# Physics 2204
## Worksheet - Work

1. Calculate the force that does 2.0 kJ of work to push a load of bricks 10.0 m.

2. What displacement is produced by a force of 80.0 N that does 240.0 J of work in pushing a wheelbarrow?

3. Andy, a construction worker does 220.0 J of work in lifting a 15 kg cement block at a constant speed. Calculate the height he lifted the block.

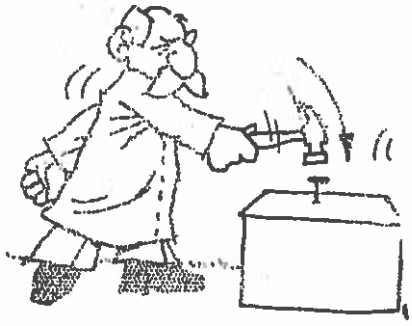
4. When Bruno took his baby sister for a ride in his wagon, he exerted a horizontal force of 150.0 N to move the wagon, and did 364 J of work. How far did he take his sister for a ride?

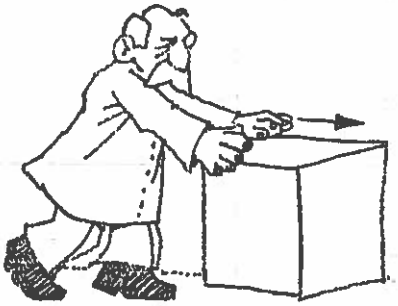
5. If you lift a 12 kg mass 2.00 m vertically 500 times, how much work did you do?

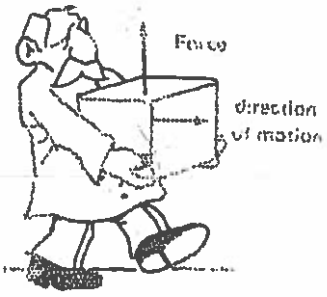
6. Molly, a Clydesdale mare, exerts a force of 670.0 N to pull a farm tractor at a speed of 4.00 km/h along the road for 2.00 h. Calculate the amount of work done by Molly.

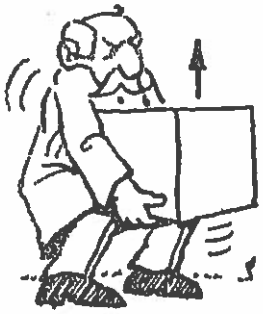
Portfolio 1

Tell whether or not work is done in each of the following







Name: _____

Period: _____

Portfolio 2

Ch. 5:1

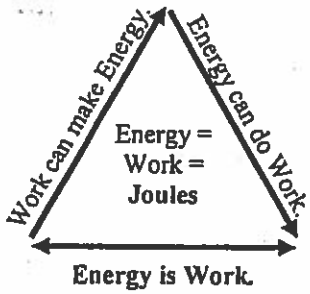
# Energy, Work, and Power

**Energy and work are interconnected—one can make the other.**

## Energy

**Energy is stored work.**
A battery can store energy to make things work whenever you want.

**Energy can cause forces,** which can cause motion, which can do work.




## Work

**Work uses energy.**
It takes energy to move things.
Energy can make things work.

**Work can create energy.**
A generator uses work to make energy, which can be stored to do more work.

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## Work

Work is defined as a force applied (moved) through a distance.

Work (in Joules) → $W = Fd$ ← Force (in newtons), distance (in meters)

*Work equals force times distance.*

If you push harder (**more force**) you do **more work.**

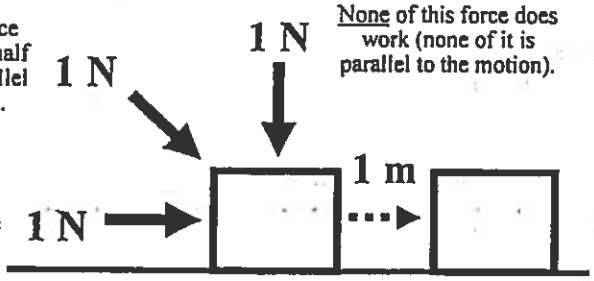
If you push longer (**more distance**) you do **more work.**

**To do work, a force has to be <u>in the direction of the motion</u>.**

<u>Half</u> of this force does work (the half that pushes parallel to the motion).

<u>None</u> of this force does work (none of it is parallel to the motion).

<u>All</u> of this force does work (it is all parallel to the motion).




*Ex: You push a 1000 newton car 5 meters. How much work did you do?*

| | |
|---|---|
| F = 1000 N<br>d = 50 m<br>W = ? | W = Fd<br>W = (1000 N)(50 m)<br>= 5,000 J (joules)<br>*(Doing 5,000 J of work takes 5,000 J of energy)* |

*Ex: How much work does a kid do while sitting? The kid weighs 45 N.*

*No work — the kid is not moving. (d = 0, W = 0)*

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## Power

How fast you do work is called **power.** If you work faster, you use more power.

