Practice Problems For Chapter 16

The problems and solutions that follow were designed by students. Although I have checked them, there are very possibly a few errors here and there. If you notice a mistake and turn in a typed correction, you will receive two extra homework points. You may also write new homework problems to add to any chapter and receive between 2 and 5 homework points per problem (see syllabus for details.) Please note: since these problems were written by students, the teacher takes no responsibility for errors – in other words, if there is a mistake and you make the same mistake on a test, you will not get credit for that mistake.

In the problems below, I have highlighted what I feel are the best problems to study prior to tests. The other problems are all ok, but they tend to be very easy problems or repeats of homework problems with slight variations. You may want to start with a few of the regular problems as warm up and then move on to the highlighted problems.

Chapter 16 Practice Problems

1.) Landon and Greg (60N) are on either end of a homeade10 ft. see-saw, if Landon is sitting 1.5 ft. from the edge and Greg is 2.5 ft from the edge and the rock in the middle of the see-saw causes a torque of 300Nm, what is Landon's force?

Annie Matusewicz '07

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2. One hot summer day Mr. Laba has an idea to cool off everyone living on Physics Lane by opening up the fire hydrant letting out gallons of cool water. So he grabs his wrench and heads over to the hydrant. If he pushes with 15N (he is exhausted from the heat) with his hands 5 cm from the end of the wrench (the part in contact with the hydrant) and cannot move it, how much torque is the hydrant withstanding? If it can take up to 20Nm before it breaks, how far must Mr. Laba place his hands on the wrench from the end? If the wrench is half a meter long, can he do it?

John Stevenson '07

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3. A wanderer is going down the street with all of his belonging on his shoulder (50N) via a simple torque use. If he has it resting on his shoulder and wishes to keep it exactly horizontal, with what force must he pull it down pulling it .15m from his shoulder (pivot point) and the weight is .35m from his shoulder?

John Stevenson '07

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4. Find the tension of the wire that is supporting a 2m long bar (5kg) that has a sign attached to it (15kg). If the center of mass of the bar is 1m from the wall and the sign is 1.7m from the wall. The wire and the bar make a 60deg angle.

John Stevenson '07

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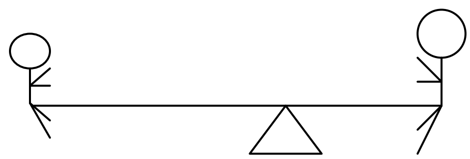
5. Consider a seesaw with a board that is 4 meters long. A child weighing 40kg and an adult weighing 60kg want to balance the system.

   a. Where would the center support have to be to even out their torques?
   b. What is the normal force exerted by the fulcrum?



Catherine Burke '07

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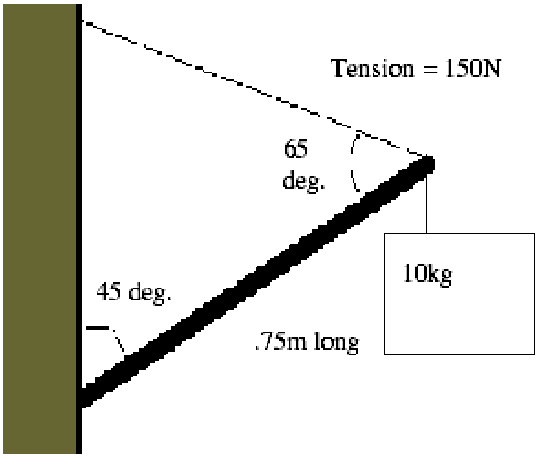
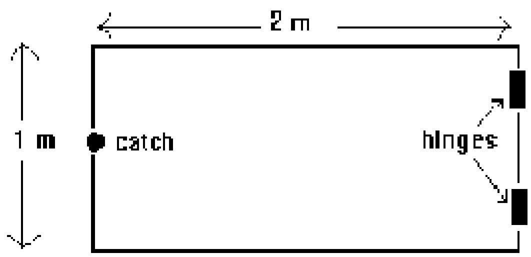
6. In the set-up below, determine the weight of the bar.



