

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, . . .).

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Dept.	Course #				Section (last 2 dig)		Exam Form																																																																								
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H11	10-11:50 TR	Hall
H12	2-3:50 TR	Cronk
H13	12-1:50 TR	Swanbom
H14	8-9:50 TR	Hegab
001	2-3:50 MW	Swanbom
002	12-1:50 TR	Moller
003	8-9:50 TR	Evans

1 lb = 4.448 N
 1 in = 25.4 mm
 1 m = 3.281 ft
 g = 9.81 m/s²

formulas repeated on back page if you want to tear them off

$$I = Pni$$

$$F = P(1 + ni)$$

$$F = P(1 + i)^n$$

$$P = F(1 + i)^{-n}$$

$$F = A \left[\frac{(1+i)^n - 1}{i} \right]$$

$$P = A \left[\frac{(1+i)^n - 1}{i(1+i)^n} \right]$$

- ★ 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

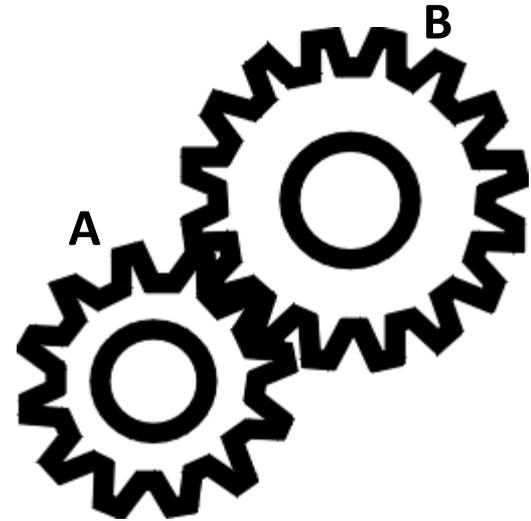
(2 points) Which physical quantity does the PING))) sensor use to measure distance (select best answer)?

- a. radio waves
- b. microwaves
- c. infrared light waves
- d. black magic
- e. sound waves
- f. ESP
- g. PINGology

Problem 2

(3 points) Suppose gear A spins at 20 RPM and transmits a torque of 4 N-m. If gear B has a larger diameter than gear A (as depicted), then the RPM of and torque transmitted by gear B are closest to...

- a. 26.67 RPM and 5.33 N-m, respectively.
- b. 26.67 RPM and 3 N-m, respectively.
- c. 15 RPM and 5.33 N-m, respectively.
- d. 15 RPM and 3 N-m, respectively.
- e. there is not enough information to solve the problem.



Problem 3

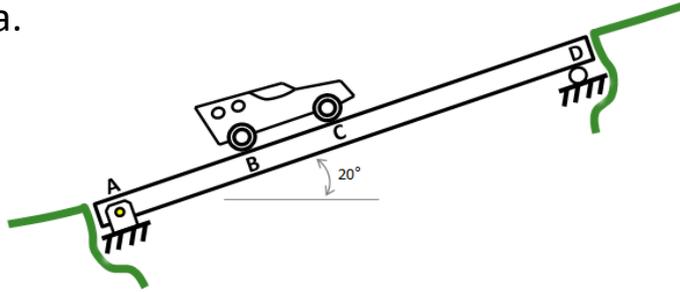
(3 points) The RFID reader discussed in this class uses which type of tag?

- a. aggressive
- b. passive aggressive
- c. passive
- d. active
- e. active passive
- f. active aggressive

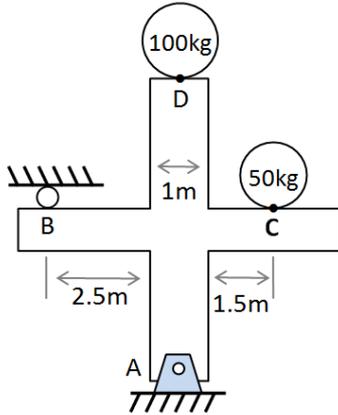
Problem 4

(3 points) When determining the forces acting on the physical systems below, which system can be best analyzed using a concurrent force system?

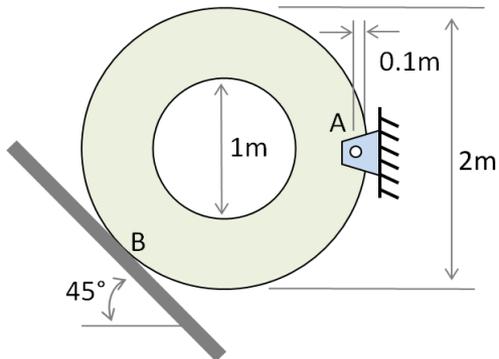
a.



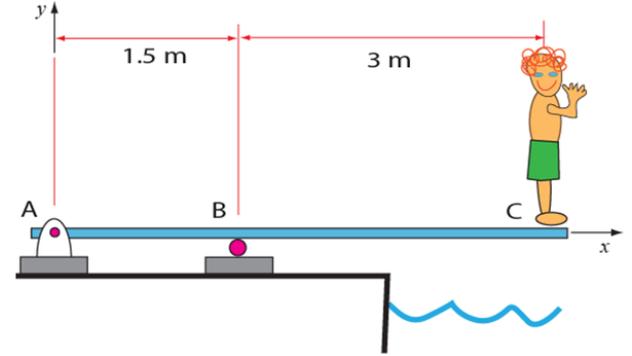
b.



