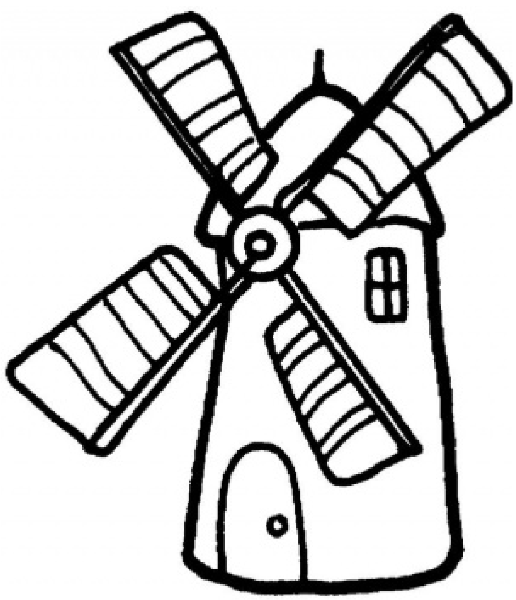
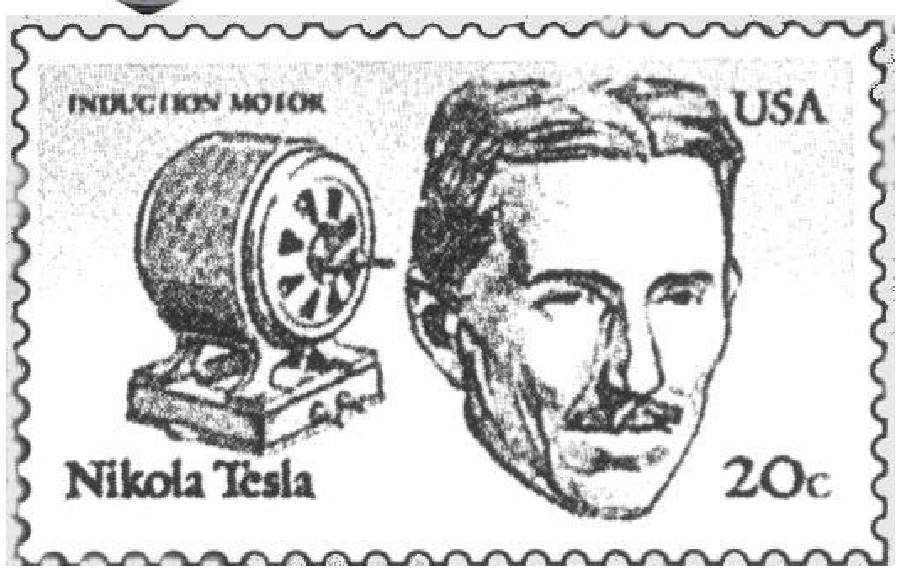
Physics Traditional 1314 Williams

