Physics 105 Class Schedule – Fall 2009

Important: The reading assignments are given here for the 8th edition of the textbook only (that's the edition I have). If you are using the 5th, 6th, or 7th editions, you need to look at the reading assignment table on the next page because your sections may be different.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
September	31 *Before first class:* Review units, trig.	1 lecture 1 Position & velocity Reading: syllabus; 2.1-2.2	2	3 lecture 2 Acceleration, 1-D motion Reading: 2.3-2.6	4	5 **HW1**
	7 **Labor Day Holiday**	8 **HW2** lecture 3 Vectors Reading: 3.1-3.5 (except for the worked examples in 3.4)	9	10 **HW3** lecture 4 2-D motion/ Exam 1 Review Reading: the rest of 3.4 **Begin Exam 1 (Ch.2-3)**	11	12
	14 Add/drop deadline	15 lecture 5 Newton's Laws of Motion Reading: 4.1-4.4	16 **End Exam 1** (late fee after 1 pm)	17 lecture 6 Using Newton's Laws: ropes, pulleys and planes Reading: 4.5	18	19 **HW4**
	21	22 lecture 7 More Newton; friction Reading: 4.6	23 **HW5**	24 lecture 8 Work & Energy Reading: 5.1-5.3	25	26 **HW6**
October	28	29 **HW7** lecture 9 Energy, cont; Power Reading: 5.4-5.7	30	1 **HW8** lecture 10 Exam 2 Review No reading assignment **Begin Exam 2 (Ch.4-5)**	2	3
	5 Withdraw deadline	6 lecture 11 Momentum Reading: 6.1-6.4 (we're skipping 6.5)	7 **End Exam 2** (late fee after 1 pm)	8 lecture 12 Mom. cont., Circular motion Reading: 7.1-7.4	9	10 **HW9**
	12	13 lecture 13 Circ. motion cont.; Gravity Reading: 7.5-7.6	14 **HW10**	15 lecture 14 Torque and equilibrium Reading: 8.1-8.2, 8.4 (we're skipping 8.3)	16	17 **HW11**
	19	20 lecture 15 Torque and rotations Reading: 8.5-8.6	21 **HW12**	22 lecture 16 Angular momentum Reading: 8.7	23	24 **HW13** Deadline to receive an extra point on extra credits
	26	27 **HW14** lecture 17 Exam 3 Review No reading assignment **Begin Exam 3 (Ch.6-8)**	28	29 lecture 18 Fluids, Pressure, Buoyancy Reading: 9.1, 9.3-9.6 (we're skipping 9.2)	30	31
November	2 **End Exam 3** (late fee after 1 pm)	3 lecture 19 Fluid motion Reading 9.7-9.8 (we're skipping 9.9-9.10)	4 **HW15**	5 lecture 20 Thermal expansion, ideal gas law Reading: 10.1-10.4	6	7 **HW16**
	9	10 lecture 21 Kinetic theory; specific & latent heat Reading: 10.5; 11.1-11.4	11 **HW17**	12 lecture 22 Heat transfer; 1st Law Reading: 11.5 (we're skipping 11.6); 12.1, 12.2, 12.3 up to "Adiabatic processes"	13	14 **HW18**
	16	17 **HW19** lecture 23 More 1st Law, engines Reading: rest of 12.3, 12.4 (we're skipping 12.5-12.6)	18	19 **HW20** lecture 24 Exam 4 Review No reading assignment **Begin Exam 4 (Ch.9-12)**	20	21
	23	24 Discontinuance deadline No class (virtual Friday) **End Exam 4** (late fee after 1 pm)	25 **No classes**	26 **Thanksgiving Holiday**	27 **Thanksgiving, cont.**	28
December	30	1 lecture 25 Vibrations, waves Reading: 13.1-13.9	2	3 lecture 26 Wave properties; sound Reading: 13.10-13.11; 14.1-14.5	4	5 **HW21**
	7	8 lecture 27 Doppler effect, inter-ference, standing waves Reading: 14.6-14.8, 14.10	9 **HW22**	10 lecture 28 Beats, resonance, music Final Exam Review Reading: 14.9, 14.11-14.12 (we're skipping 14.13)	11 **Reading Day**	12 **HW23** **Reading Day** All late FBDs and extra credits due at 11:59 pm
	14 **Begin Final exam (Ch. 2-14)**	15 …	16 …	17 …	18 **End Final** All late computer-graded HW due at 11:59 pm	19

Physics 105 Reading Assignments, detailed version – Fall 2009

Important: Please let me know ASAP if you detect any errors in the correspondences given in this table.

For date/class	8th edition	5th edition	6th edition	7th edition
Sep 1, lecture 1	Syllabus 2.1, 2.2 Displacement; Velocity	Syllabus 2.1-2.3	Syllabus 2.1-2.3	Syllabus 2.1, 2.2
Sep 3, lecture 2	2.3-2.6 Acceleration; Motion Diagrams; 1D motion with constant acceleration; Free falling objects	2.4-2.7	2.4-2.7	2.3-2.6
Sep 8, lecture 3	3.1-3.5 Vectors and their properties; Components of a vector; Displacement, velocity, acceleration in 2D; Motion in 2D; Relative velocity → Note: skip the worked examples in section 3.4	3.1-3.6 → skip the worked examples in 3.5	3.1-3.6 → skip the worked examples in 3.5	3.1-3.5 → skip the worked examples in 3.4
Sep 10, lecture 4	3.4, cont. (the worked examples)	3.5, cont.	3.5, cont.	3.4, cont.
Sep 15, lecture 5	4.1-4.4 Forces; Newton's first law; Newton's second law; Newton's third law	4.1-4.4	4.1-4.4	4.1-4.4
Sep 17, lecture 6	4.5 Applications of Newton's laws	4.5	4.5	4.5
Sep 22, lecture 7	4.6 Forces of friction	4.6	4.6	4.6
Sep 24, lecture 8	5.1-5.3 Work; Kinetic energy and the work-energy theorem; Gravitational potential energy	5.1-5.3	5.1-5.3	5.1-5.3
Sep 29, lecture 9	5.4-5.7 Spring potential energy; Systems and energy conservation; Power; Work done by a varying force	5.4-5.8	5.4-5.8	5.4-5.7
Oct 1, lecture 10	No assignment	n/a	n/a	n/a
Oct 6, lecture 11	6.1-6.4 Momentum and impulse; Conservation of momentum; Collisions; Glancing collisions → We're skipping 6.5	6.1-6.4	6.1-6.4 → skip 6.5	6.1-6.4 → skip 6.5
Oct 8, lecture 12	7.1-7.4 Angular speed and angular acceleration; Rotational motion under constant angular acceleration; Relations between angular and linear quantities; Centripetal acceleration	7.1-7.6, 7.10	7.1-7.7	7.1-7.4
Oct 13, lecture 13	7.5, 7.6 Newtonian gravitation; Kepler's laws	7.7-7.9	7.8-7.10	7.5, 7.6
Oct 15, lecture 14	8.1, 8.2, 8.4 Torque; Torque and the two conditions for equilibrium; Examples of objects in equilibrium → We're skipping 8.3	8.1, 8.2, 8.4 → skip 8.3	8.1, 8.2, 8.4 → skip 8.3	8.1, 8.2, 8.4 → skip 8.3
Oct 20, lecture 15	8.5, 8.6 Relationship between torque and angular acceleration; Rotational kinetic energy	8.5, 8.6	8.5, 8.6	8.5, 8.6
Oct 22, lecture 16	8.7 Angular momentum	8.7	8.7	8.7
Oct 27, lecture 17	No assignment	n/a	n/a	n/a
Oct 29, lecture 18	9.1, 9.3-9.6 States of matter; Density and pressure; Variation of pressure with depth; Pressure measurements; Buoyant forces and Archimedes' Principle → We're skipping 9.2	9.1, 9.3-9.6 → skip 9.2	9.1, 9.3-9.6 → skip 9.2	9.1, 9.3-9.6 →skip 9.2
Nov 3, lecture 19	9.7, 9.8 Fluids in motion; Other applications of fluid dynamics → We're skipping 9.9, 9.10	9.7, 9.8 → skip 9.9, 9.10	9.7, 9.8 → skip 9.9, 9.10	9.7, 9.8 → skip 9.9, 9.10
Nov 5, lecture 20	10.1-10.4 Temperature and the Zeroeth law of thermodynamics; Thermometers and temperature scales; Thermal expansion of solids and liquids; Macroscopic description of an ideal gas	10.1-10.5	10.1-10.5	10.1-10.4
Nov 10, lecture 21	10.5, 11.1-11.4 The kinetic theory of gases; Heat and internal energy; Specific heat; Latent heat and phase change	10.6, 11.1-11.4, 12.1	10.6, 11.1-11.4	10.5, 11.1-11.4
Nov 12, lecture 22	11.5, 12.1-12.3 Energy transfer; Work in thermodynamic processes; The First Law of thermodynamics; Thermal processes → We're skipping 11.6 → Note just read section 12.3 up to and <u>not</u> including "adiabatic processes"	11.5-11.8, 12.2-12.3 → skip 11.9-10 → read section 12.3 only up to Example 12.2	11.5-11.8, 12.1-12.2 → skip 11.9 → read section 12.2 only up to Example 12.3	11.5, 12.1-12.2 → skip 11.6 → read section 12.2 only up to "adiabatic processes"
Nov 17, lecture 23	12.3, cont., (from "adiabatic processes" to the end) 12.4 Heat engines and the 2nd Law of Thermodynamics → We're skipping 12.5 and 12.6	12.3 cont., 12.4-12.6 → skip 12.7, 12.8	12.2 cont., 12.4-6 →skip 12.3,12.7-8	12.2 cont., 12.3 → skip 12.4, 12.5
Nov 19, lecture 24	No assignment	n/a	n/a	n/a
Dec 1, lecture 25	13.1-13.9 Vibrations and Waves chapter, up to and including "The speed of waves on springs" section	13.1-13.11	13.1-13.11	13.1-13.9
Dec 3, lecture 26	13.10, 13.11 Interference of waves; Reflection of waves 14.1-14.5 Sound chapter, up to and including "Spherical and plane waves" section	13.12, 13.13, 14.1-14.5	13.12, 13.13, 14.1-14.5	13.10, 13.11, 14.1-14.5
Dec 8, lecture 27	14.6-14.8, 14.10 The Doppler effect; Interference of sound waves; Standing waves; Standing waves in air columns	14.6-14.8, 14.10	14.6-14.8, 14.10	14.6-14.8, 14.10
Dec 10, lecture 28	14.9, 14.11, 14.12 Forced vibrations and resonance; Beats; Quality of sound → We're skipping 14.13	14.9, 14.11, 14.12 → skip 14.13	14.9, 14.11, 14.12 → skip 14.13	14.9, 14.11, 14.12 → skip 14.13

Physics 105 – Fall 2009 – Sections 1 and 2
Dr John S. Colton

Instructor: Dr. John S. Colton, john_colton @ byu.edu, N335 ESC, 422-3669.

Instructor Office Hours: 3:30-5 pm WF, generally to be held in the Physics Tutorial Lab in N304 ESC. Private meetings are available by appointment.

Textbook: *College Physics*, by Serway & Faughn (5th, 6th, 7th editions) or by Serway & Vuille (8th edition). Only volume 1 is needed for Physics 105; but volume 2 is used in Physics 106, so if you're planning to take that course also, it may be cheaper to get a book with both volumes combined. Feel free to obtain an inexpensive used copy.

Website: http://www.physics.byu.edu/faculty/colton/courses/phy105-fall09. You can navigate there via www.physics.byu.edu → Courses → Class Web Pages → Physics 105 (Colton). The website is your gateway to all things class related: you go there to do warmup exercises, turn in homework, check your current grade. I will also post things such as lecture notes, practice exams, videos of demos, and links to cool websites.

Homework Boxes: You will turn in some homework problems and all extra credit assignments to the closed boxes just outside N357 ESC. They will be returned to the open boxes above.

Homework Solutions: Homework solutions will be posted in the glass cases outside N361 ESC.

Google group: The following Google group is available for you to discuss physics concepts and HW problems with other students: http://groups.google.com/group/physics-105-fall-2009

Blackboard: The course will *not* use Blackboard at all. There is no Blackboard site.

Student Email Addresses: I will often send class information via email to your email address that is listed under Route-Y. If you do not use that address, please set it to forward to the email account you do use.

Course Objectives: In this class you will learn the basics about the physics of motion (kinematics), energy and forces (mechanics), heat (thermodynamics), and sound (acoustics). You will learn and apply mathematical methods, reasoning, and general problem solving skills. Students who successfully complete this course will be able to:

- Solve introductory physics problems involving fundamental physics equations and laws
- Answer qualitative questions involving physics concepts
- Recognize physics principles at work in the world around them

I also hope that as you learn more about the physical laws governing the universe, your appreciation for the order, simplicity and complexity of God's creations will increase. I sincerely believe that one can come to know the Creator better by studying His creations.

Brigham Young:

> Man is organized and brought forth as the king of the earth, to understand, to criticize, examine, improve, manufacture, arrange and organize the crude matter and honor and glorify the work of God's hands. This is a wide field for the operation of man, that reaches into eternity; and it is good for mortals to search out the things of this earth.

Steve Turley (former BYU Physics Department chair):

> My faith and scholarship also find a unity when I look beneath the surface in my discipline to discover the Lord's hand in all things (see D&C 59:21). It is His creations I study in physics. With thoughtful meditation, I have found striking parallels between His ways that I see in the scriptures and His ways that I see in the physical world. In the scriptures I see a God who delights in beauty and symmetry, who is a God of order, who develops things by gradual progression, and who establishes underlying principles that can be

relied on to infer broad generalizations. I see His physical creations following the same pattern. Just as numerous gospel ordinances and practices serve as types of Christ, His creations are full of types we can use to strengthen our faith, teach us valuable spiritual lessons, and bring us to Christ. These types are so strong that Alma invokes them as a proof to Korihor of the existence of God. In Alma 30:44 we read, "even the earth, and all things that are upon the face of it, year, and its motions, yea and also all the planets which move in their regular form do witness that there is a Supreme Creator."

Class Identification Number: Each of you will receive a personal identification number for this course, called a "Class ID" (CID). The purpose of this number is to protect your privacy. Most of you will receive your CID by e-mail before the first day of classes. If you did not receive it by email, you can obtain it over the internet—go to the course website and click on the relevant link.

Clickers: We will use "i-clickers" in class. On the reverse side of your clicker is an alphanumeric ID code for your transmitter. You must go to the course website and register your transmitter ID number. We need this information in order to give you credit for your in-class quizzes. Please also write down your clicker number here: ___________________________ (The numbers frequently wear off during the course of the semester, and if you want to sell back the clicker or use it in another class, you will need to know the identification number.)

Grading: If you hit these grade boundaries, you are guaranteed to get the grade shown. Please note that these boundaries are curved a bit from the standard 90-80-70-60 scale. Expect about half the class to get B's and above, and about half to get B-'s and below.

A	93%	B+	85%	C+	73%	D+	54%
A-	89%	B	81%	C	65%	D	49%
		B-	77%	C-	58%	D-	45%

Grades will be determined by the following weights:

- Reading assignments and pre-class "warm-up" quizzes: 3%
- Class participation and "clicker" quizzes: 3%
- Homework: 30%
- 4 Midterm Exams: 44%
- Final Exam: 20%

Reading Assignments and Pre-class "Warm-up" Quizzes: Reading assignments are shown on the schedule, and should generally be done the day before class. After reading the assignment, go to the course website to complete a short "warm-up" exercise. Your grade will be based solely on your answer to the question, "Did you do the reading assignment?"—2 points if yes, 1 point if no. You get 0 points if you don't bother to visit the website to answer the question. There will be additional (non-graded) questions on the reading assignment, as well as feedback forms. These warm-up exercises will be due at 8:00 am each class day, to give me some time to look them over before the morning class. You will not be allowed to make up a missed warm-up exercise **for any reason**. However, to allow for sickness and other emergencies you will be allowed four free warm-ups: I will convert your four warm-up exercises with the most missed points into perfect scores.

Class Participation and "Clicker" Quizzes: Clicker-based quiz questions will be given throughout each lecture to encourage student involvement. I will ask you conceptual questions, have you work problems, have you guess what will happen in a demonstration, etc. So that you are not penalized for not yet knowing the correct answers, these "clicker questions" will be graded on participation only. That is, if you transmit any answer, you get full credit. You will not be allowed to make up a missed clicker quiz **for any reason**

(tardy, excused absence, unexcused absence, registered late, forgot or lost clicker, etc.). However, so that you are not penalized unduly for missing class when circumstances necessitate, you will get four free clicker quizzes: I will convert your four clicker quizzes with the most missed points into perfect scores.

