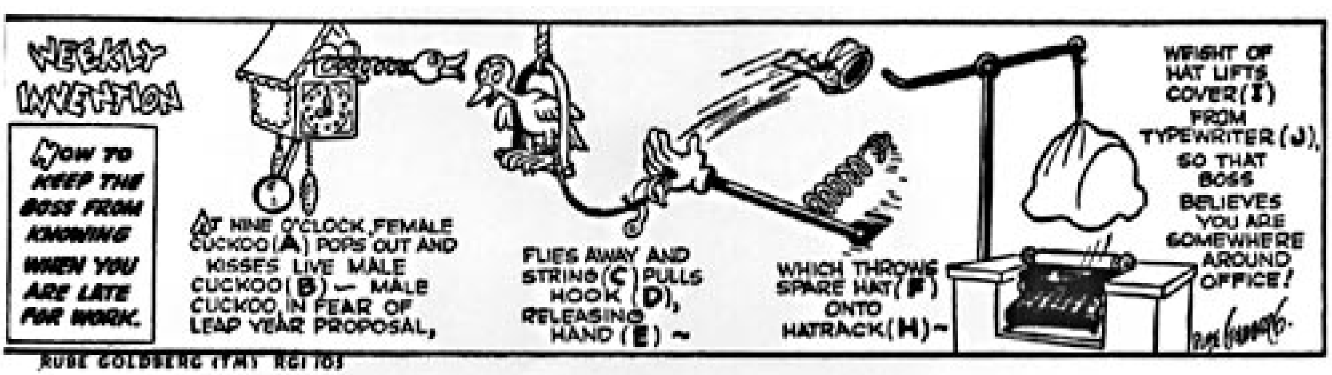
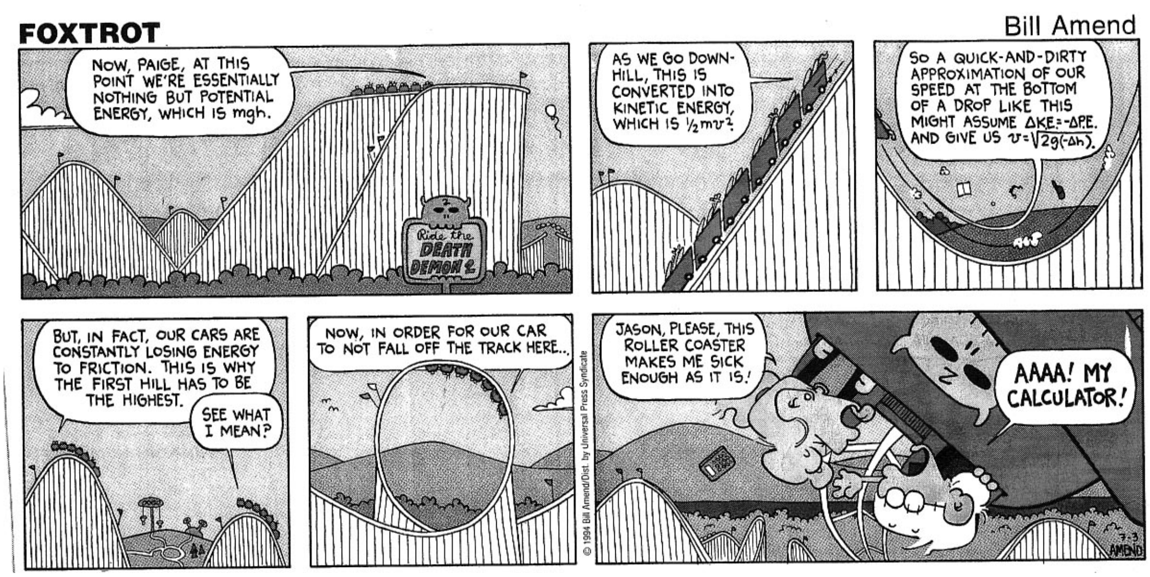
Physics Regular 1314 Williams

