Problems

Physics for the Life Sciences I

Mechanics
Oscillators
Fluids
Thermodynamics

PHYS 105
Sections 01A
MTRF 9:00
PEngel 173

Text:
College Physics
with Enhanced WebAssign
By Open Stax

Spring 2021
Block A
Tom Kirkman

==> d1-18.txt <==
10. (a) Refer to Table 1.3 to determine the average distance between the Earth and the Sun. Then calculate the average speed of the Earth in its orbit in kilometers per second.
(b) What is this in meters per second?
1 AU = 1.495978707×10^11 m

The U.S. federal debt is a little greater than $27 trillion. If you made 100-bill stacks of $100 bills and used them to evenly cover a football field (between the end zones, approximately of how high would the money pile be?

A single bill is approximately 2.5 in. by 6 in. A stack of 100 bills is about 0.5 in. thick. Football field: 100 yards x 160 ft

24. A marathon runner completes a 42.188 km course in 2 h , 30 min, and 12 s . There is an uncertainty of 25 m in the distance traveled and an uncertainty of 1 s in the elapsed time. (a) Calculate the percent uncertainty in the distance.
(b) Calculate the percent uncertainty in the elapsed time.
(c) What is the average speed in meters per second?
(d) What is the uncertainty in the average speed?

How many significant digits in the following numbers?

•0.03	•1230
•0.030	•0.007
•70.0	•0.720
•0.72	•721
•0.60×10^{24}	•3.912×10^{14}

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==> d2-18.txt <==
26. Professional Application: Blood is accelerated from rest
to 30.0 cm/s in a distance of 1.80 cm by the left ventricle
of the heart. (a) Make a sketch of the situation. (b) List
the knowns in this problem. (c) How long does the
acceleration take? (d) Is the answer reasonable when compared
with the time for a heartbeat?
t=.120 s

The subway stops in downtown New York are so close together
that the subway train must start deaccelerating before it
reaches its maximum possible speed. Thus the train
accelerates at +1.25 m/s^2 for the first half the distance
between stops and then deaccelerates at -1.25 m/s^2 for the
second half of the distance between stops. The 23rd and 28th
Street stations are just 500 m apart. What is the total
travel time between those two stops?
40 s

25. At the end of a race, a runner decelerates from a velocity
of 9 m/s at a rate of 2 m/s^2 . (a) How far does she
travel in the next 5 s? (b) What is her final velocity?

24. While entering a freeway, a car accelerates from
30 mph to 70 mph in 10 s.  (a) What is the acceleration in m/s^2?
(b) What distance is traveled?

65. A graph of v(t) is shown for a world-class
track sprinter in a 100 m race. (a) What is his
average velocity for the first 4 s? (b) What is
his instantaneous velocity at t = 5 s ? (c) What
is his average acceleration between 0
and 4 s? (d) What is his time for the race?
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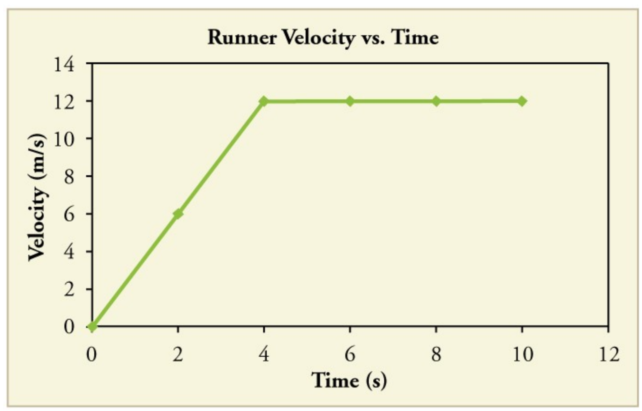

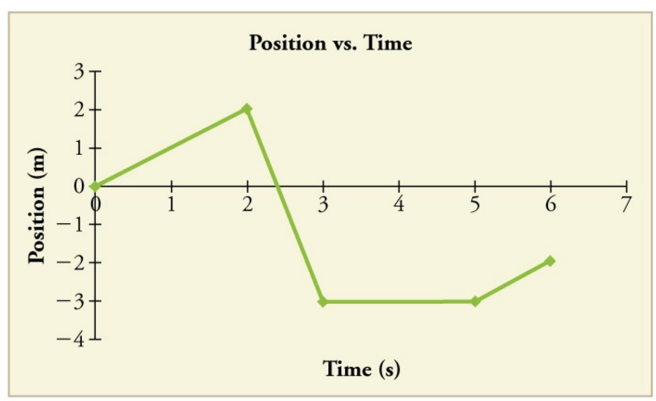


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66. The figure shows the position graph for a
particle for 5 s. Draw the corresponding velocity
and acceleration graphs.
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==> d3-18.txt <==
47. (a) Calculate the height of a cliff if it takes 2.35 s
for a rock to hit the ground when it is thrown straight up
from the cliff with an initial velocity of 8.00 m/s. (b) How
long would it take to reach the ground if it is thrown
straight down with the same speed?
H=8.26 m, t=.717

49. You throw a ball straight up with an initial velocity of
15.0 m/s. It passes a tree branch on the way up at a height
of 7.00 m. How much additional time will pass before the
ball passes the tree branch on the way back down?
t1=.58, t2=2.49, interval t= 1.91

50. A kangaroo can jump over an object 2.50 m high.
(a) Calculate its vertical speed when it leaves the ground.
(b) How long is it in the air?
t=.714 s

PHYS 105 Spring 2018 Quiz 1

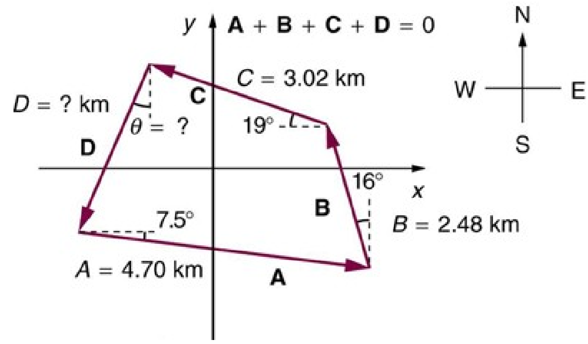
Walking across a bridge, I find myself 60 m above the water. If I throw a stone
straight down as hard as I can, I find it hits the water 2 seconds later. What is
the speed of my throw? (g=9.8 m/s^2)

==> d4-18.txt <==
44. A rescue helicopter is hovering over a person whose boat has sunk. One of the rescuers throws a life preserver straight down to the victim with an initial velocity of 1.40 m/s and observes that it takes 1.8 s to reach the water. (a) List the knowns in this problem. (b) How high above the water was the preserver released?
H=18 m

57. A coin is dropped from a hot-air balloon that is 300 m above the ground and rising at 10.0 m/s upward. For the coin, find (a) the maximum height reached, (b) its position and velocity 4.00 s after being released, and (c) the time before it hits the ground.
H=5.1+300=305 m, y=262 m, v=-29.2 m/s, t=8.91 s

53. There is a 250-m-high cliff at Half Dome in Yosemite National Park in California. Suppose a boulder breaks loose from the top of this cliff. (a) How fast will it be going when it strikes the ground? (b) Assuming a reaction time of 0.300 s, how long will a tourist at the bottom have to get out of the way after hearing the sound of the rock breaking loose (neglecting the height of the tourist, which would become negligible anyway if hit)? The speed of sound is 335 m/s on this day.
v=-70 m/s, t=7.143-1.046=6.10 s

55. Suppose you drop a rock into a dark well and, using precision equipment, you measure the time for the sound of a splash to return. (a) Neglecting the time required for sound to travel up the well, calculate the distance to the water if the sound returns in 2.0000 s. (b) Now calculate the distance taking into account the time for sound to travel up the well. The speed of sound is 332.00 m/s in this well.
H=19.6 m, 18.5 m



==> d5-18.txt <==

22. A farmer wants to fence off his four-sided plot of flat land. He measures the first three sides, shown as A, B, and C in Figure 3.62, and then correctly calculates the length and orientation of the fourth side D. What is his result?
2.97 km 22.2° W of S

23. In an attempt to escape his island, Gilligan builds a raft and sets to sea. The wind shifts a great deal during the day, and he is blown along the following straight lines: 2.50 km 45.0° north of west; then 4.70 km 60.0° south of east; then 1.30 km 25.0° south of west; then 5.10 km straight east; then 1.70 km 5.00° east of north; then 7.20 km 55.0° south of west; and finally 2.80 km 10.0° north of east. What is his final position relative to the island?
7.34 km 63.5° S of E

56. A football quarterback is moving straight backward at a speed of 2.00 m/s when he throws a pass to a player 18.0 m straight downfield. The ball is thrown at an angle of 25.0° relative to the ground and is caught at the same height as it is released. What is the initial velocity of the ball relative to the quarterback? 17.0 m/s 22.1°

62. The velocity of the wind relative to the water is crucial to sailboats. Suppose a sailboat is in an ocean current that has a velocity of 2.20 m/s in a direction 30.0° east of north relative to the Earth. It encounters a wind that has a velocity of 4.50 m/s in a direction of 50.0° south of west relative to the Earth. What is the velocity of the wind relative to the water? 6.68 m/s, 53.3° S of W

==> d6-18.txt <==

25. A projectile is launched at ground level with an initial speed of 50.0 m/s at an angle of 30.0° above the horizontal. It strikes a target above the ground 3.00 seconds later. What are the x and y distances from where the projectile was launched to where it lands?

x=130 m, y=30.9 m

34. An arrow is shot from a height of 1.5 m toward a cliff of height H. It is shot with a velocity of 30 m/s at an angle of 60° above the horizontal. It lands on the top edge of the cliff 4.0 s later. (a) What is the height of the cliff? (b) What is the maximum height reached by the arrow along its trajectory? (c) What is the arrow’s impact speed just before hitting the cliff?

