\mathbf{i} + 185.5\mathbf{j} - 143.37\mathbf{k}$$

c) F_2 in cartesian form is

$$\vec{F}_2 = 400((\cos 120^\circ)\mathbf{i} + (\cos 45^\circ)\mathbf{j} + (\cos 60^\circ)\mathbf{k})$$

$$\vec{F}_2 = -200\mathbf{i} + 282.84\mathbf{j} + 200\mathbf{k}$$

d) Combine $\vec{F}_1$ and $\vec{F}_2$ to make $\vec{F}_R$

$$\vec{F}_R = (86.5 + (-200))\mathbf{i} + (185.5 + 282.84)\mathbf{j} + (-143.37 + 200)\mathbf{k}$$

$$\vec{F}_R = -113.5\mathbf{i} + 468.34\mathbf{j} + 56.63\mathbf{k}$$

e) Find the magnitude of $\vec{F}_R$

$$|\vec{F}_R| = \sqrt{(-113.5)^2 + (468.34)^2 + (56.63)^2}$$

$$|\vec{F}_R| = 485.21 \text{ N}$$

f) Then find the coordinate angles α, β, γ

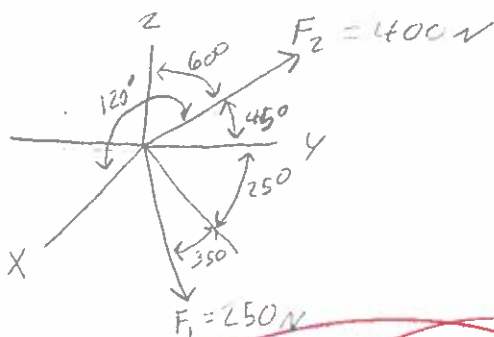
$$\begin{aligned}\alpha &= \cos^{-1}\left(\frac{(\vec{F}_R)_i}{|\vec{F}_R|}\right) \\ &= \cos^{-1}\left(\frac{-113.5}{485.21}\right) \\ &= 103.52^\circ\end{aligned}$$

$$\begin{aligned}\beta &= \cos^{-1}\left(\frac{(\vec{F}_R)_j}{|\vec{F}_R|}\right) \\ &= \cos^{-1}\left(\frac{468.34}{485.21}\right) \\ &= 15.15^\circ\end{aligned}$$

$$\begin{aligned}\gamma &= \cos^{-1}\left(\frac{(\vec{F}_R)_k}{|\vec{F}_R|}\right) \\ &= \cos^{-1}\left(\frac{56.63}{485.21}\right) \\ &= 83.29^\circ\end{aligned}$$

Good

-0



ONE SIDE

a) coordinates for a, b, and c

$$A = \begin{bmatrix} 0 \\ 4 \\ 0 \end{bmatrix}$$

$$B = \begin{bmatrix} 2 \\ 0 \\ -6 \end{bmatrix}$$

$$C = \begin{bmatrix} -2.5 \\ 16 \\ 2.5 \end{bmatrix} = \begin{bmatrix} -2.5 \\ 0 \\ 6 \end{bmatrix}$$

Why? explain

B) Next we would find the unit vectors and the length

$$r_{AB} = B - A = \begin{bmatrix} 2 \\ -4 \\ -6 \end{bmatrix}$$

$$\text{Length}_{AB} = |r_{AB}| = 7.483 \text{ ft}$$

$$r_{AC} = C - A = \begin{bmatrix} -2.5 \\ -4 \\ 6 \end{bmatrix}$$

$$\text{length}_{AC} = |r_{AC}| = 7.432 \text{ ft}$$

$$u_{AB} = \frac{r_{AB}}{\text{length}_{AB}} = \begin{bmatrix} 0.267 \\ -0.535 \\ -0.802 \end{bmatrix}$$

$$u_{AC} = \frac{r_{AC}}{\text{length}_{AC}} = \begin{bmatrix} -0.328 \\ -0.524 \\ 0.786 \end{bmatrix}$$

are i, j, k

Not how vectors are represented in this course

provide coordinates use same as class

C) Then we would find the force vectors (Force = Mag. * Unit Vec.)

$$F_{AB} = 50 \text{ lb} \cdot \begin{bmatrix} 0.267 \\ -0.535 \\ -0.802 \end{bmatrix} = \begin{bmatrix} 13.363 \\ -26.726 \\ -40.089 \end{bmatrix} \text{ lb f}$$

$$F_{AC} = 80 \text{ lb} \cdot \begin{bmatrix} -0.328 \\ -0.524 \\ 0.786 \end{bmatrix} = \begin{bmatrix} -26.205 \\ -41.928 \\ 62.892 \end{bmatrix} \text{ lb f}$$

Not vector notation

What is it?

D) Now we can get the resultant force by combining $F_{AB} + F_{AC}$

$$F_R = \begin{bmatrix} 13.363 \\ -26.726 \\ -40.089 \end{bmatrix} + \begin{bmatrix} -26.205 \\ -41.928 \\ 62.892 \end{bmatrix} = \begin{bmatrix} -12.842 \\ -68.654 \\ 22.803 \end{bmatrix} \text{ lb f}$$

$$\text{length } F_R = |F_R| = 73.473 \text{ lb f}$$

?? NOT a vector

Not length - force is NOT a length

E) lastly we can find the coordinate angles

$$\alpha = \cos^{-1} \left(\frac{F_{Rx}}{\text{length}_{F_R}} \right) = \cos^{-1} \left(\frac{-12.842}{73.473} \right) = 100.066^\circ$$

$$\beta = \cos^{-1} \left(\frac{F_{Ry}}{\text{length}_{F_R}} \right) = \cos^{-1} \left(\frac{-68.654}{73.473} \right) = 159.134^\circ$$

$$\gamma = \cos^{-1} \left(\frac{F_{Rz}}{\text{length}_{F_R}} \right) = \cos^{-1} \left(\frac{22.803}{73.473} \right) = 71.919^\circ$$

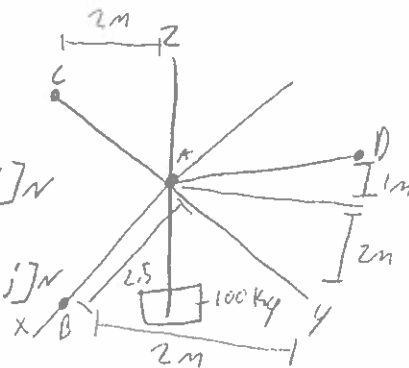
a) First we should represent the forces in vector form

$$T_{AB} = T_{AB} \left[\frac{(2.5-0)\mathbf{i} + (0-0)\mathbf{j} + (0-0)\mathbf{k}}{\sqrt{2.5^2 + 0^2 + 0^2}} \right] = [T_{AB}\mathbf{i}] \text{ N}$$

$$T_{AC} = T_{AC} \left[\frac{(0-0)\mathbf{i} + (-2-0)\mathbf{j} + (0-0)\mathbf{k}}{\sqrt{0^2 + (-2)^2 + 0^2}} \right] = [-T_{AC}\mathbf{j}] \text{ N}$$

$$T_{AD} = T_{AD} \left[\frac{(-2-0)\mathbf{i} + (2-0)\mathbf{j} + (1-0)\mathbf{k}}{\sqrt{(-2)^2 + 2^2 + 1^2}} \right] = T_{AD} \left[\frac{-2\mathbf{i} + 2\mathbf{j} + \mathbf{k}}{3} \right] \text{ N}$$

$$W_A = -(100 \cdot 9.81)\mathbf{k} = [-981\mathbf{k}] \text{ N}$$



B) Now we use the Equilibrium equation

$$\sum \mathbf{F} = 0, \quad T_{AB} + T_{AC} + T_{AD} + W_A = 0$$

$$[T_{AB}\mathbf{i}] + [-T_{AC}\mathbf{j}] + \left[T_{AD} \left(\frac{-2\mathbf{i} + 2\mathbf{j} + \mathbf{k}}{3} \right) \right] + [-981\mathbf{k}] = 0$$

C) equate the $\mathbf{i}$ component

$$T_{AB} - 0.6667 T_{AD} = 0$$

D) equate the $\mathbf{j}$ component

$$-T_{AC} + 0.6667 T_{AD} = 0$$

E) equate the $\mathbf{k}$ component

$$0.3333 T_{AD} - 981 = 0$$

$$T_{AD} = 2943 \text{ N}$$

F) substitute T_{AD} to C) and D)

$$T_{AB} - 0.6667(2943) = 0$$

$$T_{AB} = 1962 \text{ N}$$

$$-T_{AC} + 0.6667(2943) = 0$$

$$T_{AC} = 1962 \text{ N}$$

Good!

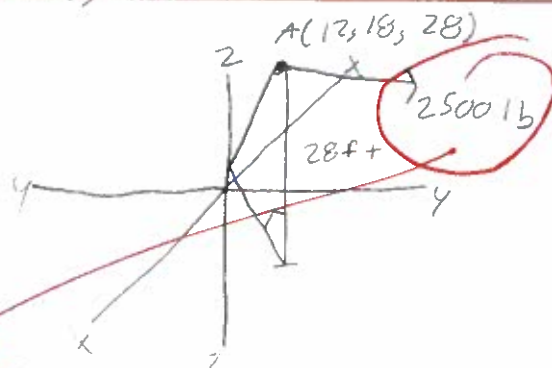
WRITING ONLY
on ONE SIDE
OF SHEET

-0

a) Finding the magnitude $|r_a|$

$$|r_a| = \sqrt{12^2 + 18^2 + 28^2}$$

$$= 35.384 \checkmark$$



b) Finding angle θ between F and r_a

$$\theta = \cos^{-1} \left(\frac{F \cdot r_a}{|F| |r_a|} \right)$$

$$= \cos^{-1} \left(\frac{1000 \cdot 18}{1000 \cdot 35.384} \right)$$

$$\theta = 59.422^\circ$$

Where did we get this? $r_a = 12i + 18j + 28k$ ft
 $F = 1000j$ lb

c) Finding magnitude of the force along r_a

$$F_1 = F \cdot \cos \theta = 1000 \cdot \cos(59.422) = 508.704 \text{ N}$$

d) Finding magnitude of the force normal to r_a

$$F_2 = F \cdot \sin \theta = 1000 \cdot \sin(59.422) = 860.941 \text{ N}$$

e) Find force vector f_1 along r_a

$$\hat{r}_a = \frac{r_a}{|r_a|} = \frac{12i + 18j + 28k}{35.384}$$

$$F_1 = 508.704 \cdot \hat{r}_a = 172.52i + 258.78j + 462.55k$$

f) Find force vector f_2 normal to r_a

$$\vec{U} \cdot \vec{r} = 0, (a\vec{i} + b\vec{j} + c\vec{k}) \cdot (12\vec{i} + 18\vec{j} + 28\vec{k}) = 0$$

$$12a + 18b + 28c = 0$$

$$a = 1$$

$$b = 1$$

$$c = \frac{-15}{14}$$

$$\vec{U} = i + j + \frac{-15}{14}k$$

$$\hat{U} = \frac{\vec{U}}{|\vec{U}|} = \frac{i + j + \frac{-15}{14}k}{1.774}$$

$$F_2 = (860.941) \cdot \hat{U}$$

$$F_2 = 485.242i + 485.242j - 59.9k$$

-150

BELOW
AVERAGE

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE ⇒
645
1000

Problem 1

[50] Textbook Problem 1-4

Problem 2

[50] Textbook Problem 1-16

Problem 3

[100] Textbook Problem 2-12

Problem 4

[100] Textbook Problem 2-24

Problem 5

[100] Textbook Problem 2-80

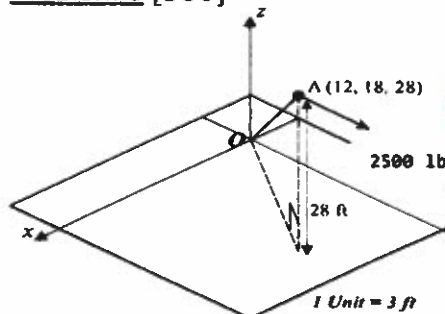
Problem 6

[150] Textbook Problem 2-88

Problem 7

[150] Textbook Problem 3-48

Problem 8 [300]



For the setup in the figure, the force, F (2500 lb) acts solely in the y -direction and the structural member OA is oriented as shown. As such, the following applies (r_A = relative position vector of the member OA):

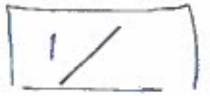
$$r_A = 12i + 18j + 28k \text{ ft}$$

$$F = 2500j \text{ lb}$$

Find the components of the force, F along and perpendicular to structural member OA by doing the following:

- [40] Find the magnitude of the position vector, r_A
- [60] Find the angle, θ , between the force, F and the member, OA
- [50] Find the magnitude of the force ALONG the position vector, r_A
- [50] Find the magnitude of the force NORMAL to the position vector, r_A
- [50] Find the force vector, F_1 , ALONG the position vector, r_A
- [50] Find the force vector, F_2 , NORMAL to the position vector, r_A

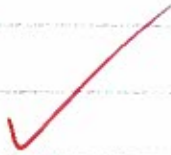
645
+50 Canvas
645



1.

a) $200 \text{ lb/ft} \cdot 1.35582 \text{ N/m} = 271.164 \text{ N/m}$

271 N/m



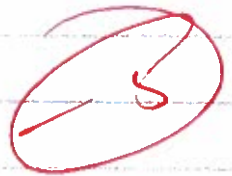
b) $350 \cdot .1570865731 \text{ kN/m}^3 = 54.98 \text{ kN/m}^3$

55 kN/m^3 or 54.9 kN/m^3

c) $8 \cdot \frac{204.8}{3600} = .67733 \text{ mm/s}$

$.677 \text{ mm/s}$

3 sig figs



Not
 $8\frac{1}{2} \times 11''$

Suggest you
use pencil

5

2

#2?

2/

$$a) 14.7 \cdot 144 = 2116.8 \text{ lb/ft}^2$$

Must
show work

$$\text{Pa} = \text{N/m}^2$$

$$2116.8 \text{ lb/ft}^2 \cdot 47.8803 = 101353.01904 \text{ Pa}$$

Not
Sufficient

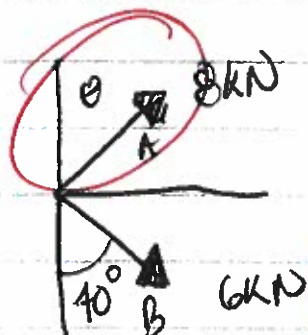
35

35

3.

#3? ← label problems

3/



$$F_R = +0j$$

Due to it being horizontally directionally

Better diagrams

$$F_{Bx} = 6 \cos 40^\circ = 4.59i$$

$$F_{By} = -6 \sin 40^\circ = -3.85j$$

$$F_B = 4.59i - 3.85j$$

Find F_{Ax}

$$F_{Ax} = F_A \cos \alpha$$

$$8 \cos 28.77^\circ = 7.01i$$

Find F_{Ay}

$$F_{Ay} + F_{By} = F_{Ry}$$

$$F_{Ay} - 3.85 = 0$$

$$F_{Ay} = 3.85j$$

Find B

$$F_R = F_A + F_B$$

$$F_A \cos B = F_{Ay} = 8 \cos B = 3.85$$

$$(4.59 + 7.01)i + (3.85 - 3.85)j$$

$$11.6i + 0j$$

Next find d

$$\cos^{-1}\left(\frac{3.85}{8}\right) = B = 61.23^\circ$$

$$\cos^2 \alpha + \cos^2 \beta = 1$$

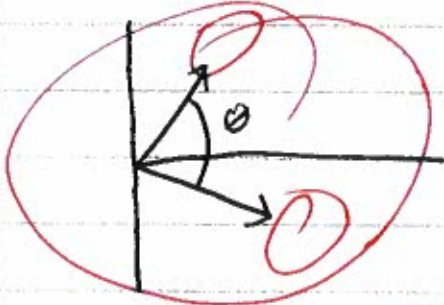
$$\cos^2 \alpha + \cos^2 61.23 = 1$$

$$\alpha = 28.77^\circ$$

#3

4.

NOT

 $8\frac{1}{2}'' \times 11$ ~~4~~

??

Incomplete diagram

$$F_x = F \cos\left(\frac{\theta}{2}\right) + F \cos\left(\frac{\theta}{2}\right)$$

$$F_x = 2F \cos\left(\frac{\theta}{2}\right)$$

$$F_y = F \sin\frac{\theta}{2} - F \sin\left(\frac{\theta}{2}\right)$$

$$F_y = 0$$

$$F_R = F_x = 2F \cos\left(\frac{\theta}{2}\right)$$

$$\boxed{\frac{\theta}{2}}$$

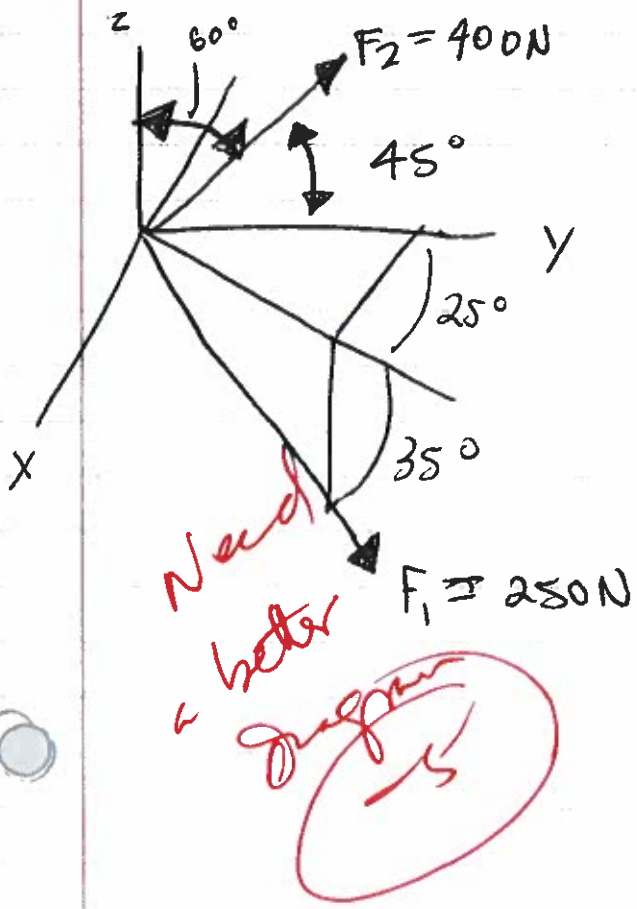
where did I get this?

Incomplete

50

50

5.



#5

$$F_1 = (250 \cos 35^\circ) \sin 25^\circ = 86.54i$$

$$+ (250 \cos 35^\circ) \cos 25^\circ = +185.6j$$

$$- 250 \sin 35^\circ = -143.39k$$

$$F_1 = 86.54i$$

$$F_1 = 86.54i + 185.6j - 143.39k$$

$$F_2 = 400 \cos 120^\circ + 400 \cos 45^\circ + 400 \cos 60^\circ$$

$$F_2 = -200i + 282.84j + 200k$$

$$F_1 + F_2 = F_R$$

$$(86.54i + -200i) + (185.6 + 282.84)j + (-143.39 + 200)k$$

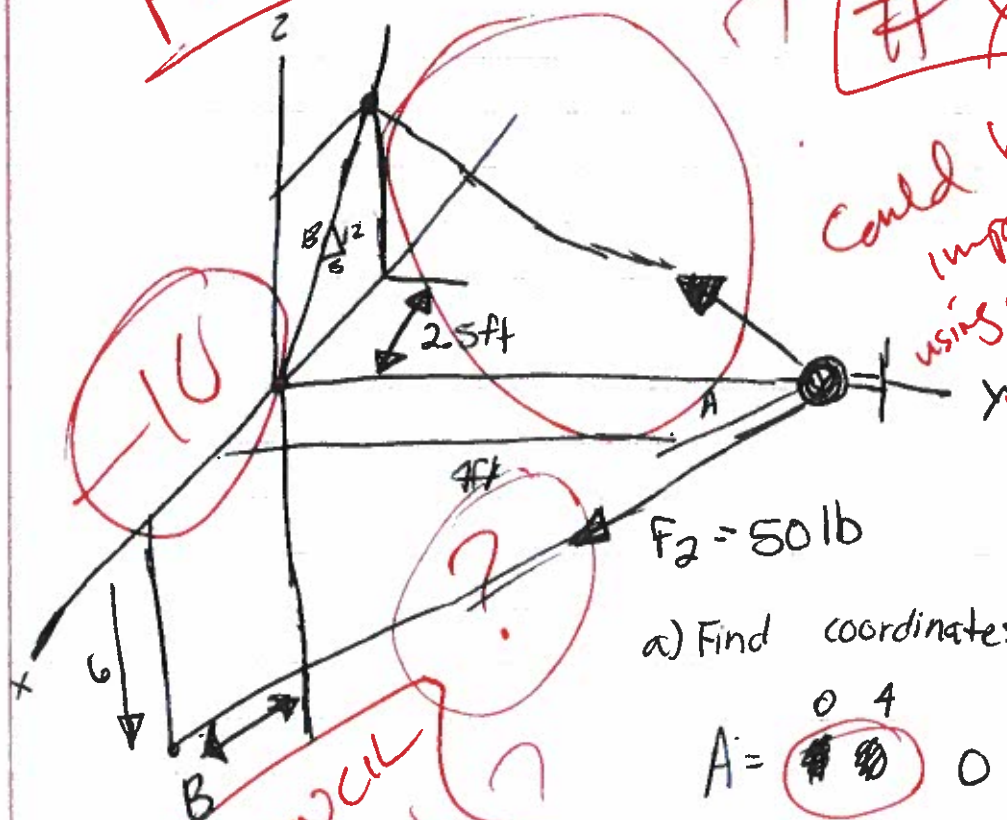
$$F_R = -113.46i + 468.44j + 56.61k$$

$|F_R|$
a, b, r
20
-35

Problem?

