BIS 250, Fall 2007
How Things Work: Motion and Mechanics

Meeting Mondays and Wednesdays, 11:00 AM-1:05 PM in UW2-031
Course Homepage: http://faculty.washington.edu/swcollin/courses/bis250/

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Office Hours: Mon & Wed 1:30-3, Tues 11-1, and by appointment

Description and Intended Audience

This course introduces students in the liberal arts to basic scientific concepts needed to understand natural and physical processes and technologies encountered in everyday life. In this, the first of a two-course sequence, we focus on the physics of motion and heat, and the machines that use them to do useful work, such as lifting heavy objects, heating and cooling, and transporting people and things. The course stresses not only scientific concepts and problem solving but also the historical context in which the concepts emerged and stories of the scientists who introduced and developed them. It builds progressively toward an exploration of the physics, history, and future prospects of the automobile, which has unleashed social, cultural, and environmental forces still reverberating across the globe.

A distinctive feature of the course is the integration of conceptual and practical understanding of physical science with the historical context and human drama of invention and discovery. We ask not only how things work, and why they work the way they do, but also how we came to understand the underlying science. Our inquiry thus moves back and forth between readings in physics and the history of science; occasionally, our discussion will extend to social and cultural implications. The course, therefore, is aimed not at students intending to pursue a career in science or engineering, who are urged to take the basic science sequences in chemistry, biology, and physics. Rather it is geared to students whose career interests may require basic understanding of science and technology, and the ability to manage it in organizations and communicate it to a non-technical audience. It is also for those who are simply curious about how and why things work as they do, and those wishing to make informed and responsible decisions about the governance of science and technology as citizens of a democratic society. No previous college-level coursework in math or science is assumed or expected.

Our starting point is how things move. Beginning with Newton's three laws of motion, we will explore the mechanics of falling objects, friction, ramps, and wheels. We then move on to the properties of solids, liquids, and gases; motion of objects through fluids (air and water); and the laws of thermodynamics (the study of heat and its inter-conversion with mechanical, chemical and other forms of energy). We work back and forth between concepts and problem solving, and the history of the growth of our understanding of these

processes; stories of key scientists and inventors are interwoven throughout. We build toward an exploration of mechanical technologies that exploit natural and physical processes to do useful work or provide enjoyment, such as roller coasters, balloons, airplanes, bicycles, and rockets. We finish with a technical and social analysis of the automobile. The course ends with a look at current and future automotive technologies and a critical analysis of the social construction and cultural impacts of "automobility."

Learning Objectives

1. Understand basic physics of devices and processes encountered in everyday life, and be able to explain them clearly in writing and orally.
2. Develop ability to solve problems using basic scientific concepts and simple algebra, and to communicate solutions and explanations in clear, correct English.
3. Understand the historical origins of commonly encountered scientific ideas and inventions.
4. Gain insight into ways in which technologies and ideas emerge and evolve over time.

Requirements

1. Seven problem sets, evenly spaced through the quarter, which ask questions and present problems using the concepts studied. You are encouraged to work together with classmates, but the final result should be your own work. These may be word processed or written out—neatly—by hand. These will be posted on Blackboard 14 days before they are due. Mostly they will be chosen from the exercises and problems at the end of the chapters of the *How Things Work* textbook. Most questions can be answered with a figure and supporting calculations, or at most two or three sentences. Some may require a paragraph or two to answer. In some cases, you may be asked to visit a web site, read a news article, or consult other external sources in answering a question.

2. One essay of between 1250 and 1500 words (5-6 pages, not including reference list, double-spaced, 12-point Times-Roman font, with 1.25-inch margins) explaining in clear, simple prose the origin of a technology or device of your choice, why it was invented (what need, if any, was it intended to serve) and how it works. You will be given a list of suggested choices, along with other details on sources; you may also choose a technology not on the list if you persuade me that it meets the criteria. The main stipulation is that it be a mechanical technology that helps humans by doing work, moving them around, entertaining us, etc. A quick list of examples would include ice skates, in-line skates, skateboards, surf boards, hot air balloons, paper-making, the printing press with moveable type, the bicycle, the jet engine, jet air liner, jet fighter, parachute, suspension bridge, pick-up truck, helicopter, hybrid car, electric car ("automobile" and "airplane" are too general), convection oven, power lawn mower, chain saw, handsaw, hammer, screwdriver, pendulum clock,

wristwatch ("clock" is too general), power vacuum cleaner, refrigerator, elevator, and escalator. You must give me a one-paragraph statement of your topic no later than October 24! You have two options for turning it in:

a. Submit a final report no later than 5 PM on December 12. The grade will be based solely on this draft.
b. Submit a first draft no later than November 26. I will mark it up and return it to you by December 5. Revise it, based on my feedback, and resubmit it no later than 5 PM on December 12. The final grade will be based on both drafts but will give more weight to the final draft.

