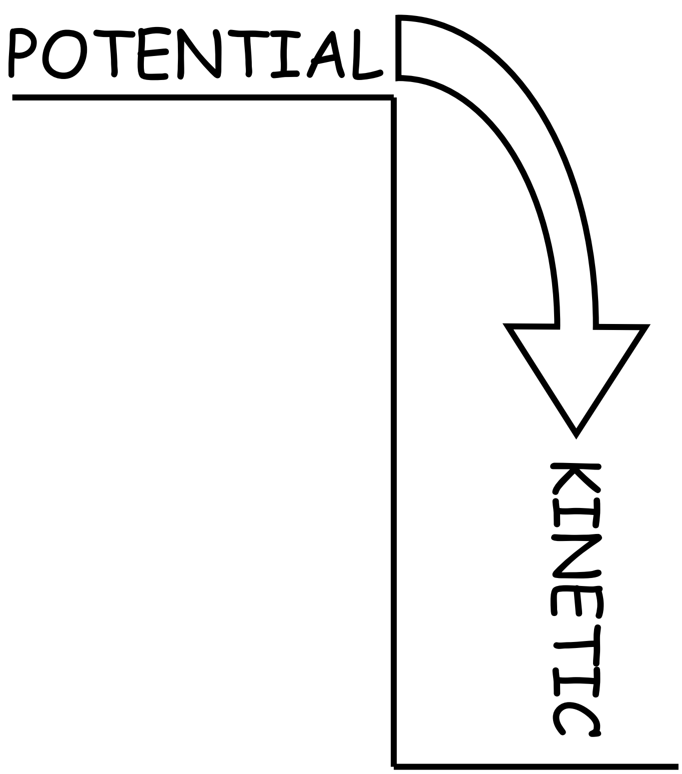
Name ______________________

Honors Physics

WORK

AND

ENERGY



Work & Energy

Name ______________________
Period __________

Work and Energy Intro questions

Read **chapter 9 pages 144 – 146** (Section 9.1)

1. Define work in terms of physics?

2. In order to do work on an object, the force and the distance must be in the **_________** direction.

3. What is the equation for work?

4. What are the units for work?

Read **chapter 9 pages 147 – 150** (Sections 9.3-9.5)

5. In what units is energy measured?

6. What are two types of mechanical energy?

7. What type of energy is energy that is stored by virtue of an object's position?

8. What is the equation for calculating gravitational potential energy?

9. What type of energy is the energy that is associated with the motion of an object?

10. What is the equation for Kinetic energy?

Work & Energy

Work and Energy Intro problems:

1. If you lift a 2.0 N book to the top of a 2.0 m high shelf, how much work have you done?

2. If you carry a 15 N Book bag, 25 m down the hallway, how much work have you done?

3. If you push against a big rock all day long and it does not move, how much work have you done?

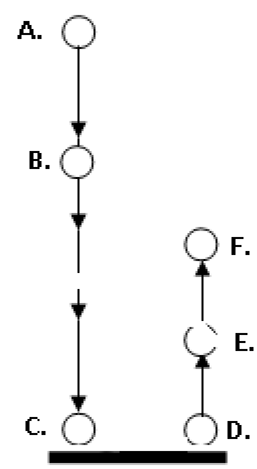
4. What is the potential energy of a 0.4 kg can of soup sitting on a 1.5 m high shelf?

5. What is the kinetic energy of a .4 kg can of soup that is rolling across the floor at a speed of 4.0 m/s?

Work & Energy Worksheet

$PE = mgh$ $KE = \frac{1}{2}mv^2$ $W = Fd$ $F_g = mg$

1. Which of the following are examples of either Potential Energy (PE) or kinetic Energy (KE)?
   ______A. Energy stored in stretched rubber bands.
   ______B. Energy of a bullet moving 350 m/s.
   ______C. Energy of gun powder.
   ______D. A can of soup sitting on a shelf 1.5 m above floor.
   ______E. A can of soup that has fallen from the shelf and is about to hit your toe.
2. How much work must be done to lift a 15 kg case of soup to a grocery shelf 0.75 m above the floor?
3. How much work does the shelf do <u>holding</u> the case of soup up? Explain.
4. What is the potential energy of a 0.4 kg can of soup sitting on a 3 m high shelf?
5. What is the kinetic energy of a .5 kg can of soup that is rolling across the floor at a speed of 2.5 m/s?
6. A ball is dropped from 2.00 m, hits the ground and bounces 1.00 m high. Label the types of energy (PE, KE) found at the different places A-F:



