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?

   $W = F \cdot d = (2.0)(2.0) = 4\ J$

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

   $W = 0$

   $\rightarrow d$ Force & dist. Not in the direction

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

   $W = 0$ dist $= 0$ $W = F(0) = 0$

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

   $PE = mgh = (.4)(9.8)(1.5) = 5.88\ J$

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?

   $KE = \frac{1}{2} m V^2 = \frac{1}{2}(.4)(4)^2 = 3.2\ J$

Energy Examples:

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

Object	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Rock	0	0	0.5	0	0	0
Large Boulder	0	12	2,000	240,000	0	240,000
Cheetah	24	1.5	60	900	17,280	18,180
Space Shuttle	300	20,000	40,000	$8X10^9$	$1.8X10^9$	$9.8X10^9$
Submarine	40	100	2,500	2,500,000	2,000,000	4,500,000
Runner	2	1	75	750	150	900
Mole	0.025	-0.5	0.75	-3.75	0.00023	-3.75
Fly	10	3	0.004	0.12	0.2	0.32

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	12.6	7	50	3,500	4,000	7,500
Car	14	0.4	1,800	7,200	176,400	183,600
Unknown	1,000	0	0.8	0	400,000	400,000
Truck	7.24	0.11	6,400	7,200	176,400	183,600
Laundry Bag	19.3	10	7	700	1,300	2,000
Unknown	3.04	3	100	3,000	463.3	3463.3

Work & Energy

Name ______________________
Period __________

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)?
   - PE A. Energy stored in stretched rubber bands.
   - KE B. Energy of a bullet moving 350 m/s.
   - PE C. Energy of gun powder.
   - PE D. A can of soup sitting on a shelf 1.5 m above floor.
   - KE 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?

   $W = F \cdot d$ $F = mg = 15(9.8) = 147$ N $W = F \cdot d$ $W = 147(.75) = 110$ N

3. How much work does the shelf do <u>holding</u> the case of soup up? Explain.

   $W = 0$ The Soup doesn't move.

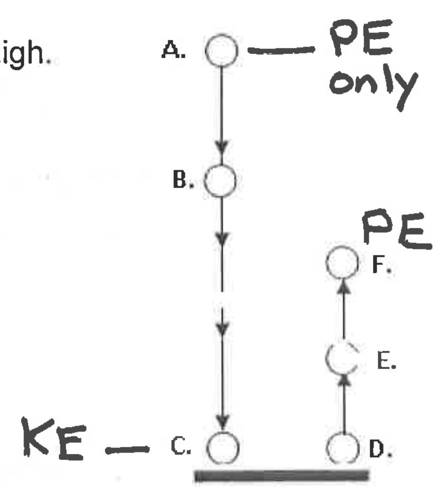
4. What is the potential energy of a 0.4 kg can of soup sitting on a 3 m high shelf?

   $PE = mgh = 3(9.8)(.4) = 11.76$ J

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?

   $KE = \frac{1}{2}mV^2 = \frac{1}{2}(.5)(2.5)^2 = 1.56$ J

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: PE
B: PE+KE
C: KE
D: KE
E: PE+KE
F: PE

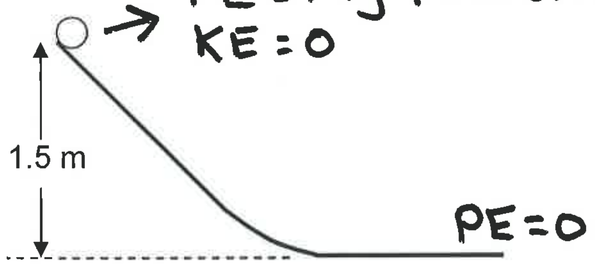
7. What can be said about the total mechanical energy in the path from A-C compared to the path from D-F; is it more, less, or the same? If different, why?

   D-F is Less Than A-C. The difference Is due to Energy loss in the Collision with the floor.

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.



