Announcements

• HW 1 is posted. Due Wednesday 2/12 at the beginning of class.
Lecture 02
Content Goals

• Heat and Temperature
• Energy and Power
• Units
Rise in Mean Sea Levels

Fig 1: Sea level curves calculated by different research groups with various methods. The curves show the sea level relative to the satellite era (since 1992). Graph: Klaus Bittermann.
ICLICKER QUESTION

Which of the following are believed to contribute to the rise in Global Mean Sea Levels:

a) Thermal Expansion of Water due to Increasing Average Temperature
b) Melting Glaciers and Ice Sheets
c) Increase of Ocean Mass due to Addition of Water from Land
d) All of the above
e) Just a) and c)
Scientific Notation

• Write a number as the product of a number between 1 and 10 and a power of ten (positive or negative).

  • Examples:
    • $12000 = 1.2 \times 10^4$
    • $0.000033 = 3.3 \times 10^{-5}$

• To write a number in scientific notation:
  1) Move the decimal point to the first non-zero digit
  2) Count the number of positions you moved the decimal point
     if to the left, the power of 10 is positive
     if to the right, the power of 10 is negative.
ICLICKER QUESTION

455 km in scientific notation (in meters) is:

a) $4.55 \times 10^3 \, m$

b) $4.55 \times 10^5 \, m$

c) $455 \times 10^3 \, m$

d) $b$ and $c$ are correct

e) None of the above
Temperature Scales

• Celsius-to-Fahrenheit

\[ T_F = \left( \frac{9}{5} \right) T_C + 32 \]

• Fahrenheit-to-Celsius:

\[ T_C = \left( T_F - 32 \right) \left( \frac{5}{9} \right) \]
Heat and Temperature

What is heat?
• Is a form of energy.
• It can be transferred from one object to another.
• It can be created at the expense of the loss of other forms of energy.

Temperature
• A measure of the average kinetic energy of the particles in a system.
• Adding heat to a system causes its temperature to increase.
Temperature Contd.

What is temperature?

• A measure of the “hidden” kinetic energy of the particles in a system (atoms and molecules).

\[
\text{Kinetic energy} = \frac{1}{2} m v^2 \quad m = \text{mass} \quad v = \text{velocity}
\]

Temperature is the speedometer of atoms and molecules!
Energy and Power Units

- International System (SI) unit for energy is the **Joule (J)**
- Other units of energy: Calorie, Dietary Calorie
- SI unit for power is the **Watt (W)**
- **Power** is the rate at which energy is transferred (or transformed) over time.
- Are these **basic** units or **derived** units?

\[ 1 \text{ J} = 1 \text{ kg} \frac{m^2}{s^2} \quad 1 \text{ W} = 1 \text{ J/s} \]

- The Kilowatt-hour is a unit of energy.
Example (energy used by a light bulb). Assume an incandescent, 100-Watt, lightbulb that is on 3 hours per day. How much energy does it use in one year?

\[ Power = \frac{Energy}{time} \quad \Rightarrow \quad Energy = Power \times time \]

*SI Unit for power is the Watt, \( 1W = 1J/s \)*

\[
t = 3600 \frac{s}{h} \times 3 \frac{h}{day} \times 365 \text{ day} = 3.9 \times 10^6 s
\]

\[
E = 10^2 W \cdot 3.9 \times 10^6 = 3.9 \times 10^8 J
\]

Follow-up: How much does it cost to operate this lightbulb per year?
ICLICKER QUESTION

1 kilowatt-sec is

a) 1 Joule
b) 100 Joules
c) 1000 Joules
d) 1000 Watts
e) None of the above

\[ Power = \frac{Energy}{time} \]
ICLICKER QUESTION

Calories/Day is a unit of

a) Energy
b) Power
c) Force
d) Temperature
e) None of the Above

\[ Power = \frac{Energy}{time} \]
ICLICKER QUESTION

Which of the following is NOT a unit of energy

a) Calorie
b) Joule
c) Terawatt-hour
d) Dietary calorie
e) Kilowatt

$Power = \frac{Energy}{time}$