Applied Physics

Work
Energy
Power

Applied Physics

Work

6-01 Work and Power

- When you apply a force on any body it covers displacement then work is said to be done on the body.

  - Pulling a Wagon
  - Climbing stairs
  - Falling Down
  - Carrying a Heavy Backpack Down the Hall

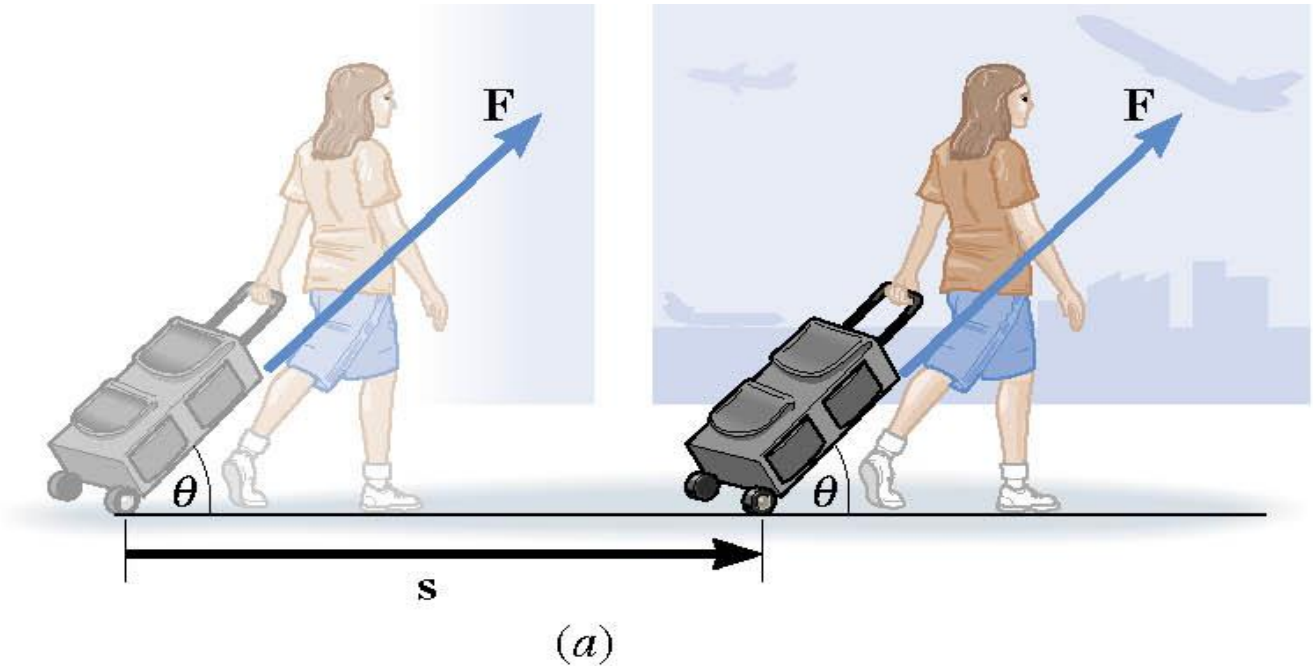
6-01 Work and Power

- Which of the following is NOT work?
  - Pushing a Stalled Car
  - Pulling a Wagon
  - Climbing stairs
  - Falling Down
  - Carrying a Heavy Backpack Down the Hall

6-01 Work and Power

- Sobia pulls a backpack on wheels down the 100-m hall. The 60-N force is applied at an angle of 30° above the horizontal. How much work is done by Sobia?

- W = 5196 J



(a)

6-01 Work and Power

- Drew is carrying books (200 N) down the 100-m hall. How much work is Drew doing on the books?

- W = 0 J

- The force is vertical displacement is horizontal.

6-01 Work and Power

- You carry some books (200 N) while walking down stairs height 2 m and length 3 m. How much work do you do?