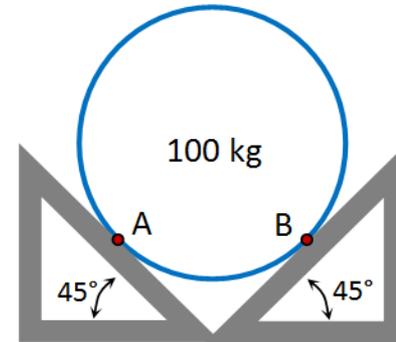
c.



d.



e.



Problem 5

(2 points) Based on the course notes, which *best* describes the rivet type used in class to make the sheet metal nameplates?

- a. Rosie rivet
- b. Blind or pop rivet
- c. Solid rivet
- d. Semi-tubular rivet
- e. Oscar rivet
- f. Drive rivet
- g. Friction-lock rivet
- h. Flush rivet
- i. Self-pierce rivet
- j. Privet rivet

Problem 6

(2 points) Thinking back to class discussions and notes about the book *The Ten Faces of Innovation*, which of the following best describes what is meant by “innovation?”

- a. Having a wide breadth of knowledge across disciplines
- b. Gathering new sources of information
- c. Keeping a “bug list” and an “idea wallet”
- d. Observing your surroundings
- e. Finding new ways to do things
- f. Bringing seemingly unrelated ideas together
- g. Coaching instead of bossing
- h. Bringing out the best in team members
- i. Promoting an energetic, inspired culture
- j. Creating relationships

Problem 7

(2 points) Which of the following statements is false about the principles of economics discussed in class?

- a. They can be used to compare the costs of labor vs. equipment purchase to automate a process.
- b. They can be used to plan retirement savings.
- c. They can be used to determine a monthly car payment.
- d. They can be used to compare loan options.
- e. They can be used to impress your friends who are not mathematically inclined.
- f. They can be used to help you make an advantageous deal with your friends who are not mathematically inclined.
- g. They may help save you from making a bad financial decision.
- h. They can be used to determine the RPM in a gear train.
- i. They can justify the difference between simple and compounded interest.

Problem 8

(2 points) The diagram below is *best* described as a(n) ...

a. brainstorming map.

b. mind map.

c. concept map.

d. design map.

e. engineering map.

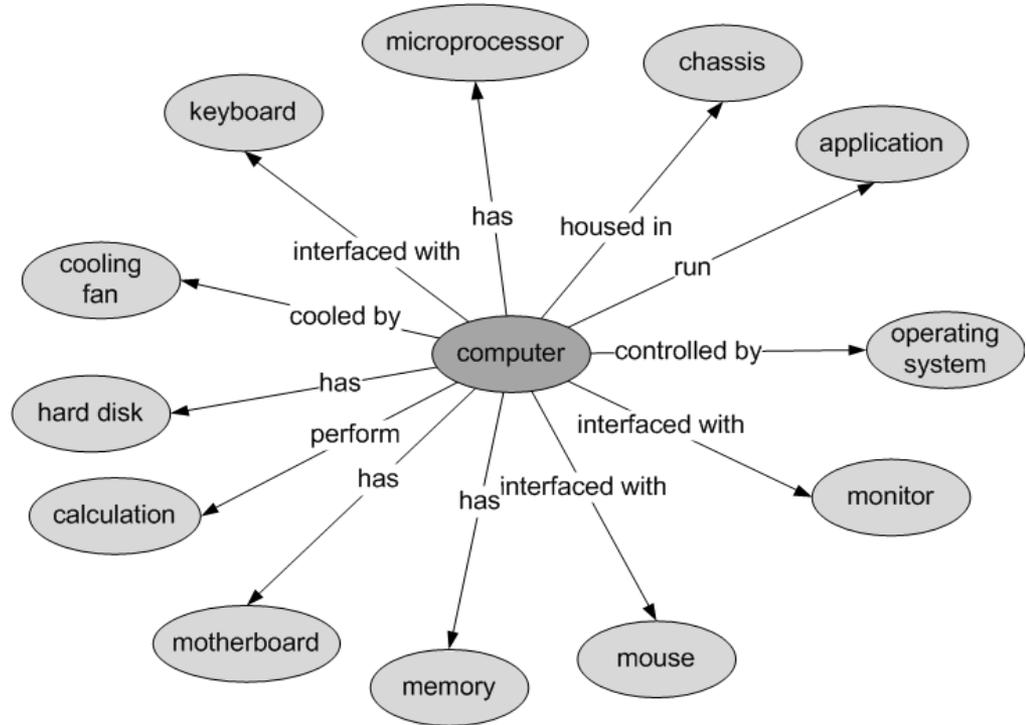
f. construction map.

g. blueprint.

h. doodle.

i. graph.

j. drawing.



Problem 9

(3 points) Consider using the Modified Pugh Method for a freshman engineering project. What are the scores for Concepts 1, 2, and 3, respectively, and which concept should you develop based on the scores?