#6?

could be improved by using a ruler



USE PENCIL to provide NEATER WORK

a) Find coordinates

$$A = \begin{pmatrix} 0 \\ 4 \\ 0 \end{pmatrix}$$

$$B = \begin{pmatrix} 2 \\ 0 \\ -6 \end{pmatrix}$$

$$C = \begin{pmatrix} -2.5 \\ 0 \\ 2.5 \end{pmatrix} \left(\frac{12}{5} \right)$$

How, why? explain

$$\vec{r}_{AB} = B - A = \begin{pmatrix} 2 \\ -4 \\ -6 \end{pmatrix}$$

$$\vec{r}_{AC} = C - A = \begin{pmatrix} -2.5 \\ -4 \\ 6 \end{pmatrix}$$

these are NOT vectors

$$\frac{\vec{r}_{AB}}{|\vec{r}_{AB}|} = \hat{u}_{AB} = \frac{2}{7.483}, \frac{-4}{7.483}, \frac{-6}{7.483}$$

$$\frac{\vec{r}_{AC}}{|\vec{r}_{AC}|} = \hat{u}_{AC} = \frac{-2.5}{7.632}, \frac{-4}{7.632}, \frac{6}{7.632}$$

could be presented better

$$|\vec{r}_{AB}| = \sqrt{2^2 + 4^2 + 6^2} = 7.483$$

$$|\vec{r}_{AC}| = \sqrt{2.5^2 + 4^2 + 6^2} = 7.632$$

$$\hat{u}_{AB} = \begin{pmatrix} 0.267 \\ -0.535 \\ -0.802 \end{pmatrix}$$

$$\hat{u}_{AC} = \begin{pmatrix} -0.328 \\ -0.524 \\ 0.786 \end{pmatrix}$$

length AB

length AC

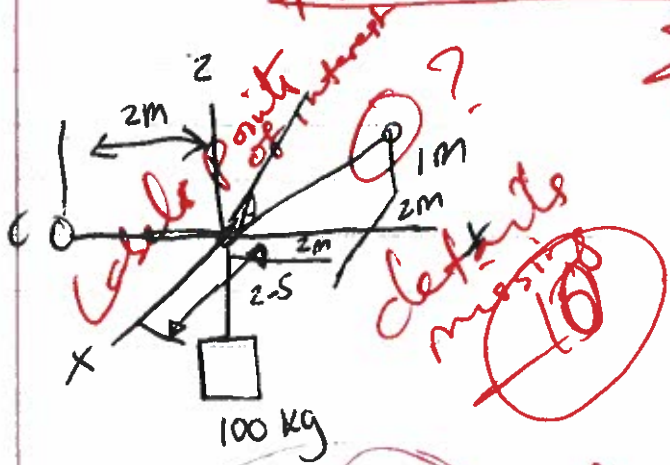
i, j, k

7.

Problem #?

#7?

Name?



$$A = \begin{matrix} i & j & k \\ 0 & 0 & 0 \end{matrix}$$

$$B = 2.5 \, 0 \, 0$$

$$C = 0 \, -2 \, 0$$

$$D = 0 \, 2 \, 1$$

Find T_{AD} to equate first

$$\frac{1}{3} k T_{AD} - W_A =$$

$$\frac{1}{3} T_{AD} - 981 = 0$$

$$T_{AD} = \boxed{2943 \text{ N}}$$

Now equate i

$$T_{AB} - \frac{2}{3} T_{AD} =$$

$$T_{AB} - \frac{2}{3} (2943) = \boxed{1962 \text{ N}}$$

$$-T_{AC} + \frac{2}{3} (2943) = -1962 \text{ N}$$

$$1962 \text{ N} - 1962 \text{ N} - (-1962 \text{ N})$$

$$T_{AC} = \boxed{1962 \text{ N}}$$

Find T_{AB} in vector form

$$T_{AB} = \frac{(2.5-0)i + (0-0)j + (0-0)k}{\sqrt{2.5^2 + 0^2 + 0^2}} = 9i$$

$$\frac{B-A}{|B-A|}$$

Find T_{AC} in vector form

$$T_{AC} = \frac{(0-0)i + (-2-0)j + (0-0)k}{\sqrt{0^2 + (-2)^2 + 0^2}} = -5j$$

$$T_{AD} = \frac{(-2-0)i + (2-0)j + (1-0)k}{\sqrt{-2^2 + 2^2 + 1^2}} = \frac{-2i + 2j + k}{3}$$

equilibrium equation

$$T_{AB} + T_{AC} + T_{AD} + W_A = 0$$

IS that the order of your work? IF so, WHY? -45

NOT justified

Problem #8?

$$\vec{r}_A = 12\mathbf{i} + 18\mathbf{j} + 28\mathbf{k} \text{ ft}$$

$$F = 2500 \text{ j lb}$$

Diegoan
-15

a) Find magnitude

$$\sqrt{12^2 + 18^2 + 28^2} = \sqrt{1252} = 35.38 \text{ ft} = |\vec{r}_A|$$

What if it is not?

b) Find angle between F and OA

$$\theta = \cos^{-1} \left(\frac{F \cdot \vec{r}_A}{|\vec{F}| |\vec{r}_A|} \right) = \cos^{-1} \left(\frac{2500 \cdot 18}{2500 \cdot 35.38} \right)$$

Since force only in y direction

$$\theta = 59.41^\circ$$

10 Show $F \cdot \vec{r}_A$ fully.

c) magnitude alongside position vector r_A

$$F \cos \theta = 2500 \cos(59.41^\circ) = 1272.22 \text{ N}$$

on

d) Normal magnitude to position vector r_A

$$F \sin \theta = 2500 \sin(59.41^\circ) = 2152.07 \text{ N}$$

on

e) Force vector along OA

$$\hat{r}_A = \frac{\vec{r}_A}{|\vec{r}_A|} = \frac{12\mathbf{i} + 18\mathbf{j} + 28\mathbf{j}}{35.38}$$

40

What are you trying to determine

This gives a unit vector

d)?

-50

\$

-50

-165

CVEG 2400

Statics & Dynamics

Fall 2021

HOMework

02

ABOVE
AVERAGE

No online
submission

-100 for late submission
-50 for not using Engineering Paper

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Vemuri

Homework 02

Assigned: 11/09/2021

Due: Sat. Nov. 13, 2021 at 08:00 PM (Canvas)

SUBMIT THIS as cover sheet with your work

Chapters 04-06

Name (PRINT)

Danario Edgar II

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE →
850
1000

YOU MUST DRAW A FREE BODY DIAGRAM (FBD) FOR EACH PROBLEM INVOLVING FORCES
YOU MUST START EACH PROBLEM ON A NEW PAGE

problem 2 [100]

textbook Problem 5-10

problem 3 [150]

textbook Problem 5-13

problem 4 [100]

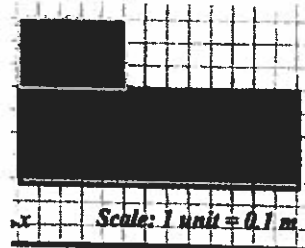
textbook Problem 6-2

problem 5 [150]

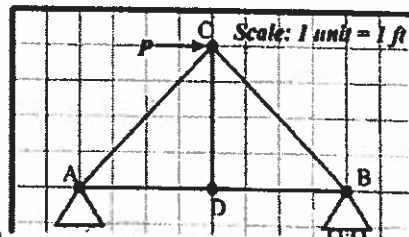
textbook Problem 6-30

- a) Determine the centroid (m) for the section (dark areas).
b) Determine the Moments of Inertia (m^4) about the x- and y-axes
c) Determine the polar Moment of Inertia about the x- and y-axes (m^4).

Put your all calculations in a table. You should include sample calculation as necessary

Problem 7 [150]The magnitude of force P is 5500 lb.

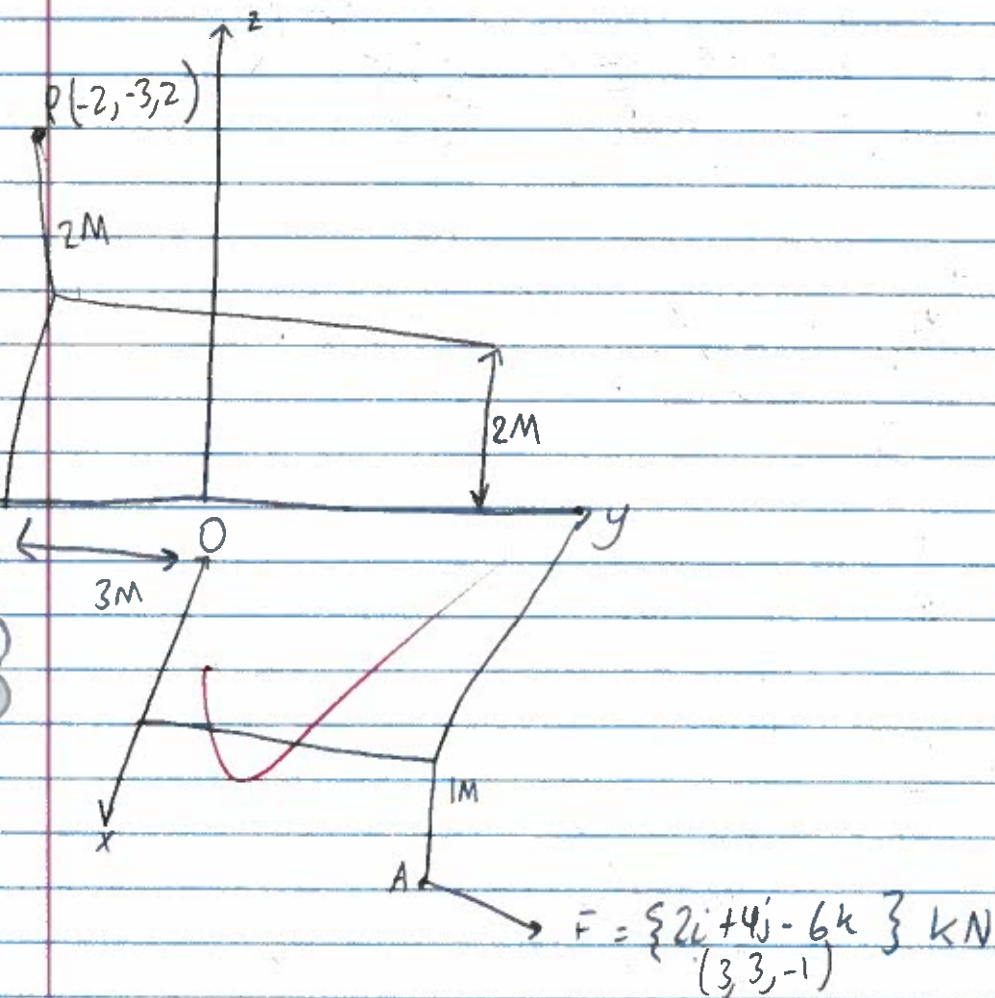
- a) Determine the reactions at the supports. R_{Ax} , R_{Ay} (at support A) and R_{Bx} (at support B) in lbs
b) Determine the force (lb) in each truss member and state whether it is in tension (T)



Homework 2

150

Problem 1



① Vector r_{PA}

$$r_{PA} = (3 - (-2))i + (3 - (-3))j + (-1 - 2)k$$

$$r_{PA} = \{5i + 6j - 3k\} \text{ m}$$

$$F = \{2i + 4j - 6k\} \text{ kN}$$

$$(\Sigma M_F)_P = r_{PA} \times F = \begin{vmatrix} i & j & k \\ 5 & 6 & -3 \\ 2 & 4 & -6 \end{vmatrix}$$

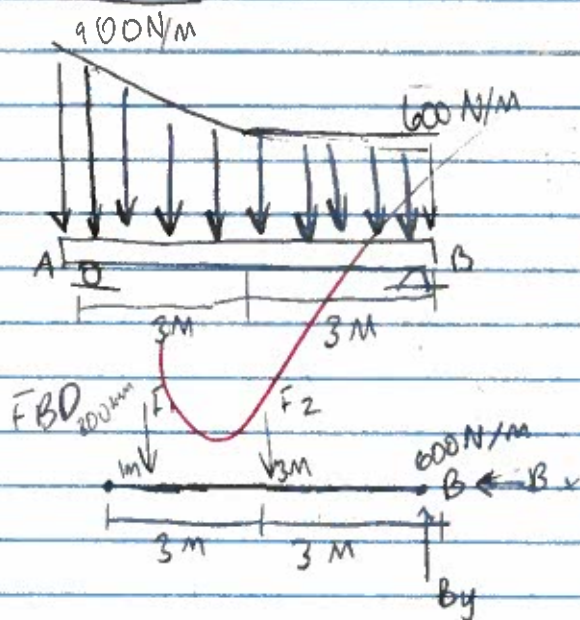
$$M_F = [(6 \cdot -6) - (-3 \cdot 4)]i - [(5 \cdot -6) - (-3 \cdot 2)]j + [(5 \cdot 4) - (6 \cdot 2)]k$$

$$M_F = [-36 - (-12)]i - [-30 - (-6)]j + [20 - 12]k$$

$$M_F = -24i + 24j + 8k \text{ kNm}$$

Problem 3

150



Triangle

$$A = \frac{1}{2}bh$$

$$= \frac{1}{2}(3)300\text{ N/m}$$

$$F_1 = 450\text{ N}$$

$$x_1 = \frac{1}{3}(3) = 1\text{ m}$$

Rectangle

$$A = bh$$

$$= 6(600\text{ N/m})$$

$$F_2 = 3600\text{ N}$$

$$x_2 = \frac{1}{2}(6) = 3\text{ m}$$

① $B_x = 0$ No forces in x

② $\sum M_B = 0$

$$\begin{aligned} \sum M_B &= 450\text{ N}(5\text{ m}) + 3600\text{ N}(3\text{ m}) - A_y(6\text{ m}) = 0 \\ &= 2250\text{ Nm} + 10800\text{ Nm} - A_y(6\text{ m}) = 0 \end{aligned}$$

$$A_y = 2175\text{ N}$$

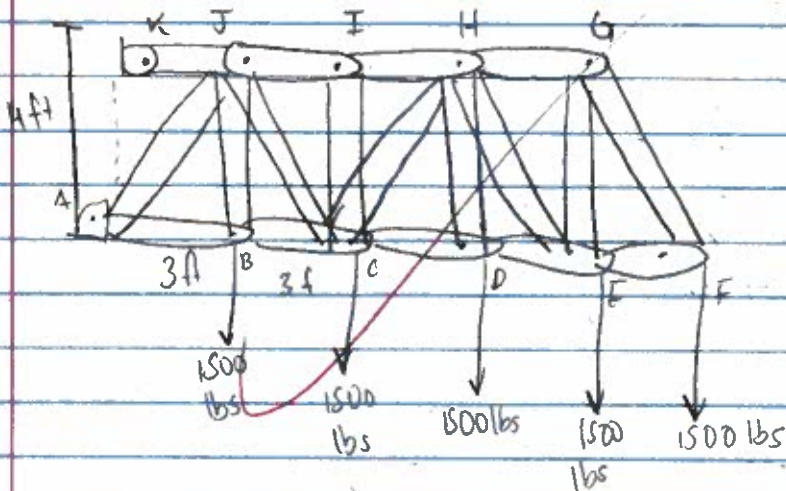
③ $\sum F_y = 0$ $A_y + B_y - F_1 - F_2 = 0$

$$2175\text{ N} + B_y - 450\text{ N} - 3600\text{ N} = 0$$

$$B_y = 1875\text{ N}$$

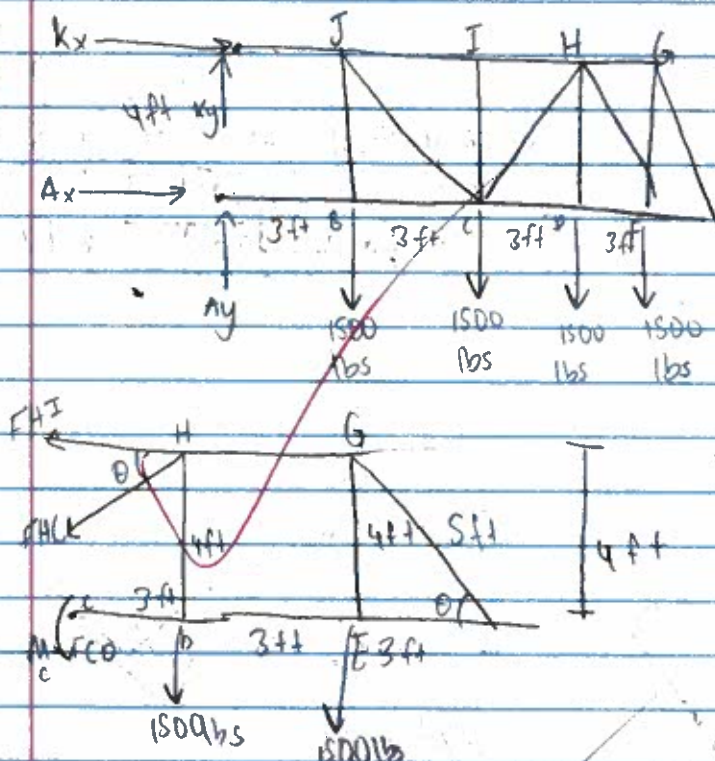
Problem 5

150



Pin $F_x \rightarrow$
 $F_y \uparrow$

Based on problem...



$F_{CD} = 337.5 \text{ lb compression}$
 $F_{CH} = 562.5 \text{ lb compression}$
 $F_{HI} = 6750 \text{ lb tension}$

$$\sum F_x = 0; -F_{HI} - \frac{3}{4} F_{CH} + F_{CD} = 0$$

$$\sum F_y = 0; -4500 \text{ lb} - \frac{4}{5} F_{CH}$$

$$F_{CH} = -5625(1) \text{ lb}$$

$$+\circlearrowleft \sum M_C = 0; -(1500)(3) - (1500)(7+3) - 1500(9 \text{ ft}) + F_{HI}(4 \text{ ft}) = 0$$

$$F_{HI} = \frac{24000}{4} = 6750 \text{ lb (T)}$$

$$F_{CD} = -F_{HI} - \frac{3}{5} F_{CH} = -6750 - \frac{3}{5}(-5625 \text{ lb}) \quad F_{CD} = -337.5 \text{ lb (C)}$$

150

b) Define Moments of Inertia

$$dx_1 = 0.66 - 0.35 = 0.31$$

$$dx_2 = 0.66 - 0.75 = -0.09$$

$$dy_1 = 0.5 - 0.85$$

$$= -0.35$$

$$dy_2 = 0.5 - 0.4 = 0.1$$

$$I_{x_1}' = (0.5)(0.3)^3/12 = 0.0012$$

$$I_{x_2}' = (1.3)(0.4)^3/12 = 0.007$$

$$I_{y_1}' = (0.5^3)(0.3)/12 = 0.003$$

$$I_{y_2}' = (1.3^3)(0.4)/12 = 0.023$$

$$I_x = I_{x_1}' + A dy_2^2$$

$$I_x = 0.0082 + 0.0026$$

$$I_x = 0.0108 \text{ m}^4$$

$$I_y = I_{y_1}' + A dx_2^2$$

$$I_y = 0.076 + 0.086$$

$$I_y = 0.0946 \text{ m}^4$$

c) Polar moment of Inertia

$$J_o = I_x + I_y$$

$$= 0.0108 \text{ m}^4 + 0.0946 \text{ m}^4$$

$$J_o = 0.1054 \text{ m}^4$$

AVERAGE

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE $\Rightarrow$
485
1000

YOU MUST DRAW A FREE BODY DIAGRAM (FBD) FOR EACH PROBLEM INVOLVING FORCES
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Problem 1 [150]

Textbook Problem 4-31

Problem 2 [100]

Textbook Problem 5-10

Problem 3 [150]

[Textbook Problem 5-13]

Problem 4 [100]

Textbook Problem 6-2

Problem 5 [150]

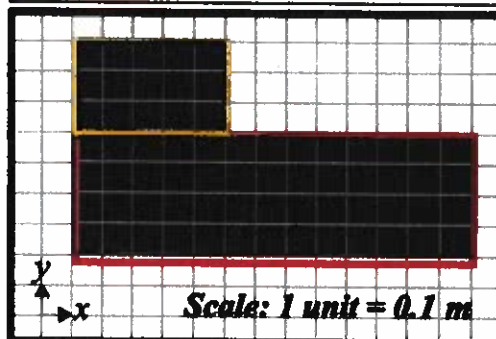
Textbook Problem 6-30

Problem 6 [200]

Using ONLY 2 sub-areas shown:

- Determine the centroid [m] for the section [dark areas].
- Determine the Moments of Inertia [m^4] about the x- and y-axes
- Determine the polar Moment of Inertia about the x- and y-axes [m^4].

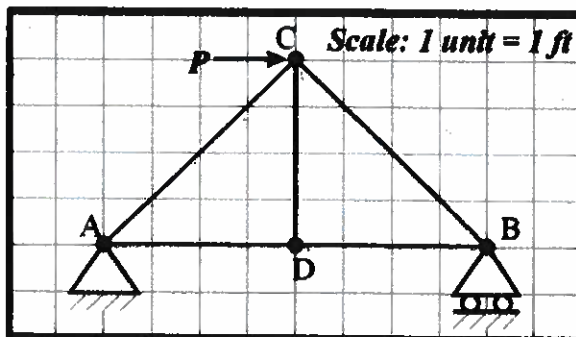
Present your all calculations in a table. You should provide sample calculation as necessary



Problem 7 [150]

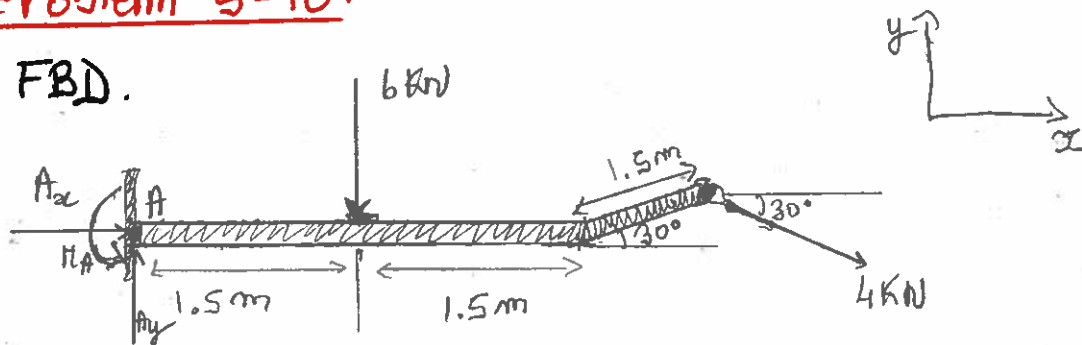
The magnitude of force P is 5500 lb.