A: ______________________________
B: ______________________________
C: ______________________________
D: ______________________________
E: ______________________________
F: ______________________________

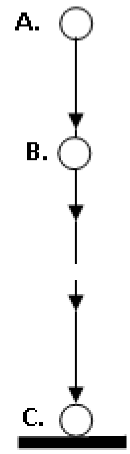
7. What can be said about the total mechanical energy in the path from A-C compared to the path from D-F; is it more, less, or the same? If they are different, why?

Work & Energy

Total Mechanical Energy (**TME**) is the sum of an objects Potential energy (**PE**) and Kinetic Energy (**KE**)

TME = KE + PE

In the diagram below, a 0.5 kg ball is dropped from rest from a height of 3.0m at point "A" as shown in the diagram to the right. The ball is 2.0m high at point "B".



1. Calculate the potential energy at points A – C and enter the values in the table below.

2. Using Kinematics, find the velocity at point B (after the ball has fallen 1.0 meter) and point C (after the ball has fallen 3 meters).

3. Using the balls velocities from part 2, find the Kinetic Energy of the ball at points A - C

Position	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Point A						
Point B						
Point C						

3. What do you notice about the total mechanical energy at points A – C?

Work & Energy

Energy Examples:

For the following objects at the given speeds and heights (above a given reference level) calculate the potential, kinetic and total energies

Remember $\boldsymbol{TME = PE + KE}$

Object	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Rock	0	0	0.5			
Large Boulder	0	12	2,000			
Cheetah	24	1.5	60			
Space Shuttle	300	20,000	40,000			
Submarine	40	100	2,500			
Runner	2	1	75			
Mole	0.025	-0.5	0.75			
Fly	10	3	0.004			

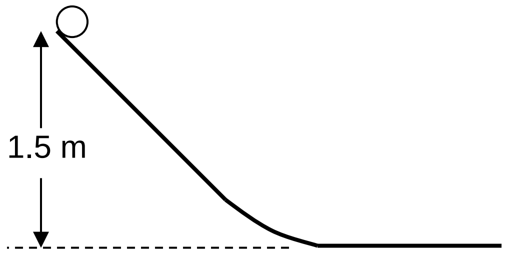
For the objects below, calculate the unknown values using your knowledge of energy

Object	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Lead Block			50		4,000	7,500
Car	14		1,800	7,200		
Unknown	1,000	0				400,000
Truck			6,400	7,200		183,600
Laundry Bag		10		700		2,000
Unknown		3	100		463.3	

Work & Energy

Conservation of Energy Worksheet

1. A marble (.5 kg) is released (down a ramp) from rest 1.5 m above floor level. Find the marble's speed at the bottom of the ramp.

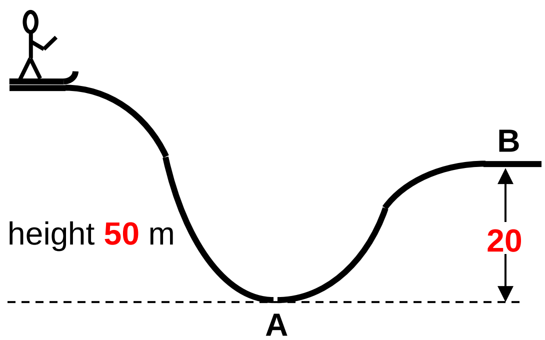


Show all calculations here

	Top of Ramp	Bottom of Ramp
PE		
KE		
TOTAL		

2. A skier rests on top of a 50m hill. The skier's mass if 60 kg. Ignoring friction, calculate the skier's speed at points A and B.