7. A trap door is set up as below:

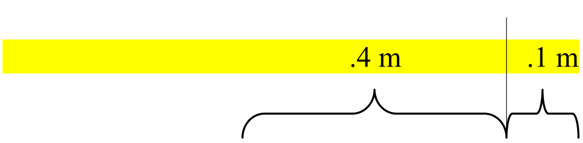


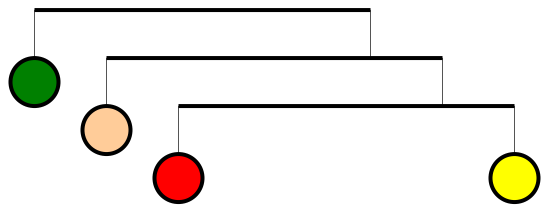
Door weights 5kg. Center of gravity is at the center.

If a 70 kg person walks across the trap door from left to right and it falls when the person is 1.7m from the hinges, each hinge can hold ____N of force.

If an 80 kg person walked across the trap door, how far could he get before the trap releases?
Emily Whitcher ‘07

8. Sam creates a weird mobile that resembles the solar system to hang from the ceiling. However, he decides to be abstract and only include the sun and three planets (Mercury, Venus, Earth). Look at diagram below:





Assume the bars and fishing wire are massless. Each bar is .5 m long, and the fishing wire is attached to each one in a similar way (4/5 way across). We know the sun has a mass of 40 g. Using torques, figure out the mass of Mercury, Venus, and Earth, if we know that each bar is level.

Fontaine Foxworth '07

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9. Mr. Laba tries to hang up a sign that reads:

WANTED:

DEAD OR ALIVE

Reward 25,000 in Gold Coin

Will be paid for the apprehension of

The Science Gals: Fontaine the Fox and Emily the Witch

Wanted for defying gravity, erasing formulas, and other acts against the Physics World.

Mr. Laba uses a wall, rod, and rope to keep the sign in equilibrium. He makes an angle of 35 degree between the rod and the rope. If the tension is 42.5 newtons what is the weight of the framed wanted poster and what is the normal force created by the rod?

Iana Gaidarski '07

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10. Mr. Laba is a heavy weight lifter. One day, he is a challenger for the heaviest weight lifted in the world competition, and he is faced with the objective of lifting a 50kg bar that has a length of 3 meters with 400kg on each side. Totaling to 850kg, Mr. Laba is ridiculously nervous. But he knows that he must try if he has any hopes of fulfilling his destiny. He plants his two hands .5

meters away from each end. With how much force would Mr. Laba have to pull in order to lift the weight? Imagine that Mr. Laba's arm pops off, and that he has to lift the entire system with only one hand that he places .2 meters away from the center of the bar (because of an error of course); how much force then would be required for Mr. Laba to lift the object. (assume that he pulls with the same force in both hands when he is using 2).

Amish Bhatia '07

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11. If a 300kg man is sitting on one side of a seesaw 5m from pivot, and a 70kg child is sitting on the other side 4m from pivot, how many 50kg children mush hang on 4m from pivot to keep this in equilibrium.

Reed Duncan (class of 2008)

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12. Newt, being jacked as he is, was hired to hold a fat kid on a see saw off the ground. He must hold the see saw parallel to the ground to keep the kids feet off the ground.

The set up is:
See saw- 3 m long
Support under the see saw is 1 meter away from the kid
Kid = 250 kg (he is sitting on the very end of the seesaw)

a. If Newt pushes straight down on the other end of the see saw to keep it still, how hard must he push?
b. If Newt can only push with 1000 N, can he hold the kid still? If not, how much longer should his side of the see saw be in order to hold it?
c. If the kid would have eaten healthier and weighed only 80 kg how hard would Newt have to push?

Colt Power (class of 2008)

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13. A man is walking on a tight rope while holding a 16 meter pole, weighed down by masses of 20 N on each side. If the pole weighs 10 kg, how much force must the man be exerting upwards for the system to be in equilibrium?

