

Form#: 22

Allowed materials include calculator (without wireless capability), pencil or pen.

Honor Statement: On my honor, I promise that I have not received any outside 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, . . .).

_____ signature

Dept.	Course #			Section (last 2 dig)		Exam Form	
4	1	2	2				
0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9

- H11
- H12
- H13
- H14
- 001
- 002
- 003

- 10-11:50 TR Hall
- 2-3:50 TR Cronk
- 12-1:50 TR Swanbom
- 8-9:50 TR Barker
- 2-3:50 MW Swanbom
- 12-1:50 TR Cronk
- 8-9:50 TR Nelson

1 lb = 4.448 N
 1 in = 25.4 mm
 1 m = 3.281 ft

★ also fill in **CWID**, name and **course (122)** . . . don't forget to black in bubbles

★ you must show your work on problems that require calculations to receive credit

Problem 1

(4 points) The sensor that is commonly used in game controllers to translate motion by the game player into movement that is seen on screen (as in tilting the controller to make an imaginary jet turn to the right) is the ...

- a. Ping sensor
- b. Accelerometer
- c. RF transmitter/receiver pair
- d. GPS
- e. RFID
- f. Rotary Encoder

Problem 2

(3 points) According to the “Ten Faces of Innovation,” the persona most likely to make sure that a customer’s needs are met in a new design would be the

- a. Anthropologist
- b. Experimentalist
- c. Cross-pollinator
- d. Hurdler
- e. Collaborator
- f. Director
- g. Experience architect
- h. Set designer
- i. Caregiver
- j. Story teller

Problem 3

(3 points) The minimum number of connections between a sensor and a microcontroller such as the Arduino is ...

- a. 0
- b. 1
- c. 2
- d. 3
- e. 4
- f. 5
- g. 6
- h. 7
- i. 10

Problem 4

(3 points) Three spur gears (Gear A, Gear B, and Gear C) are connected in series (each one next to the other, with Gear B in the middle). Which of the following statements **MUST** be true?

- a. If Gear A is spinning faster than Gear B, then Gear A must have a larger torque than Gear B.
- b. If Gear B is spinning faster than Gear C, then Gear B must have a larger torque than Gear C.
- c. If Gear A is spinning counterclockwise, then Gear C must also be spinning counterclockwise.
- d. If Gear A is spinning counterclockwise, then Gear C must be spinning clockwise.
- e. If Gear A has more teeth than Gear C, then Gear A must be spinning faster than Gear B.
- f. If Gear A has more teeth than Gear C, then Gear A must be spinning more slowly than Gear B.

Problem 5

(3 points) When working with sheet metal, the device most likely used to bend the metal would be ...

- a. Break
- b. Brake
- c. Shear
- d. Sheer
- e. Rivet gun
- f. Hand punch
- g. Letter punch
- h. Sheet metal

Problem 6

(3 points) Which of the following is NOT a good reason for using a mind map or concept map for product design?

- a. connecting ideas
- b. brainstorming
- c. comparing design alternatives
- d. organizing thoughts
- e. keeping a record of part of the design process

Problem 7

(3 points) An engineer is trying to convince her parents that she needs a new computer for her engineering studies. She is wanting to use her engineering knowledge to make a persuasive argument for the purchase. Therefore, she has designed a Pugh Matrix using the following table. She already owns an Alpha computer; the other 4 choices represent choices for new computers. Based on the Modified Pugh analysis technique which accounts for weighting factors, she will convince her parents she needs a ...

- Alpha computer (the one she already owns)
- Beta computer
- Gamma computer
- Delta computer
- Epsilon computer
- None of the computers represents a good choice; she should keep researching her options

