

TAM 210/211 - Written Assignment Instructions

To teach you how to prepare your analyses in a logical manner, you will be asked to submit an INDIVIDUAL assignment on a weekly basis. Find below the requirements and guidelines for this written assignment:

1. Use Engineering Solution Format (description and example at the end of this document)
2. Solutions should be NEAT. Do not cross out text or formulas except to indicate an algebraic cancelation. Make sure erasures are complete, i.e., that the previous text does not show through.
3. Your name and discussion session number must be printed legibly on the top of the first page.
4. Use plain white paper (with no lines). It is acceptable to recycle, i.e. use the clean back-side of used sheets of paper.
5. Use proper units.
6. Long problems can span multiple pages. Do not crowd a solution so that it will fit on a single page.
7. Scan your report and save it in pdf format. Files in any other format will not be graded.
8. While scanning make sure you scan all the pages of your written report in ONE pdf file. We will only grade a single pdf file.
9. Your scanned work must be in portrait format.
10. IN SUMMARY, WE WILL ONLY GRADE REPORTS UPLOADED AS A PDF FILE, SINGLE DOCUMENT, PORTRAIT FORMAT! NO EXCEPTIONS!! Submitted assignments that do not comply with these guidelines will receive a ZERO score.

How to submit a written assignment

1. Written assignments will be posted on compass 2g. Please log into compass 2g and go to course content, and click on the folder “Written Assignments”.
2. Click on the available assignment, for example, Written Assignment 1.
3. To save/read the problem statement, click on the attached file, e.g. WA1.pdf
4. To start the submission process, click on “Browse my computer” and select your scanned document.
5. After you are finished uploading your document, please click on “SUBMIT” to complete your submission.
6. You must be able to open your document from compass. Check the preview to verify your submission was completed successfully. Note that this preview cannot be upside down; TAs will be reading and grading your report directly from compass and will NOT download your document. If the document does not appear correctly on compass, your assignment will not be graded and therefore you will receive a zero score.

7. These assignments are due at 11:59pm. Late reports will not be accepted (you will not be able to upload it on compass 2g). No exceptions. **DO NOT SEND YOUR LATE WRITTEN REPORT BY EMAIL.**

Engineering solution format Problem solving is a very important skill to learn as you become an engineer. Problem solving requires relevant topical knowledge, logical reasoning, common sense, a persevering attitude, and clear communication of the solution and solution procedure. This document focuses on the last aspect, namely the presentation of your homework solutions using a standard format.

A homework solution presented in the standard format is a concise document that combines verbal description, mathematical analysis, schematics and plots. It is not a formal document like a published article. Rather, a solution in engineering format is a neat, legible, and mathematically correct presentation of your thought process from start to finish. It is extremely unlikely that you will be able to create a high quality homework solution in a single draft. Good problems usually do not have immediately obvious solutions. Therefore, it is important to work all or at least parts of your homework assignment on scrap paper. The scrap versions allow you to test out ideas, and do sample calculations that help you refine your thinking. After you have worked out the solution on scrap paper, you are ready to transcribe your solution to the standard format. The transcription process allows for further refinement in your thinking and improved clarity in your written documentation.

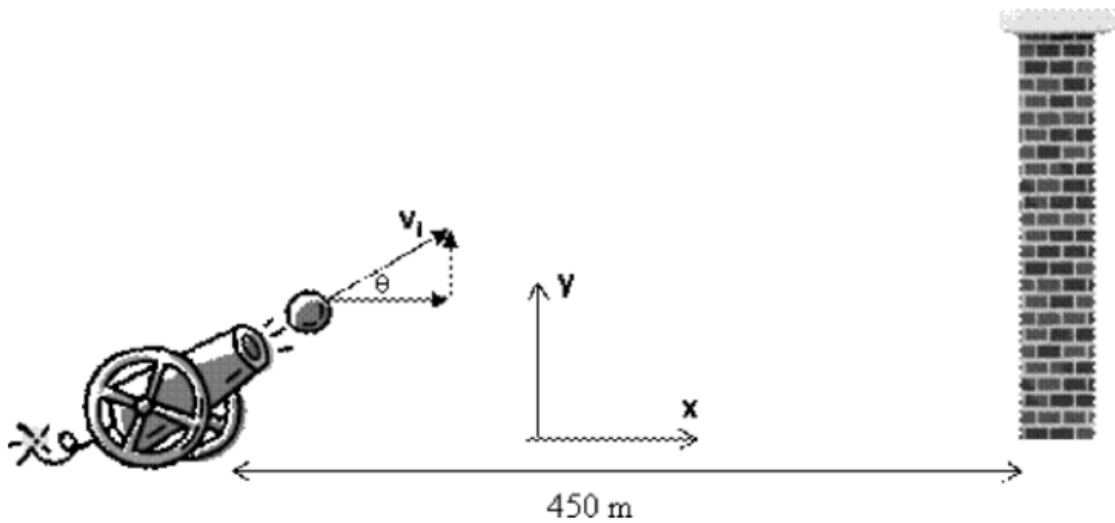
For typical engineering problems, the standard format consists of at least three sections: Given, Find, Solution.