H=1.5+25.5=27.0 m, max=1.5+34.4=35.9, vy=-13.2, v= 20 m/s

40. An eagle is flying horizontally at a speed of 3.00 m/s when the fish in her talons wiggles loose and falls into the lake 5.00 m below. Calculate the velocity of the fish relative to the water when it hits the water.

vy=-9.90 m/s, v=10.3 m/s

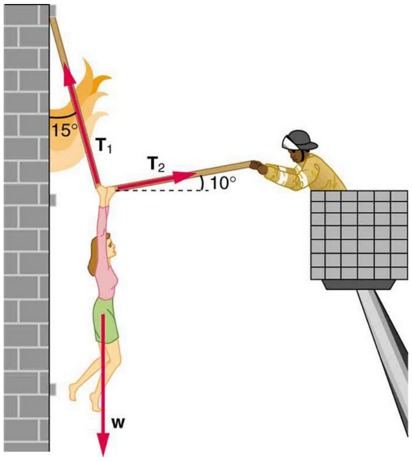
37. Serving at a speed of 170 km/h, a tennis player hits the ball at a height of 2.5 m and an angle θ below the horizontal. The service line is 11.9 m from the net, which is 0.91 m high. What is the angle θ such that the ball just crosses the net? Will the ball land in the service box, whose out line is 6.40 m from the net?

6.1°, yes

==> d7-18.txt <==

10. A powerful motorcycle can produce an acceleration of 3.50 m/s^2 while traveling at 90.0 km/h. At that speed the forces resisting motion, including friction and air resistance, total 400 N. (Air resistance is analogous to air friction. It always opposes the motion of an object.) What is the magnitude of the force the motorcycle exerts backward on the ground to produce its acceleration if the mass of the motorcycle with rider is 245 kg?
1.26 kN

20. Suppose a 60.0-kg gymnast climbs a rope. (a) What is the tension in the rope if he climbs at a constant speed? (b) What is the tension in the rope if he accelerates upward at a rate of 1.50 m/s^2 ?
T1=588 N, T2=678 N

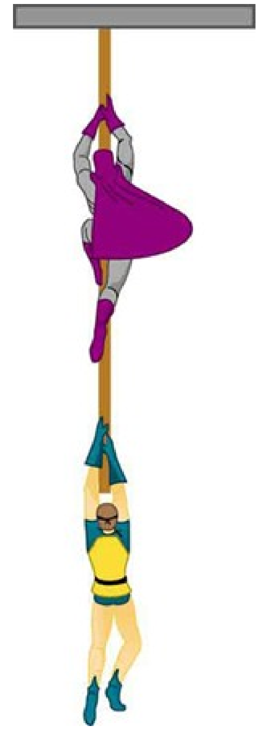


42. A 76.0-kg person is being pulled away from a burning building as shown in Figure 4.41. Calculate the tension in the two ropes if the person is momentarily motionless. Include a free-body diagram in your solution.
T1=736 N, T2=194 N

A spider of mass m=9E-5 kg hangs straight down on a 30 cm long thread she has just created. What is the tension in the thread? A steady breeze from the south pushes the hanging spider towards the north so that the thread makes an angle of 20° with the vertical. What is the tension in the thread now? Please draw a free body diagram for each situation!
T=.882 mN, .939 mN

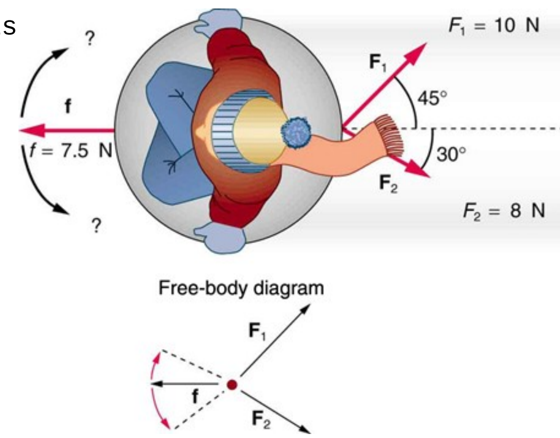
==> d8-18.txt <==

34. Figure 4.39 shows Superhero and Trusty Sidekick hanging motionless from a rope. Superhero's mass is 90 kg, while Trusty Sidekick's is 55 kg, and the mass of the rope is negligible. (a) Draw a free-body diagram of the situation showing all forces acting on Superhero, Trusty Sidekick, and the rope. (b) Find the tension in the rope above Superhero. (c) Find the tension in the rope between Superhero and Trusty Sidekick. Indicate on your free-body diagram the system of interest used to solve each part.
Tb=1.42 kN, Tc=539 N

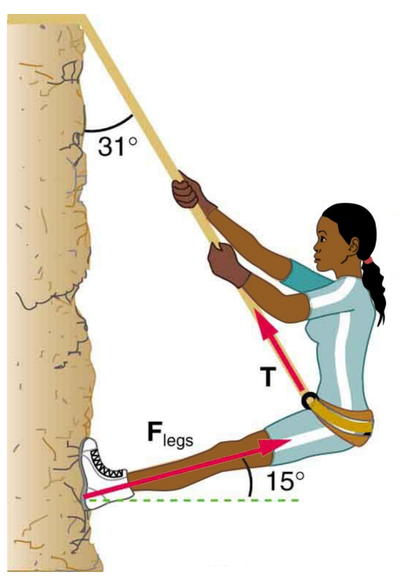


35. A nurse pushes a cart by exerting a force on the handle at a downward angle 35.0° below the horizontal. The loaded cart has a mass of 28 kg, and the force of friction is 60 N. (a) Draw a free-body diagram for the system of interest. (b) What force must the nurse exert to move at a constant velocity?
F=73 N

31. Two children pull a third child on a snow saucer sled exerting forces F1 and F2 as shown from above in Figure 4.36. Find the acceleration of the 49 kg sled and child system. Note that the direction of the frictional force is unspecified; it will be in the opposite direction of the sum of F1 and F2 .
a=.14 m/s^2, direction: 12.4°



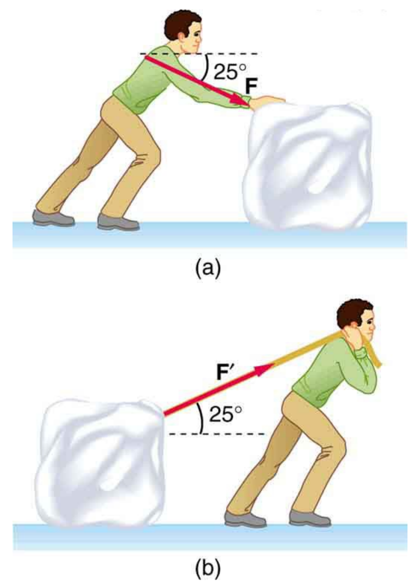
17. Consider the 52 kg mountain climber in Figure 5.22. (a) Find the tension in the rope and the force that the mountain climber must exert with her feet on the vertical rock face to remain stationary. Assume that the force is exerted parallel to her legs.
Assume negligible force exerted by her arms.
Flegs=272 N, T=512 N



==> d9-18.txt <==

4. Suppose you have a 120 kg wooden crate resting on a wood floor. (a) What maximum force can you exert horizontally on the crate without moving it? (b) If you continue to exert this force once the crate starts to slip, what will the magnitude of its acceleration then be? μs=0.5, μk=0.3

F=588 N; a=1.96 m/s^2



18. A contestant in a winter sporting event pushes a 45 kg block of ice across a frozen lake as shown in Figure 5.23(a). (a) Calculate the minimum force F he must exert to get the block moving. (b) What is the magnitude of its acceleration once it starts to move, if that force is maintained?

19. Repeat Exercise 5.18 with the contestant pulling the block of ice with a rope over his shoulder at the same angle above the horizontal as shown in Figure 5.23(b).

μs=0.1, μk=0.03

18: F=51.0 N, a=.720 m/s^2

19: F=46.5 N, a=.629 m/s^2

42. When water freezes, its volume increases by 9.05% (that is, ΔV / V0 = .0905). What force per unit area is water capable of exerting on a container when it freezes?

B=2.2e+9 N/m^2; 2e8 N/m^2 = 2e4 N/cm^2

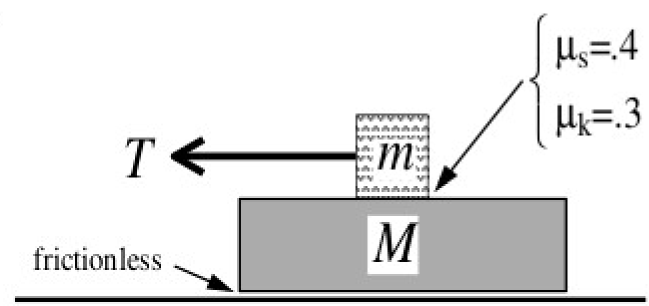
25. Calculate the speed a spherical rain drop would achieve falling from 5 km (a) in the absence of air drag (b) with air drag. Take the radius of the drop to be 2 mm, the density to be 1000 kg/m^3 , and the surface area to be πr^2.