Criteria	Weight	Concept 1	Concept 2	Concept 3
Cost	1	(0)	(+)	(-)
Reliability	4	(+)	(0)	(-)
Marketability	2	(-)	(0)	(+)
Environmentally friendly	3	(-)	(-)	(+)
Ease of use	2	(+)	(+)	(+)
Score				

- a. -1, 0, +2, Concept 1
- b. -1, 0, +2, Concept 2
- c. -1, 0, +2, Concept 3
- d. +1, 0, -2, Concept 1
- e. +1, 0, -2, Concept 2
- f. +1, 0, -2, Concept 3
- g. +1, 0, +2, Concept 1
- h. +1, 0, +2, Concept 2
- i. +1, 0, +2, Concept 3

Problem 10

(2 points) An three-axis accelerometer sitting still on a table will give a non-zero output for one or more of the three accelerations. Select the answer below that describes the main reason that this happens.

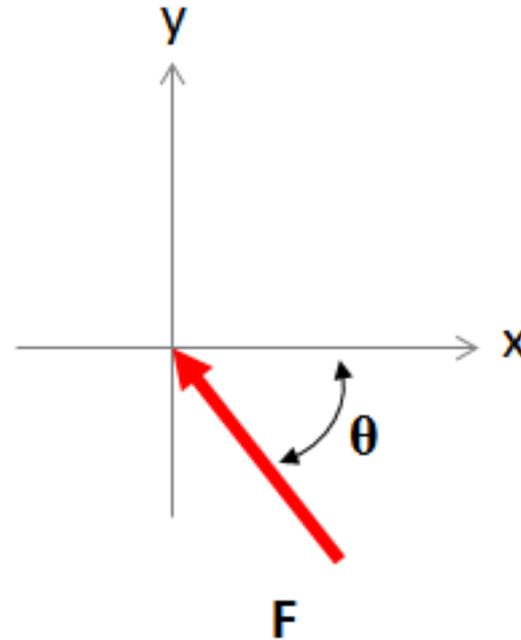
- a. as the earth spins on its axis, the rotation tries to sling the accelerometer outward; the accelerometer is sensing the force associated with this acceleration
- b. the non-zero acceleration is due to the Coriolis acceleration caused by rotation of the earth about its axis
- c. the earth changes direction as it moves around the sun, thus accelerating and inducing a corresponding force
- d. gravity exerts a force on the accelerometer (the accelerometer doesn't know the difference between a force due to gravity and a force due to acceleration)
- e. a few scientists are still trying to figure this out . . . with earth's rotation on its axis, our revolution about the sun, and gravity, it's really confusing and very few people really want to think about it
- f. because Griff's has awesome shakes

Problem 11

(5 points) Given the force and coordinate axes below (where $F = 2,510$ lb and $\theta = 55^\circ$), the x-component of the force is closest to...

Note: The graphic below may not be drawn to scale.

- a. -2054 lb
- b. -1965 lb
- c. -1440 lb
- d. -1193 lb
- e. 1193 lb
- f. 1440 lb
- g. 1965 lb
- h. 2054 lb

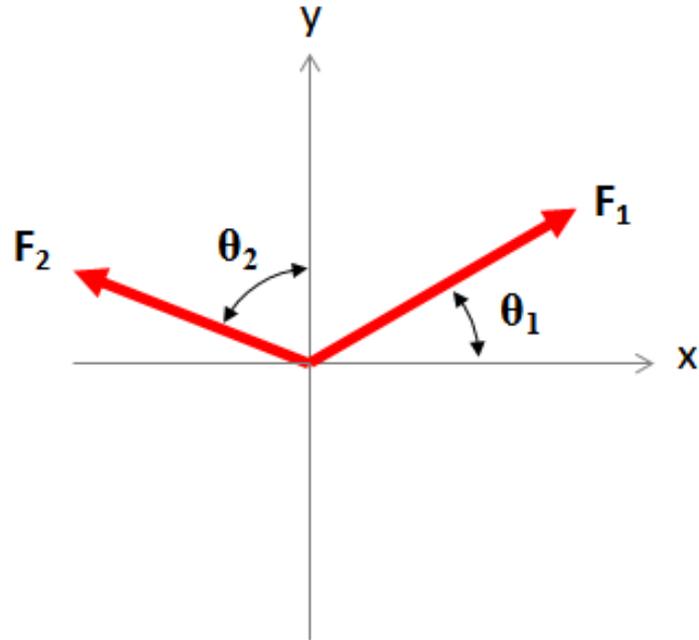


Problem 12

(5 points) For the forces shown below (where $F_1 = 50\text{ N}$, $\theta_1 = 18^\circ$, $F_2 = 42\text{ N}$ and $\theta_2 = 65^\circ$), the angle of the resultant force (measured from the positive x axis) is closest to...

Note: The graphic below may not be drawn to scale.