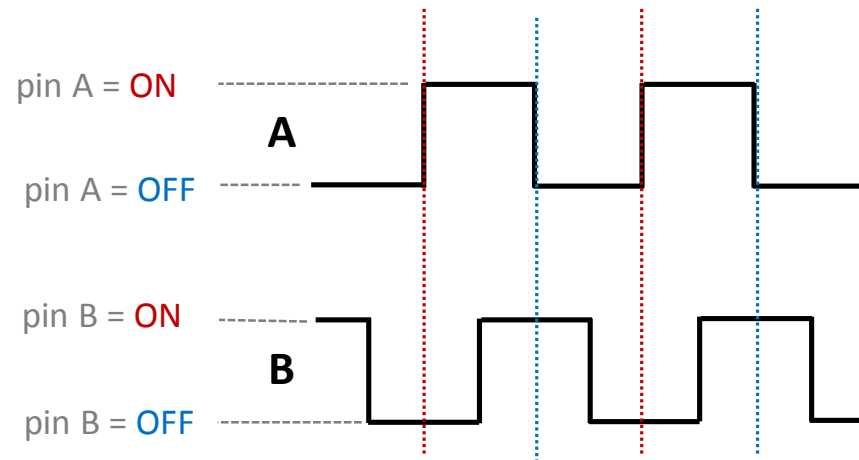
	Weight	Alpha	Beta	Gamma	Delta	Epsilon
Price	10	0	-	-	-	-
Screen Size	3	0	+	0	0	+
Size of Hard Drive	7	0	+	+	-	+
Reputation for quality	3	0	+	+	0	0
Processor Speed	5	0	+	-	+	0
Carrying Weight	10	0	0	0	0	+

Problem 8

(3 points) If a rotary encoder is connected to a microcontroller, and the graph below shows the relationship between pin voltages, then the microcontroller will detect a counterclockwise rotation if either of which sets of conditions are met?

- a. Pin A goes OFF and Pin B is ON, or Pin A goes ON and Pin B is ON.
- b. Pin A goes ON and Pin B is ON, or Pin A goes OFF and Pin B is ON.
- c. Pin A goes OFF and Pin B is OFF, or Pin A goes ON and Pin B is ON.
- d. Pin A goes OFF and Pin B is ON, or Pin A goes ON and Pin B is OFF.
- e. Pin A goes ON and Pin B is OFF, or Pin A goes OFF and Pin B is OFF.

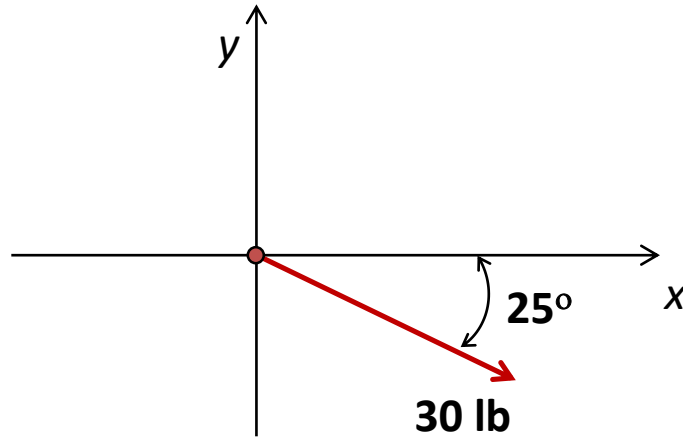
← counterclockwise rotation of knob
→ clockwise rotation of knob



Problem 9

(5 points) The x component of the force shown below is closest to . . .

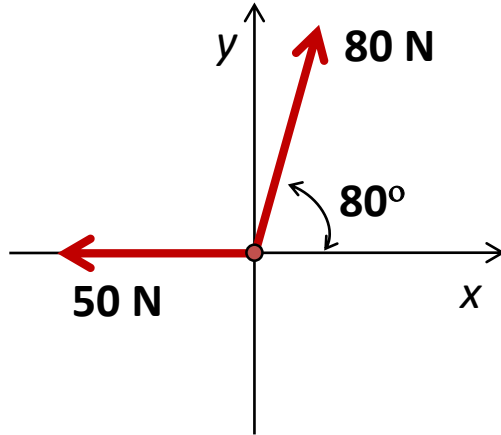
- a. -8.9 lb
- b. 12.7 lb
- c. -12.7 lb
- d. 27.2 lb
- e. -27.2 lb
- f. 30 lb



Problem 10

(5 points) The angle that the resultant of the force system below makes with the **positive x-axis** is closest to . . .