Power (in watts) → $P = \frac{W}{t}$ ← Work (in joules), Time (in seconds)

*Power equals work divided by time.*

Putting in the work equation: $P = \frac{Fd}{t}$

A machine that **works faster** (in less time) is **more powerful.**

A **more powerful** light bulb gives off the **same** amount of light (work), it **just does it faster.**

*Ex: You do 120 joules of work in 2 seconds. How much power did you use?*

| | |
|---|---|
| W = 120 J<br>t = 2 sec<br>P = ? | P = W/t<br>= 120 J/2 sec<br>= 60 watts<br>*(same as a light bulb)* |

*Ex: Two guys lift two 40 N rocks up a 5 m staircase. Bob does it in 10 seconds. Joe does it in 20 seconds. <u>Compare</u> their work and power.*

| Bob: F = 40 N; d = 5 m; t = 10 s | Joe: F = 40 N; d = 5 m; t = 20 s |
|---|---|
| W = Fd = 40N(5m) = (200 J) | W = Fd = 40N(5m) = (200 J) |
| P = W/t = 200J/10s = (20 w) | P = W/t = 200J/20s = (10 w) |

*They do the **same** amount of **work** (200 J), but Bob uses **more power** (20 w).*

Name: _____

Period: _____



| | |
|---|---|
| 1. F or $F_w$ = _____ | 8 w |
| 2. W or E= _____ | 30 N |
| 3. MA = _____ | 10 |
| 4. p = _____ | 25 m |
| 5. d = _____ | 24 kgm/s |
| 6. P = _____ | 90 J |

| | |
|---|---|
| 1. Energy | A. Uses energy and can create energy. |
| 2. Power | B. The units for energy and work. |
| 3. Work | C. The rate of doing work (faster work uses more of this). |
| 4. Joules | D. Has the ability to create forces; stored work. |

**More, Less, or the Same amount of Work?**

___ You use more force to move an object.

___ You lift a 20 N object faster.

___ You raise an object a shorter height.

___ You move a lighter object.

___ You move an object farther.

**More or Less Power?**

___ An engine can lift an object faster.

___ Someone takes more time to push a car.

___ You take the same amount of time to do more work.

___ Same distance; same time; more force.

You move a 25 N object 5 meters. How much work did you do?

_____

You carry a 20 N bag of dog food up a 6 m flight of stairs. How much work was done?

_____

You push down on a 3 N box for 10 minutes. How much work was done?

_____

You use 35 J of energy to move a 7 N object. How far did you move it?

**Is the person doing work?**

___ When pushing a 1000 N car 20 meters?

___ When lifting a rock off the ground?

___ When holding a book in their hands?

___ When pushing hard against a brick wall?

___ When walking up the stairs?

You do 45 J of work in 3 seconds. How much power do you use?

_____

A car uses 2,500 Joules in 25 seconds. Find power.

_____

A 60 watt light bulb runs for 5 seconds. How much energy does it use?

_____

You push a 10 N object 10 meters. How much work was done on the object?

_____

On the same object as in the previous question, you have to push with 15 N to move it 10 meters. How much work do you do?

_____

What was the difference in the work to move the object and the work you do?

Why was there a difference?

Portfolio #8 4

*Energy*

Name: _____

## WORK AND POWER

Date: _____

1. A $1.20 \times 10^3$-kg block starting from rest is accelerated by a $2.20 \times 10^3$-N force for a distance of 50.0 meters along a horizontal frictionless surface.

   a. What is the final velocity of the mass?

   $v_f = 13.5 m/s$

   b. How much work was done on the mass?

   $W = 110\,000 J$

2. A stockboy is told to put boxes of mass 5.0 kg on shelves that are 1.5 meters above the floor. The young man finds that he can do this at a rate of 4.0 per minute.

   a. How much work will he do in 15 minutes?

   $W = 4410 J$

   b. What is his power for this job?

   $P = 4.9 W$

3. A weight lifter lifts 250 N of weight when doing curls. If he lifts the weight a distance of 40 cm on each curl (rep), how many reps must he make in 1.0 minute in order to reach a power of 25 Watts?

   $n = 15$

4. A horse pulls a carriage filled with people around a circular park road of radius 0.50 km. The horse exerts an average force of 800 N.

   a. How much work does the horse do in a round trip?

   $W = 2512 J \approx 2\,512\,000 J$

   b. If it takes 12 minutes to circle the park, what is the horse's power?

   $P = 3.5 kW \quad 3500 W$

5. A young boy starts from home and pulls his wagon around the block (a distance of 700 meters). The wagon weighs 90.0 N and the handle makes an angle of 40° with the road. If he pulls with an average force of 75.0 N, how much work does he do?

   $F_x = 57.5 N$

   $W = 40\,217 J$

Portfolio # 3

Name: _____

# POTENTIAL AND KINETIC ENERGY

Date: _____ 17

1. A weight lifter lifts 100 kg of mass from the floor to a position above her head, 2.2 meters off the floor.

   a. How much work did she do on the mass?

   $W = 2156\ J$

   b. How much potential energy does the mass now have with respect to the floor?

   $PE = 2156\ J$

2. A crane does $3.00 \times 10^4$ J of work on a crate in order to lift it 20.0 meters to the roof of a construction site.

   a. What is the potential energy of the crate with respect to the ground?

   $PE = 3.00 \times 10^4\ J$

   b. What is the mass of the crate?