- a. 74°
- b. 79°
- c. 83°
- d. 88°
- e. 92°
- f. 95°
- g. 101°
- h. 107°
- i. 116°

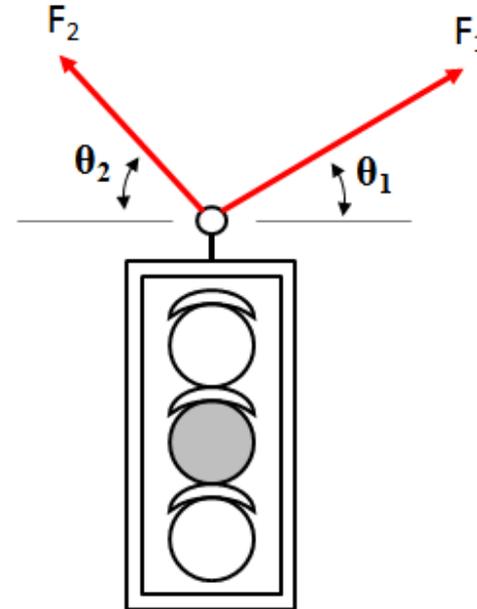


Problem 13

(5 points) A traffic light suspended in equilibrium from cables has a weight of 30 pounds. If the angles shown are $\theta_1 = 30^\circ$ and $\theta_2 = 50^\circ$, forces F_1 and F_2 are closest to...

Note: The graphic below may not be drawn to scale.

- a. $F_1 = 18.7$ lb and $F_2 = 33.2$ lb
- b. $F_1 = 33.2$ lb and $F_2 = 18.7$ lb
- c. $F_1 = 17.3$ lb and $F_2 = 21.8$ lb
- d. $F_1 = 21.8$ lb and $F_2 = 17.3$ lb
- e. $F_1 = 20.6$ lb and $F_2 = 22.1$ lb
- f. $F_1 = 22.1$ lb and $F_2 = 20.6$ lb
- g. $F_1 = 16.5$ lb and $F_2 = 29.9$ lb
- h. $F_1 = 29.9$ lb and $F_2 = 16.5$ lb
- i. $F_1 = 19.6$ lb and $F_2 = 26.4$ lb
- j. $F_1 = 26.4$ lb and $F_2 = 19.6$ lb



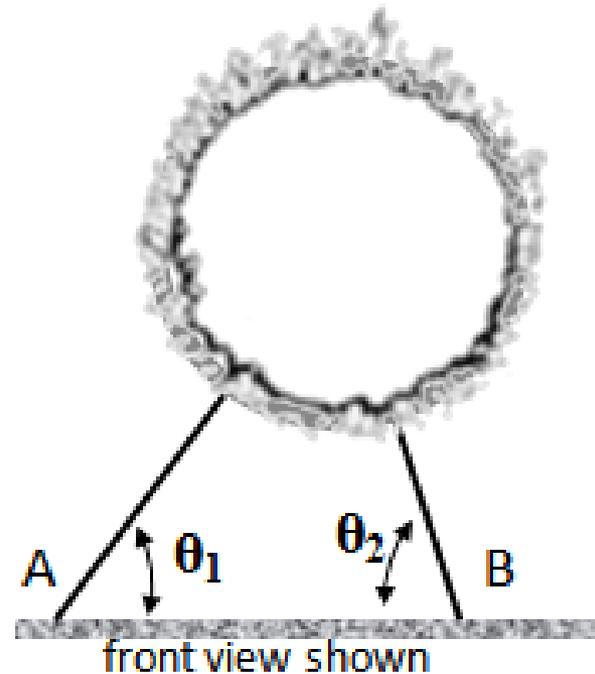
Problem 14

(5 points) For the next E&S Day, your Living with the Lab instructors are considering putting on a stunt performance by jumping a motorcycle through a flaming hoop. Unfortunately, their fabrication skills are a bit rusty so the two rigid supports of the flaming hoop are of uneven length. If the hoop weighs 48 pounds and $\theta_1 = 45^\circ$ and $\theta_2 = 65^\circ$, the force provided by support B is closest to...

Notes:

- Assume that the legs are collinear with a radius from the center of the hoop.
- Neglect moments on the structure (i.e., consider it a 2-dimensional problem).
- The graphic below may not be drawn to scale and does not guarantee that the stunt performance will take place.
- Your actual LWTL instructors would not make such an error during fabrication.

