

# Concepts of energy and heat

Measuring energy in the metric system:

$F = ma$       Force = mass x acceleration

Unit: ***Newton***

1 kg accel'd 1 m/sec per sec

# Concepts of energy and heat

## ***Work***

1 Newton of force sustained over 1 meter distance

Joule = 1 Newton • meter

# Concepts of energy and heat

## ***Power***

The ***rate*** of work

Watt = 1 Joule per second

Think of a small fan powered by:

- one AA battery
- one D battery
- one car battery

# Energy at the Earth surface

Total global energy use per day

1.2 exa-joules (10<sup>18</sup> joules)

Energy from Earth interior per day

3.6 EJ

Energy from the Sun per day

about 4,000,000 EJ

# Energy from the Sun

Drives the hydrologic cycle

Provides chemical energy to sustain  
{almost} all life on the planet

Produces differential heating of the oceans  
and atmosphere that drives circulation  
and creates weather

# Types of energy

## ***Kinetic energy***

energy of a mass in motion

$$KE = 1 / 2 \text{ mass} \times \text{velocity}^2$$

Related concept: ***Momentum*** (or inertia)

### *Newton's First Law of Motion*

An object at rest will remain at rest ...

An object in motion will remain in motion ...

UNLESS \_\_\_\_\_

# Types of energy

## ***Potential energy***

stored energy

available to be converted to kinetic energy

## Types of potential energy

*(How can energy be stored?)*

gravitational

chemical

electrical

elastic

# Converting energy

A pendulum – from potential to kinetic and back

A corollary: *Will a pendulum swing forever?*

Loss of energy

Increase in entropy

Loss of energy applies to ANY conversion  
this is fundamental to *EFFICIENCY*



# Heat

*Fundamentally, what is heat?*

The kinetic energy of molecules  
vibrating and moving (colliding)