Work, Energy & Power

Chapter 5



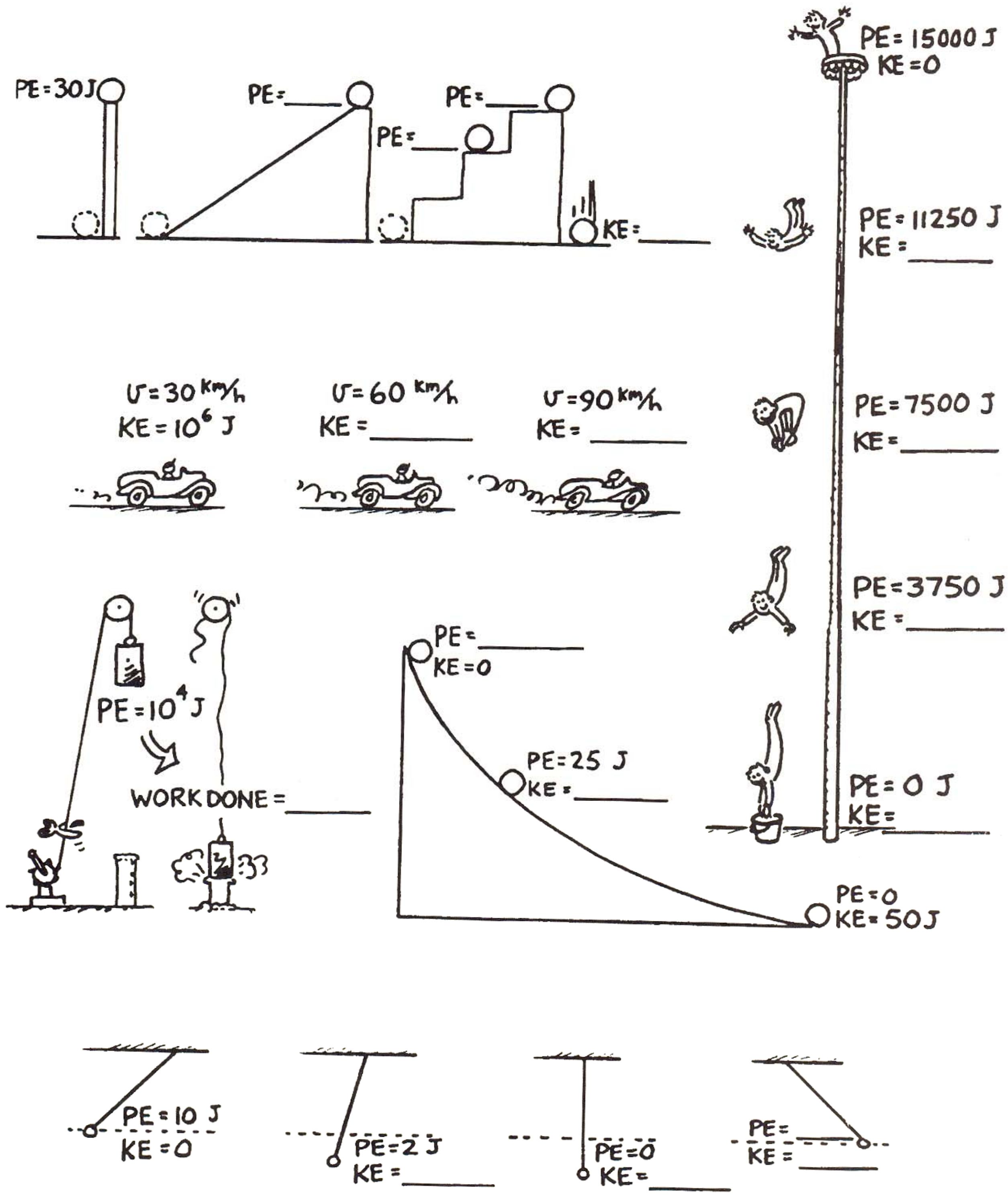


Name Period Date

Concept-Development Practice Page **8-2**

Conservation of Energy

1. Fill in the blanks for the six systems shown.



Name:___________________________________No:________

Lab: Pop-Up Toy Phun! ☺

Purpose:

Using the conservation of energy, calculate how fast a pop-up toy is moving just before it hits the table. List all steps in your procedure, show your data neatly in a table, and show a complete sample calculation on this lab sheet.

Power-up Practice problems – Show **all work** for full credit.

Use your packet and any notes as resources.

1. You lift 10 bags of grain weighing 500 N in 45 seconds. Your friend lifts 15 bags of 350 N grain in 1.0 minutes. You lift your grain to 3 meters and he lifts his grain up to a height of 4 meters. Find out how much power is required to do your task and you buddy's too.

Show your work here:

Your power is ______________ watts

Your buddy's power is ______________ watts

2. How much work is done by you if your mass is 75 kg and your go up the 2,109 steps (I looked this up) of the Sears Tower? Assume each step is 21 cm and assume you are an Earthling bound by gravity whose acceleration is 9.8 m/s^2.

Show your work here:

The work you do is ______________ Joules

Name:________________________________No:________

POWER UP!

Objective: The purpose of this activity is to determine your power rating for running up a flight of stairs and to compare your power rating with your classmates and an everyday household object.