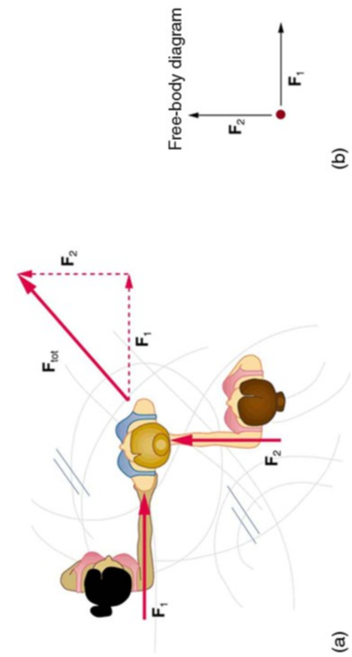
air density= 1.21 kg/m^3, C=.45

v=313 m/s; v=9.8 m/s

PHYS 105 Spring 2018 Quiz 3

A large slab (M=10 kg) floats frictionlessly on a flat surface. A block (m=1 kg) rests on top of the slab. The surface between the slab and the block has a coefficient of static friction of μ_s=0.4 and a coefficient of kinetic friction μ_k=0.3. The block is pulled with a horizontal force T. If T is sufficiently small the block+slab will move together as one object; if T is larger, there will be slippage and the block will accelerate faster than the slab (and will eventually be pulled off the slab). (A) Draw free body diagrams for each mass separately. Show and name all forces acting each mass. (B) If T=15 N, there will be slippage. Find the acceleration of each mass in this case.





==> d10-18.txt <==
7. Consider the 65 kg ice skater being pushed by two others shown in Figure 5.21. (a) Find the direction and magnitude of Ftot, the total force exerted on her by the others, given that the magnitudes F1 and F2 are 26.4 N and 18.6 N, respectively. (b) What is her initial acceleration if she is initially stationary and wearing steel-bladed skates that point in the direction of Ftot ? (c) What is her acceleration assuming she is already moving in the direction of Ftot ?
μs=0.4 [sic: as in my hardcopy], μk=0.02
Ftot=32.3 N @35.3°
static friction < 255 N (no acceleration)
kinetic friction = 12.7 N; a=.3 m/s^2

33. (a) By how much does a 65 kg mountain climber stretch her 0.8 cm diameter nylon rope when she hangs 35 m below a rock outcropping?
Y=5e9 N/m^2
Δx=8.9e-2 m=8.9 cm

34. A 20 m tall hollow aluminum flagpole is equivalent in stiffness to a solid cylinder 4 cm in diameter. A strong wind bends the pole much as a horizontal force of 900 N exerted at the top would. How far to the side does the top of the pole flex?
S=25e9 N/m^2
Δx=5.7e-4 = .57 mm

==> d13-18.txt <==
15. Helicopter blades withstand tremendous stresses. In
addition to supporting the weight of a helicopter, they are
spun at rapid rates and experience large centripetal
accelerations, especially at the tip.
(a) Calculate the magnitude of the centripetal acceleration at
the tip of a 4.00 m long helicopter blade that rotates at
300 rev/min. a=3.95e3 m/s^2

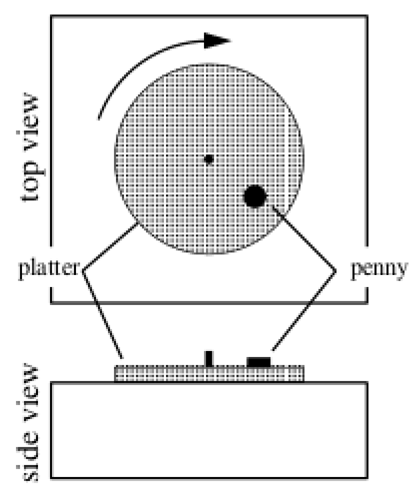
16. Olympic ice skaters are able to spin at about 5 rev/s.
(a) What is their angular velocity in radians per second?
(b) What is the centripetal acceleration of the skater's
nose if it is 0.120 m from the axis of rotation?
w=31.4 rad/s, a=118 m/s^2

20. At takeoff, a commercial jet has a 60.0 m/s speed. Its tires
have a diameter of 0.850 m.
(a) At how many rev/min are the tires rotating?
(b) What is the centripetal acceleration at the edge of the tire?
(c) With what force must a determined 1e-15 kg
bacterium cling to the rim?
w=141 rad/s = 1.35e3 rpm, a=8.47e3 m/s^2, F=8.47e-12 N

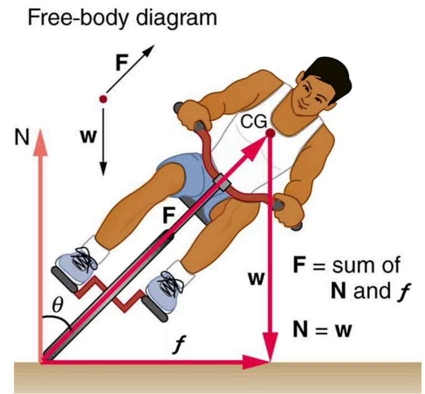
19. A rotating space station is said to create "artificial
gravity"---a loosely-defined term used for an acceleration that
would be crudely similar to gravity. The outer wall of the
rotating space station would become a floor for the
astronauts, and centripetal acceleration supplied by the floor
would allow astronauts to exercise and maintain muscle and
bone strength more naturally than in non-rotating space
environments. If the space station is 200 m in diameter, what
angular velocity would produce an "artificial gravity" of
9.80 m/s^2 at the rim?
w=.313 rad/s=3 rpm

PHYS 105 Spring 2018 Quiz 4

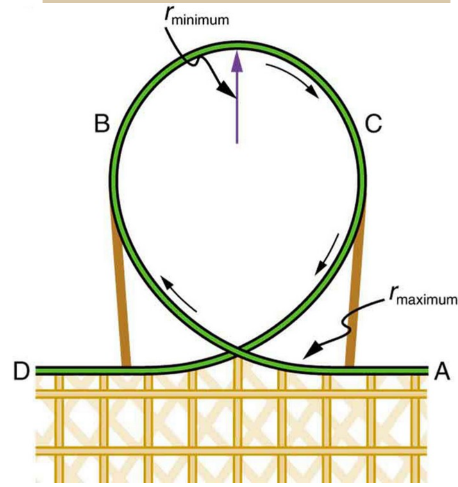
A record player is set for 33 1/3 revolutions per minute (rpm). It is found that a
penny will stick with the platter as long as its distance from the platter center
is less than 15 cm. (A) Draw a free body diagram of the penny sitting on the
rotating platter. Show and name all forces acting on the penny. Show the direction
of the acceleration (if there is any). (B) Calculate the coefficient of static
friction for the penny on the platter.



==> d14-18.txt <==
28. Part of riding a bicycle involves leaning at the correct angle when making a turn, as seen in Figure 6.36. To be stable, the force exerted by the ground must be on a line going through the center of gravity. The force on the bicycle wheel can be resolved into two perpendicular components: friction parallel to the road (this must supply the centripetal force), and the vertical normal force (which must equal the system's weight).
(a) Show tan(θ) =v^2/Rg



31. Modern roller coasters have vertical loops like the one shown in Figure 6.38. The radius of curvature is smaller at the top than on the sides so that the downward centripetal acceleration at the top will be greater than the acceleration due to gravity, keeping the passengers pressed firmly into their seats. What is the speed of the roller coaster at the top of the loop if the radius of curvature there is 15.0 m and the car just barely remains in contact with the rails?
It turns out that the increase in speed along a frictionless track equals the increase in speed for an equilivalent vertical fall. Find the height needed to start the car. Find the normal force at the bottom of the loop.
v^2=R g, h=R/2 (above top of loop), 6mg



Find the net force on the Moon if it is New, 1st Quarter, Full
G=6.674e-11
Mearth= 5.9724e+24, Msun= 1.9885e+30, Mmoon=7.35ee+22
Earth-Sun distance=1.496e11   Earth-Moon distance=3.84e8

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==> d15-18.txt <==
ISS orbits 400 km up with a period of 92.65 minutes
the Moon orbits Earth-Moon distance=3.84e8 in 27.3 days;
check kepler's 3d: P^2/r^3 = constant; Rearth=6378 km
* ? 92.65^2/(Rearth+400e3)^3
    .2756511569394287E-16
* ? (27.3*24*60)^2/(3.84e8)^3
    .2729333496093750E-16
What is the altitude of a geosynchronous satellite?
* ? ((24*60)^2/res)^(1/3)
    42213858.96663869
* ? (res-Rearth)/1609
    22272.04597056476    miles

Io: orbitR=421700 km, period=42.459 hours, find Mjupiter?
* ? (2*pi/(42.459*60*60))^2*421700e3^3/6.67e-11
    .1899766309121713E+28 (wiki: 1.8982e27 kg)

47. Astronomical observations of our Milky Way galaxy
indicate that it has a mass of about 8.0e+11 solar masses.
A star orbiting on the galaxy's periphery is about 6.0e+4
light years from its center. (a) What should the orbital
period of that star be? (b) If its period is 6.0e+7 year
instead, what is the mass of the galaxy? Msun=1.988e30
* ? 2*pi/sqrt(6.67e-11*8.0e+11*1.988e30)*(6.0e+4*c*year)^1.5/year
    261438215.8494172
* ? (2*pi/(6e7*year))^2*(6.0e+4*c*year)^3/6.67e-11
    .3019548491657213E+44
* ? res/Msun
    15185209263644.66

Mearth=5.972e+24 kg, Msun=1.989e+30 kg, Mmoon=7.342e+22 kg
Earth-Sun distance=1.496e11 m   Earth-Moon distance=3.84e8 m
Rearth=6378137 m
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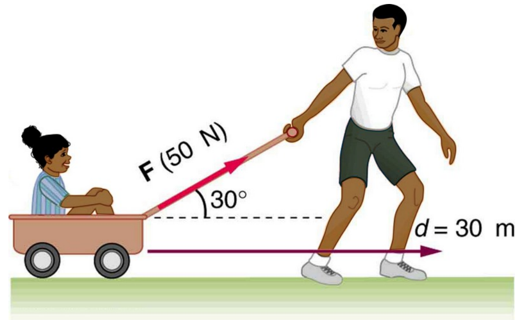
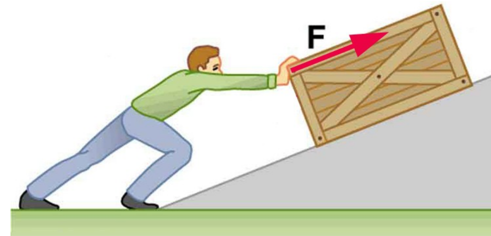


==> d16-18.txt <==
6. How much work is done by the boy pulling his sister
30.0 m in a wagon as shown in Figure 7.36? Assume no
friction acts
on the wagon.
1.30e3 J



5. Calculate the work done by an 85.0-kg man who pushes a
crate 4.00 m up along a ramp that makes an angle of 20
with the horizontal. (See Figure 7.35.) He exerts a force of
500 N on the crate parallel to the ramp and moves at a
constant speed. Be certain to include the work he does on the
crate and on his body to get up the ramp.
just crate: 2000 J; self: mgh=85*9.8*4*sin(20)=1.14e3 J

20. A 100-g toy car is propelled by a compressed spring that
starts it moving. The car follows the curved track in Figure
7.39. Show that the final speed of the toy car is 0.687 m/s if
its initial speed is 2.00 m/s and it coasts up the frictionless
slope, gaining 0.180 m in altitude.