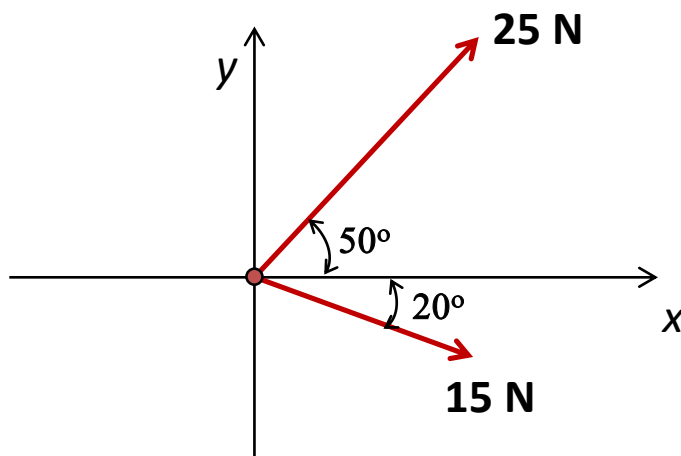
- a. 5.1°
- b. 13.9°
- c. 24.6°
- d. 36.1°
- e. 65.4°
- f. 114.6°
- g. 155.4°
- h. 204.6°



Problem 11

(5 points) The resultant of the forces shown below is closest to . . .

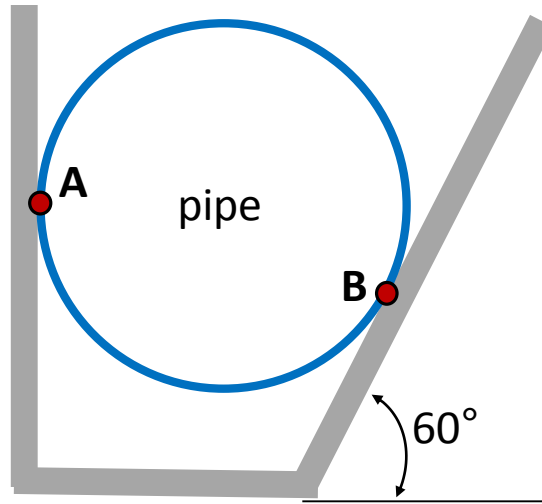
- a. 8.1 N
- b. 12.5 N
- c. 21.8 N
- d. 25.8 N
- e. 33.3 N
- f. 50.1 N



Problem 12

(5 points) A 200 lb pipe is placed in a rack as shown in the figure below. The pipe exerts a force at B that is closest to . . .

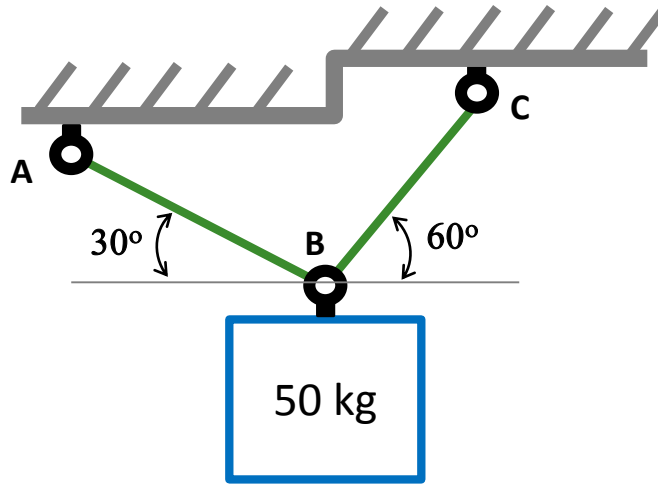
- a. 100 lb
- b. 173 lb
- c. 200 lb
- d. 230 lb
- e. 400 lb



Problem 13

(5 points) If the block shown in the figure has a mass of 50 kg, the tension in cable BC is closest to ...

