# Practice Problems For Chapter 17

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 17 – Practice Problems

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1. If a disk is spinning at 2.4 rev/sec after 2 secs from rest and has a mass of 14 kg and a radius of 5.2m, what force was used in this acceleration?

John Stevenson ‘07

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2. Consider a ride that is essentially a hoop spinning at a radius of 5m around a center point with all the riders (all the mass) sitting on the edges (consider the bars used for the rotation to be mass less). If the ride goes 45 mph after 5 seconds of acceleration, what force was used in the initial acceleration if the hoop and riders have a weight of 2000N?

John Stevenson ‘07

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3. A little boy throws a baseball (radius 4cm; mass 300g) up into the air. If 20 N went into spinning the ball and 50N went into linear motion, how fast was the ball spinning and how fast was it moving? If the ball lands 1 m from where it started, what angle did the boy throw the ball at? The time it takes to actually throw the ball is 0.1sec

Emily Whitcher ‘07

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4. The contraption shown below shoots foam discs.

If the discs exit the shooter moving at 10m/s and spinning at 150 rad/sec, how much energy is used to shoot each disc? (mass=5g, r=2cm)

How far should each disc travel if it is shot at 0° from a height of 1m?

Emily Whitcher ‘07

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5. Mr. Laba is the pitcher at an important baseball game. Arnold Schwarzenegger steps up to bat. Mr. Laba has a longstanding hate of Arnold and his big muscles, so he hurls the ball straight at Arnold at 130 mph. The ball is also spinning at 70 rad/sec.
a. What is the kinetic energy of the ball (mass=.25 kg, radius=.035 m)?
b. Arnold dodges the ball and starts running away. Mr. Laba throws a second ball with the same kinetic energy. How far does Arnold have to run before Mr. Laba won’t be able to hit him again (Ignore Mr. Laba’s height)? (hint- if Mr. Laba decides not to spin the ball, it will go faster)

Moritz Sudhof ‘07

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6. Mr. Laba hops in his Porsche 911 Turbo and puts the pedal to the metal. He is soon zooming along at 160 mph. The Porsche and Mr. Laba combined have a mass of 1500 kg, and the wheels have a mass of 10 kg and a radius of .2 m each. The wheels are like discs. What is the kinetic energy of the Porsche?

Moritz Sudhof ‘07

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7. For some odd reason, there’s a huge, massive disk spinning on the school campus. It has a radius of 40 m and a mass of 600 kg. It is just sitting there right now. However, the whole school will blow up if it doesn’t stop spinning at 10 rev/sec in 4 sec- Oh, no! Nobody knows how the disk got there or how it could possibly blow up the school if it didn’t start spinning. It’s a mystery present from the aliens, and we’re all scared. Luckily, Mr. Laba decides to save the day. How much force does he need to apply to the edge of the disk in order save the school?

Moritz Sudhof ‘07

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8. Mr. Laba wants to demonstrate his monster strength, so he brings his class outside where he has placed a huge, huge iron ball (radius = 1 m, mass = 400 kg). He picks up the huge ball and hurls it up in the air. He only uses 20% of the energy to give it spin as it rises (because the ball is tie-dye colored, and it gives a cool visual effect to see it spin), and the big ball rises 460 m in the air. When it falls back to the ground and accidentally squishes a student, its spin is still the same. How fast was it spinning?

Moritz Sudhof ‘07

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9. Donkey Kong decides to jump onto a large spinning disk, held in the air between trees, which helps him reach the evil boss of the jungle. The disk has a mass of 100kg and has a radius of 10m. If it spins at 30 rad/s. and DK jumps on with a mass of 60kg. What will the new angular velocity of the disk be?

Connor Nickell ‘08

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10. On a heavy topspin forehand, the ball rotates at 55 revolutions per second. If Dallas puts 20 percent of his force into spin when he hits the .3 kg ball, how much force must he put on the ball in order for the shot to qualify as a heavy forehand? (a tennis ball has a radius of .02 meters)

John Wheeler (class of 2008)

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11. John is working on his toss in order to improve his tennis game. Knowing that it will ultimately improve his game, John reduces the amount of spin on his toss. Using his physics knowledge, John tries to predict how much spin his new toss will have. (the original toss was 3.5m with 20 percent spin and the new toss will have the same amount of force but only 10 percent spin)

John Wheeler (class of 2008)

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12. Reed is attempting to gain some more distance on his basketball shot by sacrificing spin. If he normally puts enough spin on the ball to make it spin at 50 radians per second and this shot only goes 10 meters, how much farther can he shoot the ball if he uses no spin? He uses the same amount of energy each shot, the first shot is in ( A basketball has a radius of .13m and is .5kg)

John Wheeler (class of 2008)

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13. Hayden is attempting to become the world greatest discus thrower. By watching film of the world’s current number one (Haska Shenkala), Hayden determines that by the time the discus hits the ground (about 3.5 seconds after it leaves his hand), it should be spinning at 7 radians per second. If Hayden can only put 2 Newton of force into rotational energy, how heavy a discus could he use if the radius of a standard discus is .2 meters?