# Rollercoaster Physics: Energy

## Packet 0-1 / Chapter 6



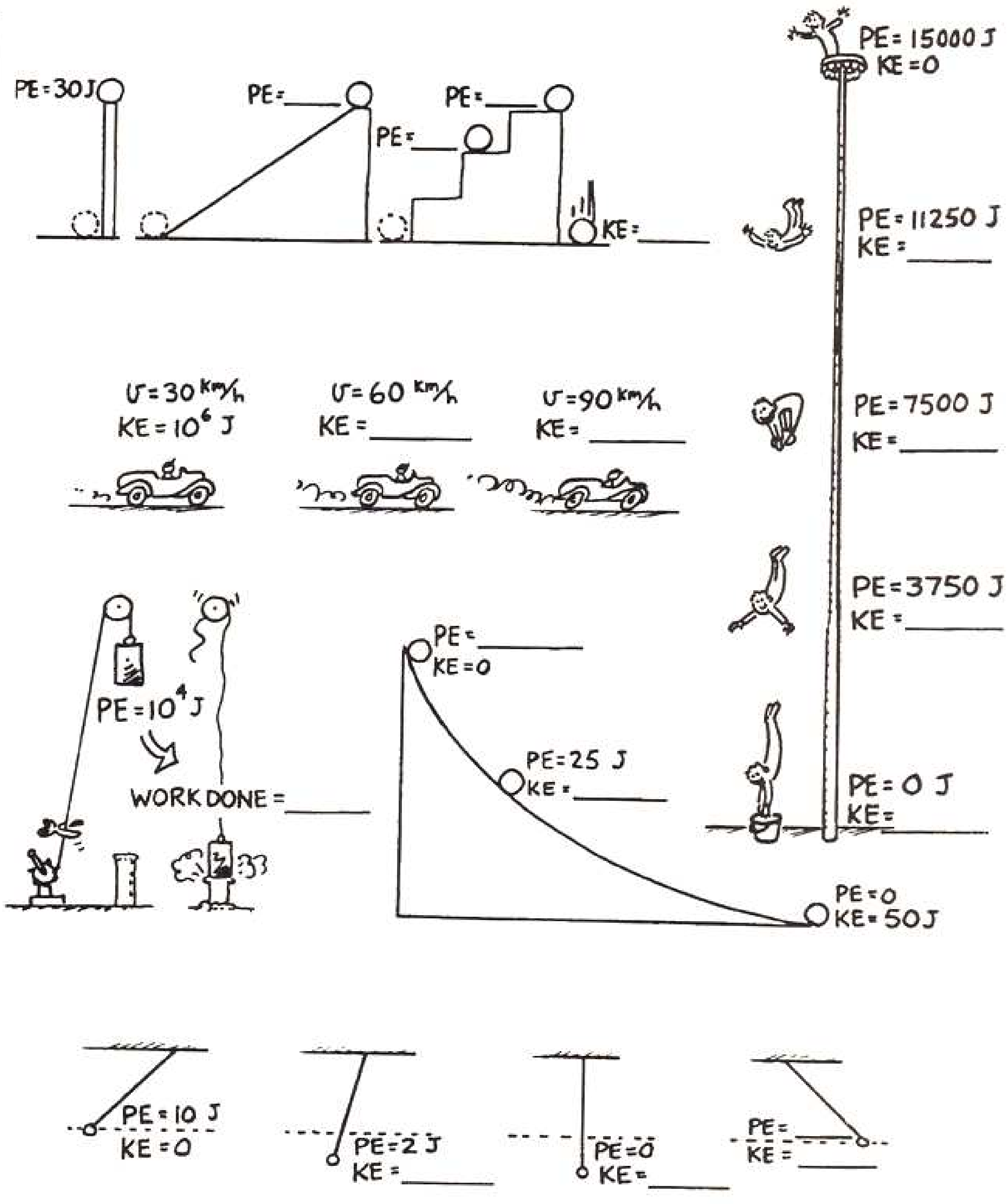



Name Period Date

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

## *Conservation of Energy*

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



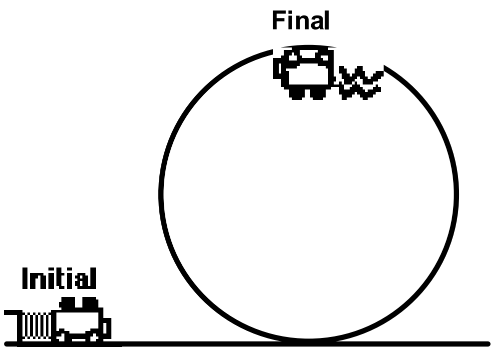
Name

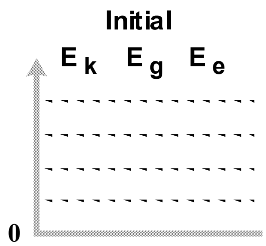
# Unit VII: Worksheet 3a

For each situation shown below:

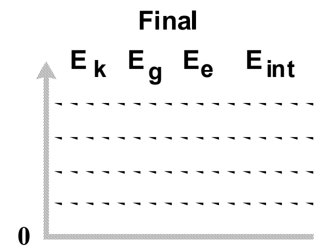
1. Show your choice of system in the energy flow diagram, unless it is specified for you.
   ***Include: kinetic (speed), gravitational (position), elastic (spring), internal (friction)*
2. Total energy is 400 kJ.
3. Sketch an energy bar graph for the initial situation.
4. Then complete the analysis by showing energy transfers and the final energy bar graph.

## 1. With friction

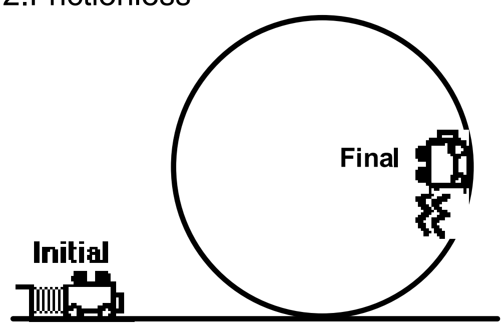


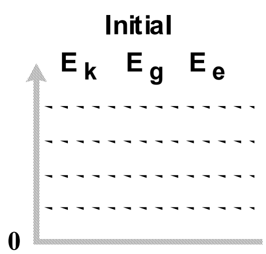




Energy Flow Diagram

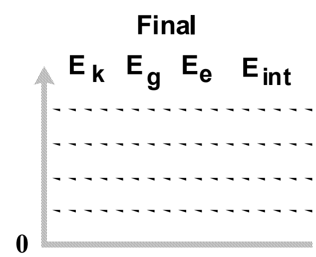



## 2.Frictionless



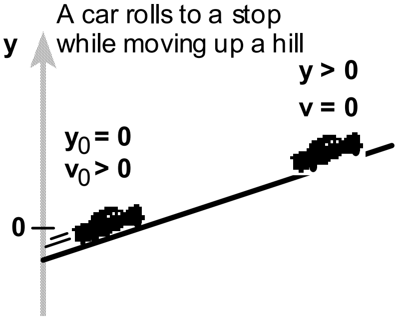



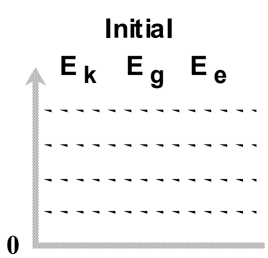

Energy Flow Diagram



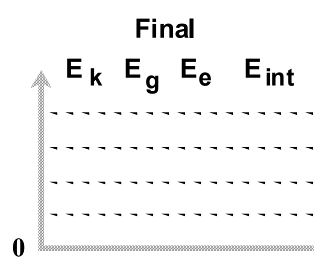

## 3. With friction

A car rolls to a stop while moving up a hill

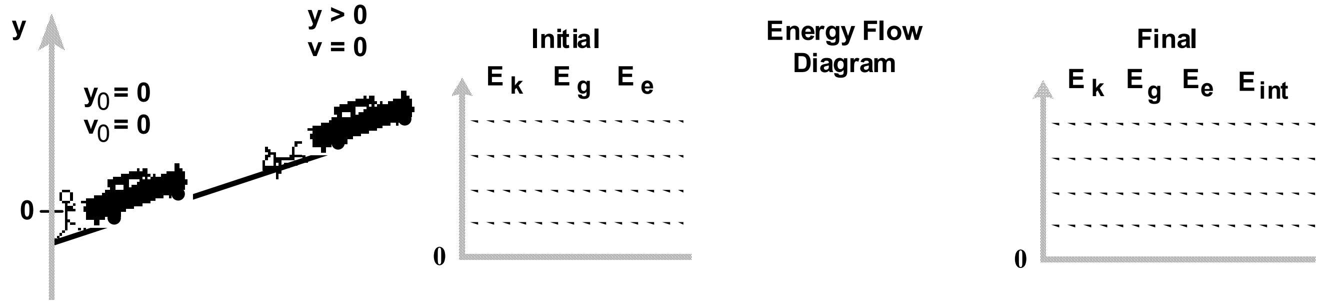


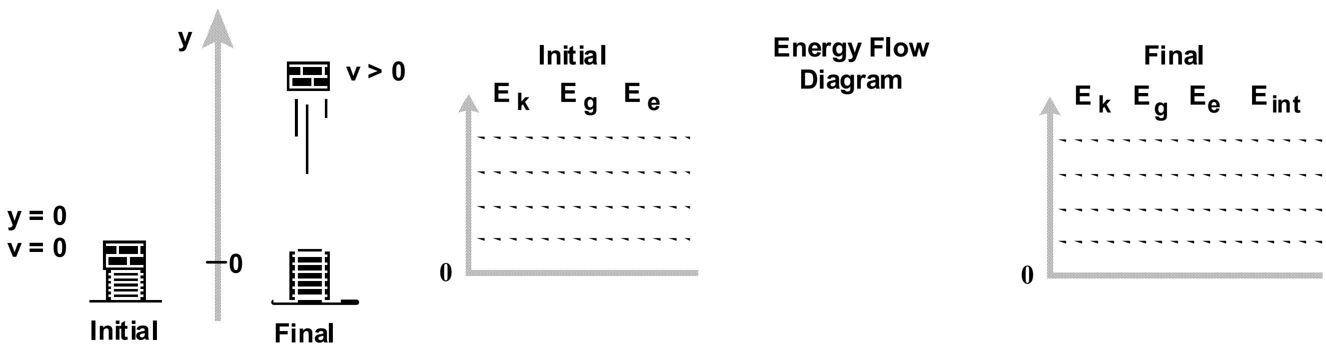

Energy Flow Diagram



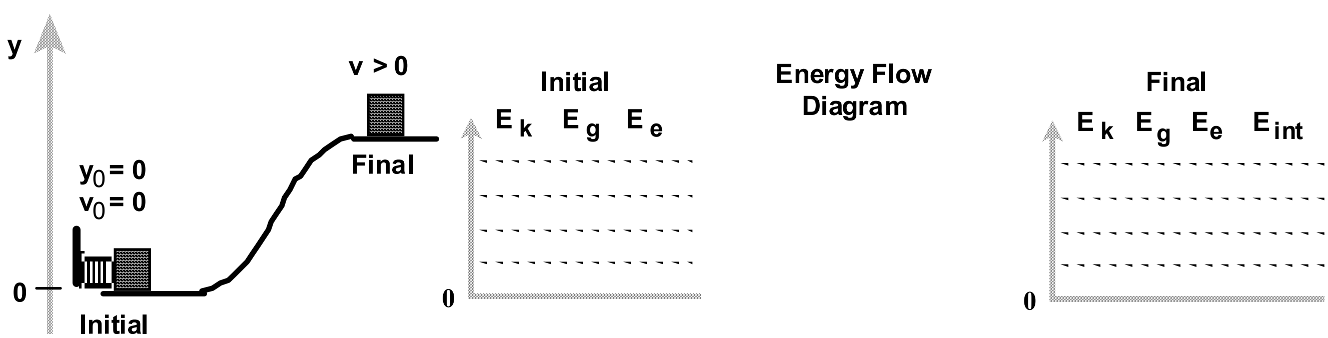
4. A person pushes a carup a hill (with friction).