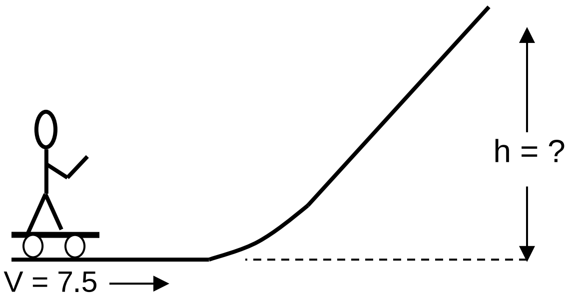
Show all calculations here



	Top of Hill	Point A	Point B
KE			
PE			
TOTAL			

Work & Energy

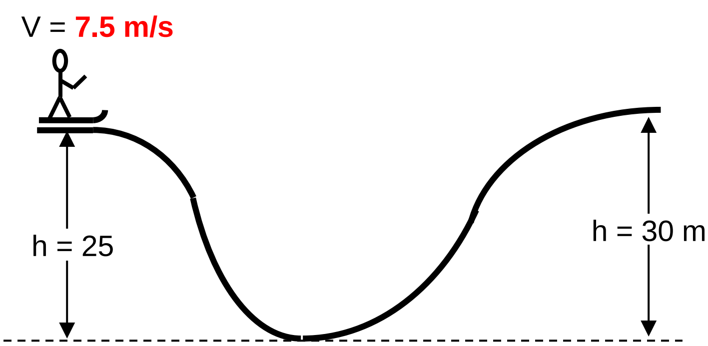
3. A 50 kg skateboarder is coasting at a speed of 7.5 m/s along a flat surface. He continues at that speed as he approaches the hill. How high up the hill can he coast before he stops? (Ignore friction.)



Show all calculations here

	Bottom of hill	Top of hill
PE =		
KE =		
TOTAL =		

4. A 55 kg skier is moving 7.5 m/s at the top of a 25 m hill. Complete the energy table below and determine his speed at the bottom of the hill. **SHOW ALL WORK.**



	Top of hill	Bottom of hill
PE		
KE		
TOTAL		

5. Does he have enough energy to get to the top of the 30m hill in front of him? Support your answer with calculations.

Work & Energy

Kinetic Energy and stopping distance

I) Which has more kinetic energy?

1. A car at 30 m/s or a bus at 30 m/s?
   Why?

2. A bus at 30 m/s or a bus at 50 m/s?
   Why?

II) **KE** of a car (m = l000 kg)

3. A 1000 kg car is traveling 20 m/s. What is its kinetic energy?

4. If the braking force of the car is 40,000 N, what distance does it take the car to stop?

5. If the same 1000 kg car is now traveling 40 m/s, what is its new kinetic energy?

6. What is the distance required to stop the car from 40 m/s with the same braking force?

7. Compare the kinetic energies and stopping distances of the car at 20 m/s & 40 m/s.

Speed	Kinetic energy	Stopping distance
20 m/s		
40 m/s		

a) When the speed doubles, the KE increases ________________

b) When the speed doubles, the stopping distance increases.________________

c) What is the written relationship between speed and KE?

d) What is the written relationship between speed and stopping distance?

Work & Energy

Coasters and More.........

$PE = mgh \qquad KE = \frac{1}{2}mv^2 \qquad E_f = E_i + W$

1. A 15 kg mass moves with a speed of 10 m/s. Calculate its kinetic energy.

2. An 8 kg bag of oranges drops a distance of 12 m. What is the kinetic energy of the bag just before it strikes the ground? (use energy not kinematics)

3. A 4 kg case of kidney beans drops 5 m.
   (a) What was the potential energy of the case of beans at its highest point?

   (b) Does everyone have to have the same answer to this question? Why or why not?

   (c) What is the kinetic energy of the case of beans just before it hits the ground?