Midterm Exams: Four midterm exams will be given in the Testing Center in the Grant Building and will be available for the days indicated on the schedule. Exams will include worked problems similar to homework problems, as well as conceptual questions related to things we discussed in class. The exams will be predominantly computer graded. The first exam will be out of 60 pts; the others will be out of 100 pts. Your exam pages (but not your bubble sheets) will be returned to you sorted by the first two digits of your CID number in the bins outside N357 ESC.

Final Exam: A comprehensive final exam will be given during the Final Exam Week in the Testing Center. You may take it any time during that week.

Homework: Please read this information carefully, as it is your responsibility to know the class policies and how to turn in your homework. All homework is due at 11:59 pm on the day marked on the schedule.

Computer homework overview: We will use a computerized grading system developed by the Physics Department specifically for the introductory classes. This system has both plusses and minuses. The biggest minus is that because you type your answer into the computer rather than turning in the work to be graded, there is no traditional partial credit. This can be frustrating to students. Instead of the traditional way of assigning partial credit, we give partial credit a different way: we let you submit a problem multiple times if you get it wrong. You get two attempts at a problem for full credit; after that, you start losing points. To allow for emergencies or adding the class late, you will get three free late assignments; after that, late work only counts for half credit.

This system offers several major advantages to students:

- Students get instant feedback as to whether they did the problem correctly.
- Each student gets a slightly different—but closely related—problem to work; this makes copying off of other students nearly impossible. (Yes, sadly even at BYU this is a problem.)
- Because the HW problems are not assigned directly from the textbook, students can purchase cheap older editions instead of all being forced to use the same, newest edition.
- By not needing to use as many TAs to *grade* the homework, the Physics Department can employ more TAs in the Tutorial Lab to help you understand how to *do* the homework.

The HW problems: The homework problems for this course are found later in this packet. Problems 1-1 through 1-6 belong to Homework 1, problems 2-1 through 2-7 belong to Homework 2, etc.

Data for the problems: Each of you will do the problems using different numbers ("data"), resulting in different numerical answers from each other. Blanks are left in the problem statements where you can write in your own data. Your data for the entire semester is available via the internet. Once you have a CID, go to the class website, click on "Online Homework", and then click on "Homework Data Sheet." You can get your own data again anytime during the semester if you lose your original data sheet. Assume that the numbers given in the problem and in your data sheet are exact. If you are given 2.2 m/s, it means 2.2000000..., to as many digits as you wish to imagine.

Answer ranges and precision: At the end of the list of homework problems, there is information about the answers. You are given a range of possible values for each answer, along with the units you must use, if any. For example, "400, 800 J" means that your answer will lie between 400 and 800 J. These numbers also indicate the accuracy to which you must calculate the answer. This is simply the number of digits shown—for example, “400, 800 J” means that the answer must be given to the nearest 1 J. As another example: “15.0, 60.0 N” means that the answer must be given to the nearest 0.1 N. In some cases, the accuracy is indicated via a plus/minus sign. For example, “32000, 39000 ±100 km” means the answer must be given to the nearest 100 km. You can always submit a more precise answer with no penalty. Tip: when working a problem, do not round off any numbers until you get your final answer; rounding along the way can sometimes lead to compounded errors that cause the final answer to be outside the specified precision range.

How to submit answers: After working the problems, you must submit your answers over the internet. Go to the class website, click on “Online Homework”, and then click on the assignment number. Fill in the numerical answers as indicated. Do not put units on your answer, but make sure that the number you submit is given in units specified by the answer range. If a very large or very small value needs to be written in scientific notation (as specified by the answer range), indicate the exponent of 10 with an “e.” For example, 3.00×10^8 would be written 3.00e8, and 1.6×10^{-19} would be written 1.6e-19. <u>Do not</u> put any spaces, commas, or “x”s in the number. <u>Do</u> put in negative signs where appropriate.

Grading and viewing correct answers: Your submission will be graded immediately. You can see your grade at any time thereafter by going to the class website, clicking on “Online Homework”, and selecting “Homework Status.” In addition to your score, the computer will show you the correct answers for the problems you missed; that should help you figure out where you went wrong.

Try again: You have 4 tries to get the problem right before the 11:59 pm deadline. After each try, a <u>new set of data</u> will appear at the bottom of the homework status page (because you will have been given the answers for the old set of data). Use this new data for the next try. You only need to resubmit the parts that you missed in the previous try. Retries will also be graded immediately.

Points per problem:. You will receive 5 points for each problem done correctly on the first or second tries, 4 points for the third try, 3 points for the fourth try, and no points thereafter. If a problem has multiple parts to it, you will receive no points unless all parts are answered correctly.

Late credit: Any points generated by tries submitted after the deadline will be marked late. You will receive full credit for late points on the three assignments with the most late points. That is, you get <u>three free late assignments</u>, chosen to maximize your points. You will receive <u>half credit</u> for all other late points. You will get <u>no credit</u> for any HW turned in after the deadline marked on the schedule (last day of finals).

Special case 1: Extra credit HW problems: Some HW problems are labeled “Extra Credit Activity”. These problems will be graded the same as regular problems, except you will not be penalized if you skip them. If you do them, they allow you to increase your score beyond the listed maximum for that assignment.

Special case 2: Multiple-choice questions: Some computer-graded problems will be multiple-choice. Each part of these problems is worth 2 points. They will have drop-down boxes for submitting your answers. You only get <u>one try</u> on those questions.

Special case 3: Free-body diagrams: Some problems require turning in a hardcopy “free-body diagram”, which will be graded by the TA. Turn these in according to your CID to the closed boxes just outside N357 ESC. The points from your FBDs will be added to the computer graded points for the assignment. These diagrams are worth a total of <u>2 points per problem</u>, regardless of the number of diagrams you had to complete for the problem. The late rules for the diagrams are different than for the computer-graded part of the assignment: if the hardcopy is turned in late, you get half credit for that problem (<u>no free late problems</u>

here). No resubmissions are possible if you get the problem wrong. You will get no credit for any FBDs turned in after the deadline marked on the schedule (last reading day).

Getting help: There are multiple ways for you to get help solving homework problems.

Other students. Your first line of defense should be other students in the class. Introduce yourself to people you sit next to. Exchange telephone numbers. Form study groups.

Google group. Visit and post to the Google group: http://groups.google.com/group/physics-105-fall-2009. Ask questions and/or help others understand things you have figured out. You are not graded on a curve, so helping others does not hurt yourself. In fact, explaining things to others helps to cement the concepts in your own mind. I will periodically post hints and answer questions in the group about specific problems.

Tutorial Lab. A physics tutorial lab is provided in N304 and N362 ESC. Teaching assistants will be available roughly 9 am to 9 pm every weekday and for several hours on Saturday. The schedule can be found via a link on our course website. At peak times (usually just before the HW is due) the Tutorial Lab may be understaffed. If you discover times when TAs are in short supply, or if you discover times when the lab is *over*staffed, please let the Tutorial Lab coordinator know. He will try to shuffle around the TAs, or possibly hire new TAs, in order to run an efficient operation. The coordinator is Dr. Richard Vanfleet, and may be contacted via the feedback form, here: http://gardner.byu.edu/tas/feedback_tutorial_lab.html Please also let him know if you have especially good or bad experiences with any specific TAs.

Dr. Colton's Office Hours. By all means come talk to me during my office hours! I will generally hold these in the Tutorial Lab.

Textbook*:* Your textbook has a bunch of worked example problems. Take advantage of it—don't just read the worked problems, but try to work them out yourself before looking at the book's solutions. Then try to understand the general principles involved in how the book approaches a given problem, not just the specific solution for that particular problem.

Private tutors. The Physics Department also keeps a list of physics majors willing to be personal tutors (for a fee). You can use the message board here: http://groups.google.com/group/byu_physics_tutors

Additional resources. One of these may prove helpful to give you more experience in solving homework problems. I'm sure there are many similar things available that I haven't listed here.

- There are a lot of worked problems posted to this website at the University of Oregon: http://zebu.uoregon.edu/~probs/
- *Student Solutions Manual and Study Guide*, by Gordon, Teague, and Serway (this is mentioned in the preface to your textbook)
- *3,000 Solved Problems in Physics (Schaum's Solved Problems),* by Alvin Halpern
- *Schaum's Outline of Beginning Physics I: Mechanics and Heat*, by Alvin Halpern
- *Schaum's Outline of College Physics*, by Frederick Bueche and Eugene Hecht
- *How to Solve Physics Problems*, by Robert Oman and Daniel Oman

Advice from Dr. Colton: I strongly encourage you to work with other students to figure out the problems, although of course the answers you submit must be from your own work. Also, even though you only submit the numerical answers, you should keep your work in some sort of organized homework notebook. Many exam questions will be very similar to homework problems, so you need to be able to review your worked homework problems in order to study for the exams. Practice good problem solving skills: draw pictures of the problems, write equations before plugging in numbers, write neatly, and use plenty of space.

Substitute units with your numbers into your algebra, and check to see that the units work out right on your final answer. Think about whether your final answer makes physical sense before submitting it.

Students will sometimes get good scores on the HW, but poor scores on exams. This is often because they really didn't *master* the HW… perhaps they got someone to help them get correct answers but didn't really understand things on their own. Your goal should not be to memorize how to do the problems, but rather to **master the strategy, concepts and skills**. Exam problems will be similar to homework problems in terms of the concepts and methods used to solve them, but the equations you end up with and the final numerical answers may be very different. If you get help on homework, be sure to learn the concepts and steps used to solve the problem, and think about how they might be different for other situations.

Extra Credit: There will be several ways to earn extra-credit points during the semester.

Homework. As mentioned above, extra-credit homework problems will periodically show up on the homework assignments.

Extra credit papers. Each of the four items below can be turned in once in the semester for extra credit. For added incentive to avoid procrastination (and to make things easier on our grader at the end of the semester), each extra credit assignment you turn in during the first half of the semester will be given one additional point. See the class schedule for the deadline.

1. "Physics of real world" paper. This is a short paper, 1-2 pages maximum, applying physics principles we have discussed in class to something you noticed in the "real world". Equations are welcome, but not necessary. The TA will grade your paper out of 3 points based on the quality of the writing, the accuracy of the physics, and how interesting it was to read; the maximum score is the equivalent of +3 points on one of your midterms. If you have a similar assignment for Physics 107, you may not use the same paper for our class.

2. "Physics of TV/movies" paper. This is a short paper, 1-2 pages maximum. In the spirit of the "Insultingly Stupid Movie Physics" website, http://www.intuitor.com/moviephysics, I'd like you to review a movie or TV show and comment on its physics. What did they get right? What did they get wrong, and what should the proper physics have been? Focus on physics learned in this class. The TA will grade your review out of 4 points based on the quality of the writing, the accuracy of the physics (yours, not the movies), and how interesting it was to read; the maximum score is the equivalent of +4 points on one of your midterms.

3. Book review. This is a book review of a physics-related book that you read during the semester, written in a style similar to book reviews that you find on amazon.com. A list of allowed books is included later in this document; if you want to write a review of a book not on the official list, you must get my permission first. This report also has a 1-2 page maximum. Include this information in your review: (1) title/author of book, (2) a rating out of five stars, (3) some info about what the book contained, and (4) your personal assessment of the quality of the book. The TA will grade your review out of 5 points based on the quality of the writing and helpfulness of the review, the maximum score being the equivalent of +5 points on one of your midterms. You can get an additional +1 point for actually submitting the review to amazon.com (provide proof in the form of a printed out page from their website).

4. Physics-related lecture. You may attend a physics-related lecture; to get extra credit you must turn in a brief report (1 page maximum) of what you learned. Include this information in your report: (1) name of speaker, (2) time/place of lecture, and (3) some info about what kind of physics was discussed, (4)

at least one thing that you learned. This could be one of the weekly Physics Department colloquia (warning: these often—but not always—get very technical), an honors lecture, a university forum, a planetarium show, or any other physics-related science lecture that you can find. If there is any question about whether a given lecture may be appropriate, please email me to ask. The TA will grade your report out of 3 points, the maximum score being the equivalent of +3 points on one of your midterms.

Having your work shared with the class. I will pick some of the best papers and/or warmup question answers to share with the class. I will award an extra credit point or two to the students so selected.

Be a "good neighbor". I plan to award some of the best helpers on the Google group extra credit for their efforts.

Final Thoughts from Dr. Colton: In a recent BYU seminar for new faculty, experts on student learning taught that **most student learning is done *outside* of the classroom**. I expect this class to follow that same trend. For the most part, you learn physics by *doing* physics. This will likely be a very homework-intensive class for you. The BYU Undergraduate Catalog states that "The expectation for undergraduate courses is three hours of work per week per credit hour for the average student who is appropriately prepared; <u>much more time may be required to achieve excellence</u>". To me, for this particular three credit hour class, that means **an average student should spend about six hours per week on homework** outside of class in order to achieve an average grade. I surveyed my class at the end of last year and found that students on average were indeed putting in about 6 hours of work per week outside of class. Some students were putting in much more than that. Unfortunately, spending extra time is still not a guarantee of a great grade. This can lead to student frustration. However, I think that happens in nearly all classes—some students grasp the material more easily than others, some students come into the class more prepared than others, etc. At any rate, I will do everything I can within reason to help you personally succeed in this course.

BYU Policies:

Prevention of Sexual Harassment: BYU's policy against sexual harassment extends to students. If you encounter sexual harassment or gender-based discrimination, please talk to your instructor, or contact the Equal Opportunity Office at 801-422-5895, or contact the Honor Code Office at 801-422-2847.

Students with Disabilities: BYU is committed to providing reasonable accommodation to qualified persons with disabilities. If you have any disability that may adversely affect your success in this course, please contact the University Accessibility Center at 801-422-2767, room 1520 WSC. Services deemed appropriate will be coordinated with the student and your instructor by that office.

Children in the Classroom: The serious study of physics requires uninterrupted concentration and focus in the classroom. Having small children in class is often a distraction that degrades the educational experience for the entire class. Please make other arrangements for child care rather than bringing children to class with you. If there are extenuating circumstances, please talk with your instructor in advance.

Book Review Extra Credit Book List

Important Note: if you want to get credit for reading a book not on this list, <u>you must get prior approval</u> from Dr. Colton first.

A Brief History of Time, by Stephen Hawking
A Briefer History of Time, by Stephen Hawking
A Short History of Nearly Everything, by Bill Bryson
Albert Einstein – A Biography, by Alice Calaprice and Trevor Lipscombe
Beyond Star Trek: Physics from Alien Invasions to the End of Time, by Lawrence Krauss
Einstein: His Life and Universe, by Walter Isaacson
From Clockwork to Crapshoot: A History of Physics, by Roger G. Newton
Front Page Physics, by Arthur Jack Meadows
Genius: The Life and Science of Richard Feynman, by James Gleick
How Math Explains the World: A Guide to the Power of Numbers, from Car Repair to Modern Physics, by James D. Stein
In Search of Schrödinger's Cat: Quantum Physics and Reality, by John Gribbin
Lise Meitner: A Life in Physics, by Ruth Lewin Sime
Measured Tones, by Ian Johnston
Miss Leavitt's Stars: The Untold Story Of The Woman Who Discovered How To Measure The Universe, by George Johnson
Mr. Tompkins in Paperback/ Mr. Tompkins in Wonderland (essentially the same book), by George Gamow
Parallax: The Race to Measure the Cosmos, by Alan Hirshfeld
Physics for Future Presidents: The Science Behind the Headlines, by Richard Muller
Physics of the Impossible: A Scientific Exploration into the World of Phasers, Force Fields, Teleportation, and Time Travel, by Michio Kaku
Quantum: A Guide for the Perplexed, by Jim Al-Khalili
Six Easy Pieces, by Richard P. Feynman
Stephen Hawking: A Biography, by Kristine Larsen
Symmetry and the Beautiful Universe, by Leon M. Lederman and Christopher T. Hill
The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos, by Mario Livio
The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory, by Brian Greene
The Fabric of the Cosmos: Space, Time, and the Texture of Reality, by Brian Greene
The God Particle: If the Universe Is the Answer, What Is the Question? by Leon Lederman
The Making of the Atomic Bomb, by Richard Rhodes
The New Cosmic Onion: Quarks and the Nature of the Universe, by Frank Close
The Physics of Baseball, by Robert K. Adair
The Physics of Basketball, by John Joseph Fontanella
The Physics of NASCAR: How to Make Steel + Gas + Rubber = Speed, by Diandra Leslie-Pelecky
The Physics of Skiing: Skiing at the Triple Point, by David Lind and Scott P. Sanders
The Physics of Star Trek, by Lawrence Krauss
The Physics of Superheroes, by James Kakalios
The Quantum World: Quantum Physics for Everyone, by Kenneth Ford
The Universe and Dr. Einstein, by Lincoln Barnett
The Universe in a Nutshell, by Stephen Hawking
Thirty Years that Shook Physics: The Story of Quantum Theory, by George Gamow
Voodoo Science: The Road from Foolishness to Fraud, by Robert Park
What Einstein Told His Barber: More Scientific Answers to Everyday Questions, by Robert Wolke
What Einstein Told His Cook, by Robert Wolke
What Einstein Told His Cook 2: The Sequel: Further Adventures in Kitchen Science, by Robert Wolke

Free-Body Diagrams

(If this doesn't make sense to you at the beginning of the semester, please return here after we discuss Newton's Second Law problems in class.)