5. A load of bricks rests on a tightly coiled spring, then is launched into the air (frictionless).




6. A crate is propelled up a hill by a tightly coiled spring (friction).



Name:________________________________No:___________

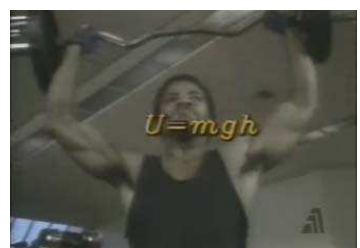
# “Conservation of Energy”
The Mechanical Universe Video Guide

1. Although energy can change forms, the total amount of energy in the Universe is ________________.
2. The Teacher in the beginning of the video mentions an energy crisis. What evidence is there that we are still in an energy crisis today?

3. Name three sources of energy currently used in out society?

4. We know work as Work = Force * Distance. The video relates gravitational potential energy to the work done with respect to gravity. What was the equation given to describe this relationship?

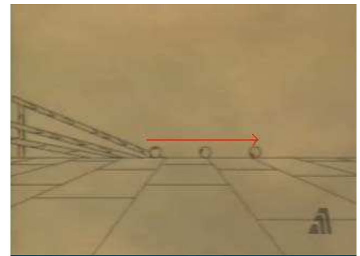

5. What is the constant force of gravity? (Hint: your answer should be an equation.)
6. What is the equation for calculating gravitational potential energy?