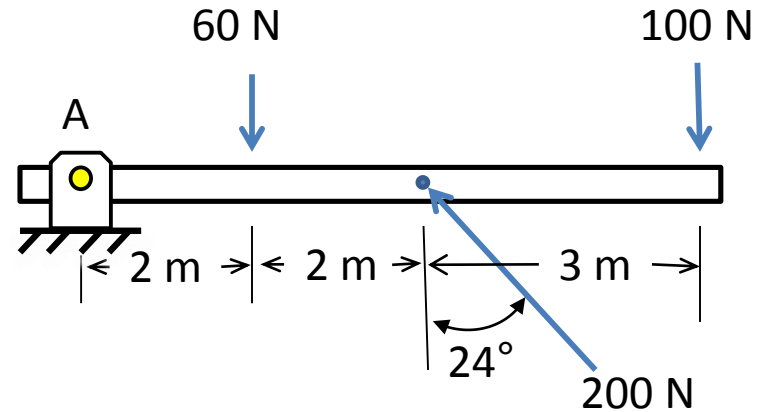
- a. 425 N
- b. 490 N
- c. 521 N
- d. 589 N
- e. 733 N



Problem 14

(5 points) A beam which is pinned at point A is subjected to three external forces. Assuming clockwise (CW) moments are positive, **the moment of the 100 N force about point A** is closest to...

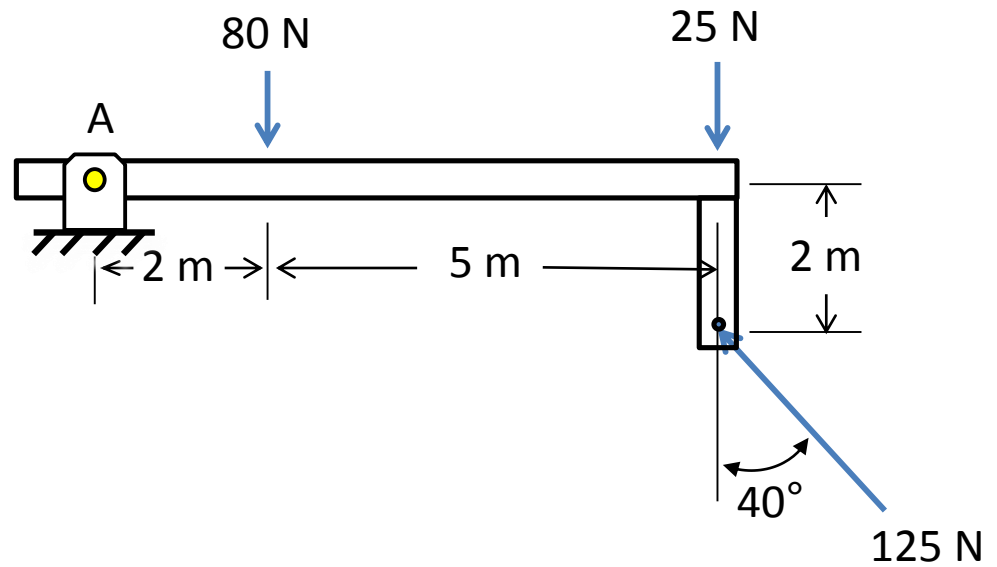
- a. 300 N-m
- b. -300 N-m
- c. 120 N-m
- d. 700 N-m
- e. -120 N-m
- f. -700 N-m
- g. 90 N-m



Problem 15

(5 points) A beam which is pinned at point A is subjected to three external forces. Assuming clockwise (CW) moments are positive, **the net moment of the force system about point A** is closest to...

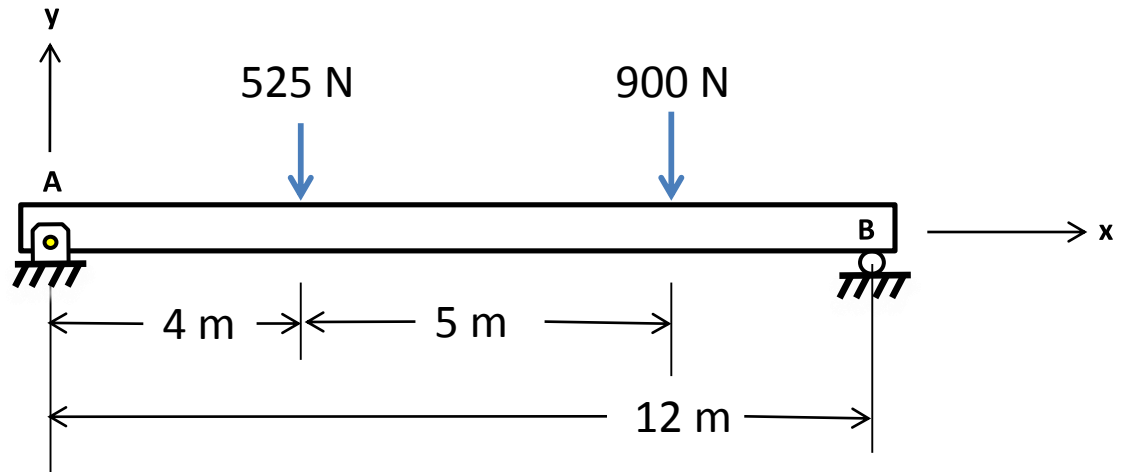
- a. 355 N-m
- b. -175 N-m
- c. 161 N-m
- d. -670 N-m
- e. -120 N-m
- f. -355 N-m
- g. 175 N-m
- h. 700 N-m