Some homework problems will require turning in hardcopy "free-body diagrams" (FBDs). Follow the instructions below for what to turn in.

A free-body diagram is a useful tool to solve problems involving Newton's Second Law. It is simply a representation of an object that includes all of the forces acting on the object. First, **draw the object by itself**—for example, if the object is sitting on a table, do not draw the table in the diagram. That is why this is called a "free"-body diagram.

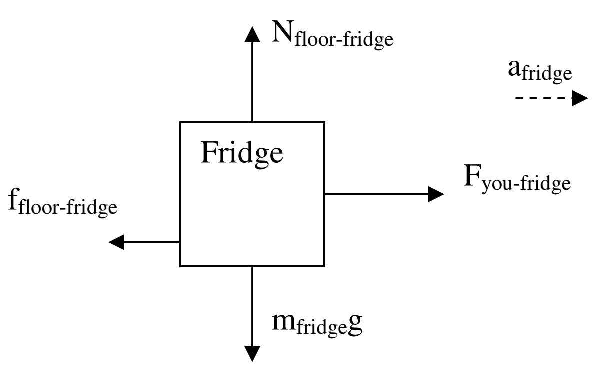
Next, **draw vectors representing the forces** acting on the object. Each vector should be an arrow attached to the object, starting at the point where the force acts and going outward in the direction of the force. Stronger forces should be drawn with longer arrows.

Label each vector with a symbol, using different symbols for different forces. Use mg or w (for *weight*) to label the force of gravity acting on the object. Do not use mg or w for any other force—for example, if the object is sitting on a table, the force of the table acting upward on the object is a normal (pushing) force, not a gravitational force. Even though the normal force may be numerically equal to the weight of the object for that situation, it is still a different force and must *not* be labeled mg or w.

If you need to draw two or more free-body diagrams representing different objects in a single situation, be sure to **use different symbols for different forces**. For example, do not use mg or w for two different objects: use m_1g or w_1 for one and m_2g or w_2 for the other. The only exception to this rule is for forces which are equal because of Newton's Third Law. If two objects are producing Third Law partner forces on each other, then you may use the same symbol for these forces in the two free-body diagrams.

If an object is moving or accelerating, then it is often helpful to draw vectors showing the direction of the velocity and/or acceleration, but **do not attach the velocity and acceleration vectors to the object**. If you do, you run the risk of getting them confused with the force vectors in the free-body diagram.

Example of free-body diagram for you pushing a refrigerator across the floor to the right:



How to Solve Physics Problems

Here's the "Colton method" for solving physics problems. It's not just the way I do problems, though; if you look at the worked problems in the book, you'll find they all follow this same sort of procedure.

Picture – Always draw a picture, often with one or more FBDs. Make sure you understand the situation described in the problem.

Equations – Work forward, not backward. That means look for equations that contain the *given* information, not equations that contain the *desired* information. What major concepts or "blueprint equations" will you use? Write down the general form of the equations that you plan to use. Only after you've written down the main equations should you start filling things in with the specific information given in the problem.

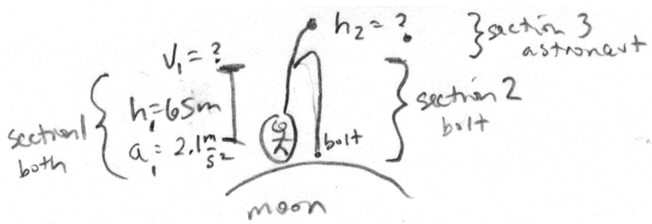
Algebra – Be careful to get the algebra right as you solve the equations for the relevant quantities. Use letters instead of numbers if at all possible. Even though you (often) won't have any numbers at this stage, solving the algebra gives you what I really consider to be the answer to the problem. And write neatly!

Numbers – After you have the answer in symbolic form, plug in numbers to obtain numerical results. Use units with the numbers, and make sure the units cancel out properly. Be careful with your calculator—punch in all calculations *twice* to double-check yourself.

Think– Does your final answer make sense? Does it have the right units? Is it close to what you were expecting? In not, figure out if/where you went wrong.

Example problem: Using a rocket pack, a lunar astronaut accelerates upward from the Moon's surface with a constant acceleration of 2.1 m/s^2. At a height of 65 m, a bolt comes loose. (The free-fall acceleration on the Moon's surface is about 1.67 m/s^2.) (a) How fast is the astronaut moving at that time? (b) How long after the bolt comes loose will it hit the Moon's surface? (c) How high will the astronaut be when the bolt hits?

Colton solution: (notice how I use the five steps given above)



(a) $v_f^2 = v_0^2 + 2a\Delta x$ for astronaut, section 1

$v_1^2 = 0^2 + 2a_1 h_1$

$v_1 = \sqrt{2a_1 h_1} = \sqrt{2(2.1\frac{m}{s^2})(65m)}$

$= \boxed{16.523\ m/s}$

(b) $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$

$0 = h_1 + v_1 t - \frac{1}{2}g_{moon}t^2$

$\frac{1}{2}g_{moon}t^2 - v_1 t - h_1 = 0$

(b) cont

quadratic formula:

$t = \dfrac{+v_1 \pm \sqrt{v_1^2 + 4(\frac{1}{2}g_{moon})(h_1)}}{2(\frac{1}{2}g_{moon})}$

$t = \dfrac{16.523\frac{m}{s} \pm \sqrt{(16.523\frac{m}{s})^2 + 2(1.67\frac{m}{s^2})(65m)}}{1.67\frac{m}{s^2}}$

$= \boxed{23.15\ s}$ (use positive root, a negative time doesn't make sense)

(c) Height of section 3 is given by that time

$y = y_0 + v_{0y}t + \frac{1}{2}a_1 t^2$

$y = 65m + (16.523\frac{m}{s})(23.15s) + \frac{1}{2}(2.1\frac{m}{s^2})(23.15)^2$

$y = \boxed{1010\ m}$

When I first did part (c), I got 0 m. This didn't seem right (using the final step, "think"), so I had to figure out what went wrong. I had used the wrong acceleration.

Physics 105 Homework Problems, Fall 2009

Secs. 1 & 2, John Colton

These problems are adapted from Serway and Faughn, *College Physics*, and are used with permission from Harcourt Brace College Publishers.

1-1. Suppose your hair grows at a rate of [01] ________ inch per day. Find the rate at which it grows in nanometers per second. Since the distance between atoms in a molecule is on the order of 0.1 nm, your answer suggests how rapidly atoms are assembled in this protein synthesis.

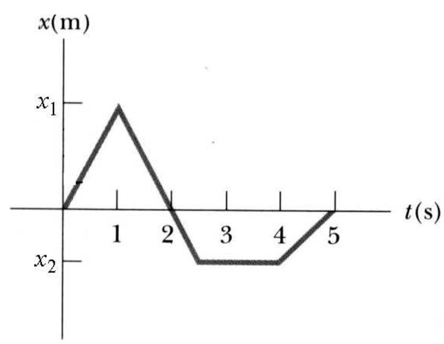
1-2. A certain bacterium swims with a speed of [02] ________ μm/s. How long would it take this bacterium to swim across a petri dish having a diameter of [03] ________ cm?

1-3. A motorist drives north for [04] ________ minutes at 85.8 km/h and then stops for 15.2 minutes. He then continues north, traveling 133 km in 2.00 h. (a) What is his total displacement? (b) What is his average velocity?

1-4. In order to qualify for the finals in a racing event, a race car must achieve an average speed of 250 km/h on a track with a total length of 1600 m. If a particular car covers the first half of the track at an average speed of [05] ________ km/h, what minimum average speed must it have in the second half of the event to qualify? Warning: The average speed is defined to be the total distance traveled divided by the total time elapsed. This is not the same as the average of the two speeds.

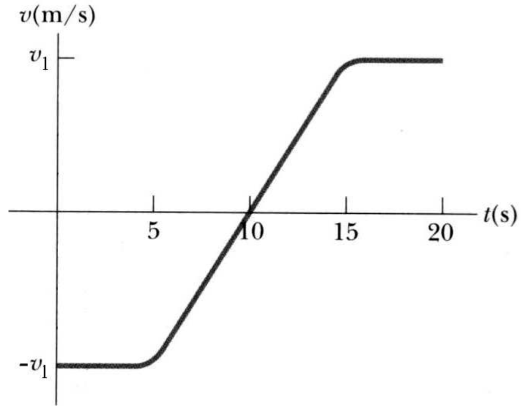
1-5. Two boats start together and race across a 60-km-wide lake and back. Boat A goes across at [06] ________ km/h and returns at the same speed. Boat B goes across at 30 km/h and its crew, realizing how far behind it is getting, returns at 90 km/h. Turnaround times are negligible, and the boat that completes the round trip first wins. (a) Which boat wins and (b) by how much time?

1-6. A tennis player moves in a straight-line path as shown in the figure. On the vertical axis in the figure, x_1 = [07] ________ m and x_2 = [08] ________ m. Find her average velocities in the time intervals (a) 0 to 1.0 s, (b) 0 to 4.0 s, (c) 1.0 s to 5.0 s, and (d) 0 to 5.0 s.



2-1. A certain car is capable of accelerating at a rate of [01] ________ m/s^2. How long does it take for this car to go from a speed of 55 mi/h to a speed of 60 mi/h?

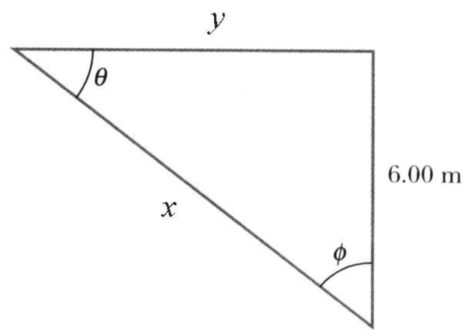
2-2. The velocity-versus-time graph for an object moving along a straight path is shown in the figure. On the vertical axis in the figure, $v_1 =$ [02] ________ m/s. (a) Find the average acceleration of this object during the time intervals (a) 0 to 5.0 s, (b) 5.0 s to 15 s, and (c) 0 to 20 s. Find the instantaneous accelerations at (d) 2 s, (e) 10 s, and (f) 18 s.



2-3. The minimum distance required to stop a car moving at 35.0 mi/h is 42.6 ft. What is the minimum stopping distance for the same car moving at [03] ________ mi/h, assuming the same rate of acceleration?

2-4. A ball is thrown directly downward, with an initial speed of [04] ________ m/s, from a height of 28.3 m. After what interval of time does the ball strike the ground?

2-5. Consider the right triangle shown in the figure. The side labeled x has length [05] ________ m. What are (a) the length of the side labeled y, (b) $\tan\theta$, and (c) $\sin\phi$?



2-6. In a certain right triangle, the two sides that are perpendicular to each other are 4.83 m and [06] ________ m long. What is the length of the third side of the triangle? (b) What is the angle for which 4.83 m is the opposite side?

2-7. Extra credit activity: Average Braking Acceleration. Drive your car at 30 mi/hr. Stop suddenly. Be sure there isn't another car following behind you when you do this. Have your passenger use a stop watch or the second hand on a wrist watch to measure how long it takes for you to stop. Record the result Δt as the answer to part (a) of this problem. Calculate the average braking acceleration $\bar{a}$ in SI units (m/s^2) and record the result (to the nearest 0.1 m/s^2) as the answer to part (b) of this problem. Also calculate the average braking acceleration in terms of g ($g = 9.80$ m/s^2) and record the result (to the nearest $0.01g$) as the answer to part (c) of this problem. Note: Enter all of your answers as positive values.

3-1. The pilot of an airplane notes that the compass indicates a heading due west (his direction relative to the air). The airplane's speed relative to the air is 154 km/h. If there is a wind of [01] ________ km/h toward the north, find (a) the magnitude and (b) the direction of the velocity of the airplane relative to the ground.

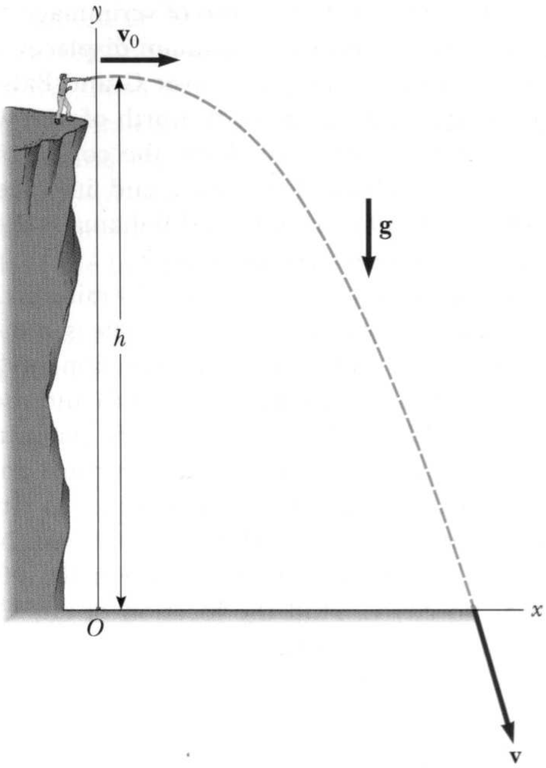
3-2. The pilot of an aircraft wishes to fly due west in a [02] ________-km/h wind blowing toward the south. If the speed of the aircraft relative to the air is [03] ________ km/h, (a) in what direction should the aircraft head, and (b) what will be its speed relative to the ground?

3-3. How long does it take an automobile traveling in the left lane at [04] ________ km/h to overtake (become even with) another car that is traveling in the right lane at [05] ________ km/h, when the cars' front bumpers are initially [06] ________ m apart?

3-4. One of the fastest recorded pitches in major-league baseball, thrown by Nolan Ryan in 1974, was clocked at 100.8 mi/h. If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically by the time it reached [07] ________ ft away? (Do not put any sign on the answer.)

3-5. An artillery shell is fired with an initial velocity of 328 m/s at [08] ________° above the horizontal. To clear an avalanche, it explodes on a mountainside 42.1 s after firing. What are the (a) x and (b) y coordinates of the shell where it explodes, relative to its firing point?

3-6. A student stands at the edge of a cliff and throws a stone horizontally over the edge with a speed of $v_0 = 18.6$ m/s. The cliff is $h =$ [09] __________ m above a flat, horizontal beach, as shown in the figure. (a) How long after being released does the stone strike the beach below the cliff? (b) With what speed of impact does it land? (c) With what angle below the horizontal does it land?



3-7. Extra credit activity: Reaction time. Ask a friend to hold the top end of a ruler so that it hangs in a vertical position (see figure). A ruler that measures centimeters would be most convenient. If not available, you will need to convert inches to meters. Hold your thumb and index finger about 1 cm apart on the two sides of the ruler near the bottom end. Ask your friend to release the ruler without warning, and you try to catch it by pressing your thumb and finger together. Measure the distance the ruler drops between the time your friend releases it and the time you catch it. (Subtract the initial position of your finger from the final position of your finger on the ruler.) Record the result Δy (in meters) as the answer to part (a) of this problem. (Enter a positive value, not a negative value.) Knowing Δy and the acceleration g of free-fall, you can calculate the time the ruler spent falling. This is your reaction time. Record the result (to the nearest 0.01 s) as the answer to part (b) of this problem.

4-1. A [01] __________-kg object undergoes an acceleration of [02] __________ m/s^2. (a) What is the magnitude of the resultant force acting on it? (b) If this same force is applied to a [03] __________-kg object, what acceleration is produced?

4-2. The parachute on a race car of weight [04] __________ N opens at the end of a quarter-mile run when the car is traveling at 35 m/s. What total retarding force must be supplied by the parachute to stop the car in a distance of 1000 m?

4-3. A bag of sugar weighs [05] __________ lb on Earth. (a) What should it weigh in newtons on the Moon, where the free-fall acceleration is $\frac{1}{6}$ that on Earth? (b) Repeat for Jupiter, where g is 2.64 times that on Earth. Find the mass of the bag of sugar in kilograms on (c) Earth, (d) the Moon, and (e) Jupiter.

