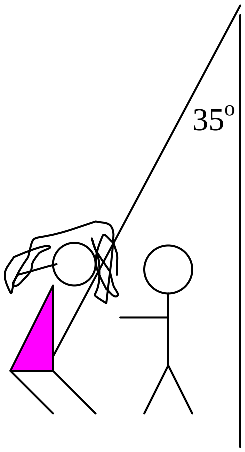
Practice Problems
For Chapter 13

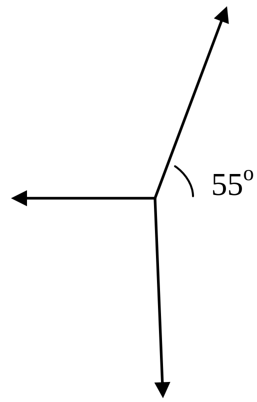
The problems and solutions that follow were designed by students. Although I have checked them, there are very possibly a few errors here and there. If you notice a mistake and turn in a typed correction, you will receive two extra homework points. You may also write new homework problems to add to any 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 13 Practice Problems

1. Jack pushes Jill on a swing using 500 N of force. The angle between the swing chain and the vertical bar is 35^o. How much does Jill weigh?





Fontaine Foxworth ‘07

2. High Heels Part 2: How much pressure does an elephant wearing high heels exert on the floor?

Moritz Sudhof ‘07

3. Mitchell places two fans so that they are facing each other, he then places a cart with low friction wheels and a sail directly in between the two fans. Fan A has a force of 20 N while Fan B has a force of 15 N. Describe what happens when both fans are turned on.

Karl Thumm ‘07

4. A section of granite floor is capable of sustaining 500 P.A. of pressure. If a 2000kg rectangular weight of dimensions 10m X 4m is resting on it, will the granite floor break?

Dallas Griffin (class of 2008)

5. Mr. Laba has had a terrible rodent problem recently. He decides to set a trap for the pesky varmint. He sets up a pulley and threads a string through it. On one end of the string is a hanging

weight with a mass of 10 kg and on the other end is a cage that will trap the mouse. The cage is above a piece of cheese on the ground that hopefully the mouse will go and eat so that Mr. Laba can have enough time to release the trap. The weight is pulled down 2m and held in place so that the cage hangs above the cheese. When the mouse comes to eat the cheese, Mr. Laba releases the 10kg weight and it takes 5sec for the cage to fall to the ground and trap the mouse. What was the mass of the cage that trapped the mouse?

Connor Nickell '08

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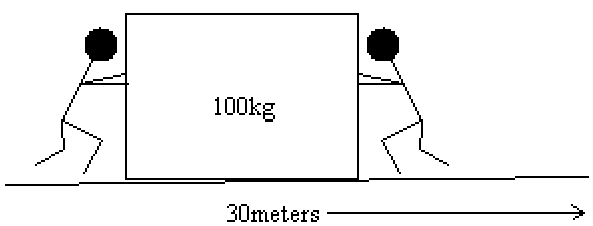
6. There's a wild new sporting event in which teams try to push against a block and move it 30m from where it starts. Each team pushes on either side of the block with 10 members. Whoever can push the block, which has a mass of 100kg, the 30m in 60sec wins the match. The twist is that every 12 meters that a team pushes the block they can add another man to help push, as long as when they've reach 12m and added a new man, they start over with a velocity of 0m/s. If Team Jackalope pushes with 98N total and Team Chupacabra with 10N per person (including ones being put in every 12m) would team Chupacabra push the block enough in the time given to win?



Connor Nickell '08

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7. For obvious reasons, men on stilts are not allowed in rooms with styrofoam floors. If Styrofoam floors collapse under pressures above 24,000 ppi and a stilt man accidentally wanders in wearing stilts with a radius of .05 meters and weighing 50 kg, would he Styrofoam floor be pierced?

John Wheeler (class of 2008)

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8. A stilt man and women wearing incredibly high heels decide to have a contest over who can put the most pressure on any given floor (it could happen…). The man's stilts have a diameter of .1 m and the women's high heels have an area of .009 m^2 each. If the man weighs 47 kg and the women weighs 43 kg, who will win the contest.

John Wheeler (class of 2008)

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9. An unusually clever stilt man decides to see if pressure changes when traveling in an elevator. Coating the floor of the elevator a few feet thick in magical silly putty which rests the standard

pressure of the stilts exactly midway between the bottom and the top of the silly putty, the stilt man first goes up and later goes down in the elevator. If a lower pressure will cause the man to rise and a higher pressure will cause the man to sink, what will be the course of the ingenious stilt man?