Problem 16

(5 points) A beam with a pin connection at A and a roller connection at B is shown below. The reaction at B required for equilibrium is closest to...

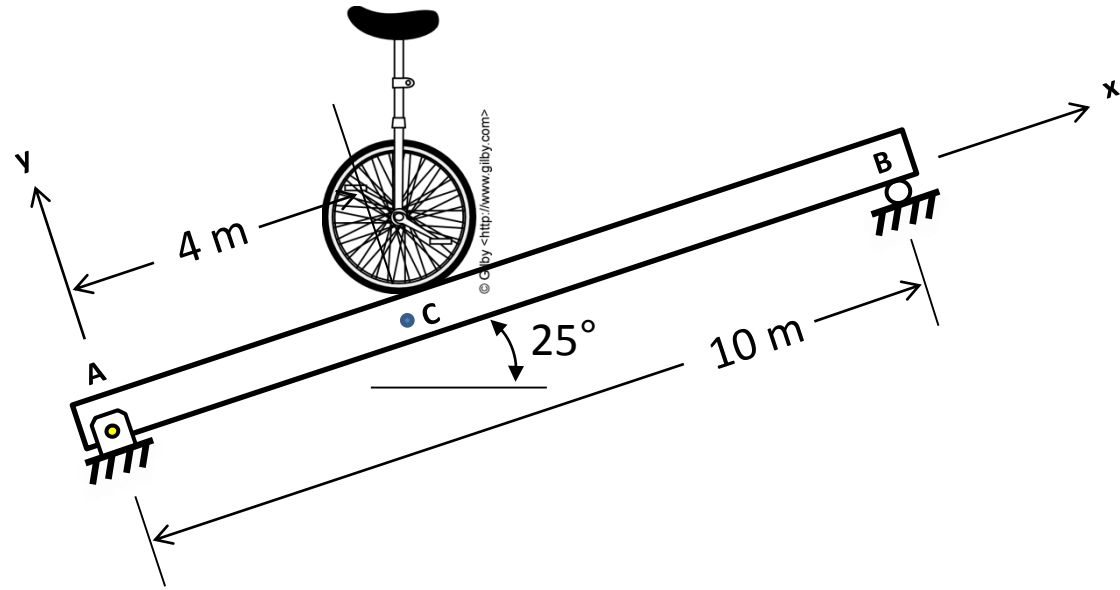
- a. -200 N
- b. 2400 N
- c. -375 N
- d. 550 N
- e. -120 N
- f. -550 N
- g. 1425 N
- h. 850 N



Problem 17

(5 points) A person (not shown) rides a unicycle up the ramp. The unicycle and rider are balanced directly above point C which is 4 m along the beam from A. The combined weight of the unicycle and rider is 867 N. The reaction at B required for equilibrium is closest to...

