

Allowed Materials: F.E. approved calculator(s) see syllabus; pencil and/or pen.

ExamForm := 1

Honor Statement: On my honor, I promise that I have not received any unauthorized assistance on this exam (I didn't look at another student's paper, I didn't view any unauthorized written materials, I didn't talk or listen to another student, I didn't use an unauthorized calculator, I did not use any electronic device to exchange information with others.) I have maintained the highest standards of academic integrity while completing this exam.

Signed: _____

0. (5 point deduction for failure to complete this problem!)

- Write in all of the indicated information in the boxes of your response form.
- Darken the appropriate circles to encode the corresponding information.
- Write your name on this exam and sign the Honor Statement.

Bubble:	For Course Section:
91	H01 - Crittenden TR 10-11:50
92	H02 - Reeves TR 2-3:50
93	H03 - Swanbom MW 12-1:50
94	H04 - Moller TR 8-9:50
01	001 - Swanbom TR 2-3:50
02	002 - Moller TR 12-1:50
03	003 - Reeves TR 8-9:50
04	004 - Easley TR 2-3:50

Notes:

- If your last name is too long, just write the first 10 letters.
- "F.I." and "M.I." are your first and middle initials, respectively
- Your "Username" is the first part of your LATEch email address
- For "Section" use the guide provided to the right
- Your "Exam Form" is printed on the upper right corner of this page.
- Indicate "ENGR" as the "Program"

Last Name	F.I.	M.I.	LA Tech Username	Course #	Section (last 2 digits)
(A) (A) (A) (A) (A) (A) (A) (A) (A) (A)	(A)	(A)	(A) (A) (A) (A) (A) (A) (A) (A) (A) (A)	(A) (A) (A) (A) (A) (A) (A) (A) (A) (A)	(A) (A)

Exam Form	Program
(A) (A)	(A) BIEN
(A) (A)	(A) CMEN
(A) (A)	(A) CVEN
(A) (A)	(A) CVTE
(A) (A)	(A) CYEN
(A) (A)	(A) FIEN

1. (3 points) When using the PING distance sensor as described in the notes, the distance of an object is computed based on:

- Choices =
- | | |
|-----|----------------------------|
| "A" | "Speed of light in vacuum" |
| "B" | "Speed of light in air" |
| "C" | "Speed of sound in vacuum" |
| "D" | "Speed of sound in water" |
| "E" | "Speed of sound in air" |
| "F" | "Speed of light in water" |

2. (3 points) To the right is a partial listing of specifications for a particular accelerometer. What is the maximum acceleration that can be measured along the x-axis if the x-axis is oriented horizontally?

- Choices =
- | | |
|-----|--------|
| "A" | "0" |
| "B" | "35.3" |
| "C" | "2.72" |
| "D" | "19.6" |
| "E" | "9.81" |
| "F" | "39.2" |
- $\frac{m}{s^2}$

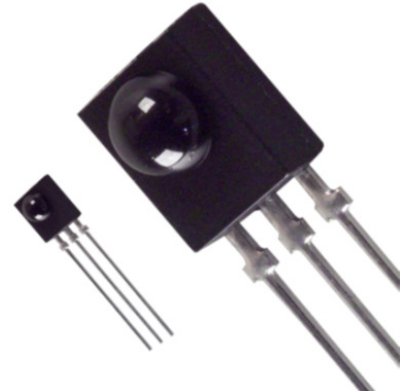
Series	-
Axis	X, Y, Z
Acceleration Range	±3.6g
Sensitivity	300mV/g
Voltage - Supply	1.8 V ~ 3.6 V
Output Type	Analog
Bandwidth	1.6kHz - XY, 550Hz - Z
Interface	-
Mounting Type	Surface Mount
Package / Case	16-LQFN Exposed Pad, CSP
Supplier Device Package	16-LFCSP-LQ (4x4)



3. (3 points) The object detection sensor pictured is like the one you implemented for a homework assignment. What type of electromagnetic radiation does this sensor detect? *Hint: you used a special LED to emit the appropriate radiation.*

Choices =

"A"	"Visible"
"B"	"X-rays"
"C"	"Gamma rays"
"D"	"Infrared"
"E"	"Ultraviolet"
"F"	"Radio waves"
"G"	"Microwaves"



4. (3 points) Which of the following is NOT one of the 10 personas or "faces of innovation"?

Choices =

"A"	"Director"
"B"	"Experimenter"
"C"	"Hurdler"
"D"	"Cross-pollinator"
"E"	"Caregiver"
"F"	"Philanthropist"
"G"	"Set designer"
"H"	"Anthropologist"
"I"	"Storyteller"
"J"	"Collaborator"



5. (3 points) When working with sheet metal, a brake would be used to make which type of feature?