John Wheeler (class of 2008)

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10. What are the smallest shoes (in terms of square meters of the soles) that a 150 kg man could wear when walking on a floor that collapses under 25,000 ppi?

John Wheeler (class of 2008)

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11. Somehow, a glitch in time occurs and your car is transplanted onto a possum. If your car is 4000 kg, a possum is crushed at 15,000 ppi, and at any given time only .4 sqr. meters of each tire is touching the ground, will the possum get crushed under one of your tires?

John Wheeler (class of 2008)

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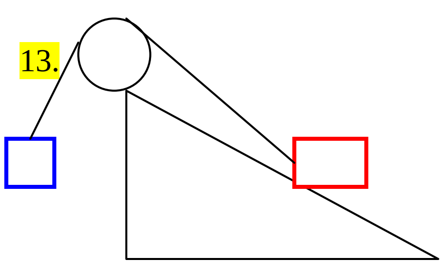
12. Imagine that you find a pin so small that it is virtually invisible. If the tip of the pin is only .000001 sqr. meters, how hard would you have to push to penetrate a metal from mars that resist a pressure of 500,000,000 ppi? Is this possible for a mere mortal?

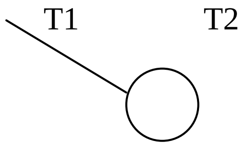
John Wheeler (class of 2008)

13.



If the mass of the red block is 3 kg, and mass of the blue block is 1.26, and the system is in equilibrium, what angle is the plane rising at?

15.



If one of the strings holding up this ball has a tension of T1 at an angle 20º north of west, and the other string is 80º north of east, and the ball is 20 kg, what is the tension of each string? Assume strings are massless, system is frictionless.

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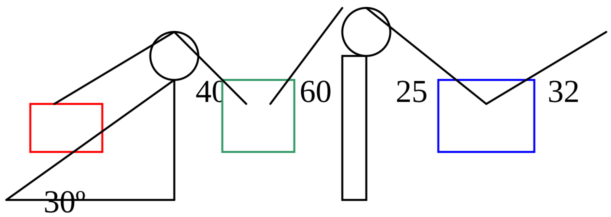
15. We've all seen those Disney movies where a very complex trap is set up using weights and counterweights, to finally launch a dart or drench someone in chocolate or something. If Bobby wants to set up his own system of weights in equilibrium as follows:



And realizes that he has to hold the last string in order to maintain such an equilibrium, what tension will be put on his arm? The red block is 2 kg; the green is 1, the blue is 3.

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16. If Shondra weighs 50 Kg and wears high heels that are 1/8 in^2 in area, and her sister LaShondra weighs 30 Kg but wears stilettos that are 1/20 in^2 in area, who puts more pressure on the ground? What percentage more?

17.

-  Your super-light travel umbrella has a mass of 200 g. If you are balancing its tip, approx. 3 cm^2, on your finger, what pressure is being put on your finger? What if it's raining, and the rain on the umbrella adds a force of 2 N?

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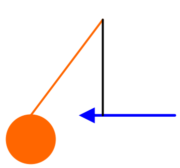
18. Mandy is playing with a yoyo, because she is a child of the '90s, when people actually played with yoyos. Unfortunately, her mischievious little brother Klaus has decided to mess up her yoyo, which weighs 1 kg, by pushing it 20^0 to the right while she is holding it. basically the set up is like this:

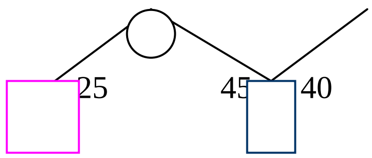


20º

Klaus’s push.

What will the change be in the tension on the string? What is the force of Klaus’ push?

19.



The pink block is 2 kg. how much does the blue block weigh if equilibrium is maintained?

