Work & Energy

Total Mechanical 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 $\boldsymbol{TME = PE + KE}$ $PE = mgh$ $KE = \frac{1}{2}mv^2$

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			
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	3,500	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	

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	235200	0	235,200
Cheetah	24	1.5	60	882	17,280	18,162
Space Shuttle	300	20,000	40,000	7840000000	1,800,000,000	9,640,000,000
Submarine	40	100	2,500	2450000	2,000,000	4,450,000
Runner	2	1	75	735	150	885
Fly	10	3	0.004	0.1176	0.200	0.318

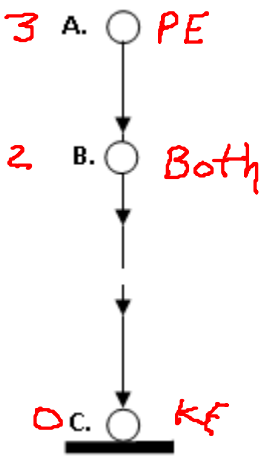
Object	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Lead Block	12.65	7.14	50	3,500	4,000	7,500
Car	14	0.41	1,800	7,200	176400	183,600
Unknown	1,000	0	0.8	0	400,000	400,000
Truck	7.42	0.11	6,400	7,200	176,400	183,600
Laundry Bag	19.08	10	7.14	700	1,300	2,000
Unknown	3.04	3	100	2940	463.3	3,403

Work & Energy

Intro to Energy Conservation

$$PE = mgh \qquad KE = \frac{1}{2}mv^2 \qquad TME = PE + KE$$

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.

   $PE_A = mgh_A = (0.5)(9.8)(3.0) = 14.7$ J

   $PE_B = (.5)(9.8)(2) = 9.8$ J

   $PE_C = 0$

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).

Vi=0
Vf=?
d= -1
a = -9.8

$v_f^2 = v_i^2 + 2 \cdot a \cdot d$
$v_f^2 = 0 + 2 \cdot (-9.8) \cdot (-1.0) = 19.6$
$v_f = \sqrt{19.6} = 4.43 \frac{m}{s}$

$v_f^2 = v_i^2 + 2 \cdot a \cdot d$
$v_f^2 = 0 + 2 \cdot (-9.8) \cdot (-3.0) = 58.8$
$v_f = \sqrt{58.8} = 7.67 \frac{m}{s}$

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

$KE_A = 0$

$KE_B \quad KE = \frac{1}{2}mv^2 = \frac{1}{2}(0.5)(4.43)^2 = 4.9 \cdot J$

$KE_C \quad KE = \frac{1}{2}(.5)(7.67)^2 = 14.7 \cdot J$

Position	Speed (m/s)	Height (m)	Mass (kg)	P.E.(J)	K.E. (J)	T.M.E.(J)
Point A	0	3.0	0.5	14.7	0	14.7
Point B	4.43	2.0		9.8	4.9	14.7
Point C	7.76	0		0	14.7	14.7

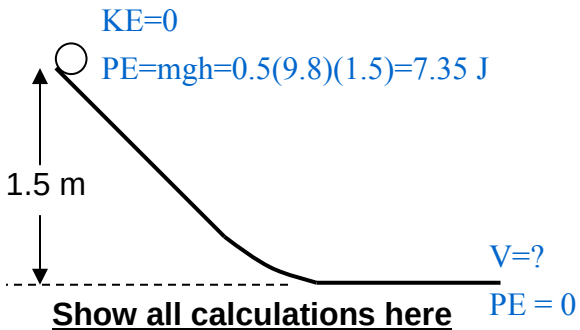
4. What do you notice about the total mechanical energy at points A – C?

   TME does not change - The Law of Conservation of Energy

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.



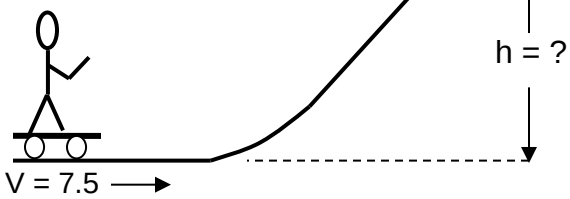
	Top of Ramp	Bottom of Ramp
PE	7.35	0
KE	0	7.35
TOTAL	7.35	7.35

Show all calculations here

$$KE = \frac{1}{2}mv^2$$
$$7.35 = \frac{1}{2}(0.5)\,v^2$$
$$7.35 = 0.25v^2$$
$$v^2 = \frac{7.35}{.25} = 29.4$$
$$v = \sqrt{29.4} = 5.42 \cdot \frac{m}{s}$$

2. 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.)

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}\,50 \cdot 7.5^2 = 1406J$$



PE=0

Show all calculations here

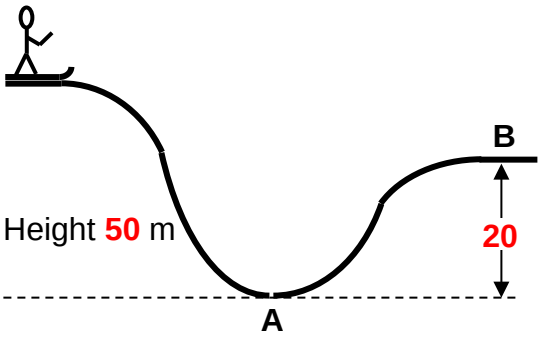
$$PE = m \cdot g \cdot h$$
$$1406 = 50 \cdot 9.8 \cdot h$$
$$h = \frac{1406}{490} = 2.87m$$

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

Work & Energy

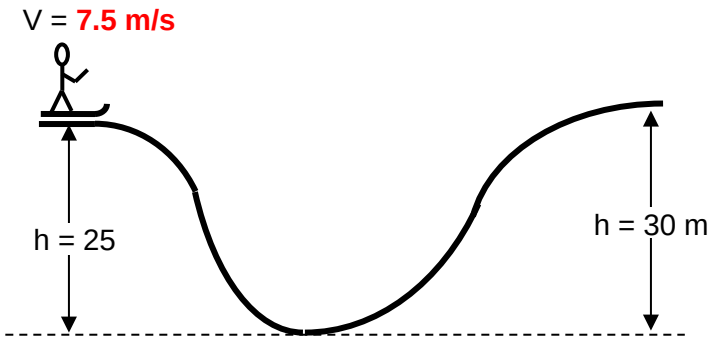
3. A skier rests on top of a 50m hill. The skier's mass if 60 kg. Ignoring friction, calculate the skier's speed at points A and B.

Show all calculations here



	Top of Hill	Point A	Point B
KE			
PE			
TOTAL			

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.