John Wheeler (class of 2008)

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14. Trying to make a lot of chili, Mr. Laba attempts to open a can of beans (he has to pry off the top). Finding the can extremely difficult to open, Mr. Laba puts his physics knowledge to use and finds a lever. If the lever is .5 meter long, it is balanced off the top end of the can .005m from the seal, and Mr. Laba uses the exact ends of the levers, how much force must he exert in order to break the 150 N seal?

John Wheeler (class of 2008)

15. Harry is standing on the edge of an extremely rigid diving board. If the board is 7 meters long, is attached to the ground at a point 1 meter from the non-pool edge, and the attachment can withstand 25,000 Newtons of force, how much would a person have to weigh in order to break the diving board?

John Wheeler (class of 2008)

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16. A ten meter board is centered on a very thin wall so that when two masses drop, they hit at exactly the same time, and the board is perfectly balanced. If one mass hits two and a half meters away from the left edge and the other mass hits half a meter from the right edge, what is the ratio of the two masses to each other?

John Wheeler (class of 2008)

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17. The physics class decides to play a game to test their knowledge of torques. Pitting the left side of the room vs. the right side of the room (from Mr. Laba's perspective), each side gets to choose three members and align them in any order along a twelve foot long plank balanced on tree stump. If the left side puts students of 80kg, 65kg, and 60kg at lengths of 2, 4, and 6 meters, what is one order of students from the left side that will balance the plank (at the same intervals)?

(rough approximations: Evan = 70kg, John = 63kg, Reed = 61 kg, Aubrey = 50 kg, Carolyn = 54 kg, Connor = 67 kg, and Dallas = 66 kg)

John Wheeler (class of 2008)

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18. Three toy trucks of mass 5 kg are dropped onto a board hovering in midair. If the board is 8 meters long and the trucks are dropped so that they rest .5 meters from the left side, 5 meters from the left side, and 6.8 meters from the left side. What is the optimal place to insert a support beam so that the board is balanced?

John Wheeler (class of 2008)

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19. In a test of physics excellence, Mr. Laba designs an exam that uses dominoes and torques. Using a very accurate balancing beam, Mr. Laba places a kitty weighing 81.34 Newtons on one end and hands each student a pack of dominoes (numbered one through twelve in the standard domino fashion). Mr. Laba then instructs the student that they have five minutes in which to come up with an answer. Feeling merciful, he then gives them the hint that they must use exactly ten dominos. Because he can touch fire, Connor realizes that since each domino will have a different mass, Mr. Laba must be asking for the total score of the dominos added together that will balance the 100 Newton weight. Measuring the one domino (1.05kg) and the two domino (1.01kg), Connor deduces that each domino will weigh .04 kg less than the numbered domino preceding it. What answer will Connor come up with if he hopes to pass the test (any one of the possible answers)?

John Wheeler (class of 2008)

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20. A very original dunking booth is made so that Evan is sitting on the left edge of a ten meter long plank. There are two balancing beams on this plank, one directly under Evan and the other in the center so that Evan is just chilling parallel to the ground. On the other end of the plank, there is a giant pool of water (hints the dunking booth). Also, the plank has absolutely no friction so that when the plank start to tilt, Evan will slide down the plank into the pool of water. Halfway between the right edge of the plank and the center of the plank is a giant sponge that will absorb 75 % percent of the water dropped onto it. If a continual amount of water is dropped onto the sponge at a rate of 1 kg per second from a height of five meters, how long will it take until the board begins to tilt and Evan slides into the pool? (The sponge will not hinder his movement in any way once he begins to slide and Evan weighs 70 kg)

John Wheeler (class of 2008)

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21. Because he can, Donald Trump creates one of the largest levers that world has ever seen. On one end of the lever, only 10 meters from the balancing point, Donald Trump decides to build a tower that will weigh 5,000,000 kilograms. Placing enough support so under the tower end of the lever so that it will never fall, Donald decides to gain some publicity by sponsoring a race for physics. Recruiting Jack who can run 100 meters in 20 seconds and can keep up this pace forever, how long will it take until Jack (starting from the tower) can actually tip the lever so that the tower begins to lean and fall? (He can only run 12 hours a day because he has to sleep and recover at least a little bit and he weighs 57 kg)