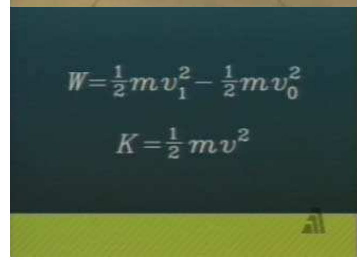

7. When the weightlifter lifts the weight, where is the potential energy stored?

8. Exercise machines use cams, pulleys and levers and inclined planes to do the same thing to the weights. What are they doing to the weights? (Hint: The video uses U to represent PE)

9. When potential energy is released, what does it transform into?

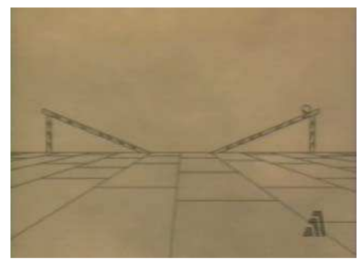


10. The video uses advanced math steps to derive an equation to find the kinetic energy of a moving object. What is this equation?



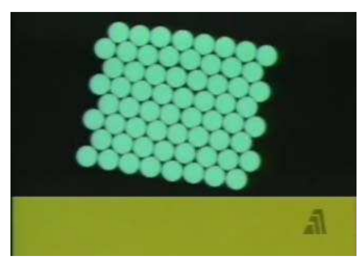

11. A pole-vaulter runs to the make as fast as they can until they reach the line and then they use the pole to convert their kinetic energy into _______________, raising them high above the ground by doing work on the pole.

12. Explain different types of energy the ball has at the left, middle, and right of the diagram.



13. What contribution did Joule make to the understanding of conservation of energy?

14. The energy that is lost in a system is transformed into what?

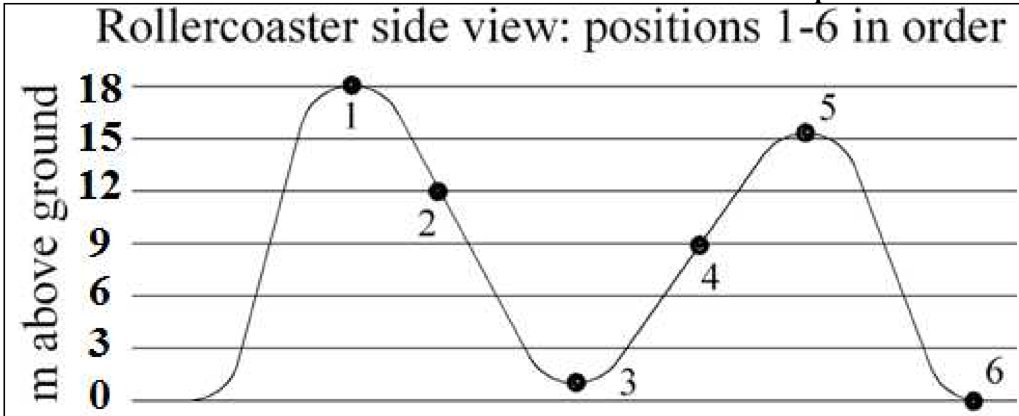


15. What is the unit of energy?

CHALLENGE:
What is the term used to describe the continuing dissipation of energy in the form of heat?

## Energy Coaster Calculation Sheet

1. **Assume the coaster below is frictionless and that the first hill is depicted below. Fill in the table.**




| Position | Speed (m/s) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |

Goal: Do self-guided lesson on computing PE, KE, ME, and speed of coaster at various points along the path of a coaster.
Lesson: PE is potential energy in various forms. For coasters we are concerned specifically with gravitational potential energy (GPE). Since GPE is almost always the type of PE we use for coasters, we get lazy and just refer to it as PE sometimes. GPE = mgh where: m is the mass in kg, g is the magnitude of gravity's acceleration (9.8 m/s$^2$ on earth) and he is the height above the elevation that is consider the "ground", the lowest point considered.