- Determine the reactions at the supports. R_{Ax} , R_{Ay} (at support A) and R_{By} (at support B) in lbs
- Determine the force [lb] in each truss member and state whether it is in tension (T) or compression (C)



Problem 5-10.

FBD.



Determine the components of the support reactions at the fixed support A.

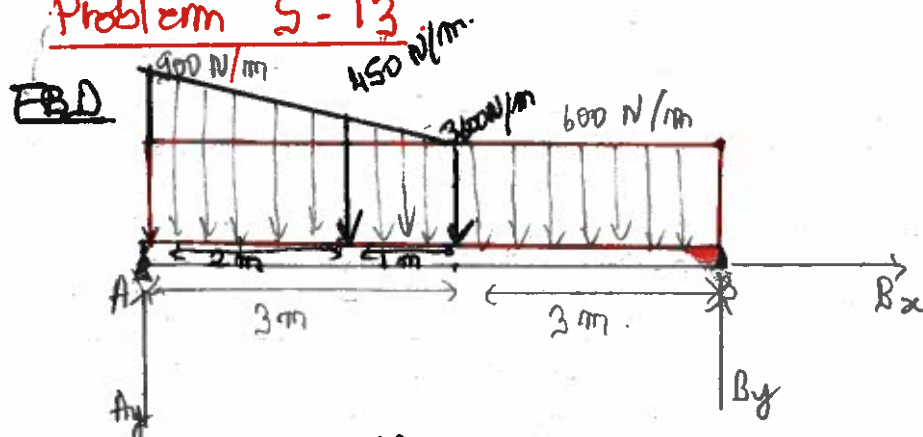
$$\begin{aligned} \bullet \sum F_x = 0 &\Rightarrow A_x + 4 \cos 30^\circ = 0 \\ &\Rightarrow A_x = -3.46 \text{ kN} \end{aligned}$$

$$\begin{aligned} \bullet \sum F_y = 0 &\Rightarrow A_y - 6 - 4 \sin 30^\circ = 0 \\ A_y &= 8 \text{ kN} \end{aligned}$$

$$\bullet \sum M_A = 0 \Rightarrow 6 \times 1.5 + (4 \cos 30^\circ \times 1.5 \times \sin 30^\circ) + [4 \times (3 + 1.5 \cos 30^\circ)]$$

$$M_A = 20.2 \text{ kN}\cdot\text{m}$$

Note: A_x is negative, therefore our vector A_x should be in the opposite direction.

Problem 5-13

To calculate the forces representing both surfaces. We can divide the figure in a rectangle and a triangle.

According to Equilibrium Equation.

$$\bullet \sum F_x = 0 \Rightarrow \underline{B_x = 0.}$$

There's no A_x because Point A is a roller.

$$\bullet \sum F_y = 0 \Rightarrow A_y + B_y = \frac{1}{2} (900 - 600) \times 3 + 600 \times 6$$

$$\Rightarrow A_y + B_y = 450 + 3600$$

$$\Rightarrow A_y + B_y = 4050 \text{ N/m.}$$

Applying moment about A.

$$\sum \zeta M_A = 0$$

$$\Rightarrow 6 B_y - 450 \times 2 - 3600 \times 3 = 0$$

$$\Rightarrow 6 B_y - 900 - 10800 = 0$$

$$\Rightarrow 6 B_y = 11700$$

$$\Rightarrow B_y = \frac{11700}{6} = 1950 \text{ N/m.}$$

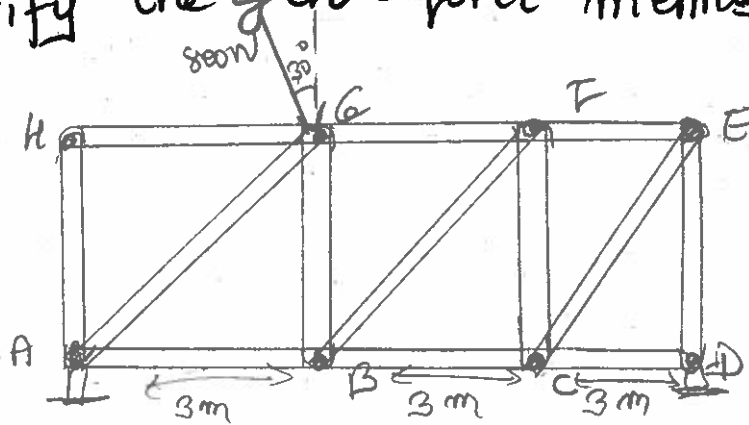
$$\underline{B_y = 1950 \text{ N/m.}}$$

Therefore $A_y = 4050 - 1950 = 2100 \text{ N/m}$
 We know $A_y + B_y = 4050$
 $\underline{A_y = 2100 \text{ N/m}}$

Problem 6-2

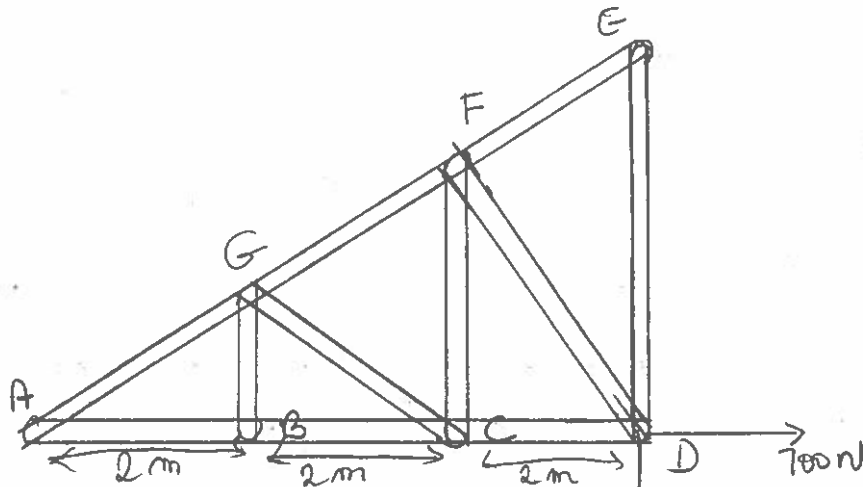
Identify the zero-force members in each truss.

(a)

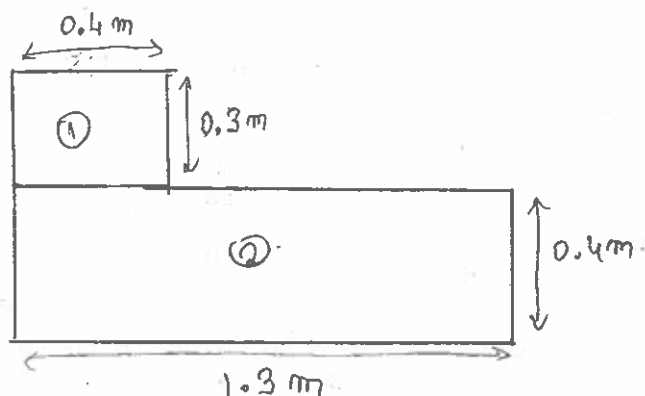


DC, FB, AH, HG, FE, FG, CB are ^{zero} force members

(b)



GB, GC, FC, FD are zero force members.

Problem 6

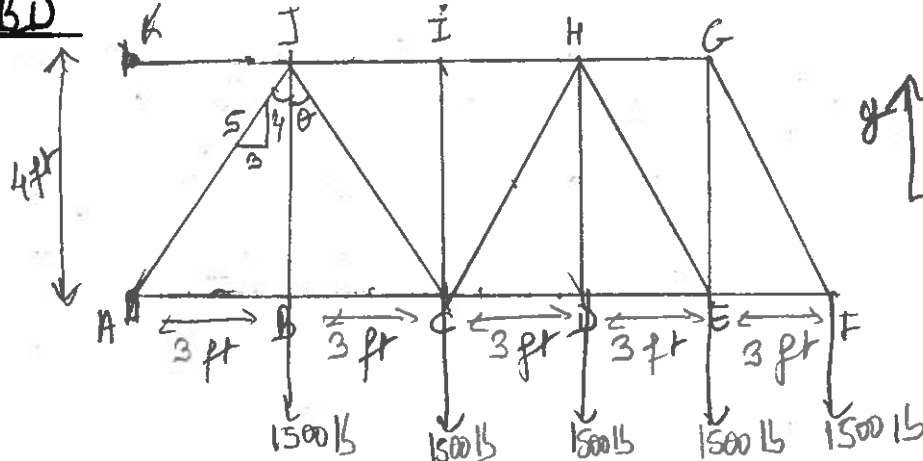
a) Centroid for the section

We know: $\bar{X} = \frac{\sum \bar{x}_i \cdot A_i}{\sum A_i}$ and $\bar{Y} = \frac{\sum \bar{y}_i \cdot A_i}{\sum A_i}$

	Area	$\bar{x}$	$\bar{x} \times \text{Area}$	$\bar{y}$	$\bar{y} \times \text{Area}$
Area 1	0.12	0.2	0.024	0.15	0.018
Area 2	0.52	0.65	0.338	0.2	0.104
Total	0.64		0.362		0.122

$$\bar{X} = \frac{0.362}{0.64} = 0.56$$

$$\bar{Y} =$$

Problem 6-30FBD

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

$$\cos \theta = \frac{4}{5}$$

- From moment of equations of equilibrium.

$$\sum \zeta H_H = 0$$

$$F_{CD} \times 4 - 1500 \times 6 - 1500 \times 3 = 0$$

$$4 F_{CD} = -13500$$

$$F_{CD} = \frac{13500}{4}$$

Compression.

$$\underline{F_{CD} = 3375 \text{ lb}}$$

$$\sum \zeta H_C = 0$$

$$\Rightarrow F_{HI} \times 4 - 1500 \times 3 - 1500 \times 6 - 1500 \times 9 = 0$$

$$4 F_{HI} = 27,000$$

$$\underline{F_{HI} = 6750 \text{ lb}}$$

Tension.

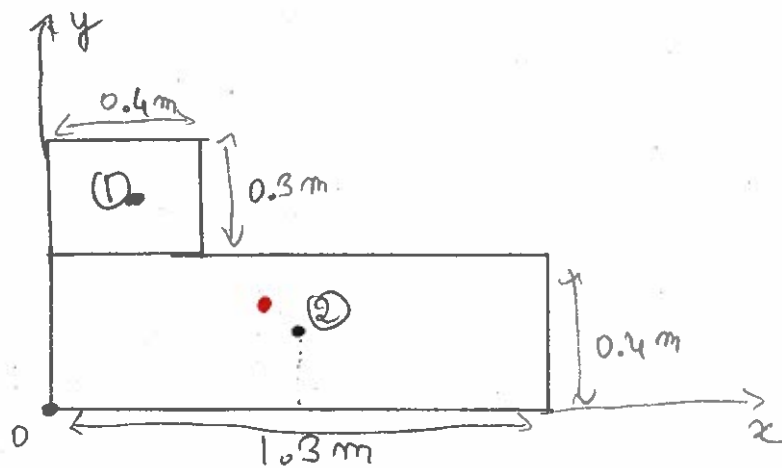
By applying equilibrium along y-axis

$$\sum F_y = 0$$

$$F_{CH} \times \frac{4}{5} - 1500 - 1500 - 1500 = 0$$

$$F_{CH} \times 0.8 = 4500$$

$$\underline{F_{CH} = 5625 \text{ lb}} \text{ Compression.}$$

Problem 6

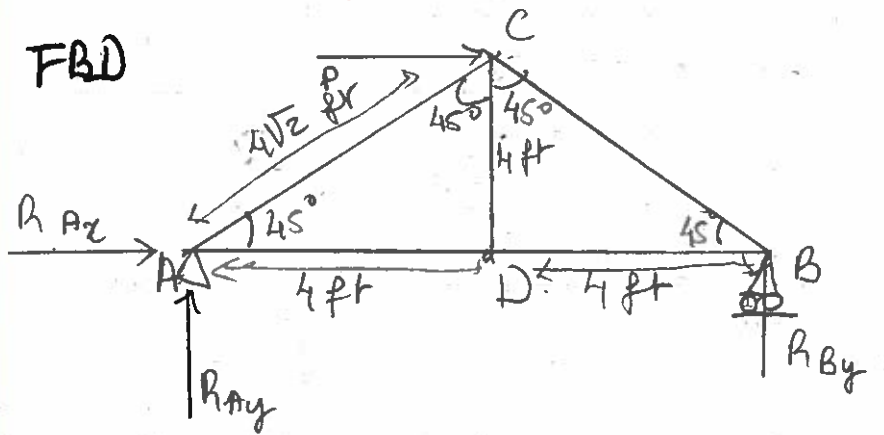
a) Centroid of the sections

We know, $\bar{X} = \frac{\sum x_i \cdot A_i}{\sum A_i}$ and $\bar{Y} = \frac{\sum y_i \cdot A_i}{\sum A_i}$

	Area	$\bar{x}$	$\bar{x} \times \text{Area}$	$\bar{y}$	$\bar{y} \times \text{Area}$
Area 1	0.12	0.2	0.024	0.55	0.066
Area 2	0.52	0.65	0.338	0.2	0.104
Total	0.64		0.362		0.17

$$\bar{X} = \frac{0.362}{0.64} = 0.56 \text{ m}, \quad \bar{Y} = \frac{0.17}{0.64} = 0.26 \text{ m}$$

b) Moment of inertia about x-axis

Problem 7.

- a) Determine reactions at the support A and B.
Applying equilibrium equation.

$$\sum F_x = 0 \Rightarrow R_{Ax} + P = 0.$$

$$\Rightarrow R_{Ax} = -P.$$

$$\Rightarrow \underline{R_{Ax} = -5500 \text{ lbs.}}$$

$$\sum F_y = 0 \Rightarrow R_{Ay} + R_{By} = 0.$$

$$\left(\sum M_A = 0 \Rightarrow R_{By} \times 8 + P \times 4 = 0. \right)$$

- b) Method of Joint.

At Joint C:

$$\sum F_x = 0.$$

$$AC \sin 45^\circ - BC \sin 45^\circ = 0.$$

$$AC = BC.$$

$$\text{Also } 2AC \cos 45^\circ = P.$$

$$AC = \frac{P}{2 \cos 45^\circ} = \frac{5500}{1.414} \approx 3,889$$

$$\text{Therefore } BC = 3,889 \text{ lbs.}$$

At Joint B.

$$\bullet \sum F_x = 0 \Rightarrow F_{BD} - F_{BC} \cos 45^\circ = 0.$$

$$F_{BD} = 3,889 \times \cos 45^\circ = 2,750 \text{ lb.}$$

$$\text{Therefore } \underline{F_{BD} = F_{BD} = 2750 \text{ lb.}}$$

AC is in Tension.

BC is in Compression.

$$\bullet \sum F_y = 0 \Rightarrow R_{By} - F_{BC} \sin 45^\circ = 0.$$

$$\Rightarrow R_{By} = F_{BC} \sin 45^\circ = 3,889 \times \sin 45^\circ$$

$$\Rightarrow \underline{R_{By} = 2750 \text{ lb}}$$

From our previous equation with $\sum F_y = 0$
we found that.

$$R_{Ay} + R_{By} = 0.$$

$$\Rightarrow R_{Ay} = -R_{By}$$

$$\Rightarrow \underline{R_{Ay} = -2750 \text{ lb.}}$$

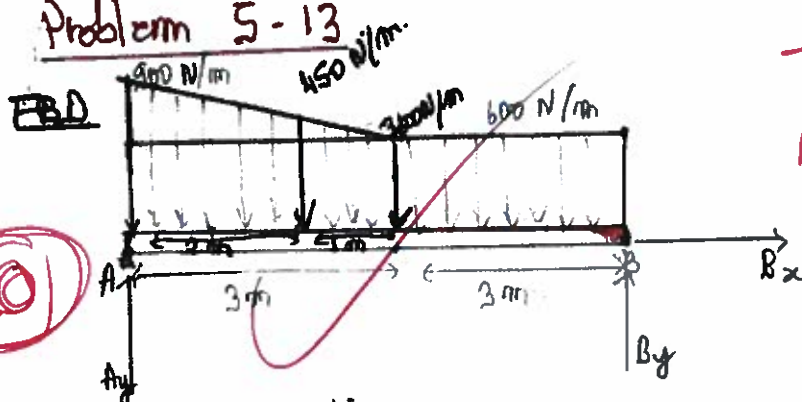
485
1000

CV66 2400

Homework 2

Laurie McQuae

Problem 5-13



-25
No cover sheet

To calculate the forces representing both surfaces. We can divide the figure in a rectangle and a triangle.

According to Equilibrium Equation.

• $\sum F_x = 0 \Rightarrow B_x = 0$

There's no A_x because Point A is a roller

• $\sum F_y = 0 \Rightarrow A_y + B_y = \frac{1}{2} (900 - 600) \times 3 + 600 \times 6$

$\Rightarrow A_y + B_y = 450 + 3600$

$\Rightarrow A_y + B_y = 4050 \text{ N/m}$

Applying moment about A.

$\sum \text{(+)} M_A = 0$

$\Rightarrow 6 B_y - 450 \times 2 - 3600 \times 3 = 0$

$\Rightarrow 6 B_y - 900 - 10800 = 0$

$\Rightarrow 6 B_y = 11700$

$\Rightarrow B_y = \frac{11700}{6} = 1950 \text{ N/m}$

$B_y = 1950 \text{ N/m}$

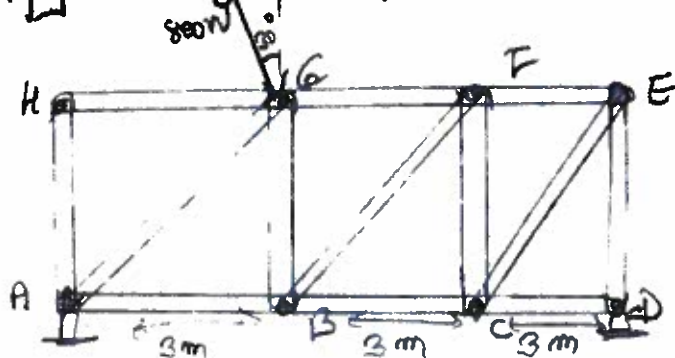
Wrong answers

Therefore $A_y = 4050 - 1950 = 2100 \text{ N/m}$
We know $A_y + B_y = 4050$
 $A_y = 2100 \text{ N/m}$

Problem 6-2

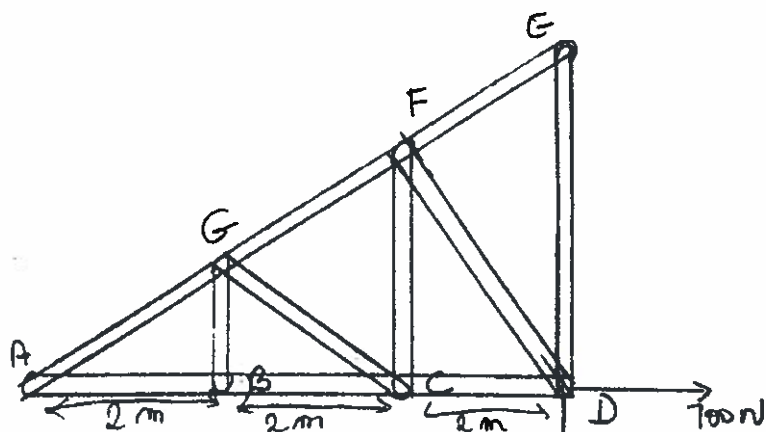
Identify the zero-force members in each truss.

(a)



DC, FB, AH, HG, FE, FG, CB are zero force members

(b)



GB, GC, FC, FD are zero force members.