   $m = 153\ kg$

3. A bowling ball that weighs 70 N is dropped from a tower 15 meters above the ground. Disregarding air friction, what is the kinetic energy of the ball when it reaches the ground?

   $KE = 1050\ J$

4. A car of mass 2000 kg is traveling at 45 m/s when the driver spots a policeman ahead. The driver applies the brakes lightly for 3.0 seconds until he slows down below the speed limit. If the average force applied by the brakes was $1.4 \times 10^4$ N, by how much did the kinetic energy of the car change?

   $a = -7\ m/s^2$

   $\Delta KE = -1\,470\,000\ J$

5. A force of $1.0 \times 10^4$ N is exerted on a 50-g bullet throughout the 10-cm length of a gun barrel.

   a. How much work was done on the bullet?

   $W = 1000\ J$

   b. How much kinetic energy did the bullet have when it left the gun barrel?

   $KE = 1000\ J$

   c. What was the speed of the bullet when it left the gun barrel?

   $v = 200\ m/s$

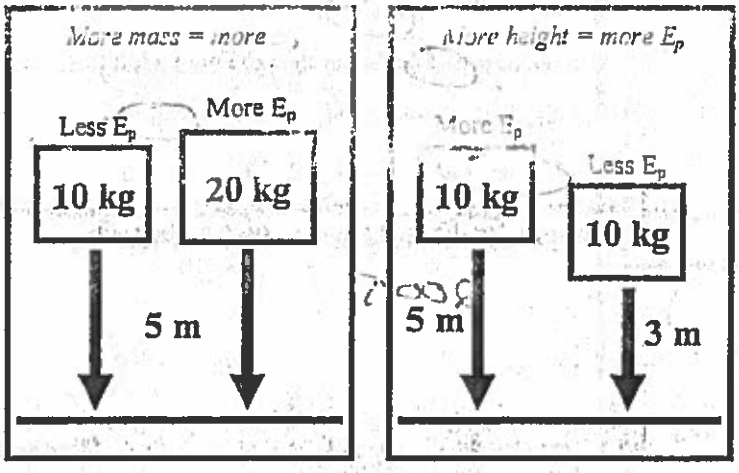
Period: _____

# Potential and Kinetic Energy

## Potential Energy

**Potential Energy is energy of position.**

An object gets potential energy from height, mass and gravity. An object with potential energy has the **potential to do work.** This potential is only released if the object falls. The energy is then transformed into energy of motion or transformed into work.




Potential Energy (in Joules) → $E_p = mgh$ ← height (in meters); mass (in kilograms); acceleration due to gravity (9.8 m/s²)

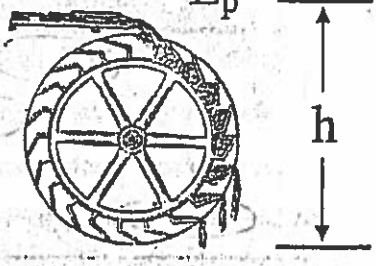
*Potential energy equals mass times gravity times height.*

And since $F_w = mg$, then $E_p = F_w h$

*Ex: How much potential energy does a 4 kg object have that is 5 meters off the ground?*

| | |
|---|---|
| m = 4 kg<br>h = 5 m<br>g = 10 m/s²<br>$E_p$ = ? | $E_p = mgh$<br>$E_p$ = (4 kg)(10 m/s²)(5 m)<br>= (40 kgm/s²)(5 m)<br>= 200 Joules |

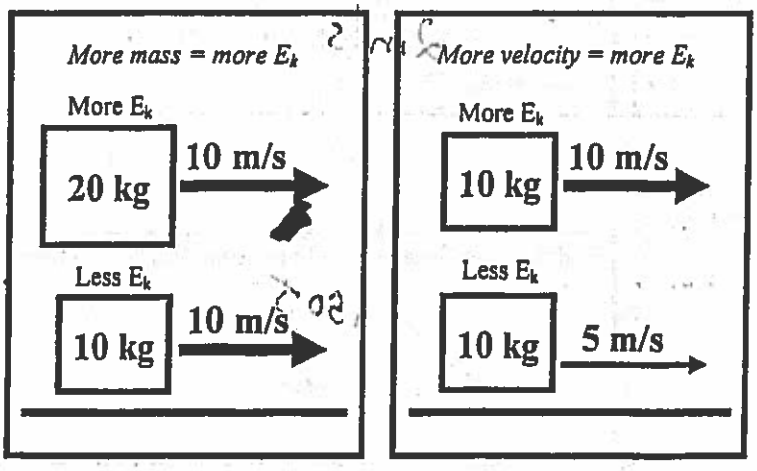
Potential energy helps us generate electricity in hydroelectric dams. When the water falls, gravity helps turn energy of height to electrical energy.




## Kinetic Energy

**Kinetic Energy is energy of motion.**

An object gets kinetic energy from its mass and velocity. An object with kinetic energy has energy stored in motion. When the object slows down the energy is released into potential energy (if going up) or some other kind of energy (like heat [thermal energy] in the brakes of car).