For purposes of this class, we will assume that coasters are lifted by mechanical means to the track's high point and then released to "coast" to a lower elevation. How much GPE does a 2000 kg coaster at rest at position 1? (353,000 J)
Sometimes for simplicity we assumed there is no friction. For your coaster project we will do exactly that. If there is no friction, then all the GPE in the beginning remains throughout the coaster ride. As elevation decreases, GPE goes down by the same number of joules that KE goes up. As the coaster ascends a hill and slows down, the exact amount of KE that is lost by slowing down is the same GPE that is gained by going up. At position 6 the coaster's GPE is how much? It's KE is how much?
(0 J; 353,000 J)

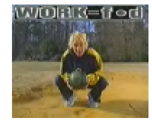
The term ME is useful for energy exchange in coasters. ME stands for mechanical energy and is the total of KE and GPE. If there is no friction GPE stays constant. If there is friction, the ME is reduced from its original value by the amount of energy that friction robbed from the system. Notice how this doesn't defy conservation of energy. Energy isn't created or destroyed, some of our energy total turns in heat from friction, a form we call internal energy. Let's look at a numeric case where there is friction. The coaster above has a 70 m long track. If friction turns 1000 J into internal energy every meter then:

1. How much internal energy is added by the end of the 70 m trip? (70,000 J)
2. How much ME is there by the end of the 70 m trip? (283,000 J…remember, there was 353,000 J previously)
3. What is the elevation at the bottom of the ramp? (0 m)
4. How much GPE is there at the bottom of the ramp? (0 J)
5. ME = GPE + KE, so how much KE is there at the bottom of the ramp? (283,000 J)
6. KE is ½mv$^2$. How fast is this coaster going at point 6? (16.8 m/s)
7. If there were no friction, how fast would the coaster be going at point? (18.8 m/s)
8. Repeat steps 1 - 7 for a 1,000 kg coaster instead of the 2,000 kg coaster we just did. How do the values in 6 and 7 change as a result?
9. For a frictionless 2,000 kg coaster, how much KE is there at pt 2? How fast at pt 2? (117,600 J; 10.84 m/s)

# <u>ESPN Sports Figures: "Tony Hawk in Perpetual Motion" Video Guide</u>

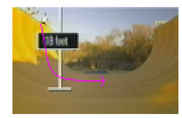
1. What is a perpetual motion machine? Can one really exist?

2. What is the equation for work?

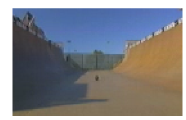


3. How do you increase the gravitation potential energy of an object?

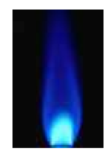
4. If an object is moving it is converting ____________________ energy into ___________________ energy.



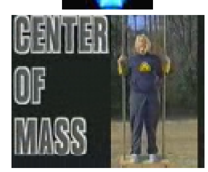
5. What force makes the bowling ball, like all other objects, eventually slow down?



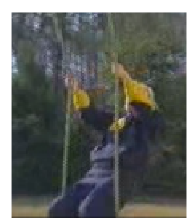
6. Where does the energy go?



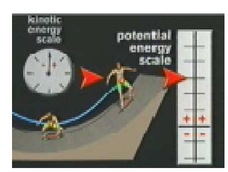
7. Where is the average person's **Center Of Mass**?




8. What must a person do with their center of mass in order to speed up on a swing?



9. What does Tony Hawk do to keep from stopping in the half pipe?




10. What is the unit of work?

11. What law must Tony Hawk obey that proves half-pipes aren't perpetual motion machines?

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.

# <u>Physics and the 100 Acre Woods</u>(Energy Transformations)

Deep in the 100 Acre Woods, Tigger-- having rashly demonstrated that Tiggers**love**to climb up trees-- has found himself perched atop a tallhickory. Far below him (8.0m to be exact), Christopher Robin, Rabbit, Kanga,andRoo are all holding the edges of a blanket and are trying to coax Tiggerinto dropping down since he refuses to climb. ("Tiggers don't climb **down**trees.") Tigger's mass is 35kg. Show ALL work and formulas in your NOTEBOOK!

1. What is Tigger's potential energy before he jumps?
2. What is Tigger's kinetic energy before he jumps?
3. What is Tigger's potential energy just before he reaches the blanket?
4. What is Tigger's kinetic energy just before he reaches the blanket?
5. How fast is Tigger moving just before he reaches the blanket?
6. What is Tigger's potential energy halfway down from the tree?
7. What is Tigger's kinetic energy halfway down from the tree?
8. What is Tigger's speed halfway down from the tree?