- a. 578 N
- b. 524 N
- c. 147 N
- d. 366 N
- e. 786 N
- f. 314 N
- g. 347 N
- h. 865 N

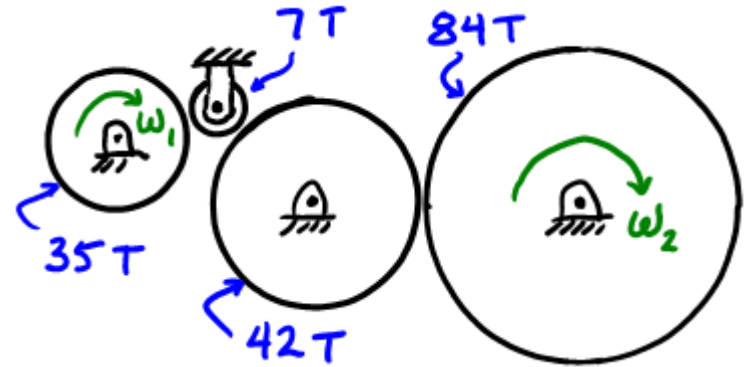


Problem 18

(5 points) The first gear in a set of gears is turned at $\omega_1 = 3600$ rpm. Assuming zero slip, and given the numbers of teeth labeled on the figure, the angular velocity of the last gear (ω_2) is closest to . . .

(positive numbers mean the same direction as the arrow for ω_2 ; negative numbers mean the opposite direction)

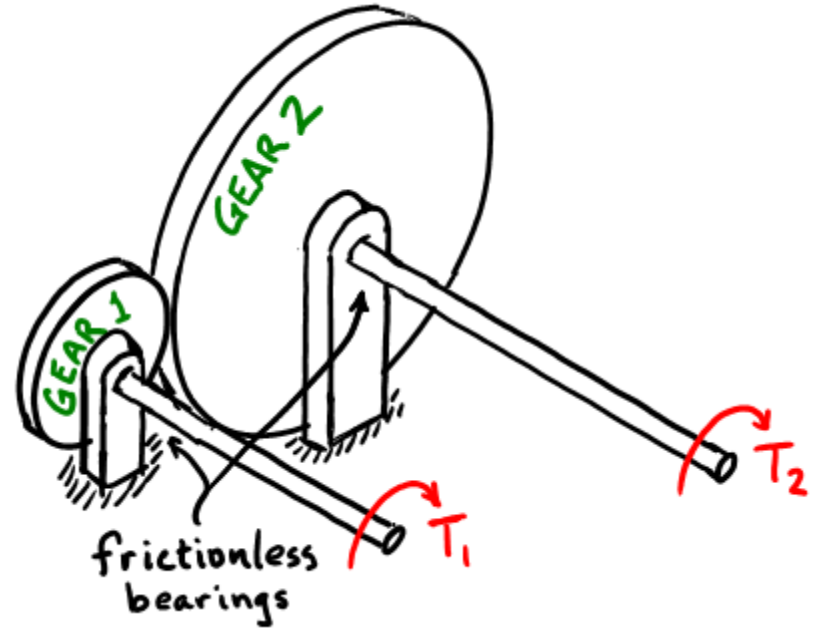
- a. -9000 rpm
- b. -8640 rpm
- c. -1800 rpm
- d. -1500 rpm
- e. -600 rpm
- f. 600 rpm
- g. 1500 rpm
- h. 1800 rpm
- i. 8640 rpm
- j. 9000 rpm



Problem 19

(5 points) Two spur gears mesh as shown. Gear 1 has 32 teeth, and gear 2 has 108 teeth. If a torque of $T_1 = 80 \text{ N}\cdot\text{m}$ is applied to the shaft of gear 1, then the torque (T_2) that must be applied to the shaft of gear 2 to keep the gearset from accelerating is closest to . . . (positive answers indicate a torque must be applied in the direction shown for T_2 ; negative answers mean the torque must be applied in the opposite direction)