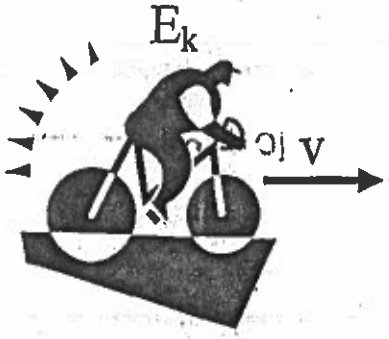



Kinetic Energy (in Joules) → $E_k = (\frac{1}{2})mv^2$ ← mass (in kilograms); velocity (m/s)

*Kinetic energy equals one-half times mass times velocity squared.*

*Ex: How much kinetic energy does a 10 kg object traveling 3 m/s?*

| | |
|---|---|
| m = 10 kg<br>v = 3 m/s<br>$E_k$ = ? | $E_k = \frac{1}{2}mv^2$<br>$E_k = \frac{1}{2}(10\text{ kg})(3\text{ m/s})^2$<br>= (5 kg)(9 m²/s²)<br>= 45 Joules |




Kinetic energy helps you bike up a hill. The energy of motion helps you overcome gravity. The faster you are moving, the easier it is to get up a hill.

Period: _____

| | |
|---|---|
| 1. F or $F_w$ = 8N | 8 w |
| 2. v = 8 m/s | 8 N |
| 3. p = 8kg m/s | 8 m |
| 4. h = 8m | 8 kgm/s |
| 5. W or E= 8J | 8 J |
| 6. P = 8W | 8 m/s |

| | |
|---|---|
| 1. Kinetic Energy C | A. Uses energy and can create energy; calculated by multiplying force times distance |
| 2. Potential Energy E | B. How far above the ground an object is. |
| 3. Work A | C. Energy of motion. |
| 4. Joules D | D. Units for energy and work. |
| 5. h B | E. Energy of position. |

## Potential ($E_p$) or Kinetic ($E_k$) Energy

$E_k$ A car is traveling 45 mph.

$E_p$ A rock is on a ledge 5 meters high.

$E_p$ A car is resting at the top of a hill.

Both A ball is thrown into the air and is still moving.

$E_k$ A ball rolling on the ground.

## Circle the one with more Potential Energy

A 25 kg mass or a 30 kg mass at the top of a hill?

A car at the top of the hill or the bottom of a hill?

A plane on the ground or a plane in the air?

A full plane or an empty plane (both are flying)?

## Circle the one with more Kinetic Energy

A 25 kg mass or a 30 kg mass going 5 m/s.

Two 10 kg masses, one going 75 m/s, one going 45 m/s.

A car at rest or a car rolling down a hill.

A heavy bike or a light bike.

Calculate the potential energy of a 5 kg object sitting on a 3 meter ledge.

147 J

A rock is at the top of a 20 meter tall hill. The rock has a mass of 10 kg. How much potential energy does it have?

1960 J

A 25 N object is 3 meters up. How much potential energy does it have. (Hint, notice the units of the object.)

75 J

How high up is a 3 kg object that has 300 joules of energy?

10.2 m

A 4 kg rock is rolling 10 m/s. Find its kinetic energy.

200 J

A 8 kg cat is running 4 m/s. How much kinetic energy does it have?

64 J

A rolling ball has 18 joules of kinetic energy and is rolling 3 m/s. Find its mass.

4kg

A 4 kg bird has 8 joules of kinetic energy. How fast is it flying?

2 m/s

Find the work done by a 25 N force applied for 6 meters.