	Top of Ramp	Bottom of Ramp
PE	7.35	0
KE	0	7.35 − 0 = 7.35
TOTAL	7.35	7.35

Show all calculations here

$KE = 7.35$

$\frac{1}{2}mv^2 = 7.35$

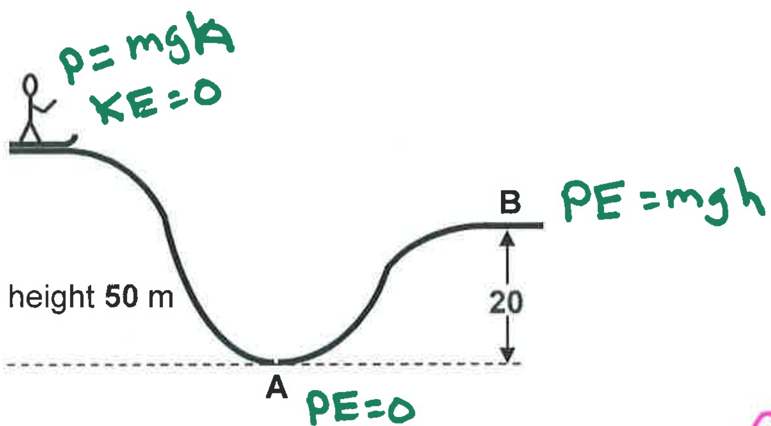
$\frac{1}{2}(.5)v^2 = 7.35$

$0.25v^2 = 7.35$

$v^2 = 29.4$

$v = \sqrt{29.4} = 5.42\ m/s$

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

$PE_{Top} = mgh = 60(9.8)50$

$PE_{Top} = 29400\ J$

$PE_B = mgh = 60(9.8)20$

$PE_B = 11760$

	Top of Hill	Point A	Point B
KE	0	29400	17640
PE	29400	0	11760
TOTAL	29400	29400	29400

29400 − 11760

@ a $KE = \frac{1}{2}mv^2$

$\frac{1}{2}mv^2 = 29400$

$\frac{1}{2}(60)v^2 = 29400$

$v^2 = 29400 \div 30 = 980$

$v_A = \sqrt{980} = 31.3\ m/s$

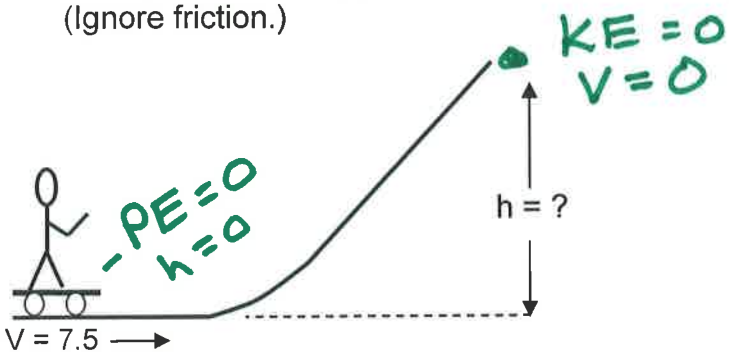
@ B $\frac{1}{2}mv_B^2 = KE_B$

$30v_B^2 = 17640$

$v_B = \sqrt{\frac{17640}{30}} = 24.2\ m/s$

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

KE @ Bottom

$K = \frac{1}{2}mv^2$

$= \frac{1}{2}(50)(7.5)^2 = 1406 J$

	Bottom of hill	Top of hill
PE =	0	1406
KE =	1406J	0
TOTAL =	1406	1406

PE @ Max height

$mgh = 1406$

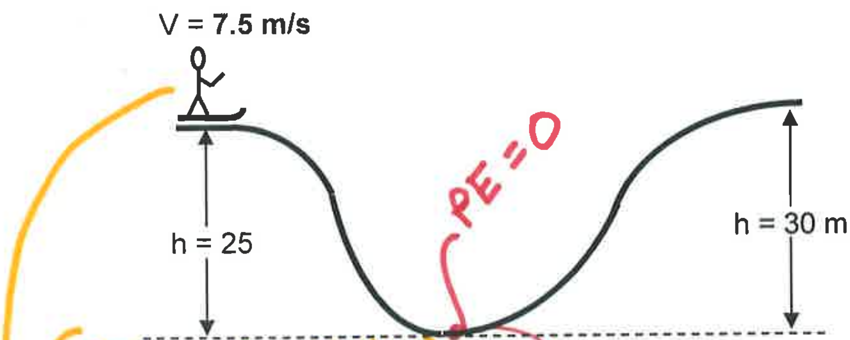
$50(9.8)h = 1406$

$490h = 1406$

$h = 1406/490$

$h = 2.87 m$

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	13475	0
KE	1547	15022
TOTAL	15022	15022

$PE = mgh = 55(9.8)25$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(55)(7.5)^2$

$KE = 15022$

$\frac{1}{2}mv^2 = 15022$

$\frac{1}{2}(55)v^2 = 15022$

$27.5v^2 = 15022$

$v^2 = 15022 \div 27.5$

$v = \sqrt{546} = 23.4 m/s$

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

PE @ 30m = mg(30) = 55(9.8)30 = 16170 J

The Skier Has an Energy of 15022 J, he needs 16170 To make it to the top so he will Stop Short.

Work & Energy

Name ____________________
Period __________

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.

