

Energy Conservation

Energy Lecture Slide 1

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 Lecture Slide 2

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

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Energy Lecture Slide 4

Pendulum Energy

Potential energy to Potential+kinetic to Kinetic energy to Potential energy
And so on

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Energy Lecture Slide 5

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
$h = \underline{A} \text{ m}$	$h = \underline{B} \text{ m}$	$h = \underline{D} \text{ m}$	$h = \underline{F} \text{ m}$
$v = 0 \text{ m/s}$	$v = \underline{C} \text{ m/s}$	$v = \underline{E} \text{ m/s}$	$v = 0 \text{ m/s}$

Energy Lecture Slide 6

Pendulum Answers

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

Energy Lecture Slide 7

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.

Energy Lecture Slide 8

Roller Coaster Energy

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

Energy Lecture Slide 9

Roller Coaster

Point	KE (J)	PE (J)	TME (J)
Start	0	40,000	40,000
Point 1	20,000	20,000	40,000
Point 2	25,000	15,000	40,000
Point 3	32,500	7,500	40,000
Point 4	35,000	5,000	40,000
Point 5	40,000	0	40,000
Point 6	40,000	0	40,000

Energy Lecture Slide 10

Ski Jumper Energy

Point	KE (J)	PE (J)	TME (J)
Start (100 m)	0	50,000	50,000
Point 1	20,000	30,000	50,000
Point 2 (30 m)	35,000	15,000	50,000
Point 3 (60 m)	20,000	30,000	50,000
End (0 m)	50,000	0	50,000

Energy Lecture Slide 11

Simple Machines

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

Energy Lecture Slide 12

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?

Energy Lecture Slide 13

Inclined Plane

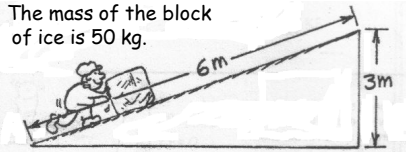


- Output work = work done if you didn't use the machine
 - Output work = (weight of load)(vertical height)
- Input work = work done using machine
 - Input work = (force exerted)(length of plane)

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Inclined Plane Problem

The mass of the block of ice is 50 kg.

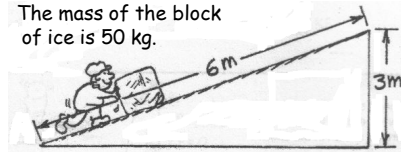


- What work would be done by the man if he lifted the block vertically upward 3m?
- How does this relate to the change in potential energy of the block?

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Inclined Plane Problem

The mass of the block of ice is 50 kg.

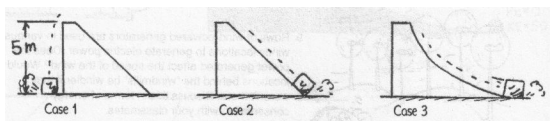


- What work would be done by the man if he slid the block along the incline to the top?
- What force would the man have to use to move the block at a constant speed along the ramp?

Energy Lecture Slide 16

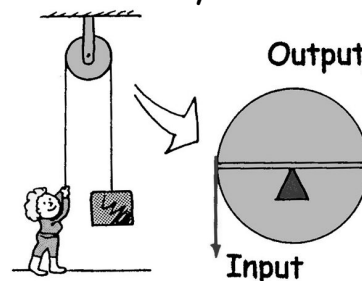
Ramps & Energy Conservation

- What is the speed of the block at the bottom of each of the 5 m high ramps? Ignore friction. Use $g = 10 \text{ m/s}^2$.



Energy Lecture Slide 17

Pulley



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

Energy Lecture Slide 18

Pulley Systems

(a) Compound Pulleys can multiply force.

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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?

Energy Lecture Slide 20

Lever

Energy Lecture Slide 21

Mechanical Advantage

- Ideal Mechanical Advantage

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

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

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

Energy Lecture Slide 22

Efficiency

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

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

Energy Lecture Slide 23


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 Lecture Slide 24

Energy Practice 2


$v = 30 \text{ km/h}$
 $KE = 10^6 \text{ J}$



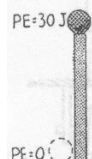
$v = 60 \text{ km/h}$
 $KE = \text{---}$



$v = 90 \text{ km/h}$
 $KE = \text{---}$

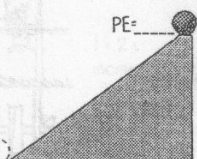


$PE = 30 \text{ J}$

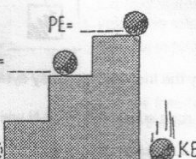


$PE = 0$

$PE = \text{---}$



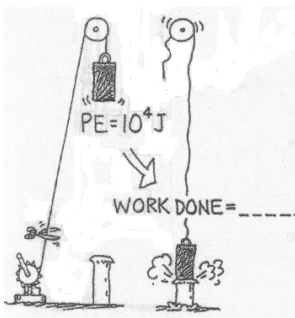
$PE = \text{---}$



$KE = \text{---}$

Energy Lecture Slide 25

Energy Practice 3



$PE = 10^4 \text{ J}$

WORK DONE = ---

$PE = 15000 \text{ J}$
 $KE = 0$

$PE = 11250 \text{ J}$
 $KE = \text{---}$

$PE = 7500 \text{ J}$
 $KE = \text{---}$

$PE = 3750 \text{ J}$
 $KE = \text{---}$

$PE = 0 \text{ J}$
 $KE = \text{---}$

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.

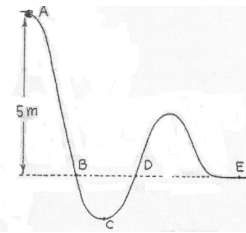
How fast is it traveling as it passes

Point B? ---


Point D? ---

Point E? ---


Maximum speed at Point ---




$PE = 10 \text{ J}$
 $KE = 0$




$PE = 2 \text{ J}$
 $KE = \text{---}$



$PE = 0$
 $KE = \text{---}$



$PE = \text{---}$
 $KE = \text{---}$



Energy Lecture Slide 27