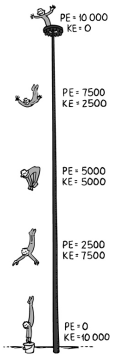
Energy Conservation

Energy Conservation

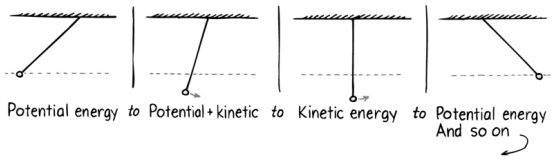
- Energy can be thought of as the capacity for doing work
- Energy may be transformed from one type of energy to another.
  - Kinetic, potential, "heat", work
- Energy can be neither created nor destroyed

Energy Conservation

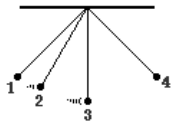
- The total energy of a system is constant.
- That is, the sum of the PE + KE + other types of energy = constant
- If PE decreases, KE increases … and vice versa



Pendulum Energy



Pendulum Energy

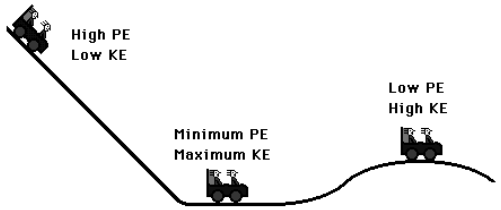


Position 1	Position 2	Position 3	Position 4
PE = 6 J	PE = 3 J	PE = 0 J	PE = 6 J
KE = 0 J	KE = 3 J	KE = 6 J	KE = 0 J
h = __A__ m	h = __B__ m	h = __D__ m	h = __F__ m
v = 0 m/s	v = __C__ m/s	v = __E__ m/s	v = 0 m/s

Pendulum Answers

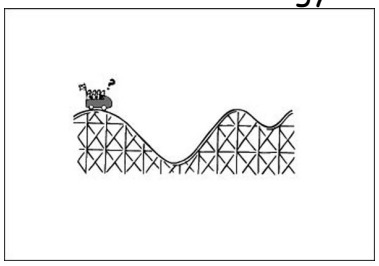
- A: **h = 0.306 m** (6 J = 2 kg *9.8 m/s/s * h)
- B: **h = 0.153 m** (3 J = 2 kg *9.8 m/s/s * h)
- C: **v = 1.73 m/s** (3 J = 0.5 * 2 kg * v^2)
- D: **h = 0 m** (0 J = 2 kg * 9.8 m/s/s*h)
- E: **v = 2.45 m/s** (6 J = 0.5 * 2 kg * v^2)
- F: **h = 0.306 m** (6 J = 2 kg * 9.8 m/s/s * h)

Roller Coaster Energy



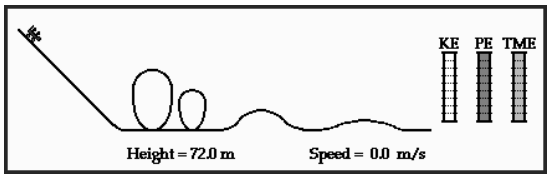
As a coaster car loses height, it gains speed; PE is transformed into KE. As a coaster car gains height it loses speed; KE is transformed into PE. The sum of the KE and PE is a constant.

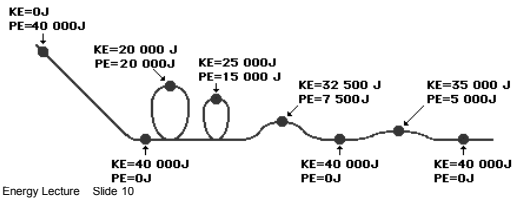
Roller Coaster Energy



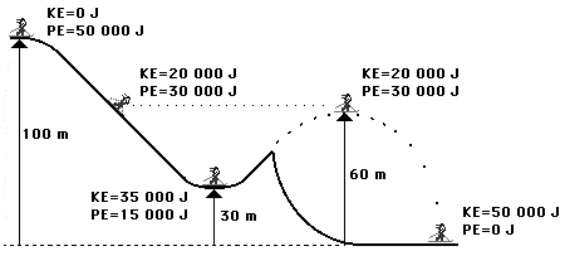
- First hill must be highest
- What impact does friction have on the height of the successive hills?

Roller Coaster





Ski Jumper Energy



Simple Machines

- If no friction, then
- Work Input = Work Output
- Inclined plane 
- Pulley 
- Lever 

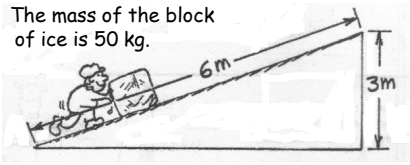
Why Use a Machine?

- If there is no friction,
  - Work done on the machine (work input) is equal to the work done by the machine (work output)
- and … when there is friction,
  - work input > than work output
- So why do we use machines?

Inclined Plane

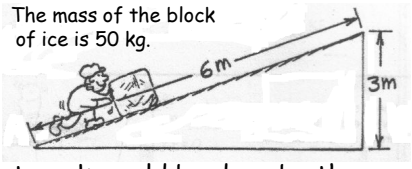
- Output work = work done if you didn't use the machine
  - Output work = (weight of load)(vertical height)
- Input work = work done using machine
  - Input work = (force exerted)(length of plane)

Inclined Plane Problem



- What work would be done by the man if he lifted the block vertically upward 3m?
- How does this relate to the change in potential energy of the block?