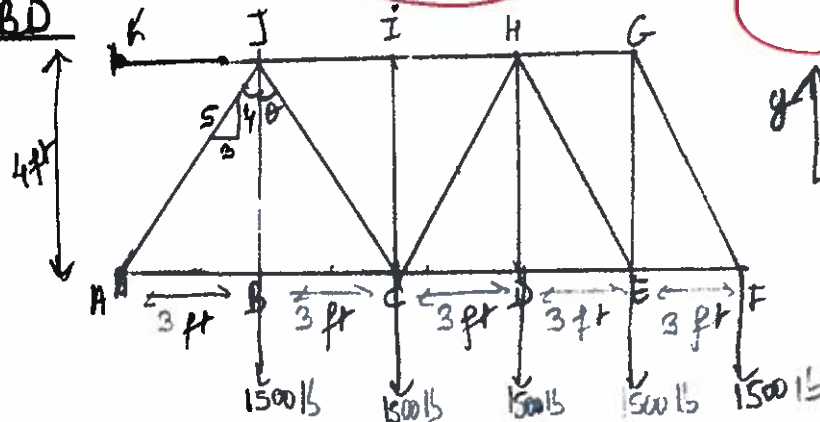
You didn't solve anything
on this question

Problem 6-30

135

-15

FBD



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

$$\cos \theta = \frac{4}{5}$$

- From moment of equations of equilibrium.

$$\sum \mathcal{M}_H = 0$$

$$F_{CD} \times 4 - 1500 \times 6 - 1500 \times 3 = 0$$

$$4 F_{CD} = -13500$$

$$F_{CD} = \frac{13500}{4}$$

Compression

$$F_{CD} = 3375 \text{ lb}$$

$$\sum \mathcal{M}_C = 0$$

$$\Rightarrow F_{HI} \times 4 - 1500 \times 3 - 1500 \times 6 - 1500 \times 9 = 0$$

$$4 F_{HI} = 27,000$$

$$F_{HI} = 6750 \text{ lb}$$

Tension

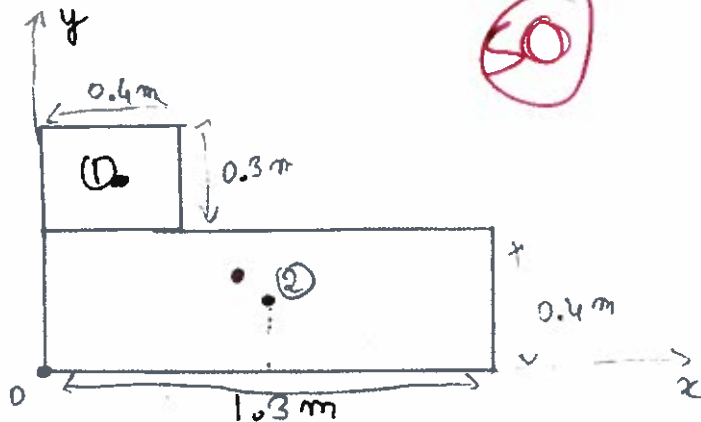
By applying equilibrium along y-axis

$$\sum F_y = 0$$

$$F_{CH} \times \frac{4}{5} - 1500 - 1500 - 1500 = 0$$

$$F_{CH} \times 0.8 = 4500$$

$$F_{CH} = 5625 \text{ lb Compression}$$

Problem 6

a) Centroid of the sections

We know, $\bar{x} = \frac{\sum x_i \cdot A_i}{\sum A_i}$ and $\bar{y} = \frac{\sum y_i \cdot A_i}{\sum A_i}$

	Area	$\bar{x}$	$\bar{x} \times \text{Area}$	$\bar{y}$	$\bar{y} \times \text{Area}$
Area 1	0.12	0.2	0.024	0.55	0.066
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Total	0.64		0.362		0.17

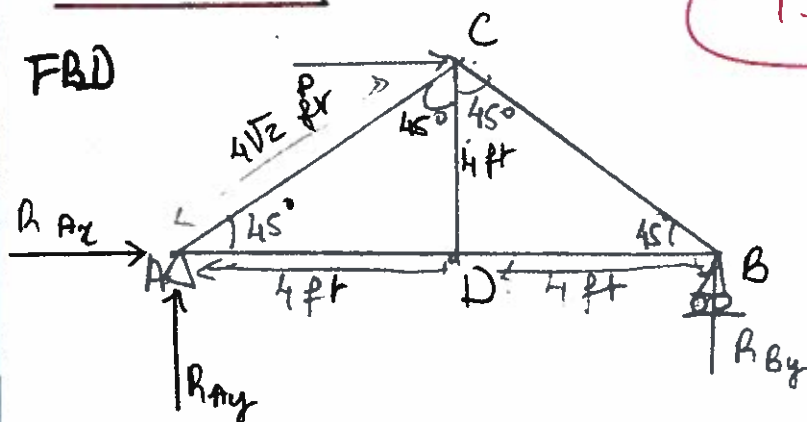
$$\bar{x} = \frac{0.362}{0.64} = 0.56 \text{ m}, \quad \bar{y} = \frac{0.17}{0.64} = 0.26 \text{ m}$$

b) Moment of inertia about x-axis.

In complete solution!!

Problem 7.

150



- a) Determine reactions at the support A and B.
Applying equilibrium equation.

$$\sum F_x = 0 \Rightarrow R_{Ax} + P = 0.$$

$$\Rightarrow R_{Ax} = -P.$$

$$\Rightarrow \underline{R_{Ax} = -5500 \text{ lbs.}}$$

$$\sum F_y = 0 \Rightarrow R_{Ay} + R_{By} = 0.$$

$$\sum M_A = 0 \Rightarrow R_{By} \times 8 + P \times 4 = 0.$$

- b) Method of Joint.

At Joint C:

$$\sum F_x = 0.$$

$$AC \sin 45^\circ - BC \sin 45^\circ = 0.$$

$$AC = BC.$$

$$\text{Also } 2AC \cos 45^\circ = P.$$

$$AC = \frac{P}{2 \cos 45^\circ} = \frac{5500}{1.414} \approx 3,889$$

$$\text{Therefore } BC = 3,889 \text{ lbs.}$$

At Joint B.

$$\bullet \sum F_x = 0 \Rightarrow F_{BD} - F_{BC} \cos 45^\circ = 0$$

$$F_{BD} = 3,889 \times \cos 45^\circ = 2,750 \text{ lb.}$$

$$\text{Therefore } \underline{F_{BD} = F_{BD} = 2750 \text{ lb.}}$$

AC is in Tension.

BC is in Compression.

$$\bullet \sum F_y = 0 \Rightarrow R_{By} - F_{BC} \sin 45^\circ = 0$$

$$\Rightarrow R_{By} = F_{BC} \sin 45^\circ = 3,889 \times \sin 45^\circ$$

$$\Rightarrow \underline{R_{By} = 2750 \text{ lb.}}$$

From our previous equation with $\sum F_y = 0$ we found that.

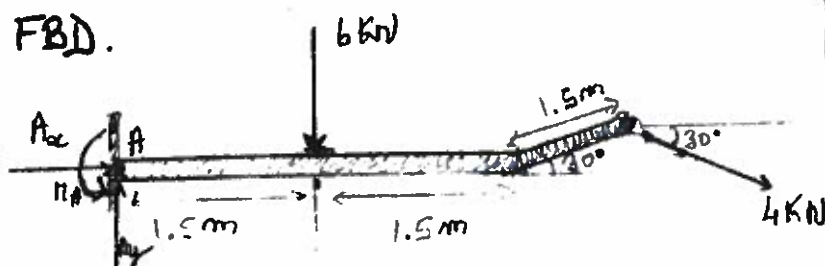
$$R_{Ay} + R_{By} = 0$$

$$\Rightarrow R_{Ay} = -R_{By}$$

$$\Rightarrow \underline{R_{Ay} = -2750 \text{ lb.}}$$

Problem 5-10.

FBD.



Determine the components of the support reactions at the fixed support A.

$$\bullet \sum F_x = 0 \Rightarrow A_x + 4 \cos 30^\circ = 0$$

$$\Rightarrow A_x = -3.46 \text{ kN}$$

$$\bullet \sum F_y = 0 \Rightarrow A_y - 6 - 4 \sin 30^\circ = 0$$

$$A_y = 8 \text{ kN}$$

$$\bullet \sum M_A = 0 \Rightarrow 6 \times 1.5 + (4 \cos 30^\circ \times 1.5 \times \sin 30^\circ) + [4 \times (3 + 1.5 \cos 30^\circ)]$$

$$M_A = 20.2 \text{ kN}\cdot\text{m}$$

Note: A_x is negative, therefore our vector A_x should be in the opposite direction.

BELOW
AVERAGE

Name: Aicha Lasse

Id: CVE 62400P01

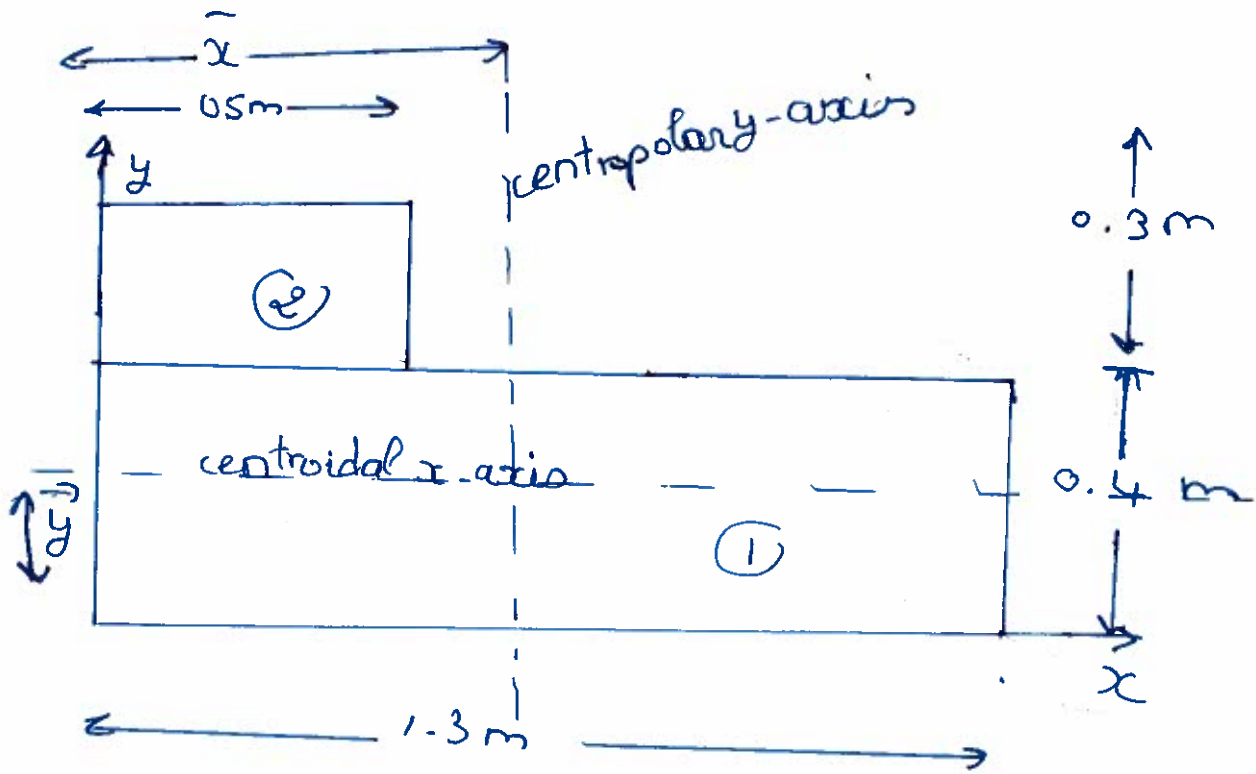
some work on chap 04 and 06.

$$\frac{250}{1000}$$

$$x^2 + 7x + 2 + \frac{18}{x^4} + \frac{31}{x^5} + \dots$$

PROBLEM 6

in the wall



$$A_1 = 1.3 \times 0.4 = 0.52 \text{ m}^2$$

$$y_1 = \frac{0.4}{2} = 0.2 \text{ m}$$

$$x_1 = \frac{1.3}{2} = 0.65 \text{ m}$$

$$A_2 = 0.5 \times 0.3 = 0.15 \text{ m}^2$$

$$y_2 = 0.4 + \frac{0.3}{2} = 0.55 \text{ m}$$

$$x_2 = \frac{0.5}{2} = 0.25 \text{ m}$$

$$\bar{y} = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = 0.278 \text{ m}$$

$$\bar{x} = \frac{A_1 x_1 + A_2 x_2}{A_1 + A_2} = \frac{(0.52 \times 0.65) + (0.15 \times 0.25)}{0.52 + 0.15} = 0.56 \text{ m}$$

Let's make a notation of each distance.

$h_1 = \text{distance between centroid of ① and } \vec{y}$
 $h_2 = \text{distance between centroid of ② and } \vec{y}$ } y direction

$k_1 = \text{distance between centroid of ① and } \vec{x}$
 $k_2 = \text{distance between centroid of ② and } \vec{x}$ } x direct

so let's now calculate:

$$h_1 = \vec{y} - y_1 = 0.078 \text{ m}$$

$$h_2 = y_2 - \vec{y} = 0.872 \text{ m}$$

$$k_1 = \vec{x}_1 - \vec{x} = 0.09 \text{ m}$$

$$k_2 = \vec{x} - x_2 = 0.31 \text{ m}$$

so the moment of inertia of the figure ① about centroidal x-axis:

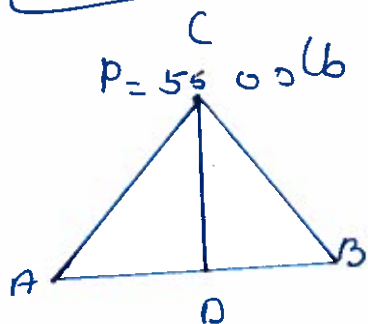
$$I_{G1x} = \frac{1.3 \times (0.4)^3}{12} + [0.52 \times (0.078)^2]$$
$$= 0.01 \text{ m}^4$$

$$I_{G2x} = \frac{0.5 \times (0.3)^3}{12} + [0.15 \times (0.872)^2]$$
$$= 0.0122 \text{ m}^4$$

now about the whole x-axis:

$$I_{Gx} = I_{Gx1} + I_{Gx2} = 0.0122 + 0.01 = 0.0222 \text{ m}^4$$

Problem 1



The truss CD is zero force vector $CD = 0$

At point C,



at the equilibrium, $\sum F_y = 0$ so we can say,

$$AC \sin 45^\circ + BC \sin 45^\circ = 0 \Rightarrow AC = BC$$

at the equilibrium $\sum F_x = 0$ So we can say,

$$2AC \cos 45^\circ = P \Rightarrow AC = 0.71P = 3905 \text{ lb (Tension)}$$

$$BC = 0.71P = 3905 \text{ lb (compression)}$$

At point B,



$$BC \sin 45^\circ = R_{By}$$

$$\text{So } R_{By} = 2750 \uparrow$$

$$R_{Bx} = 2750$$

$$R_{BD} = 2750$$

At point D



at point A



at the equilibrium

$$\sum F_y = 0$$

$$R_{Ay} = 3905 \sin 45^\circ = 2750$$

at the equilibrium,

$$\sum F_x = 0$$

$$2750 - 3905 \sin 45 = R_{Ax}$$

$$R_{Ax} = -550$$

let's do the same calculation of Inertia about centroidal y-axis

$$I_{y_1} = \frac{0.4 \times (1.3)^3}{12} + [0.52 \times (0.09)^2] = 0.0774 \text{ m}^4$$

$$I_{y_2} = \frac{0.3 \times (0.5)^3}{12} + [0.15 \times (0.31)^2] = 0.0175 \text{ m}^4$$

The moment of Inertia about the whole y-axis

$$I_y = I_{y_1} + I_{y_2} = 0.0774 + 0.0175 = 0.0949 \text{ m}^4$$

let's calculate the polar moment of Inertia about the centroidal axis:

$$J = I_{x_c} + I_{y_c} = 0.0949 + 0.0222 = 0.1171 \text{ m}^4$$



Name: Aicha Ware

CISSE

class: CVE 62400P01

homework 02 chap 04 and 06.

250
1000

No Cover Sheet (-25)

Review

12/01/2021

→ Questions

Grading appear to be graded too hard

Questions 1, 2, 3, 4, 5, are missing!!

CVEG 2400

Statics & Dynamics

Fall 2021

HOMEWORK 03

ABOVE
AVERAGE



Department of Civil & Environmental Engineering

H

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azewi

Homework 03

Assigned: 11/27/2021

Due: Tues., Nov 30, 2021 at 10:00 PM (Canvas)

Chapters 08 & 12

Name [PRINT]

Kennedy Dent

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE ⇒

1000

1000

YOU MUST DRAW A FREE BODY DIAGRAM [FBD] FOR EACH PROBLEM INVOLVING FORCES

YOU MUST START EACH PROBLEM ON A NEW PAGE. USE 8.5" X 11" Engineering Paper.

WRITE ONLY ON ONE SIDE OF PAPER

SEE HOMEWORK GUIDELINES

Problem 1 [200]

Textbook Problem 8-4

Problem 2 [300]

Textbook Problem 8-16

Problem 3 [200]

Textbook Problem 12-12

Problem 4 [200]

Textbook Problem 12-20

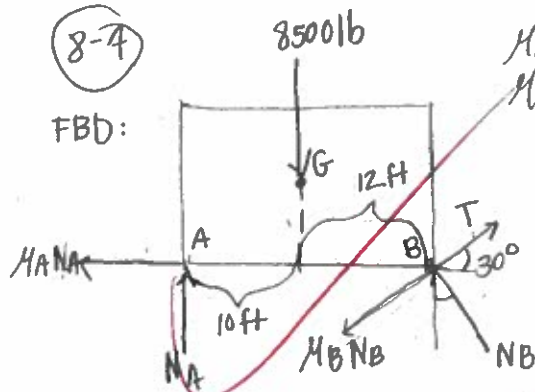
Problem 5 [300]

Textbook Problem 12-52

Problem #1

(8-4)

FBD:



$$\mu_A = 0.3$$

$$\mu_B = 0.2$$

Determine the force
in the cable needed to
begin the lift

- Moment @ B:

$$\sum M_B = 8500(12\text{ft}) - N_A(22\text{ft}) = 0$$

$$N_A = 4636\text{ lb}$$

- Sum of forces in x-direction

$$\sum F_x = 0; T \cos 30^\circ - \mu_B N_B \cos 30^\circ - N_B \sin 30^\circ - \mu_A N_A = 0$$

$$T(0.866) - (0.2)(0.866)N_B - (0.5)N_B = 0.3(4636\text{ lb}) = 0$$

$$0.866T - 0.1732N_B - 0.5N_B = 1390.91$$

$$0.866T - 0.673N_B = 1390.91 \quad (i)$$

$$\sum F_y = 0; -8500\text{ lb} + N_A + T \sin 30^\circ + N_B \cos 30^\circ - \mu_B N_B \sin 30^\circ = 0$$

$$0.5T + (0.866N_B) + 4636\text{ lb} - 8500\text{ lb} - (0.2)(0.5)N_B = 0$$

$$0.5T + 0.766N_B = 3864 \quad (ii)$$

$$0.866T - 0.673N_B = 1390.9$$

$$T = \frac{1390.9 + 0.673N_B}{0.866}$$

$$\Rightarrow 0.5T + 0.766N_B = 3864$$

$$0.5\left(\frac{1390.9 + 0.673N_B}{0.866}\right) + 0.766N_B = 3864$$

$$803.1 + 0.389N_B = 3864 - 0.766N_B$$

$$1.1546N_B = 3060.9$$

$$N_B = 2651.0\text{ lb}$$

$$\therefore T = \frac{-0.766N_B + 3864}{0.5}$$

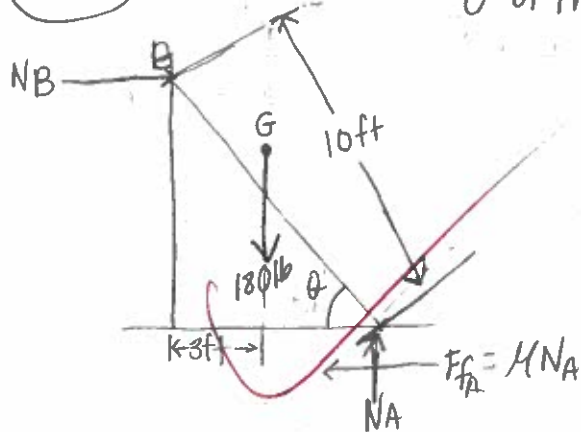
$$T = \frac{-0.766(2651) + 3864}{0.5}$$

$$T = 3666\text{ lb}$$

200

Problem #2

(8-16)

Determine the inclination θ of the latter if $\mu = 0.4$ 

$$\sum F_x = 0;$$

$$N_B - F_{fA} = 0$$

$$N_B = F_{fA}$$

$$\sum F_y = 0; -180 \text{ lb} + N_A = 0$$

$$N_A = 180 \text{ lb}$$

Moment about B

$$\begin{aligned} \sum M_B &= -180 \text{ lb}(3 \text{ ft}) + N_A \times 10 \cos \theta - F_{fA} \sin \theta \times 10 = 0 \\ &= -540 \text{ lb} \cdot \text{ft} + 180 \times 10 \cos \theta - 0.4(N_A) \sin \theta \times 10 = 0 \\ &= -540 \text{ lb} \cdot \text{ft} + 1800 \cos \theta - 720 \sin \theta = 0 \\ &\quad \quad \quad 180 \\ &= -316 \text{ ft} + 10 \cos \theta - 4 \sin \theta = 0 \\ &\quad \quad \quad 10 \cos \theta = 4 \sin \theta + 3 \end{aligned}$$

$$\theta = 52.03^\circ$$

200

Problem #3

12-12

a)