Purpose Questions:

1. What variables do you need to know to determine your Power for running up a flight of stairs?

____

2. What variables do you need to know to determine the Work you do to run up a flight of stairs?

____

3. What is the Force you need to exert to move up a flight of stairs equal to?

____

Materials:

stopwatch meter stick your muscles your brain calculator / pencil

Data: *(show sample calculations for Trial #1)*

Trial #	Time (s)	Force (lbs)	Force (N)	Distance (m)	Work (J)	Power (W)	Power (hp)
1							
2							
3							

Useful facts:

2.205 pounds (lbs) = 9.81 Newtons (N)
100 cm = 1 meter (m)
746 Watts = 1 horse power (hp)
1 Calorie (food) = 1000 calories (heat)
1 calorie = 4.18 J

Sample Calculations (4 Steps!):

Mas: (spanish for more)…SHOW all work for calculations

1. How fast would you need to run up the stairs to demonstrate 1 hp? (I'm looking for time in seconds)

2. Running up the stairs 1,000 times would burn
    a. How many Joules?
    b. How many Calories?

3. If a strong man CAN easily demonstrate 1 hp, does that mean he's as strong as a horse? Explain and use "8 hours" or "all day" in your explanation.

Physics bowling ball on a ramp challenge – **Names:___________________**

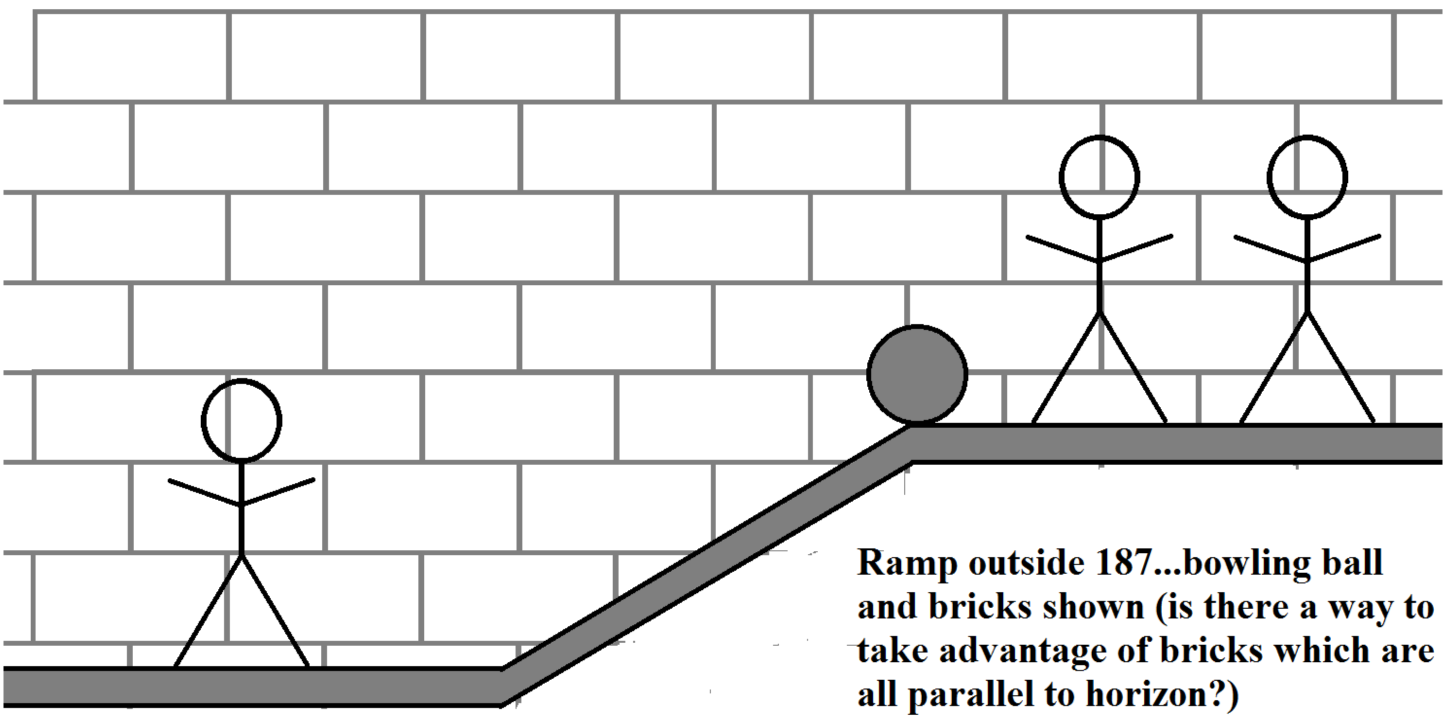
Each Group turns this in.
Write equations for PE and KE and what each variable stands for below:

PE = ______________

KE = _____________________

How long will it take for the ball to go down the ramp?