John Wheeler (class of 2008)

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22. Jake is carrying a magical pole with 100 kilogram on one end. If the pole is fifteen meters long and fifteen kilogram weights spontaneously appear on the other side of the pole every second and start at 2.5 meters from the center and progress .5 meters away from the center every second (i.e. every weight appears .5 meters farther towards the edge than the previous weight). At what point will the pole begin to tilt so that the magical side moves towards the floor?

John Wheeler (class of 2008)

Chapter 16 Solutions

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1. Sum of the torques equals zero.

Tgreg + Tlandon – Trock = 0
Trock – Tgreg = Tlandon
250- 60*2.5= 100 = Tlandon
F*d = 100
F*3.5 = 100
F = 28.57

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2. *Work:*

T=Fdperp
T=15(.05)
Answer T=.75
20=15dperp
Answer: d= 1.33m; no, he wont make it

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3. *Work:*

Fx=0
Fy=0
Tp-Tb=0
Tp=Tb
*.15x=.35*50*
Answer: x= 116.66N

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4. *Work:*

T=0
Tt-Tmg-Ts=0
T(dsin60)-mgd2-mgd3=0
T(2)(sin60)-(49)(1)-(147)(1.7)=0
2sin60T=298.9
Answer: T=172.56999N

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5. Answer. The torques can be calculated initially using the fulcrum as a pivot point.

Distance from child to pivot =x. therefore from adult to pivot it equals 4-x.
Tchild=Tadult
(40)(9.8)x=(60)(9.8)(4-x)
40x=240-60x
100x=240
x=2.4 meters from the child

normal force?
EFy=0
N=Fchild+Fadult
N=(40)(9.8)+(60)(9.8)
N=980 N

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6. ∑T=0

T=Fd
Tt=150sin65(.75)
Tm=10*9.8*sin45 (.75)
Tb=9.8*m*(.375) sin 45

Tm+Tb=Tt
52 + 2.6m = 102
2.6m=50
m=19.2kg or 188.5N

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7. ∑T=0

Td=5*9.8(1)
Tp=70*9.8(.3)
Th=F(2)

Td+Tp=Th
49+205.8=2F
F=127.4
Each hinge can hold 63.7N of force

∑T=0
Td=5*9.8(1)
Tp=80*9.8(x)
Th=127.4

Td+Tp=Th
49+80*9.8*x=2(127.4)
205.8= 784x
x=.26m

They could walk .26m from left to right before the trap fell.

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8. A. ΣT = 0

Tm=Ts T = Fd
.4(m)(9.8) = (.1)(40)(9.8)

mass of **Mercury = 10 g**
(10+40)(.1)(9.8) = (.4)(v)(9.8)
mass of **Venus = 12.5**
(50+12.5)(.1)(9.8) = (.4)(e)(9.8)
mass of **Earth = 15.625**

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9. ΣF = 0

ΣF x= 0

N-Tcos35=0

N-42.5cos35=0

N=42.5Tcos 35

<u>N= 34.8</u>

ΣF y= 0

Ty-mg=0

Mg=42.5sin35

M= 24.4/9.8

<u>M=2.48 kg</u>

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10. Entire length is 3 meters

400kg-.5 - force upwards – 1m – center – 1m – force upwards - .5m- 400kg
\/___________^________(center)_________^____________\/
Pivot Pt.
T(weight1)+T(weight2) < Force Upwards 1 + Force upwards 2
400kg(9.8)(1.5) + 400(9.8)(1.5) < F (1m) + F (1m)
5880N < Force on both hands.

T(weight 1)+T(weight2) = T(one hand lift)
400kg(9.8(1.5))(2) = F (.2)
F = 58800N with one hand.