1. Given: Restate what is known
 - Assign symbolic variables to all relevant quantities/parameters of the problem.
 - List the known values of the symbolic variables that will be used in the solution (if any).
 - Make a free body diagram of the physical features including the symbolic variables.
2. Find: Briefly and concisely state the desired result.
3. Solution
 - Draw additional sketches to aid in the solution (if needed).
 - Identify the fundamental principles used in the solution, and start with a general mathematical equation or formula that is the starting point for your analysis.
 - Use algebra, calculus, and other mathematical manipulations to convert the starting formula into a form used to compute the solution (or parts of it).
 - Give a verbal description of the important equations used in the problem solution (no need to explain every intermediate step).
 - After an algebraic solution is obtained, substitute the known parameters, constants, etc. into the formula(s). Of course this step is not needed in case numerical values are not assigned to the problem. Waiting until the end to substitute numerical values is a good idea, but is not an absolute rule. Use common sense. Using symbols instead of numbers makes it easier to read and debug an analysis. If a formula becomes too long or cumbersome, it may be acceptable to substitute numerical values and simplify.

- Some problems will require comments on the solution. Is it reasonable? Is the solution consistent with the assumptions made at the start of the analysis? Would a small but reasonable change in the assumptions or the input parameters have a drastic effect on the solution.

Example of good written assignment:

A cannonball is fired at a wall located 450 meters away (the diagram is not to scale). The initial horizontal component of the ball's velocity is 90 m/s and the initial angle is $\theta = 24^\circ$. Determine the initial speed of the ball, the time it takes to reach the wall, and the maximum height the ball reaches.

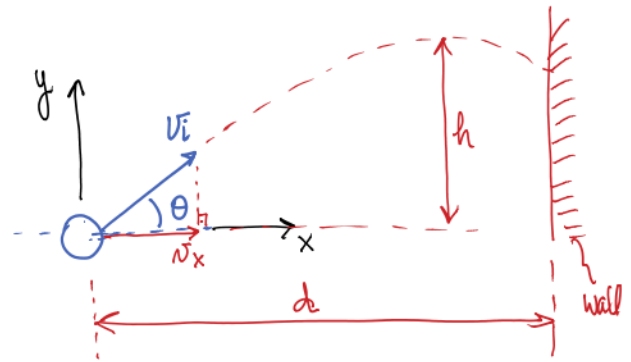


Name: Mariana Silva
 Discussion: AE1

(*1)

Given:

- Initial horizontal component of the velocity: $v_{x0} = 90 \text{ m/s}$
- Distance from cannon ball to wall: $d = 450 \text{ m}$
- Initial angle: $\theta = 24^\circ$



- Find:
- initial speed of the ball (v_i)
 - times that ball takes to reach the wall (Δt)
 - maximum height the ball reaches (h)

Solution:

- a) Using trigonometric functions, the following relation exists between the initial speed (v_i) and the horizontal component of the velocity:

$$\cos \theta = \frac{v_{x0}}{v_i} \Rightarrow \boxed{v_i = \frac{v_{x0}}{\cos \theta}} \quad \text{or } v_i = \frac{90 \text{ m/s}}{\cos(24^\circ)} \therefore v_i = 98.5 \text{ m/s} //$$

- b) Motion in the horizontal direction:

$$x = v_{x0} t$$

Therefore $d = v_{x0} t \Rightarrow \boxed{\Delta t = \frac{d}{v_{x0}}}$ or $\Delta t = \frac{450 \text{ m}}{90 \text{ m/s}} \therefore \Delta t = 5 \text{ s} //$

