Review for Test #2 Oct 20

Topics:
- Gravity - under, on, above the Earth, orbits, escape velocity
- Phases of matter and fluid mechanics, buoyancy
- Temperature, Heat and Thermodynamics - 3 laws
- Heat transfer and phase changes
- The Earth and global warming • Special Relativity

Methods
- Conceptual Review and Practice Problems Chapters 6 - 9
- Review lectures (on-line) and know answers to clicker questions and homeworks.
- Go over practice test. Attend SI sessions.
- Bring:
- Banner ID and Two Number 2 pencils
- Simple calculator (no electronic notes)

Reminder: There are NO make-up tests for this class

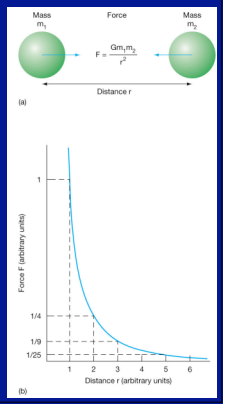
Test #2 Review

How to take a multiple choice test
1) Before the Test:
- Study hard (~2 hours/day Now through Sunday)
- Get plenty of rest the night before

2) During the Test:
- Draw simple sketches to help visualize problems
- Solve numerical problems in the margin
- Come up with your answer first, then look for it in the choices
- If you can't find the answer, try process of elimination
- If you don't know the answer, Go on to the next problem and come back to this one later
- TAKE YOUR TIME, don't hurry
- If you don't understand something, ask me. This is not meant to be a vocabulary test.

Gravitational Force

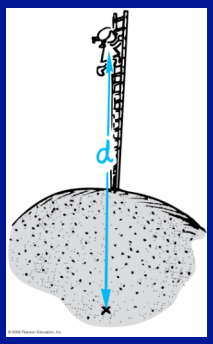
- The gravitational force is always attractive
- The strength of the attraction decreases rapidly (as the square of) increasing distance



Gravity and Orbits

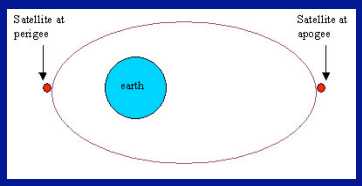
- Gravity decreases as you climb out of the "potential well"

How much has the girl's weight dropped after she climbs a distance equal to the distance from the surface to the center of the Earth?



Review

- projectile orbits
- terms: apogee, perigee
- geosynchronous orbit

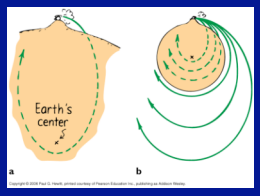


What shape is the orbit for a geosynchronous satellite?

Review

- Orbital velocity

$$v_{orb} = \sqrt{\frac{G\,M}{R}}$$

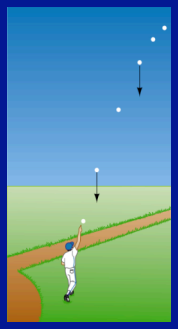


- Escape Velocity

$$v_{esc} = \sqrt{\frac{2\,G\,M}{R}}$$

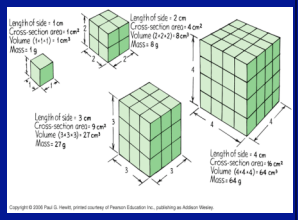
Escape Velocity

- Speed at which an object can permanently escape from a body determined by strength of the gravitational force
- Earth: 11 km/s
- Moon: 2.4 km/s
- Sun: 42.5 km/s
- Explains why moon has no atmosphere!



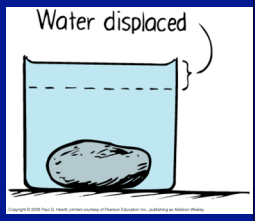
Scaling

- An ant can lift several times its own body weight
  - Why can't an elephant do the same thing?
    - Objects grow heavier at a faster rate than they grow stronger
      - Strength related to 2-d cross-sectional area
      - Weight is related to volume
  - What happens to the area to volume ratio of an object as its size increases?



Archimedes' Principle

- An immersed object is buoyed up by a force equal to the weight of the fluid it displaces
  - What property of an object determines how much fluid a completely submerged object will displace?
    - The volume of the object
      - Regardless of shape, mass
    - For partially submerged object, it is the volume of the submerged part
      - Boat



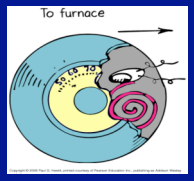
DEMO : Archimedes Principle

Temperature and Heat

- What is temperature?
  - A measure of how warm or cold an object is with respect to some standard
  - Related to the random thermal motion of the molecules in a substance; $kT = KE = 1/2\ mv^2$
- What is heat?
  - The energy transferred between objects due to a temperature difference
    - Energy in transit (similar to work)

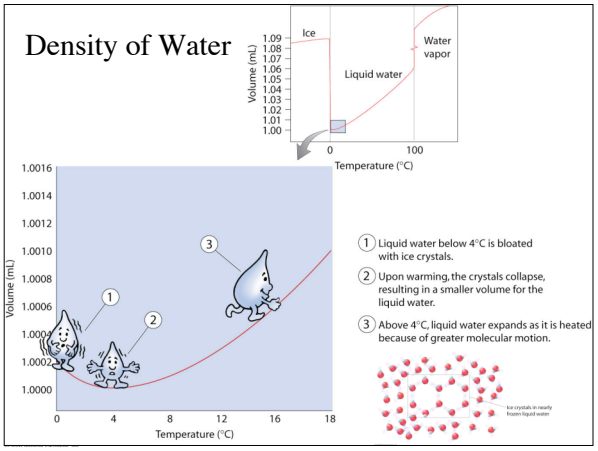
Thermal Expansion

- Why do objects tend to expand when heated and contract when cooled?
  - As temperature increases, molecules jiggle faster and move farther apart
- Important engineering consideration
  - Ex. Expansion joints in bridges
    - Golden gate bridge contracts more than a meter in cold weather



The unequal expansion of a bimetallic strip can operate a thermostat.