How long will it take
to reach a speed of 120 km/h?
what distance does car travel

$$v_0 = 70 \text{ km/h}$$

$$a = 6000 \text{ km/h}^2$$

$$v = 120 \text{ km/h}$$

$$v = v_0 + a_c t$$

$$120 \text{ km/h} = 70 \text{ km/h} + (6000 \text{ km/h}^2)t$$

$$t = \frac{(120 - 70) \text{ km/h}}{6000 \text{ km/h}^2}$$

$$t = 1/120 = 0.0083 \text{ h} = 30 \text{ sec}$$

$$b) \quad S = v_0 t + \frac{1}{2} a t^2$$

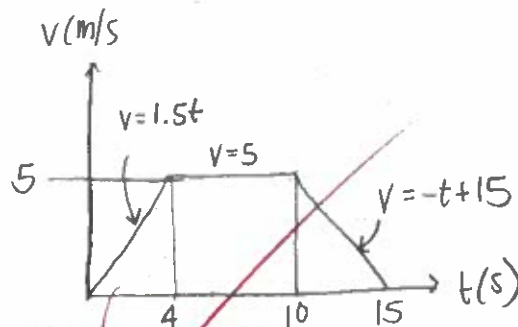
$$= (70 \text{ km/h}) \left(\frac{1}{120} \right) + \frac{1}{2} (6000 \text{ km/h}^2) \left(\frac{1}{120} \right)^2$$

$$S = 0.79 \text{ km}$$

Problem #5

200

12-52



a) determine the distance traveled until 15s

b) plot a-t and s-t graph

a) total area under curve = distance

$$S = \frac{1}{2}(4)(5) + (6)(5) + \frac{1}{2}(5)(5)$$

$$S = 10 + 30 + 12.5$$

$$S = 52.5 \text{ m}$$

b) $v = \frac{ds}{dt}$

$$ds = v dt$$

$$\int_0^S ds = \int_0^t 1.25t dt$$

$$S = 0.625t^2$$

when $t = 4\text{s}$, $S = 10\text{m}$

$$\int_{10}^S ds = \int_4^t 5 dt$$

$$S = 5t - 10$$

$$S = 5(4) - 10$$

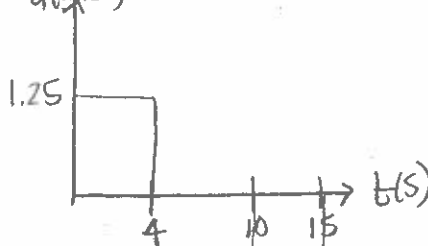
$$S = 10\text{m} @ 4\text{s}$$

when $t = 10\text{s}$, $S = 40\text{m}$

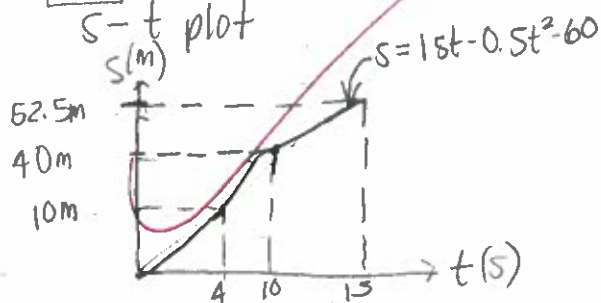
$$\int_{40}^S ds = \int_{10}^t (15-t) dt = -15t + 0.5t^2 - 60 = S$$

when $t = 15\text{s}$, $S = 52.5\text{m}$

a-t plot



s-t plot



Problem #4

12-20

a) determine the position of particle @ $t=4s$

200

b) What is the total distance traveled during the time interval $t=0s$ to $t=4s$?c) what is acceleration when $t=2s$

$$v = (3t^2 - 6t) \text{ ft/s} \quad \rightarrow \quad s = \int v dt = \int (3t^2 - 6t) dt$$

$$s = 4 \text{ ft when } t = 0s \quad \rightarrow \quad \begin{aligned} s &= t^3 - 3t^2 + C \\ 4 &= 0^3 - 3(0)^2 + C \\ C &= 4 \end{aligned}$$

$$\therefore s = t^3 - 3t^2 + 4$$

a) what is x @ $t=4s$

$$s = t^3 - 3t^2 + 4$$

$$s = (4)^3 - 3(4)^2 + 4$$

$$s = 20 \text{ ft}$$

$$c) a = \frac{dv}{dt} = 6t - 6$$

$$a(2) = 6(2) - 6$$

$$a = 6 \text{ ft/s}^2$$

$$b) \quad v = (3t^2 - 6t)$$

$$v = 3t(t-2)$$

@ $t=0$

$$v=0 \quad t=0, 2$$

$$s(0) = 0^3 - 3(0)^2 + 4 = 4$$

$$s(2) = 2^3 - 3(2)^2 + 4 = 0$$

$$s(4) = 20$$

$$s \text{ from } 0 \text{ to } 4 = 20 + 4 + 0 \text{ ft}$$

$$24 \text{ ft}$$

AVERAGE



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Azizi

Homework 03

Assigned: 11/27/2021

Due: Tues., Nov 30, 2021 at 10:00 PM (Canvas)

Chapters 08 & 12

SUBMIT THIS as cover sheet with your work

Name [PRINT]

Tyrese Washington

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

GRADE ⇒

900

1000

YOU MUST DRAW A FREE BODY DIAGRAM [FBD] FOR EACH PROBLEM INVOLVING FORCES
YOU MUST START EACH PROBLEM ON A NEW PAGE. USE 8.5" X 11" Engineering Paper.
WRITE ONLY ON ONE SIDE OF PAPER
SEE HOMEWORK GUIDELINES

Problem 1 [200]

Textbook Problem 8-4

Problem 2 [300]

Textbook Problem 8-16

Problem 3 [200]

Textbook Problem 12-12

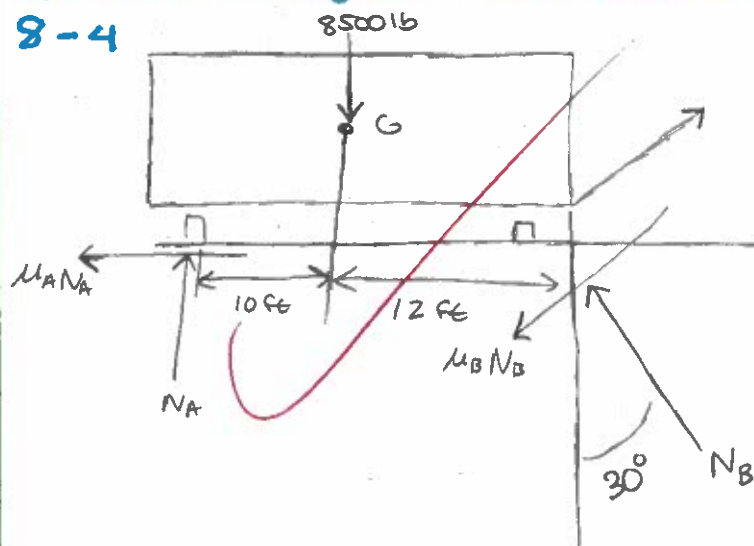
Problem 4 [200]

Textbook Problem 12-20

Problem 5 [300]

Textbook Problem 12-52

8-4



200

$$\sum M_B = 0$$

$$8500(12) - N_A(22) = 0$$

$$N_A = 4636.364 \text{ lb}$$

$$\sum F_x = 0$$

$$T \cos 30^\circ - 0.2 N_B \cos 30^\circ - N_B \sin 30^\circ - 0.3 \times (4636.364) = 0$$

$$T(0.866) - 0.67321 N_B = 1390.91 \quad \text{--- ①}$$

$$\sum F_y = 0$$

$$4636.364 - 8500 + T \sin 30^\circ + N_B \cos 30^\circ - 0.2 N_B \sin 30^\circ = 0$$

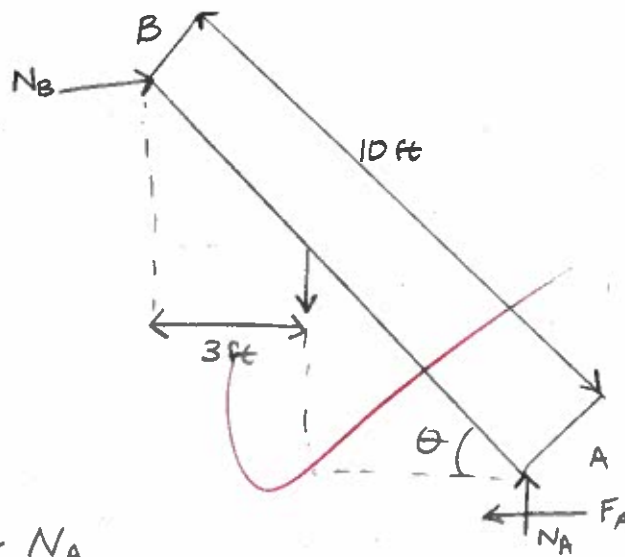
$$T(0.5) + 0.766 N_B = 3863.636 \quad \text{--- ②}$$

$$T = 3666.5 \text{ lb}$$

$$N_B = 2650.6 \text{ lb}$$

8-16

200



$$F_A = M_s \times N_A$$

$$\sum F_x = 0$$

$$N_B - F_A = 0$$

$$N_B = F_A$$

$$\sum F_y = 0$$

$$-mg + N_A = 0$$

$$N_A - mg = 180 \text{ lb}$$

$$\sum M_B = 0$$

$$-mg(3) + N_A(10 \cos \theta) - F_A(10 \sin \theta) = 0$$

$$-180(3) + N_A(10 \cos \theta) - 0.4(N_A)(10 \sin \theta) = 0$$

$$-540 + 180(10) \cos \theta - 720 \sin \theta = 0$$

$$10 \cos \theta = 4 \sin \theta + 3$$

$$\theta = 52.025^\circ$$

12-20

initial speed = 70 km/hr V_1
final speed = 120 km/hr V_2
acceleration = 6000 km/hr²

200

$$V_2 = V_1 + at$$

$$120 = 70 + 6000(t)$$

$$t = \frac{120 - 70}{6000}$$

$$t = \frac{1}{120} \text{ hr} \rightarrow \frac{1}{120} \times 3600 = 30 \text{ sec}$$

$$S = 70 \left(\frac{1}{120} \right) + \frac{1}{2} (6000) \left(\frac{1}{120} \right)^2$$

$$S = 0.792 \text{ km}$$

12-12

$$V = 3t^2 - 6t$$

$$S = \int (3t^2 - 6t) dt = t^3 - 3t^2 + C \quad \text{--- ①}$$

a) $S = 4$ at $t = 0$

$$4 = 0^3 - 0t^2 + C$$

$$C = 4$$

$$S = t^3 - 3t^2 + 4$$

$$t = 4$$

$$S = 4^3 - 3(4)^2 + 4$$

$$S = 20 \text{ ft}$$

$$3t^2 - 6t = 0$$

$$(3t - 6)t = 0$$

$$t = 0$$

$$S = 0^3 - 3(0)^2 + 4$$

$$S = 4 \text{ ft}$$

$$t = 2$$

$$S = 2^3 - 3(2)^2 + 4 = 0 \text{ ft}$$

$$t = 4$$

$$S = 20 \text{ ft}$$

$$t = 0 \text{ to } 4$$

$$S = 4 + 20$$

$$S = 24$$

c) $a = \frac{dv}{dt}$

$$a = d(3t^2 - 6t) / dt$$

$$a = 6t - 6$$

a at time $t = 2$

$$a = 6(2) - 6$$

$$a = 6 \text{ ft/s}^2$$

200

12-52

$$TD = \frac{1}{2}(5)(4) + (10-4)(5) + \frac{1}{2}(15-10)(5) = 52.5 \text{ m}$$

100

$$a = \frac{d}{dt}(1.25t)$$

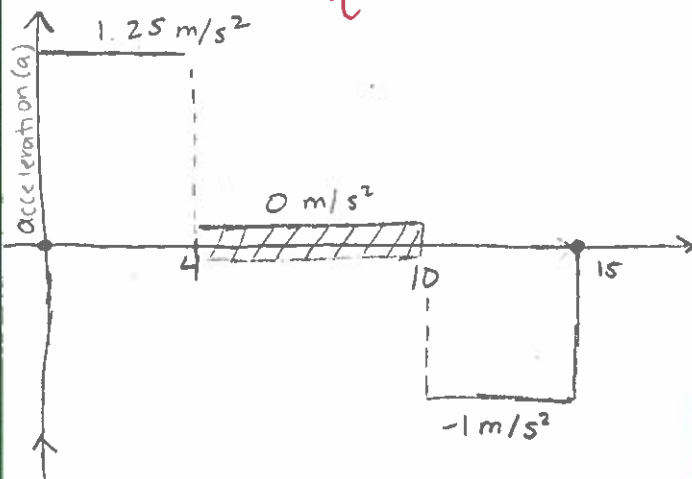
$$a = 1.25 \text{ m/s}^2$$

$$a = \frac{d}{dt}(b)$$

$$a = 0 \text{ m/s}^2$$

$$a = \frac{d}{dt}(-t + 15)$$

$$a = -1 \text{ m/s}^2$$



Incomplete

You should have solved for when $t = 4 \text{ sec}$; $t = 10 \text{ sec}$ and $t = 15 \text{ sec}$ respectively

for $t < 4 \text{ s}$

$$a = \frac{dv}{dt} = 1.25$$

$$\int_0^s ds = \int_0^t 1.25t dt$$

$$s = 0.625 t^2$$

When $t = 4 \text{ s}$; $s = 10 \text{ m}$

$$\frac{ds}{dt} = 1.25t$$

$$s = \int 1.25t$$

$$= \frac{1.25}{2} t^2$$

$$= 0.625 t^2$$

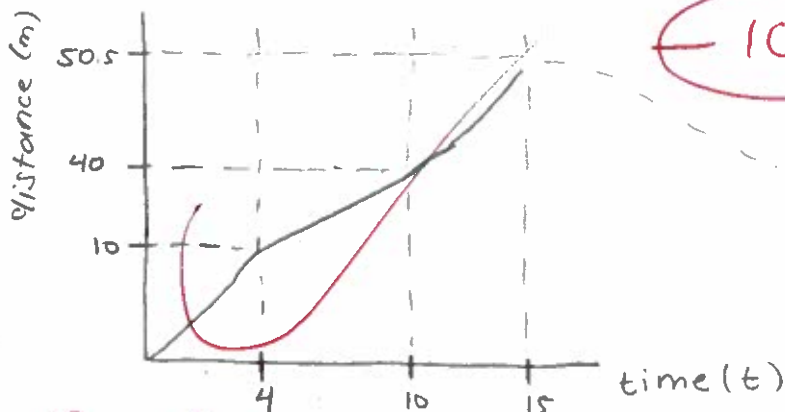
$$\frac{ds}{dt} = 5$$

$$s = \int 5 dt$$

$$= 5t$$

$$\frac{ds}{dt} = -t - 15$$

$$s = -\frac{t^2}{2} + 15t + C$$



100

For $4 \text{ s} < t < 10 \text{ s}$

$$a = \frac{dv}{dt} = 0$$

$$\int_{10}^s ds = \int_4^t s = dt \Rightarrow s = 8t - 1$$

$$s = 40 \text{ m}$$

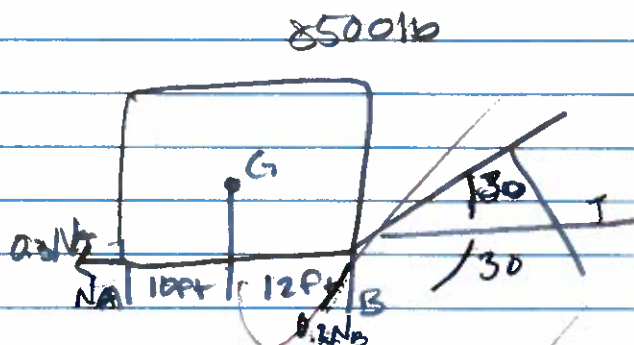
When $t = 10 \text{ sec}$, $s = 40 \text{ m}$

BELOW
AVERAGE

750
1000

Homework 3

Problem 1



$$\sum M_B = 0$$

$$8500(12) - N_A(22) = 0$$

$$N_A = 4636.364 \text{ lb}$$

in the x-direction

$$\sum F_x = 0$$

$$T \cos 60^\circ - 0.2 N_B \cos 30^\circ - N_B \sin 30^\circ - 0.3(4636.364) = 0$$

$$T(0.866) - 0.67321 N_B = 1390.91$$

in y-direction

$$\sum F_y = 0$$

$$4636.364 - 8500 + T \sin 30^\circ + N_B \cos 30^\circ - 0.2 N_B \sin 30^\circ = 0$$

$$T(0.5) + 0.766 N_B = 3863.636$$

$$T = 3664.51 \text{ lb}$$

$$T = 3.67$$

$$N_B = 2650.61 \text{ lb}$$

COVER?
Eng. Paper

-20

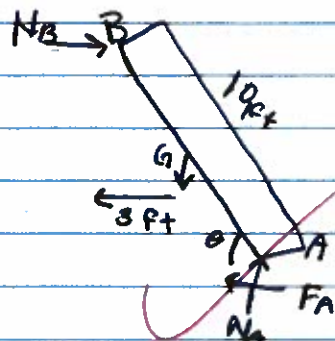
200

you did not use
engineering paper

-30

200

Problem 2 mass 180 lb $\mu_s = 0.4$



$$F_A = \mu_s \times N_A$$

$$\sum F_y = 0$$

$$\sum F_x = 0$$

$$-mg + N_A = 0$$

$$N_B - F_A = 0$$

$$N_A = mg = 180 \text{ lb}$$

$$N_B = F_A$$

moment about Point B

$$\sum M_B = 0$$

$$-mg \times 3 + N_A \times 10 \cos \theta - F_A \times 10 \sin \theta = 0$$

$$-180 \times 3 + N_A \times 10 \cos \theta - 0.4 \times N_A \times 10 \sin \theta = 0$$

$$-540 + 180 \times 10 \cos \theta - 0.4 \times 180 \times 10 \sin \theta = 0$$

$$-540 + 1800 \cos \theta - 720 \sin \theta = 0$$

$$10 \cos \theta = 4 \sin \theta + 3$$

$$\theta = 52.025^\circ$$

Problem 3

70 km/h acc 6000 km/h²

How long? 120 km/h

200

$$V_t = V_0 + at$$

$$120 = 70 + 6000t$$

$$t = 0.00833 \text{ h}$$

$$= 0.00833 \times 3600 = \boxed{30 \text{ sec}}$$

$$V_f^2 = V_0^2 + 2a \Delta s$$

Δs = distance traveled during time

$$120^2 = 70^2 + (2 \times 6000 \times \Delta s)$$

$$\Delta s = 0.792 \text{ km}$$

$$= \boxed{0.792 \text{ m}}$$

Problem 4

$$v = (3t^2 - 6t) \text{ ft/s} \quad g = 4 \text{ ft/s}^2 \text{ when } t=0 \quad t=4 \text{ s}$$

$$t=0 \text{ to } t=4 \text{ s} \quad \text{acc. } t=2 \text{ s}$$

a) When $s=4$ at $t=0$

$$4 = 0^3 - 0t^2 + C$$

$$C=4$$

$$s = t^3 - 3t^2 + 4$$

Position at time $t=4$

$$S = 4^3 - 3 \times 4^2 + 4$$

$$S = 20 \text{ ft}$$

$$b) 3t^2 - 6t = 0$$

$$(3t-6)t=0$$

at time $t=0$, position

$$S = 0^3 - 3 \times 0^2 + 4$$

$$S = 4 \text{ ft}$$

at time $t=4$

$$g = 20 \text{ ft}$$

Total distance

$$S = 4 + 20$$

$$S = 24 \text{ ft}$$

c) acceleration

$$a = dv/dt$$

$$a = d(3t^2 - 6t)/dt$$

$$a = 6t - 6$$

acceleration at $t=2$

$$a = 6 \times 2 - 6$$

$$a = 6 \text{ ft/s}^2$$

V.

CLASSWORK

[06]

CVEG 2400

Statics & Dynamics

Fall 2021

Classwork 01

ABOVE
AVERAGE

11



Department of Civil & Environmental Engineering

CVEG 2454P01

Statics & Dynamics

Fall 2021

Dr. Vzevi

Classwork01Sep01A

Assigned: 09/01/2021

Due: Wed. Sep 01, 2021 (In Class)

Chapter 02

Name [PRINT]

Larry Hengue

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

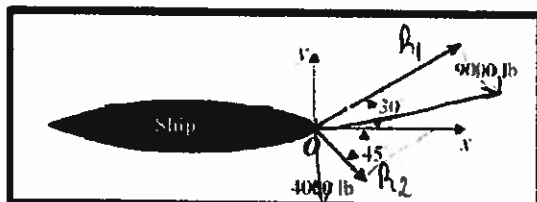
GRADE ⇒

100
100

Using the vector (Cartesian coordinates, i and j) method, solve the following problem

Problem 1 (a) [50]

A ship is pulled into the dock by two ropes, which exert 4000 lb and 9000 lb. Determine the resultant force.



$$\vec{R}_1 = 9000 \cos 30^\circ \vec{i} + 9000 \sin 30^\circ \vec{j}$$

$$\vec{R}_1 = 7,794.2 \vec{i} + 4500 \vec{j}$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$\theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$

$$\vec{R}_2 = 4000 \cos 45^\circ \vec{i} - 4000 \sin 45^\circ \vec{j}$$

$$\vec{R}_2 = 2,828.42 \vec{i} - 2,828.42 \vec{j}$$

$$\vec{R} = \vec{R}_1 + \vec{R}_2 = (7,794.2 + 2,828.42) \vec{i} + (4500 - 2,828.42) \vec{j}$$

$$\vec{R} = 10,622.6 \vec{i} + 1,671.58 \vec{j}$$

RESULTANT FORCE, R = 10,753.3 lb

b) [20] Determine the components of the resultant force, R in the x- and y-directions

$$|R| = \sqrt{10,622.6^2 + 1,671.58^2} = 10,753.3 \text{ lb}$$

$$R_x = \sqrt{10,622.6^2} = 10,622.6 \text{ lb}$$

$$R_y = \sqrt{1,671.58^2} = 1,671.58 \text{ lb}$$

RESULTANT FORCE (x-direction), $R_x = 10,622.6$ lb

RESULTANT FORCE (y-direction), $R_y = 1,671.58$ lb

c) [30] Determine the angle of the resultant force, R in reference to the x-axis

$$\theta = \tan^{-1} \left(\frac{1,671.58}{10,622.6} \right) = 8.9^\circ$$

ANGLE (RESULTANT FORCE) (with reference to x-direction) =

8.9°

AVERAGE

Chapter 02

Name [PRINT] Akili Toman

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

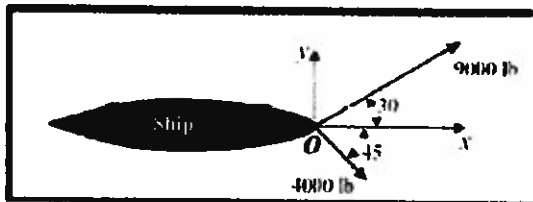
GRADE →

68
100

Using the vector (Cartesian coordinates, i and j) method, solve the following problem

Problem 1 (a) [50]

A ship is pulled into the dock by two ropes, which exert 4000 lb and 9000 lb. Determine the resultant force.