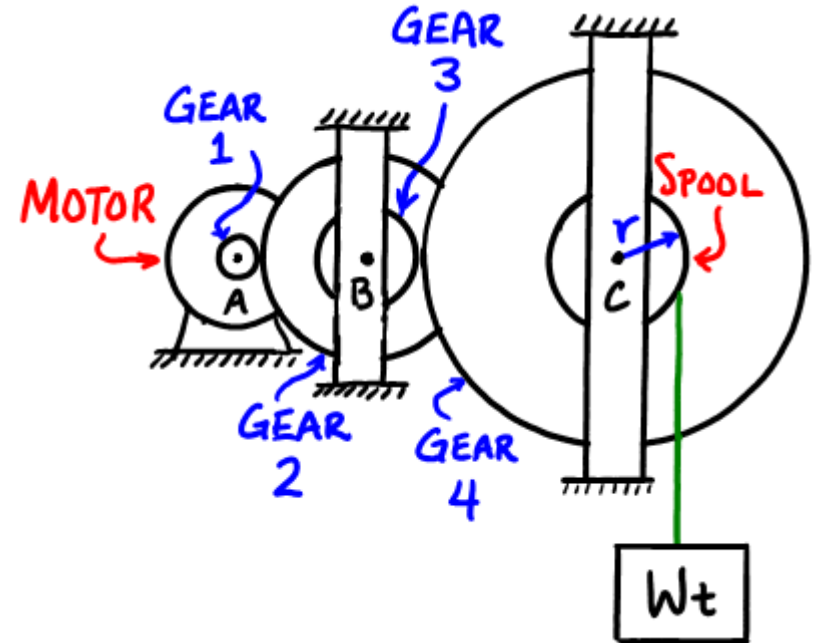
- a. $-350 \text{ N}\cdot\text{m}$
- b. $-270 \text{ N}\cdot\text{m}$
- c. $-135 \text{ N}\cdot\text{m}$
- d. $-61.7 \text{ N}\cdot\text{m}$
- e. $-23.7 \text{ N}\cdot\text{m}$
- f. $23.7 \text{ N}\cdot\text{m}$
- g. $61.7 \text{ N}\cdot\text{m}$
- h. $135 \text{ N}\cdot\text{m}$
- i. $270 \text{ N}\cdot\text{m}$
- j. $350 \text{ N}\cdot\text{m}$



Problem 20

(5 points) In the gear train shown, gear 1 has 14 teeth, gear 2 has 43 teeth, gear 3 has 22 teeth, and gear 4 has 92 teeth. A rope carrying a weight of $W_t = 300\text{lb}$ is being wound at a constant rate onto a spool with a radius of $r = 1\text{ ft}$. The spool is directly attached to gear 4. Gears 2 and 3 are rigidly connected to each other. Assuming 100% efficient gears, the torque supplied by the output shaft of the motor (shaft A) is closest to . . .

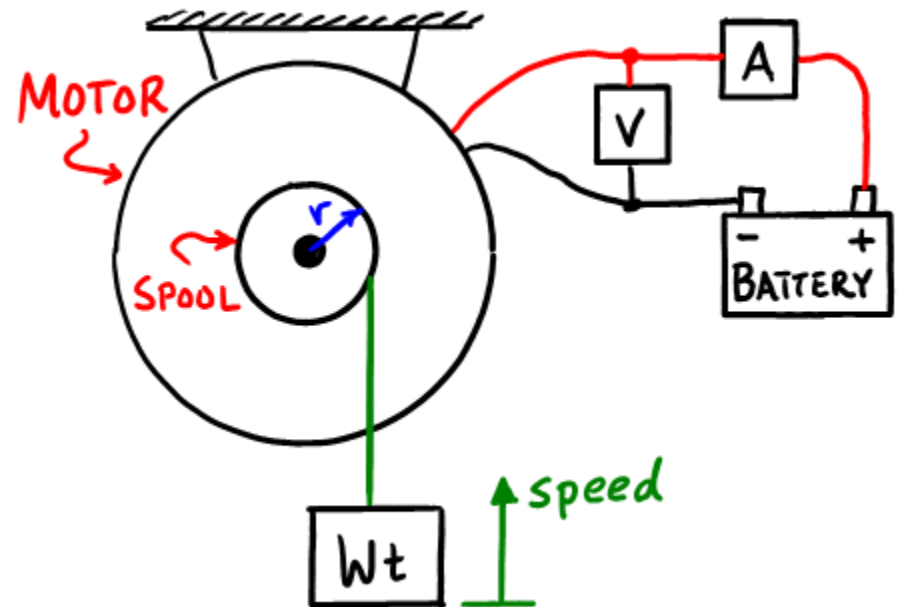
- a. $12.0\text{ in}\cdot\text{lb}$
- b. $23.4\text{ in}\cdot\text{lb}$
- c. $45.7\text{ in}\cdot\text{lb}$
- d. $143.4\text{ in}\cdot\text{lb}$
- e. $280.3\text{ in}\cdot\text{lb}$
- f. $547.8\text{ in}\cdot\text{lb}$
- g. $2644\text{ in}\cdot\text{lb}$
- h. $4901\text{ in}\cdot\text{lb}$