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11. Work: Delta T=0

300kg*5m= 70kg*4m+ 50kgX*4m

1500= 280+200X
1220=200X
6.1 Children

12.

a. *ΣŤ=0*

Mgd – Fd=0
250(9.8)(1) – F(2)=0
250(9.8)(1) = F(2)
F= 1225 Newtons

b. *ΣŤ=0*

Mgd – Fd=0
250(9.8)(1) – 1000(d)=0
250(9.8)(1) = 1000(d)
d= 2.45 meters
.45 meters longer

c. *ΣŤ=0*

Mgd – Fd=0
80(9.8)(1) – F(2)=0
80 (9.8)(1) = F(2)
F= 392 Newtons

13.

Sum of the Forces = 0
X = (2)(20) + (16)(9.8)
X = 196.8 N

14.

Sum of T = 0
T(Mr. Laba) – T(seal) = 0
(.5-.005)(F) = (.005)(150)
F = 1.52 N

15.

Sum of T = 0
T(Overweight person) – T(attachment) = 0
(6)(m)(9.8) = (1)(25,000)
m = 425.17 kg

16.

Sum of T = 0
T(Left ball) – T(right ball) = 0
(2.5)(m1)(9.8) = (4.5)(m2)(9.8)

(2.5)m1 = (4.5)m2
Ratio of m1 to m2 is 5:9

17.

Sum of Left = Sum of Right
(2)(80) + (4)(65) + (6)(60) = 780
2(x1) + 4(x2) + 6(x3) = 780
(x1) +2(x2) + 3(x3) = 390
By trial and error,
(54) + 2(63) + 3(70) = 390
So, one order is Carolyn, John, Evan

18.

Averaging the two trucks farthest from the left edge results in a 10 kg object 5.9 meters from the left edge.
Sum of T = 0
(9.8)(5)(x-.5) = (9.8)(10)(5.9-x)
49(x-.5) = 98(5.9-x)
x-.5 = 11.8 – 2x
3x = 12.3
X = 4.1 meters from the left edge

19.

Sum of Torques = 0
(distance 1)(81.34) = (distance 1)(9.8)(x)
X = 8.30 kg
In the progression above, the twelfth domino must have a mass of .61 kg
(10)(.61) + x = 8.30
X = 2.20kg more are needed.
Using the twelve through three dominos adds 2.2 kg
So, Connor could turn in the answer 75 (3-12 added together)

20.

$x = V_i t + (1/2)at^2$
5m = (.5)(9.8)(sec^2)
After 1.01 seconds, the water will begin to hit the sponge
Sum of Torques = 0
(5m)(9.8)(70) = (2.5)(9.8)(m)
140 kg = mass needed to dunk Evan
So if the sponge absorbs .75 kg per second,
140/.75 = 186.67 seconds are needed until Evan gets wet
186.67 seconds + 1.01 seconds = 187.68 seconds until Evan gets dunked

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21.

Sum of Torques = 0
(10)(5,000,000)(9.8) = (x)(57)(9.8)

X = 877,193m
100m/20sec = 5 m/s
It will take him two seconds to get to the start of the lever
877,193 / 5 = 175,438.6 seconds
(60)(60)(12) = 43,200s
He can run for 43,200 seconds per day
175,483.6/43,200 = 4.062120 days + 2 seconds
4 days, 1 hour, 29 min, 29 seconds

22.

Sum of T = 0
(100)(9.8)(7.5) = 7350
7350 / 9.8 = 750 kgm
(2.5)(15) + (3)(15) + (3.5)(15) + (4)(15) + (4.5)(15) + (5)(15) + (5.5)(15) + (6)(15) + (6.5)(15) + (7)(15) = 712.5
(2.5)(15) + (3)(15) + (3.5)(15) + (4)(15) + (4.5)(15) + (5)(15) + (5.5)(15) + (6)(15) + (6.5)(15) + (7)(15) + (7.5)(15) = 825
It won’t be until the last weight appears after 11 seconds that the pole will tip in favor of the magical side