- 21 lb
- 24 lb
- 27 lb
- 30 lb
- 33 lb
- 36 lb
- 39 lb
- 42 lb
- 45 lb
- 48 lb



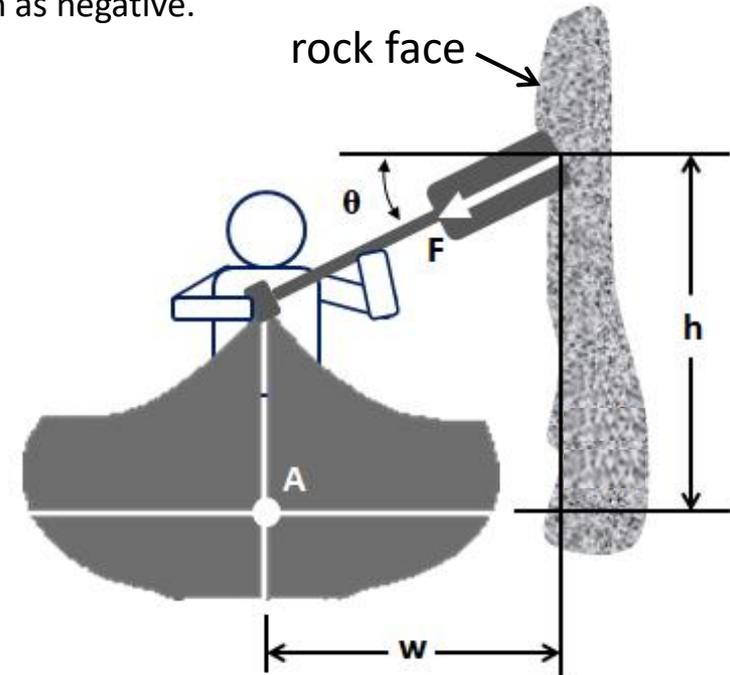
Problem 15

(5 points) A canoeer uses his paddle to keep from crashing into a rock face ($F = 90\text{ N}$, $h = 1.9\text{ m}$, $w = 1.2\text{ m}$ and $\theta = 20^\circ$). The moment that the force from the paddle generates about point A is closest to...

Notes:

- Assume that all the force delivered to the paddle from the rock face is transferred to the canoeer at the center of his chest in the direction of the axis of the paddle (neglect the transfer of force through his arms/shoulders).
- Consider clockwise rotation as positive and counter-clockwise rotation as negative.
- The graphic below may not be drawn to scale.

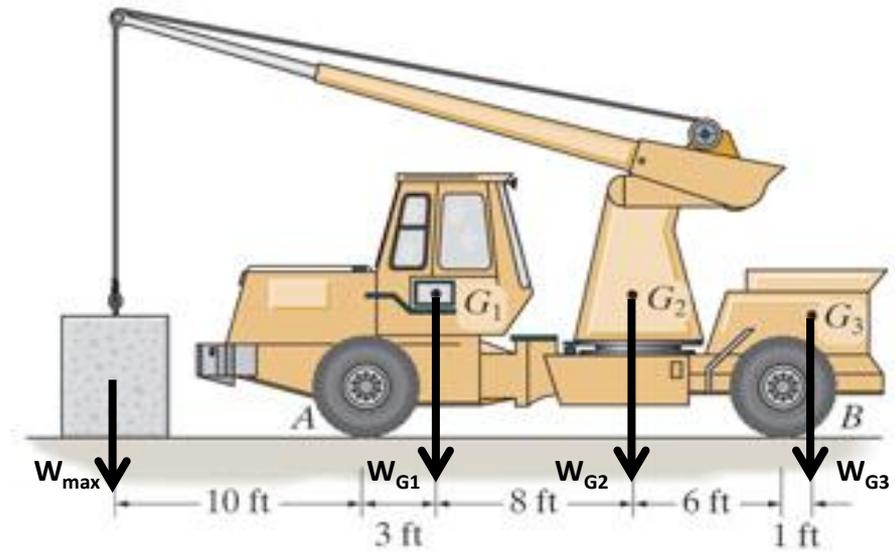
- 165 N-m
- 148 N-m
- 124 N-m
- 103 N-m
- 79 N-m
- 79 N-m
- 103 N-m
- 124 N-m
- 148 N-m
- 165 N-m



Problem 16

(5 points) The crane shown below consists of three parts, which have weights $W_{G_1} = 3700$ lb, $W_{G_2} = 950$ lb, and $W_{G_3} = 1300$ lb. These weights occur at the center of gravity of each part at points, G_1 , G_2 , and G_3 , respectively. Neglecting the weight of the boom, the maximum weight (W_{\max}) the crane can lift without tipping over is closest to...

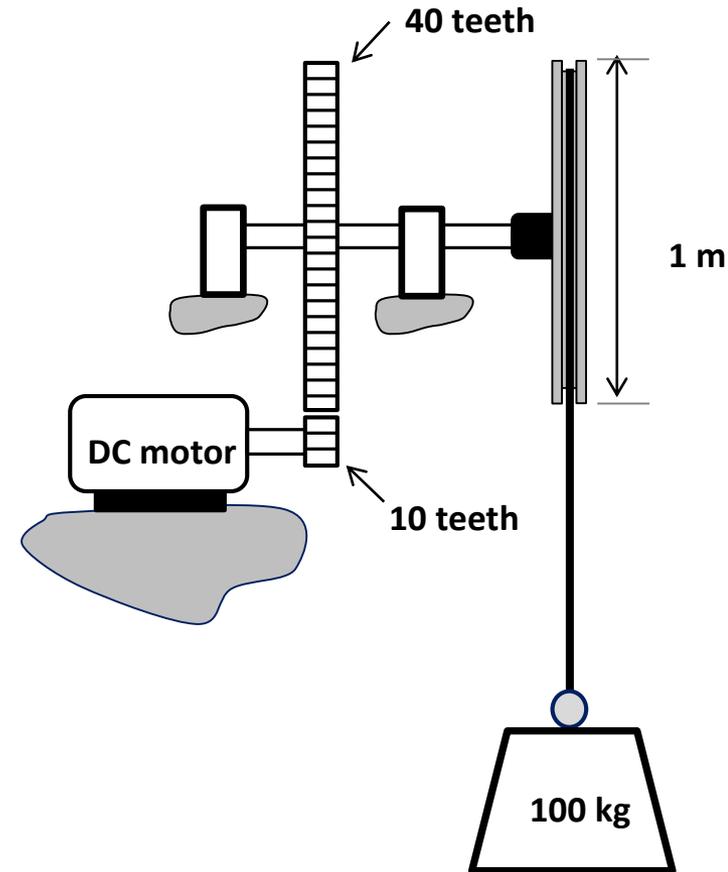
- a. 1,290 lb
- b. 3,390 lb
- c. 3,450 lb
- d. 4,500 lb
- e. 44,950 lb
- f. 77,350 lb
- g. 100,450 lb



Problem 17

(5 points) A 100 kg mass is lifted by a pulley with a diameter of 1 m. The motor and gear train have a system efficiency of 74%. If the 100 kg mass is lifted 3 m in one second, the DC power that must be delivered to the motor is closest to . . .