Choices =

"A"	"Connection between two sheets"
"B"	"Focused bend (rounded corner)"
"C"	"Impressed lettering"
"D"	"Jagged cut"
"E"	"Smooth cut"
"F"	"Sweeping, curved bend"
"G"	"Round hole"

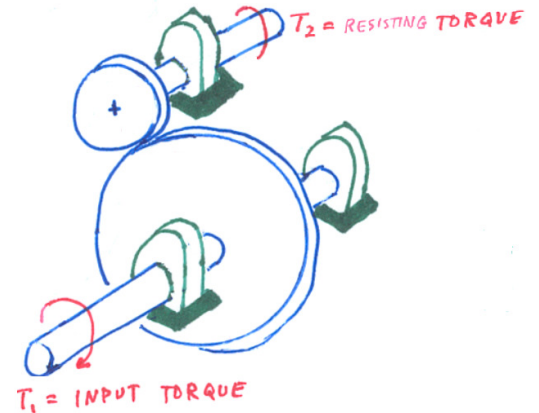


6. (3 points) Which is NOT true of a mind map?

Choices =

"A"	"Helps with brainstorming"
"B"	"Can include doodles"
"C"	"Can be colorful"
"D"	"Uses linking phrases"
"E"	"Helps to generate ideas"
"F"	"Shows how ideas relate"
"G"	"Helps to connect ideas"

7. (3 points) Two spur gears transmit torque between parallel shafts with 100% efficiency. Gear 2 spins twice as fast as Gear 1. Input torque T_1 is applied to the shaft of gear 1 clockwise as shown. For the system to operate at constant speed, the resisting torque T_2 must be equal to:



- Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"twice } T_1 \text{ (CW)} \\ \text{"B"} \quad \text{"Not enough information"} \\ \text{"C"} \quad \quad \text{"zero"} \\ \text{"D"} \quad \text{"half of } T_1 \text{ (CW)} \\ \text{"E"} \quad \text{"twice } T_2 \text{ (CCW)} \\ \text{"F"} \quad \text{"half of } T_1 \text{ (CCW)} \end{array} \right)$
- Note: CW=clockwise;
CCW=counterclockwise

8. (3 points) You and a friend are planning a trip from Ruston, LA, to Washington, DC. You want to use a decision matrix to help select your mode of transportation. Your baseline option is driving your own small car. You have identified four criteria to help in your selection and have assigned the weights and relative improvements given in the table. Based on the matrix, which mode of transportation should you choose?

- Choices = $\left(\begin{array}{l} \text{"A"} \quad \quad \text{"Flying"} \\ \text{"B"} \quad \quad \text{"Riding bus"} \\ \text{"C"} \quad \text{"Driving your small car"} \\ \text{"D"} \quad \text{"Renting large SUV"} \end{array} \right)$

MODES OF TRANSPORTATION		Driving your small car		Renting large SUV		Flying		Riding bus	
Criteria	Weight	relative improvement	score	relative improvement	score	relative improvement	score	relative improvement	score
cost	3	0		-2		-3		2	
comfort	1	0		3		2		2	
cargo capacity	2	0		3		0		-1	
combined time for making arrangements and traveling	2	0		-1		3		-2	

9. (3 points) Which type of program element gives priority to a specified function so that under certain conditions the Arduino suspends its current task, runs the prioritized function, then resumes the suspended task where it left off?

- Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"Suspend loop"} \\ \text{"B"} \quad \text{"Rabbit trail"} \\ \text{"C"} \quad \quad \text{"Pause"} \\ \text{"D"} \quad \text{"Interrupt"} \\ \text{"E"} \quad \text{"Suspend function"} \\ \text{"F"} \quad \text{"For loop"} \end{array} \right)$

10. (3 points) The five steps in the IDEO design process are listed below in random order. Select the proper order.

1. Implement the new concept for commercialization.
2. Visualize new-to-the-world concepts and the customers who will use them.
3. Evaluate and refine the prototypes in a series of quick iterations.
4. Understand the market, the client, the technology, and the perceived constraints.
5. Observe real people in real-life situations.