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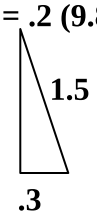
20. A yoyo is hanging by a 1.5 m string. It the yoyo is .2 kg, what is the tension in the string? If someone pushed the yoyo .3 m to the left, what would the tension of the string be then?
Franci Rooney ‘08

T = G = .2 (9.8) = 1.96



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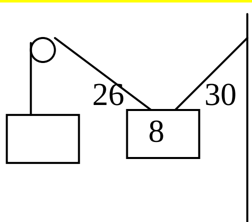
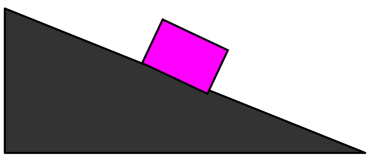
21. What should the mass of the second block be for the system to be in equilibrium?



22.



In a FedEx factory, a box is dropped down the chute to be packaged. If the chute is elevated at 30º and the box is 5 kg (it's a Barbie doll for Suzie), what is the acceleration of the box?

Francie Rooney ('08)

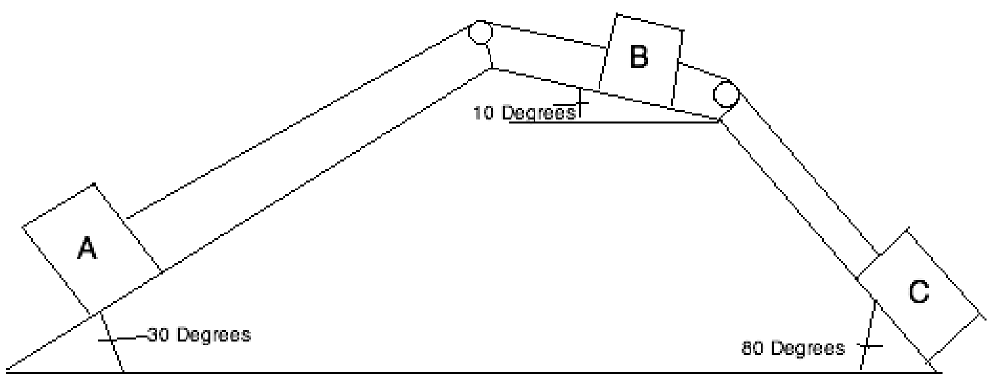
23.)

In the following diagram:

a. Find the forces acting on each object.

b. If A = 2000 g and B = 1500 g, then what is the value of C if the system is in equilibrium

Matthew Porter (class of 2010)



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24. A tetherball is held out from the pole it's attached to, making a 23 degree angles. What force is needed to keep the ball still if it weighs 2 kg?

Bethany Berg (class of 2011)

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25. While trying to hold a 90kg rock on a frictionless hill that makes an 18 degree angle with the horizontal, how much force will be needed in the push to keep the rock steady?

Bethany Berg (class of 2011)

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26. There was a 25 kg box and three forces acted on it. The first force pushed with 15 N at 30 degrees. The second force pushed with -29 N at 120 degrees. The third force pushed with 13 N at 350 degrees. How far does the object move after 10 seconds and in what direction?

Bethany Berg (class of 2011)

Chapter 13 Solutions

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1. A. $\Sigma Fx = 0 = P - Tx$ P=Tx
500 = Tcos55
T=871.7
$\Sigma Fy = 0 = Ty - mg$ Ty = mg
871.7sin55 = mg
Jill weighs 714.07 N

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2. Mass of an elephant = 2,000 kg
Area of high heels = 0.002 m^2

P = F/A
P = (2000)(9.8)/(.002)
P = 9800000 Pa

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3. Fan A exerts a force 5 N greater than Fan B. This will cause the cart to move towards Fan B. However Fan B is still exerting a force on the sail as well as one on Fan A just as Fan A is exerting a greater force on both the fan and Fan B.

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4. ma=f
(2000kg)(-9.8)=F
F=-19,600 N

P=F/A
=19,600 N / 40m^2
=490 P.A.
500 P.A. > 490 P.A.
No, the floor will not break.

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5. t = 5sec
Vi = 0m/s
Δx = 2m
Mass of hanging weight (mg) = 10kg
T = ?
Mass of Crate (m_c) = ?