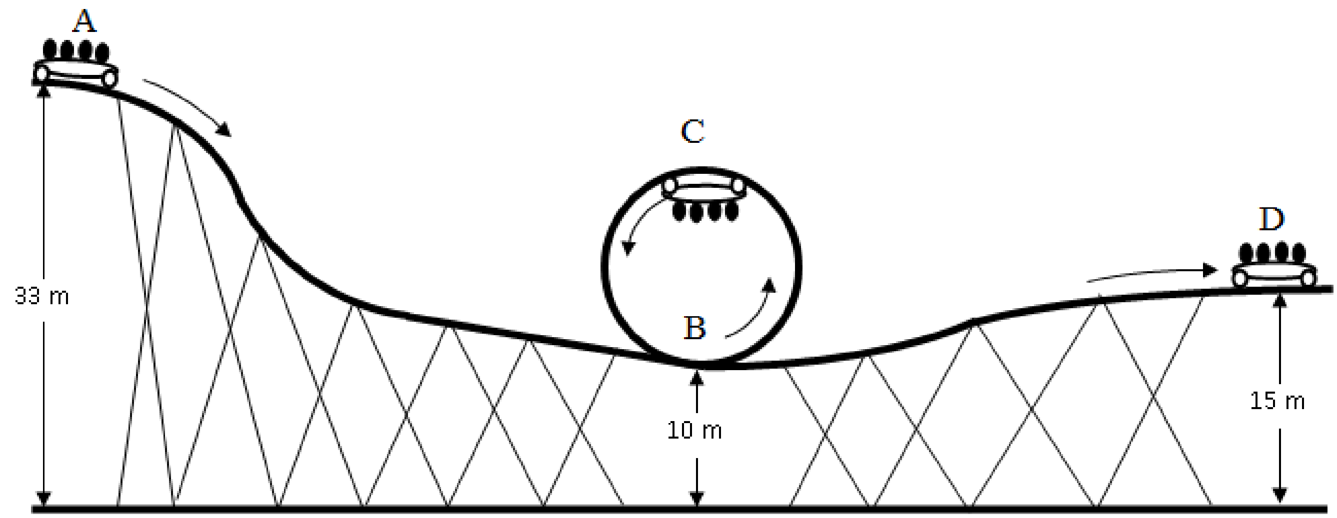
   (d) At what speed do the beans hit the ground?

4. A 2.0 kg ball is dropped from a height of 20.0 m. Ignore air resistance and determine the kinetic energy, gravitational potential energy, and total mechanical energy at each of the heights indicated below:

HEIGHT	**KE**	**PE**	**TME**
20.0 m			
15.0 m			
10.0 m			
0.0m			

Work & Energy

5. A roller coaster has a mass of 3000 kg. It starts from rest at point A, continues to point B, through the loop and then to point D. Find the speed of the coaster at points B and D. The speed at C is 16.0 m/s; find the diameter of the loop.



	Point A	Point B	Point C	Point D
PE =				
KE =				
TOTAL =				

Work & Energy

Power Problems and More

Conversion 1 Hp = 746 Watts

1. How much work is done in pulling a wagon 50 m along a level road by a force of 20 N applied to the handle if the handle makes an angle of 30° with the ground. *(866 J)*

2. A boy's mass is 50 kg. If he walks up a flight of stairs 12 m high in 30 seconds, what power has he used? *(196 W)*

3. An elevator in the Empire State Building in New York rises to the 80th floor in 50 seconds. If the height is 302 meters, what power must be developed in order to lift 12 people averaging 80 kg each to this floor? *(56824 W)*

4. A 2-kg mass is raised 6 m at a constant speed of 3 m/s by a vertical rope. What is the power supplied by the rope?

5. A 70 kg person runs up a long flight of stairs in 4 seconds. The vertical height of the stairs is 4.5 m. Calculate his power output in watts and horsepower. *(1.03 Hp)*

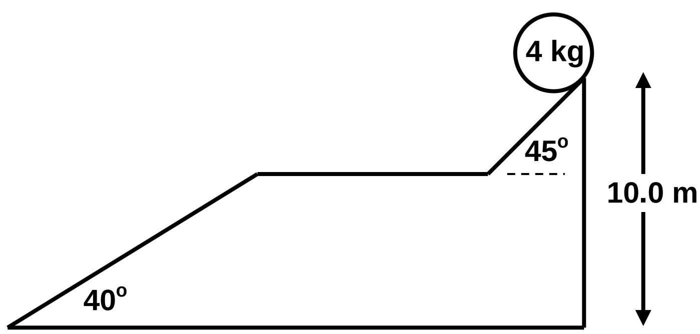
6. How long will it take a 2.0 hp motor to lift a 400 kg piano to a sixth story window 20 meters above? *(52.6 s)*