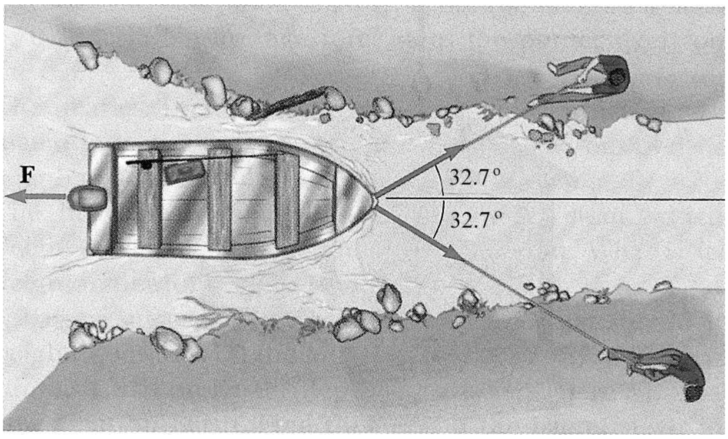
4-4. A performer in a circus is fired from a cannon as a "human cannonball" and leaves the cannon with a speed of [06] __________ m/s. The performer's mass is 82.6 kg. The cannon barrel is 9.29 m long. Find the average net force exerted on the performer while he is being accelerated inside the cannon.

4-5. A boat moves through the water with two forces acting on it. One is a 2270-N forward push by the water on the propeller, and the other is an [07] __________-N resistive force due to the water around the bow. (a) What is the acceleration of the 982-kg boat? (b) If it starts from rest, how far will it move in 10.0 s? (c) What will its velocity be at the end of this time?

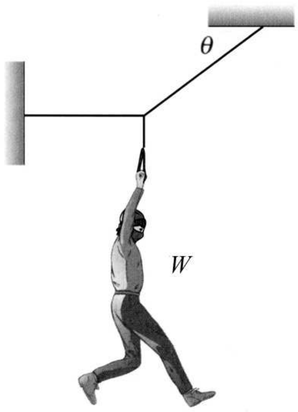
4-6. A freight train has a mass of [08] _______________ kg. If the locomotive can exert a constant pull of 7.54×10^5 N, how long does it take to increase the speed of the train from rest to [09] __________ km/h?

5-1. A [01] __________-kg bucket of water is raised from a well by a rope. The upward acceleration of the bucket is 3.37 m/s^2. (a) Draw a free-body diagram of the bucket. Be sure to indicate the direction of the acceleration. (b) Find the force exerted by the rope on the bucket. (Turn in part (a) on the sheet provided in your packet.)

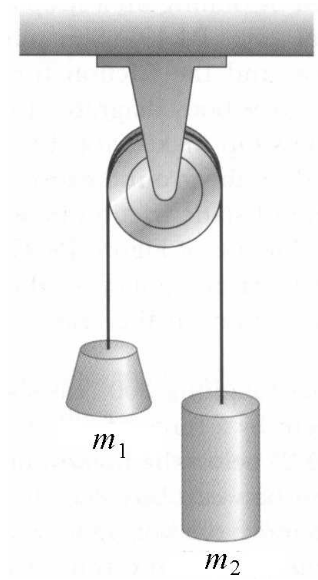
5-2. Two people are pulling a boat through the water as in the figure. Each exerts a force of [02] ________ N directed at a 32.7° angle relative to the forward motion of the boat. (a) Draw a free-body diagram of the boat. (b) If the boat moves with constant velocity, find the resistive force **F** exerted by the water on the boat. (Turn in part (a) on the sheet provided in your packet.)



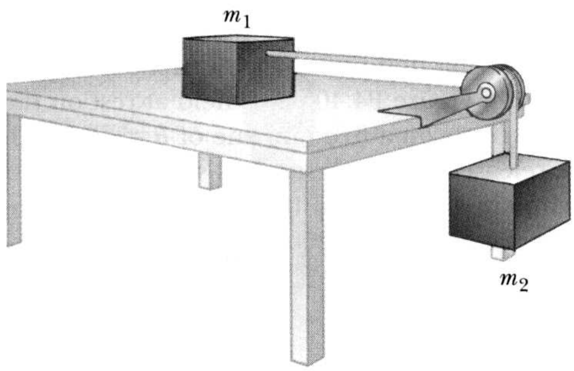
5-3. Two cables support a cat burglar. In the figure, $W =$ [03] ________ N, and $\theta =$ [04] ________°. (a) Draw a free-body diagram of the point where the three cables meet. Find (b) the tension in the cable connected to the ceiling and (c) the tension in the cable connected to the wall on the left. Neglect the mass of the cables. (Turn in part (a) on the sheet provided in your packet.)



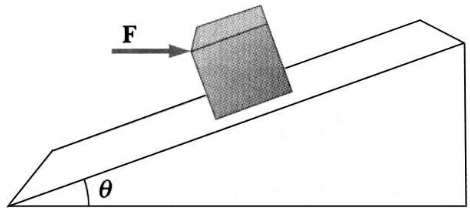
5-4. Two objects with masses $m_1 = 3.24$ kg and $m_2 =$ [05] ________ kg are connected by a light string that passes over a frictionless pulley as in the figure. (a) Draw a free-body diagram of the object with mass m_1. (b) Draw a free-body diagram of the object with mass m_2. Determine (c) the acceleration of each object, (d) the tension in the string, and (e) the distance each object will move in the first second of motion if both objects start from rest. (Turn in parts (a) and (b) on the sheet provided in your packet.)



5-5. A mass, $m_1 =$ [06] ________ kg, resting on a frictionless horizontal table is connected to a cable that passes over a pulley and then is fastened to a hanging mass, $m_2 =$ [07] ________ kg, as in the figure. When we release the mass m_1, it accelerates across the table. (a) Draw a free-body diagram of the mass on the table, and (b) draw a free-body diagram of the hanging mass. Find (c) the acceleration of the masses and (d) the tension in the cable. Neglect the mass of the cable and pulley. (Turn in parts (a) and (b) on the sheet provided in your packet.)



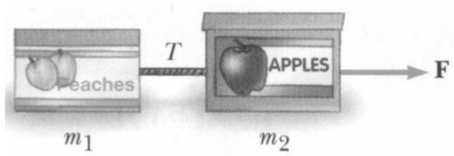
5-6. A block of mass $m =$ [08] __________ kg is held in equilibrium on a frictionless incline of angle $\theta =$ [09] __________$^\circ$ by the horizontal force **F**, as shown in the figure. (a) Draw a free-body diagram of the block. (b) Determine the value of F. (c) Determine the normal force exerted by the incline on the block. (Turn in part (a) on the sheet provided in your packet.)



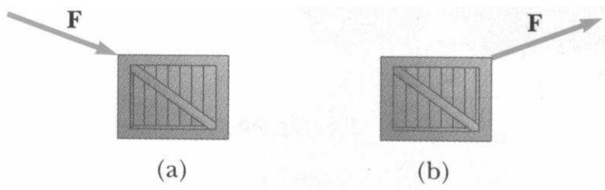
6-1. A dockworker loading crates on a ship finds that a [01] __________-kg crate, initially at rest on a horizontal surface, requires a 75-N horizontal force to set it in motion. However, after the crate is in motion, a horizontal force of 60 N is required to keep it moving with a constant speed. Find the coefficients of (a) static and (b) kinetic friction between crate and floor.

6-2. A hockey puck is hit on a frozen lake and starts moving with a speed of 12.7 m/s. 5.00 s later, its speed is [02] __________ m/s. (a) What is its average acceleration while it is moving? (b) What is the average value of the coefficient of kinetic friction between the puck and ice? (c) How far does the puck travel during this 5.00-s interval?

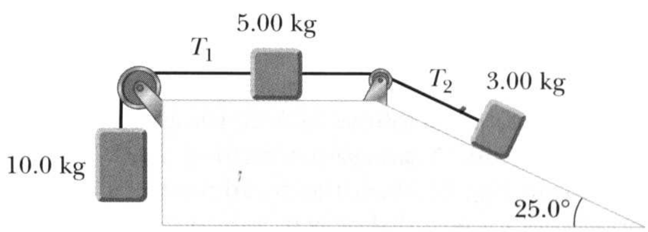
6-3. Two boxes of fruit on a frictionless horizontal surface are connected by a light string as in the figure, where $m_1 =$ [03] __________ kg and $m_2 = 25.4$ kg. A force of 52.1 N is applied to the 25.4-kg box. (a) Draw a free-body diagram of the box on the right. (b) Draw a free-body diagram of the box on the left. Determine (c) the acceleration of each box and (d) the tension in the string. Suppose now that the surface is not frictionless, the coefficient of kinetic friction between each box and the surface being 0.10. Add this force of friction to the free-body diagrams you drew in parts (a) and (b). Determine (e) the acceleration of each box and (f) the tension in the string. (Turn in parts (a) and (b) on the sheet provided in your packet.)



6-4. A [04] __________-N crate is being pushed across a level floor at a constant speed by a force **F** of 312 N at an angle of 23.7° below the horizontal as shown in Figure (a). (a) Draw a free-body diagram of the crate in Figure (a). (b) What is the coefficient of kinetic friction between the crate and the floor? Suppose next that the 312-N force is instead pulling the block at an angle of 23.7° above the horizontal as shown in Figure (b). (c) Draw a free-body diagram of the crate in Figure (b). (d) What will be the acceleration of the crate? Assume that the coefficient of friction is the same as found in (b). (Turn in parts (a) and (c) on the sheet provided in your packet.)



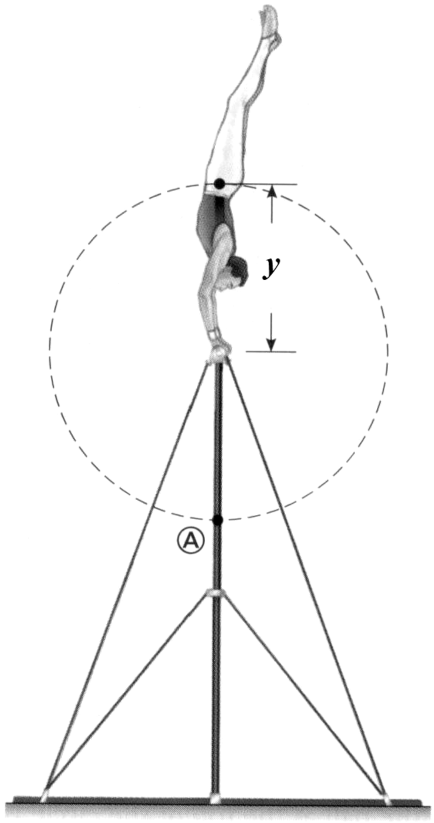
6-5. The three blocks of masses 10.0 kg, 5.0 kg, and 3.0 kg are connected by light strings that pass over frictionless pulleys as shown in the figure. The acceleration of the 5.00-kg block is [05] __________ m/s^2 to the left and the surfaces are rough. (a) Draw a free-body diagram of the 10.0 kg block. (b) Draw a free-body diagram of the 5.0 kg block. (c) Draw a free-body diagram of the 3.0 kg block. Find (d) the tension T_1 and (e) the tension T_2 in the two strings, and (f) the coefficient of kinetic friction between blocks and surfaces. (Assume the same μ_k for both blocks in contact with surfaces.) (Turn in parts (a), (b), and (c) on the sheet provided in your packet.)



7-1. A 6.93-kg bowling ball moves at [01] __________ m/s. How fast must a [02] __________-g Ping-Pong ball move so that the two balls have the same kinetic energy?

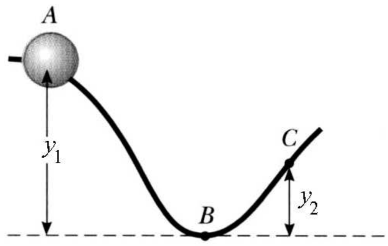
7-2. An outfielder throws a 0.150-kg baseball at a speed of [03] __________ m/s and an initial angle of 32.8°. What is the kinetic energy of the ball at the highest point of its motion?

7-3. A gymnast swings on the high bar as shown in the figure. Starting from rest directly over the bar, he swings around the bar while keeping his arms and legs outstretched. Treating the gymnast as though his entire mass were concentrated at a point $y =$ [04] ________ m from the bar, determine his speed as he passes under the bar at position A.



7-4. On a frozen pond, a 8.54-kg sled is given a kick that imparts to it an initial speed of $v_0 =$ [05] ________ m/s. The coefficient of kinetic friction between sled and ice is $\mu_k =$ [06] ________. Use the work-kinetic energy theorem to find the distance the sled moves before coming to rest.

7-5. A 378-g bead slides on a curved wire, starting from rest at point A in the figure. In the figure, $y_1 =$ [07] ________ m and $y_2 =$ [08] ________ m. If the wire is frictionless, find the speed of the bead (a) at B and (b) at C.

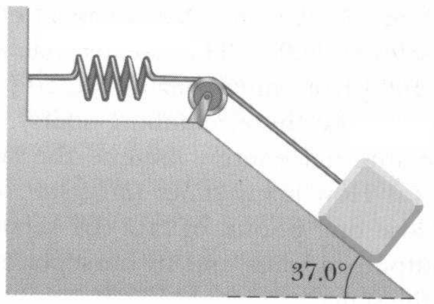


7-6. Tarzan swings on a 28.6-m long vine initially inclined at an angle of [09] ________° with the vertical. What is his speed at the bottom of the swing (a) if he starts from rest? (b) if he pushes off with a speed of 4.28 m/s?

8-1. A 0.254-kg block is placed on a light vertical spring ($k =$ [01] ________ N/m) and pushed downward, compressing the spring 0.126 m. After the block is released, it leaves the spring and continues to travel upward. What height above the point of release will the block reach if air resistance is negligible?

8-2. In the dangerous “sport” of bungee jumping, a daring student jumps from a balloon with a specially designed elastic cord attached to his waist The unstretched length of the cord is 25.3 m, the student weights [02] __________ N, and the balloon is 36.5 m above the surface of a river below. Calculate the required force constant of the cord if the student is to stop safely 4.00 m above the river.

8-3. A [03] __________-kg block situated on a rough incline is connected to a spring of negligible mass having a spring constant of 119 N/m (see figure). The block is released from rest when the spring is unstretched, and the pulley is frictionless. The block moves 22.3 cm down the incline before coming to rest. Find the coefficient of kinetic friction between the block and incline.



8-4. While running, a person dissipates about 0.65 J of mechanical energy per step per kilogram of body mass. If a [04] __________-kg person develops a power of 78 W during a race, how fast is the person running? Assume a running step 1.5 m long.

8-5. A skier of mass 74.9 kg is pulled up a slope by a motor-driven cable. (a) How much work is required to pull him 63.2 m up a [05] __________°-slope (assumed frictionless) at a constant speed of [06] __________ m/s? (b) How many horsepower must a motor have to perform this task?

8-6. A [07] __________-kg elevator starts from rest. It moves upward for 3.00 s with constant acceleration until it reaches its cruising speed, 1.66 m/s. (a) What is the average power of the elevator motor during this interval? (b) Compute its power during an upward cruise with constant speed (equal to its cruising speed).

9-1. A pitcher claims he can throw a 0.145-kg baseball with as much momentum as a [01] __________-g bullet moving with a speed of 1500 m/s. (a) What must the baseball’s speed be if the pitcher’s claim is valid? (b) Which has greater kinetic energy, the ball or the bullet?

9-2. High-speed stroboscopic photographs show that the head of a 232-g golf club is traveling at 54.9 m/s just before it strikes a [02] __________-g golf ball at rest on a tee. After the collision, the club head travels (in the same direction) at [03] __________ m/s. Find the speed of the golf ball just after impact.

9-3. A [04] __________-N man stands in the middle of a frozen pond of radius 5.41 m. He is unable to get to the other side because of lack of friction between his shoes and the ice. To overcome this difficulty, he throws his 1.29-kg physics textbook horizontally towards the north shore, at a speed of 5.12 m/s. How long does it take him to reach the south shore?

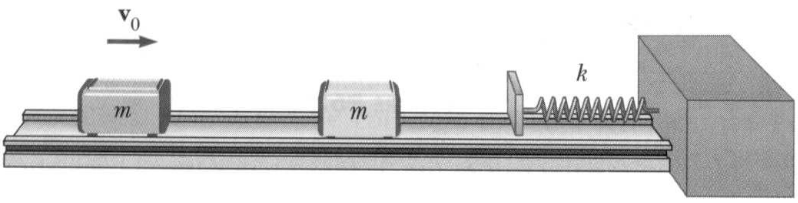
9-4. A railroad car of mass [05] __________ kg moving at [06] __________ m/s collides and couples with two coupled railroad cars, each of the same mass as the single car and moving in the same direction at 1.24 m/s. (a) What is the speed of the three coupled cars after the collision? (b) How much kinetic energy is lost in the collision?