   $KE = \frac{1}{2}mV^2 = \frac{1}{2}(15)(10)^2 = 750\text{ J}$

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)

   $E_f = E_I + ~~W~~$ E_f = KE @ Bottom, E_I = PE @ Top

   $KE = mgh = 8(9.8)(12) = 941\text{ J}$

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?

   $PE = mgh = 4(9.8)(5) = 196\text{ J}$

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

   No PE depends on where you pick as h=0.

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

   $E_f = E_I$ $\frac{1}{2}mV^2 = 196$
   KE = PE $KE = 196$

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

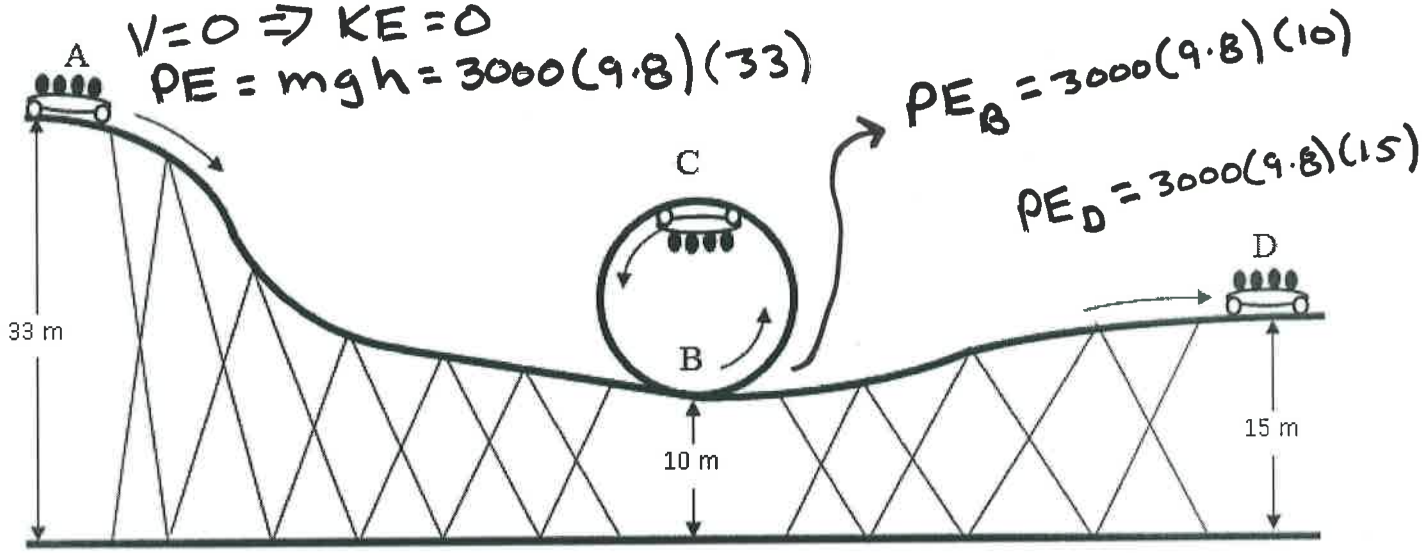
   $\frac{1}{2}mV^2 = 196$ $V^2 = 196 \div 2$ $V = \sqrt{98} = 9.9\text{ m/s}$
   $\frac{1}{2}(4)V^2 = 196$

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	0	(2)(9.8)20 = 392J	392
15.0 m	392 - 294 = 98	2(9.8)(15) = 294	392
10.0 m	392 - 196 = 196	2(9.8)(10) = 196	392
0.0m	392	2(9.8)(0) = 0	392

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 =	970,200	294,000	586200	441000
KE =	0	676,200	384000	529200
TOTAL =	970,200	970,200	970,200	970,200

$V \Rightarrow C = 16\ m/s$

$KE_C = \frac{1}{2}mV^2 = \frac{1}{2}(3000)(16)^2 = 384000\ J$

Velocities @ B & D $\quad KE = \frac{1}{2}mv^2$

$\frac{1}{2}mV_B^2 = 676200$

$\frac{1}{2}(3000)V_B^2 = 676,200$

$V_B^2 = 676200/1500 = 450.8$

$V_B = \sqrt{450.8} = 21.2\ m/s$

$1500V_D^2 = 529200$

$V_D = \sqrt{\frac{529200}{1500}} = 18.8\ m/s$

Find h @ "C"

$mgh_C = PE_C$

$3000(9.8)h_C = 586200$

$h_C = \frac{586200}{29400} = 19.9\ m$

$R = 19.9\ m - 10\ m$

$= 9.9\ m$