- W = −400 J

6-01 Work and Power

- A suitcase is hanging straight down from your hand as you ride an escalator. Your hand exerts a force on the suitcase, and this force does work. Which one of the following is correct?
- The W is negative when you ride up and positive when you ride down
- The W is positive when you ride up and negative when you ride down
- The W is positive
- The W is negative

6-01 Work and Power

- Two cars with the same mass do the same amount of work to get to 100 km/h.

- Which car is better
  - Takes 8.0 s
  - Takes 6.2 s

- Sometimes the time taken to do the work is important

6-01 Work and Power

- Rate that work is done

$$P = \frac{W}{t}$$

- Unit: joule/s = **watt (W)**

6-01 Work and Power

- Since work changes the amount of energy in an object

- Power is the rate that energy is changing

6-01 Work and Power

- A 1000 kg car accelerates from 0 to 100 km/h in 3.2 s on a level road. Find the average power of the car.

- P = 119889.06 W

6-01 Work and Power

- Electrical Energy
  - Often measured in kWh because $Pt = W$
- If it costs \$0.10 per kWh, how much will it cost to run a 1000 W microwave for 2 minutes?

6-01 Work and Power

- Calculate the electricity bill amount for a month of 31 days, if the following devices are used as specified:
  a) 3 bulbs of 30 watts for 5 hours
  b) 4 tube lights of 50 watts for 8 hours
  c) 1 fridge of 300 watts for 24 hours
  Given the rate of electricity is 2 Rs. per unit

6-01 Work and Power

✵ **Solution**

The energy consumed by the bulbs,

As we know enegry=power×time

3 bulbs × 30 watts × 5 hours × 31 days = 13950 Wh

The energy consumed by the tubes,

4 tubes × 50 watts × 8 hours × 31 days = 49600 Wh

The energy consumed by the fridge,

1 fridge × 300 watts × 24 hours × 31 days = 223200 Wh

Therefore, the total energy consumption is given by,

13950+49600+223200 = 286750 Wh = 286.75 KWh

We need to convert it into units, where 1 unit = 1 kWh

So, electricity bill = 286.75 units × 2 rs = Rs. 573.5

In this lesson you will…

- Find kinetic energy.
- Find potential energy.

Types of Energy

6-02 Types of Energy

- Energy is the ability to do work
- Kinetic Energy - Energy due to motion
  - If something in motion hits an object, it will move it some distance

6-02 Types of Energy

- Potential energy
  - Energy due to position

- $W = Fd$
- Gravity
- $W_{gravity} = mgh$

$$PE = mgh$$

- Since the force of gravity is down
  - We only worry about the vertical distance
- Potential Energy is not absolute
  - It is a difference

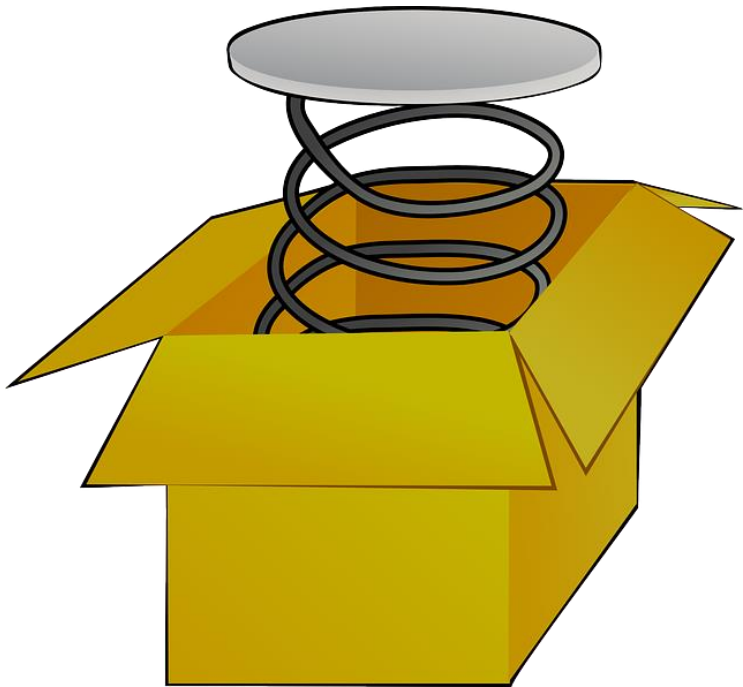
- The path the object takes doesn't matter, just the vertical distance