A toy plane with a mass of 0.78 kg is tied to a string and
made to travel at a speed of 24 m/s in a horizontal circle
with a 15 m radius. The person holding the string pulls the
plane in, increasing the tension in the string, increasing
the speed of the plane and decreasing the radius of the
plane's orbit. What is the net work done (in J) on the
plane if the tension in the string is finally four time
the initial tension and the radius decreases to 11 m.
434 J

==> d17-18.txt <==
23. A pogo stick has a spring with a force constant of
2.50e4 N/m , which can be compressed 12.0 cm. To
what maximum height can a child jump on the stick using only
the energy in the spring, if the child and stick have a total
mass of 40.0 kg? h=.459 m

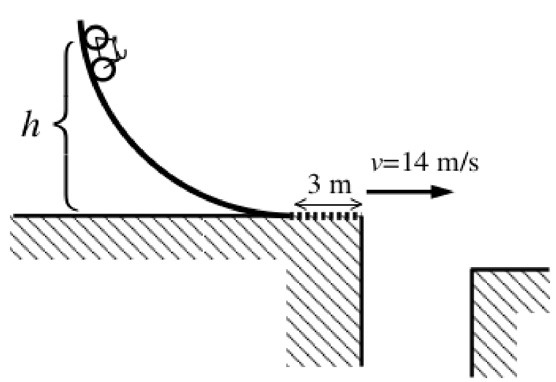
25. (a) How high a hill can a car coast up (engine
disengaged) if work done by friction is negligible and its initial
speed is 110 km/h? (b) If, in actuality, a 750-kg car with an
initial speed of 110 km/h is observed to coast up a hill to a
height 22.0 m above its starting point, how much thermal
energy was generated by friction? (c) What is the average
force of friction if the hill has a slope 2.5 above the
horizontal?
h=47.6 m, missing E=1.89e5 J, =F d where d=2.5/sin(2.5)
F=375 N

A spring (spring constant k=250 N/m) is hanging from the ceiling.
A mass (m=0.35 kg) is attached to the spring, pulled down 6 cm,
nd then released. What is the velocity of the mass when it rises
to 1 cm above the initial (relaxed, unattached) spring-end position
(i.e., at y=+.01 m)? v=1.06 m/s
.5 k .06^2 +mg(-.06)=.5 m v^2 + .5 k .01^2 +mg(.01)
.5 k (.06^2-.01^2) + mg(-.07) = .5 m v^2
 k/m (.06^2-.01^2) + 2g(-.07) =   v^2

37. A 500 kg dragster accelerates from rest to a final speed of
110 m/s in 400 m (about a quarter of a mile) and encounters
an average frictional force of 1200 N. What is its average
power output in watts and horsepower if this takes 7.30 s?
P=4.80e5 W = 643 hp (746 W = 1 hp)

PHYS 105 Spring 2018 Quiz 5

Stuntman Rupert has decided his Terminator+bike (mass = 100 kg) should have a
horizontal velocity of 14 m/s for the crack-jump scene of Godzilla vs. Terminator.
Since he’s not really the Terminator, he could not achieve the required speed using
his own muscles. So he’s decided to build a frictionless ramp out of view of the
camera to provide all the required energy. However, the movie frame will include 3
m on the rough surface before the crack (which has a frictional force of 800 N).
(A) Calculate the work done by the frictional force as the bike travels over the
rough surface. (B) Calculate the bike+rider kinetic energy (at the crack edge)
required for a successful jump. (C) Calculate the height h at which Rupert should
start. W=-2400 J, KEf=9800 J, h=12.4 m



==> d18-18.txt <==

23. Train cars are coupled together by being bumped into one another. Suppose two loaded train cars are moving toward one another, the first having a mass of 150,000 kg and a velocity of 0.300 m/s, and the second having a mass of 110,000 kg and a velocity of -0.120 m/s . (The minus indicates direction of motion.) What is their final velocity?
.122 m/s

34. A battleship that is 6.00e7 kg and is originally at rest fires a 1100-kg artillery shell horizontally with a velocity of 575 m/s. (a) If the shell is fired straight aft there will be negligible friction opposing the ship's recoil. Calculate its recoil velocity. (b) Calculate the increase in internal kinetic energy (that is, for the ship and the shell). This energy is less than the energy released by the gun powder--significant heat transfer occurs.
-1.05e-2 m/s, KEf=1.82e8 J

35. Two manned satellites approaching one another, at a relative speed of 0.250 m/s, intending to dock. The first has a mass of 4.00e3 kg , and the second a mass of 7.50e3 kg .
(a) Calculate the final velocity (after docking) by using the frame of reference in which the first satellite was originally at rest. (b) What is the loss of kinetic energy in this inelastic collision? (c) Repeat both parts by using the frame of reference in which the second satellite was originally at rest. Explain why the change in velocity is different in the two frames, whereas the change in kinetic energy is the same in both.   .163 m/s DKE=-81.6 J;   -.087 m/s same

17. Water from a fire hose is directed horizontally against a wall at a rate of 50.0 kg/s and a speed of 42 m/s. Calculate the magnitude of the force exerted on the wall, assuming the water's horizontal momentum is reduced to zero. F=-2.10e3 N

==> d19-18.txt <==
old exam 105t212.pdf #14; KE conserved 25 J

30. A 70 kg ice hockey goalie, originally at rest, catches a
0.15 kg hockey puck slapped at him at a velocity of 35 m/s.
Suppose the goalie and the ice puck have an elastic
collision and the puck is reflected back in the direction from
which it came. What would their final velocities be in this
case? -34.85 m/s, .1497 m/s

29. Two manned satellites approach one another at a relative
speed of 0.250 m/s, intending to dock. The first has a mass
of 4e3 kg, and the second a mass of 7.5e3. If the two
satellites collide elastically rather than dock, what is
their final relative velocity? immediate: -.25 m/s
work in initial rest frame of 2: v2=0, v1=.25 m/s
v2'=.174 m/s, v1'=-.076 m/s

46 A 5.5 kg bowling ball moving at 9 m/s collides with a
0.85 kg bowling pin, which is scattered at an angle of 85
to the initial direction of the bowling ball and with a speed
of 15 m/s. (a) Calculate the final velocity (magnitude and
direction) of the bowling ball. (b) Is the collision elastic?
(c) Is linear kinetic energy greater after the collision?
vy=-15*sin(85)*.85/5.5= -2.31 m/s
vx=(5.5*9-.85*15*cos(85))/5.5= 8.80...9.096 m/s @14.7 Yes

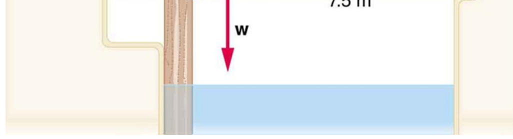
8. A car moving at 10 m/s crashes into a tree and stops in
0.26 s. Calculate the force the seat belt exerts on a
passenger in the car to bring him to a halt. The mass of
the passenger is 70 kg. F=2690 N

==> d20-18.txt <==
8-49. Ernest Rutherford (the first New Zealander to be awarded the Nobel Prize in Chemistry) demonstrated that nuclei were very small and dense by scattering helium-4 nuclei (4He) from gold-197 nuclei (197Au). The energy of the incoming helium nucleus was 8e-13 J and the masses of the helium and gold nuclei were 6.68e-27 kg 3.29e-25 kg respectively (note that their mass ratio is 4 to 197).
(a) If a helium nucleus scatters to an angle of 120 during an elastic collision with a gold nucleus, calculate the helium nucleus's final speed and the final velocity (magnitude and direction) of the gold nucleus. (b) What is the final kinetic energy of the helium nucleus?
v1f=15012135; angle=29.5, v2f=536140

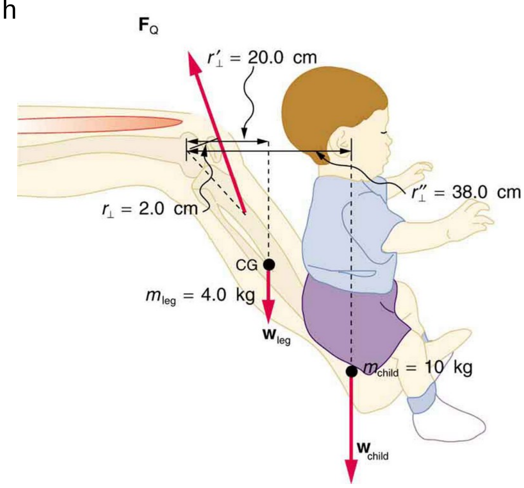
8-60. How much of a single-stage rocket that is 100,000 kg can be anything but fuel if the rocket is to have a final speed of 8 km/s, given that it expels gases at an exhaust velocity of 2.2e3 m/s? 2.63e3 kg

