Conservation of Energy

Mrs.T.Pandimeena
Guest Lecturer
Department of physics (SF)
CPA College, Bodinayakanur

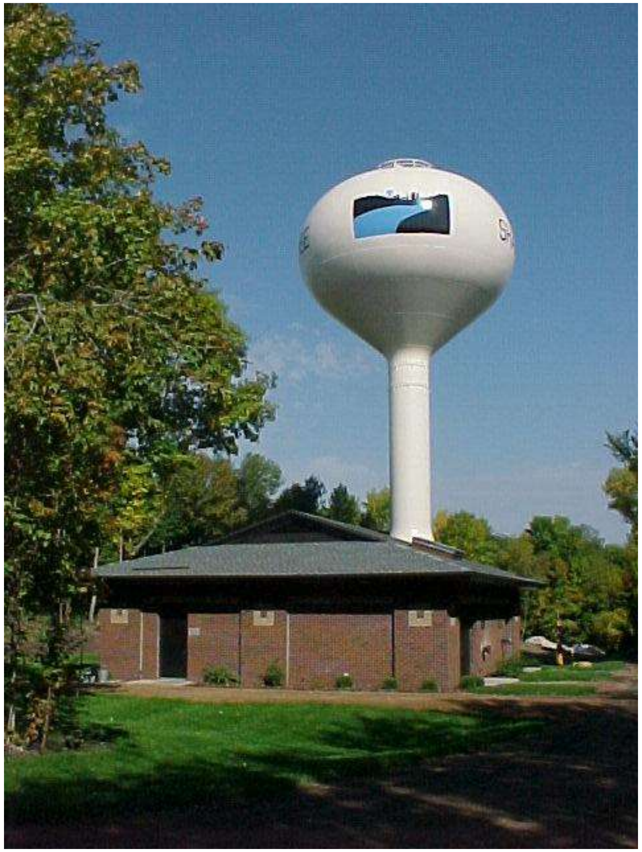
Where's the energy?

- When I did work, I transferred energy to the ball.
- But zero net work done on the ball.
- Ball's kinetic energy has not changed.
- Energy is 'stored' as potential energy.
- Can think of this as energy stored in the gravitational field.

Potential energy

- The potential energy of a system is the work required to get the system into that configuration.
- Some examples
  - For a pendulum, it is the work required to move the bob to the top of its swing.
  - For a falling apple, it is the work required to lift the apple.
  - For a spring, it is the work required to compress the spring

Storing energy



Water tower and pumphouse

Water is pumped into tower when electricity cost is low

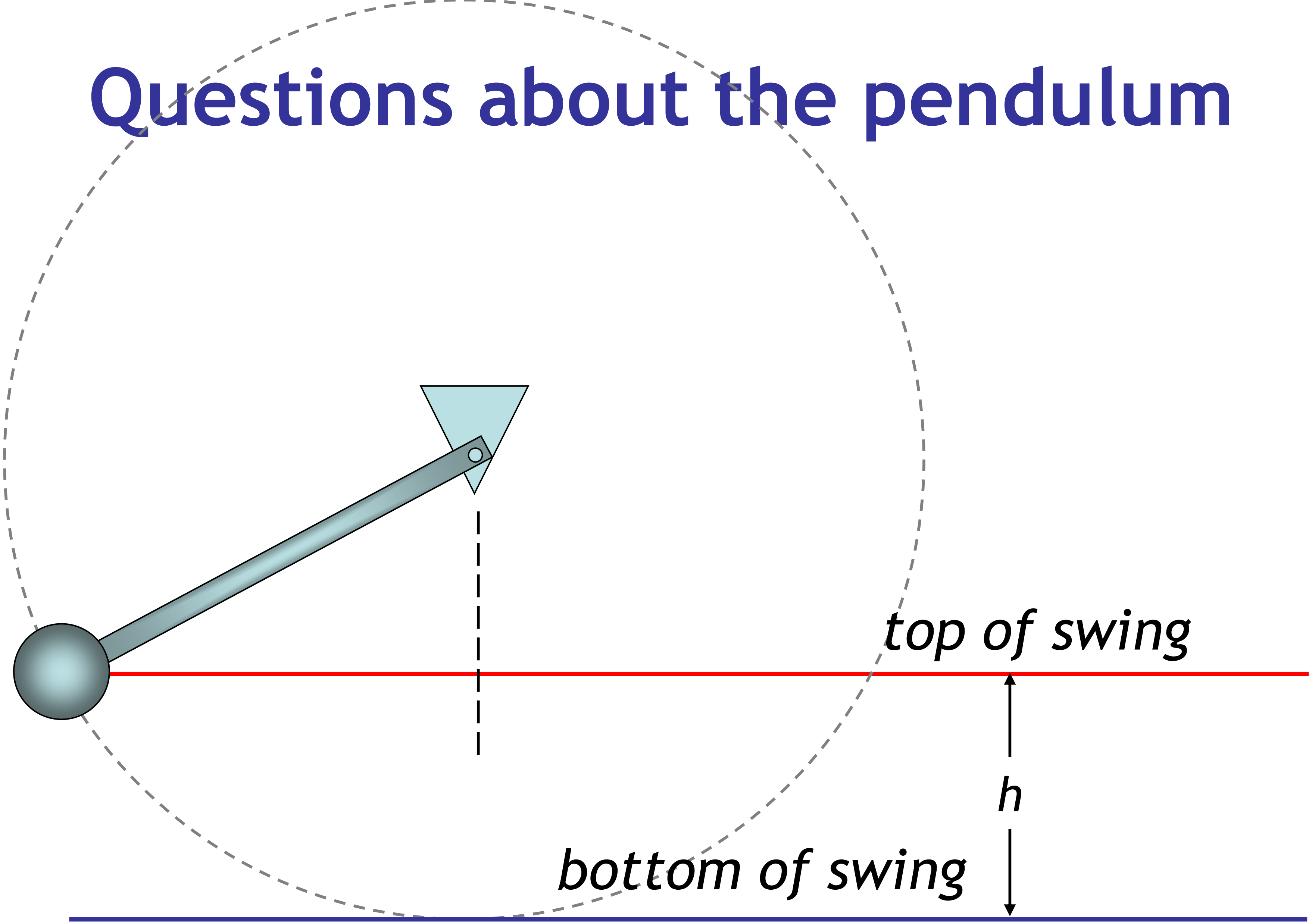
Electrical energy transformed into potential energy.