John Wheeler (class of 2008)

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14. Upon the news that it is no longer a planet, Pluto goes into a state of depression. Rotating slower, Pluto’s rotational period (akin to a day on earth) changes from 6.387

earth days to 10 days. This decelerating takes place over a period of 122 days. If Mr. Laba found a way to translate all this lost energy into the electricity industry in order to raise funds for founding a political party with the sole issue of reinstating Pluto as a planet, how much energy would he gain? (r = 1137km) (m = 1.27 x $10^{22}$)

John Wheeler (class of 2008)

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15. In an alternate universe, cars are powered by midgets hoola-hooping. If these midgets hoola-hoop with hoops of radius .3 meters and mass .5 kg, can reach speeds of 10 revolutions per second in only 7 seconds, and a car takes 100 N to start, how many midgets are needed to start a car?

John Wheeler (class of 2008)

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16.) The alpha team and omega team decide the first sport they will battle in is soccer. Julie kicks the ball(.127 m radius) (.4 kg) and sends it rocketing off at 25 m/sec and 50 rad/sec. What is the ball's kinetic energy?

Julie Mirliss (class of 2010)

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17.) Maura, part of the alpha team, was opening the van full of Frisbees when a wooden plank(3 m long) fell out of the van making a 35 degree angle with the ground. One Frisbee(.175 kg) with a radius of .15 m traveled down the incline at a linear speed of 3 m/sec. What is the frisbee's final angular speed?

Julie Mirliss (class of 2010)

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*1. Work:*
*2.4 rev/sec= 2.4*2pi=4.8pi=15.079 rad/sec*
*wf=wi+alphat*
*15.079=0+alpha2*
*alpha=7.5398*
*T=Ialpha*
*T=mr$^2$alpha*
*T=2854.2666*
*F*Dperp=2854/5.2*
*Answer: F=548.897 N*

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*2. Work:*
*45 mph→20.1168 m/sec*
*vt=wr*
*20.1168=w5*
*w=4.02336 rad/sec*
*wf=wi+alphat*
*4.02336=0+alpha5*
*alpha=.804672*
*T=Ialpha*
*T=mr$^2$alpha*
*F*dper=4105.469*
*F=4105.469/5*
*Answer: F=821.0938776N*

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3.
Fd=Iα I=(2mr^2)/5
20(.04)=((2(.3)(.04)^2)/5)α
.8=1.92(1m^-4) α
α=4166.66 rad/sec^2

F=ma
50=.3a
a=166.66 m/sec^2

vf=at
166.66 (.1)
**16.66 m/s**

ωf=αt
ωf=4166.66 (.1)
**416.66 rad/sec**

$\Delta x=(Vi^2 \sin 2\theta)/9.8$
$1=16.66^2 \sin 2\theta/9.8$
$9.8=277.55 \sin 2\theta$
$.03530824=\sin 2\theta$
$2\theta=.03531558$
**$\theta=1.02°$**

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4.
$\frac{1}{2} mv^2=T$
$\frac{1}{2}(.05)10^2=2.5$

$\frac{1}{2} I\omega^2=T$
$\frac{1}{2} (mr^2/2)150^2=T$
$\frac{1}{2} ((.05)(.02)^2/2) * 150^2=T$
$T=.1125$

**2.6125 Joules of energy**

$\Delta y=1/2gt^2$
$1=1/2(9.8)t^2$
$2=9.8 t^2$
$t=.452$ seconds

$\Delta x=Vxt$
$\Delta x=10(.452)$
**$\Delta x=4.52m$**

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5.
a.
130mph = 57.8 m/sec
$I = 2/5mr^2 = 2(.25)(.035^2)/5 = 1.225 \times 10^{-4}$

$T = \frac{1}{2} mv^2 + \frac{1}{2}I\omega^2$
$T = 417.6 + .3$
$T = 417.9$ J

b.
$417.9 = \frac{1}{2} mv^2$
$v = 57.82$ m/s
$\Delta X = (v^2 \sin 2\theta)/g$
$\Delta X = (57.82^2 \sin 90)/9.8$
$\Delta X = 341.143$ m

Arnold has to run further than 341.143 m to escape Mr. Laba's wrath

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6.
160 mph = 71.1 m/s
$I = ½ mr^2 = ½ (10)(.2^2) = .2$

$\omega = v/r = 71.1/.2 = 355.5$ rad/sec

$T = ½ mv^2 + 4 (½ I\omega^2)$
T = 3791407.5 + 4(12638)
T = 3841959.5 J

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7.