9-5. Most of us know intuitively that in a head-on collision between a large dump truck and a subcompact car, you are better off being in the truck than the car. Why is this? Many people imagine that the collision force exerted on the car is much greater than that experienced by the truck. To substantiate this view, they point out that the car is crushed, whereas the truck is only dented. This idea of unequal forces, of course, is false. Newton's third law tells us that both objects experience forces of the same magnitude. The truck suffers less damage because it is made of stronger metal. But what about the two drivers? Do they experience the same forces? To answer this question, suppose that each vehicle is moving at [07] __________ m/s and that they undergo a perfectly inelastic head-on collision. Each driver has mass 82.6 kg. Including the drivers, the total vehicle masses are 810 kg for the car and 4280 kg for the truck. If the collision time is 0.129 s, (a) what force does the seat belt exert on the truck driver? (b) What force does the seat belt exert on the car driver?

9-6. An 8.29-kg mass moving east at [08] __________ m/s on a frictionless horizontal surface collides with a 18.5-kg mass that is initially at rest. After the collision, the first mass moves south at [09] __________ m/s. What is (a) the magnitude and (b) the direction of the velocity of the second mass after the collision? (c) What percentage of the initial kinetic energy is lost in the collision? Note that the first mass changes the direction of its motion. Use the approach as in the example, "Collision at an Intersection", in the textbook (Example 6.8 in the 7th and 8th editions, Example 6.9 in the 6th edition, and Example 6.10 in the 5th edition).

9-7. A 11.4-g object moving to the right at [10] ________ cm/s makes an elastic head-on collision with a 14.3-g object moving in the opposite direction with some unknown velocity. After the collision, the second object is observed to be moving to the right at [11] ________ cm/s. Find the initial velocity of the second object. Be sure to include a minus sign if it is moving to the left. (*Hint:* Use Eqs. [6.10] and [6.14] in the textbook, similar to Example 6.7. (Eqs. [6.7] and [6.11] in the 5th edition of the textbook))

10-1. Two carts of equal mass $m = 0.253$ kg are placed on a frictionless track that has a light spring force constant $k = 54.7$ N/m attached to one end of it, as in the figure. The cart on the left is given an initial velocity of $v_0 =$ [01] ________ m/s to the right, and the cart on the right is initially at rest. If the carts collide elastically, find (a) the velocity of the cart on the right just after the first collision and (b) the maximum compression of the spring.



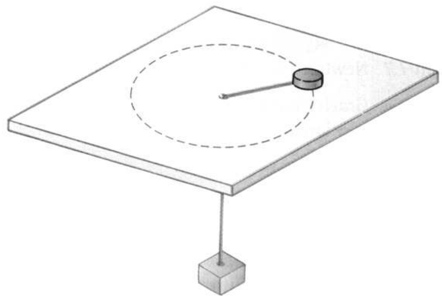
10-2. A dentist's drill starts from rest. After 3.23 s of constant angular acceleration, it turns at a rate of [02] ________ rev/min. (a) Find the drill's angular acceleration. (b) Determine the angle (in radians) through which the drill rotates during this period.

10-3. An electric motor rotating a workshop grinding wheel at a rate of 128 rev/min is switched off. Assume constant negative angular acceleration of magnitude [03] ________ rad/s^2. (a) How long does it take for the grinding wheel to stop? (b) Through how many radians has the wheel turned during the interval found in (a)?

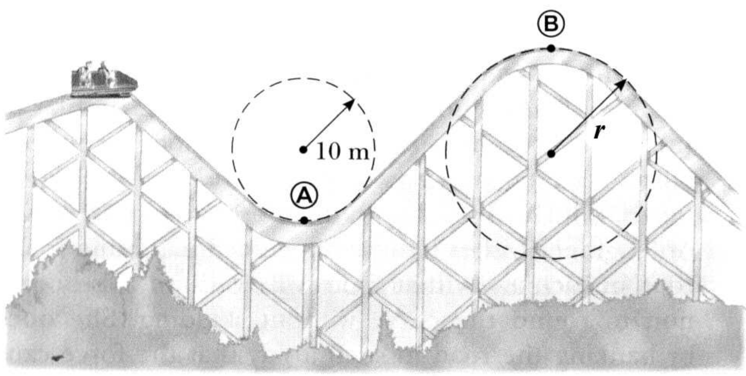
10-4. A race car starts from rest on a circular track of radius 400 m. The car's speed increases at the constant rate of [04] ________ m/s^2. At the point where the magnitudes of the centripetal and tangential accelerations are equal, determine (a) the speed of the race car, (b) the elapsed time, and (c) the distance traveled.

10-5. An engineer wishes to design a curved exit ramp for a toll road in such a way that a car will not have to rely on friction to round the curve without skidding. She does so by banking the road in such a way that the force causing the centripetal acceleration will be supplied by the component of the normal force toward the center of the circular path. (a) Draw a free-body diagram of the car. (b) Find the angle at which the curve should be banked if a typical car rounds it at a 50.0-m radius and a speed of [05] ________ m/s. Hint: Do not use "tilted" coordinate axes. (Turn in part (a) on the sheet provided in your packet.)

10-6. An air puck of mass 255 g is tied to a string and allowed to revolve in a circle of radius 1.04 m on a frictionless horizontal table. The other end of the string passes through a hole in the center of the table, and a mass of [06] ________ g is tied to it. The suspended mass remains in equilibrium while the puck on the tabletop revolves. (a) What is the tension in the string? (b) What is the force causing the centripetal acceleration of the puck? (c) What is the speed of the puck?



10-7. A roller-coaster vehicle has a mass of 500 kg when fully loaded with passengers (see figure). (a) Draw a free-body diagram of the vehicle at A. (b) If the vehicle has a speed of [07] ________ m/s at A, what is the magnitude of the force that the track exerts on the vehicle at this point? (c) Draw a free-body diagram of the vehicle at B. (d) If the radius of curvature of the track at B is $r =$ [08] ________, what is the maximum speed the vehicle can have at B in order for gravity to hold it on the track? (Turn in parts (a) and (c) on the sheet provided in your packet.)

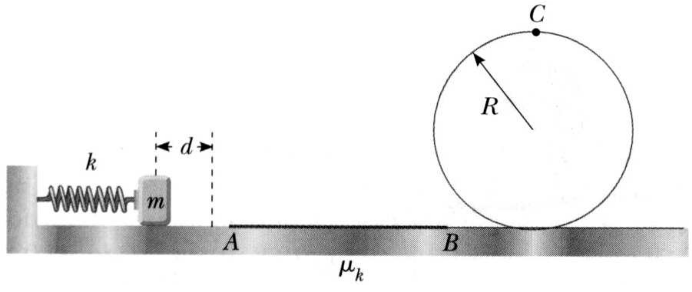


11-1. Use the data in the textbook to find the net gravitational force exerted by Earth and the Moon on a spaceship with mass [01] ________ kg located halfway between them. Use 384,000 km for the distance from Earth to the Moon (center to center).

11-2. Geosynchronous satellites have a angular velocity that matches the rotation of the Earth and follow circular orbits in the equatorial plane of the Earth. (Almost all communications satellites are geosynchronous and appear to be stationary above a point on the Equator.) Consider a satellite in geosynchronous orbit about a planet similar to the Earth except that its mass is [02] ________________ kg and the period of the rotation about its axis is [03] ________ h. What must be the radius of the orbit of this satellite?

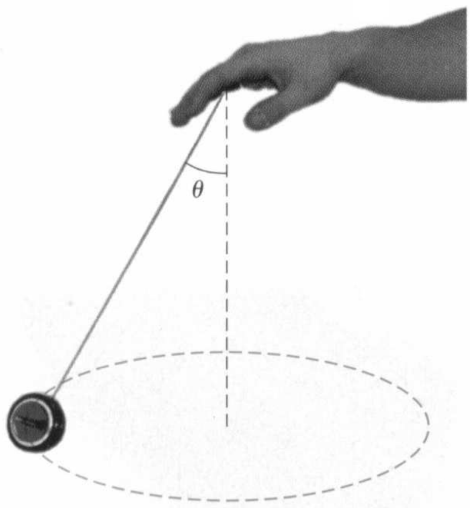
11-3. Neutron stars are extremely dense objects that are formed from the remnants of supernova explosions. Many rotate very rapidly. Suppose that the mass of a certain spherical neutron star is twice the mass of the Sun and its radius is [04] ________ km. Determine the greatest possible angular speed it can have so that the matter at the surface of the star on its equator is just held in orbit by the gravitational force.

11-4. A massless spring of constant $k = 78.4$ N/m is fixed on the left side of a level track. A block of mass $m = 0.525$ kg is pressed against the spring and compresses it a distance d, as in the figure. The block (initially at rest) is then released and travels toward a circular loop-the-loop of radius $R = 1.53$ m. The entire track and the loop-the-loop are frictionless except for the section of track between points A and B. Given that the coefficient of kinetic friction between the block and the track along AB is $\mu_k =$ [05] ________, and that the length of AB is 2.54 m, determine the minimum compression d of the spring that enables the block to just make it through the loop-the-loop at point C. (Hint: The force exerted by the track on the block will be zero at point C if the block barely makes it through the loop-the-loop.)



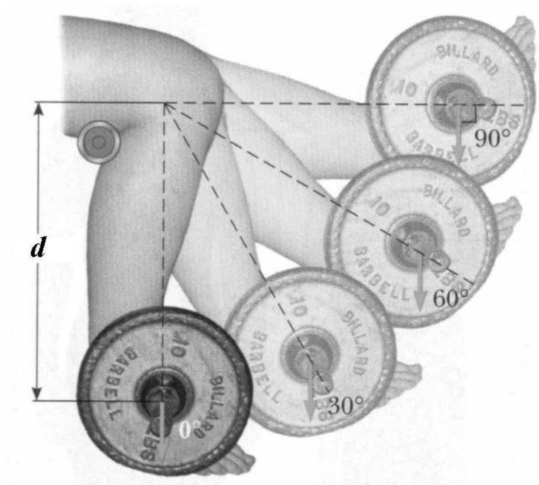
11-5. A 0.434-kg pendulum bob passes through the lowest part of its path at a speed of [06] _________ m/s. (a) What is the tension in the pendulum cable at this point if the pendulum is 80.7 cm long? (b) When the pendulum reaches its highest point, what angle does the cable make with the vertical? (c) What is the tension in the pendulum cable when the pendulum reaches its highest point?

11-6. A 0.537-kg ball that is tied to the end of a [07] _________-m light cord is revolved in a horizontal plane with a cord making a 28.6° angle with the vertical (see figure). (a) Draw a free-body diagram of the ball. (b) Determine the ball's speed. (c) If instead the ball is revolved so that its speed is 4.24 m/s, what angle does the cord make with the vertical?
Hint: Recall that $\sin^2\theta = 1 - \cos^2\theta$. You will need to use the quadratic formula to solve for $\cos\theta$. (Turn in part (a) on the sheet provided in your packet.)

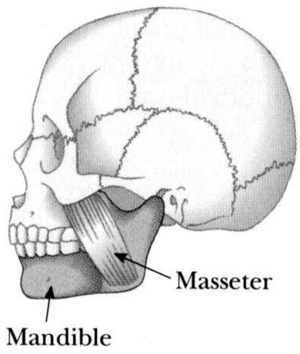


12-1. If the torque required to loosen a nut that is holding a flat tire in place on a car has a magnitude of 45.2 N·m, what *minimum* force must be exerted by the mechanic at the end of a [01] _________ cm lug wrench to accomplish the task?

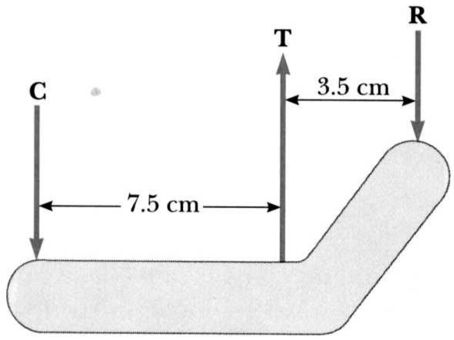
12-2. As part of a physical therapy program following a knee operation, a 10.0-kg object is attached to an ankle, and leg lifts are done as sketched in the figure. The value of d in the figure is [02] _________ cm. Calculate the torque about the knee due to this weight for the position at (a) 0°, (b) 30°, (c) 60°, and (d) 90°.



12-3. The chewing muscle, the masseter, is one of the strongest in the human body. It is attached to the mandible (lower jawbone). The jawbone is pivoted about a socket just in front of the auditory canal. The forces acting on the jawbone are equivalent to those acting on the curved bar as shown in the figure. **C** is the force exerted against the jawbone by the food being chewed, **T** is the tension in the masseter, and **R** is the force exerted on the mandible by the socket. Find (a) **T** and (b) **R** if you bite down on a piece of steak with a force of [03] ________ N.



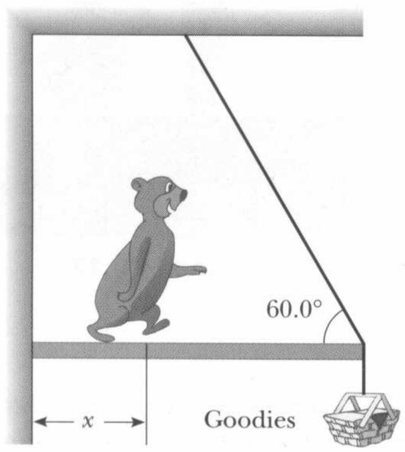
(a)



(b)

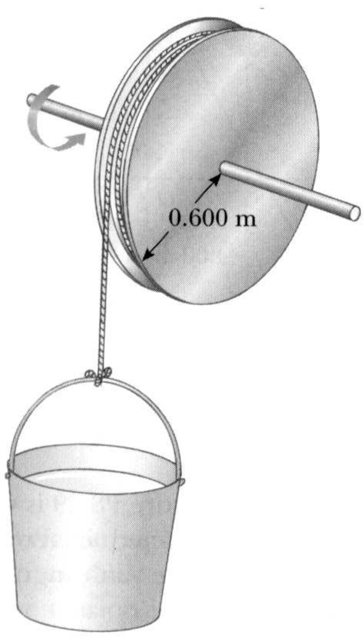
12-4. An 8.31-m, 267-N uniform ladder rests against a smooth (frictionless) wall. The coefficient of static friction between the ladder and the ground is 0.582, and the ladder makes a 52.6° angle with the ground. A [04] ________-N person is standing on the ladder a distance d from the bottom end of the ladder. (a) Draw a free-body diagram of the ladder. (b) How far up the ladder (distance d) can the person climb before the ladder begins to slip? Hint: Among other things, you may want to look at the sum of the torques about the point where the ladder touches the wall. Be careful with angles! (Turn in part (a) on the sheet provided in your packet.)

12-5. A hungry 728-N bear walks out on a beam in an attempt to retrieve some "goodies" hanging at the end (see figure). The beam is uniform, weighs 216 N, and is [05] ________ m long; the goodies weigh 82 N. (a) Draw a free-body diagram for the beam. When the bear is at $x = 1.00$ m, find (b) the tension on the wire and (c) the magnitude of the reaction force at the hinge where the beam is connected to the wall. (d) If the wire can withstand a maximum tension of 900 N, what is the maximum distance the bear can walk before the wire breaks? (Turn in part (a) on the sheet provided in your packet.)



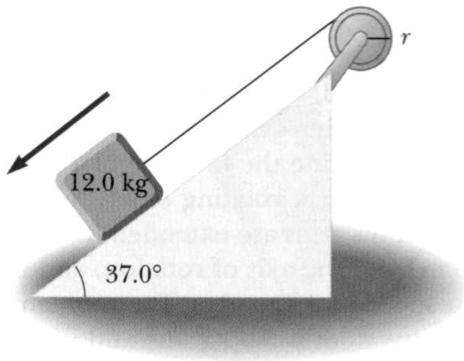
13-1. A bicycle wheel has a diameter of 64.7 cm and a mass of 1.85 kg. Assume that the wheel is a hoop with all the mass concentrated on the outside radius. The bicycle is placed on a stationary stand and a resistive force of [01] ________ N is applied tangent to the rim of the tire. (a) What force must be applied by a chain passing over a 9.4-cm diameter sprocket in order to give the wheel an angular acceleration of 4.57 rad/s^2? (b) What force is required if you shift to a 5.6-cm diameter sprocket?