Take 10 minutes to plan what to measure, send one representative out there to make measurements. Representative will have two minutes to make measurements and a few meter sticks. All you get are meter sticks and your cleverness. Come back within two minutes and check back in with teacher. Start computing the time it should take for a ball to roll down the ramp. Good luck!



Bowling ball challenge computations

Show all computations here:

1. Show how you used conservation of energy (GPE = mgh, KE = 1/2 mv^2)

2. How long is the ramp?

3. How fast do you think the ball will be going when it reaches the BOTTOM of the ramp?

4. What is the AVERAGE speed of the ball?

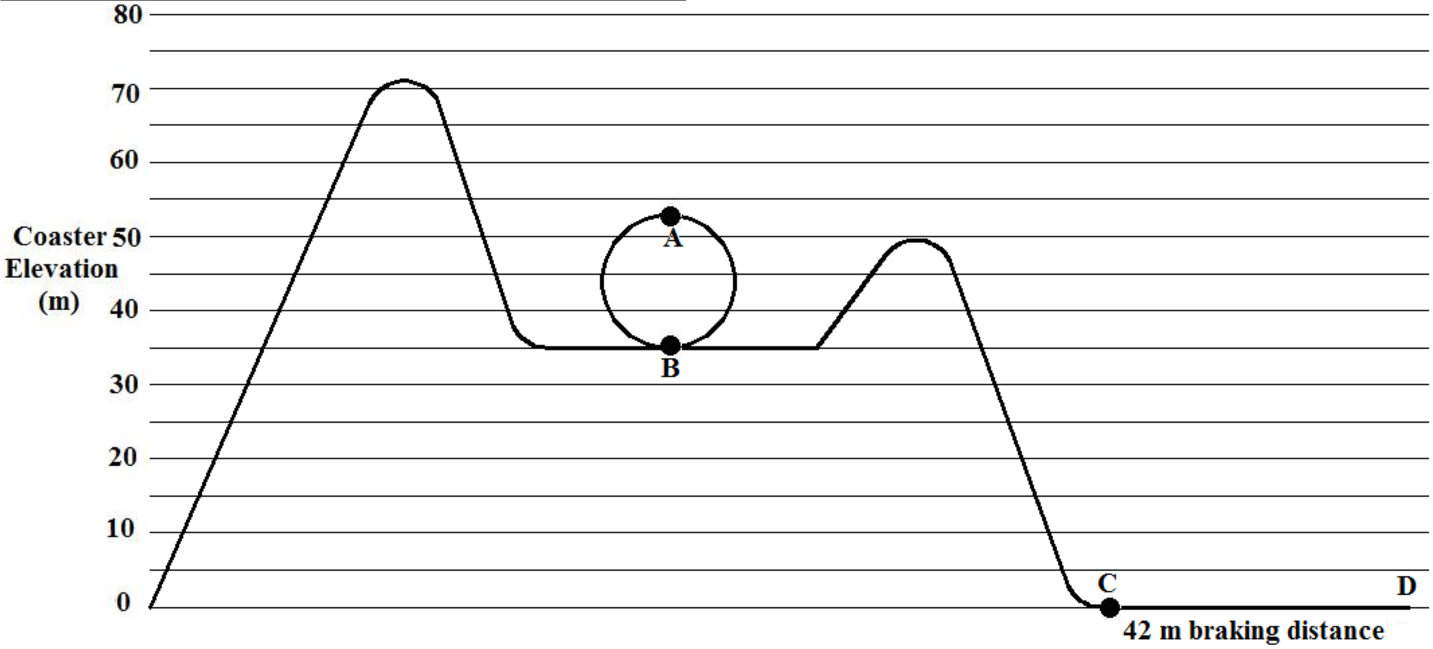
5. How long will it take to go down the ramp?

