ASTR 1020
Introductory Astronomy 2: Stars & Galaxies
January 23, 2008

Professor Jack Burns

Newcomers - All class info is at website:
http://solo.colorado.edu/~jaburns/Astr1020Sp08/index.html

Fiske Planetarium Show: Colorado Skies: Observational Astronomy, Thursday, Jan. 24 at 8:00 pm.

Planetarium
• To receive extra credit for attending a Fiske Planetarium show (1 point), you will need to sign your name on a sheet at the end of the show.
• Either the ticket-taker or the person doing the show will provide you with access to the sheet.
• Fiske shows are free each Thursday night!

Homework
• Reading: Chapter 5, sections 5.1, 5.2; summary of key concepts.
• Need volunteers for Astronomy in the News on Fridays (please E-mail me).

Astronomy Video of the Day

Monty Python’s Scales of the Universe

Today’s Class: Energy and Matter

Types of energy

Conservation of Energy

Gravity

Matter: atoms, molecules

Clicker Question from Reading

Which of the following energy types is also a form of kinetic energy (choose one)?

A.) E=mc²
B.) Thermal (heat) energy
C.) gravitational potential energy
D.) Sunlight
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A.) $E=mc^2$
B.) Thermal (heat) energy
C.) gravitational potential energy
D.) Sunlight

Types of energy:

1) Kinetic Energy
   - Movement energy, greater for larger masses, faster movement
   - Examples: rolling, falling, zooming, swinging, etc.

2a.) Thermal energy
   - The "heat energy" of things.
   - A form of kinetic energy, but with random motion. Increasing thermal energy causes atoms to move faster.
   - Thermal energy measured with an "absolute" temperature scale
     - $T$ (degrees Celsius) = $\frac{T \text{ (Fahrenheit)} - 32}{1.8}$.
     - $T$ in "degrees Kelvin" = Celsius + 273.15 degrees.

   - Examples:
     - Hot pizza oven
       $450^\circ F \times \frac{1.8}{(450-32)} = 232^\circ C = 505^\circ K$
     - Room temp
       $70^\circ F = (70-32)/1.8 = 21^\circ C = 294^\circ K - 300^\circ K$ (remember this number)
     - Surface of the Sun = 5000 K
     - Interstellar gas = 10 K
     - Absolute zero = no thermal energy in matter (all atomic motion stops) = 0 K

2.) Potential energy
   - Energy which has the potential to become kinetic, thermal, or radiative energy. Think of it as stored energy.
   - Examples: rock on a high ledge (gravitational potential), flashlight battery (electric potential), candy bar (chemical potential), rubber band (stored energy)
Mass energy= a special form of potential energy

Matter can be thought of as a type of energy and be converted under special situations by energy.

\[ E = mc^2 \]

\( m \) = mass converted to energy
\( c \) = speed of light

Since \( c \) is large, this means that a tiny amount of matter can release a great deal of energy. Foundation for the Sun's energy, atom bomb.

3) Radiative energy

• All types of light:
  - Sunlight, lamplight
  - Radio waves
  - X-rays
  - \( \Rightarrow \) MUCH more on this later!

Conservation of Energy

• AN IMPORTANT CONCEPT!!!!!!!!!!!!

• Energy can be converted from one type of energy to another, but never created or destroyed.

• Many actions in the universe represent the conversion of one form of energy to another. Remembering conservation of energy is key to understanding how everything works.

What are Newton’s three laws of motion?

Newton’s first law of motion: An object moves at constant velocity unless a net force acts to change its speed or direction.

Newton’s second law of motion

\[ \text{Force} = \text{mass} \times \text{acceleration} \]

Newton’s third law of motion:

For every force, there is always an equal and opposite reaction force.
What determines the strength of gravity?

The Universal Law of Gravitation:
1. Every mass attracts every other mass.
2. Attraction is directly proportional to the product of their masses.
3. Attraction is inversely proportional to the square of the distance between their centers.

Clicker Question

If Earth were twice as far from the Sun, the force of gravity attracting Earth to the Sun would be
a) Twice as strong
b) Half as strong
c) One-quarter as strong