Work & Energy

7. A hydraulic jack provides a lifting force of 800 N at a speed of 0.5 m/s. What power does it produce?

8. If a car generates 15 hp when traveling at a steady 80 km/hr, what must be the average force exerted on the car due to all frictional forces. (Hint: What are the fundamental units for work.) *(503.55 N)*

9. Calculate the work that gravity does on the object as is slides to the ground. (Assume no friction) *(392 J)*



Work & Energy Review

1. Define with an equation and in words:
   a. kinetic energy

   b. potential energy

   c. work

   d. power

2. Define the principle of conservation of energy and tell how it applies to a swinging pendulum.

3. Give the standard and fundamental units for

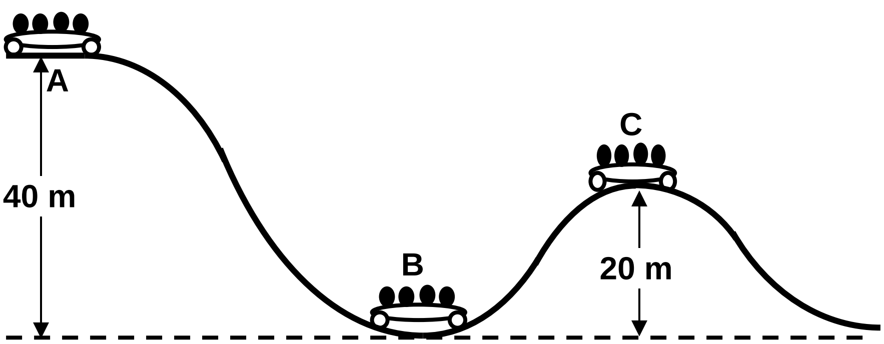
   a. work
   b. power

   c. energy (kinetic)
   d. energy (potential)

4. What is meant by the term mechanical energy?

5. Apply the Law of Conservation of Energy in the following problem:
   A 2000 kg car traveling at 40 m/s suddenly slams on its brakes which supply a 100,000 N braking force. How far will the car skid before coming to a complete stop?

6. Find the KE and PE at all the marked points on the roller coaster. If it begins at rest at point A. (mass = 500 kg) Assume mechanical energy is conserved.



	KE	PE
A		
B		
C		

Work & Energy

7. Spiderman (84 kg) climbs 150 m up the side of a building.
   a) How much work did Spiderman do to reach this height?

   b) How much PE does he have at this height?

   c) If he reached this height in 2 min. how much power did he generate?

8. a) How much work is done when lifting a 25 kg box to a shelf 3 m above the floor? (Just enough force is used to overcome the box's weight?)

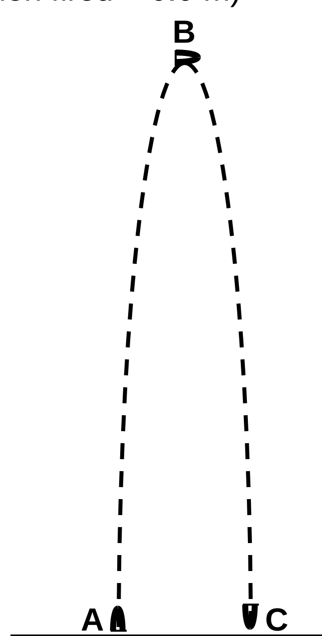
   b) What is the potential energy of the box as it sits on the shelf?

   c. If the box were to fall, how much kinetic energy would it have just before hitting the floor?

   d. How much work would the floor have to do to stop to box?!

9. A 0.1 kg bullet is fired at 100 m/s directly from the ground. (Height when fired = 0.0 m) Fill in the chart below. Assume no air resistance.

	When fired (A)	At the Peak (B)	Just before it hits the ground (C)
PE			
KE			
TE			



10. Using energy considerations, How high will the bullet in problem #8 go?

11. How fast will the bullet in problem #8 be going when it hits the ground?