Density of Water



Three Laws of Thermodynamics

- *1st law*
  - *Energy can neither be created nor destroyed.*
- *2nd law*
  - *The entropy of an isolated system always increases.*
- *3rd law*
  - *Nothing can be cooled to absolute 0 K.*

What would be the entropy of a crystal at 0 K?

Clicker Question:

Which of the following must always increase for any physical process (like a chemical reaction)?

A: energy

B: temperature

C: entropy

D: heat

Clicker Question:

Suppose you buy some ice-cream at the store, and you don't want it to melt on the long bike-ride home. What can you do?

A: Leave it exposed to the air so the breeze keeps it cool.

B: Wrap it up in your down jacket.

C: Shield it from the sun, but don't otherwise cover it up.

D: Nothing, how fast it melts only depends on distance.

Clicker Question:

Hydrogen and oxygen molecules in a gas sample have the same temperature. This means the hydrogen molecules, on the average, have the same ...

A: kinetic energy, but more speed.

B: speed, but less kinetic energy.

C: speed, but more kinetic energy.

D: kinetic energy and the same speed.

Phases of Matter

- What are the different phases of matter and some of the properties of each?
  - Solid: Fixed shape
  - Liquid: Takes shape of container, incompressible
  - Gas: Takes shape of container, easily compressible
    - Gas and liquids both flow => both are "fluids"
  - Plasma: A gas that is electrified or "ionized"

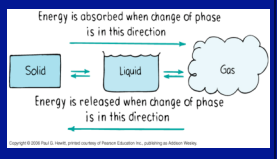
Changes of Phase

- List the four phases of matter in order of increasing internal energy

  solid => liquid => gas => plasma
- List the processes that take you from a solid to a plasma

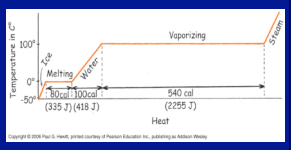
  melting => evaporation => ionization
- List the processes that take you from a plasma to a solid

  electron capture => condensation => freezing



Temperature and Phase Changes

- Temperature is constant during a change of phase
  - Absorbed heat goes into breaking molecular bonds => increased potential energy. Translational K.E. remains unchanged. (Left to Right)
  - Extracted heat allows molecular bonds to form (decreased potential energy) at fixed temp. (Right to Left)

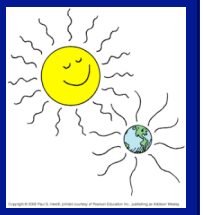


A material absorbs energy when melting or vaporizing and expels energy when condensing or freezing.

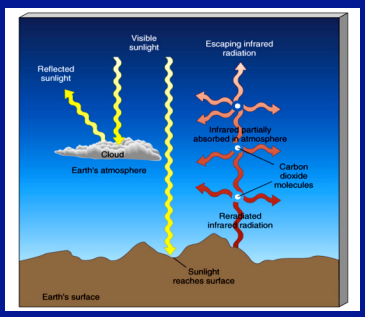
During a phase change, the energy goes into the change of state rather than into changing the object's temperature.

The Temperature of the Earth

- Neglecting other effects, at equilibrium the Earth would reradiate all of the energy received from the Sun and have an average temperature of -23° C.
- Why is the average temperature of Earth so much (about 40° C) higher?



The Greenhouse Effect



Main greenhouse gases are H_2O and CO_2.

If no greenhouse effect, surface would be 40 °C cooler!

Demo

Postulates of Special Relativity

- 1st Postulate
  - The laws of nature are the same in all uniformly moving frames of reference.
    - Uniform motion – in a straight line at a constant speed
- Ex. Passenger on a perfectly smooth train
- 2nd Postulate
  - The speed of light is the same in all uniformly moving reference frames

Relativistic Summary

- time dilation : $t = t_0/\gamma$
- length contraction: $L = L_0/\gamma$
- $m = \gamma m_0$ where $\gamma = \dfrac{1}{\sqrt{1 - \dfrac{v^2}{c^2}}}$
- 0.14c --> $\gamma = 1.01$
- 0.99c --> $\gamma = 7.14$
- 0.998c --> $\gamma = 15$

Clicker Question:

For increased atmospheric pressure, the boiling temperature of a liquid:

A: goes down.

B: remains at 100 C.

C: goes up.

D: drops to absolute 0 K.

Clicker Question:

According to the special theory of relativity, events that are simultaneous in one frame of reference

A: may or may not be simultaneous in other frames of reference.

B: are simultaneous in all frames of reference.

C: are not simultaneous in any other frames of reference.

D: are special events that should be celebrated with your relatives.

Clicker Question:

The speed of electrons moving through electric cables must be:

A: equal to the speed of light

B: greater than the speed of light

C: less than the speed of light

D: zero

Test #2 Useful Equations

Newton's Law of Gravity: $F = \frac{G M m}{R^2}$

Escape Velocity: $v_{esc} = \sqrt{\frac{2 G M}{R}}$

Orbital Velocity: $v_{orb} = \sqrt{\frac{G M}{R}}$

Density = Mass/Volume

$F_b = m_w g = V d_w g$

Celsius <--> Fahrenheit conversion: $C = 5/9 (F - 32)$; or $F = 9/5\ C + 32$

$Q = c\ m\ \Delta T$; $KE = 1/2\ mv^2$; $KE = k\ T$