- h is measured from any chosen point. Just be consistent

6-02 Types of Energy

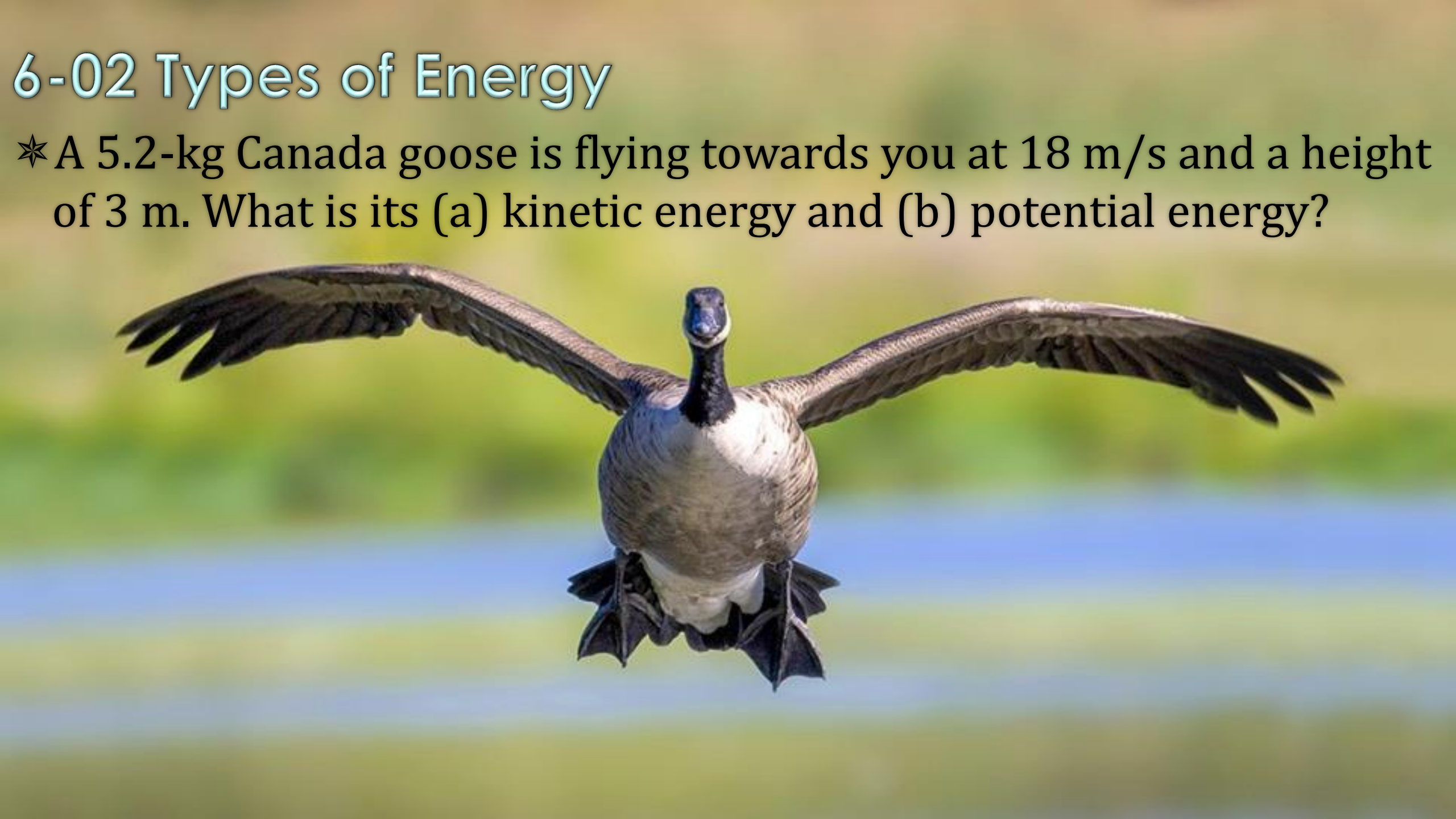
- Spring Potential Energy
  - $W = Fd$
  - $F = kx$ and $d = x$, but it requires calculus to properly calculate the work because the size of the force changes with the distance.