$$F_1 = 9000 \cos 30^\circ + 9000 \sin 30^\circ$$

$$F_2 = 4000 \cos 45^\circ + 4000 \sin 45^\circ$$

$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$7794.22 \quad \theta = \tan^{-1} \left| \frac{R_y}{R_x} \right|$$

$$1800 \cos 45^\circ + 4500 \sin 45^\circ$$

$$2828.42 \mathbf{i} + 2828.42 \mathbf{j}$$

$$R = \sqrt{R_x^2 + R_y^2}$$

$$F_1 = 9000 \cos 30^\circ \mathbf{i} + 9000 \sin 30^\circ \mathbf{j}$$

$$F_2 = 4000 \cos 45^\circ \mathbf{i} + 4000 \sin 45^\circ \mathbf{j}$$

RESULTANT FORCE $R = 10622 \mathbf{i} + 7328.42 \mathbf{j} \text{ lb}$

b) [20] Determine the components of the resultant force, R in the x- and y-directions

RESULTANT FORCE (x-direction), $R_x = 10622 \text{ lb}$

RESULTANT FORCE (y-direction), $R_y = 7328.42 \text{ lb}$

c) [30] Determine the angle of the resultant force, R in reference to the x-axis

ANGLE (RESULTANT FORCE) (with reference to x-direction) =

60.3°

BELOW
AVERAGE

Chapter 02

Name [PRINT] Tyreese Washington

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

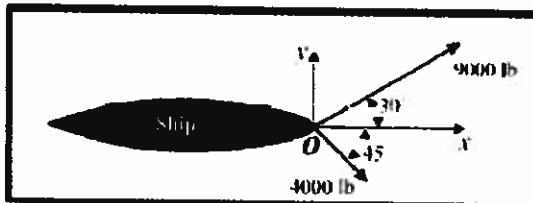
GRADE ⇒

25
100

Using the vector (Cartesian coordinates, i and j) method, solve the following problem

Problem 1 (a) [50]

A ship is pulled into the dock by two ropes, which exert 4000 lb and 9000 lb. Determine the resultant force.



$$|R| = \sqrt{R_x^2 + R_y^2}$$

$$F_x + F_y \cos 30^\circ$$

$$9000 \cos 30^\circ + 4000 \cos 45^\circ = 7794.23 + 2828.43 = 10622.66 \text{ lb}$$

RESULTANT FORCE, $R = 10622.66 \text{ lb}$

b) [20] Determine the components of the resultant force, R in the x- and y-directions

RESULTANT FORCE (x-direction), $R_x =$ _____ lb

RESULTANT FORCE (y-direction), $R_y =$ _____ lb

c) [30] Determine the angle of the resultant force, R in reference to the x-axis

ANGLE (RESULTANT FORCE) (with reference to x-direction) = _____ °

CVEG 2400

Statics & Dynamics

Fall 2021

Classwork 02

ABOVE
AVERAGE

Chapter 03

Name [PRINT]

Kennedy Dent

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

$$(\Sigma F_x) \mathbf{i} + (\Sigma F_y) \mathbf{j} + (\Sigma F_z) \mathbf{k} = 0$$

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

$$\Sigma F_z = 0$$

1) find position vector

2) find unit vector

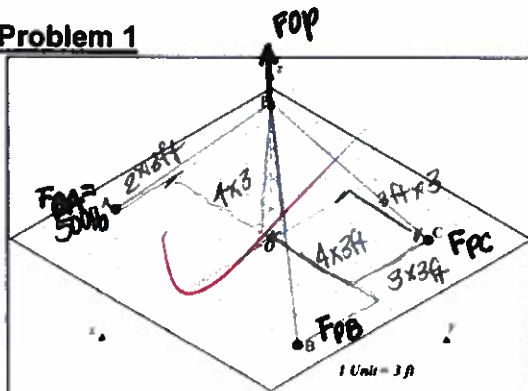
3) multiply unit vector by mag of force = F_{cable}

GRADE $\Rightarrow$

300

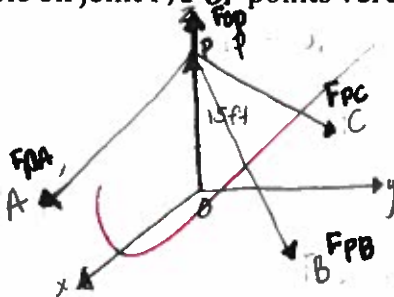
300

Problem 1



A 15 ft tall pole is supported by three cables. The pole (OP) is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, $|F_{PA}|$ is 500 lb, determine the tension [lb] in the other two cables, $|F_{PB}|$ and $|F_{PC}|$. Also, determine the force [lb] exerted by the pole on joint P, $|F_{OP}|$.

(a) [50] Provide the **Free Body Diagram** [Hint: Since the cables are tension, the force exerted by the pole on joint P, F_{OP} points vertically upward in the z-direction and its magnitude is $|F_{OP}|$]



* multiply all points by 3 due to units

position vectors:

$$\begin{aligned} A &= (6, -12, 0) \\ B &= (9, 12, 0) \\ C &= (-9, 9, 0) \\ P &= (0, 0, 15) \end{aligned}$$

$$\begin{aligned} r_{PA} &= \{ (6-0)\mathbf{i} + (-12-0)\mathbf{j} + (0-15)\mathbf{k} \} \text{ ft} \\ r_{PB} &= \{ (9-0)\mathbf{i} + (12-0)\mathbf{j} + (0-15)\mathbf{k} \} \text{ ft} \\ r_{PC} &= \{ (-9-0)\mathbf{i} + (9-0)\mathbf{j} + (0-15)\mathbf{k} \} \text{ ft} \end{aligned}$$

b) [75] Determine each of the vector force equations [HINT: $F_{OP} = |F_{OP}| \mathbf{k}$]

$$\begin{aligned} F_{PA} &= 500 \text{ lb} \left(\frac{6\mathbf{i} - 12\mathbf{j} - 15\mathbf{k}}{20.12} \right) \\ F_{PA} &= 500 \text{ lb} \left(\frac{6}{20.12}\mathbf{i} - \frac{12}{20.12}\mathbf{j} - \frac{15}{20.12}\mathbf{k} \right) \end{aligned}$$

$$\begin{aligned} F_{PB} &= |F_{PB}| u_{PB} \\ &= |F_{PB}| \left(\frac{9}{21.21}\mathbf{i} + \frac{12}{21.21}\mathbf{j} - \frac{15}{21.21}\mathbf{k} \right) \\ &= |F_{PB}| (0.424\mathbf{i} + 0.57\mathbf{j} - 0.707\mathbf{k}) \\ &= |F_{PB}| (0.424\mathbf{i} + 0.57\mathbf{j} - 0.707\mathbf{k}) \end{aligned}$$

$$\begin{aligned} F_{PC} &= |F_{PC}| u_{PC} \\ &= |F_{PC}| \left(\frac{-9}{19.67}\mathbf{i} + \frac{9}{19.67}\mathbf{j} - \frac{15}{19.67}\mathbf{k} \right) \\ &= |F_{PC}| (-0.457\mathbf{i} + 0.457\mathbf{j} - 0.762\mathbf{k}) \end{aligned}$$

FORCE vector, $F_{PA} =$	149.11	-298.21	-372.76	$\mathbf{k}$	lb
FORCE vector, $F_{PB} =$	$F_{PB} \left(\frac{9}{21.21} \right)$	$+ F_{PB} \left(\frac{12}{21.21} \right)$	$- F_{PB} \left(\frac{15}{21.21} \right)$	$\mathbf{k}$	lb
FORCE vector, $F_{PC} =$	$F_{PC} \left(-\frac{9}{19.67} \right)$	$+ F_{PC} \left(\frac{9}{19.67} \right)$	$- F_{PC} \left(\frac{15}{19.67} \right)$	$\mathbf{k}$	lb
FORCE vector, $F_{OP} =$	0	0	$ F_{OP} $	$\mathbf{k}$	lb

Continues on next page

75

$$\begin{aligned} F_{OP} &= |F_{OP}| u_{PB} \\ &= |F_{OP}| \mathbf{k} \end{aligned}$$

c) [50] Provide the **EQUILIBRIUM** Equations - in equation form with only numbers on the RHS.
[SHOW ALL WORK]

Σ component = 0

for i component:

$$\Sigma F_x \Rightarrow 149.11 + \frac{9}{21.21}|F_{PB}| - \frac{9}{19.67}|F_{PC}| = 0$$

$$\text{eqn 1} \Rightarrow \left(\frac{9}{21.21}\right)|F_{PB}| - \left(\frac{9}{19.67}\right)|F_{PC}| = -149.11$$

for j component:

$$\Sigma F_y \Rightarrow -298.11 + |F_{PB}|\left(\frac{12}{21.21}\right) + |F_{PC}|\left(\frac{9}{19.67}\right) = 0$$

$$\text{eqn 2} \Rightarrow |F_{PB}|\left(\frac{12}{21.21}\right) + |F_{PC}|\left(\frac{9}{19.67}\right) = 298.11$$

for y component:

$$\Sigma F_z = -372.76 - |F_{PB}|\left(\frac{15}{21.21}\right) - |F_{PC}|\left(\frac{15}{19.67}\right)$$

$$\text{eqn 3} \Rightarrow -|F_{PB}|\left(\frac{15}{21.21}\right) - |F_{PC}|\left(\frac{15}{19.67}\right) + |F_{OP}| = 0$$

SO

d) [75] Solve the **EQUILIBRIUM** Equations USING THE SUBSTITUTION METHOD
[SHOW ALL WORK]

① eqn 1 & eqn 2

$$\left(\frac{9}{21.21}\right)|F_{PB}| - \left(\frac{9}{19.67}\right)|F_{PC}| = -149.11$$

$$\left(\frac{12}{21.21}\right)|F_{PB}| + \left(\frac{9}{19.67}\right)|F_{PC}| = 298.11$$

$$\frac{0.49}{0.49}|F_{PB}| \mp 0 = \frac{149}{0.49}$$

$$|F_{PB}| = 150.81 \text{ lb}$$

75

② using eq. 2 to find $|F_{PC}|$

$$|F_{PB}|\left(\frac{12}{21.21}\right) + |F_{PC}|\left(\frac{9}{19.67}\right) = 298.11$$

$$(156.51 \text{ lb})\left(\frac{12}{21.21}\right) + |F_{PC}|\left(\frac{9}{19.67}\right) = 298.11$$

$$85.15 + |F_{PC}|\left(\frac{9}{19.67}\right) = 298.11$$

$$|F_{PC}| = \frac{(298.11 - 85.15) \text{ lb}}{0.458}$$

$$|F_{PC}| = 464.9 \text{ lb}$$

③ using eqn 3

$$(-150.81)\left(\frac{15}{21.21}\right) - (464.9)\left(\frac{15}{19.67}\right) + |F_{OP}| = 0$$

$$-106.43 - 354.52446 = -372.76$$

$$|F_{OP}| = 372.76 + 106.43 + 354.52$$

$$|F_{OP}| = 833.69$$

$$|F_{OP}| = 834 \text{ lb}$$

e) [50] Provide your results
[SHOW ALL WORK]

SO

Tension, $|F_{PA}| = 500 \text{ lb}$

Tension, $|F_{PB}| = 151 \text{ lb}$

Tension, $|F_{PC}| = 465 \text{ lb}$

Force, $|F_{OP}| = 834 \text{ lb}$

AVERAGE

M



Department of Civil & Environmental Engineering

CVEG 2400P01

Statics & Dynamics

Fall 2021

Dr. Nzewi

Classwork03_2021Sep20A

Assigned: 09/20/2021

Due: Tues. Sep 21, 2021 at 10:00 PM (Canvas) In-class 09/22/2021

Chapter 03

Name [PRINT]

Kayla Freeman

SUBMIT THIS as cover sheet with your work

Instructions:

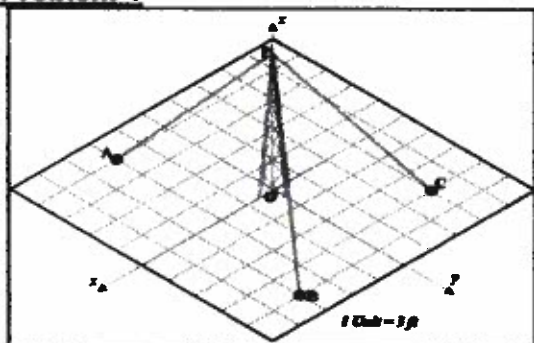
In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

$$(\Sigma F_x)i + (\Sigma F_y)j + (\Sigma F_z)k = 0$$

$$\begin{aligned}\Sigma F_x &= 0 \\ \Sigma F_y &= 0 \\ \Sigma F_z &= 0\end{aligned}$$

GRADE $\Rightarrow$
251
300

Problem 1



A 15 ft tall pole is supported by three cables. The pole (OP) is subjected only to vertical loading due to the tension in the cables. If the tension in cable PA, $|F_{PA}|$ is 500 lb, determine the tension [lb] in the other two cables, $|F_{PB}|$ and $|F_{PC}|$. Also, determine the force [lb] exerted by the pole on joint P, $|F_{OP}|$.

(a) [50] Provide the **Free Body Diagram** [Hint: Since the cables are tension, the force exerted by the pole on joint P, F_{OP} points vertically upward in the z-direction and its magnitude is $|F_{OP}|$]

40

Continues on next page

b) [75] Determine each of the vector force equations [HINT: $F_{OP} = |F_{OP}| \mathbf{k}$]

60

$$\begin{array}{l} \text{FORCE vector, } F_{PA} = 148.44 \quad | \quad -296.88 \quad | \quad -371.10 \quad \mathbf{k} \quad \text{lb} \\ \text{FORCE vector, } F_{PB} = |F_{PB}| \frac{9}{21.21} \quad | \quad |F_{PB}| \frac{12}{21.21} \quad | \quad -|F_{PB}| \frac{15}{21.21} \quad \mathbf{k} \quad \text{lb} \\ \text{FORCE vector, } F_{PC} = -|F_{PC}| \frac{9}{19.67} \quad | \quad |F_{PC}| \frac{9}{19.67} \quad | \quad -|F_{PC}| \frac{15}{19.67} \quad \mathbf{k} \quad \text{lb} \\ \text{FORCE vector, } F_{OP} = 0 \quad | \quad 0 \quad | \quad |F_{OP}| \quad \mathbf{k} \quad \text{lb} \end{array}$$

c) [50] Provide the EQUILIBRIUM Equations - in equation form with only numbers on the Right-Hand-Side [RHS] of the equations. [SHOW ALL WORK] $\sum F = 0$

$$\sum F_x: 148.44 + |F_{PB}| \frac{9}{21.21} - |F_{PC}| \frac{9}{19.67} + 0 = 0$$

$$\sum F_y: -296.88 + |F_{PB}| \frac{12}{21.21} + |F_{PC}| \frac{9}{19.67} + 0 = 0$$

$$\sum F_z: -371.10 - |F_{PB}| \frac{15}{21.21} - |F_{PC}| \frac{15}{19.67} + |F_{OP}| = 0$$

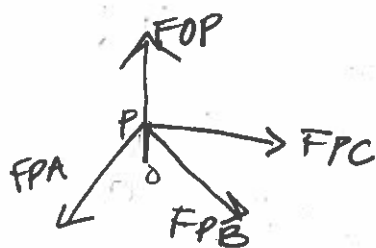
d) [75] Solve the EQUILIBRIUM Equations USING THE SUBSTITUTION METHOD [SHOW ALL WORK, as appropriate]

75

e) [50] Provide the final results [Summary] [SHOW ALL WORK, as appropriate]

$$\begin{array}{l} \text{Tension, } |F_{PA}| = 500 \quad \text{lb} \\ \text{Tension, } |F_{PB}| = 149.95 \quad \text{lb} \\ \text{Tension, } |F_{PC}| = 163.49 \quad \text{lb} \\ \text{Force, } |F_{OP}| = 820.60 \quad \text{lb} \end{array}$$

a) FBD

Coordinates

$$P: (0, 0, 15)$$

$$A: (6, -12, 0)$$

$$B: (9, 12, 0)$$

$$C: (-9, 9, 0)$$

$$O: 0, 0, 0$$

$$B) \vec{r}_{PA} = (6-0)i + (-12-0)j + (0-15)k$$

$$\vec{r}_{PA} = \{ 6i - 12j - 15k \} \text{ ft}$$

$$|\vec{r}_{PA}| = \sqrt{6^2 + 12^2 + 15^2} = 20.12 \text{ ft}$$

$$\vec{u}_{PA} = \frac{6}{20.12}i - \frac{12}{20.12}j - \frac{15}{20.12}k$$

$$\vec{F}_{PA} = |\vec{F}_{PA}| \vec{u}_{PA} \rightarrow 500 \left(\frac{6}{20.12}i - \frac{12}{20.12}j - \frac{15}{20.12}k \right)$$

$$\vec{F}_{PA} = 148.44i - 296.88j - 371.10k \text{ lb}$$

$$\vec{r}_{PB} = (9-0)i + (12-0)j + (0-15)k \text{ ft}$$

$$\vec{r}_{PB} = 9i + 12j - 15k$$

$$|\vec{r}_{PB}| = \sqrt{9^2 + 12^2 + 15^2} = 21.21 \text{ ft}$$

$$\vec{u}_{PB} = \frac{9}{21.21}i + \frac{12}{21.21}j - \frac{15}{21.21}k$$

$$\vec{r}_{PC} = (-9-0)\mathbf{i} + (9-0)\mathbf{j} + (0-15)\mathbf{k}$$

$$\vec{r}_{PC} = -9\mathbf{i} + 9\mathbf{j} - 15\mathbf{k}$$

$$|\vec{r}_{PC}| = \sqrt{9^2 + 9^2 + 15^2} = 19.67 \text{ ft}$$

$$\vec{u}_{PC} = \left\{ \frac{-9}{19.67}\mathbf{i} + \frac{9}{19.67}\mathbf{j} - \frac{15}{19.67}\mathbf{k} \right\}$$

$$C: \sum F = 0$$

F_x:

$$148.44 + |F_{PB}| \frac{9}{21.21} - |F_{PC}| \frac{9}{19.67} + 0 = 0$$

F_y

$$-296.88 + |F_{PB}| \frac{12}{21.21} + |F_{PC}| \frac{9}{19.67} + 0 = 0$$

F_z

$$-371.10 - |F_{PB}| \frac{15}{21.21} - |F_{PC}| \frac{15}{19.67} + |F_{OP}| = 0$$

D&E

$$F_x \rightarrow 148.44 + |F_{PB}| \frac{9}{21.21} - |F_{PC}| \frac{9}{19.67} + 0 = 0$$

$$|F_{PB}| \frac{9}{21.21} - |F_{PC}| \frac{9}{19.67} = -148.44$$

$$\frac{|F_{PB}| \frac{9}{21.21}}{\frac{9}{21.21}} = \frac{-148.44 + |F_{PC}| \frac{9}{19.67}}{\frac{9}{21.21}} = |F_{PB}|$$

$$|FPB| = 1.07829 (FPC - 324.424)$$

$$|FPB| = 1.07829 FPC - 349.823 \quad (1)$$

Plug into

Fy equation

$$-296.88 + |FPB| \frac{12}{21.21} + |FPC| \frac{9}{19.67} + 0 = 0$$

$$(1.07829 FPC - 349.823) \frac{12}{21.21} + FPC \frac{9}{19.67} = 296.88$$

Solve For FPC

$$0.610 FPC - 197.9196 + FPC \frac{9}{19.67} = 296.88$$

$$+ 197.9196$$

$$0.610 FPC + FPC \frac{9}{19.67} = 494.799$$

$$FPC 1.06755 = \frac{494.799}{1.06755}$$

$$FPC = 463.4916$$

Plug into equation (1)

$$|FPB| = 1.07829 (463.49) - 349.823$$

$$|FPB| = 149.9516$$

Plug FPB & FPC into Fz equation, Solve for FOP

$$-371.10 - (149.95) \frac{15}{21.21} - (463.49) \frac{15}{19.67} + FOP = 0$$

$$-371.10 - 106.044 - 353.449 + FOP = 0$$

$$-830.60 + FOP = 0$$

$$-830.60 = -FOP$$

$$FOP = 830.6016$$

BELOW
AVERAGE

Chapter 03

Name [PRINT] Hunter Evans

SUBMIT THIS as cover sheet with your work

Instructions:

In all the problems you must provide enough details and description of the solution method to demonstrate your knowledge of the solution method. A substantial portion of the grade will be based on your methods.

$$(\Sigma F_x) \mathbf{i} + (\Sigma F_y) \mathbf{j} + (\Sigma F_z) \mathbf{k} = 0$$

$$\Sigma F_x = 0$$

$$\Sigma F_y = 0$$

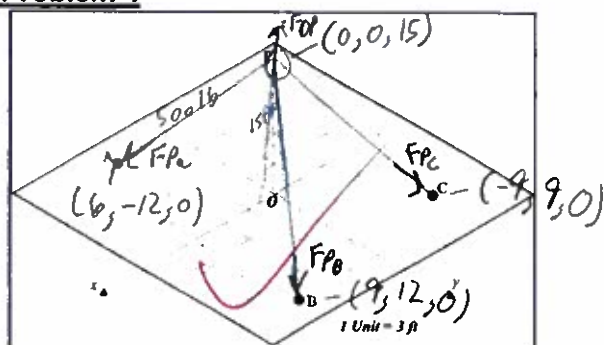
$$\Sigma F_z = 0$$

GRADE →

65

300

Problem 1



A 15 ft tall pole is supported by three cables. The pole (OP) is subjected **only** to vertical loading due to the tension in the cables. If the tension in cable PA, $|F_{PA}|$ is 500 lb, determine the tension [lb] in the other two cables, $|F_{PB}|$ and $|F_{PC}|$. Also, determine the force [lb] exerted by the pole on joint P, $|F_{OP}|$.