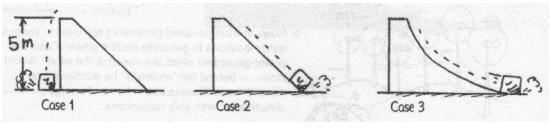
Inclined Plane Problem



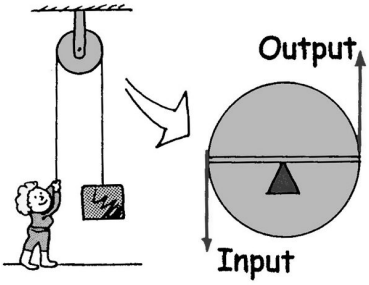
- What work would be done by the man if he slid the block along the incline to the top?
- What force would the man have to use to move the block at a constant speed along the ramp?

Ramps & Energy Conservation

- What is the speed of the block at the bottom of each of the 5 m high ramps? Ignore friction. Use g = 10 m/s/s.

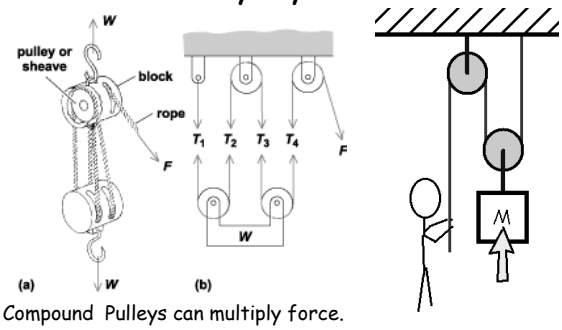


Pulley



- Mechanical Advantage of Single Pulley is 1
- Single pulley changes direction of force

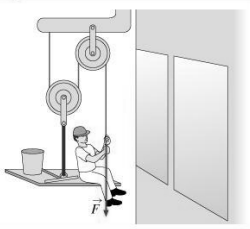
Pulley Systems



Compound Pulleys can multiply force.

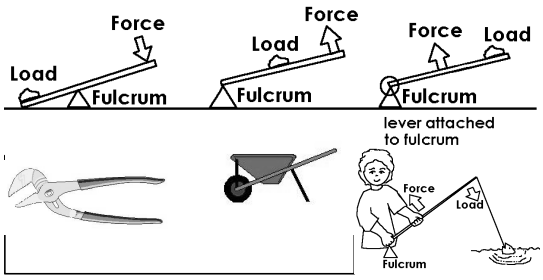
Window Washer

- The window washer has a mass of 75 kg and the platform plus the bucket and squeegee has a mass of 25 kg.
- What force does the washer have to exert to lift himself and the platform?



- What length of rope will he have to pull in order to lift himself 12 m?

Lever



Mechanical Advantage

- Ideal Mechanical Advantage

$$AMA = \frac{Force\ without\ machine}{Force\ with\ machine}$$

$$IMA = \frac{Distance\ with\ machine}{Distance\ without\ machine}$$

$$efficiency = \frac{AMA}{IMA}$$

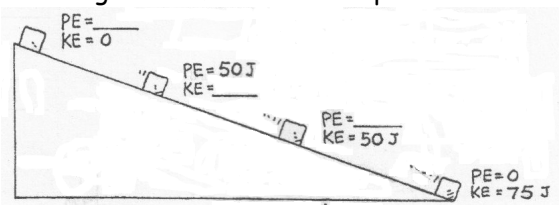
Efficiency

- Because of friction,
  - work output < work input
  - Efficiency < 100%
  - Efficiency can also be found by

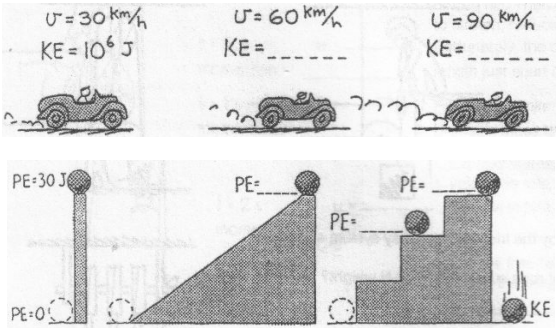
$$Efficiency = \frac{WorkOutput}{WorkInput}$$

Energy Practice 1

- Both the KE and PE of a block freely sliding down a ramp are shown below only at the bottom position in the sketch. Fill in the missing values for the other positions

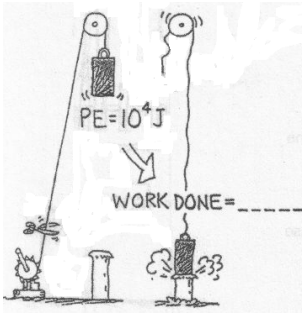


Energy Practice 2



Energy Lecture Slide 25

Energy Practice 3



Energy Lecture Slide 26

Energy Practice 4

A big metal bead slides due to gravity along an upright friction-free wire. It starts from rest at the top of the wire as shown in the sketch.

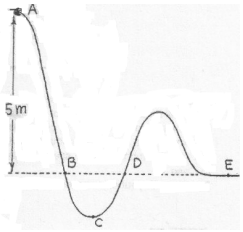
How fast is it traveling as it passes

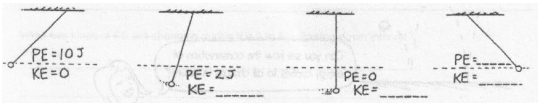
Point B? _____

Point D? _____

Point E? _____

Maximum speed at Point _____





Energy Lecture Slide 27