9-12. Suppose the weight of the drawbridge in Figure 9.34 is supported entirely by its hinges and the opposite shore, so that its cables are slack. (a) What fraction of the weight is supported by the opposite shore if the point of support is directly beneath the cable attachments? (b) What is the direction and magnitude of the force the hinges exert on the bridge under these circumstances? The mass of the bridge is 2500 kg. Fa=4083 Fb=20417 N

9-13. Suppose a 900-kg car is on the bridge in Figure 9.34 with its center of mass halfway between the hinges and the cable attachments. (The bridge is supported by the cables and hinges only.) (a) Find the force in the cables. (b) Find the direction and magnitude of the force exerted by the hinges on the bridge T=1.32e4 N, Fx=1.01e4 N Fy=2.48e4 N

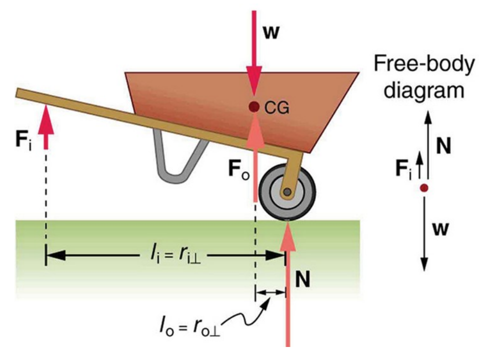


==> d22-18.txt <==
17. To get up on the roof, a person (mass 70 kg) places a 6 m aluminum ladder (mass 10 kg) against the house on a concrete pad with the base of the ladder 2 m from the house. The ladder rests against a plastic rain gutter, which we can assume to be frictionless. The center of mass of the ladder is 2 m from the bottom. The person is standing 3 m from the bottom. What are the magnitudes of the forces on the ladder at the top and bottom?
Q: is the force at the top horizontal or perpendicular to ladder?
Ftop=133 N or 125 N (friction=118 N, N=742 N)

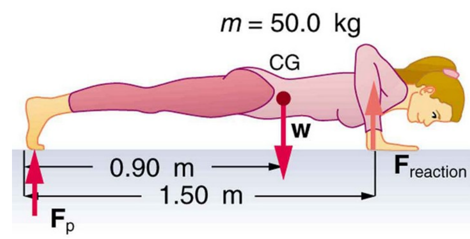


34. A father lifts his child as shown in Figure 9.43. What force should the upper leg muscle exert to lift the child at a constant speed? 2254 N

21. a) What is the mechanical advantage of a wheelbarrow, such as the one in Figure, if the center of gravity of the wheelbarrow and its load has a perpendicular lever arm of 5.5 cm, while the hands have a perpendicular lever arm of 1.02 m? (b) What upward force should you exert to support the wheelbarrow and its load if their combined mass is 55 kg? (c) What force does the wheel exert on the ground?
MA=102/5.5=18.55, Fhand=29.1 N, N=W-29.1=510 N



37. (a) What force should the woman in Figure 9.45 exert on the floor with each hand to do a push-up? Assume that she moves up at a constant speed. (b) The triceps muscle at the back of her upper arm has an effective lever arm of 1.75 cm, and she exerts force on the floor at a horizontal distance of 20 cm from the elbow joint. Calculate the magnitude of the force in each triceps muscle, and compare it to her weight. (c) How much work does she do if her center of mass rises 0.24 m? (d) What is her useful power output if she does 25 pushups in one minute?
.5*W*.9/1.5=147 N, 147*20/1.75=1680 N, 118 J, 49 W



PHYS 105 Spring 2018 Quiz 7

A straight, uniform pole vault pole is 5 m long and has a mass of 10 kg. A pole vaulter places one hand at the end of the pole and the other hand 50 cm from the pole's end and holds the pole horizontal with no support other than his two hands. Draw a free body diagram showing the pole and where every force is applied. Calculate the force applied by each hand (your diagram should display the direction of these hand forces).

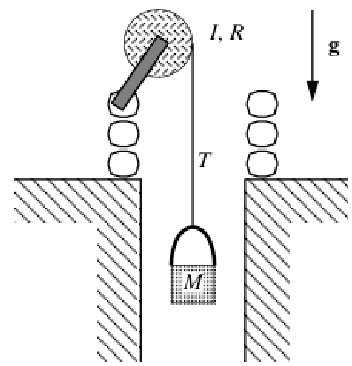
==> d23-18.txt <==
3. You have a grindstone (a disk) that is 90 kg, has a 0.34 m radius, and is turning at 90 rpm, and you press a steel axe against it with a radial force of 20 N. (a) Assuming the kinetic coefficient of friction between steel and stone is 0.20, calculate the angular acceleration of the grindstone. (b) How many turns will the stone make before coming to rest?
a=-.26 rad/s^2 t=27 rev

8. During a very quick stop, a car decelerates at 7 m/s^2 .
(a) What is the angular acceleration of its 0.28 m radius tires, assuming they do not slip on the pavement?
(b) How many revolutions do the tires make before coming to rest, given their initial angular velocity is 95 rad/s ?
(c) How long does the car take to stop completely?
(d) What distance does the car travel in this time?
(e) What was the car's initial velocity?
a = -25 rad/s^2, t=28.7 rev, t=3.8 s, x=50.7 m, v=26.6 m/s

16. Zorch, an archenemy of Superman, decides to slow Earth's rotation to once per 28.0 h by exerting an opposing force at and parallel to the equator. Superman is not immediately concerned, because he knows Zorch can only exert a force of 4.E7 N (a little greater than a Saturn V rocket's thrust). How long must Zorch push with this force to accomplish his goal?
Mearth=5.9724E+24 kg, Rearth= 6.3781E+06 m, t=3.95e18 s

13. A soccer player extends her lower leg in a kicking motion by exerting a force with the muscle above the knee in the front of her leg. She produces an angular acceleration of 30 rad/s^2 and her lower leg has a moment of inertia of 0.750 kg m^2 . What is the force exerted by the muscle if its effective perpendicular lever arm is 1.90 cm?
F=1.18e3 N

==> d24-18.txt <==
a=Mg/(I/R^2+M)=1.6 m/s^2
PHYS 105 Spring 2018 Quiz 8



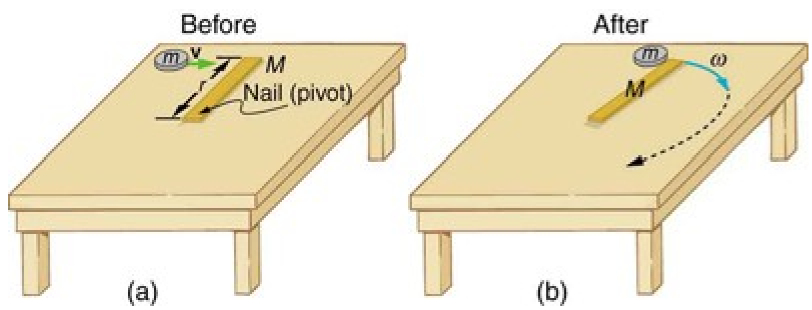
An old stone well consists of a bucket (mass M=2 kg) and a reel with crank (moment of inertia I= 0.9 kg m^2 and radius R=.3 m) to pull the bucket up. The bucket is released from the top of the well; as it falls it pulls the rope down and, as a result, the crank assembly runs backward. Find the acceleration of the bucket. Of course, your answer will include two free body diagrams: one of the forces on the bucket and one of the torques on the reel.

39. A playground merry-go-round has a mass of 120 kg and a radius of 1.8 m and it is rotating with an angular velocity of 0.500 rev/s. What is its angular velocity after a 22 kg child gets onto it by grabbing its outer edge? The child is initially at rest. w=.366 rev/s = 2.30 rad/s

43. Repeat Example 10.15 in which the disk strikes and adheres to the stick 0.1 m from the nail.

Suppose the disk in Figure 10.26 has a mass of 50 g and an initial velocity of 30 m/s when it strikes the stick that is 1.2 m long and 2 kg.
(a) What is the angular velocity of the two after the collision?
(b) What is the kinetic energy before and after the collision?
(c) What is the total linear momentum before and after the collision?
Li=mvx=Lf=(I+mx^2) w; Irod=1/3 ML^2; KE=1/2 I w^2
w= (.05 30 .1)/(1/3 2 1.2^2 + .05 .1^2) = .156 rad/s
KEi=22.5 J, KEf=1/2 (I+mx^2) w^2 = 1.08e-2 J
pi=1.5 kg m/s; pf=(m x + M L/2)w=.188 kg m/s
(reduced p means a negative--backward-- impulse from nail)

105iQt2.pdf p 24 & 25



==> d27-18.txt <==
5. Suppose you have a coffee mug with a circular cross section and vertical sides (uniform radius). What is its inside radius if it holds 375 g of coffee when filled to a depth of 7.5 cm? Assume coffee has the same density as water.
R=4 cm