**<u>Other Energy Questions:</u>**

9. A bird of mass 1.0kg dives down to spear a fish out of an ornamentalpond. If the bird is moving at 2.0m/s when it is 10.m above the pond, howfast will it be moving when it reaches the water's surface?
10. A car is moving along a flat highway at 20.0m/s when the brake linebursts. The driver, being a student of physics, drives the car up a nearbydirt hill.
    a) Neglecting the effects of friction, how high up the hill will the car go?
    b) Why should the driver still be concerned?
11. Why are perpetual motion machines impossible?
12. Two slides of equal height are side-by-side at a children's playground.Slide A has a 30 degree angle as measured from the horizontal. Slide Bhas a 60 degree angle. If child A slides down slide A and child B slidesdown slide B, which child will be moving the fastest at the bottom?
13. For the same slides, if friction is taken into account, how does youranswer change?

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

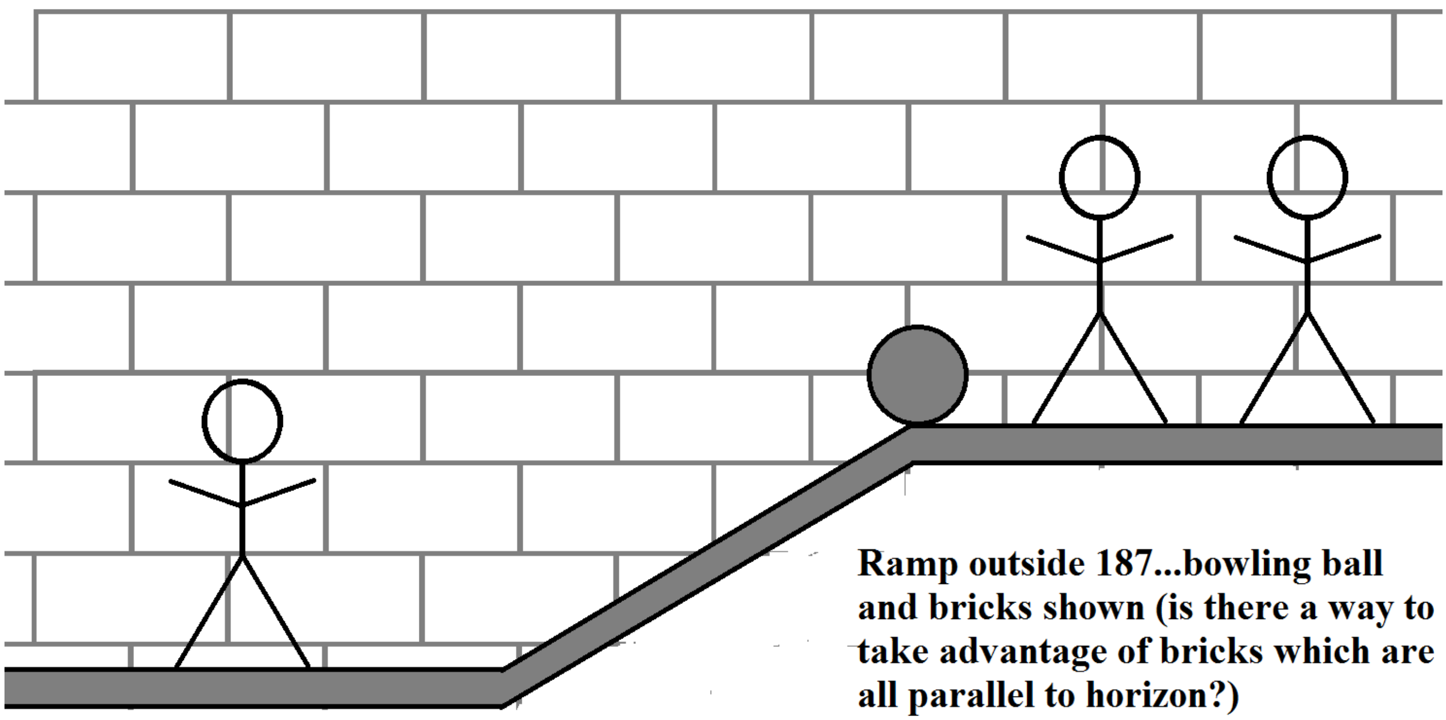
Each Group turns this in.
Write equations for PE and KE and what each variable stands for below:

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?