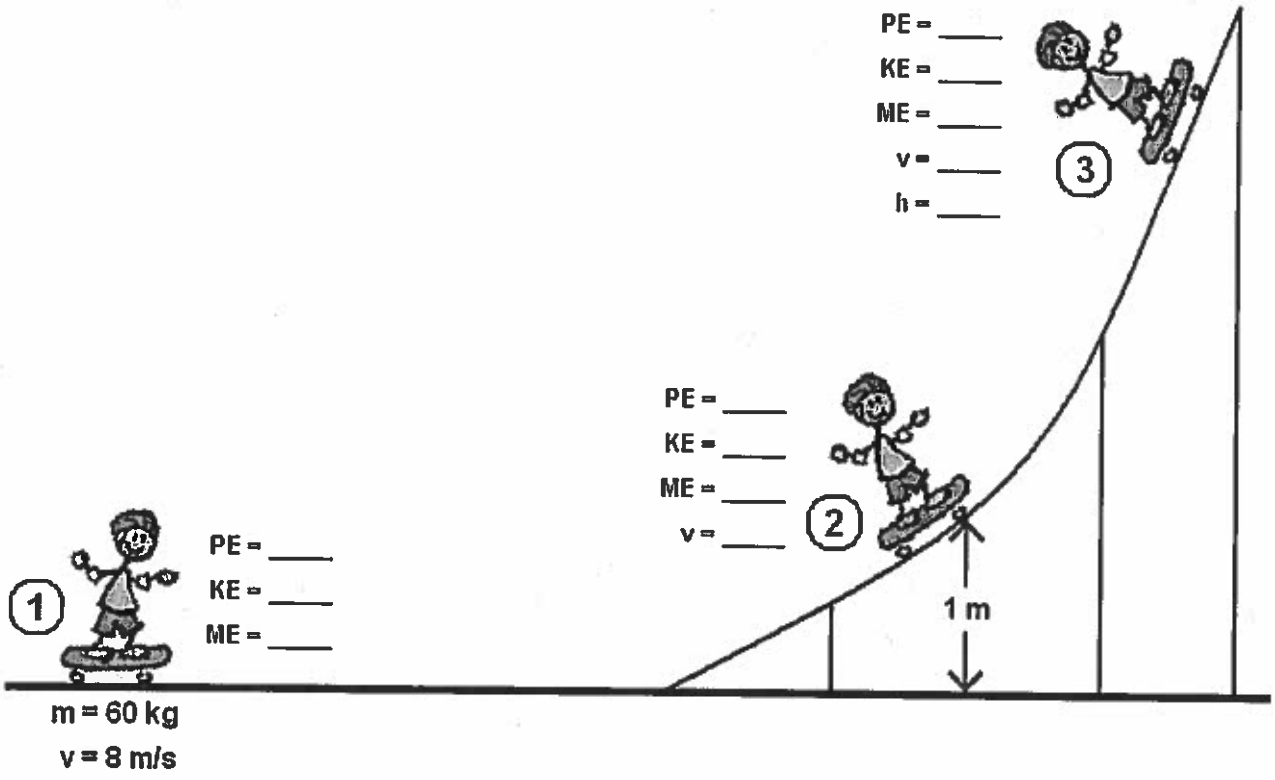
150 J

Name:_____ Date:_____ Class: Worksheet 6

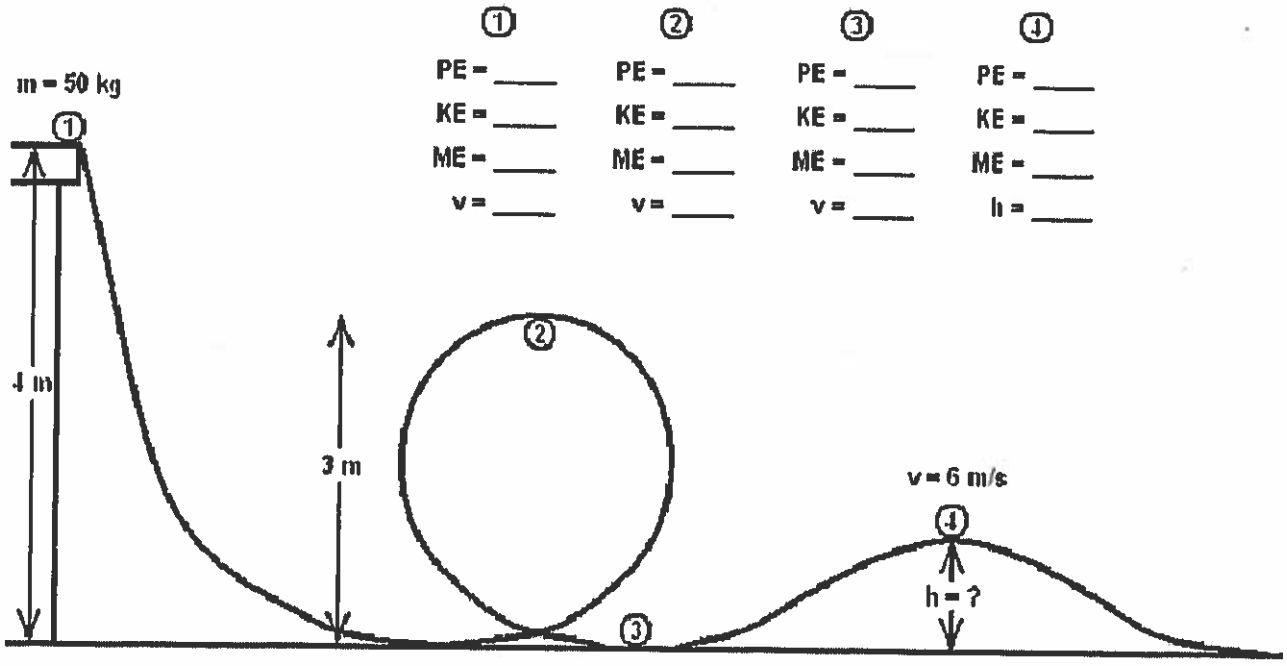
**PHYSICAL SCIENCE WORKSHEET**
**CONSERVATION OF ENERGY #2**

$KE = \frac{1}{2}mv^2$ $GPE = mgh$ $ME = KE + GPE$

1. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the skater at the various locations.