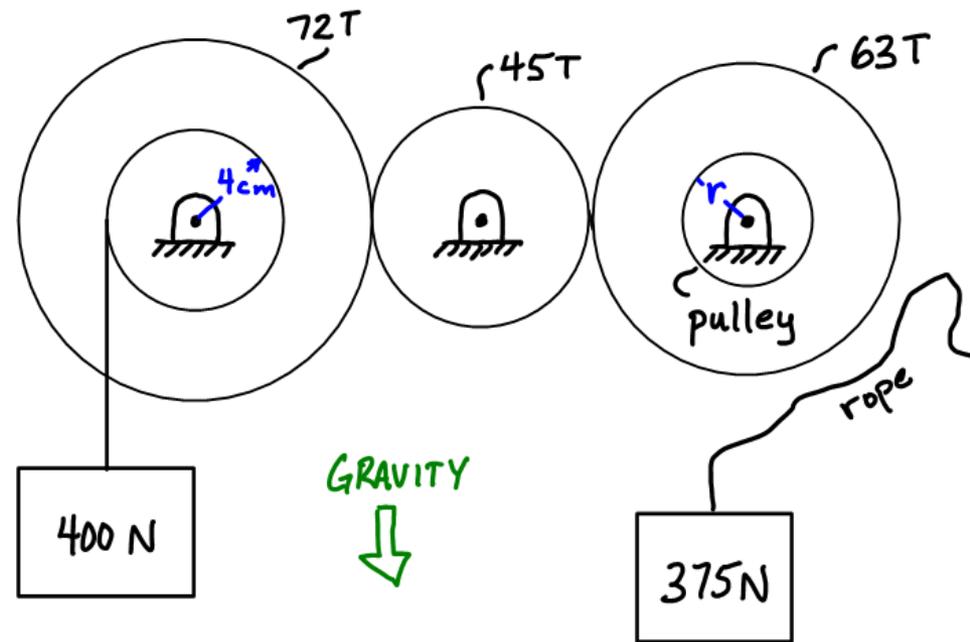
- a. 410 W
- b. 1,250 W
- c. 2,180 W
- d. 2,940 W
- e. 3,980 W
- f. 4,170 W
- g. 12,490 W



Problem 18

(5 points) A 375N weight is to be hung on the inner pulley of the gear with 63 teeth. The combination of pulley radius and orientation of the 375N weight that causes the system to be in equilibrium is closest to:

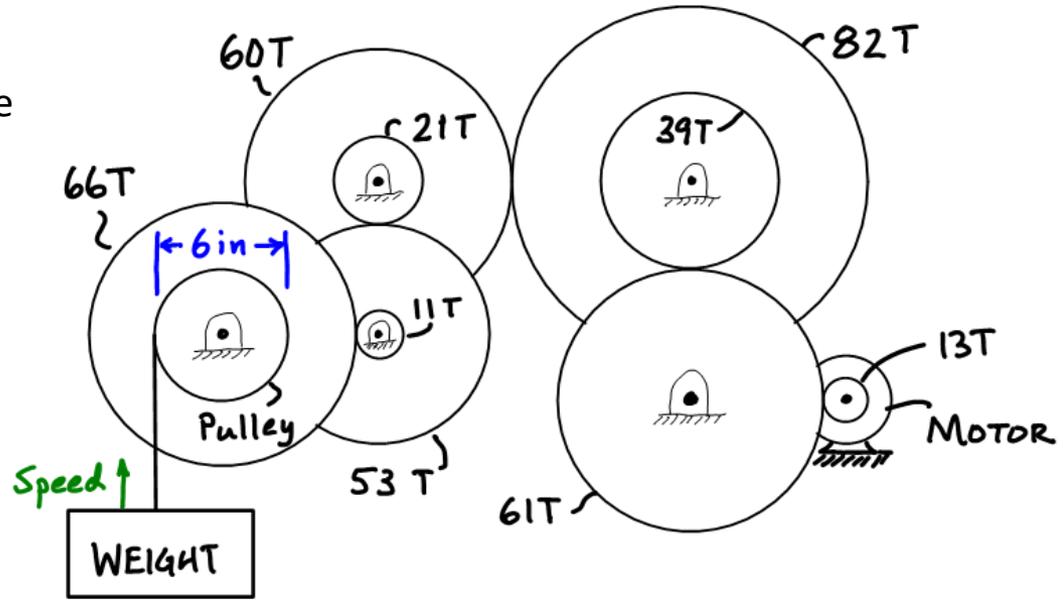
- a. 3.58cm; hanging from the right of the pulley
- b. 3.73cm; hanging from the right of the pulley
- c. 3.89cm; hanging from the right of the pulley
- d. 4.04cm; hanging from the right of the pulley
- e. 4.19cm; hanging from the right of the pulley
- f. 3.58cm; hanging from the left of the pulley
- g. 3.73cm; hanging from the left of the pulley
- h. 3.89cm; hanging from the left of the pulley
- i. 4.04cm; hanging from the left of the pulley
- j. 4.19cm; hanging from the left of the pulley