Work, power, weight, cost of energy HW Quiz – use correct UNITS!

1. Mike pushes Anne on frictionless roller skates. Initially, Anne is motionless and after pushing her she is moving at 6.0 m/s. Assume her mass is 55 kg.
    a. How much work did Mike do?
    b. If Mike extends his arm by 40 cm when he pushes, how hard did he push Anne?
    c. How much does Anne weight?
    d. How high of a ramp could Anne coast up (maximum possible height)?

2. My driveway is 30 m long It takes me ten snow throws to clear each meter of driveway length. If on average each time I lift the snow to a height 0.80 m from ground level and the mass of a typical shovel of snow is 10 kg then
    a. How much work did I do to clear my driveway?
    b. How powerful am I if it takes me 30 minutes to do the job?
    c. If I use a snowblower instead, what would be the energy cost (at local rate you should know!)?

Coaster power, energy, braking practical problem



The following ride sketch has been sent to the rollercoaster design center for your physics consultant expertise. You are told a 5,000 kg coaster must be lifted to the shown height in 15 seconds. Psychologists have the opinion that 15 seconds will create the optimal suspense going up the first hill. Red-out and black-out specialists need to know how fast the coaster is going at points A and B to confirm they won't rider sickness problems. You also need to specify the magnitude of the braking force required to stop in 42 m. Others on the coaster design team will allow for brake wear over time, but for now you need to provide them with the required braking force. Please answer the following questions: (and below and on the back, show your work!)

1. How powerful must your first-hill motor be in horsepower? 311 hp ______________________________
2. How fast are you going at points A, B and C? 18.8 m/s; 26 m/s; 37.3 m/s _____________
3. How much KE do you have at point C (assume frictionless)? 3.48×10^6 J __________________________
4. What is the magnitude of the braking force required? ____________________________________

PE of first hill = 5000 * 9.8 * 71 = 3.48×10^6 J, Power = W/t = 3.48×10^6/15 = 232,000 W = 311 hp

Conservation of energy or v = √(2gh) = √(19.6 * (71 - 53)) = 18.8 m/s; 26 m/s; 37.3 m/s

3.48×10^6 J

W = F d, 3.48×10^6 J = F (42) → F = 83,000 N (19,000 lb)

Unit 05 – Vocabulary and Equations – Work, Energy & Power

Vocabulary:
previous vocabulary
Joule (J), Newton (N), Watt (W), Horsepower (hp)
Work (W)
Force (F)
Weight (Wt.)
kinetic energy (KE)
potential energy (PE)
gravitational potential energy (GPE, PE)
mechanical energy (ME)
elastic energy, spring constant
internal energy, heat
efficiency

Themed:
lever, inclined plane, pulley
isolated system

Symbols:
P, W, t, PE, KE, GPE, m, g, h, v, k

Equations & constants:
You get these on test:

$v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$

1 mi. = 1609 m =5280 ft
1 m/sec = 2.24 mph
0.4536 kg = 1 lb

$\Delta x = v_0 \Delta t + ½ at^2$, $v_f^2 = v_i^2 + 2a \Delta x$

$v = v_0 + a \Delta t$ (v means v_f)

$v_x = v \cos\Theta$, $\Delta x = v_x t$, $v_i = v \sin \Theta$, $\Delta y = v_y t$

