Early E. C.: / 1
Total HW Points Unit 7: / 32
Total Lab Points Unit 7: / 28
Unit 7 Apps.: / 5
Late, Incomplete, No Work, No Units Fee? Y / N

Unit 7 – Work, Energy, Conservation of Energy, Power

Essential Fundamentals of Work, Energy, Power

1. Energy is transferred between systems in different ways.

Add more here!

Equation Sandbox

In Unit 7, some of the following equations will be used. Practice isolating variables to prepare for it.

Possible 7.1 Pts: 5
Late, Incomplete, No Work, No Units Fee: -1 -2 -3
Final Score: / 5

7.1 Problems – Work: Constant Force
Section 5.1 of your book.

1. If a person does 50.0 J of work in moving a 30.0-kg box over a 10.0-m distance on a horizontal surface, what is the force required?

2. A 500.0-kg light-weight helicopter hovers above the ground before a maneuver.
   A. What force is required to keep the helicopter airborne?

   B. How much work is done by this force?

3. Now the 500.0 kg helicopter lifts from the ground with an acceleration of 2.00 m/s^2.
   A. Over a 5.00-s interval, what is the work done by the helicopter? (Hint: Use the position equation to determine distance.)

   B. What is the work done by the gravitational force during this maneuver?

Possible 7.2 Pts: 5
Late, Incomplete, No Work, No Units Fee: -1 -2 -3
Final Score: / 5

7.2 Problems – Work: Variable Force
Section 5.2 of your book.

1. A spring has a constant of 30.0 N/m. How much work is required to stretch the spring 2.0 cm from its equilibrium position?

2. To measure the spring constant of a certain spring, a student hangs a 0.40 kg mass on it and it stretches by 5.0 cm.
   A. What is the spring constant?

   B. How much work did the student do on the spring?

3. A spring has a force constant of 2.5 E 3 N/m.
   A. How much work is done in stretching the relaxed spring by 6.0 cm?

   B. How much more work is done in stretching the spring an additional 2.0 cm?

Possible 7.3 Pts: 5
Late, Incomplete, No Work, No Units Fee: -1 -2 -3
Final Score: / 5

7.3 Problems – Kinetic Energy
Section 5.3 of your book.

1. How much work would be necessary to make a stationary 6.5 kg shot put have a launch speed of 2.5 m/s?

2. A. How much kinetic energy does a 1200-kg automobile traveling at 25.0 m/s have?

   B. What work would be required to reduce its speed to 6.94 m/s?

3. A. A constant net force of 75 N acts on an object initially at rest as it moves 0.60 m. Assuming no friction in the system, what is the final kinetic energy of the object?

   B. If the object has a mass of 0.20 kg, what is its final speed?

Possible 7.4 Pts: 6
Late, Incomplete, No Work, No Units Fee: -1 -2 -3
Final Score: / 6

7.4 Problems – Potential Energy
Section 5.4 of your book.

1. How much more gravitational potential energy does a 1.0-kg hammer have when it's on a shelf 1.2 m high than when it is on a shelf 0.90 m high?

2. A. The gravitational potential energy of a 2.0-kg object decreases by 10.0 J. With this information, you can determine which one of the following choices: (1) the object's initial height, (2) the object's final height, (3) both the initial and final height, (4) the difference between the two heights. Defend your choice.

   B. What can you say has physically happened to the object – in other words, in what direction and how much did it move?

3. A. A 0.50-kg mass is placed on the end of a vertical spring that has a spring constant of 75 N/m and eased down into its equilibrium position. Determine the change in the spring's potential energy. Realize that $F_G = F_{Spring}$ in this problem.

   B. Determine the system's change in gravitational potential energy.

   C. Why is there a difference in energy?

Possible 7.5 Pts: 7
Late, Incomplete, No Work, No Units Fee: -1 - 2 -3
Final Score: / 7

7.5 Problems – Conservation of Energy
Section 5.5 of your book.

1. A. A 0.300-kg ball is thrown vertically upward with an initial speed of 10.0 m/s. If the initial potential energy is taken as zero, find the ball's kinetic, potential, and mechanical energy at its initial position (immediately after it's released).

   B. Find the ball's kinetic, potential, and mechanical energy at 2.50 m above the initial position.

   C. What is the maximum height of the ball?

   D. Find the ball's kinetic, potential, and mechanical energy at that height.

2. A. A 2.0-kg rubber ball is dropped from a height of 1.0 m above the floor and it bounces back to a height of 0.70 m. What was the ball's speed just before hitting the floor?

   B. What is the ball's speed just as it leaves the ground?

   C. For the previous problem, how much energy did the ball lose and where did that energy go?

Possible 7.6 Pts: 4
Late, Incomplete, No Work, No Units Fee: -1 - 2 -3
Final Score: / 4

7.6 Problems – Power
Section 5.6 of your book.

1. A girl consumes 8.4 E 6 J of food energy per day while maintaining a constant weight.
   A. What is her average power output?