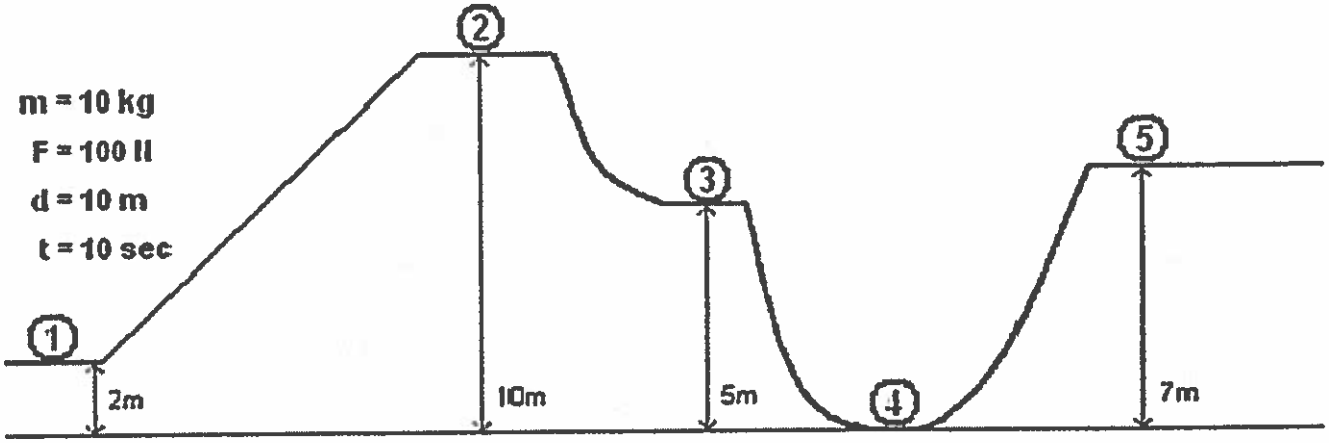


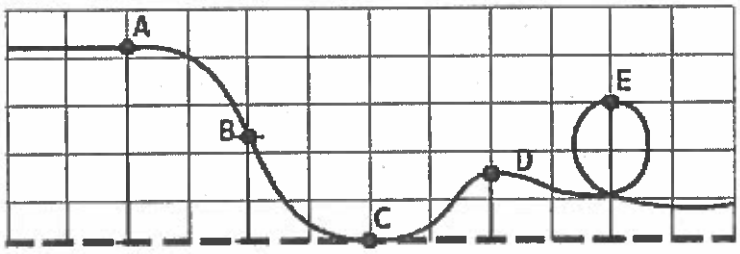

2. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations.



3. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations.

| ② | ③ | ④ | ⑤ |
|---|---|---|---|
| PE = ____ | PE = ____ | PE = ____ | PE = ____ |
| KE = ____ | KE = ____ | KE = ____ | KE = ____ |
| ME = ____ | ME = ____ | ME = ____ | ME = ____ |
| v = ____ | v = ____ | v = ____ | v = ____ |



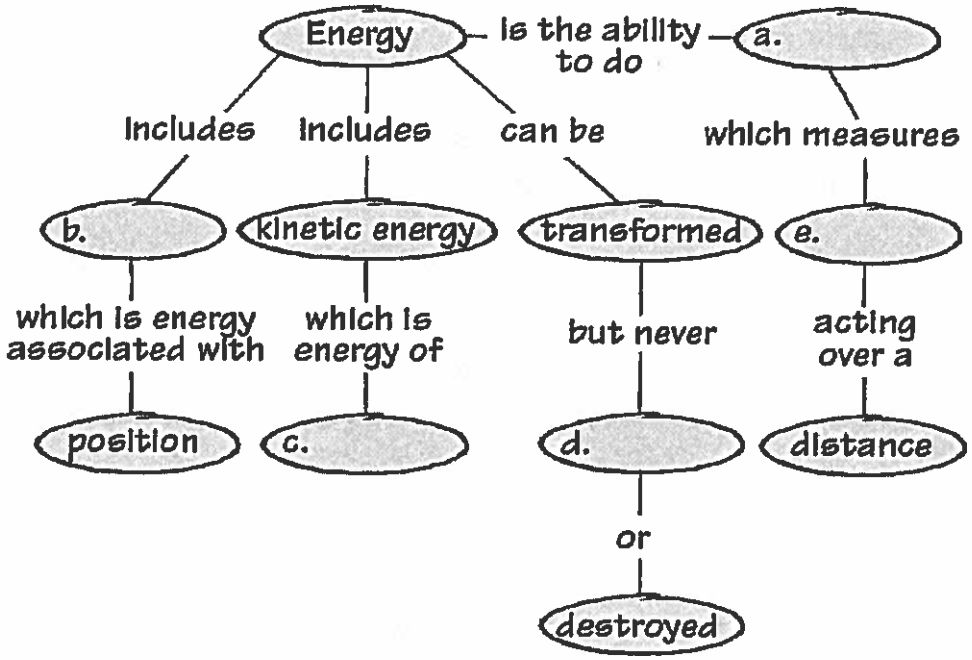

4. The diagram above shows five different points on a roller coaster.

   a. List the points in order from the point where the car would have the greatest potential energy to the point where it would have the least potential energy.

   b. Now list the points in order from the point where the car would have the greatest kinetic energy to the point where it would have the least kinetic energy.

   c. Compare the 2 lists to each other. What do you notice about the lists?

5. Complete the concept map below by writing the correct word or phrase in the lettered box.




6. An object has a mechanical energy of 1575 J and a potential energy of 1265 J.
   a. What is the kinetic energy of the object?

   b. If the mass of the object is 12 kg, what is its speed?

   c. How high above ground is the object?