- c) Motion in the vertical direction:

$$y = v_{y0} t - \frac{1}{2} g t^2$$

$$v_y = v_{y0} - g t$$

g is the acceleration due to gravity
 $v_{y0} = v_i \sin \theta$

When the ball reaches the maximum height, the velocity in the y-direction is equal to zero, i.e., $v_y = 0$

Hence, $0 = v_{y0} - gt \Rightarrow t = \frac{v_{y0}}{g} = 4s < 5s \Rightarrow$ the ball reaches the maximum height before it hits the wall!

$$h = v_{y0} \left(\frac{v_{y0}}{g} \right) - \frac{1}{2} g \left(\frac{v_{y0}}{g} \right)^2$$

$$= \frac{v_{y0}^2}{g} - \frac{1}{2} g \frac{v_{y0}^2}{g^2}$$

$$= \frac{1}{2} \frac{v_i^2 \sin^2 \theta}{g} = \frac{1}{2} \frac{v_{x0}^2 \sin^2 \theta}{\cos^2 \theta g}$$

$$\Rightarrow h = \frac{1}{2} \frac{v_{x0}^2 \tan^2 \theta}{g}$$

$$\text{or } h = \frac{1}{2} \frac{(90)^2 (\tan(24^\circ))^2 (\text{m/s})^2}{9.81 \text{ m/s}^2}$$

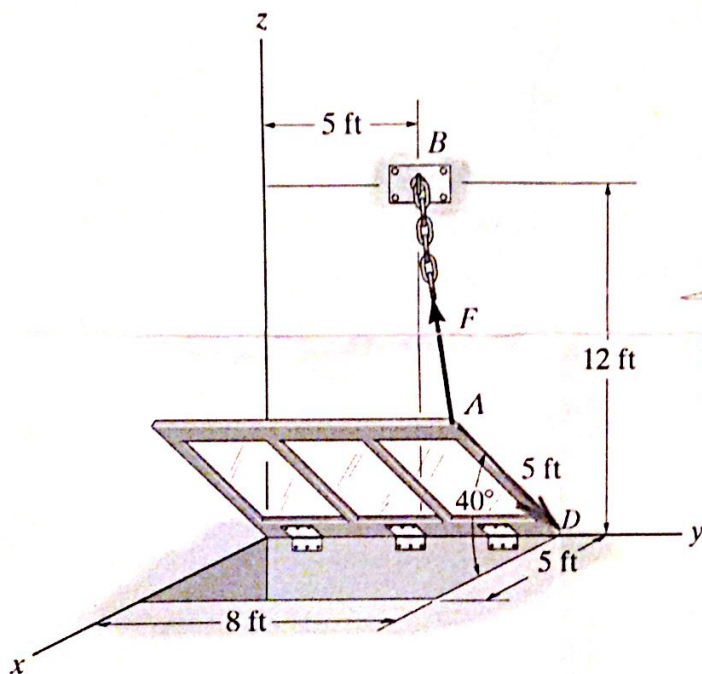
$$h = 81.8 \text{ m}$$

"Bad" Example

TAM 210/211 Written Assignment 1 (due on September 5th)

The window is held open by chain AB, developing a force along the chain equal to $F = 65 \text{ lb}$.

- Express this force as a Cartesian vector \vec{F} , using the system of coordinates illustrated below.
- Determine the directional cosines.
- What is the length of the chain AB?
- Determine the projection of the force vector that is parallel to the window edge AD.



$$\begin{aligned}
 1. \vec{F}_x &= -5 \cos 40^\circ \hat{i} \\
 \vec{F}_y &= (5-8) \hat{j} = -3 \hat{j} \\
 \vec{F}_z &= (12-5 \sin 40^\circ) \hat{k} \\
 \therefore \vec{F} &= -5 \cos 40^\circ \hat{i} - 3 \hat{j} + (12-5 \sin 40^\circ) \hat{k}
 \end{aligned}$$

$$\begin{aligned}
 3. |\vec{AB}| &= \sqrt{(-5 \cos 40^\circ)^2 + (-3)^2 + (12-5 \sin 40^\circ)^2} \\
 &= \sqrt{25 \cos^2 40^\circ + 9 + 144 + 25 \sin^2 40^\circ - 120 \sin 40^\circ} \\
 &= \sqrt{178 + 120 \sin 40^\circ} \\
 &= \underline{\underline{16.0 \text{ m}}}
 \end{aligned}$$