13-2. A cylindrical 5.87-kg reel with a radius of 0.600 m and a frictionless axle, starts from rest and speeds up uniformly as a [02] ________-kg bucket falls into a well, making a light rope unwind from the reel (see figure). The bucket starts from rest and falls for 4.00 s. (a) Draw a free-body diagram of the reel. (b) Draw a free-body diagram of the bucket. (c) What is the linear acceleration of the falling bucket? (d) How far does it drop? (e) What is the angular acceleration of the reel? (Turn in parts (a) and (b) on the sheet provided in your packet.)



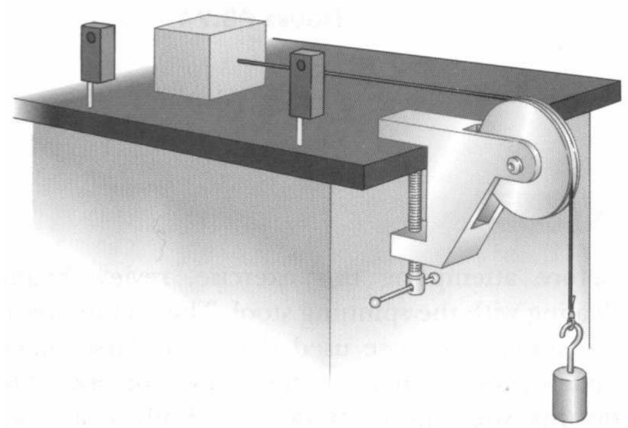
13-3. A potter's wheel having a radius of 0.561 m and a moment of inertia of 12.5 kg$\cdot$m^2 is rotating freely at 53.7 rev/min. The potter can stop the wheel in [03] _________ s by pressing a wet rag against the rim and exerting a radially inward force of 68.2 N. Find the effective coefficient of kinetic friction between the wheel and the wet rag.

13-4. A 12.0-kg object is attached to a cord that is wrapped around a wheel of radius $r = 11.2$ cm (see figure). The acceleration of the object down the frictionless incline is measured to be [04] _________ m/s^2. The axle of the wheel is frictionless. (a) Draw a free-body diagram of the object. (b) Draw a free-body diagram of the wheel. Determine (c) the tension in the rope, (d) the moment of inertia of the wheel, and (e) the angular speed of the wheel 2.00 s after it begins rotating, starting from rest. (Turn in parts (a) and (b) on the sheet provided in your packet.)



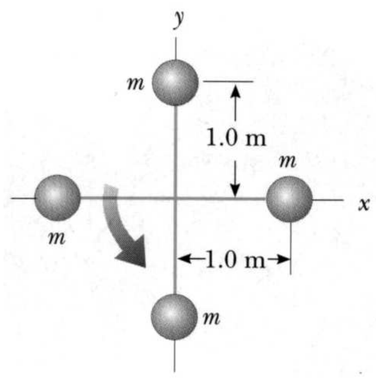
13-5. In a circus performance, a large 5.13-kg hoop of radius 3.62 m rolls without slipping. If the hoop is given an angular speed of 3.13 rad/s while rolling on the horizontal and allowed to roll up a ramp inclined at [05] _________° with the horizontal, how far (measured by the change in position of the center of mass along the incline) does the hoop roll?

13-6. In the figure the sliding block has a mass of 0.858 kg, the counterweight has a mass of [06] ________ kg, and the pulley is a uniform solid cylinder with a mass of 0.354 kg and an outer radius of 0.0310 m. The coefficient of kinetic friction between the block and the horizontal surface is 0.255. The pulley turns without friction on its axle. The light cord does not stretch and does not slip on the pulley. The block has a velocity of 0.824 m/s toward the pulley when it passes through a photogate. (a) Use energy methods to predict its speed after it has moved to a second photogate, 0.700 m away. (b) Find the angular speed of the pulley at the same point.



14-1. Suppose an Earth-like planet has a mass of [01] ________ kg. It is a sphere with uniform density. In all other respects, it is just like the Earth: it has the same length of day (24 hours), the same length of year (365.26 days), the same radius, and its orbit also has the same radius as the Earth's orbit. Using additional data from your textbook, calculate the angular momentum of this planet that (a) arises from its spinning motion on its axis, and (b) arises from its orbital motion about the sun.

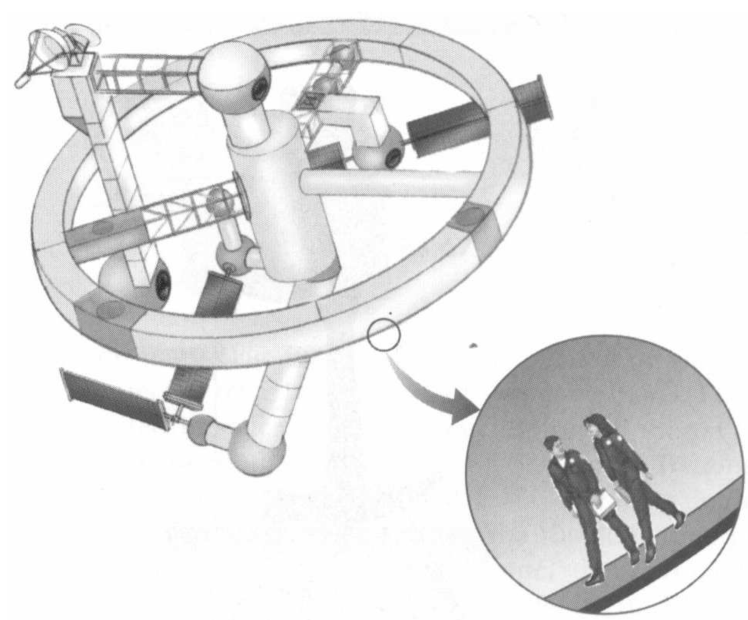
14-2. The system of small objects shown in the figure is rotating at an angular speed of [02] ________ rev/s. The objects are connected by light, flexible spokes that can be lengthened or shortened through internal forces (*e.g.*, motors triggered via remote control). What is the new angular speed if the spokes are shortened to 0.56 m? (An effect similar to that illustrated in this problem occurred in the early stages of the formation of our Galaxy. As the massive cloud of dust and gas that was the source of the stars and planets contracted, an initially small angular speed increased with time.)



14-3. A comet moves about the Sun in an elliptical orbit, with its closest approach to the Sun being 0.593 A.U. and its greatest distance being [03] ________ A.U. (1 A.U. = Earth-Sun distance). If the comet's speed at closest approach is 54.2 km/s, what is its speed when it is furthest from the Sun? You may neglect any change in the comet's mass and assume that its angular momentum about the Sun is conserved. (This orbit is similar to that of Halley's comet.)

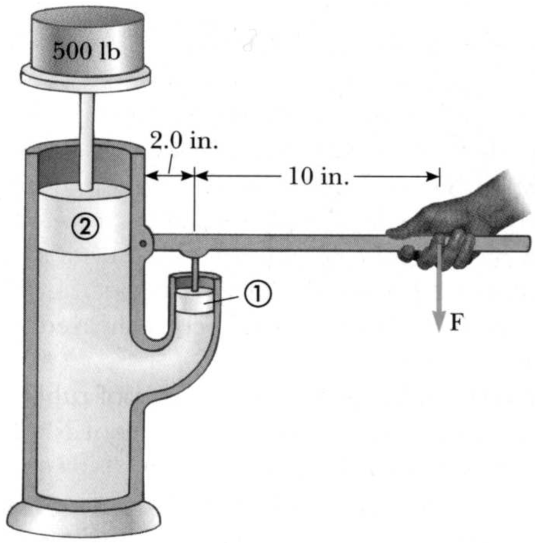
14-4. A student sits on a rotating stool holding two 3.09-kg masses. When his arms are extended horizontally, the masses are 1.08 m from the axis of rotation, and he rotates with an angular speed of [04] ________ rad/s. The moment of inertia of the student plus stool is 3.25 kg$\cdot$m^2 and is assumed to be constant. (Note that this moment of inertia does not include the two 3.09-kg masses.) The student then pulls the masses horizontally to 0.34 m from the rotation axis. (a) Find the new angular speed of the student. Find the kinetic energy of the rotating system (student, stool, and masses) (b) before and (c) after the masses are pulled in.

14-5. A space station shaped like a giant wheel has a radius 118 m and a moment of inertia of [05] ________ kg$\cdot$m^2. A crew of 150 are living on the rim, and the station is rotating so that the crew experience an apparent acceleration of 1 g (see figure). The people add to the total angular momentum of the system. When 100 people move to the center of the station for a union meeting, the angular speed changes. What apparent acceleration is experienced by the managers remaining at the rim? Assume an average mass of 65 kg for all the inhabitants.



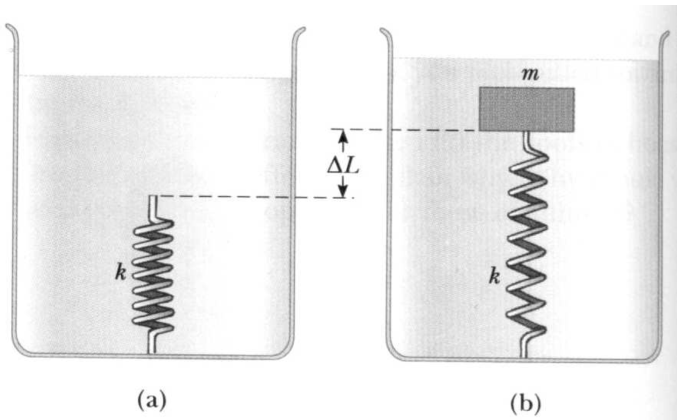
15-1. A [01] ________-kg ballet dancer stands on her toes during a performance with $26.5\ \text{cm}^2$ in contact with the floor. What is the pressure exerted by the floor over the area of contact (a) if the dancer is stationary, and (b) if the dancer is jumping upwards with an acceleration of $4.41\ \text{m/s}^2$?

15-2. Piston 1 in the figure has a diameter of [02] ________ in.; piston 2 has a diameter of 1.5 in. In the absence of friction, determine the force F necessary to support the 500-lb weight.

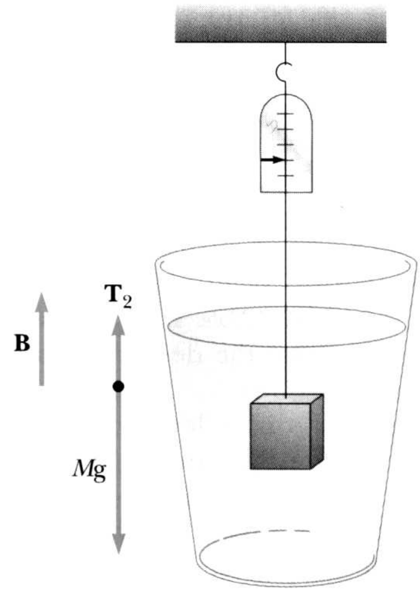


15-3. A rectangular air mattress is 2.1 m long, 0.48 m wide, and [03] ________ m thick. If it has a mass of 2.3 kg, what additional mass can it support in water?

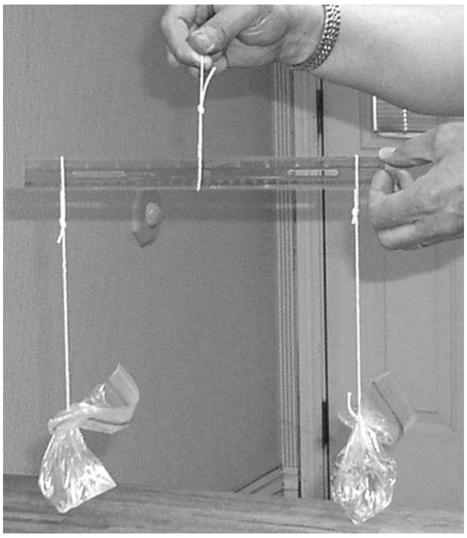
15-4. A light spring of constant $k = 163$ N/m rests vertically on the bottom of a large beaker of water. A 5.29-kg block of wood (density=[04] ________ kg/m^3) is connected to the spring and the mass-spring system is allowed to come to static equilibrium. (a) Draw a free-body diagram of the block. (b) What is the elongation ΔL of the spring? (Turn in part (a) on the sheet provided in your packet.)



15-5. A 10.0-kg block of metal is suspended from a scale and immersed in water as in the figure. The dimensions of the block are 12.0 cm $\times$ 10.0 cm $\times$ [05] ________ cm. The 12.0-cm dimension is vertical, and the top of the block is 5.00 cm below the surface of the water. What are the forces exerted by the water on (a) the top and (b) the bottom of the block? (Take atmospheric pressure to be 1.0130×10^5 N/m^2.) (c) What is the buoyant force? (d) What is the reading of the spring scale?



15-6. Extra credit activity: Density of cooking oil. The purpose of this activity is to compare the density of cooking oil with the density of water. Measure a half cup of water, pour it into a plastic sandwich bag, and seal the bag shut. Measure a half cup of cooking oil, pour it into another bag, and seal the bag shut. If you don't have a measuring cup, make a mark on a drinking cup about half-way to the top and use that. The exact volume doesn't matter. We only care that the volume of water and volume of cooking oil are equal. Cut two pieces of string, each about 15 inches long, and tie the bags to opposite ends of a ruler (see figure). Tie a third string at the center of the ruler. Holding the center string, adjust the positions of the bags until they are balanced and the ruler hangs horizontally. Record the distance of each bag from the center of the ruler where the third piece of string is tied. Record the distance for the bag containing water as the answer to part (a) of this problem. Record the distance for the bag containing cooking oil as the answer to part (b) of this problem. You may use any units (inches, cm, etc) for these two values as long as you use the same units for both values. Draw a free-body diagram of the ruler. Write an expression for the net torque about the center of mass of the ruler. Solve this expression for the ratio of the mass of the water to the mass of the cooking oil. Since they have equal volumes, this result is also the ratio of their densities. Using the known density of water, calculate the density of cooking oil, and record the result (to the nearest 0.01 g/cm^3) as the answer to part (c) of this problem.



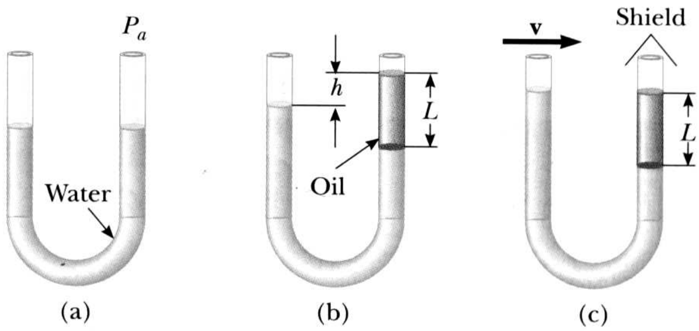
16-1. A cowboy at a dude ranch fills a horse trough that is 1.53 m long, 61 cm wide, and 42 cm deep. He uses a 2.0-cm-diameter hose from which water emerges at [01] ________ m/s. How long does it take him to fill the trough?

16-2. (a) Calculate the mass flow rate (in grams per second) of blood ($\rho = 1.0$ g/cm^3) in an aorta with a cross-sectional area of 2.0 cm^2 if the flow speed is [02] ________ cm/s.
(b) Assume that the aorta branches from a large number of capillaries with a combined cross-sectional area of 3.0×10^3 cm^2. What is the flow speed in the capillaries?

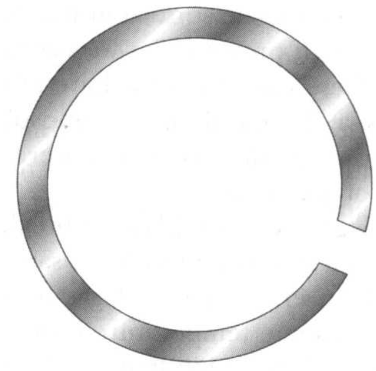
16-3. When a person inhales, air moves down the bronchus (windpipe) at [03] ________ cm/s. The average flow speed of the air doubles through a constriction in the bronchus. Assuming incompressible flow, determine the pressure drop in the constriction. Neglect the change of pressure due to change in height y in the wind pipe. Use 1.20 kg/m^3 for the density of air.

16-4. A large storage tank, open to the atmosphere at the top and filled with water, develops a small hole in its side at a point [04] ________ m below the water level. If the rate of flow from the leak is 2.53×10^{-3} m^3/min, determine (a) the speed at which the water leaves the hole and (b) the diameter of the hole.