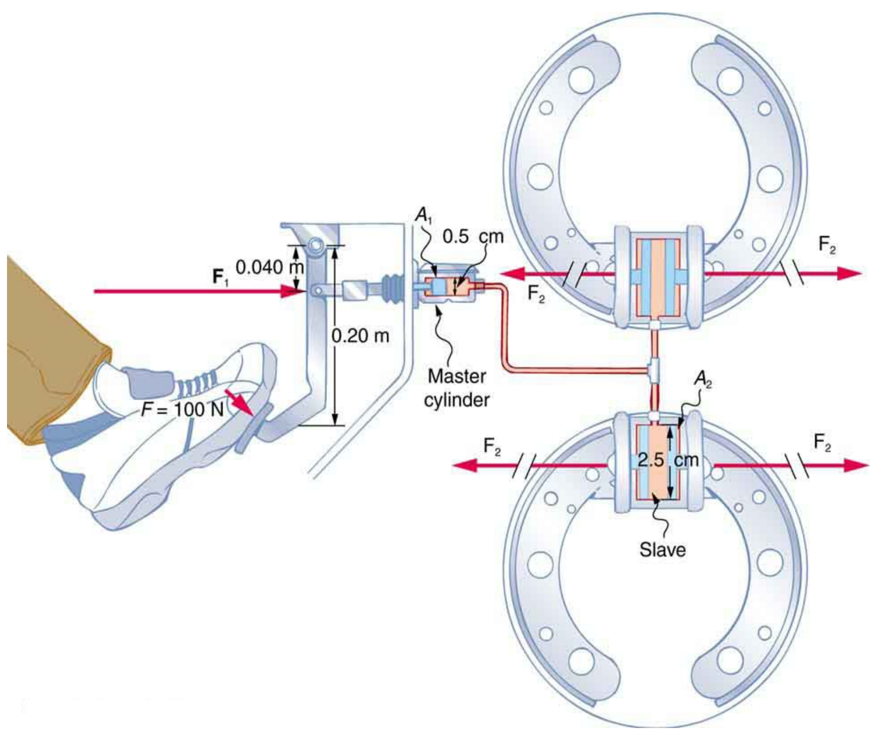
11. As a woman walks, her entire weight is momentarily placed on one heel of her high-heeled shoes. Calculate the pressure exerted on the floor by the heel if it has an area of 1.5 cm^2 and the woman's mass is 55 kg. Express the pressure in Pa. (In the early days of commercial flight, women were not allowed to wear high-heeled shoes because aircraft floors were too thin to withstand such large pressures.)
P=3.59e6 N/m^2

19. How much force is exerted on one side of an 8.5 in by 11 in sheet of paper by the atmosphere? How can the paper withstand such a force? 1370 lbs, Po=1.0132e5 Pa

22. The left side of the heart creates a pressure of 120 mm Hg by exerting a force directly on the blood over an effective area of 15 cm^2 . What force does it exert to accomplish this? Hg density = 13.6e3 kg/m^3, F=24 N

24. How much pressure is transmitted in the hydraulic system considered in Example 11.6? Express your answer in pascals and in atmospheres. 2.55e7 Pa = 2.51 atm

35. Assuming bicycle tires are perfectly flexible and support the weight of bicycle and rider by pressure alone, calculate the total area of the tires in contact with the ground. The bicycle plus rider has a mass of 80 kg, and the gauge pressure in the tires is 3.5e5 Pa. 22.4 cm^2



==> d28-18.txt <==
41. A rock with a mass of 540 g in air is found to have an apparent mass of 342 g when submerged in water. (a) What mass of water is displaced? (b) What is the volume of the rock? (c) What is its average density? Is this consistent with the value for granite? water= 198 g, density=2.73 g/mL, yes

42. Archimedes' principle can be used to calculate the density of a fluid as well as that of a solid. Suppose a chunk of iron with a mass of 390.0 g in air is found to have an apparent mass of 350.5 g when completely submerged in an unknown liquid. (a) What mass of fluid does the iron displace? (b) What is the volume of iron, using its density as given in Table 11.1 (c) Calculate the fluid's density and identify it.
fluid=39.5 g, density Fe=7.8 g/mL, ethyl alcohol = .79 g/mL

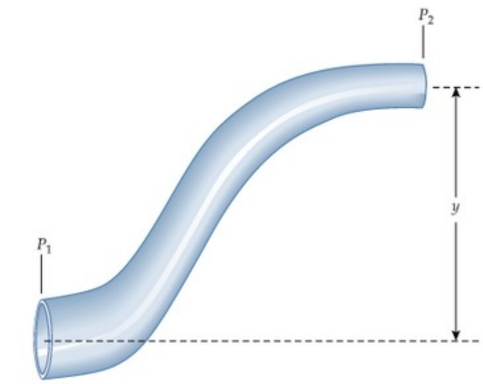
54. What is the pressure inside an alveolus having a radius of 2.5e-4 m if the surface tension of the fluid-lined wall iso the same as for soapy water? You may assume the pressure is the same as that created by a spherical bubble.
γ=.037 N/m, P=592 N/m^2

64. Calculate the contact angle θ for olive oil if capillary action raises it to a height of 7.07 cm in a glass tube with a radius of 0.1 mm. Is this value consistent with that for most organic liquids?
γ=.032 N/m, ρ=.92 g/mL, θ= 5°

iQuizt3.pdf pp 13-20

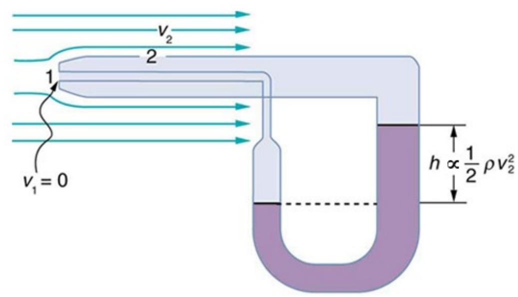
==> d29-18.txt <==
1. What is the average flow rate in cm^3/s of gasoline to the engine of a car traveling at 100 km/h if it averages 10 km/L? 2.78 cm^3/s
How fast is the gasoline moving if the supply tube has a diameter of .5 cm? 14.2 cm/s

Water flows through a pipe as shown in the figure. The pressure and velocity at point 1 are respectively 1.9e5 Pa and 1.25 m/s. The radius of the pipe at points 1 and 2 are respectively 3.3 cm and 1.2 cm. If the vertical distance between points 1 and 2 is 2.75 m, determine the following.
(a) speed of flow at point 2 (9.45 m/s)
(b) pressure at point 2 (1.19e5 Pa)
(c) volume flow rate of the fluid through the pipe (4.3 L/s)



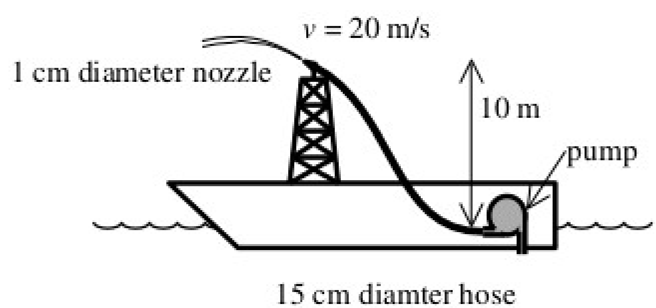
23. (a) What is the pressure drop due to the Bernoulli effect as water goes into a 3 cm diameter nozzle from a 9 cm diameter fire hose while carrying a flow of 40 L/s? 1.58e6 Pa

24. (a) Using Bernoulli's equation, find the equation for fluid speed v for a pitot tube, like the one in Figure h is the height of the manometer fluid, ρ' is the density of the manometer fluid, ρ is the density of the moving fluid, and g is the acceleration due to gravity. (Note that v is indeed proportional to the square root of h , as stated in the text.) (b) Calculate v for moving air if a mercury manometer's h is 0.2 m. (144 m/s)
air density=1.29 kg/m^3, Hg density = 13.7e3 kg/m^3



PHYS 105 Spring 2018 Quiz 9

On a Lake Superior fire-fighting boat, a pump below decks provides the pressure to squirt water from the nozzle 10 m vertically above the pump. A 15 cm diameter hose connects the pump to the nozzle which has an end diameter of 1 cm. The velocity of the water as it leaves the nozzle is 20 m/s. The density of lake water is 1000 kg/m^3. (A) How much water must the pump suck from the lake (in m^3/s)?
(B) What pressure does the pump produce, given atmospheric pressure is 100 kPa?



==> d30-18.txt <==
29. (a) Calculate the retarding force due to the viscosity of the
air layer between a cart and a level air track given the
following information: air temperature is 20 C (so η=.0181e-3 Pa·s),
the cart is moving at 0.4 m/s, its surface area is 2.5e-2 m^2,
and the thickness of the air layer is 6.e-5 m
F=3.02e-3 N

31. A glucose solution being administered with an IV has a
flow rate of 4 mL/min . What will the new flow rate be if
the glucose is replaced by whole blood having the same
density but a viscosity 2.5 times that of the glucose? All
other factors remain constant. ratios: 4/2.5=1.6 mL/min

47. An oil gusher shoots crude oil 25 m into the air through
a pipe with a 0.1 m diameter. Neglecting air resistance but
not the resistance of the pipe, and assuming laminar flow,
calculate the gauge pressure at the entrance of the 50 m
long vertical pipe. Take the density of the oil to be
900 kg/m^3 and its viscosity to be 1 N s/m^2
Note that you must take into account the
pressure due to the 50 m column of oil in the pipe.

estimate exit speed: sqrt(2 g h)=22.14 m/s
(Note: for Poiseuille flow the max speed is 2x average)
Reynolds # = .1*900*22.1/1=1989 (nearly turbulent)
  P=v 8 L/r^2=3.5e6 Pa
  P= gh+ P =3.98e6 Pa

64. Oxygen reaches the veinless cornea of the eye by
diffusing through its tear layer, which is 0.5 mm thick. How
long does it take the average oxygen molecule to do this?
t=x^2/(2 D), D=1e-9 m^2/s; 125 s

osmotic pressure = i M R T

==> d31-18.txt <==
6. One of the hottest temperatures ever recorded on the
surface of Earth was 134 F in Death Valley, CA. What is this
temperature in Celsius degrees? What is this temperature in
Kelvin? 57 C, 330 K

