NS 540 Concepts in Physics I: Force and Motion
Course Schedule

N.B.: The schedule below has not yet been adapted to the blended schedule of online and in-class meetings. Course readings may vary between course offerings.

Session 1: Describing motion

Sections from Cutnell & Johnson: Sections 2.1, 2.2, 2.7
Activities: Motion worksheet; Lab activity – Position, Velocity, and Acceleration
History/Philosophy Activities: Introduction to Aristotle's theory of motion. Discussion of excerpts of his *Physics*.
Assignments for next session:
WebAssign: Assignment 1

Session 2: Motion with constant acceleration

Sections from Cutnell & Johnson: Sections 2.3 – 2.8
Active Physics: Sports, Chapter 1, Activity 5 – Acceleration
Activities: Lab activity – Motion with Constant Acceleration
Assignments for next session:

- Toulmin, S. and Goodfield, J. (1962). The premature synthesis. In *The fabric of heavens: The development of astronomy and dynamics.* (pp. 90 – 105) New York: Harper & Row.

Session 3: Forces in 1-Dimension

Sections from Cutnell & Johnson: Sections 4.1 – 4.8; 4.10
Activities: Lab activity – Forces between Carts; Newton's Laws; Free-body diagrams
History/Philosophy Activities: Class discussion on assigned reading 'The premature synthesis'. Discussion of Zeno's paradoxes and Aristotle's response to this conceptual challenge to motion.
Assignments for next session:
WebAssign: Assignment 2

Session 4: Motion in Two Dimensions

Sections from Cutnell & Johnson: Sections 1.5 – 1.9; Sections 3.1 – 3.3
Active Physics: Sports, Chapter 1, Activity 8 – Projectile Motion
Activities: Vectors and vector addition; Independence of X and Y
Assignments for next session:

- Galileo, G. (1959). Accelerated motion. (excerpts from *Dialogues concerning two sciences*). In Shamos, Morris (ed.) *Great Experiments in Physics*. New York: Holt, Rinehart and Winston.

- Newton, I. (1959). The laws of motion. (excerpts from the Principia). In Shamos, Morris (ed.) *Great Experiments in Physics*. New York: Holt, Rinehart and Winston.

Session 5: Projectile Motion

Test 1: One hour.

Sections from Cutnell & Johnson: Sections 3.5

Activities: Analyzing projectile motion; Monkey/hunter; Lab activity – Projectile Motion

History/Philosophy Activities: Group and class discussion on Galileo's understanding of acceleration in his Dialogues. A comparison of Aristotle's, Galileo's and Newton's understanding of *force*.

Assignments for next session:

WebAssign: Assignment 3

Session 6: Forces in 2-Dimensions

Sections from Cutnell & Johnson: Sections 4.9; 4.11 – 4.13

Activities: Friction; Free-body diagrams; Applying Newton's Second Law

Assignments for next session:

- Toulmin, S. and Goodfield, J. (1962). The creation of mechanics. In *The fabric of heavens: The development of astronomy and dynamics.* New York: Harper & Row.

Session 7: Relative Velocity; Review

Sections from Cutnell & Johnson: Section 3.3

Activities: Relative velocity in 1-D; Relative velocity in 2-D; Review force concepts

History/Philosophy Activities: Group and class discussion on projectile motion contrasting Aristotle's, Galileo's and Newton's accounts.

Assignments for next session:

WebAssign: Assignment 4

Session 8: Beyond Force

Sections from Cutnell & Johnson: Section 7.1; 6.1 – 6.4

Activities: Impulse; Work and Kinetic Energy; Lab activity – Energy and Work

Assignments for next session:

Summaries of two papers

- Halloun, I. A. and Hestenes, D. (1985). Common sense concepts about motion. *Am. J. Phys*, 53, 1056 – 1065.
- Clement, J. (1982). Students' preconceptions in introductory mechanics. *Am. J. Phys.*, 50, 66 – 71.

Session 9: Momentum Conservation

Test 2: One hour.

Sections from Cutnell & Johnson: Section 7.2 – 7.6

Active Physics: Sports, Chapter 2, Activity 7 – Collisions

Activities: Momentum conservation; collisions

Science Education Research Activity: overview; group and class discussion on the assigned Halloun & Hestenes and Clement articles.