$$PE_S = \frac{1}{2}kx^2$$



6-02 Types of Energy

- A 5.2-kg Canada goose is flying towards you at 18 m/s and a height of 3 m. What is its (a) kinetic energy and (b) potential energy?



6-02 Types of Energy

- Let's say a coil suspension spring on a car is compressed 9.0 cm to after it is installed in a car. If it has a spring constant of 33000 N/m, what is the potential energy stored in the spring?

In this lesson you will…

- Convert energy from one form to another

Mechanical Energy Conservation

6-03 Mechanical Energy Conservation

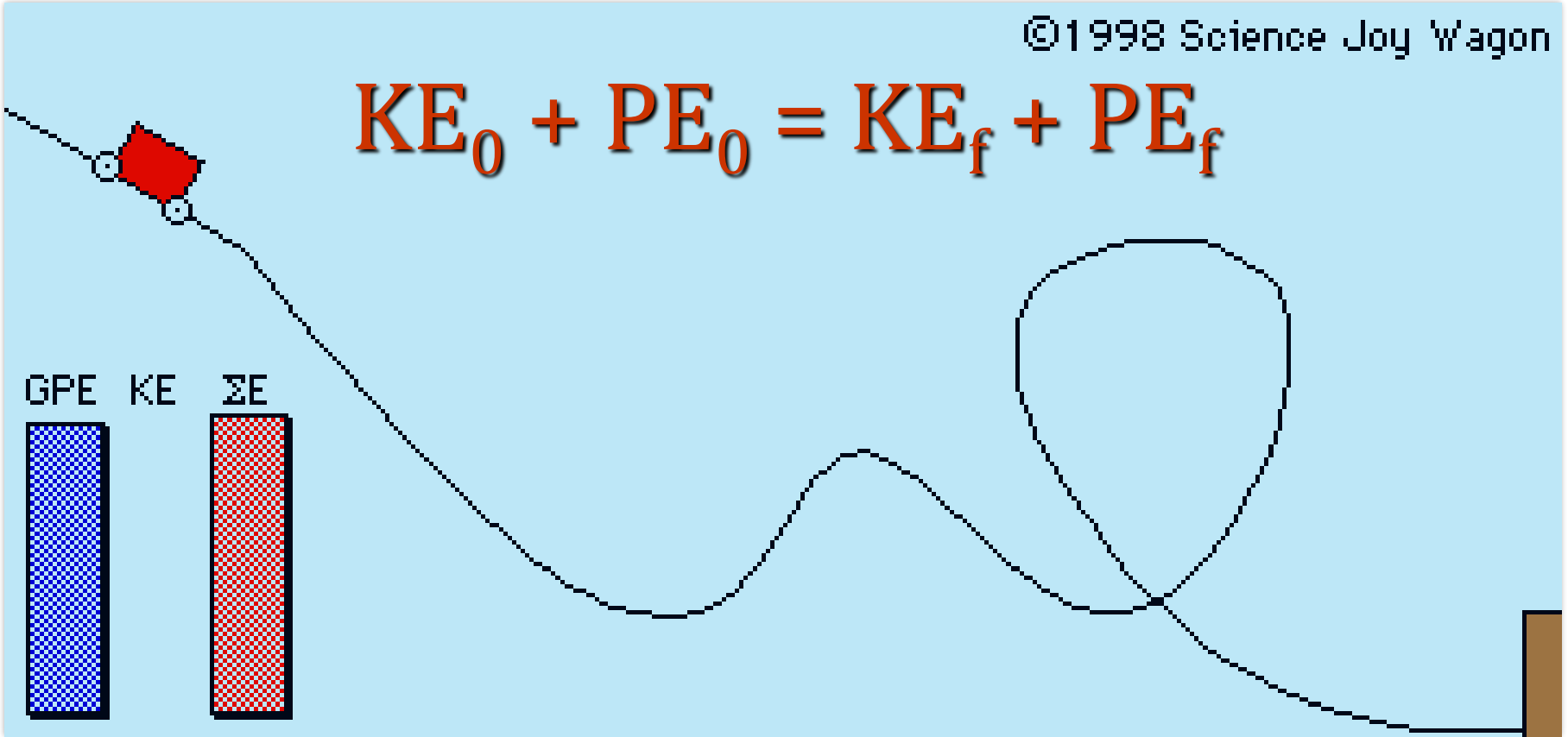
- Potential energy can be converted into Kinetic energy and back
- Think of an object thrown up
- Bottom → 0 PE, high KE
- Top → high PE, 0 KE