17. (a) If a 500 mL glass beaker is filled to the brim with ethyl
alcohol at a temperature of 5 C, how much will overflow
when its temperature reaches 22 C ? (b) How much less
water would overflow under the same conditions?
α C_2H_5OH=1100e-6 1/K, α H_2O=210e-6 1/K,
9.35 mL,   1.79 mL, neglect   pyrex ~ 5% of water

28. Calculate the number of moles in the 2 L volume of air
in the lungs of the average person. Note that the air is at
37 C (body temperature). 7.86e-2 mol
Since 1982, STP is defined as 273.15 K (0°C) and exactly 10^5 Pa
(i.e., a bit less than 1 atm) STP air ρ=1.2754 kg/m^3

31. An expensive vacuum system can achieve a pressure as
low as 1e-7 N/m^2 at 20 C . How many atoms are
there in a cubic centimeter at this pressure and temperature?
2.47e7 atoms/cm^3

37. (a) What is the gauge pressure in a 25 C car tire
containing 3.6 mol of gas in a 30 L volume? (b) What will
its gauge pressure be if you add 1 L of gas originally at
atmospheric pressure and 25 C ? Assume the temperature
returns to 25 C and the volume remains constant.
1.96e5 Pa, 2.00e5 Pa

Initially you have 5 quarts of room temperature (70 F) air at
15 psi (absolute). You compress the air down to 1 quart, which
raises its temperature to 550 F. What is the gauge pressure?
1 atm=14.7 psi, absolute zero=-460 F
P2=143 (absolute) = 128.3 (gauge) psi

PHYS 105 Spring 2018 Quiz 10

50 g of ice (from the freezer at –20°C), is used to cool 250 g of water (at room
temperature: 22°C) in an insulated container. The final mixture is all liquid. What
is the final temperature? water heat of fusion = 334 J/g,
ice specific heat = 2.09 J/(g·K), water specific heat = 4.186 J/(g·K)

==> d32-18.txt <==
42. The escape velocity of any object from Earth is 11.2 km/s.
(b) At what temperature would oxygen molecules (molecular
mass is equal to 32 g/mol) have an rms velocity equal to
Earth's escape velocity?
T=11.2e3^2*.032/(3*R)=1.61e5 K

Our atmosphere is made up of N2 (28 g/mol), O2 (32 g/mol),
Ar (40 g/mol) for an average of about 29 g/mol. Find the
rms speed at 300 K . sqrt(3 R 300/.029)=508 m/s

63. What is the dew point (the temperature at which 100%
relative humidity would occur) on a day when relative
humidity is 39% at a temperature of 20 C ?
.39*17.2=6.71 -> bit less than 5 C
linear interpolation: 0->4.84, 5->6.8...4.77 C

68. If you want to cook in water at 150 C, you need a pressure
cooker that can withstand the necessary pressure. (a) What
pressure is required for the boiling point of water to be this
high? (b) If the lid of the pressure cooker is a disk 25 cm in
diameter, what force must it be able to withstand at this
pressure? From Table 13.5, vapor pressure =4.76e5 Pa
F=(4.76e5-1.01e5)*pi*.125^2=1.84e4 N

You are driving to the top of Pikes Peak (alt=4302 m)
from Colorado Springs (alt=1839 m) on a hot day (105 F)
with the barometric pressure of 90e3 Pa, and the density of
air 1 kg/m^3. Your tires show a gauge pressure of 30 psi.
What is the gauge pressure of your tires on the mountain
top where the temperature is freezing?
pressure at top=90e3-1*9.8*(4302-1839) assuming constant density
=65862 Pa x0.000145038=9.55 psi ;   90e3x0.000145038=13.1 psi
absolute tire pressure at top= (30+13.1)*(460+32)/(105+460)=37.5
gauge pressure=37.5-9.55=28 psi

==> d33-18.txt <==
c (J/gK) Al=.9, liquid H2O=4.186, solid H2O=2.09
latent heats water (J/g): fusion:334, vapor:2256

13. (a) How much heat transfer is required to raise the
temperature of a 0.750 kg aluminum pot containing 2.5 kg of
water from 30 C to the boiling point and then boil away
0.750 kg of water?
.9*750*70+4.186*2500*70+750*2256=2.47e6 J

24. A 0.050 kg ice cube at -30 C is placed in 0.400 kg
of 35 C water in a very well-insulated container. What is
the final temperature?
2.09*50*30+334*50+50*4.186*(x-0)+400*4.186*(x-35)=0; x=20.6 C

25. If you pour 0.010 kg of 20 C water onto a 1.2 kg
block of ice (which is initially at -15 C), what is the final
temperature? You may assume that the water cools so rapidly
that effects of the surroundings are negligible.
1200*2.09(x+15)+10*4.186(0-20)-10*334+10*2.09*(x-0)=0;
x= -13.2 C

A 250 g block of aluminum is pulled from a container of
liquid nitrogen (T = -196 C) and placed in 400 g of water
which initially had a temperature of 20 C. The final state
consists of everything at 0 C with 15 g of ice formed. Find
the specific heat of the aluminum.
250*c*196+400*4.186*(0-20)-15*334=0; c=.786 J/gK

==> d34-18.txt <==

39. Suppose a person is covered head to foot by wool clothing with average thickness of 2 cm and is transferring energy by conduction through the clothing at the rate of 50 W. What is the temperature difference across the clothing, given the surface area is 1.4 m^2? kwool=.04 J/s m K, T=17.9 C

59. Find the net rate of heat transfer by radiation from a skier standing in the shade, given the following. She is completely clothed in white (head to foot, including a ski mask), the clothes have an emissivity of 0.2 and a surface temperature of 10 C , the surroundings are at -15 C, and her surface area is 1.6 m^2 . P=-36 W, σ=5.67e-8 W/(m^2 K^4)

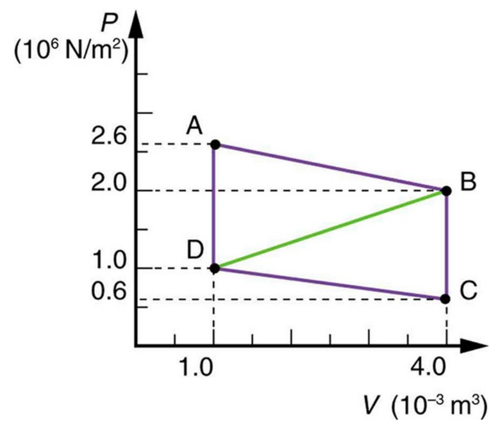
73.Heat transfers from your lungs and breathing passages by evaporating water. (a) Calculate the maximum number of grams of water that can be evaporated when you inhale 1.5 L of 37 C air with an original relative humidity of 40%. (Assume that body temperature is also 37 C .) (b) How many joules of energy are required to evaporate this amount? (c) What is the rate of heat transfer in watts from this method, if you breathe at a normal resting rate of 10 breaths per minute? Lv=2430 J/g, saturated=44 g/m^3 (all at 37 C)
P=16 W

63. A large body of lava from a volcano has stopped flowing and is slowly cooling. The interior of the lava is at 1200 C , ts surface is at 450 C , and the surroundings are at 27 C
a) Calculate the rate at which energy is transferred by radiation from 1 m^2 of surface lava into the surroundings, assuming the emissivity is 1. (b) Suppose heat conduction to the surface occurs at the same rate. What is the thickness of the lava between the 450 C surface and the 1200 C interior, assuming that the lava's conductivity is the same as that of brick? kbrick=.84 J/s m K, P=-15 kW, d=4.2 cm

==> d35-18.txt <==
2. How much heat transfer occurs from a system, if its internal energy decreased by 150 J while it was doing 30 J of work?
-120 J (heat lost)

5. Suppose a woman does 500 J of work and 9500 J of heat transfer occurs into the environment in the process. (a) What is the decrease in her internal energy, assuming no change in temperature or consumption of food? (b) What is her efficiency?
-10,000 J, 5%

14. Calculate the net work output of a heat engine following path ABCDA in the figure below. 4.5 kJ



15. What is the net work output of a heat engine that follows path ABDA in the figure above. 2.4 kJ

54. Find the increase in entropy of 1 kg of liquid nitrogen that starts at its boiling temperature, boils, and warms to 20 C at constant pressure. T=-195.8 C, Lv= 201 J/g, cp=1.04 J/g K
 S=1000*201/(273.15-195.8)= 2599 J/K (for boil)
 1000*1.04*(20+195.8)/(273.15+(20-195.8)/2)= 1212 J/K (book)
 1000*1.04*ln((273.15+20)/(273.15-195.8)) = 1386 J/K (TK)

52. (a) In reaching equilibrium, how much heat transfer occurs from 1 kg of water at 40 C when it is placed in contact with 1 kg of 20 C water in reaching equilibrium? (b) What is the change in entropy due to this heat transfer? (c) How much work is made unavailable, taking the lowest temperature to be 20 C ?
Tf=30 C; Q=1000*4.186*10=41.9 kJ
m c (ln((To+30)/(To+40))+ln((To+30)/(To+20)))=4.56 J/K

==> d36-18.txt <==
28. A certain gasoline engine has an efficiency of 30%.
What would the hot reservoir temperature be for a Carnot
engine having that efficiency, if it operates with a cold
reservoir temperature of 200 C? 676 K

33. A coal-fired electrical power station has an efficiency of
38%. The temperature of the steam leaving the boiler is
550 C . What percentage of the maximum efficiency does
this station obtain? (Assume the temperature of the
environment is 20 C .) 59%

40. In a very mild winter climate, a heat pump has heat
transfer from an environment at 5 C to one at 35 C .
What is the best possible coefficient of performance for these
temperatures? COP=10.3

42. (a) What is the best coefficient of performance for a
refrigerator that cools an environment at -30 C and has
heat transfer to another environment at 45 C ? (b) How
much work in joules must be done for a heat transfer of 4186
kJ from the cold environment? (c) What is the cost of doing
this if the work costs 10.0 cents per 3.6e6 J (a kilowatt-
hour)? (d) How many kJ of heat transfer occurs into the warm
environment?
COP=3.24; W=4186 kJ/COP=1.29e6 J, 3.6cents, 5.48e6 J