7. A 5 kg object is moving downward at a speed of 12 m/s. If it is currently 2.6 m above the ground...
   a. What is its kinetic energy?

   b. What is its potential energy?

   c. What is its mechanical energy?

8. A 59 kg man has a total mechanical energy of 150,023 J. If he is swinging downward and is currently 2.6 m above the ground, what is his speed?

9. A 74 kg student, starting from rest, slides down an 11.8 meter high water slide. How fast is he going at the bottom of the slide?

10. Calculate the kinetic energy of a 750 kg compact car moving at 50 m/s.

11. Determine the mechanical energy of a 450 kg roller coaster moving at 30 m/s at the bottom of the first dip which is 15 meters above the ground.

12. Julie has a mass of 49 kg. What is her potential energy when standing on the 6 meter diving board? (She is 6 meters above the water.) Julie jumps off the diving board.

    a. What is her kinetic energy just before she hits the water?

    b. What is Julie's speed just as she hits the water?

For TTD 110 Ch 1

## Worksheet: Energy

1. What is the KE of a baseball having a mass of 0.14 kg that is thrown with a velocity of 18 m/s?

   If the baseball above was initially at rest, how much work was done on it to give this kinetic energy?

2. A racecar has a mass of 1500 kg. What is its KE in joules if it has a speed of 110 km/hr?

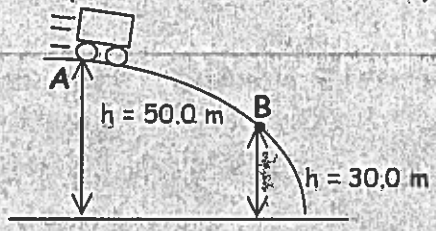
3. Relative to the floor, what potential energy does a 2.5 kg package have that sits on a shelf 2.2 m high?

   What work was done to give it this PE?

Hint: Use law of conservation of mechanical energy to solve remaining problems.

4. A 500.0 kg pig is standing at the top of a muddy hill on a rainy day. The hill is 100.0 m long with a vertical drop of 30.0 m. The pig slips and begins to slide down the hill. What is the pig's speed at the bottom of the hill?

5. Frank, a San Francisco hot dog vendor, has fallen asleep on the job. When an earthquake strikes, his $3.00 \times 10^2$ kg hot dog cart rolls down Nob Hill and reaches point A at a speed of 8.00 m/s. How fast is the hot dog cart going at point B when Frank finally wakes up and starts to run after it?




6. While on the moon, the Apollo astronauts enjoyed the effects of a small gravity. If Neil Armstrong jumped up on the moon with an initial speed of 1.51 m/s to a height of 0.700 m, what amount of gravitational acceleration did he experience?

7. In a wild shot, Bo flings a pool ball of mass m off a 0.68 m high pool table, and the ball hits the floor with a speed of 6.0 m/s. How fast was the ball moving when it left the table?

Physics 2204 Worksheet 8: Hooke's Law

(1) What is the elastic force a spring will exert if it has k =175N/m and is stretched 30cm?

(2) How far must a spring (spring constant = 35N/m) be pulled in order to exert a force of 63N?

(3) How far will a spring with rest length 82cm and spring constant 0.50N/m be if it is stretched until it exerts 0.25N?

(4) A spring has a rest length of 1.30m. When a 20kg mass is hung on it, it stretches to 3.60m. What is its spring constant?

(5) A spring stretches with spring constant 125 N/m stretches 5.5 cm when an object is hung from it. What is the object's mass?

(6) A 12.4 kg mass is suspended from an elastic band (k=210 N/m). How far will the elastic band stretch?

(7) How much work is done when you stretch a spring (k=425 N/m) 23.6 cm?

(8) If you do 7.5 J of work to stretch a spring 5.0 cm, what is the spring constant?

(9) If a 10.0 kg mass is hung from a spring (k=360 N/m), how much elastic potential energy is contained in the spring?

(10) When an 8.5 kg mass is suspended from a spring, it gains 2.75 J of elastic potential energy. What is the spring constant?

A.P. Physics (B) Homework/Worksheet Name_____

## Hooke's Law, Work, and Spring Potential Energy

**Directions:** Answer all the questions on a separate sheet of paper. Show all work on problems. Answer all verbal questions in complete sentences.

1. As you stretch a spring, what happens to the amount of force you need to keep stretching the spring farther?

2. As you stretch a spring, what happens to the potential energy stored on the stretched spring?

3. What is the relationship between the work done stretching or compressing a spring, and the potential energy stored in the spring?

4. Use the data table to the right to answer this question. ***You will need a sheet of graph paper.*** The information represents the data recorded from a spring stretching experiment.
   A) Find the slope of the line. What does it represent?
   B) What does the area under the graph represent?
   C) What is the potential energy stored in the spring when it is stretched to 0.0275 m?
   D) How much work would be done stretching the spring to 0.100 m?

| Elongation In meters | Force in Newtons |
|---|---|
| 0.00500 | 0.875 |
| 0.01000 | 1.805 |
| 0.01500 | 2.700 |
| 0.02000 | 3.455 |
| 0.02500 | 4.375 |
| 0.03000 | 5.150 |
| 0.03500 | 6.300 |
| 0.04000 | 7.000 |
| 0.04500 | 7.075 |
| 0.05000 | 8.805 |

5. You find that a spring requires a force of 85 N to stretch it 0.050 m.
   A) What is the spring's elastic constant? (Hint: what is "k"?)
   B) How much potential energy is stored in the stretched spring?
   C) What was the work done stretching the spring?