$\Delta x = Vi(t) + (1/2)a(t^2)$
$(2) = (1/2)a(5^2)$
4 = 25a
.16m/s^2 = a

$\Sigma F = ma$

$T - mg = ma$
$T - (10)(9.8) = 10(.16)$
$T - 98 = 1.6$
$T = 99.6$N

$\Sigma F = m_c a$
$m_c g - T = m_c a$
$-T = m_c(.16) - m_c(9.8)$
$T = m_c(9.8) - m_c(.16)$
$(99.6N) = m_c(9.8 - .16)$
$99.6 = 9.64 m_c$
$10.33kg = m_c$

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6. Team Chupacabra = 100N
Team Jackelope = 98N
Mass of Block = 100kg
Distance to add a man = 12m

$\Sigma F = ma$
$100N - 98N = (100kg)a$
$.02 m/s^2 = a$

$\Delta x = .5(a)(t^2)$
$12 = .5(.02)(t^2)$
34.64sec = t

$\Sigma F = ma$
$110N - 98N = (100kg)a$
$.12 m/s^2 = a$
Therefore adding one man means adds .10 m/s^2 to the original acceleration (.02m/s^2).

$\Delta x = .5(a)(t^2)$
$12 = .5(.12)(t^2)$
14.14sec = t
Total time so far = 48.78s
Total distance so far = 24m

$.12 + .10 = .22 m/s^2 = a$

$\Delta x = .5(a)(t^2)$
$12 = .5(.22)(t^2)$
10.44sec = t
Total time so far = 59.22sec
Total distance so far = 36m
Therefore Team Chupacabra will win in time because they make it 36m at approximately a minute and they only have to move the block 30m to win.

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7. A = (3.14)(r^2)(2)
A = .0157 m^2
P = F/A
P = (50)(9.8)/(.0157) = 31,210
There goes the floor.

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8. A = (3.14)(r^2)(2)
A = .0157 m^2
P = F/A
P = (47)(9.8)/(.0157) = 29,938 for man

A = .018 m^2
P = F/A
P = (43)(9.8)/(.018)= 23,411 for women

The man wins the contest!!

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9. As the elevator goes up, the stilt man will sink to the bottom of the silly putty because an increased normal force will increase the pressure. When the elevator goes down, the man will rise to the very top of the silly putty because a decreased normal force will cause the pressure to decrease in turn.

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10. P = F/A
P = (150)(9.8)/(A) = 25,000
A = .0588 sqr. meters
A/2 = .0294 sqr. meters (Two shoes)

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11. P = F/A
P = (4000)(9.8)/(.4)(4)
P = 24,500
24,500 > 15,000 so the possum is crushed!!

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12. P = F/A
P = (F)/(.000001) = 500,000,000
F = 500 ppi
It's easy

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13. RED Efx = T – 29.4cosø = 0
RED Efy = N – 29.4sinø = 0
BLUE Efx = 0
BLUE Efy = T- (1.26*9.8)
T = 12.348
12.348 – 29.4cosø = 0
$\cos^{-1} .42 = 65.16°$

14. Efx = T2cos80 – T1cos20 = 0
Efy = T2sin80 + T1sin20 – (20*9.8) = 0
T2sin80 + T1sin20 = 196
T2sin80 = 196-T1sin20
T2 = (196-T1sin20)/sin80
(196-T1sin20)(cos80)/sin80 – T1cos20 = 0
Ti = 223
T2 = 1207

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15. RED Efx = 19.6cos240 + T = 0
T = 9.8
GREEN Efx = 9.8cos140 + Tcos60 = 0
T = 15.01
BLUE Efx = 15.01cos155+ Tcos32 = 0
T = 16.04, this will be the tension put on his arm.

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16. Pressure = Force/Area
Shondra's pressure = 50*9.8 / .00008m^2, or 6125000
LaShondra's pressure 30*9.8 / 9187500
LaShondra puts more pressure on the ground, 33 1/3% more, actually.

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17. P = f/a. The force acting is the gravitational force, therefore F = .2 kg * 9.8. the area is the amount of space in contact with your finger, or .0003 m^2. Therefore, the pressure on your finger is 6533 Pascals. With the rain, the pressure is 13,200 Pascals.

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18. The first thing to do would be to determine the force on the string without the push. This is opposite to the gravitational force, since the yoyo is in equilibrium. Therefore, it is equal to 9.8N.

Secondly, the force in concert with the push has to be determined.
Efy = gravity + string in the y direction
Efy = -9.8 + Tsin70 = 0
Efx = Klause's Push + Tcos20 = 0
Both sums are equal to zero because the system is in equilibrium.
T = 9.8/sin70 = 10.42
Klause's push = -10.42cos70, or -3.566.

Klaus's push is 3.566 N, and the change in tension is from 9.8 to 10.42.