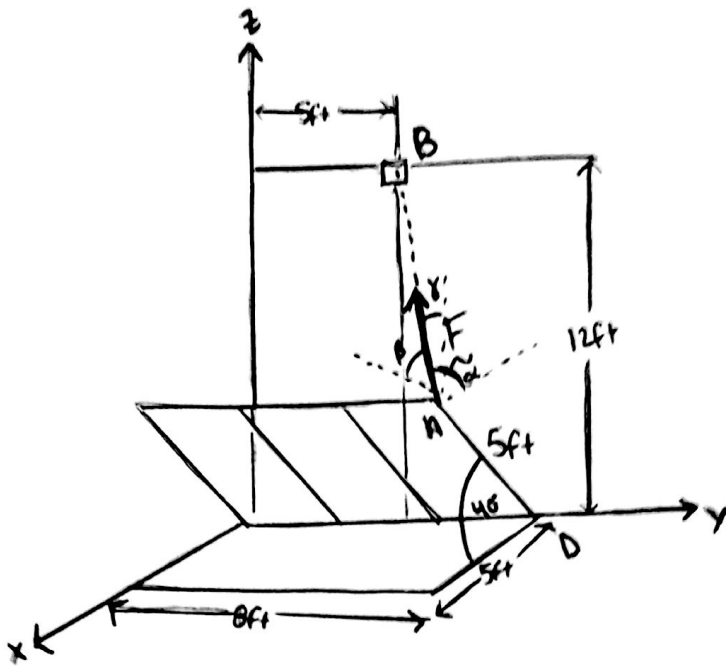
$$\begin{aligned}
 2. \alpha &= \cos^{-1} \left(\frac{-5 \cos 40^\circ}{16} \right) \quad \beta = \cos^{-1} \left(\frac{-3}{16} \right) \\
 &= 104^\circ \quad \quad \quad = 101^\circ
 \end{aligned}$$

$$\begin{aligned}
 \gamma &= \cos^{-1} \left(\frac{12-5 \sin 40^\circ}{16} \right) \\
 &= \underline{\underline{56.7^\circ}}
 \end{aligned}$$

$$\begin{aligned}
 4. \vec{AD} &= -5 \cos 40^\circ \hat{i} - 5 \sin 40^\circ \hat{k} \\
 |\vec{AD}| &= \sqrt{(-5 \cos 40^\circ)^2 + (-5 \sin 40^\circ)^2} \\
 &= 5 \\
 \vec{u}_{AD} &= -\cos 40^\circ \hat{i} - \sin 40^\circ \hat{k} \\
 \vec{F}_{\text{proj}} &= \frac{\vec{F} \cdot \vec{AD}}{|\vec{AD}|} \cdot \vec{u}_{AD} \\
 &= \frac{25 \cos^2 40^\circ + 0 + 25 \sin^2 40^\circ - 60 \sin 40^\circ}{5} \cdot (-\cos 40^\circ \hat{i} - \sin 40^\circ \hat{k}) \\
 &= (5 - 12 \sin 40^\circ) \cdot (-\cos 40^\circ \hat{i} - \sin 40^\circ \hat{k})
 \end{aligned}$$

$$\vec{F}_{\text{proj}} = (12 \sin 40^\circ \cos 40^\circ - 5 \cos 40^\circ) \hat{i} + (12 \sin^2 40^\circ - 5 \sin 40^\circ) \hat{j}$$

Given



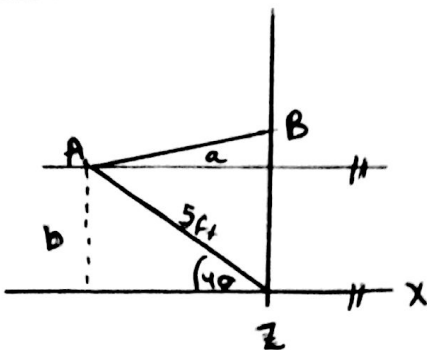
$$F = 65 \text{ lbs}$$

$$|r_{AB}| = 13.0 \text{ ft}$$

Find

Use the unit vector from A to B to find the vector components of force \vec{F} and the magnitude of the vector \vec{AE} . After the force vector \vec{F} is found, use it to find the angles α , β , γ .