- Choices = $\left(\begin{array}{l} \text{"A"} \quad \text{"5, 4, 2, 1, 3"} \\ \text{"B"} \quad \text{"4, 5, 2, 3, 1"} \\ \text{"C"} \quad \text{"2, 5, 3, 4, 1"} \\ \text{"D"} \quad \text{"5, 4, 2, 3, 1"} \\ \text{"E"} \quad \text{"4, 5, 2, 1, 3"} \\ \text{"F"} \quad \text{"2, 4, 1, 5, 3"} \end{array} \right)$

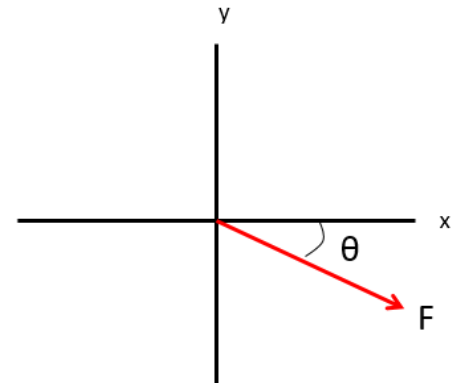


11. (5 points) The y-component of the force depicted below is closest to:

- Choices = $\left(\begin{array}{l} \text{"A"} \quad -115.9 \\ \text{"B"} \quad -228.7 \\ \text{"C"} \quad -250.0 \\ \text{"D"} \quad -433.0 \\ \text{"E"} \quad -586.7 \\ \text{"F"} \quad 115.9 \\ \text{"G"} \quad 228.7 \\ \text{"H"} \quad 250.0 \\ \text{"I"} \quad 433.0 \\ \text{"J"} \quad 586.7 \end{array} \right) \cdot \text{N}$

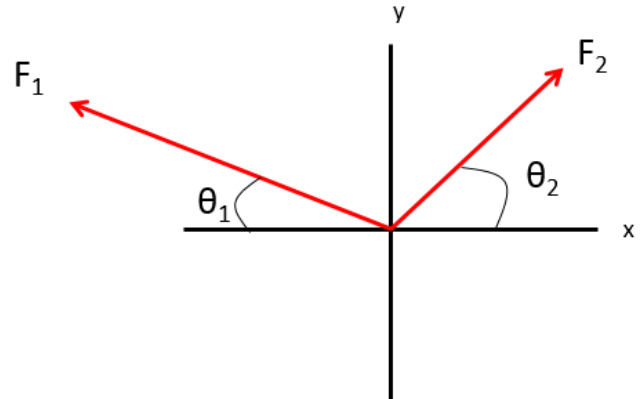
$$F = 500 \text{ N}$$

$$\theta = 30 \cdot \text{deg}$$



12. (5 points) The resultant magnitude of the two forces depicted below is closest to:

- Choices = $\left(\begin{array}{l} \text{"A"} \quad -0.9 \\ \text{"B"} \quad -11.8 \\ \text{"C"} \quad -42.2 \\ \text{"D"} \quad -134.2 \\ \text{"E"} \quad -206.0 \\ \text{"F"} \quad 0.9 \\ \text{"G"} \quad 11.8 \\ \text{"H"} \quad 42.2 \\ \text{"I"} \quad 134.2 \\ \text{"J"} \quad 206.0 \end{array} \right) \cdot \text{lbF}$



$$F_1 = 130 \cdot \text{lbF}$$

$$\theta_1 = 25 \cdot \text{deg}$$

$$F_2 = 100 \cdot \text{lbF}$$

$$\theta_2 = 45 \cdot \text{deg}$$

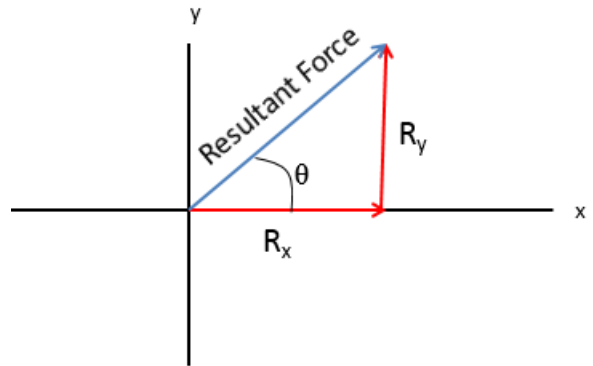


13. (5 points) The resultant of the two forces depicted below creates an angle with the x-axis that is closest to...