Work is extracted when needed to transport the water to homes.

Energy conservation

- In Newtonian mechanics, it is found that the total energy defined as the sum of kinetic (visible) and potential (invisible) energies is conserved.
- $E = K + U = \text{constant}$
- Many situations become much clearer from an energy perspective.

Questions about the pendulum



Conservation of energy

- This was an example of conservation of energy.
- Energy was converted from potential to kinetic.
- As the pendulum swings, energy is converted back and forth, potential to kinetic.

Work Done by Gravity

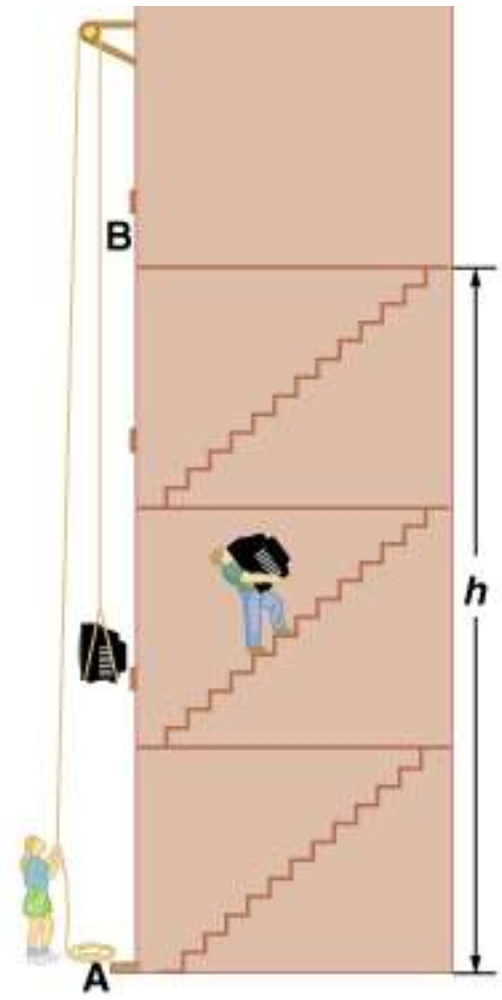
- Change in gravitational energy,

  Change in energy = mgh

  true for any path : h, is simply the height difference, $y_{final} - y_{initial}$

- A falling object converts gravitational potential energy to its kinetic energy

- Work needs to be done on an object to move it vertically up - work done is the same no matter what path is taken



Potential E independent of path

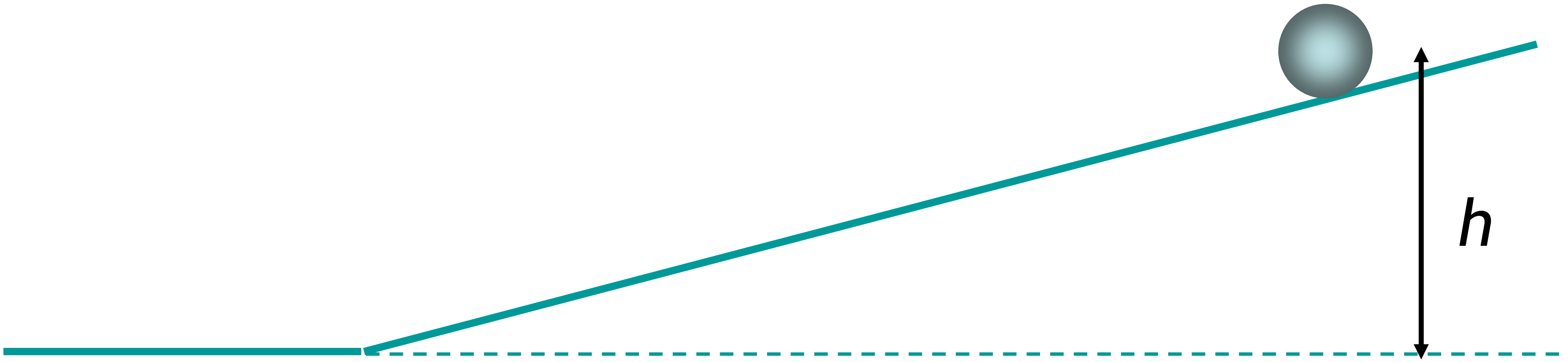
- Since the gravitational force is pointed directly downward, only the vertical distance determines the potential energy.