   B. Why must her weight be constant?

2. A 1500-kg race car can go from rest to 90.0 km/h in 5.0 s. What average power is required to do this?

3. Water is lifted out of a well 30.0 m deep by a motor rated at 1.00 hp. Assuming 90.0% efficiency, how many kilograms of water can be lifted in 1.0 minute?

AP Physics 1	Unit 7.1 Lab - Mousetrapmobile Challenge
Reminder: Update Table of Contents	Correction Credit: Half

Challenge:

Groups of 1 – 4 must design and build a vehicle powered only by a standard-issue mousetrap.

Specifications:

1. Vehicle uses only the energy of the mousetrap's spring to propel itself.
2. Only specially provided mousetraps can be used.
3. Vehicles launch from the double doors.
4. Only the distance that the mousetrap travels will be recorded.
5. Components ahead of the mousetrap (on the race track) are acceptable.
6. Distance is measured when vehicle stops.
7. No mousetrap modifications are allowed.

Mousetrapmobile Lab (7.1) Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Performance:	At least 8 floor tiles	1 2 3 4
Design:	Full Page	/ 1
	Labels	/ 2
	Dimensions	/ 2
	Materials List	/ 2
	Neatly Drawn	/ 2
Extra Credit:	Farthest Single Run	+ 1
	More than 15 Tiles	+ 1
Penalties: Not Ready:	At Registration	-2
	On Race Day	-5
Question 1: Improvements to Mousetrapmobile		/ 3
Work Not Shown Fee:		-1 -2 -3
Late Lab Fee:		-4
Total:		**/ 18**

Scoring Guide:

1. The vehicle must travel at **least** eight floor tile lengths (4 points)
2. **Design – In your Lab Notebook.**:
   a. Full page (1 point)
   b. Components of car labeled with dimensions (4 points)
   c. Materials list present (2 points)
   d. Neatly drawn (2 points)
3. **Timeline**:
   a. ___/___ ~ Challenge issued and 20 minutes design time.
   b. ___/___ ~ 20 minutes design time.
   c. ___/___ ~ 20 minutes design time.
   d. ___/___ Mousetrapmobile spring constant measuring lab.
   e. ___/___ Mousetrapmobile Registration (must be ready to roll!) (-2 points if not)
   f. ___/___ **Race Day** – your car must be completely ready to go. (-5 points if not)

Extra Credit:

Farthest single run = **+1**. More than 15 tiles = **+1**.

Question: Rephrase and write in full sentences for full credit.

1. Write about the strengths and weaknesses of your vehicle, then explain how you could improve your car's performance. (4 Points)

AP Physics 1	Unit 7.2 Lab - Mousetrap Spring Constant	
Reminder: Update Table of Contents		Correction Credit: Half

Theory:

Helical springs derive their energy storage by being twisted, rather than extended or compressed. As a result, we need to use a modified version of Hooke's Law to compute the spring constants of your mousetraps:

Equation 1: $\tau = -\kappa\theta$

τ = Torque (N·m) (Note: This unit is a Newton meter, which is NOT a Joule (See Unit 9))

κ = Torsional Spring Constant (N·m/radian)

θ = Angle of displacement (radians)

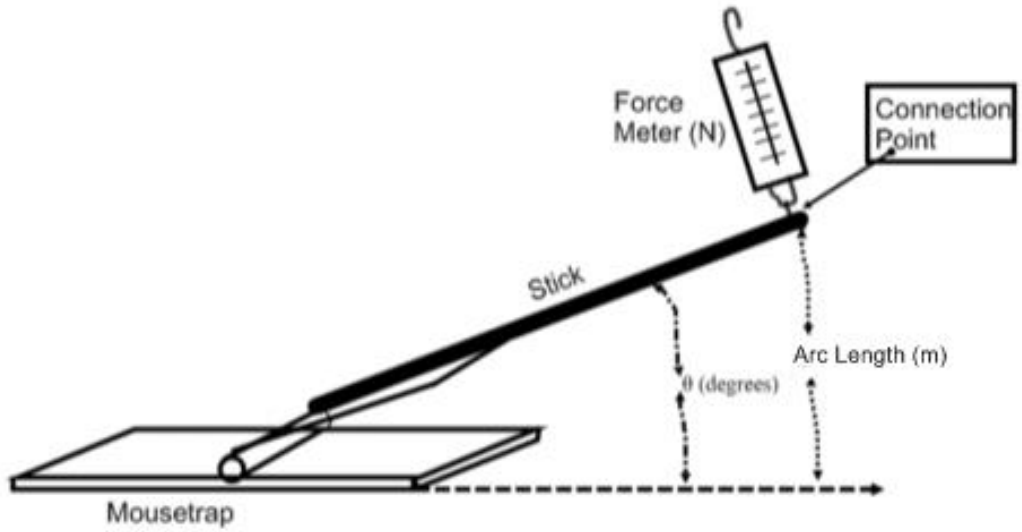
The stored energy (in Joules) in a torsion spring is given by:

Equation 2: $U = \frac{1}{2}\kappa\theta^2$

Mousetrap Spring Lab (7.2) Scoring Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Mission 1:	Data Table	/ 1
	Arc Length Traveled	/ 1
	Torque at 90°	/ 2
	Spring Constant (κ)	/ 2
	Stored Energy	/ 2
Work Not Shown Fee:		-1 -2
Late Lab Fee:		-3
Total:		/ 10

Mission 1: Procedure – Show your work for all calculations.

1. Connect a welding rod or skewer to your mousetrap's jaw after disconnecting it (the snapping part).
2. Connect a tension meter to the end of the rod with tape, then measure the distance from the spring to the meter, and pull on it until it's gone exactly $\pi/2$ radians (90°). Record the distance from spring to meter, and your tension measurement at this angle.
3. Calculate the arc length the connection point traveled from 0 to $\pi/2$ radians.
4. The torque (τ) at that connection point will be the product of the force times arc length: $\tau = F \bullet s$.
5. Use algebra to isolate your torsional spring constant (κ). Show your work.
6. Calculate the stored energy of the spring at $\pi/2$ radians using Equation 2
7. Put all values, measured or calculated, in a well-labeled data table.



AP Physics 1	Unit 7 - Work & Energy				
Application Problems, AP Test Preparation Questions					
Presentation Points:	/ 5	Late Fee:	-2	Completion (Booklet Check)	/ 5

These problems represent what you could expect to encounter on the AP Exam.

Your grade on this problem set depends on the presentation you provide for your assigned problems, and whether **all** problems are complete when you submit your Booklet at the end of the Unit.

Application Problems

1. A 60.0 kg skier starts from the top of a frictionless hill with an initial speed of 4.0 m/s. How fast will she be moving after dropping 10.0 m in elevation?

2. What constant force is needed to change the speed of a 1650 kg vehicle from 10.0 m/s to 40.0 m/s in 18 meters?

3. A roofer lifts supplies a height of 20.0 m with a winch. How long would it take him to lift a 200. kg load, if the power output of the winch is 537 W?

4. What is the constant (k) of a spring that stores 15.5 Joules of potential energy when compressed 32.0 cm?

5. What is the efficiency of a 5.0 hp motor if it lifts 25 kg 45 meters in 9.0 seconds?

6. A. How much work is done decelerating a 1000.0 kg car from 15 m/s to 0.0 m/s?

B. If the car stops in 12 seconds, what power do the brakes have?

AP Test Questions

1. A force **F** of strength 20 N acts on an object of mass 3 kg as it moves a distance of 4 m. If **F** is perpendicular to the 4 m displacement, the work done is equal to
   a) 0 J b) 60 J c) 80 J d) 600 J

2. Under the influence of a force, an object of mass 4 kg accelerates from 3 m/s to 6 m/s in 8 s. How much work was done on the object during this time?
   a) 27 J b) 54 J c) 72 J d) 96 J

3. A box of mass *m* slides down a frictionless inclined plane of length *L* and height *h*. What is the change in its gravitational potential energy?
   a) $-mgL$ b) $-mgh$ c) $-mgL/h$ d) $-mgh/L$

4. While a person lifts a book of mass 2 kg from the floor to a tabletop, 1.5 m above the floor, how much work does the gravitational force do on the book?
   a) -30 J b) -15 J c) 0 J d) 15 J e) 30 J

5. A block of mass 3.5 kg slides down a frictionless inclined plane of length 6.4 m that makes an angle of 30 degrees with the horizontal. If the block is released from rest at the top of the incline, what is its speed at the bottom?
   a) 5.0 m/s b) 6.4 m/s c) 8.0 m/s d) 10 m/s

6. As a blob of mass 4.08 kg drops from the edge of a 40.0-meter-high cliff, it experiences air resistance, with average force during the descent is 30 N. At what speed will the rock hit the ground?
   a) 10 m/s b) 14 m/s c) 16 m/s d) 20 m/s