Choices = $\left(\begin{array}{l} \text{"A"} \ 28.7 \\ \text{"B"} \ 31.6 \\ \text{"C"} \ 34.5 \\ \text{"D"} \ 35.8 \\ \text{"E"} \ 37.3 \\ \text{"F"} \ 39.3 \\ \text{"G"} \ 40.1 \\ \text{"H"} \ 42.8 \\ \text{"I"} \ 46.4 \\ \text{"J"} \ 49.9 \end{array} \right) \cdot \text{deg}$

$$R_x = 318 \cdot \text{lbf}$$

$$R_y = 268 \cdot \text{lbf}$$



14. (5 points) The three forces shown are applied to an object which remains in equilibrium at the origin. Using the information given, F_2 is found to be closest to:

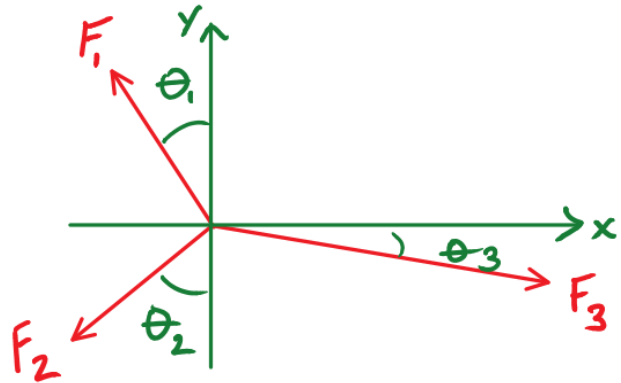
Choices = $\left(\begin{array}{l} \text{"A"} \ 215.1 \\ \text{"B"} \ 231.4 \\ \text{"C"} \ 247.1 \\ \text{"D"} \ 262.8 \\ \text{"E"} \ 278.4 \\ \text{"F"} \ 294.2 \\ \text{"G"} \ 309.9 \\ \text{"H"} \ 325.6 \end{array} \right) \cdot \text{N}$

$$F_1 = 350 \text{ N}$$

$$\theta_1 = 30 \cdot \text{deg}$$

$$\theta_2 = 52 \cdot \text{deg}$$

$$\theta_3 = 15 \cdot \text{deg}$$

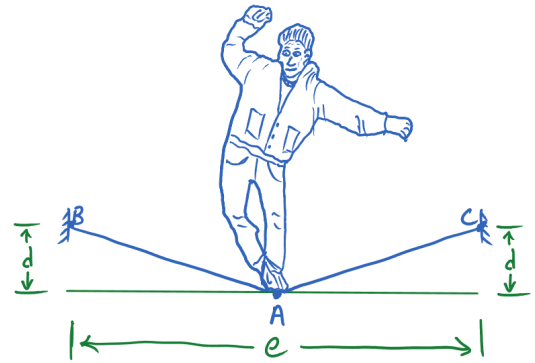


15. (5 points) A daredevil weighing $W = 175 \cdot \text{lbf}$ walks across a rope between B and C. When he is halfway between B and C, the tension in the rope is closest to:

Choices = $\begin{pmatrix} \text{"A"} & 153 \\ \text{"B"} & 168 \\ \text{"C"} & 183 \\ \text{"D"} & 198 \\ \text{"E"} & 213 \\ \text{"F"} & 228 \\ \text{"G"} & 243 \\ \text{"H"} & 258 \end{pmatrix} \cdot \text{lbf}$

$$d = 2.7 \cdot \text{ft}$$

$$e = 12 \cdot \text{ft}$$



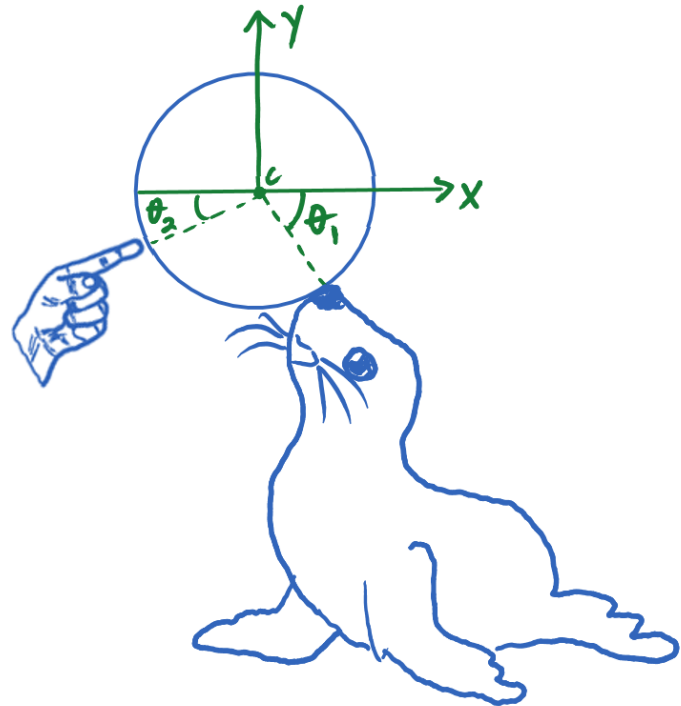
16. (5 points) With a helping hand from a friendly passerby, Alex the Seal is able to support the ball. If the ball weighs W pounds, the force Alex's nose is applying to the ball is closest to:

Choices = $\begin{pmatrix} \text{"A"} & 2.79 \\ \text{"B"} & 3.06 \\ \text{"C"} & 3.33 \\ \text{"D"} & 3.59 \\ \text{"E"} & 3.86 \\ \text{"F"} & 4.13 \\ \text{"G"} & 4.39 \\ \text{"H"} & 4.66 \end{pmatrix} \cdot \text{lbf}$

$$W = 3.5 \cdot \text{lbf}$$

$$\theta_1 = 34 \cdot \text{deg}$$

$$\theta_2 = 16 \cdot \text{deg}$$



Note:

- Alex's nose is slimy from eating fish, so assume his nose is frictionless
- Point C is the center of gravity for the ball
- The helping hand provides a force directed toward point C
- Gravity acts in the downward (-y) direction

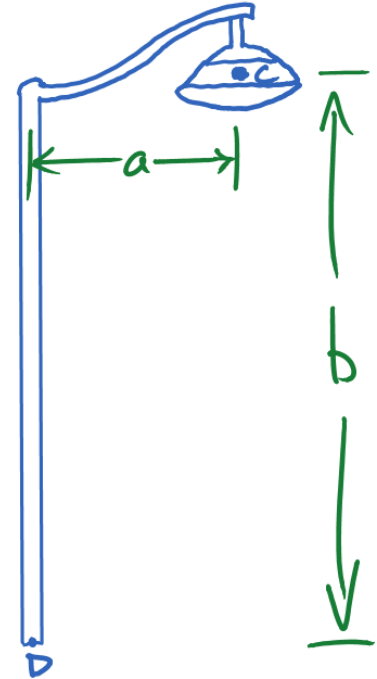
17. (5 points) Considering only the weight of the lamp (center of gravity at point C), the moment generated about point D is closest to:

Choices = $\left(\begin{array}{l} \text{"A"} \quad -395 \\ \text{"B"} \quad -580 \\ \text{"C"} \quad -1357 \\ \text{"D"} \quad -2420 \\ \text{"E"} \quad -3090 \\ \text{"F"} \quad 395 \\ \text{"G"} \quad 580 \\ \text{"H"} \quad 1357 \\ \text{"I"} \quad 2420 \\ \text{"J"} \quad 3090 \end{array} \right) \cdot \text{N}\cdot\text{m}$

$$\text{mass}_{\text{lamp}} = 35 \cdot \text{kg}$$

$$a = 115 \cdot \text{cm}$$

$$b = 9 \cdot \text{m}$$



NOTE:

- neglect the weight of the pole/support
- consider clockwise rotation as positive and counter-clockwise rotation as negative

18. (5 points) Considering only the three forces shown, the moment generated about point A would be:

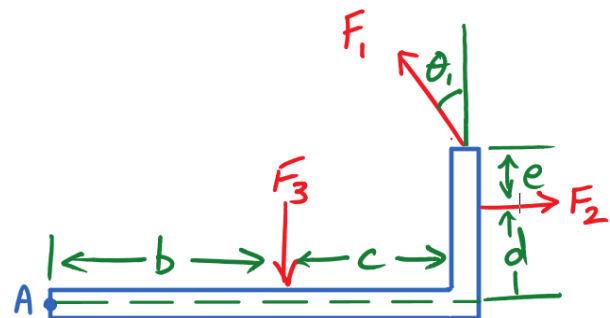
Choices = $\left(\begin{array}{l} \text{"A"} \quad -52.487 \\ \text{"B"} \quad -55.139 \\ \text{"C"} \quad -57.790 \\ \text{"D"} \quad -60.449 \\ \text{"E"} \quad -63.167 \\ \text{"F"} \quad 52.487 \\ \text{"G"} \quad 55.149 \\ \text{"H"} \quad 57.820 \\ \text{"I"} \quad 60.478 \\ \text{"J"} \quad 63.129 \end{array} \right) \cdot \text{N}\cdot\text{m}$

$$F_1 = 20 \text{ N} \quad b = 8 \text{ m}$$

$$F_2 = 14 \text{ N} \quad c = 6 \cdot \text{m}$$

$$F_3 = 25 \text{ N} \quad d = 5 \cdot \text{m}$$

$$\theta_1 = 30 \cdot \text{deg} \quad e = 3 \cdot \text{m}$$



Note:

- consider clockwise rotation as positive and counter-clockwise rotation as negative