- $\Delta KE = -\Delta PE$
- $KE_f - KE_0 = -(PE_f - PE_0)$
- Rearrange
- Conservation of Mechanical Energy

$$KE_f + PE_f = KE_0 + PE_0$$

6-03 Mechanical Energy Conservation

- If there is only kinetic and potential energy
- Total mechanical energy is constant



6-03 Mechanical Energy Conservation

- A toy gun uses a spring to shoot plastic balls ($m = 50\ g$). The spring is compressed by 3.0 cm. Let $k = 2.22 \times 10^5\ N/m$.
- (a) Of course, you have to do some work on the gun to arm it. How much work do you have to do?
- (b) Suppose you fire the gun horizontally. How fast does the ball leave the gun?
- (c) Now suppose you fire the gun straight upward. How high does the ball go?

6-03 Mechanical Energy Conservation

- A 1500-kg car is driven off a 50-m cliff during a movie stunt. If it was going 20 m/s as it went off the cliff, how fast is it going as it hits the ground?

In this lesson you will…

- Convert energy from one form to another with work

Work and Conservation of Energy

6-04 Work and Conservation of Energy

- We can write Work done by net external force as
  - $W_{net} = \Delta KE + \Delta PE$
  - $KE_0 + PE_0 + W_{net} = KE_f + PE_f$
  - $E_0 + W_{net} = E_f$

6-04 Work and Conservation of Energy

- Law of Conservation of Energy
  - The total energy is constant in any process. It may change form or be transferred from one system to another, but the total remains the same
- Energy is transformed from one form to another
  - Box sliding down incline
    - PE transformed to KE
    - KE transformed to Heat and Sound
  - Engine
    - Chemical to KE and Heat

6-04 Work and Conservation of Energy

- A rocket starts on the ground at rest. Its final speed is 500 m/s and height is 5000 m. If the mass of the rocket stays approximately 200 kg. Find the work done by the rocket engine.

- $W = 3.48 \times 10^7$ J

6-04 Work and Conservation of Energy

- A 1500-kg car's brakes failed and it coasts down a hill from rest. The hill is 10 m high and the car has a speed of 12 m/s at the bottom of the hill. How much work did friction do on the car?

- $W_f = -39000$ J

6-04 Work and Conservation of Energy

- Captain Proton's rocket pack provides 800,000 J of work to propel him from resting on his ship which is near the earth to 50 m above it. Captain Proton's mass is 90 kg. What is his final velocity?

- $v = 130$ m/s