Preparation Notes for Chapter 7 and 8 (Newton's Laws; 3-4 classes)

Work

Reading: 7.1-7.3; Problems 21, 61

1. "Give a verbal definition of work" –> (an energy transfer) W=**F.d** = F d cos(θ); scalar, units N.m = J
2. "Discuss the work done by a parent in pushing a stroller completely around the block. (Clears up whether the d in the work equation is total displacement or whether you have to do it in pieces.)
3. sketch graph of F versus x as below for the parent pushing the stroller in a straight line, but over ice and then through mud (as well as dry pavement) (variable F); "how would we determine the work done in this case"; discuss; give integral form for work
4. Student presentation on Hooke's Law
5. Derive equation for work done by a spring; $\mathbf{F}_s$ = - k **x**; consider case where spring starts compressed to -x_i and extends to +x_f while pushing a block which is attached to it – what work does it do on the block?

Kinetic energy and the work-kinetic energy theorem; power

Reading 7.4-7.5; Problems 39, 41; 47, (65)

(1) define kinetic energy K; state work-KE theorem: W = K_f - K_i "How could we modify this equation to show the contribution of work done by friction explicitly?" students may have no clue; may also reveal confusion about sign of work done by friction

2. Student presentation on Work and the Baseball Pitcher

3. Student presentation on power (i.e. going up stairs)'

(5) (In fall only) What is the power associated with food intake of 2500 kcal/day (1 kcal = 4186 J)? why is our room so hot?

(6) Do problem 41 in class

Other suggestions:

(1) Quick Quiz 7.5 Can frictional forces ever increase an object's kinetic energy ? Give the example of a crate sitting on an accelerating truck (assuming that the crate doesn't slip)

(2) "give a verbal definition of power" P=dW/dt = **F.v** ; units Watts = J/s

(3) Puzzler at start of Chapter 7 could be a good discussion topic.

(4) Power of Niagara Falls (1.2E6 kg/s with height of 50 m) and convert to number of 60 W light bulbs.

Potential Energy

Reading: 8.1-8.4; Problems 13, 59

(1) "what is work done by gravity as ball falls from one height to another?" W = **F.d** = mgy_i - mgy_f; define U_g = mgy gravitational potential energy; W = U_i - U_f = - ΔU (ΔU = U_f - U_i)

(2) Student presentation on Elastic Potential Energy

(3) puzzler – "Ring the Bell" (see picture at start of Chapter 8) – students discuss what is the best strategy? (handy to have a photocopy of picture)

Conservation of Mechanical Energy

(1) Define mechanical energy E = K + U; for an object, K+U = constant if there are only conservative forces present "define conservative forces, or give an example?" work done is independent of path; no work done if the path is a closed loop

(2) Student presentation on conservation of energy and the bicycle

(3) "give examples of systems where E is conserved (or very close to conserved)"

Effect of Non-Conservative Forces on Mechanical Energy

Reading 8.5-8.7; Problems 37, 39

(1) effect of non-conservative forces on mechanical energy: applied force: W_{app} = Δ(K+U) (can be positive or negative) kinetic friction: W_{fr} = - F_{fr}d = Δ(K+U)

(2) Discussion: "we use chemical energy in walking up stairs and therby gain potential energy. Do we regain this energy as we walk downstairs? If not, where does it go?"

(3) Student presentation on power and energy in design of mountain roads.

(4) Do problem 37 in class

Relationship between conservative forces and potential energy

(I have so far just assigned this as reading, but not discussed it in class; seems too abstract for the current flavor of the course)

- Obtain the relationship, solve problem 8.41 as an example (this is the important case corresponding to the gravitational and electric forces).

- Describe the three types of equilibrium and ask the students to provide examples; I like to do problem 8.46

Suggested Presentation Topics

(1) Hooke's law

(2) Work and the Pitcher (Ch7, Q10)

(3) Power

(4) Power and Energy in Design of Mountain Roads (Ch8, Q1)

(5) Conservation of energy for a freely falling object

(6) Elastic potential energy

(7) Conservation of energy for a bicyclist gliding down a hill

(8) Compare the power and energy requirements of a mini-van and a compact car

Content of Chapter 7 and 8

Work: for a constant force; for a varying force (in general and for a spring)
Kinetic energy and the work-kinetic energy theorem, with and without friction
Power
Potential energy: gravitational, elastic
Mechanical energy E; Conservation of E; conservative forces
Non-conservative forces; effect on mechanical energy
(optional?) Relationship between conservative forces and potential energy
(optional?) Equilibrium

(Concept Maps for Chapter 7 and 8 are also available)