19. (5 points) While the Captain has been very active, Mr. Scrub has just been standing around not doing his job. Therefore, the Captain holding the knife is forcing Mr. Scrub to walk the plank. Given the weights of the pirates and the distances in the information below, the magnitude of the reaction at A is closest to:

Choices = $\left(\begin{array}{l} \text{"A"} \ 0.002960 \\ \text{"B"} \ 0.003172 \\ \text{"C"} \ 0.003396 \\ \text{"D"} \ 0.003608 \\ \text{"E"} \ 0.003825 \\ \text{"F"} \ 0.004041 \\ \text{"G"} \ 0.004256 \\ \text{"H"} \ 0.004472 \end{array} \right) \cdot \text{N}$

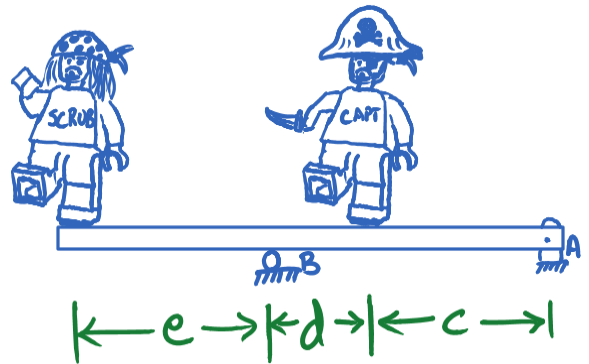
$$W_{\text{Captain}} = 0.0159 \cdot \text{N}$$

$$W_{\text{Scrub}} = 0.0123 \cdot \text{N}$$

$$c = 11 \cdot \text{cm}$$

$$d = 5 \cdot \text{cm}$$

$$e = 12 \cdot \text{cm}$$



Note:

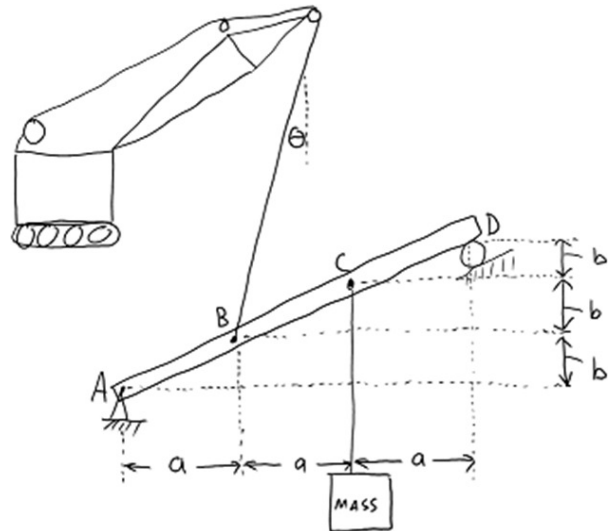
- A is a pinned joint
- Consider the men's weights to act at the vertical lines in the dimensions
- Gravity acts in the downward direction
- Mr. Scrub did not deserve this punishment



20. (5 points) The crane's cable is pulling on the beam with a tension $T_c = 300 \text{ N}$ at the angle θ , measured from the vertical.

The mass $m = 50 \text{ kg}$ is suspended from the beam in the position shown. Dimensions are given below the image. If the beam is in static equilibrium, the reaction at D is closest to:

Choices = $\left(\begin{array}{l} \text{"A"} \ 159.4 \\ \text{"B"} \ 169.3 \\ \text{"C"} \ 179.6 \\ \text{"D"} \ 189.7 \\ \text{"E"} \ 199.9 \\ \text{"F"} \ 210.0 \\ \text{"G"} \ 220.2 \\ \text{"H"} \ 230.3 \\ \text{"I"} \ 240.5 \\ \text{"J"} \ 250.7 \end{array} \right) \cdot \text{N}$



$$a = 80 \cdot \text{cm} \quad b = 60 \cdot \text{cm} \quad \theta = 15 \cdot \text{deg}$$



21. (5 points) The x component of reaction at A is closest to:

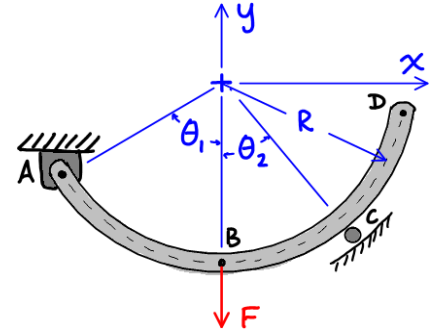
- Choices = $\left(\begin{array}{l} \text{"A"} \quad 122.6 \\ \text{"B"} \quad 132.3 \\ \text{"C"} \quad 142.0 \\ \text{"D"} \quad 151.8 \\ \text{"E"} \quad 161.3 \\ \text{"F"} \quad 170.8 \\ \text{"G"} \quad 180.5 \\ \text{"H"} \quad 190.2 \\ \text{"I"} \quad 199.9 \\ \text{"J"} \quad 209.4 \end{array} \right) \cdot \text{N}$

$$F = 400 \cdot \text{N}$$

$$R = 34 \cdot \text{cm}$$

$$\theta_1 = 54 \cdot \text{deg}$$

$$\theta_2 = 36 \cdot \text{deg}$$



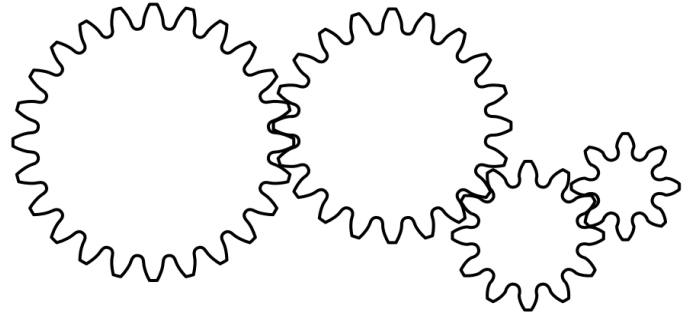
22. (5 points) A DC motor operates at a voltage of $V_m = 12 \text{ V}$ and consumes a current of $I_m = 0.5 \text{ A}$. The motor turns a gear train to lift a mass of $m = 12 \cdot \text{kg}$. If the system operates for time $t = 2 \cdot \text{min}$ with an efficiency of $\eta = 80\%$, then the change in height of the mass is closest to:

- Choices = $\left(\begin{array}{l} \text{"A"} \quad 4.644 \\ \text{"B"} \quad 4.893 \\ \text{"C"} \quad 5.142 \\ \text{"D"} \quad 5.389 \\ \text{"E"} \quad 5.638 \\ \text{"F"} \quad 5.885 \\ \text{"G"} \quad 6.140 \\ \text{"H"} \quad 6.381 \\ \text{"I"} \quad 6.632 \\ \text{"J"} \quad 6.884 \end{array} \right) \cdot \text{m}$



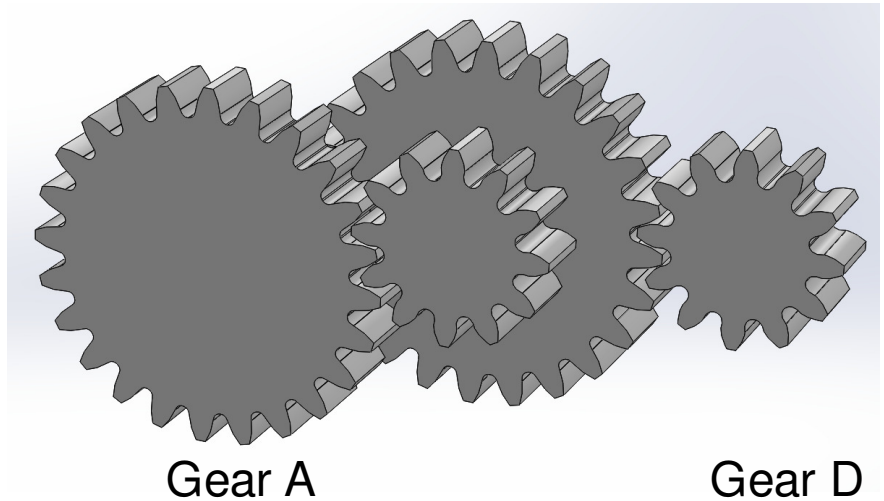
23. (5 points) Four spur gears mesh together as shown below. If the largest gear spins at 200 RPM, and transmits $T_1 = 23 \cdot \text{ft} \cdot \text{lbf}$ of torque, the Torque transmitted by the smallest gear is closest to:

Choices =	"A"	6.89	·ft·lbf
	"B"	7.28	
	"C"	7.67	
	"D"	8.05	
	"E"	8.44	
	"F"	8.84	
	"G"	9.22	
	"H"	9.62	
	"I"	9.99	
	"J"	10.40	



24. (5 points) Four spur gears mesh together as shown below. Gear A has 24 teeth and meshes with Gear B. Gear B has 12 teeth and is stacked with Gear C. Gear C has 24 teeth and meshes with Gear D. Gear D has 12 teeth. If Gear A spins at $\text{RPM}_A = 220 \cdot \text{rpm}$, then Gear D spins closest to:

Choices =	"A"	612	·rpm
	"B"	656	
	"C"	702	
	"D"	747	
	"E"	791	
	"F"	835	
	"G"	880	
	"H"	925	
	"I"	969	
	"J"	1014	

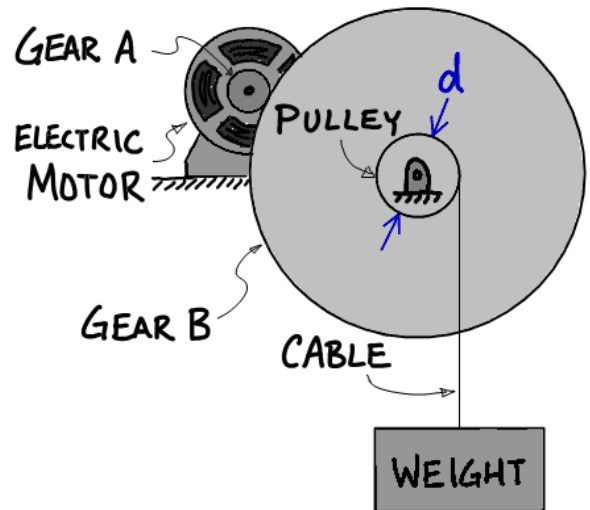




25. (5 points) The electric motor shown is supplied with a voltage of $V_m = 115\text{ V}$ and a current of $I_m = 5\text{ A}$ while lifting a weight. The overall system efficiency is $\eta = 60\%$, Gear A has $N_A = 15\text{ teeth}$, and Gear B has $N_B = 194\text{ teeth}$. The speed that Gear A is turning is closest to:

- Choices =
- | | |
|-----|-------|
| "A" | 141.7 |
| "B" | 150.1 |
| "C" | 158.6 |
| "D" | 167.1 |
| "E" | 175.6 |
| "F" | 184.0 |
| "G" | 192.6 |
| "H" | 201.0 |
| "I" | 209.5 |
| "J" | 218.1 |
- rpm

Weight = 3·kN
d = 17·cm



Hint: Power may be broken down:

$$\text{Power} = \frac{\text{Energy}}{\text{Time}} = \frac{\text{Force} \cdot \text{Length}}{\text{Time}} = \text{Force} \cdot \frac{\text{Length}}{\text{Time}}$$

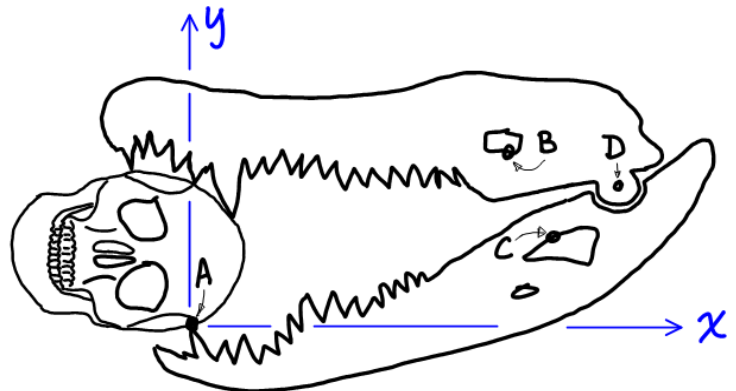
Remember the definition of efficiency:

$$\eta = \frac{\text{useful_power_out_of_system}}{\text{required_power_into_system}}$$



26. (5 points) The set of alligator jaws shown have powerful muscles that connect between points B and C. These muscles contract, causing the jaws to hinge about point D and close on alligator snacks. The way the snack shown becomes oriented in the alligator jaws leads to a force of $F_A = 130\text{ lbf}$ being applied to the snack at A along a line that is perpendicular to a line between A and D. The force that the jaw muscles must exert to achieve this force at A is closest to:

- Choices =
- | | |
|-----|-----|
| "A" | 431 |
| "B" | 467 |
| "C" | 505 |
| "D" | 541 |
| "E" | 577 |
| "F" | 615 |
| "G" | 652 |
| "H" | 688 |
| "I" | 725 |
| "J" | 762 |
- lbf



coordinates of points:

$$(x_A \ y_A) = (0 \ 0) \cdot \text{in} \quad (x_B \ y_B) = (16.1 \ 8.5) \cdot \text{in}$$

$$(x_C \ y_C) = (18 \ 4.7) \cdot \text{in} \quad (x_D \ y_D) = (21.3 \ 7.1) \cdot \text{in}$$