$I = ½ mr^2 = .5(600)(40^2) = 480000$
10 rev/sec = 62.8 rad/sec

$\omega_f = \omega_i + \alpha t$
$62.8 = 0 + 4\alpha$
$\alpha = 15.7$ rad/sec$^2$

$\Sigma T = I\alpha = (480000)(15.7)$
T = 7539822.4
F = T/d = 7539822.4/40
F = 188495.56 N

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8.
$½mv^2 = mgh$
$½mv^2 = (400)(9.8)(460)$
$½mv^2 = 1803200$ J
This is 80% of the ball's energy
1803200/80 = x/20
450800 J is 20%, used for spin

$450800 \text{ J} = ½I\omega^2$
$I = 2/5\ mr^2 = 160$
$\omega^2 = 5635$
$\omega = 75$ rad/sec

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9. $\omega$ = 30rad/s
radius = 10m

mass of disk = 100kg
DK = 60kg

$I\omega = I\omega_2 + m(v_t)r$
$V_t = \omega r$
$(mr^2/2)\omega = (mr^2/2)\omega_2 + m\omega r^2$
$(100(10^2)/2)(30) = [(100(10^2)/2) + (60)(10^2)]\omega_2$
$(5000)(30) = [5000 + 6000]\omega_2$
$150000 = (11000)\omega_2$
$13.64 \text{ rad/s}^2 = \omega_2$

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10.
$I = (2/5)mr^2 = (.4)(.3)(.02)(.02) = .000048$
$\alpha = 55 \text{ rad/sec}^2$
$T = I\alpha$
$T = (55)(.0048) = .00264$ Nm
$F = T/d$
$F = (.00264)/(.02)$
$F = .132$ N
$(.132)/(.2) = .66$ N
(He needs to work out a little bit)

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11.
$\frac{1}{2}mv^2 = mgh$
$\frac{1}{2}mv^2 =$ 10.29J (this is 80% of its energy)
$(2.57)/(2)J = \frac{1}{2}I\omega^2$
$I = (2/5)mr^2 = (.4)(.3)(.02)(.02) = .000048$
$1.29J = (.5)(.000048)(\omega^2)$
$\omega = 231.84$ r/s

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12.
$\omega = 50$ r/s
$I = (.4)(.13)(.13)(.5) = .00338$
$T = q + \frac{1}{2}(.0038)(50)^2$
$T = q + 4.23$
$x = (V^2\sin 2(\text{angle}))/g$
$10 = (V^2)/9.8$
$V = 9.90$
$q = 1/2mv^2$
$T = 24.5 + 4.23 = 28.73$
$T = 1/2mv^2$
$28.73 = (.5)(.5)(V^2)$

$V = 10.72$
$x = (10.72)(10.72)\sin 2(45))/9.8$
$x = 11.72m$
11.72 – 10 = 1.72 meters farther than his original shot

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13.

$I = ½ mr^2 = (.04x)\ m^2kg$
$\omega_f = \omega_i + \alpha t$
$7 = (\alpha)(3.5)$
$\alpha = 2\ rad/sec^2$

$T= I\alpha$
$T = Fd$
$(2)(.2) = (2)(.04x)$
$X = 5kg$

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14.

$I = 2(mr^2)/5$
$I = 6.567 \times 10^{27}$
$v = d/t$
$v(original) = 1137(2)(3.14)/(6.387)$ V(final) = 1137(2)(3.14)/(10)
$\omega_f = \omega_i + \alpha t$
$\acute{\omega} = 2\pi\nu$
$714.04/(2)(3.14) = 1117.95/(2)(3.14) + \alpha(122)$
$\alpha = .53\ rad/days^2$
$\alpha = 6.13 \times 10^{-6}\ rad/sec^2$
$T = I\alpha$
$T = (6.567 \times 10^{27})(6.13 \times 10^{-6})$
$4.03 \times 10^{22}/(1137km) = F$
$3.54 \times 10^{19}$ of energy (this could raise a lot of funds…)

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15.

$I = mr^2$
$I = (.5)(.3)(.3) = .045$
$T = I\alpha$
$10\ rev/s = \alpha(7)$
$\alpha = (1.43)(2)(3.14) = 8.98\ r/s$
$T = F/d$
$100/.3 = T = 300$
$300 = (x)(8.98)(.045)$
X = 742.39 midgets needed

16.

$T= 1/2mv^2+1/2Iw^2$

$I= 2/5mr^2$

128.75 J

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17.

Ti=Tf and I of Frisbee=.002

$.5mv^2 + .5(.5mr^2 )(V/r)^2= .5mvf^2 + .5I(vf/r)^2+(-mgh)$

$3.186= .0875vf^2 + .001(vf/r)^2-5.145$

95211.4=vf2(.0875+.001/r2)

1.463 m/sec=Vf

Wf= 9.75 rad/sec