Problem 19

(5 points) The motor shaft turns at 800 RPM. The speed at which the weight travels is closest to:

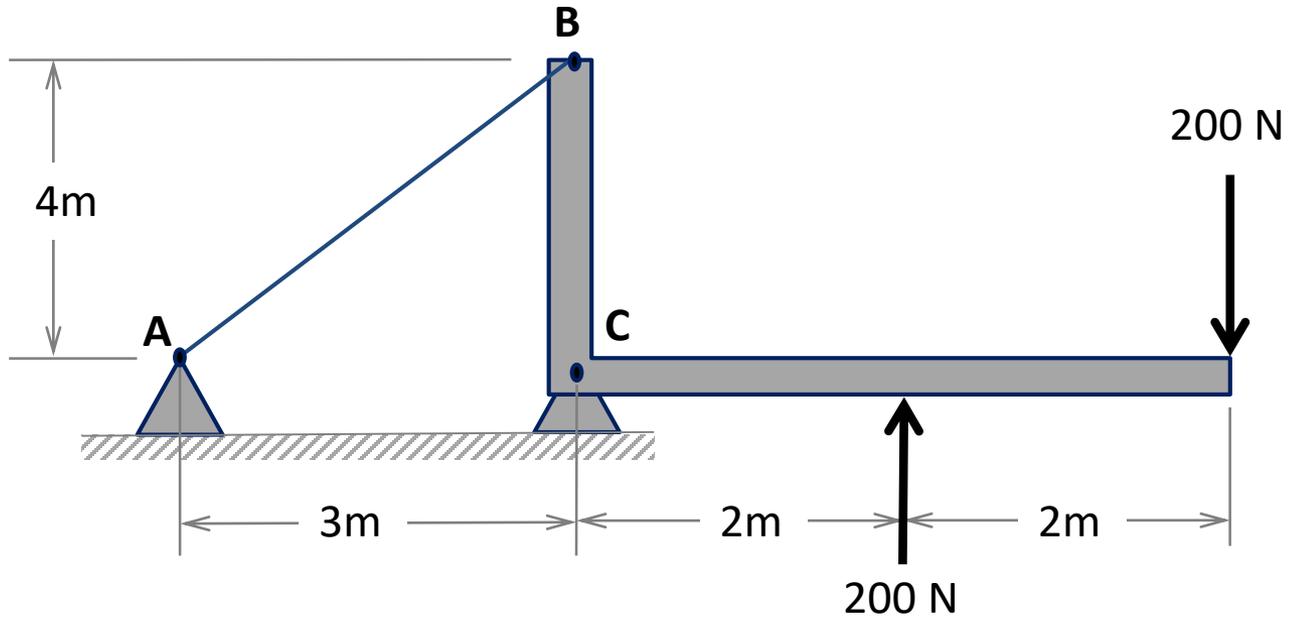
- a. 0.400 ft/s
- b. 0.439 ft/s
- c. 0.477 ft/s
- d. 0.516 ft/s
- e. 0.553 ft/s
- f. 0.592 ft/s
- g. 0.630 ft/s
- h. 0.668 ft/s
- i. 0.707 ft/s



Problem 20

(5 points) The tension in cable AB is closest to:

- a. 0 N
- b. 100 N
- c. 167 N
- d. 200 N
- e. 300 N
- f. 500 N
- g. 667 N
- h. 1000 N



Problem 21

(5 points) Tiffany wants to buy a new tablet computer now, but doesn't have any money. She can get a loan for the tablet at a 12% annual interest rate, compounded monthly, and plans to make monthly payments of \$75 for the next two years. The most she can therefore pay for the tablet today is closest to ...

- a. \$1,600
- b. \$1,800
- c. \$2,000
- d. \$2,200
- e. \$2,400
- f. \$2,600
- g. \$2,800
- h. \$3,000

Problem 22

(5 points) Bill is moving to New York City, and wants to buy an apartment for \$375,000. If Bill can get a mortgage for the apartment at 4% annual interest, compounded monthly, and plans to pay the mortgage off in 30 years, then his monthly payments (for just paying off the loan, not for taxes or insurance) will be closest to ...

- a. \$600
- b. \$900
- c. \$1,200
- d. \$1,500
- e. \$1,800
- f. \$2,100
- g. \$2,400
- h. \$2,700
- i. \$3,000

Problem 23

(5 points) One of your professors wants to save \$800 to buy a Mont Blanc pen. (They are really nice.) If the professor can save money in an account that draws 9% annual interest, then the amount that needs to be put into the savings account today (assuming annual compounding) in order to withdraw the \$800 by the end of 5 years is closest to ...

- a. \$16
- b. \$160
- c. \$225
- d. \$350
- e. \$425
- f. \$520
- g. \$675
- h. \$800

Problem 24

(5 points) A student is able to get to get a loan of \$8000 at 10% simple annual interest. At the end of 4 years, the student will owe a total of approximately ...