Solution



$$\vec{F} = F \cdot \hat{u}_{AB}$$

$$\hat{u}_{AB} = \frac{\vec{r}_{AB}}{|r_{AB}|}$$

$$a = 13 \cos(40^\circ)$$

$$b = 13 \sin(40^\circ)$$

To find vector from A to B:

$$\vec{r}_{AB} = \vec{r}_B - \vec{r}_A = (x_B \hat{i} + y_B \hat{j} + z_B \hat{k}) - (x_A \hat{i} + y_A \hat{j} + z_A \hat{k})$$

$$= (0\hat{i} + 5.00\hat{j} + 12\hat{k}) - (5\cos 40^\circ \hat{i} + 8.00\hat{j} + 5\sin 40^\circ \hat{k})$$

$$= (-3.83\hat{i} - 3.00\hat{j} + 8.78\hat{k})$$

length of AB:

$$|\vec{r}_{AB}| = \sqrt{r_x^2 + r_y^2 + r_z^2} = \sqrt{3.83^2 + 3^2 + 8.78^2} = 10.0 \text{ ft}$$

unit vector AB:

$$\vec{u}_{AB} = \frac{-3.83}{10.0} \hat{i} - \frac{3.00}{10.0} \hat{j} + \frac{8.78}{10.0} \hat{k}$$

$$\vec{F} = 65 \left(\frac{-3.83}{10.0} \hat{i} - \frac{3.00}{10.0} \hat{j} + \frac{8.78}{10.0} \hat{k} \right)$$

$$= (-24.8\hat{i} - 19.4\hat{j} + 56.8\hat{k}) \text{ lbs}$$

2.) $|\vec{F}| = \sqrt{F_x^2 + F_y^2 + F_z^2} = \sqrt{24.8^2 + 19.4^2 + 56.8^2} = 65.0 \Rightarrow$ consistent with given information

$$\cos \alpha = \frac{F_x}{|\vec{F}|} = \frac{-24.8}{65.0} = -.382$$

$$\alpha = \cos^{-1}(-.382) = 112^\circ$$

$$\cos \beta = \frac{F_y}{|\vec{F}|} = \frac{-19.4}{65.0} = -.298$$

$$\beta = \cos^{-1}(-.298) = 107^\circ$$

$$\cos \delta = \frac{F_z}{|\vec{F}|} = \frac{56.8}{65.0} = .874$$

$$\delta = \cos^{-1}(.874) = 29.0^\circ$$

$$3.) \text{ length of chain } AB = |\vec{r}_{AB}| = 10.0\text{ft}$$

4.) $\text{Proj}_{AD} AB = \frac{\vec{r}_{AD} \cdot \vec{F}_{AB}}{|\vec{r}_{AD}|^2} \vec{r}_{AD} \Rightarrow$ formula to find the projection of force vector, \vec{F}_{AB} , that is parallel to window edge AD.

$$\begin{aligned} \vec{r}_{AD} &= \vec{r}_D - \vec{r}_A = (x_D \hat{i} + y_D \hat{j} + z_D \hat{k}) - (x_A \hat{i} + y_A \hat{j} + z_A \hat{k}) \\ &= (0 \hat{i} + 8 \hat{j} + 0 \hat{k}) - (5 \cos(40) \hat{i} + 8.00 \hat{j} + 5 \sin(40) \hat{k}) \\ &= (-5 \cos 40^\circ \hat{i} + 0 \hat{j} - 5 \sin 40^\circ \hat{k}) \end{aligned}$$

$$|\vec{r}_{AD}| = \sqrt{(-5 \cos 40^\circ)^2 + (-5 \sin 40^\circ)^2} = 5.00\text{ft}$$

The magnitude of the vector AD will give the length of AD. The result of $|\vec{r}_{AD}|$ is consistent with the figure.

$$\begin{aligned} \text{Proj}_{AD} AB &= \frac{(-24.8 \hat{i} - 19.4 \hat{j} + 56.8 \hat{k}) \cdot (-5 \cos 40^\circ \hat{i} - 5 \sin 40^\circ \hat{k})}{(5.00)^2} \times \\ &\quad (-5 \cos 40^\circ \hat{i} - 5 \sin 40^\circ \hat{k}) \\ &= \frac{-87.6}{25.0} (-5 \cos 40^\circ \hat{i} - 5 \sin 40^\circ \hat{k}) \\ &= \boxed{(13.4 \hat{i} + 11.3 \hat{k}) \text{ lbs}} \end{aligned}$$