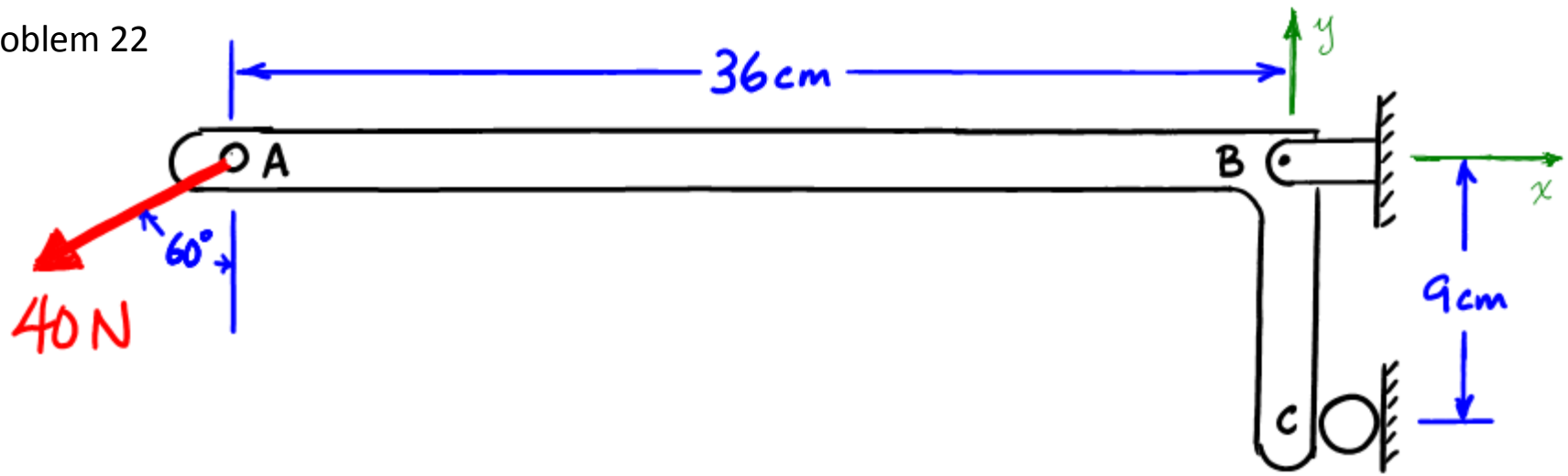
Problem 21

(5 points) A battery is hooked up to a motor through a volt meter and an ammeter. The volt meter reads 12.2V and the ammeter reads 410mA. A weight of 25N is lifted at a speed of 600 cm/min by a cord which is being wound around a spool with a radius of $r = 20$ mm. The efficiency of the motor is closest to . . .

- What is described in the problem cannot be happening; the circuit is connected incorrectly.
- What is described in the problem cannot be happening; it violates the conservation of energy.
- 95%
- 80%
- 65%
- 50%
- 35%
- 20%
- 5%



Problem 22



(5 points) The direction of the resultant force placed on arm ABC at the pin at B (measured counter-clockwise from the positive x axis) is closest to . . .

- a. 0.0°
- b. 1.1°
- c. 5.5°
- d. 9.9°
- e. 15.5°
- f. 25°
- g. 35°
- h. 45°
- i. 60°
- j. 90°

Problem 23

(5 points) Dr. Cronk participates in a circus act where he and a large alligator balance on a beam. Dr. Cronk who has a mass of 100 kg stands on one end of the beam while the center of mass of the 360 kg alligator is located 3 m to the left of the pinned joint at B. Dr. Cronk pulls on a rope that passes through frictionless pulleys at D and E and is attached to the beam at A; the tension in the rope is the same at all points. To remain balanced, Dr. Cronk must pull down on the rope with a force that is closest to . . .

- a. 10.1 N
- b. 28.1 N
- c. 59.5 N
- d. 108 N
- e. 221 N
- f. 357 N
- g. 550 N
- h. 610 N
- i. 738 N