A balloon as a physical model  
forces pushing out  
forces pushing in

# Heat

Ways of transferring heat

Conduction

Convection – convection cells

Radiation – electromagnetic energy

# Density and buoyancy

In a *FLUID*, materials will rise or sink according to density

*Why?*

*What is the driving force for buoyancy?*

# Atmospheric physics

Atmospheric pressure

Static at sea level

High pressure

Low pressure

*What causes changes in the density of air?*

Humidity, relative humidity, and dewpoint

Compressing and expanding air

# Understanding Units of Acceleration

Initial speed of 50 mph

Acceleration of 2 mph per second

**Time (sec)**



**0**

**1**

**2**

**3**

**10**

**20**

**50**

**52**

**54**

**56**

**70**

**90**

**Speed (mph)**

# Understanding Units of Acceleration

Initial speed of 0 m/sec

Acceleration of gravity

9.81 m/sec per second

Time (sec)	Speed (m/sec)
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<b>0.0</b>	<b>0.00</b>
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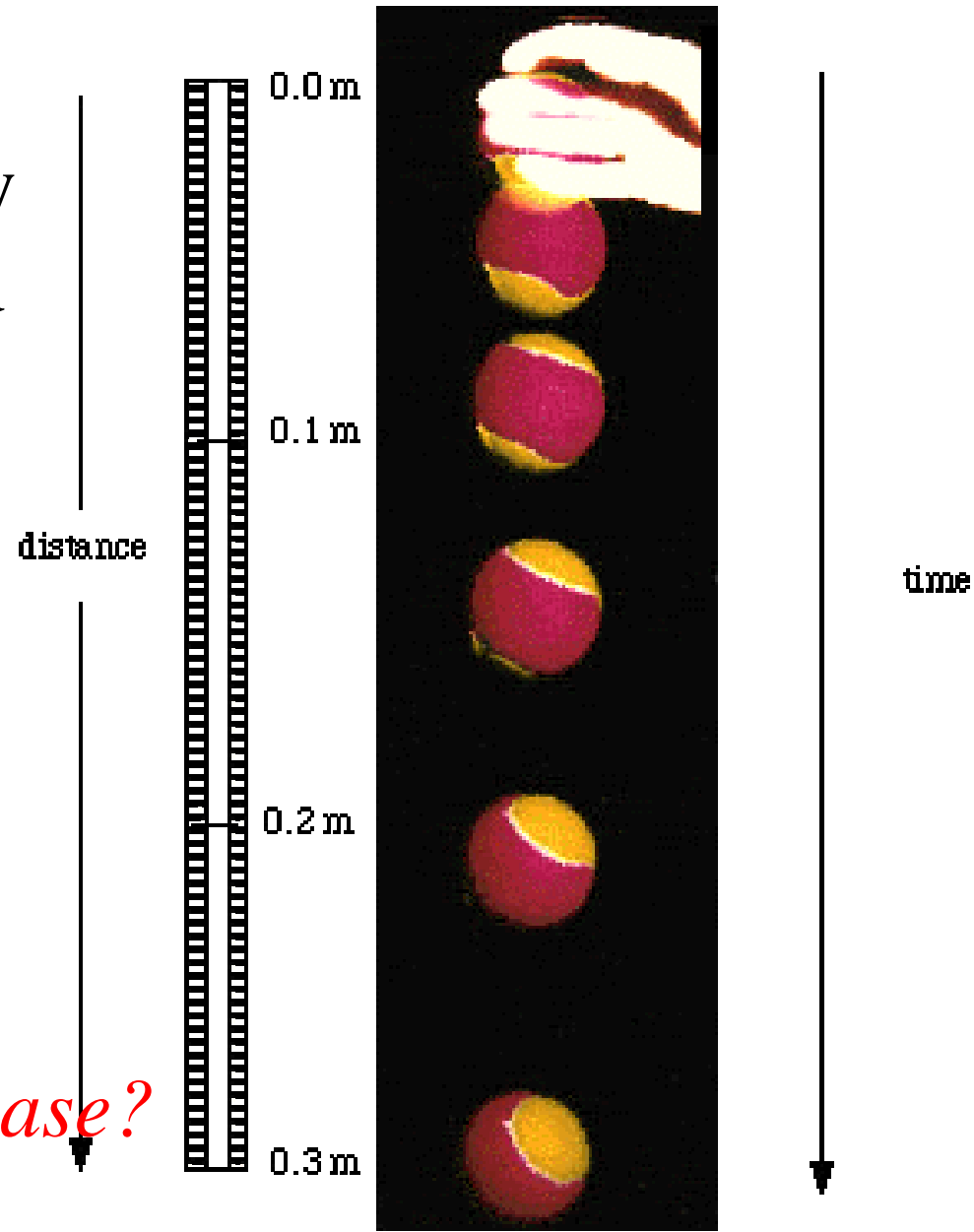
<b>0.1</b>	<b>0.98</b>
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<b>0.2</b>	<b>1.96</b>
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<b>0.3</b>	<b>2.94</b>
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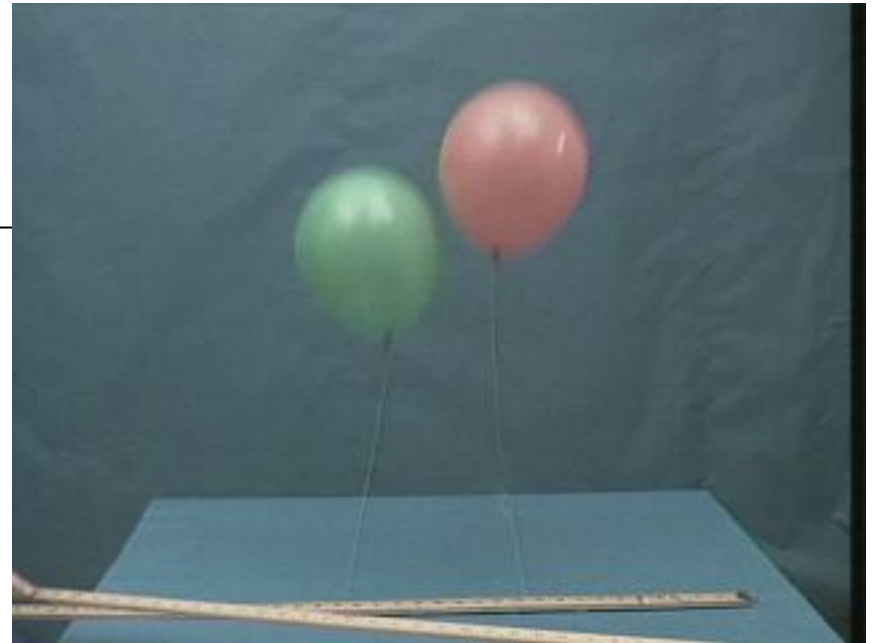
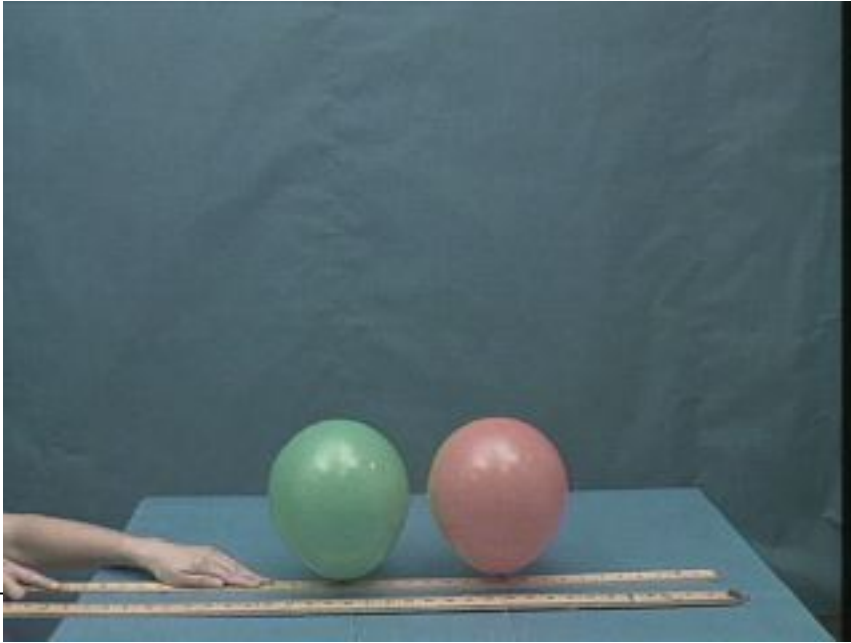
<b>0.4</b>	<b>3.92</b>
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*Will this continue to increase?*



# Density & Buoyancy

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Composition: He H

# Density & Buoyancy

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Composition:  $\text{SF}_6$   $\text{CO}_2$   $\text{O}_2$   $\text{N}_2$