$F = ma$ $F_f = \mu F_n$ $p = mv$ $I = \Delta P = F\Delta t$

$W = Fd$ $P = W/t$ $PE = mgh = mg\Delta y$ $KE = ½ mv^2$

$W = ½ kx^2$ $F = kx$

1 hp = 746 W, 3,600,000 J = 1 kW-hr, 1 lb = 4.45 N

Themed: $AMA = F_{out}/F_{in}$ $IMA = d_{in}/d_{out}$

$P = F v$ $Wt. = mg$

Unit Objectives - Williams

1. I understand all the vocabulary & math of this unit and all demos, videos, equations, and class assignments.
2. I remember objectives & vocabulary from previous units.
3. I understand that positive work requires a parallel force components and increases the energy of the object
4. I can compute work where forces are at various angles relative to the displacement of the object
5. I know that work can be negative and what this implies
6. I can compute work, power and various energy forms in absolute and relative terms based on speed, mass, height and force direction values or changes in these values
7. I know conservation of energy including ME & friction converts useful energy (ME) to internal energy
8. I know common forms of energy and can identify them
9. I am able to compute power and can explain how it differs from work
10. I have memorized the current cost of energy locally per kilowatt hour
11. Given information on work, power, time etc., I can compute energy cost using the factor label method
12. I understand the relationship between work, force, energy and distance for brakes
13. I can recognize the relationships between W, P, t, d, K, etc graphically
14. I understand elastic systems including how force and stored energy vary with elongation/compression

DuPage ROE Objectives

401. I can identify if masses have kinetic and/or potential energy at a given instant.
402. I can identify potential energy as a function of position.
403. I can identify kinetic energy as a function of velocity.
404. I can calculate gravitational potential energy and kinetic energy.
405. I can identify an isolated system and analyze it.
406. I can identify that energy is transferred between different forms.
407. I can solve problems using conservation of mechanical energy.
408. I can apply the mathematical definition of work as the product of Force and displacement.
409. I can identify situations of positive work, negative work, zero work.
410. I can identify work as a change in energy.
412. I can analyze the rate of energy change of a system in terms of power.

<u>Physics Calendar - Work, Energy & Power: 2013-14(Williams) - Chapter 5 (11 days)</u>

Bold and underlined means put in journal notes (for any problems: Show your work!);

1	Mo:10/28/13	GOALS: Intro work and energy • Demo: weights, rubber band, Ball O' Death, What power is • How to solve some problems, show Powerup lab, HW time • 2nd period: review Lockdown procedures	• **<u>(05-01)</u>** Notes: Work, Power, ME, KE, PE, Conservation of Energy**:3,5,6,7,8** • **<u>(05-02)</u>** p 162: 1,3,4
2	Tu:10/29/13 Lockdown drill	GOALS: HW Q's, Powerup lab, HW time • Notes quiz? Bowling ball ramp challenge? Any HW Q's? • Do Powerup lab, finish and then HW time	• **<u>(05-02A)</u>**Notes: Power up lab**:9** • Sheet: R05-01
3	We:10/30/13	GOALS: Cost of energy, review & Group Quiz • Learn kW-hr problems, review/questions • Group quiz (review is always fair game)	• **<u>(05-03)</u>** Notes: Cost of energy in Hinsdale area (your house)**: 10,11** • **<u>(05-04)</u>** p 163 : 1-6
4	Th:10/31/13	GOALS: Work done by spring systems • Discuss spring systems • Rubberband lab • Work time	• **<u>(05-05)</u>** Notes: Work done by a spring system**:13,14** • **<u>(05-06)</u>** p 172: Prac. D and Section review 1-3
5	Fr:11/01/13	GOALS: Sliding blocks lab (braking work), review • Discuss negative work (braking) • Sliding block lab • Possible Group sheet for grade	• **<u>(05-07)</u>** Notes: How much work brakes do**:12**
6	Mo:11/04/13	GOALS: Review, pop-up toy lab, Group Quiz • Review (questions or clickers) • Show pop-up toy lab • Do lab and group quiz questions, both due at class end	• **<u>(05-08)</u>** p 181: Prac. F, 1-5
7	Tu:11/05/13	GOALS: New and old problem mix • Group quiz: New and old problem mix, due by class end • Decide what value for BBall game tomorrow (EC for winning group? 5 pt assignment with 90% avg? group quiz instead?) • HW time	• **<u>(05-09)</u>** p 172: 1-4
8L	We:11/06/13	GOALS: Basketball contest (ok, not real BBall) • BBall review game and/or group quiz and/or clix • Class management chooses tomorrow's review format • HW time	• Sheet: R05-02
9	Th:11/07/13 PT Conf 6-9	GOALS: Review for test (It's MONDAY…don't come to class surprised!) • Class choice?	• Study for test
10ED	Fr:11/08/13 11:30 dism	GOALS: Being changed to non-attendance day? • I think you get to sleep in!	• WARNING-Monday Exam!
11	Mo:11/11/13	• Work, Energy & Power exam	•