Assignments for next session:

WebAssign: Assignment 5

Due before next session: Participate in on-line discussion of the papers selected for preparing your curriculum design project or literature review project:

On motion in 1-D (these are short and related):

- Trowbridge, D.E. & McDermott, L.C. (1980). Investigation of student understanding of the concept of velocity in one dimension, *Am. J. Phys,*. 48(12),1020–1028.
- McDermott, L.C., Rosenquist, M.L. & van Zee, E.H. (1987). Student difficulties in connecting graphs and physics: Examples from kinematics. *Am. J. Phys*., 55 (6), 503 – 513.
- Rosenquist, M.L. & McDermott, L.C. (1987). A conceptual approach to teaching kinematics. *Am. J. Phys*., 55 (5) 407 – 415.

On other misconceptions in mechanics:

- McDermott, L.C., Shaffer, P.S. and Somers, M.D. (1994). Research as a guide for teaching introductory mechanics: An illustration in the context of the Atwood's Machine, *Am. J. Phys,*. 62 (1), 46 – 55.
- McCloskey, M. (1983). Intuitive Physics. *Sci. Am.*, 248 (4), 122-130.

Session 10: Energy

Sections from Cutnell & Johnson: Sections 6.5 – 6.8

Activities: Lab activity – Collisions.

Assignments for next session:

Continue reading papers for projects.

Session 11: Energy Conservation

Sections from Cutnell & Johnson: Section 6.10

Active Physics: Sports, Chapter 1, Activity 10 – Pole Vault

Activities: Springs, Hooke's Law, Elastic Potential Energy; Energy Conservation

Science Education Research Activity: Work in pairs planning culminating projects.

Assignments for next session:

WebAssign: Assignment 6

Session 12: Combining Momentum and Energy

Sections from Cutnell & Johnson: Sections 7.3, 7.6

Activities: Ballistic pendulum-type situations; Comparing analysis methods

Science Education Research Activity: Students' presentations

Session 13

Test 3: One hour.
Cumulative Take home examination.
Science Education Research Activity: Students' presentations.
Hand in journals.
Course debriefing.
Course evaluations.

Bibliography

Selections from primary sources

Aristotle (1989). Book II. (excerpts from *Physics*). In Matthews, M. (Ed.) *The scientific background to modern science. Selected readings*. (pp. 5 – 26). Indianapolis: Hackett.

Galileo, G. (1959) Accelerated motion. (excerpts from *Dialogues concerning two sciences*). In Shamos, M. (Ed.) *Great Experiments in Physics*. New York: Holt, Rinehart and Winston.

Newton, I**.** (1959). The laws of motion (excerpts from the *Principia*)**.** In Shamos, M. (ed.) *Great Experiments in Physics***.** New York: Holt, Rinehart and Winston.

Selections from secondary sources

Bostock, D. (1996). Introduction: Aristotle's cosmology. In Aristotle. *Physics*. (pp. xv, xvii) Oxford: Oxford Univ. Press.

Toulmin, S. and Goodfield, J. (1962) The premature synthesis (Chap. 3); The creation of mechanics (Chap. 8). In *The fabric of heavens: the development of astronomy and dynamics.* (pp. 90 – 105; 210 - 227). New York: Harper & Row.

Selections from Physics Education Research Literature

Trowbridge, D.E. & McDermott, L.C. (1980). Investigation of student understanding of the concept of velocity in one dimension, *Am. J. Phys., 48* (12), 1020–1028.

McDermott, L.C., Rosenquist, M.L. & van Zee, E.H. (1987). Student difficulties in connecting graphs and physics: Examples from kinematics. *Am. J. Phys., 55*, 503 – 513.

Rosenquist, M.L. & McDermott, L.C. (1987). A conceptual approach to teaching kinematics. *Am. J. Phys., 55* (5) 407 – 415.

McDermott, L.C., Shaffer, P.S. and Somers, M.D. (1994). Research as a guide for teaching introductory mechanics: An illustration in the context of the Atwood's Machine, *Am. J. Phys., 62* (1), 46 – 55.

McCloskey, M. (1983). Intuitive Physics. *Sci. Am., 248* (4), 122-130.

Halloun, I. A. and Hestenes, D. (1985). Common sense concepts about motion. *Am. J. Phys., 53,* 1056 – 1065.

Clement, J. (1982). Students' preconceptions in introductory mechanics. *Am. J. Phys, 50,* 66 – 71.