16-5. A U-tube open at both ends is partially filled with water, as in Figure (a). Oil ($\rho = 754$ kg/m^3) is then poured into the right arm and forms a column $L =$ [05] ________ cm high, as in Figure (b). (a) Determine the difference h in the heights of the two liquid surfaces. (b) The right arm is then shielded from any air motion while air is blown across the top of the left arm until the surfaces of the two liquids are at the same height (Fig. P9.80c). Determine the speed of the air being blown across the left arm. Assume that the density of air is 1.29 kg/m^3.



17-1. The figure shows a circular steel casting with a gap. If the casting is heated, (a) does the width of the gap increase or decrease? (b) The gap width is 1.60 cm when the temperature is 30°C. Determine the change in the gap width when the temperature is [01] ________°C.



17-2. A grandfather clock is controlled by a swinging brass pendulum that is 1.3 m long at a temperature of 20°C. (a) By how much does the length of the pendulum rod change when the temperature drops to [02] ________°C? (b) If a pendulum's period is given by $T = 2\pi\sqrt{L/g}$, where L is its length, does the change in length of the rod cause the clock to run fast or slow?

17-3. An underground gasoline tank at 54°F can hold [03] ________ gallons of gasoline. If the driver of a tanker truck fills the underground tank on a day when the temperature is 90°F, how many gallons, according to his measure on the truck, can he pour in? Assume that the temperature of the gasoline cools to 54°F upon entering the tank. Use the coefficient of volume expansion for gasoline given in the textbook.

17-4. A tank having a volume of 100 liters contains helium gas at 150 atm. How many balloons can the tank blow up if each filled balloon is a sphere [04] ________ cm in diameter at an absolute pressure of 1.20 atm?

17-5. An air bubble has a volume of 1.50 cm^3 when it is released by a submarine [05] ________ m below the surface of a lake. What is the volume of the bubble when it reaches the surface where the atmospheric pressure is 1.00 atm? Assume that the temperature and the number of air molecules in the bubble remains constant during the ascent.

17-6. Extra credit activity: Normal force on your car's tires. Park your car on a relatively smooth pavement like concrete. The tires have an approximately rectangular "footprint" where it is in contact with the pavement. Choose one of the tires and determine the area of its footprint. Do this by sliding a sheet of paper as far under the tire as possible. Use a pencil to mark the position of the paper on the pavement (see figure). Repeat for all four sides of the footprint. Use these marks to determine the width and length of the footprint. Record the width and length (in inches) as the answers to parts (a) and (b) of this problem. Be sure to record the decimal form (for example 6.5, not 6 1/2). Use a tire gauge to measure the gauge pressure of the air in the tire. Record the result in pounds/inch^2 (psi) as the answer to part (c) of this problem. If you don't have a tire gauge, use the recommended inflation pressure of your tire. This is usually printed on the end of the front left door of the car. It might also be printed on the tire itself. Assuming that the normal force of the pavement is balanced by the force exerted by the gauge pressure of the air inside the tire, calculate the normal force on the tire and record the result (to the nearest 100 pounds) as the answer to part (d) of this problem.
Optional: Multiply your answer by four (if your car has four tires) and compare this with the total weight of the car (usually printed on the end of the front left door of the car).

18-1. If [01] __________ mol of gas is confined to a 5.0-L vessel at a pressure of 8.0 atm, what is the average translational kinetic energy of a gas molecule?

18-2. A cylinder contains a mixture of helium and argon gas in equilibrium at a temperature of [02] __________°C. What is the average kinetic energy of (a) each helium molecule and (b) each argon molecule? What is the rms speed of (c) each helium molecule and (d) each argon molecule?

18-3. An aluminum rod is 20 cm long at 20°C and has a mass of 350 g. If [03] __________ J of energy is added to the rod by heat, what is the change in length of the rod?

18-4. A 0.42-kg iron horseshoe that is initially at [04] __________°C is dropped into a bucket containing 19 kg of water at 22°C. By how much does the temperature of the water rise? Neglect any energy transfer to or from the surroundings.

18-5. A [05] __________-g block of ice is cooled to −78.3°C. It is added to 567 g of water in an 85-g copper calorimeter at a temperature of 25.3°C. Determine the final temperature. Remember that the ice must first warm to 0°C, melt, and then continue warming as water. The specific heat of ice is 2090 J/kg·°C.

18-6. What mass of steam that is initially at 121.6°C is needed to warm [06] __________ g of water and its 286-g aluminum container from 22.5°C to 48.5°C?

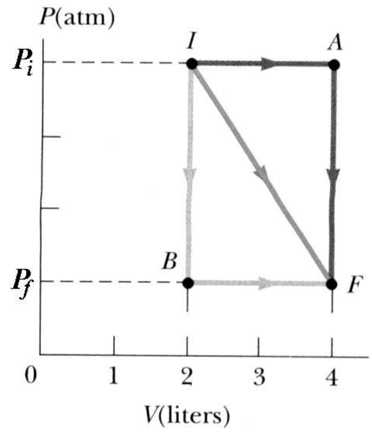
19-1. A Styrofoam box has a surface area of 0.832 m^2 and a wall thickness of 2.09 cm. The temperature of the inner surface is 4.8°C, and that outside is 25.5°C. If it takes [01] __________ h for 5.54 kg of ice to melt in the container, determine the thermal conductivity of the Styrofoam.

19-2. Water is being boiled in an open kettle that has a 0.52-cm-thick circular aluminum bottom with a radius of 12.0 cm. If the water boils away at a rate of [02] __________ kg/min, what is the temperature of the lower surface of the bottom of the kettle? Assume that the top surface of the bottom of the kettle is at 100.0°C. Use the thermal conductivity of aluminum at 25°C (the value given in the table in the textbook).

19-3. Calculate the temperature at which a tungsten filament that has an emissivity of 0.25 and a surface area of 2.5×10^{-5} m^2 will radiate energy at the rate of [03] __________ W in a room where the temperature is 22°C.

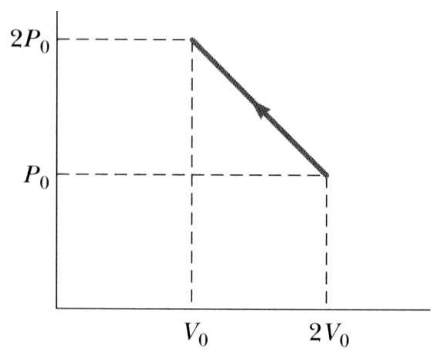
19-4. A sample of helium behaves as an ideal gas as it is heated at constant pressure from 273 K to 369 K. If [04] __________ J of work is done by the gas during this process, what is the mass of helium present?

19-5. A gas expands from I to F along the three paths indicated in the figure. Calculate the work done on the gas along paths (a) IAF, (b) IF, and (c) IBF. P_i = [05] ________ atm and P_f = [06] ________ atm.

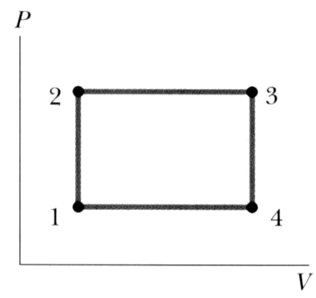


19-6. A movable piston having a mass of 7.78 kg and a cross-sectional area of 5.26 cm^2 traps 0.205 moles of an ideal gas in a vertical cylinder. If the piston slides without friction in the cylinder, how much work will be done on the gas when its temperature is decreased from [07] ________°C to 24°C? Hint: Since the piston slides without friction, the pressure will remain constant.

20-1. A monatomic ideal gas undergoes the thermodynamic process shown in the PV diagram in the figure. Determine whether each of the values (a) ΔU, (b) Q, (c) W for the gas is positive, negative, or zero. (Note that W is the work done *on* the gas.)



20-2. When a gas follows path 123 on the PV diagram in the figure, [01] ________ J of energy flows into the system by heat, and −167 J of work is done on the gas. (a) What is the change in the internal energy of the system along that path? (b) How much heat energy Q flows into the system if the gas follows path 143? The work done on the gas along this path is [02] ________ J. What net work would be done on the system if the system followed (c) path 12341? (d) path 14321? What is the change in internal energy of the system if the system followed (e) path 12341? (f) path 14321?



20-3. [03] ________ moles of a monatomic ideal gas have a volume of 1.00 m^3, and are initially at 354 K. (a) Heat is carefully removed from the gas as it is compressed to 0.50 m^3, causing the temperature to remain constant. How much work was done on the gas in the process? (b) Now the gas is expanded again to its original volume, but so quickly that no heat has time to enter the gas. This cools the gas to 223 K. How much work was done by the gas in this process?

20-4. A heat engine performs [04] ________ J of work in each cycle and has an efficiency of 32.9%. For each cycle of operation, (a) how much energy is absorbed by heat and (b) how much energy is expelled by heat?

20-5. An engine absorbs 1678 J from a hot reservoir and expels [05] ________ J to a cold reservoir in each cycle. (a) What is the engine's efficiency? (b) How much work is done in each cycle? (c) What is the power output of the engine if each cycle lasts for 0.326 s?

20-6. A nuclear power plant has an electrical power output of 1000 MW and operates with an efficiency of 33%. If the excess energy is carried away from the plant by a river with a flow rate of [06] ________ kg/s, what is the rise in temperature of the flowing water?

21-1. An object-spring system oscillates with an amplitude of 3.51 cm. If the spring constant is [01] ________ N/m and the object has a mass of 0.500 kg, determine (a) the mechanical energy of the system, (b) the maximum speed of the object, and (c) the maximum acceleration.

21-2. A [02] ________-kg block hangs without vibrating at the end of a spring ($k = 548$ N/m) that is attached to the ceiling of an elevator car. The car is rising with an upward acceleration of 3.14 m/s^2 when the acceleration suddenly ceases (at $t = 0$). (a) What is the angular frequency of oscillation of the block after the acceleration ceases? (b) By what amount is the spring stretched during the time that the elevator car is accelerating? This distance, minus the stretch due to gravity alone, will be the amplitude of the ensuing oscillation of the block.

21-3. A man enters a tall tower, needing to know its height. He notes that a long pendulum extends from the ceiling almost to the floor and that its period is [03] ________ s. (a) How tall is the tower? (b) If this pendulum is taken to the Moon, where the free-fall acceleration is 1.67 m/s^2, what is the period there?

21-4. An aluminum clock pendulum having a period of 1.0000 s keeps perfect time at 20.0°C. (a) When placed in a room at a temperature of [04] ________°C, will the clock gain time or lose time? (b) How much time will the clock gain or lose every hour?

21-5. If the frequency of oscillation of the wave emitted by an FM radio station is [05] ________ MHz, determine the wave's (a) period of vibration and (b) wavelength. (*Hint:* Radio waves travel at the speed of light, 3.00×10^8 m/s.)

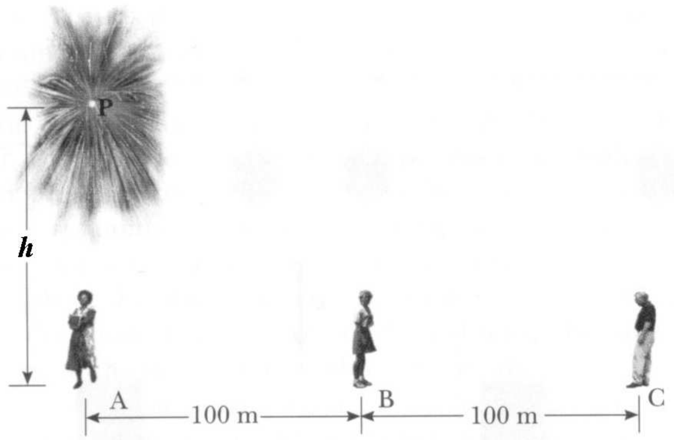
21-6. A phone cord is 4.89 m long. The cord has a mass of 0.212 kg. A transverse wave pulse is produced by plucking one end of the taut cord. That pulse makes four round trips (down and back) along the cord in [06] ________ s. What is the tension in the cord?

22-1. You are watching a pier being constructed on the far shore of a saltwater inlet when some blasting occurs. You hear the sound in the water [01] ________ s before it reaches you through the air. How wide is the inlet? (Hint: See Table 14.1. Assume the air temperature is 25°C. Be sure to use the speed of sound in "Sea water", not "Water".)

22-2. A family ice show is held at an enclosed arena. The skaters perform to music with level 81.7 dB. This is too loud for your baby who yells at [02] ________ dB. (a) What total sound intensity engulfs you? (b) What is the combined sound level?

22-3. The intensity level of an orchestra is [03] ________ dB. A single violin achieves a level of 68.2 dB. How does the intensity of the sound of the full orchestra compare with that of the violin's sound? (Find the ratio of the intensities.)

22-4. A skyrocket explodes at a height $h =$ [04] ________ m above the ground (see figure). Three observers are spaced 100 m apart, with observer A directly under the point of the explosion. (a) What is the ratio of sound intensities heard by observers A and B? (b) What is the ratio of intensities heard by observers A and C? Neglect the height of the observers.



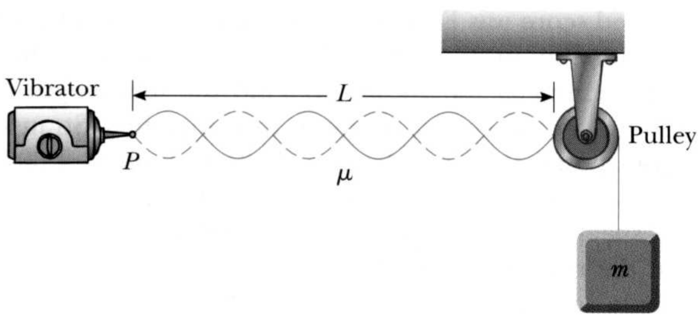
22-5. A stereo speaker (considered a small source) emits sound waves with a power output of [05] ________ W. (a) Find the intensity 10.5 m from the source. (Assume that the sound is emitted uniformly in all directions from the speaker.) (b) Find the intensity level, in decibels, at this distance. (c) At what distance would you experience the sound at the threshold of pain, 120 dB?

23-1. A train at rest emits a sound at a frequency of [01] ________ Hz. An observer in a car travels away from the sound source at a speed of 34 m/s. What is the frequency heard by the observer? (Take the speed of sound to be 345 m/s.)

23-2. A bat flying at [02] ________ m/s emits a chirp at 40.95 kHz. If this sound pulse is reflected by a wall, what is the frequency of the echo received by the bat? (*Hint:* This is exactly the same as the situation where the source and observer are both moving towards each other.) Use 345 m/s for the speed of sound.

23-3. A pair of speakers separated by [03] ________ m are driven by the same oscillator at a frequency of 690 Hz. An observer, originally positioned at one of the speakers, begins to walk along a line perpendicular to the line joining the two speakers. (a) How far must the observer walk before reaching a relative maximum in intensity? (b) How far will the observer be from the speaker when the first relative minimum is detected in the intensity? (Take the speed of sound to be 345 m/s.)

23-4. In the arrangement shown in the figure, an object of mass $m =$ [04] ________ kg hangs from a cord around a light pulley. The length of the cord between point P and the pulley is $L = 2.0$ m. When the vibrator is set to a frequency of 150 Hz, a standing wave with six loops is formed. What must be the linear mass density of the cord?



23-5. A pipe open at both ends has a fundamental frequency of [05] ________ Hz when the temperature is 0°C. (a) What is the length of the pipe? (b) What is the fundamental frequency at a temperature of 30°C? Assume that the displacement antinodes occur exactly at the ends of the pipe. Neglect thermal expansion of the pipe.

23-6. Two identical mandolin strings under 205.6 N of tension are sounding tones with fundamental frequencies of 523 Hz. The peg of one string slips slightly, and the tension in it drops to [06] ________ N. How many beats per second are heard?

23-7. A speaker at the front of a room and an identical speaker at the rear of the room are being driven at 456 Hz by the same sound source. A student walks at a uniform rate of [07] ________ m/s away from one speaker and toward the other. How many beats does the student hear per second? (Take the speed of sound to be 345 m/s.)