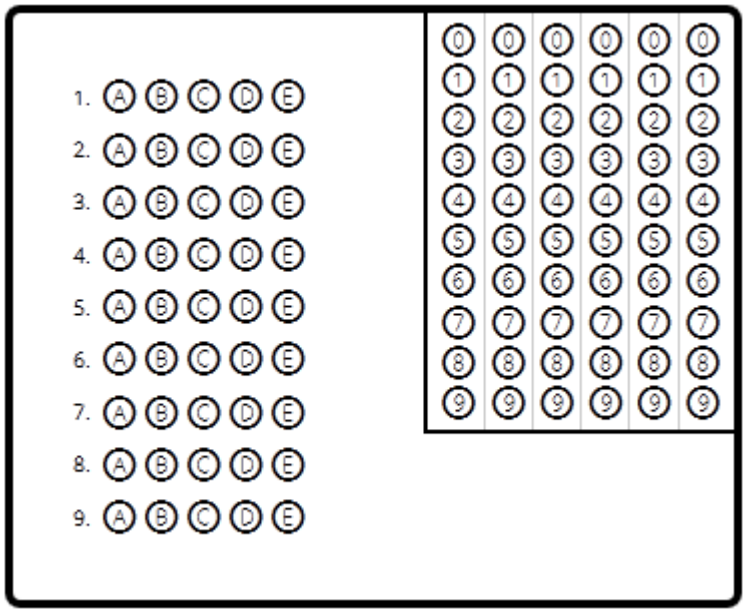
7. An astronaut drops a rock from the top of a crater on the moon. When the rock is halfway down to the bottom of the crater, its speed is what fraction of the final impact speed?
   a) ¼ b) $1/(2\sqrt{2})$ c) ½ d) $1/\sqrt{2}$

8. A force of 200 N is required to keep an object sliding at a constant speed of 2 m/s across a rough floor. How much power is being expended to maintain this motion?
   a) 50 W b) 100 W c) 200 W d) 400 W

AP Physics 1		Unit 7 Review - Work & Energy					
Points:	/ 18	Late or Incomplete Fee:	-2 -4 -6	Correction Credit:		Final Score:	

Solve these problems here, THEN enter your responses in the bubble sheet provided.

Each question is worth two points.



1. A 5.00 kg box slides a 10.0 meter distance on ice. If the coefficient of kinetic friction is 0.200, what is the work done by the force of friction?

   A. -98.1 J B. 10.0 J
   C. 98.1 J D. -10.0 J
   E. 0.0 J

2. If a 10. N force is used to compress a spring with a spring constant of 4.0 E 2 N/m, how far is the spring compressed?

   A. 40.0 m B. 0.025 m C. 0.125 m D. 25 cm E. 0.0 cm

3. What is the work done by a 10.0 N force on a spring of constant 400.0 N/m?

   A. 0.025 J B. 2.5 J C. 0.125 J D. 1.25 J E. 0.0 J

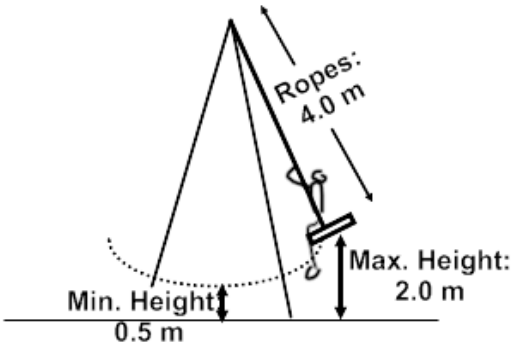
4. A 0.200 kg ball with a horizontal speed of 10.0 m/s strikes a wall and bounces directly back with only half the original speed. How much kinetic energy is lost in the collision?

   A. 7.50 J B. 1.0 J C. 20.0 J D. 2.5 J E. 5.0 J

5. A 0.200 kg ball with a horizontal speed of 10.0 m/s strikes a wall and bounces directly back with only half the original speed. What percentage of the ball's kinetic energy is lost in the process?
A. 25% B. 50% C. 75% D. 100% E. 0.0 %

6. A student has six textbooks, each with a thickness of 4.0 cm and a weight of 30.0 N. What is the minimum work the student would have to do to place all the books in a vertical stack, starting with all the books on the surface of the table?
A. 10.8 J B. 18 J C. 120 J D. 9.0 N E. 0.0 N

7. A girl swings back and forth on a swing with ropes that are 4.00 meters long. The maximum height she reaches is 2.00 meters above the ground. At the lowest point, she is 0.500 meters above the ground. Where does the girl attain the greatest maximum speed of her swing?
A. At 2.0 m height B. At 1.25 m height
C. At 0.5 m height D. Not enough information.



8. For the previous problem, what is the girl's maximum speed at that height?
A. 5.42 m/s B. 1.40 m/s C. 2.88 m/s D. 2.00 m/s E. 0.0 m/s

9. A pump lifts 200.0 kg of water per hour a height of 5.0 m. What is the minimum necessary power output rating of the water pump (in watts)?
A. 13.2 W B. 100 W C. 2.7 W D. 3.7 W E. 164 W