19. Pink Efy = T sin25 – (9.8*2) = 0
T = 19.6/sin25
T = 46.377
Blue Efy = -9.8*M + 46.377sin135 + T2sin40
Blue Efx = -46.377cos135 + T2cos40
Blue Efy = -9.8M + 32.793 + .642T2
Blue Efx = 32.793 + .766T2
T2 = 32.793/.766 = 42.810
9.8M = 32.793 + .642(42.810)
M = 6.15

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20. cos(.3/1.5) = 78.46, that's the angle you use with gravity for the second part of the problem.
Scenario 2 → Efy = T- 1.96sin 78.46
T = 1.92

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21. 8(9.8) = t1sin30 + t2sin26
T1cos30 = t2cos26
78.4 = t2 cos26*sin30/cos30 + t2sin26
t2 = 50.55
9.8x = 50.55
x = 5.15 kg

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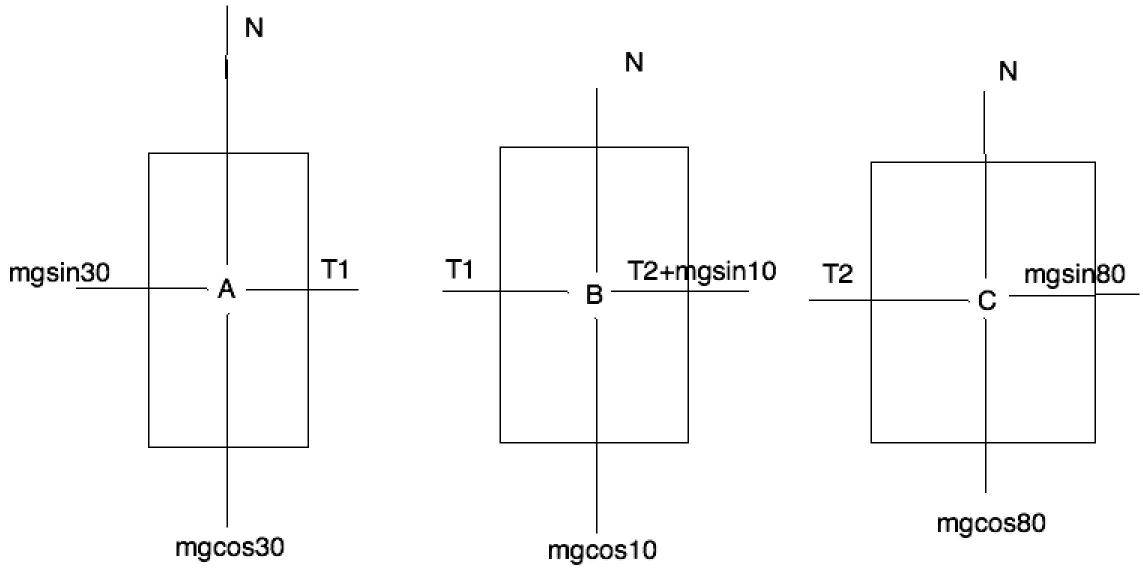
22. Set axes along the plane, so that the box is accelerating in the positive x direction. Therefore, to determine the accleration, Ef = ma and Ef equals sum of the forces in the x direction. Efx = 5*9.8sin-60, or 42.43. Therefore, ma = 42.43. Since m is equal to 5, a = 8.486 m/s^2.

23.)



a.

b. mgsin30 = $T_2 m_2$gsin10

2(9.8)sin30 = T_2 + 1.5(9.8)sin10

9.8 = T_2 + 2.6

T_2 = 7.25 N

7.25 = mgsin80

7.25 = m(9.8)sin80

***m_c* = 751.2 g**

24.

∑Fy= 0
mg = Tcos23
2(9.8) = Tcos23
T = 21.29 N
∑Fx = 0
P = Tsin23
P = 8.319 Newtons

25.

$\sum Fx = 0$
P = mgsin18
P = 90(9.8)sin18
P= 272.55 N

26.

$\sum Fx = ma$
15cos30 – 29cos120 + 12cos350 = 25a
Ax = 1.57 m/s^2

$\sum Fy = ma$
15sin30 – 29sin120 + 12sin350 = 25a
Ay = -.232

$A^2 = 1.57^2 + -.232^2$
A = 1.58
Δx= ½ at^2
Δx= .5(1.58)100
Δx= 79 meters

Arctan(-.232/1.57) = -.8405 +360 = 351.6
79 meters @ 351.6 degrees