47. (a) On a winter day, a certain house loses 5e8 J
of heat to the outside (about 500,000 Btu). What is the total
change in entropy due to this heat transfer alone, assuming
an average indoor temperature of 21 C and an average
outdoor temperature of 5 C ?
5e8(-1/(273+21)+1/(273+5))=9.79e4 J/K

==> d37-18.txt <==
55. A large electrical power station generates 1000 MW of electricity with an efficiency of 35%. (a) Calculate the heat transfer to the power station, Qh, in one day. (b) How much heat transfer Qc occurs to the environment in one day? (c) If heat transfer in the cooling towers is from 35 C water into the local air mass, which increases in temperature from 18 C to 20 C, what is the total increase in entropy due to this heat transfer? (d) How much energy becomes unavailable to do work because of this increase in entropy, assuming an 18 C lowest temperature? (Part of Qc could be utilized to operate heat engines or for simply heating the surroundings, but it rarely is.)
Qh=(1000e6*24*3600)/.35 = 2.47e14 J; Qc=Qh-(1000e6*24*3600)
  S=Qc*(1/(273+19)-1/(273+35))=2.86e10 J/K
W= S*(273+18)=8.31e12 J

old exam #15
A: (4452-2828) kJ = 1624 kJ
B: 10e6*(.06789-.01803)=499 kJ
C: Q = U+W=(4452-2545)kJ+499 kJ=2406 kJ
D: Q=(273+311)*(5.6159-8.2124)=-1514 kJ

59. (a) If tossing 100 coins, how many ways (microstates) are there to get the three most likely macrostates of 49 heads and 51 tails, 50 heads and 50 tails, and 51 heads and 49 tails? (b) What percent of the total possibilities is this? (Consult Table15.4.) 24%

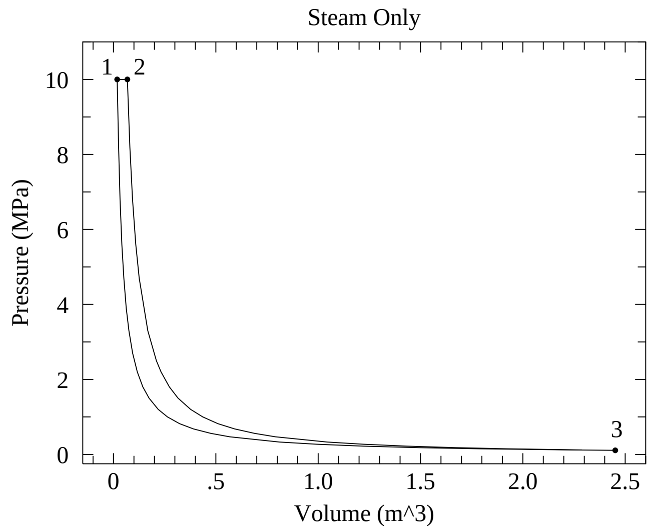
60. (a) What is the change in entropy if you start with 100 coins in the 45 heads and 55 tails macrostate, toss them, and get 51 heads and 49 tails? (b) What if you get 75 heads and 25 tails? (c) How much more likely is 51 heads and 49 tails than 75 heads and 25 tails? (d) Does either outcome violate the second law of thermodynamics?
k ln(9.9e28/6.1e28), k ln(2.4e23/6.1e28), 9.9e28/2.4e23, NO

The following questions are worth 10 pts each

Record your steps! (Grade based on method displayed not just numerical result)

15. The following problem is based on "steam table" data—accurate values of V, T, U, S etc. for the real gas 'steam' rather then the mythical ideal gas. This problem is similar to the power plant cycle discussed in class, except here the steam is kept hot: no condensation and re-boiling.

- Initially, 1 kg of steam is just above its boiling point at a temperature of 311°C and pressure of 10 MPa (point 1).
- The steam is heated to 1200°C (point 2) isobarically.
- The high pressure steam is piped to a turbine where it expands adiabatically until the temperature returns to 311°C (point 3). This is the process that turns the generator.
- The resulting low pressure steam is isothermally compressed to return to its initial state.



point	Volume (m^3)	Pressure (MPa)	Temperature (°C)	U (kJ)	Entropy (kJ/K)
1	0.01803	10.	311	2545	5.6159
2	0.06789	10.	1200	4452	8.2124
3	2.45158	0.11	311	2828	8.2124

A. How much work does the steam <u>do</u> in the turbine?

B. How much work does the steam <u>do</u> in path $1 \rightarrow 2$?

C. How much heat is added to the steam in path $1 \rightarrow 2$?

D. How much heat is removed from the steam in path $3 \rightarrow 1$?

==> d40-18.txt <==
1. Fish are hung on a spring scale to determine their mass
(a) What is the force constant of the spring in such a scale if it the spring stretches 8 cm for a 10 kg load?
(b) What is the mass of a fish that stretches the spring 5.5 cm?
(c) How far apart are the half-kilogram marks on the scale?
k=1.23e3 N/m, 6.88 kg, 4 mm

8. If your heart rate is 150 beats per minute during strenuous exercise, what is the time per beat in units of seconds? 0.4 s

15. A 0.5 kg mass suspended from a spring oscillates with a period of 1.5 s. How much mass must be added to the object to change the period to 2 s? .389 kg

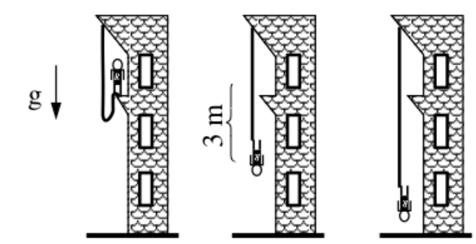
17. Suppose you attach the object with mass m to a vertical spring originally at rest, and let it bounce up and down. You release the object from rest at the spring's original rest length.
(a) Show that the spring exerts an upward force of 2 m g on the object at its lowest point. (b) If the spring has a force constant of 10 N/m and a 0.25 kg mass object is set in motion as described, find the amplitude of the oscillations.
(c) Find the maximum velocity.
A=.245 m; v=1.55 m/s

24. What is the period of a 1 m long pendulum? 2.01 s

34. If a pendulum-driven clock gains 5 s/day, what fractional change in pendulum length must be made for it to keep perfect time? 0.0116%

PHYS 105 Spring 2018 Quiz 12

Rupert (mass = 80 kg) decides to bungie jump out of a tall building. The bungie has a spring constant of 160 N/m and a length such that it will start taking effect after Rupert has fallen 3 m. What is the extension of the bungie cord when Rupert’s fall is temporarily stopped?



==> d41-18.txt <==
35. The length of nylon rope from which a mountain climber is
suspended has a force constant of 1.4e4 N/m .
(a) What is the frequency at which he bounces, given his
mass plus and the mass of his equipment is 90 kg?
(b) How much would this rope stretch to break the climber's
fall if he free-falls 2 m before the rope runs out of slack?
y=-.569 m; f=1.99 Hz

54. Radio waves transmitted through space at 3e8 m/s by the
Voyager spacecraft have a wavelength of 0.12 m.
What is their frequency?   f=2.5e9 Hz

61. A wave traveling on a Slinky that is stretched to 4 m
takes 2.4 s to travel the length of the Slinky and back again.
(a) What is the speed of the wave? (b) Using the same Slinky
stretched to the same length, a standing wave is created
which consists of three antinodes and fournodes. At what
frequency must the Slinky be oscillating?
v=3.33 m/s, f=1.25 Hz

62. Three adjacent keys on a piano (F, F-sharpand G) are
struck simultaneously, producing frequencies of 349, 370, and
392 Hz. What beat frequencies are produced by this
discordant combination?   21,22,43 Hz

A string is strung between two supports 1.5 m apart and then the
tension is adjusted so that the wave speed is 250 m/s. When the
string is vibrating in the standing wave pattern shown below:
(A) What is the wavelength? (B) What is the frequency of the
fundamental? (C) Directly on the below diagram label an anti-node
and show one amplitude.
wavelength=.6 m (f=417 Hz), fundamental=83.3 Hz

==> d42-18.txt <==
41. A piano tuner hears a beat every 2 s when listening to a 264 Hz tuning fork and a single piano string. What are the two possible frequencies of the string? 263.5, 264.5

64. The low frequency speaker of a stereo set has a surface area of 0.05 m^2 and produces 1 W of acoustical power. What is the intensity at the speaker? If the speaker projects sound uniformly in all directions, at what distance from the speaker is the intensity 0.1 W/m^2 ?
20 W/m^2; r=.892 m

I= (p)^2/2   v; I0=1e-12 W/m^2; decibel=10 log10(I/I0)
18. (a) What is the decibel level of a sound that is twice as intense as a 90 dB sound? (b) What is the decibel level of a sound that is one-fifth as intense as a 90 dB sound?
93, 83

19. (a) What is the intensity of a sound that has a level 7 dB lower than a 4.e-9 W/m^2 sound? (b) What is the intensity of a sound that is 3 dB higher than a 4.e-9 W/m^2 sound? 7.9e-10 W/m^2, 7.9e-9 W/m^2

30. (a) What frequency is received by a person watching an oncoming ambulance moving at 110 km/h and emitting a steady 800 Hz sound from its siren? The speed of sound on this day is 345 m/s. (b) What frequency does she receive after the ambulance has passed?
  f/f=9%

37. What is the minimum speed at which a source must travel toward you for you to be able to hear that its frequency is Doppler shifted? That is, what speed produces a shift of 6% (semitone) on a day when the speed of sound is 331 m/s?
20 m/s = 45 mph