3. In-class final exam, on December 10. This will consist of 30-40 multiple choice questions similar to the exercises and problems given in the textbook and on your problem sets. A sample exam will be available toward the end of the quarter (mid-late November).

4. In-class quick-quizzes: These may be given at any time in the quarter, always at the start of a class, so be prepared. Each will feature one, two, or three questions taken from the reading for that class or the last previous class. The questions may be multiple-choice or short-answer. ALWAYS BRING YOUR CALCULATORS TO CLASS! There will be 8 of these over the course of the quarter; the lowest 3 grades will be dropped.

5. In-class participation, supplemented by contributions to the course discussion board, which will be maintained on Blackboard beginning the second week of the quarter. Participation on the discussion board is optional: while non-participation won't hurt you if you're actively engaged in class, informed contributions to the discussion will help you, especially if you're shy about speaking up in class. Rules and other details will be posted on the board.

Breakdown of Grading

1. Problem sets (weighted evenly across the seven sets)……...35 %
2. Essay……20
3. Final exam……25
4. In-class quick quizzes……..10
5. In-class participation……10

100 %

Course Texts

Louis A. Bloomfield, *How Things Work: The Physics of Everyday Life, Third* Edition (John Wiley, 2006). ISBN 047146886X

John Gribbin, *The Scientists: A History of Science Told through the Lives of its Greatest Inventors* (Random House, 2002). ISBN 1400060133

General Information and Rules

1. Disability services: If you believe that you have a disability and would like academic accommodations, please contact Disability Support Services at 425.352.5307, 425.352.5303 TDD, 425.352.5455 FAX, or at dss@uwb.edu. You will need to provide documentation of your disability as part of the review process prior to receiving any accommodations.

2. Academic integrity: Submitting others' work as your own is an offense against the community of scholars and learners that make up the university. Plagiarism and other form of cheating that I can substantiate will likely result in a failure grade for that assignment and a referral of the case to the appropriate administrative officer. Know your responsibilities by familiarizing yourself with the student conduct code (http://www.uwb.edu/students/policies/academicconduct.xhtml).

3. Support for quantitative skills: The Quantitative Skills Center is an excellent resource for help with basic computational and problem solving questions. Do not hesitate to contact them if you need support (http://www.uwb.edu/qsc/). For assistance with the writing process, contact the Writing Center (http://www.uwb.edu/writingcenter/)

4. Submitting work: All work should be submitted in class or given to me personally. If you leave something under my door or ask a friend to submit it, assume I haven't received it unless you receive an email acknowledgement from me. Late work will be penalized 0.3 grade points for each day it is late, with the weekend (Friday to Monday) counting as one day.

5. The syllabus may be amended if circumstances warrant to correct errors or adjust the schedule of readings or of assignments. However, unless an error has clearly been made in the original, due dates are never brought forward, and additional required work never added to a syllabus.

6. In grading, I'm obliged to follow UW practice, which is described here: http://www.washington.edu/students/gencat/front/Grading_Sys.html Normally, conversion from the 100-point scale is as follows: 95-100= 4.0, 90=3.5, 85=3.0, 80=2.5 and so on. A grade of 88 would, for example, correspond to a 3.3 on the 4-point scale by this method. I do not curve grades.

Schedule

Readings should be done *before* the class meeting for which they are assigned.

Textbook abbreviations: HTW = How Things Work; TS = The Scientists

Sept 26 Course Introduction

PART I: LAWS OF MOTION

Oct 1 Skating and Inertia; Falling Objects and Projectiles
READ: How Things Work (HWT), Sections 1.1 and 1.2 (pp. 3-21)

Oct 3 Hour 1: Ramps, Work, and Energy Conservation
READ: HTW, Section 1.3 (pp. 22-34)
Hour 2: Seesaws, Levers, and Rotational Motion (begin)
READ: HTW, Section 2.1 (pp. 42-46)

Oct 8 Hour 1: Seesaws, Levers, and Rotational Motion (finish)
READ HTW, Section 2.1 (pp. 47-53)
Hour 2: Wheels, Friction, and Kinetic Energy
READ: HTW, Section 2.2 (pp. 54-62)

TURN IN! Problem Set 1

Oct 10 Bumper Cars, Collisions, and the Conservation of Momentum
READ HTW, Section 2.3 (pp. 63-75).