(a) [50] Provide the **Free Body Diagram** [Hint: Since the cables are tension, the force exerted by the pole on joint P, $\mathbf{F}_{OP}$ points vertically upward in the z-direction and its magnitude is $|F_{OP}|$]

$$|r_{PA}| = \sqrt{6^2 + (-12)^2 + 15^2} = 20.12 \text{ ft}$$

$$\mathbf{r}_{PA} = (6-0)\mathbf{i} + (-12-0)\mathbf{j} + (0-15)\mathbf{k} = 6\mathbf{i} - 12\mathbf{j} - 15\mathbf{k}$$

$$\mathbf{u}_{PA} = \frac{\mathbf{r}_{PA}}{|r_{PA}|} = \frac{6}{20.12}\mathbf{i} - \frac{12}{20.12}\mathbf{j} - \frac{15}{20.12}\mathbf{k}$$

$$|r_{PB}| = \sqrt{9^2 + 12^2 + 15^2} = 21.21 \text{ ft}$$

$$\mathbf{r}_{PB} = (9-0)\mathbf{i} + (12-0)\mathbf{j} + (0-15)\mathbf{k} = 9\mathbf{i} + 12\mathbf{j} - 15\mathbf{k}$$

$$\mathbf{F}_{PB} = |F_{PB}| \left(\frac{9}{21.21}\mathbf{i} + \frac{12}{21.21}\mathbf{j} - \frac{15}{21.21}\mathbf{k} \right)$$

b) [75] Determine **each** of the **vector force equations** [HINT: $\mathbf{F}_{OP} = |F_{OP}| \mathbf{k}$]

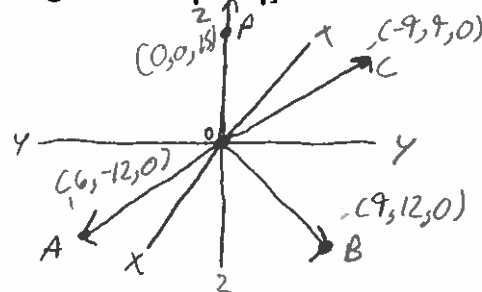
$$\mathbf{F}_{PA} = |F_{PA}| \mathbf{u}_{PA}$$

$$\mathbf{r}_{PC} = (-9-0)\mathbf{i} + (9-0)\mathbf{j} + (0-15)\mathbf{k} = -9\mathbf{i} + 9\mathbf{j} - 15\mathbf{k}$$

$$|r_{PC}| = \sqrt{(-9)^2 + 9^2 + 15^2} = 19.67 \text{ ft}$$

$$\mathbf{F}_{PC} = |F_{PC}| \left(\frac{-9}{19.67}\mathbf{i} + \frac{9}{19.67}\mathbf{j} - \frac{15}{19.67}\mathbf{k} \right)$$

$$\mathbf{F}_{OP} = 0\mathbf{i} + 0\mathbf{j} + |F_{OP}|\mathbf{k}$$



FORCE vector, $\mathbf{F}_{PA} = 147.1 \mathbf{i} - 298.21 \mathbf{j} - 372.76 \mathbf{k} \text{ lb}$

FORCE vector, $\mathbf{F}_{PB} = 63.65 \mathbf{i} - 84.87 \mathbf{j} - 106.08 \mathbf{k} \text{ lb}$

FORCE vector, $\mathbf{F}_{PC} = -213.35 \mathbf{i} + 213.35 \mathbf{j} - 355.59 \mathbf{k} \text{ lb}$

FORCE vector, $\mathbf{F}_{OP} = 0 \mathbf{i} + 0 \mathbf{j} + 840.58 \mathbf{k} \text{ lb}$

Continues on next page

c) [50] Provide the **EQUILIBRIUM** Equations - in equation form with only numbers on the RHS.
[SHOW ALL WORK]

$$\uparrow = -0.30 F_{PA} - 0.42 F_{PB} + 0.46 F_{PC} + 0 = 0$$

$$\rightarrow = -0.60 F_{PA} - 0.57 F_{PB} + 0.46 F_{PC} + 0 = 0$$

$$\uparrow = 0.75 F_{PA} + 0.71 F_{PB} + 0.77 F_{PC} + F_{OP} = 0$$

d) [75] Solve the **EQUILIBRIUM** Equations **USING THE SUBSTITUTION METHOD**
[SHOW ALL WORK]

$$\uparrow = -0.30(500) - 0.42 F_{PB} + 0.46 F_{PC} = 0$$

$$-0.42 F_{PB} + 0.46 F_{PC} = 150$$

$$\rightarrow = -0.60(500) + 0.57 F_{PB} + 0.46 F_{PC} = 0$$

$$0.57 F_{PB} + 0.46 F_{PC} = 300$$

$$\uparrow = 0.75(500) + 0.71 F_{PB} + 0.77 F_{PC} + F_{OP} = 0$$

$$375 + 0.71 F_{PB} + 0.77 F_{PC} + F_{OP} = 0$$

$$F_{PC} = \frac{150 + 0.42 F_{PB}}{0.46}$$

$$0.57 F_{PB} + 0.46 \left(\frac{150 + 0.42 F_{PB}}{0.46} \right) = 300$$

$$0.57 F_{PB} + 150 + 0.42 F_{PB} = 300$$

$$F_{PB} = 150$$

$$0.57(150) + 0.46 F_{PC} = 300$$

$$\frac{0.46 F_{PC}}{0.46} = \frac{214.5}{0.46}$$

$$F_{PC} = 466.3$$

e) [50] Provide your results
[SHOW ALL WORK]

$$375 + 0.71(150) + 0.77(466.3) + F_{OP} = 0$$

$$92.79 + F_{OP} = 0$$

$$F_{OP} = 840.55$$

Tension, $|F_{PA}| = 500$ lb

Tension, $|F_{PB}| = 150$ lb

Tension, $|F_{PC}| = 466.3$ lb

Force, $|F_{OP}| = 840.55$ lb

Your steps were not clearly shown,
I Didn't see how you arrived at your answer

CVEG 2400

Statics & Dynamics

Fall 2021

Classwork 03

ABOVE
AVERAGE

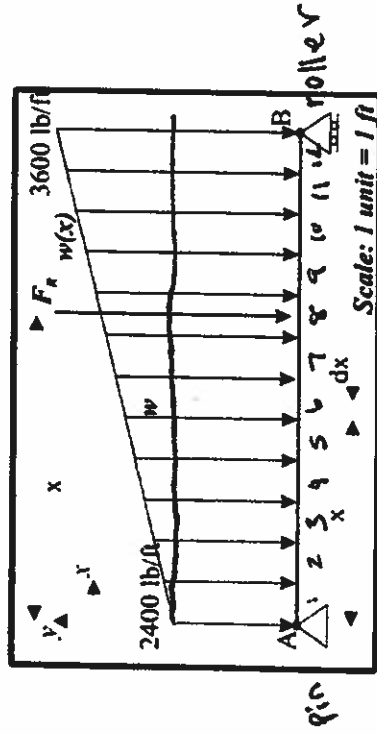
Course: CVEG 2400P01 Name: Kayla Freeman

DUE: 10/27/2021 In class

Classwork: 20210ct27A [130/150] Date: 20210ct27

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

Determine the equivalent force and its location for the load intensity diagram and draw the free-body diagram (FBD)



$$\vec{F}_R = \vec{F}_1 + \vec{F}_2$$

$$\vec{F}_1 = (0.5)(12) \left(\frac{2400}{2} \right) = 21600 \text{ lb}$$

$$\vec{F}_2 = 2400 \text{ lb} (12 \text{ ft}) = 28800 \text{ lb}$$

$$\text{Rectangle } \bar{x} = 0.5 \times 12 = 6 \text{ ft}$$

$$F_R = 21600 \text{ lb} + 28800 \text{ lb} = 50400 \text{ lb}$$

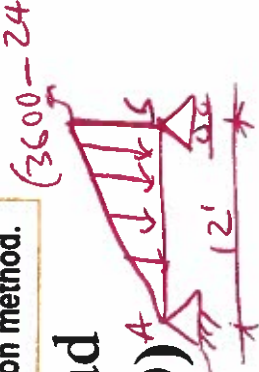
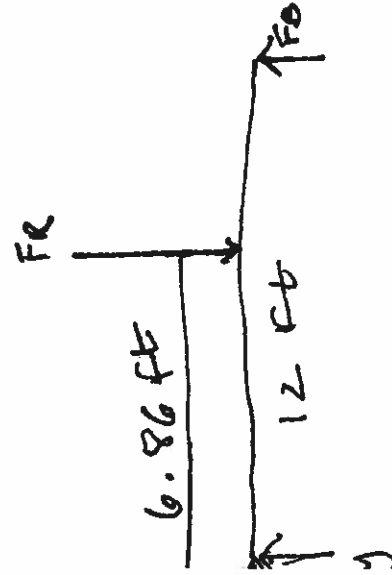
$$\sum M_R = 8 \text{ ft} \times (21600) + (6 \text{ ft}) (28800 \text{ lb})$$

$$M_R = 345600 \text{ lb} \cdot \text{ft}$$

$$\bar{x} = \frac{M_R}{F_R} = \frac{345600 \text{ lb} \cdot \text{ft}}{50400 \text{ lb}} = 6.86 \text{ ft}$$

Nice works, but your F_1 is wrong and it affects your whole works

FBD



AVERAGE

Course: CVEG 2400P01 Name: Danano Edgari

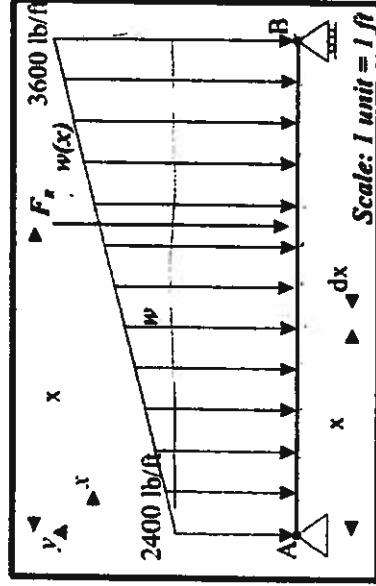
DUE: 10/27/2021 In class

14

Classwork: 20210ct27A [100/150] Date: 20210ct27

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

Determine the equivalent force and its location for the load intensity diagram and draw the free-body diagram (FBD)



① $\frac{F_R \text{ triangle}}{2400(12)}$

28800 lb/ft

② $\frac{F_R \text{ triangle}}{\frac{1}{2}(1200)(12)}$

7200 lb

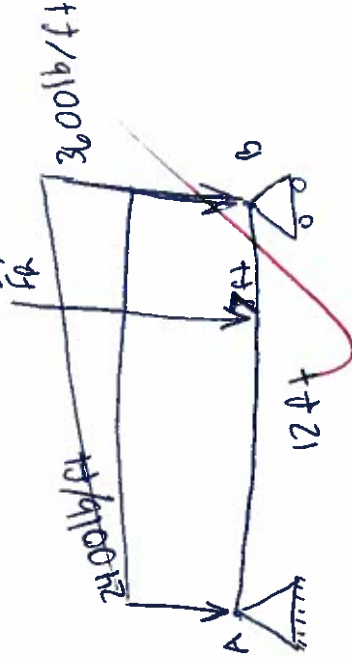
$F_{eq} = 28800 + 7200 = 36000 \text{ lb}$

$\frac{4}{3} \cdot \frac{12}{1} = 8$

$w = 6 \text{ ft} \quad w(x) = 8 \text{ ft} -$

7 ft

$\sum M_0 =$



BELOW
AVERAGE

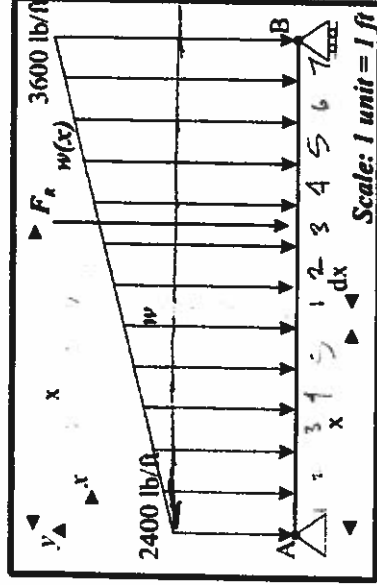
Course: CVEG 2400P01 Name: Akili Todman

DUE: 10/27/2021 In class

Classwork: 20210ct27A [30/150] Date: 20210ct27

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

Determine the equivalent force and its location for the load intensity diagram and draw the free-body diagram (FBD)



$$x_1 = 5 \quad x_2 = 7$$
$$F_1 = \frac{1}{2} \cdot 2400 \cdot 5 = 6000$$

$$F_2 = \frac{2}{3} \cdot 2400 \cdot 7 = 11200$$

$$F_R = F_1 + F_2 = 17,200$$

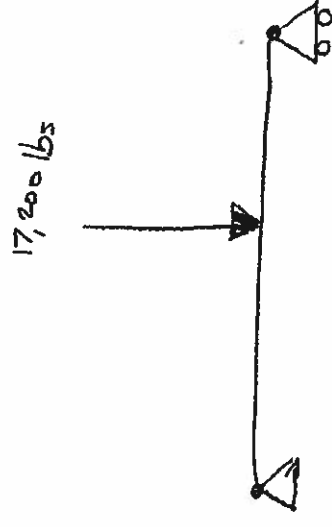
$$\bar{x}_1 = \frac{1}{2} \cdot 5 = 2.5$$

$$\bar{x}_2 = \frac{2}{3} \cdot 7 = 9.67$$

$$6000(2.5) + 17,200(9.67) = 181324$$

$$181324 = 17,200 \bar{x}$$

$$\bar{x} = 10.54$$



CVEG 2400

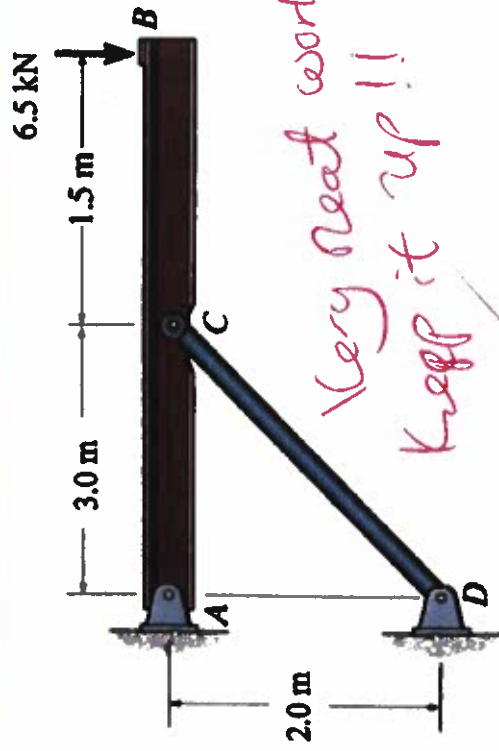
Statics & Dynamics

Fall 2021

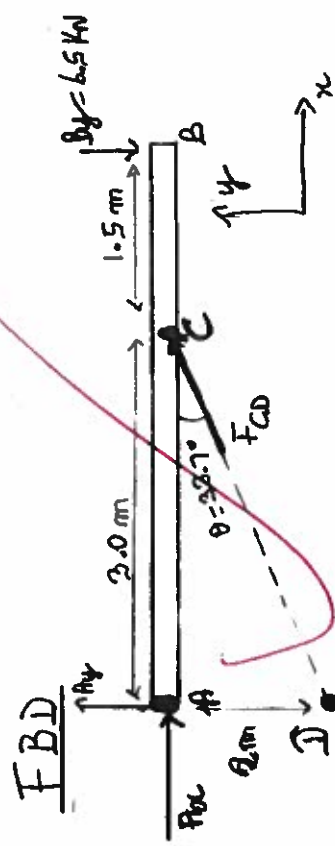
Classwork 04

ABOVE
AVERAGE

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.



Very neat work
Keep it up!!



Calculation of angle θ

$$\tan \theta = \frac{\sin \theta}{\cos \theta} = \frac{2 \text{ m}}{3 \text{ m}} = 0.6667$$

$$\theta = \tan^{-1}(0.6667) \approx \theta = 33.7^\circ$$

For the 6.5 kN load at B, the beam, AB, has pins at A and C. Determine the reactions at A and C [kN]. Assume that the x- and y-axes are in the horizontal and vertical directions. That is, the x-axis is along AB, and so on. Be sure to begin by drawing a complete free-body diagram of the beam.

$$\sum \pm M_A = 0 \Rightarrow F_{CD} \times \sin 33.7^\circ \times 3 - 6.5 \times 4.5 = 0$$

$$\Rightarrow F_{CD} = \frac{6.5 \times 4.5}{3 \times \sin 33.7^\circ} = 17.57 \text{ kN}$$

$$\sum F_x = 0 \Rightarrow A_{2c} + F_{CD} \cos 33.7^\circ = 0$$

$$A_{2c} = -17.57 \times \cos 33.7^\circ$$

$$A_{2c} = -14.62 \text{ kN}$$

$$\sum F_y = 0 \Rightarrow A_y + F_{CD} \sin 33.7^\circ - B_y = 0$$

$$\Rightarrow A_y = -17.57 \times \sin 33.7^\circ + 6.5$$

$$\Rightarrow A_y = -3.25 \text{ kN}$$

We conclude that the forces at A are in opposite direction of the convention we assumed.

AVERAGE

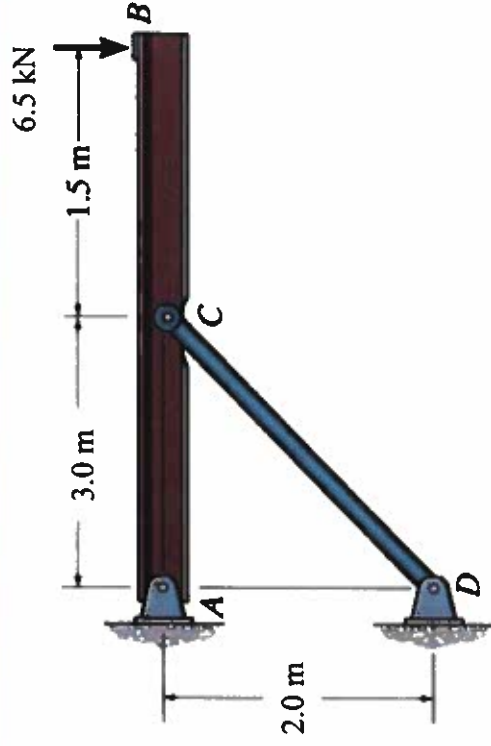
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Course: CVEG 2400P01 Full Name: Hunter Evans DUE: 11/02/2021 11 PM (Canvas)

Classwork: 2021Nov02A [100/200] Date: 2021Nov02

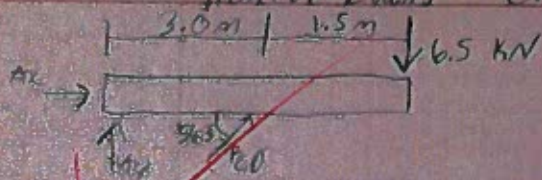
SUBMIT THIS SHEET
AS COVER

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.



For the 6.5 kN load at B, the beam, AB, has pins at A and C. **Determine the reactions at A and C [kN].** Assume that the x- and y-axes are in the horizontal and vertical directions. That is, the x-axis is along AB, and so on. Be sure to begin by drawing a complete free-body diagram of the beam.

Hunter Evans CVE62400



$$\tan \theta = \frac{b}{a} = \frac{3.0}{2.0} = 1.5$$

$$\theta = \tan^{-1} \frac{3}{2} = 56.3$$

$$1. \sum M_A = F_{CD} \sin(56.3) \cdot 3 - 6.5 \times 4.5$$

$$F_{CD} = \frac{6.5 \times 4.5}{\sin(56.3) \cdot 3} = 11.72 \text{ kN}$$

$$2. \sum F_x = A_x + 11.72 \cos(56.3) = 0$$

$$A_x = -6.5 \text{ kN}$$

$$3. \sum F_y = A_y + 11.72 \sin(56.3) - 6.5 = 0$$

$$A_y = -11.72 \sin(56.3) + 6.5$$

$$A_y = -3.25 \text{ kN}$$

-100
 Couldn't determine the values for the rxns at A & C

1. Have to find the moment of A to solve for the force of FcD.

2. Once we found the force for FcD we can find the horizontal force acting on point A.

3. Then we find the force acting on point A vertically, which in doing so we have to add the force and direction of the vertical force acting on point B.

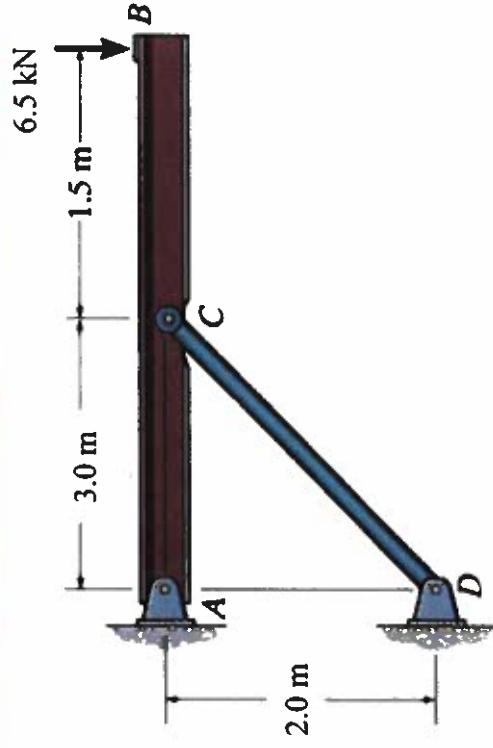
BELOW
AVERAGE

Course: CVEG 2400P01 Full Name: Papa Acha DUE: 11/02/2021 11 PM (Canvas)

Classwork: 2021Nov02A [50/200] Date: 2021Nov02

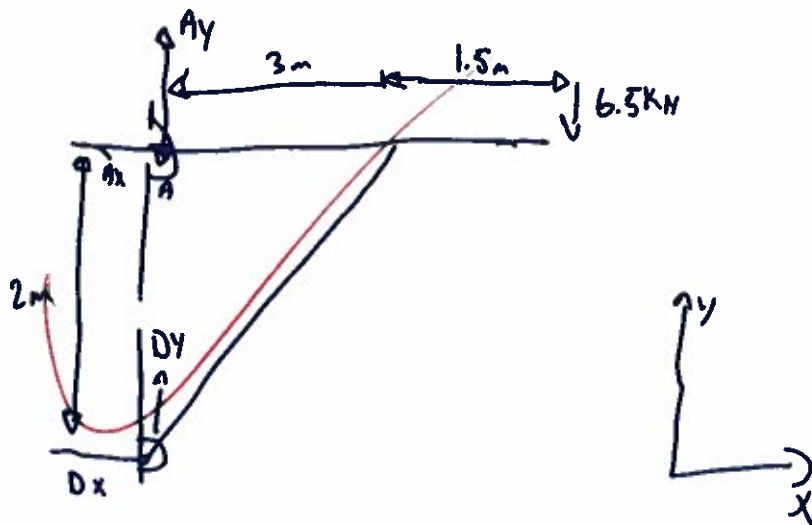
SUBMIT THIS SHEET
AS COVER

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.