- We say it is ‘independent of the path’

- This is true for most ‘non-contact’ (field) forces.
  - Gravity
  - Electromagnetism
  - Nuclear forces

Testing conservation of energy

- Speed at bottom of ramp should be related to change in potential energy.
- On flat section, use timer and distance traveled to determine speed.



Power

$$P = \frac{Work}{time}, \quad \frac{\text{Joules(J)}}{\text{second(s)}} \equiv \text{Watts (W)}$$

Power is the rate at which work is done

It is measured in Watts.

(also Horsepower, 1 horsepower = 750 Watts)

Example

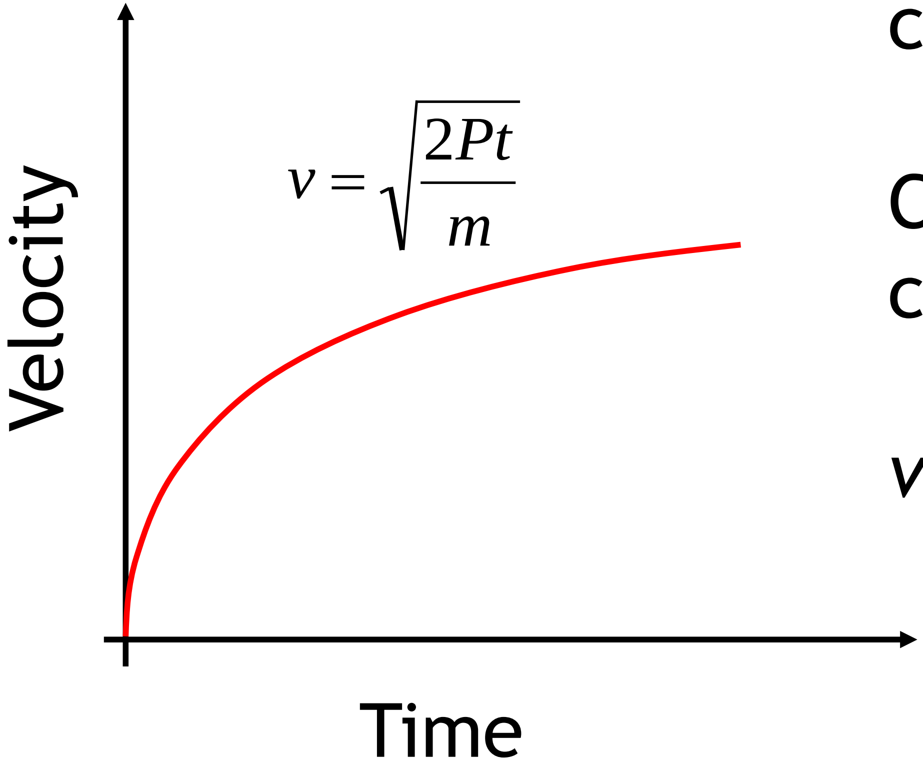
- Suppose the engine of a car puts out a fixed power *P*.
- How would the velocity of the car change with time if all that power went directly to moving the car?

Power is energy transfer / unit time.
Energy appears as kinetic energy of car $E_{kinetic}=(1/2)mv^2$

So $E_{kinetic}$ increases at constant rate, $E_{kinetic} = Pt$

Then $v^2=2Pt/m$, $v = \sqrt{\frac{2Pt}{m}}$

Velocity for fixed power



$$v = \sqrt{\frac{2Pt}{m}}$$

Not the same as a constant force.

Constant force gives constant acceleration

$v = at$ (constant force)

Can get back to total energy

- (Power)x(time) = Energy

- If power is in kilowatts = 1000 J/sec,
  Then can talk about a kilowatt-hour

- 1 kW-hour = (1000 J / sec)x(3600 sec)
  $= 3.6 \times 10^6$ J = 3,600,000 J

Energy is also measured in other ways

- Thermal energy sometimes measured in calories.

- 1 calorie ~ 4200 J = amount of thermal energy required to raise 1 kg of water 1˚C.

- But all energy is equivalent.
- Many times it changes form.