## Unit 11 Physics Themed – Vocabulary and Equations – Rollercoaster Work/Energy

| **Vocabulary:** | **Symbols:** |
| --- | --- |
| Joule<br>Newton<br>Kinetic energy<br>Potential energy<br>Gravitational potential energy<br>Mechanical energy<br>Elastic potential energy<br>Chemical energy<br>Nuclear energy<br>Electrical energy<br>Internal energy<br>Deformation energy<br>Sound energy<br>Light energy<br>Thermal energy<br>Total energy<br>Efficiency<br>Friction<br>Conservation of energy<br>Frictionless<br>Pendulum<br>Perpetual motion machine<br>Work | PE, KE, GPE, m, g, h, v<br><br>**Equations & constants:**<br><br>PE = mgh     $g = 9.8\ m/s^2$<br>$KE = ½mv^2$     1 kg = 2.2 lbs<br>ME = KE + PE     1 mile = 1609 m<br>Weight = m * g     60 mph = 27 m/s |

**Unit Objectives - Williams**

1. I understand all the vocabulary & math of this unit and all demos, videos, equations, and class assignments; I remember objectives & vocabulary from previous units.
2. I understand what conservation energy means including common examples of real world exchanges of energy
3. I can to track the exchange energy for masses moving up and down hills while ME remains constant
4. Compute/graph energy totals & categories using GPE, KE, ME including using correct units and including how changes in mass, speed and height change the results
5. Compute weight/mass
6. Identify and understand other forms of energy in unambiguous situations
7. Follow energy flow in pendulums and rollercoasters including consequential changes in speed and position when heights are changed as well as novel situations; understand why first hill must be tallest
8. I can account for, but not directly calculate for friction/thermal energy including the unavoidable energy flow in that direction
9. I understand how to use each of the math equations, including what situations to use them, variable names, units and assumptions

**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>**Rollercoaster Energy Calendar: 2013-14 (Williams)**</u>

Bold and underlined means put in journal notes.

| | | | |
|---|---|---|---|
| 1 | **Mo:04/07/14** | GOALS: Energy Introduction/show coasters<br>• Show coasters (energy, speed as f(elevation), braking)<br>• ME = KE + GPE, find V withouth using NIFTY<br>• <u>**(11-01)**</u> Notes: Work, Power, ME, KE, PE, Conservation of Energy**:3,5,6,7,8** | • <u>**(11-02)**</u> Notes: Reading packet 1, pages 1-4<br>• H11-01 sheet (start in class) |
| 2 | **Tu:04/08/14** | GOALS: Pop up toy lab, coaster energy problems<br>• Go over HW/quiz<br>• Show pop up toy lab, do lab, start HW | • H11-02 sheet<br>• <u>**(11-04)**</u> Reading packet 1 problems: 3 – 12, 14 - 22 |
| 3 | **We:04/09/14** | GOALS: Pumping skateboards/swingsets, cost of coaster energy<br>• Discuss pumping skateboards &swingsets, Tony Hawk video if time<br>• <u>**(11-03)**</u> Notes: Cost of energy in Hinsdale area (your house)<br>• Start HW sheet | • <u>**(11-05)**</u> Reading packet 1 problems:: 23, 24, 26-28, 31-34<br>• H11-03 sheet |
| 4 | **Th:04/10/14** | GOALS: What braking does (coasters and cars, 11-07)<br>• <u>**(11-07)**</u> Notes: How much work brakes do (mention what "work" is<br>• Mini lab: Work to stop a sliding book | • <u>**(11-06B)**</u> Reading packet 1 problems:: 29, 30, 35-38<br>• H11-04 sheet |
| 5 | **Fr:04/11/14**<br>**ACT tomorr.** | GOALS: Group quiz and "retro problems"<br>• Group work time/competitive quiz possible<br>• Catch up time including anything missed yet | • Catch up on journal assignments or missing sheets we didn't do yet |
| 6 | **Mo:04/14/14** | GOALS: Review/recap, more practice<br>• Review, recap unit<br>• Possibly: Energy to make a ball roll up a hill (mini-lab) | • H11-05 sheet |
| 7 | **Tu:04/15/14** | GOALS: Go over questions on quest, review for quest<br>• Anything we need to get ready for test<br>Energy Quest: focus on coaster speeds, braking work, energy conservation | • Review for test<br>• Make sure journal ready! |
| 8 | **We:04/16/14** | • Coaster energy quest<br>Energy Quest: focus on coaster speeds, braking work, energy conservation | • Relax! |