For the 6.5 kN load at B, the beam, AB, has pins at A and C. **Determine the reactions at A and C [kN].** Assume that the x- and y-axes are in the horizontal and vertical directions. That is, the x-axis is along AB, and so on. Be sure to begin by drawing a complete free-body diagram of the beam.

①



$$\sum F_x = 0$$

$$A_x + D_x = 0$$

$$A_x = -D_x$$

$$A_y + D_y - 6.5 = 0$$

$$A_y + D_y = 6.5$$

$$(A_x \times 2) + (6.5 \times 4.5) = 0$$

$$A_x = -14.625 \text{ kN}$$

Reactions at A and C
were not determined

-150

CVEG 2400

Statics & Dynamics

Fall 2021

Classwork 05

ABOVE
AVERAGE

Course: CVEG 2400P01 Name: Larry Hengue

DUE: 8:00 AM 11/29/2021 class/Canvas 11/27/2021

Classwork: 2021Nov23A [300/300]

Date: 2021Nov23

(YOU MUST Submit Cover sheet)

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

A block is resting on an incline as shown in the figure. Assume the Coefficient of Friction, μ is 0.10. WRITE ON ONLY 1 SIDE OF PAPER.

- a) [150] Determine the force, F_1 [lb] required for moving the 10 lb block up the incline. You must draw the free-body diagram [FBD]

Hint: Think about the direction of the friction force in this situation.

FBD

According to Equilibrium:

$$\sum F_x = 0 \Rightarrow -F_1 + F_g + W_x = 0$$

$$\Rightarrow -F_1 + \mu_g n + W \sin 30^\circ = 0$$

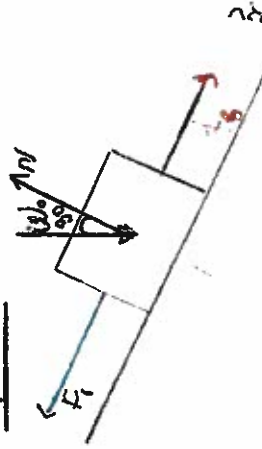
$$\Rightarrow F_1 = \mu_g n + W \sin 30^\circ \quad (1)$$

$$\sum F_y = 0 \Rightarrow n - W_y = 0$$

$$\Rightarrow n - W \cos 30^\circ = 0$$

$$\Rightarrow n = W \cos 30^\circ$$

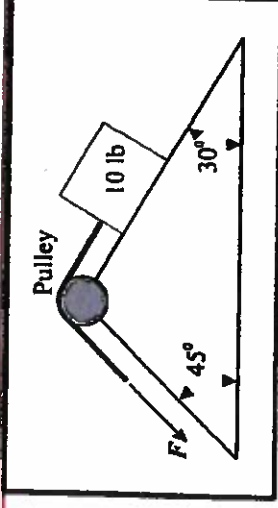
$$\Rightarrow n = 8.66 \text{ lb}$$



From Equation (1)

$$F_1 = 0.1 \times 8.66 + 10 \sin 30^\circ$$

$$F_1 = 5.87 \text{ lb}$$



- b) [150] Now, determine the force, F_2 [lb] required to keep the 10 lb block from slipping down the inclined surface. You must draw ANOTHER the free-body diagram [FBD]. Hint: Think about the direction of the friction force in this situation.

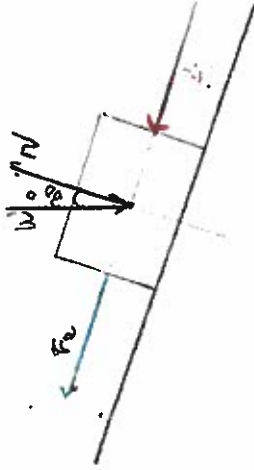
$$\sum F_x = 0 \Rightarrow -F_2 - f_g + W_x = 0$$

$$-F_2 = \mu_g n - W_x$$

$$F_2 = W_x - \mu_g n$$

$$F_2 = 10 \sin 30^\circ - 0.1 \times 8.66$$

$$F_2 = 4.13 \text{ lb}$$



AVERAGE

2400901Name:

2021Nov23A (50/3401)

2021Nov23A (50/3401)

YOU MUST Submit Exam sheet!

Date: 2021Nov23

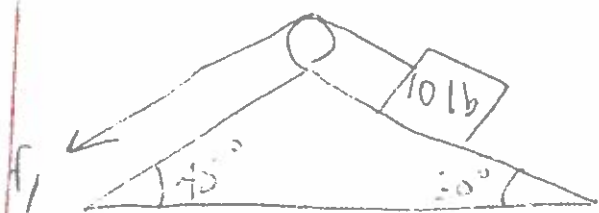
A block is resting on an incline as shown in the figure. Assume the Coefficient of Friction, μ is 0.10. **WRITE ON ONLY 1 SIDE OF PAPER.**

a) [150] Determine the force, F_1 [lb] required for moving the 10 lb block up the incline. You must draw the free-body diagram [FBD]

Hint: Think about the direction of the friction force in this situation



b) [150] Now, determine the force, F_2 [lb] required to keep the 10 lb block from slipping down the inclined surface. You must draw **ANOTHER** the free-body diagram [FBD]. **Hint:** Think about the direction of the friction force in this situation.

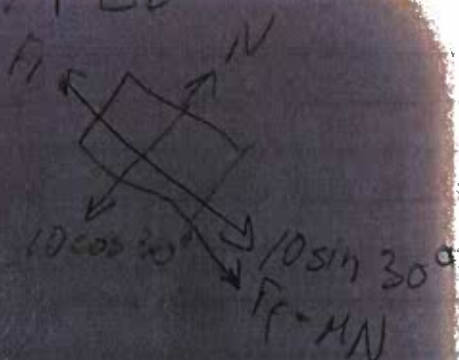


a) $f_1 = \text{unknown}$

b) $f_2 = \text{unknown}$

(friction) $= \mu = .4$

a) FBD



$$\sum f_y = 0$$

$$N = 10 \cos 30^\circ$$

$$N = 8.66 \text{ lbs}$$

$$\sum f_x = 0$$

$$f_1 - 10 \sin 30^\circ - \mu(8.66) = 0$$

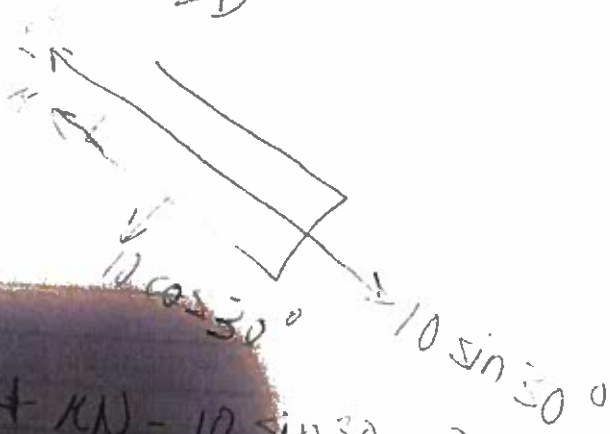
$$f_1 = (5.0 + 3.76) =$$

$$8.76 \text{ lbs}$$

Please
Full show
working

b)

(B)



$$F_2 + KN - 10 \sin 30^\circ = 0$$

$$F_2 + .1 \times 8.46 = 0$$

$$F_2 = \boxed{4.13416}$$

BELOW
AVERAGE

Course: CVEG 2400P01Name: Paper Action

DUE: 8:00 AM 11/29/2021class/Canvas 11/27/2021

Classwork: 2021Nov23A [50/300]

Date: 2021Nov23

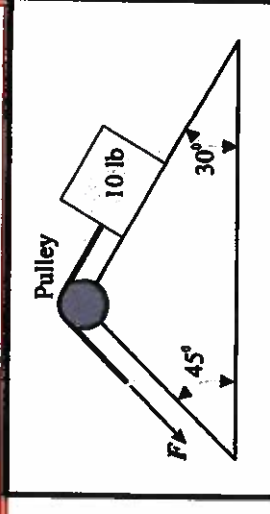
(YOU MUST Submit Cover sheet)

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

A block is resting on an incline as shown in the figure. Assume the Coefficient of Friction, μ is 0.10. WRITE ON ONLY 1 SIDE OF PAPER.

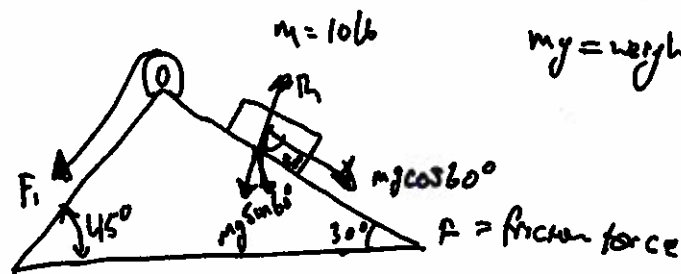
a) [150] Determine the **force, F_1 [lb]** required for moving the 10 lb block **up** the incline. You must draw the free-body diagram [FBD]

Hint: Think about the direction of the **friction force** in this situation.



b) [150] Now, determine the **force, F_2 [lb]** required to keep the 10 lb block **from slipping down the inclined surface**. You must draw **ANOTHER** the free-body diagram [FBD]. **Hint:** Think about the direction of the **friction force** in this situation.

A)



$R = \text{Normal reaction}$
 $mg = \text{weight of block}$

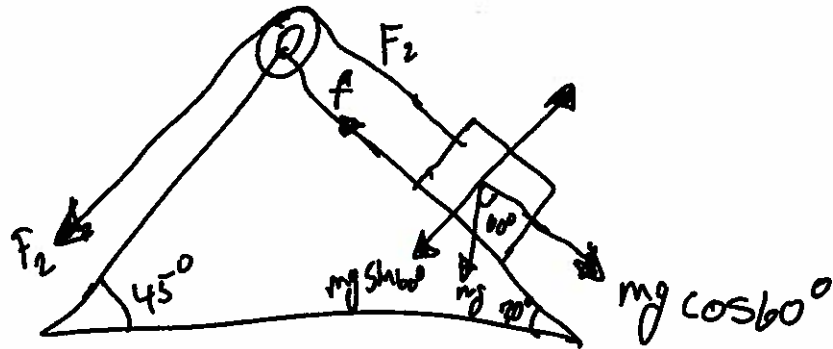
$$mg \times \cos 60^\circ = 10 \times 32.2 \times \frac{1}{2} \text{ lb} = 161 \text{ lb} = \text{ft/s}^2$$

$$R = mg \sin 60^\circ$$

$$f = \mu R = \mu \times mg \sin 60^\circ = 0.1 \times 10 \times 32.2 \times \frac{\sqrt{3}}{2} = 27.9 \text{ lb} = \text{ft/s}^2$$

$$F_i = mg \times \cos 60^\circ + f = (161 + 27.9) \text{ lb} = 188.9 \text{ lb} = \text{ft/s}^2$$

b)



$$mg \times \cos 60^\circ = 10 \times 32.2 \times \frac{1}{2} = 161 \text{ lbf}$$

$$f = \mu R = \mu \times mg \sin 60^\circ = 0.1 \times 10 \times 32.2 \times \frac{\sqrt{3}}{2} = 27.9 \text{ lbf}$$

$$F_1 = mg \times \cos 60^\circ - f = (161 - 27.9) \text{ lbf} = 133.1 \text{ lbf}$$

CVEG 2400

Statics & Dynamics

Fall 2021

Classwork 06

ABOVE
AVERAGE

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

A particle travels along the path $y = 3x^2$ such that, at $t = 2s$, the velocity in the x -direction, $V_x = (2t + 1)$ m/s. In addition, when time, $t = 0$ s, ($x = 0$, $y = 0$, $z = 0$) m.

Determine at $t = 2$ s:

- 1) The position, x [m] of the particle in the **x-direction**.
- 2) The position, y [m] of the particle in the **y-direction**.
- 3) The magnitude [m] of position $|r|$
- 4) The velocity, v_x [m/s] in the **x-direction**
- 5) The velocity, v_y [m/s] in the **y-direction**
- 6) Provide the velocity, V [m/s] in vector format.
- 7) The speed, S [m/s]
- 8) The acceleration, a_x [m/s²] in the **x-direction**
- 9) The acceleration, a_y [m/s²] in the **y-direction**
- 10) Provide the acceleration, a [m/s²] in vector format.
- 11) The magnitude of the acceleration $|a|$ [m/s²]

A particle travels along the path $y = 3x^2$ such that, at $t = 2s$, the velocity in the x-direction, $v_x = (2t+1) \text{ m/s}$.

1) position, $x \text{ [m]}$

$$x = \int v_x = \int_0^t (2t+1) dt = \frac{2t^2}{2} + t \Big|_0^{t=2s}$$

$$x = \frac{2^2 + 2}{1} = 2^2 + 2 = 6 \text{ m}$$

2) position, $y \text{ [m]}$

$$y = 3x^2 = 3(6)^2 = 108 \text{ m}$$

3) magnitude $[m]$ of position vector: $\sqrt{x^2 + y^2} = \sqrt{6^2 + 108^2}$
 $|r| = 108.2 \text{ m}$

4) $v_x \text{ [m/s]}$ in x-direction

$$v_x = (2t+1) \text{ m/s} \\ = 2(2)+1 = 5 \text{ m/s}$$

5) $v_y \text{ [m/s]}$ in y-direction

$$v_y = \frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt} \\ = \frac{d(3x^2)}{dx} \cdot (2t+1) \\ = (6x)(2t+1)$$

$$v_y = (6)(6)(2^2+1)$$

$$v_y = 180 \text{ m/s}$$

6) $V \text{ [m/s]}$ vector format $V = [5i + 180j + 0k] \text{ m/s}$

7) speed $[m/s]$ $s = \sqrt{\text{Velocity}}$

$$s = \sqrt{5^2 + 180^2} \\ s = 180.1 \text{ m/s}$$

8) $a_x \text{ [m/s}^2\text{]} = \frac{d^2x}{dt^2} = \frac{d(v_x)}{dt} = \frac{d(2t+1)}{dt} = 2 \text{ m/s}^2$

9) $a_y \text{ [m/s}^2\text{]} = \frac{d(v_y)}{dt} = \frac{d(6x)(2t+1)}{dt} = \frac{d(2t+1)}{dt} \cdot 6x + (6x) \frac{d(2t+1)}{dt}$

$$\text{where } t=2s \\ x = 6ft = (2t+1)(2t+1) + 6x(2) \\ = (2(2)+1)(2(2)+1) + 6(6)(2)$$

$$a_y = 97 \text{ m/s}^2$$

10) $a [m/s^2]$ in vector form

$$d = a_x i + a_y j$$
$$\boxed{a = 2i + 97j \text{ m/s}^2}$$

11) magnitude $|a| [m/s^2]$

$$|d| = \sqrt{2^2 + 97^2} [m/s^2]$$

$$\boxed{|a| = 97.02 \text{ m/s}^2}$$

AVERAGE

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

A particle travels along the path $y = 3x^2$ such that, at $t = 2s$, the velocity in the x -direction, $V_x = (2t + 1)$ m/s. In addition, when time, $t = 0$ s, $(x = 0, y = 0, z = 0)$ m.

Determine at $t = 2$ s:

- 1) The position, x [m] of the particle in the **x-direction**.
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- 8) The acceleration, a_x [m/s²] in the **x-direction**
- 9) The acceleration, a_y [m/s²] in the **y-direction**
- 10) Provide the acceleration, a [m/s²] in vector format.
- 11) The magnitude of the acceleration $|a|$ [m/s²]

$$\frac{200}{400}$$

$$y = 3x^2, t = 2s, v_x = (2t + 1)$$

$$t = 0$$

$$x = 0, y = 0, v = 0$$

1) $v_x = (2t + 1)$
 $t = 2s$
 $= 2(2) + 1 = 5 \text{ m/s}$

x-direction: $(v_x)(t) = (5)(2) = 10 \text{ m}$

2) y-direction
 substitute $\rightarrow y = 3x^2 = 3(10)^2 = 300 \text{ m}$

3) $r = (x^2 + y^2)^{1/2} = \sqrt{(10)^2 + (300)^2} = 300.16 \text{ m}$

4) $dy/dt = (3x^2)(2t + 1)(10)$
 $= v_x = (2t + 1) = 2(2) + 1 = 5 \text{ m/s}$

5) $t = 2$
 $y = 3x^2$
 $dy/dx = (2x)(4) = (3^2)(10)^2 = 900 \text{ m/s}$

6) $v_x = 2t + 1$
 $t = 2s$
 $= (2(2) + 1) = 5 \text{ m/s}$

$\vec{v} = 5i + 180j$

$v_x = \int v_x = t^2 + t$
 $t = 2s$
 $= (2^2 + 2) = 6 \text{ m/s}$

$y = 3x^2$
 $t = 2s$
 $= 6(2^2 + 2)(2(2) + 1) = 180 \text{ m/s}$

$$7) \sqrt{V_x^2 + V_y^2} = \sqrt{(8)^2 + (110)^2} = 180.06 \text{ m/s}$$

$$8) \frac{dx}{dt} (2 + t) = 2 \text{ m/s}^2$$

$$9) \begin{cases} y = 3(t^2 + t) \\ V_y = 3(2t + 1) \end{cases}$$

10) vector form

$$2i + 222j$$

$$11) (a_x i + a_y j)$$

$$\sqrt{(2)^2 + (222)^2}$$

$$\begin{matrix} a_x = 2 \\ a_y = 222 \end{matrix}$$

$$222 \text{ m/s}^2$$

Please Show Full Working

BELOW
AVERAGE

You must provide enough details and description of the solution method to demonstrate your knowledge of the solution method.

A particle travels along the path $y = 3x^2$ such that, at $t = 2s$, the velocity in the x-direction, $V_x = (2t + 1)$ m/s. In addition, when time, $t = 0$ s, ($x = 0$, $y = 0$, $z = 0$) m.

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- 11) The magnitude of the acceleration $|a|$ [m/s²]

$$\frac{100}{400}$$

sol 11

$$y = 3n^2$$

$$\frac{dy}{dt} = 6n \frac{dn}{dt}$$

$$\frac{dy}{dt} = 6n \times 5$$

$$\boxed{v_y = 30m}$$

$$\int \frac{dy}{dt} = v_y, \frac{dn}{dt} = v_n$$

$$v_n = (2t+1) \Big|_1 = 2$$

$$\textcircled{E} \boxed{v_n = 5m/s}$$

$$\textcircled{5} \text{ at } n=0 \quad v_y = 0 \quad (\text{at } t=0) \quad (v_{y \text{ initial}} = 0)$$

$$\text{at } t=2$$

$$(v_y)^2 - (v_y)^2_p = 200$$

$$y_{10m^2} = 2 \times 3 \text{ m}^2 \text{ ay}$$

$$a_y = \frac{900 \text{ m/s}^2}{6}$$

$$v_{y \text{ final}} = v_{y \text{ initial}} + a_y t$$

$$v_{y \text{ final}} = 0 + \frac{900}{6} \times 2$$

$$v_{y \text{ final}} = 300 \text{ m/s}$$

⑥ vector form of velocity

$$\vec{v} = v_x \hat{i} + v_y \hat{j}$$

$$\vec{v} = (5\hat{i} + 300\hat{j}) \text{ m/sec}$$

Position in the x direction

$$x_f - x_i = (v_{ix} t) + \frac{1}{2} a_x t^2$$

$$v_x|_{t=0} = 1 \text{ m/s (initial)}$$

$$a_x = \frac{dv_x}{dt} = 2 \text{ m/sec}^2$$

$$x_f = 1 \times 2 + \frac{1}{2} \times 2 \times 4$$

$$x_f = 6 \text{ m}$$

$$y_f - y_i = (v_{iy} t) + \frac{1}{2} a_y t^2$$

$$y_f = 0 \times 2 + \frac{1}{2} \times \frac{900}{63} \times 4^2$$

$$(y_i = 0) \text{ at } t=0$$

$$y_f = 300 \text{ meter}$$

$$3) \vec{r} = x\hat{i} + y\hat{j} \\ = (6\hat{i} + 300\hat{j}) \text{ m}$$

$$|\vec{r}| = \sqrt{36 + 90000} \text{ m}$$

$$= \sqrt{90036} \text{ m}$$

$$|\vec{r}| = 300.0599 \text{ m}$$

$$Q \text{ Speed (s)} = |\vec{r}| = \sqrt{(6)^2 + (300)^2} \\ = \sqrt{90036}$$

$$\boxed{\text{Speed} = 300.041 \text{ m/s}}$$

$$Q \text{ am } \frac{dv}{dt} = \frac{d}{dt} (2t+1) = 2 \text{ m/s}^2$$

$$(a) a_y = 150 \text{ m/sec}^2$$

$$(b) \vec{a} = a_x \hat{i} + a_y \hat{j} = (2\hat{i} + 150\hat{j}) \text{ m/sec}^2$$

$$(c) |\vec{a}| = \sqrt{a_x^2 + a_y^2} = \sqrt{4 + 22500} =$$

$$150.0133 \text{ m/sec}^2$$