Oct 15 History 1: Galileo—Father of the Science of How Things Work
READ: TS, middle of p. 72 through p. 103

In-class video: *Galileo's Battle for the Heavens* (segments)
Preview at http://www.pbs.org/wgbh/nova/galileo/

TURN IN! Problem Set 2

PART II: MECHANICS

Oct 17 Hour 1: Springs and Scales
READ HTW, Section 3.1 (pp. 83-89)
Hour 2: Bouncing Balls
READ HTW, Section 3.2 (pp. 90-97)

Oct 22 Hour 1: Carousels and Roller Coasters
READ: HTW, Section 3.3 (pp. 98-107)
Hour 2: Bicycles
READ: HTW, Section 4.1 (pp. 113-120)

TURN IN! Problem Set 3

Oct 24 Rockets and Space Travel
READ: HTW, Section 4.2 (pp. 121-135)

LAST DAY FOR SUBMITTING ESSAY TOPIC!

Oct 29 History 2: Kepler and Newton--Founders of Classical Mechanics
READ: TS, middle of p. 50 through p. 67 (Kepler)
READ: TS, pp. 175-192 (Newton)

In-class video: *Day the Universe Changed*, Part 5 (segments) or *Newton's Dark Secrets*--preview at http://www.pbs.org/wgbh/nova/newton/

TURN IN! Problem Set 4

PART III: GASES AND FLUIDS

Oct 31 Hour 1: Balloons, Air Pressure, and Buoyancy
READ: HTW, Section 5.1 (pp. 140-150)
Hour 2: History 3--Solving the Riddles of the Vacuum, Air, and Air Pressure
READ: TS, p. 115 to middle of p. 118 (on Gassendi, Descartes)

Nov 5 Hour 1: Pumps, Water Pressure, and Fluid Flow
READ HTW, Section 5.2 (pp. 151-161)
Hour 2: History 4--Solving the Riddle of Gases
READ: TS, middle of p. 126 to bottom of p. 142 (on Boyle)

Nov 7 Hour 1: Garden Watering; Faucets, and Nozzles
READ HTW, Section 6.1 (pp. 167-177)
Hour 2: Baseballs, Golf Balls, and Aerodynamics
READ HTW, Section 6.2 (pp. 178-185)

TURN IN! Problem Set 5

Nov 12 HOLIDAY

Nov 14 Airplanes, Jet Engines, and Flight
READ HTW, Section 6.3 (pp. 186-198)

PART IV: HEAT AND THERMODYNAMICS

Nov 19 Hour 1: Woodstoves, Heat, and Heating Systems
READ: HTW, Section 7.1 (pp. 205-214)
Hour 2: History 5--Unraveling the Mystery of "Heat"
READ: TS, middle of p. 300 to middle of p. 312

TURN IN! Problem Set 6

Nov 21 Water, Steam, and Ice
READ: HTW, Section 7.2 (pp. 215-223)

Nov 26 Hour 1: Air Conditioners and the Laws of Thermodynamics
READ: HTW, Section 8.1 (pp. 239-248)
Hour 2: Beginnings of the Science of Thermodynamics
READ: TS, middle of p. 381-top of p. 390

TURN IN FIRST DRAFT OF ESSAY (if you've chosen this option)

Nov 28 Internal Combustion Engines and Automobiles
READ: HTW, Section 8.2 (pp. 249-259)

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*Note: The starred articles assigned below on Dec 3 and 5 will be accessible from the library e-reserve page by the end of the second week of the quarter.

Dec 3 Automotive Technology, Then and Now
*READ: D.C. Mowery & N. Rosenberg, Paths of Innovation, Chapter 3, p. 47 to middle of p. 59.
*READ: J.J. Romm and A.A. Frank, "Hybrid Vehicles Gain Traction," *Scientific American* (April 2006): 72-79.

In-class video (tentative): *Who Killed the Electric Car?*
Preview at http://www.sonyclassics.com/whokilledtheelectriccar/

TURN IN! Problem Set 7

Dec 5 Hour 1: Discuss—The Future of Automotive Technology
*READ: J. Ogden, "High Hopes for Hydrogen," *Scientific American* (September 2006).
Hour 2: Review for Final Exam

One or two optional review sessions will be offered between the last day of class and the date of the final exam.

Dec 10 FINAL EXAM (In-Class)

Dec 12 ALL ESSAYS TO ME BY 5 PM!