Answers to Homework Problems, Physics 105, Fall Semester, 2009
Secs. 1 & 2, John Colton

1-1. 5.0, 12.0 nm/s
1-2. 5.00, 9.00 h
1-3a. 150, 210 km
1-3b. 60.0, 70.0 km/h
1-4. 300, 800 km/h
1-5b. 15.0, 60.0 min
1-6a. 3.00, 5.00 m/s
1-6b. -0.25, -0.75 m/s
1-6c. -0.75, -1.25 m/s
1-6d. 0
2-1. 2.0, 6.0 s
2-2a. 0
2-2b. 1.40, 1.80 m/s^2
2-2c. 0.70, 0.90 m/s^2
2-2d. 0
2-2e. 1.40, 1.80 m/s^2
2-2f. 0
2-3. 80, 180 ft
2-4. 1.50, 2.50 s
2-5a. 3.00, 11.00 m
2-5b. 0.500, 1.700
2-5c. 0.500, 0.900
2-6a. 7.00, 9.50
2-6b. 30.0, 40.0
3-1a. 150, 170 km/h
3-1b. 5.0, 20.0° north of west
3-2a. 10.0, 21.0° north of west
3-2b. 150, 230 km/h
3-3. 8.0, 30.0 s
3-4. 1.80, 3.60 ft
3-5a. 5500, 9000 ± 10 m
3-5b. 1500, 4000 ± 10 m
3-6a. 2.50, 3.50 s
3-6b. 30.0, 40.0 m/s
3-6c. 55.0, 65.0°
4-1a. 7.0, 18.0 N
4-1b. 1.50, 6.00 m/s^2
4-2. 400, 600 N
4-3a. 3.0, 8.0 N
4-3b. 50.0, 120.0 N
4-3c. 2.00, 5.00 kg
4-3d. 2.00, 5.00 kg
4-3e. 2.00, 5.00 kg
4-4. 600, 1500 ± 10 N
4-5a. 0.150, 0.500 m/s^2
4-5b. 5.0, 25.0 m
4-5c. 1.50, 5.00 m
4-6. 4.00, 12.00 min
5-1b. 20, 70 N
5-2b. 600, 1400 ± 10 N
5-3b. 700, 1100 N
5-3c. 500, 900 N
5-4c. 1.00, 3.00 m/s^2
5-4d. 30.0, 40.0 N
5-4e. 0.50, 1.20 m
5-5c. 6.00, 8.00 m/s^2
5-5d. 30.0, 40.0 N
5-6b. 35.0, 65.0 N
5-6c. 40.0, 70.0 N
6-1a. 0.20, 0.60
6-1b. 0.20, 0.60
6-2a. -1.00, -1.80 m/s^2
6-2b. 0.100, 0.200
6-2c. 40.0, 50.0 m
6-3c. 1.00, 1.50 m/s^2
6-3d. 10.0, 30.0 N
6-3e. 0.10, 0.50 m/s^2
6-3f. 10.0, 25.0 N
6-4b. 0.150, 0.300
6-4d. 0.200, 0.700 m/s^2
6-5d. 70.0, 90.0 N
6-5e. 30.0, 40.0 N
6-5f. 0.500, 0.800
7-1. 125, 200 m/s
7-2. 60, 120 J
7-3. 5.50, 7.00 m/s
7-4. 1.30, 3.10 m
7-5a. 8.50, 11.00 m/s
7-5b. 5.00, 10.00 m/s
7-6a. 8.0, 20.0 m/s
7-6b. 8.0, 20.0 m/s
8-1. 9.0, 20.0 m
8-2. 600, 1100 N/m
8-3. 0.050, 0.200

8-4. 0.70, 4.00 m/s
8-5a. 19000, 27000 $\pm$100 J
8-5b. 0.60, 1.50 hp
8-6a. 5.0, 12.0 hp
8-6b. 8.0, 20.0 hp
9-1a. 20.0, 45.0 m/s
9-2. 40.0, 120.0 m/s
9-3. 50.0, 70.0 s
9-4a. 1.60, 2.00 m/s
9-4b. 7000, 43000 $\pm$100 J
9-5a. 1000, 2000 ± 10 N
9-5b. 6000, 10000 ± 10 N
9-6a. 4.50, 9.50 m/s
9-6b. 8.0, 30.0° north of east
9-6c. 15.0, 60.0%
9-7. between -90 and $+10$ cm/s
10-1a. 2.00, 5.00 m/s
10-1b. 0.100, 0.400 m
10-2a. 600, 1000 rad/s^2
10-2b. 3000, 6000 ± 10 rad
10-3a. 5.00, 9.00 s
10-3b. 30.0, 60.0 rad
10-4a. 10.0, 20.0 m/s
10-4b. 20.0, 30.0 s
10-4c. 150, 250 m
10-5b. 10.0, 40.0°
10-6a. 7.80, 9.40 N
10-6b. 7.80, 9.40 N
10-6c. 5.60, 6.20 m/s
10-7b. 15000, 40000 ± 100 N
10-7d. 9.0, 15.0 m/s
11-1. 200, 500 N
11-2. 32000, 39000 $\pm$100 km
11-3. 5000, 20000 ± 100 rad/s
11-4. 0.750, 0.800 m
11-5a. 5.00, 10.00 N
11-5b. 30.0, 70.0°
11-5c. 1.50, 4.00 N
11-6b. 1.50, 2.50 m/s
11-6c. 50.0, 70.0°
12-1. 80, 160 N
12-2a. 0, -50 N·m
12-2b. 0, -50 N·m
12-2c. 0, -50 N·m
12-2d. 0, -50 N·m
12-3a. 120, 190 N
12-3b. 80, 130 N
12-4b. 6.50, 7.50 m
12-5b. 350, 450 N
12-5c. 600, 800 N
12-5d. 3.00, 5.00 m
13-1a. 700, 1000 ± 10 N
13-1b. 1100, 1700 ± 10 N
13-2c. 2.00, 5.00 m/s^2
13-2d. 15.0, 40.0 m
13-2e. 3.50, 9.00 rad/s^2
13-3. 0.250, 0.400
13-4c. 40.0, 60.0 N
13-4d. 0.200, 0.400 kg·m^2
13-4e. 30.0, 50.0 rad/s
13-5. 30.0, 60.0 m
13-6a. 1.20, 1.80 m/s
13-6b. 40.0, 60.0 rad/s
14-1a. 5.00×10^{33}, 9.00×10^{33} kg·m^2/s
14-1b. 2.00×10^{40}, 4.00×10^{40} kg·m^2/s
14-2. 6.0, 20.0 rev/s
14-3. 0.80, 1.10 km/s
14-4a. 1.80, 2.20 rad/s
14-4b. 2.50, 3.40 J
14-4c. 6.50, 9.00 J
14-5. 10.0, 20.0 m/s^2
15-1a. 1.00×10^5, 3.00×10^5 Pa
15-1b. 2.00×10^5, 4.00×10^5 Pa
15-2. 1.0, 20.0 lb
15-3. 40, 100 kg
15-4b. 0.170, 0.320 m
15-5a. 500.0, 1100.0 N
15-5b. 500.0, 1100.0 N
15-5c. 5.0, 12.0 N
15-5d. 80.0, 100.0 N
16-1. 10.0, 25.0 min
16-2a. 50, 99 g/s
16-2b. 0.15, 0.40 mm/s
16-3. -0.010, -0.040 Pa

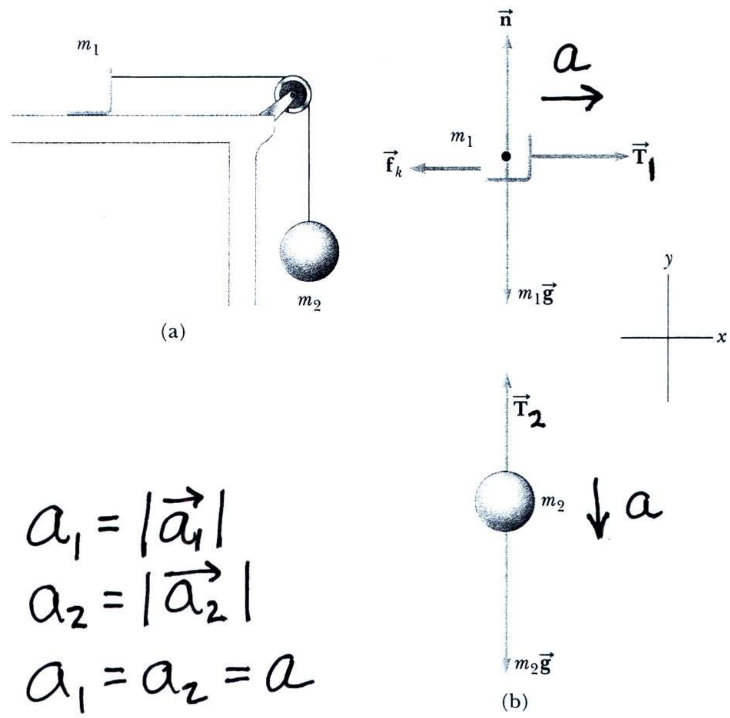
16-4a. 13.0, 20.0 m/s
16-4b. 1.50, 2.00 mm
16-5a. 1.20, 2.50 cm
16-5b. 10.0, 20.0 m/s
17-1b. 10, 30 μm
17-2a. -0.20, -1.50 mm
17-3. 500, 1100 gal
17-4. 100, 900 balloons
17-5. 10.0, 25.0 cm^3
18-1. 2.0×10^{-21}, 9.0×10^{-21} J
18-2a. 7.00×10^{-21}, 9.90×10^{-21} J
18-2b. 7.00×10^{-21}, 9.90×10^{-21} J
18-2c. 1500, 2000 ± 10 m/s
18-2d. 400, 600 ± 10 m/s
18-3. 1.0, 3.0 mm
18-4. 1.00, 2.00°C
18-5. 10.0, 20.0°C
18-6. 10.0, 20.0 g
19-1. 0.0600, 0.1100 J/s·m·°C
19-2. 103.0, 110.0°C
19-3. 2500, 4000 ± 100°C
19-4. 100, 200 mg
19-5a. -600, -850 J
19-5b. -400, -650 J
19-5c. -200, -450 J
19-6. 500, 1000 J
20-2a. 200, 300 J
20-2b. 250, 400 J
20-2c. -50, -150 J
20-2d. 50, 150 J
20-2e. 0, 0 J
20-2f. 0, 0 J
20-3a. 3000, 7000 ± 20 J
20-3b. 3000, 7000 ± 20 J
20-4a. 600, 950 J
20-4b. 400, 650 J
20-5a. 30.0, 60.0%
20-5b. 500, 900 J
20-5c. 1500, 3000 W
20-6. 0.20, 0.50°C
21-1a. 0.120, 0.190 J
21-1b. 0.700, 0.900 m/s
21-1c. 10.0, 25.0 m/s^2
21-2a. 11.0, 17.0 rad/s
21-2b. 4.5, 9.5 cm
21-3a. 20.0, 100.0 m
21-3b. 20.0, 50.0 s
21-4b. 0.5 ,2.5 s
21-5a. 9.0×10^{-9}, $12.0 \times 10^{-9} \pm 0.1 \times 10^{-9}$ s
21-5b. 2.70, 3.40 m
21-6. 100, 300 N
22-1. 2.00, 3.00 km
22-2a. 1.50×10^{-4}, 1.90×10^{-4} W/m^2
22-2b. 82.0, 84.0 dB
22-3. 10, 50
22-4a. 1.0, 5.0
22-4b. 2.0, 20.0
22-5a. 5.0, 70.0 mW/m^2
22-5b. 95.0, 110.0 dB
22-5c. 0.50, 3.00 m
23-1. 600, 850 Hz
23-2. 42.20, 42.70 kHz
23-3a. 0.10, 0.60 m
23-3b. 0.50, 1.50 m
23-4. 2.0, 7.0 g/m
23-5a. 0.400, 0.600 m
23-5b. 300, 450 Hz
23-6. 9.0, 17.0 Hz
23-7. 2.0, 6.0 Hz

Corrections, pp. 104-105, 7th Edition

EXAMPLE 4.13 Connected Objects

Goal Use both the general method and the system approach to solve a connected two-body problem involving gravity and friction.

Problem **(a)** A block with mass $m_1 = 4.00$ kg and a ball with mass $m_2 = 7.00$ kg are connected by a light string that passes over a frictionless pulley, as shown in Figure 4.23a. The coefficient of kinetic friction between the block and the surface is 0.300. Find the acceleration of the two objects and the tension in the string. **(b)** Check the answer for the acceleration by using the system approach.



$a_1 = |\vec{a}_1|$

$a_2 = |\vec{a}_2|$

$a_1 = a_2 = a$

Figure 4.23 (Example 4.13) (a) Two objects connected by a light string that passes over a frictionless pulley. (b) Free-body diagrams for the objects.

Strategy Connected objects are handled by applying Newton's second law separately to each object. The free-body diagrams for the block and the ball are shown in Figure 4.23b, with the $+x$-direction to the right and the $+y$-direction upwards. The magnitude of the acceleration for both objects has the same value, $|\vec{a}_1| = |\vec{a}_2| = a$. The block with mass m_1 moves in the positive x-direction, and the ball with mass m_2 moves in the negative y-direction, [redacted] Using Newton's second law, we can develop two equations involving the unknowns T and a that can be solved simultaneously. In part **(b)**, treat the two masses as a single object, with the gravity force on the ball increasing the combined object's speed and the friction force on the block retarding it. The tension forces then become internal and don't appear in the second law.

Solution

(a) Find the acceleration of the objects and the tension in the string.

Write the components of Newton's second law for the cube of mass m_1:

$$\sum F_x = T_1 - f_k = m_1 a_1 \qquad \sum F_y = n - m_1 g = 0$$

The equation for the y-component gives $n = m_1 g$. Substitute this value for n and $f_k = \mu_k n$ into the equation for the x-component:

$$T_1 - \mu_k m_1 g = \text{[redacted]}\ m_1 a \qquad (1)$$

Apply Newton's second law to the ball, [redacted]

$$\sum F_y = -m_2 g + T_2 = \text{[redacted]} -m_2 a \qquad (2)$$

$$T_1 = T_2 = T$$

Subtract Equation (2) from Equation (1), eliminating T and leaving an equation that can be solved for a_1 (substitution can also be used):

$$m_2 g - \mu_k m_1 g = (m_1 + m_2)\text{[redacted]}\, a$$

$$a\ \text{[redacted]} = \frac{m_2 g - \mu_k m_1 g}{m_1 + m_2}$$

Substitute the given values to obtain the acceleration.

$$a\ \text{[redacted]} = \frac{(7.00\text{ kg})(9.80\text{ m/s}^2) - (0.300)(4.00\text{ kg})(9.80\text{ m/s}^2)}{(4.00\text{ kg} + 7.00\text{ kg})}$$

$$= 5.17\text{ m/s}^2$$

Substitute the value for a_1 into Equation (1) to find the tension T:

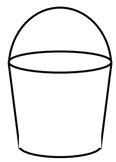
$$T = 32.4\text{ N}$$

Physics 105 – Fall 2009
Homework Set 5

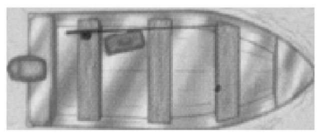
CID: ____________

Score: ________ out of 12 points

5-1. (a)



5-2. (a)



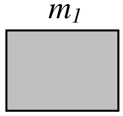
5-3. (a)

5-4. (a)

(b)

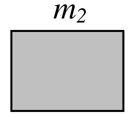
5-5. (a)

m_1

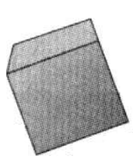


(b)

m_2



5-6.

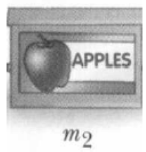


Physics 105 – Fall 2009
Homework Set 6

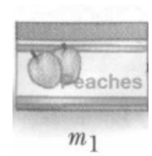
CID: ___________

Score: ________ out of 6 points

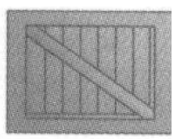
6-3. (a)



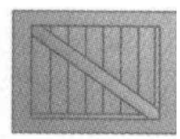
(b)



6-4. (a)



(c)



6-5. (a)

(b)

(c)

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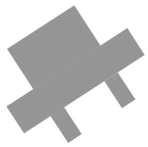
Homework Set 10

CID: ___________

Score: ________ out of 4 points

10-5. (a)



10-7. (a) at point A

(c) at point B

CID: ___________

Score: ________ out of 2 points

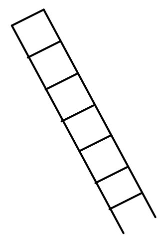
11-6. (a)

Physics 105 – Fall 2009
Homework Set 12

CID: ___________

Score: ________ out of 4 points

12-4. (a)



12-5. (a)

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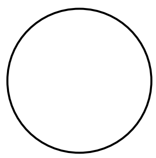
Homework Set 13

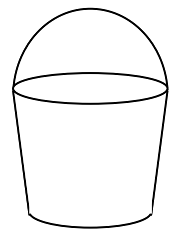
CID: ___________

Score: ________ out of 4 points

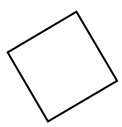
13-2. (a)



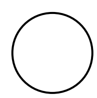
(b)



13-4. (a)



(b)



CID: ___________

Score: ________ out of 2 points

15-4. (a)