6. In a toy dart gun, a spring has an elastic constant of 250 N/m. When a suction dart is pressed into the gun, it compresses the spring 0.0375 m.
   A) What is the amount of force needed to compress the dart in that far?
   B) What is the potential energy stored in the spring when it is compressed?

7. You notice that it takes 40.0 Joules of work to stretch a spring a certain distance. If you stretch the spring to three times this distance, how much work would you have to do? (Hint: what is the relation between the distance a spring is stretched and the energy stored in the spring?)

Portfolio 10

**Physics 2204**

**Worksheet** **Simple Harmonic Motion**

1. A spring with a spring constant of 98.0 N/m has a 1.40 kg block attached to its free end. If the block is pulled out 57.0 cm from its rest position and released, what is its speed a distance of 16.0 cm from the equilibrium position?

2. A spring with $k$ = 500.0 N/m is drawn back 0.070 m and used to launch a puck with a mass of 0.060 kg. What maximum speed will the puck attain?

3. A sled with a mass of 40.0 kg and moving at 4.20 m/s strikes a spring with $k$ = 1200 N/m. How far is the spring displaced as the sled comes to a rest?

4. You do 42.0 J of work with scissors. If the scissors do 40.0 J of work, what is the efficiency of the scissors?

5. A 534 g mass is attached to the end of a vertical spring with spring constant 11.0 N/m. The spring is then stretched 17.6 cm from its equilibrium position and set into motion.
   a. What is the elastic potential energy at 17.6 cm?
   b. Calculate the speed of the mass as it passes the equilibrium position.
   c. Find the elastic potential energy and the kinetic energy at a distance of 6.40 cm from equilibrium.

6. A 534 g mass is attached to the end of a vertical spring with spring constant 12.0 N/m. The spring is then stretched 18.6 cm from its equilibrium position and set into motion.
   a. What is the elastic potential energy at 18.6 cm?
   b. Calculate the speed of the mass as it passes the equilibrium position.
   c. Find the elastic potential energy and the kinetic energy at a distance of 6.40 cm from equilibrium.

7. A 434 g mass is attached to the end of a vertical spring with spring constant 10.0 N/m. The spring is then stretched 10.6 cm from its equilibrium position and set into motion.
   a. What is the elastic potential energy at 10.6 cm?
   b. Calculate the speed of the mass as it passes the equilibrium position.
   c. Find the elastic potential energy and the kinetic energy at a distance of 5.40 cm from equilibrium.

8. A spring with spring constant 850 N/m is stretched 70.0 cm from equilibrium. Draw a graph of the applied force versus the distance from equilibrium.

9. 4.00 N of force is applied to a spring with spring constant 5.0 N/m.
   a. How far will the spring stretch?
   b. What is the potential energy of the spring?

10. A 150.0 g mass causes a spring to stretch 3.0 cm.
    a. Calculate its spring constant.
    b. Calculate its elastic potential energy.

# Physics Review: Energy Part II

Note: This is only a **small sample** of the material that could be fair game for the quiz. All class examples should be reviewed especially cases involving simple harmonic motion, and the total energy cases involving three energies. The questions that were assigned in the text are also fair game for the quiz.

1. A toy gun has its spring compressed 3.0cm by a 50.0g projectile. The spring constant was measured at 400.0 N/m. Calculate the velocity of the projectile if it is launched horizontally?

2. A large bungee cord is used to propel a jet of mass $2.5\times10^{3}kg$ horizontally off an aircraft carrier. The rubber band is pulled back 35m and released such that the jet takes off at 95m/s. What is the spring constant of the rubber band?

3. A spring with a spring constant of 350.0 N/m is compressed a certain distance by a 3.0 kg mass. If the maximum speed of the mass upon release is 2.0m/s, determine the distance the spring was compressed?

4. What minimum force will compress a spring 15cm if the spring constant is $4.0\times10^{3}N/m$?

5. A bungee cord needs to transfer $2.0\times10^{6}J$ of energy. A 10.0kg mass extends the bungee cord 1.3m. What is the maximum extension of the bungee cord?

6. A spring with k=15 N/m is connected to a mass of 245g and set in motion. If the mass has a maximum speed of 0.87m/s, calculate the amplitude?

7. A 5.0kg mass on a spring is extended 0.30m from the equilibrium position and released. k= 65N/m
   a. What is the initial elastic potential energy of the spring?
   b. What maximum speed does the mass reach?
   c. Find the speed of the mass when the displacement is 0.15m?

8. A 102kg mass is dropped from 12m onto a spring with 0.52cm of recoil. What is the spring constant?

9. If a system consists of a spring and mass and has a total energy of 0.011J where k=16N/m, determine the amplitude of motion?

10. Do problems 112, 113(a, b, c) on page 376 of text. if you want