- a. \$8,000
- b. \$9,100
- c. \$10,000
- d. \$10,500
- e. \$11,200
- f. \$11,900
- g. \$13,000
- h. \$14,500

Problem 25

(5 points) You decide to borrow \$2000 from Easy Loan for 2 years at 8% annual interest compounded monthly. If you repay the loan in equal monthly payments, the amount of each payment is closest to ...

- (a) \$45.00
- (b) \$75.25
- (c) \$90.50
- (d) \$108.27
- (e) \$128.30
- (f) \$150.00
- (g) \$175.45
- (h) \$200.00
- (i) \$227.48

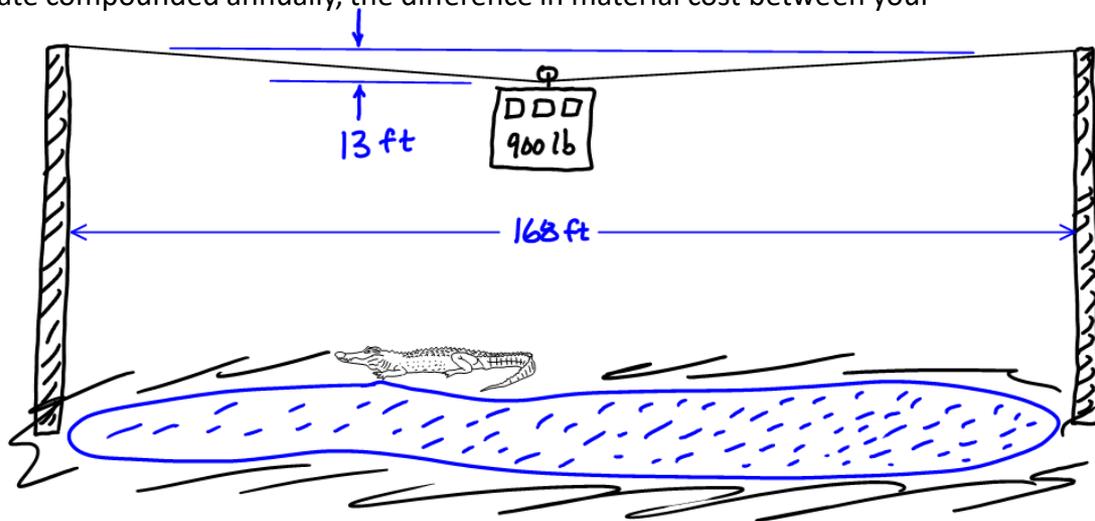
Problem 26

(5 points) You plan to install a Gondola that goes over the alligator pond at your theme park. The fully loaded gondola will weigh 900lb. The supports of the cable or rope are level with each other and span a distance of 168ft. The wheel of the Gondola is designed to have 13ft of drop from the level of the supports when the Gondola is at the center of the span (which is the position of the Gondola where the cable or rope is most severely stressed). You are trying to decide whether you should use hemp fiber rope or stainless steel cable to support the Gondola. In either case, a number of smaller strands will be woven together to create the larger tension member (rope or cable). Each strand of the hemp rope can safely support 600lb, whereas each strand of the stainless cable can safely support 1200lb. You must determine the number of strands that you will need in either case to support the load (must be a whole number of strands).

The hemp rope costs \$0.36 per foot per strand, and the stainless cable costs \$3.95 per foot per strand. You plan on needing an additional 10ft of material more than that which is stretched across the pond so that you can properly make connections at the ends. You plan on using the gondola system for 6 years. If you choose hemp rope, it will have to be replaced every year because of how it degrades in its environment. (You do not expect the price of hemp rope to change for the next several years.) If you choose the stainless cable, it will last the entire 6 years, and is expected to have a scrap value of \$0.75 per foot per strand at the end of that time.

Based on a present value analysis, using a 5% annual interest rate compounded annually, the difference in material cost between your two options is closest to:

- The hemp will cost \$93.50 more than the stainless
- The hemp will cost \$98.74 more than the stainless
- The hemp will cost \$104.03 more than the stainless
- The hemp will cost \$109.30 more than the stainless
- The hemp will cost \$114.63 more than the stainless
- The hemp will cost \$93.50 less than the stainless
- The hemp will cost \$98.74 less than the stainless
- The hemp will cost \$104.03 less than the stainless
- The hemp will cost \$109.30 less than the stainless
- The hemp will cost \$114.63 less than the stainless



NOTE: The cable or rope is bought at the beginning of the first period. Make sure the cash flow diagram you use is appropriate for the equations used to compute the present value.

$$1 \text{ lb} = 4.448 \text{ N}$$

$$1 \text{ in} = 25.4 \text{ mm}$$

$$1 \text{ m} = 3.281 \text{ ft}$$

$$g = 9.81 \text{ m/s}^2$$

$$I = Pni$$

$$F = P(1 + ni)$$

$$F = P(1 + i)^n$$

$$P = F(1 + i)^{-n}$$

$$F = A \left[\frac{(1+i)^n - 1}{i} \right]$$

$$P = A \left[\frac{(1+i)^n - 1}{i(1+i)^n} \right]$$