Lecture 24: Thurs, 13 Dec 2007

"Reading quizzes"

Q1. Did you fill out the online BYU course evaluations?
A. Yes B. No

Q2. Did you fill out the online BYU course evaluations?
A. Yes B. No

Q3. Did you fill out the Colton-specific online survey?
A. Yes B. No

Announcements

1. Final exam:
   a. Take in testing center anytime during finals week
      → See their website for detailed times and dates.
   b. Will have 37 problems
   c. 8-10 problems on new stuff; rest is cumulative
   d. Problems will (on average) be easier than problems on midterm exams.
   e. Average time should be <2 hours
      i. No time limit
   f. Average score? Last year median = 72; we made this year's exam substantially easier
   g. Formulas that need to be memorized posted on website as usual
   h. Dr. Hess advice: Don't study on the day you take final
2. Late homework deadline for HW 21-24: the last day of finals, Fri Dec 21

Final exam formulas (the new ones)

To be given on exam

spring $\omega = \sqrt{\frac{k}{m}}$, $T = 2\pi\sqrt{\frac{m}{k}}$

pendulum $\omega = \sqrt{\frac{g}{L}}$, $T = 2\pi\sqrt{\frac{L}{g}}$

wave speed $v = \sqrt{\frac{T}{\mu}}$, $\mu = m/L$ $\quad v = \sqrt{\frac{B}{\rho}}$ $\quad v = \sqrt{\frac{Y}{\rho}}$

v_{air} = 340 m/s, unless otherwise specified

$A_{sphere} = 4\pi r^2$

decibels $\beta = 10\log\left(\frac{I}{I_0}\right)$ $\quad I_0 = 10^{-12}$ W/m^2

Doppler: $f' = f\frac{v \pm v_0}{v \pm v_S}$

standing waves: $f_n = n\frac{v}{2L}$ $\quad n = 1,2,3,...$ $\quad f_n = n\frac{v}{4L}$ $\quad n = 1,3,5,...$

To be memorized

$f = \frac{1}{T}$, $\omega = 2\pi f$, $T = \frac{2\pi}{\omega}$

Wave speed $v = f\lambda$

Intensity $I = P/A$

Final exam – Concepts from Chap 13-14

Bold = something that must be memorized

1. Sinusoidal Oscillations Asin(ωt) or Acos(ωt)
   a. Period vs. frequency vs. angular frequency
      i. $f = \frac{1}{T}$, $\omega = 2\pi f$, $T = \frac{2\pi}{\omega}$ (memorized!)
   b. Simple harmonic motion
      i. a spring: $\omega = \sqrt{\frac{k}{m}}$
      ii. a pendulum: $\omega = \sqrt{\frac{g}{L}}$
2. Traveling Waves: sinusoidal in space and in time
   a. Speed vs. wavelength vs. frequency
      i. **v = f λ**
   b. equations for wave speed in different materials
      i. sqrt(force-like quantity / mass-like quantity)
   c. Decibel scale (sound): $\beta = 10\log\left(\frac{I}{I_0}\right)$ $\quad I_0 = 10^{-12}$ W/m^2
   d. Intensity of a wave ***I = P/A***
      i. Spherical waves, A = $4\pi r^2$

e. Doppler effect: $f' = f\dfrac{v \pm v_0}{v \pm v_S}$

i. If moving towards, frequency shifts up: numerator + and/or denominator –.

ii. If moving away, opposite.

3. Interference/superposition of waves

a. Constructive/destructive interference

i. Waves off by λ, waves off by λ/2

b. Standing waves

i. Nodes & antinodes

ii. Closed-closed or open-open

1. L = 1/2 λ, 2/2 λ, 3/2 λ, …

2. $f_n = n\dfrac{v}{2L} \quad n = 1,2,3,...$

iii. Open-closed

1. L = 1/4 λ, 3/4 λ, 5/4 λ, …

2. $f_n = n\dfrac{v}{4L} \quad n = 1,3,5,...$

Review Problems:

1. A train whistle gives off a tone of 500 Hz when the train is still. Now the train approaches the station quite fast at a speed of 80 m/s. What whistle frequency will a person at the station hear as the train nears the station?

2. **Q4.** You hear a 70 dB sound. If this sound is coming out spherically from a speaker that puts out 0.5 Watts in sound power, how far away from the speaker are you? __________m

A: 26 B: 58 C: 63 D: 74 E: 113

3. **Q5.** The sound now has its *intensity increased* by a factor of 100. The new decibel-level will be_____________ dB.

A: 50 B: 60 C: 80 D: 90 E: 170

4. A mass on a spring oscillates with a certain frequency. The mass is removed, and a mass weighing 9 times as much is put on the same spring. What is the ratio of the new frequency to the old frequency?

$\dfrac{f_{new}}{f_{old}} =$

5. **Q6.** When people stand up and sit down in a stadium to perform the "wave", this is an example of what kind of wave?

A. Longitudinal
B. Circular
C. Simple Harmonic
D. Transverse

6. **Q7.** A standing wave is set up in a 2.0 m length string fixed at both ends. The string vibrates in 5 distinct segments when driven at 120 Hz. (a) What is the fundamental frequency of the string?

A: 20 B: 24 C: 30 D: 60 E: 120

(b) What is the speed of the waves on the string?

7. **Q8.** A girl in a crowd hears two speakers putting out identical sounds near 700 Hz. What difference in distances between her and the two speakers will give a *minimum* in the sound intensity? (Speed of sound = 340 m/s)

A. 0.243 B: 0.486 C: 0.527 D: 0.735 E: 1.28

8. Geraldo the Great swings on a trapeze (rope) of length 18 m. Approximately how long will it take him to swing from his maximum height where he stops, to the bottom of his swing where he is moving most quickly?

"Great ideas in Physics 105"

Adapted from Dr Hess's Semester Review

Motion can be described

…kinematic equations

Motion can be explained by forces

… Newton's 3 laws

types of forces: gravity, tension, normal, friction, etc.

Conservation

…of energy (linear and rotational)

→ 1st law of thermodynamics

…of momentum (linear and angular)

Applications of these ideas in mechanics:

fluids (static and moving)

vibration and waves

Temperature and microscopic motion

…description of ideal gas

…*statistical* behavior of large numbers of particles

→ heat flow: transfer of random kinetic energy

→ 2nd law of thermodynamics

(disorder increases in all natural processes)

What's left to learn?

Electricity and magnetism

electric, magnetic fields

currents, circuits and generators

electromagnetic waves:

radio, microwave, light, x-rays, gamma rays

"Modern" physics:

Quantum mechanics: what we can and can't know about the microscopic world; explains fundamental particles, atomic/molecular interactions, semiconductor devices, nuclear physics

Relativity:

special relativity…time and space depend on reference frame and velocity. mass ↔ energy

general relativity…how the shape of time and space interacts with mass: gravity, black holes

Cosmology:

How to describe the distant past and distant future?

What does the current universe look like?

Complexity (with other disciplines)

How fundamental laws → organization:

large scale structure in the universe

earth: magnetic field, weather, life

Summary of the semester, from the student perspective:

"I learned…"

- That x and y motions are independent of each other.
- That a bullet shot from a rifle will hit the ground at the same time as one dropped from the same height if the bullet is shot parallel to the ground (neglecting air resistance).
- That if you have a feather and a lead ball in a vacuum, they will fall and hit the ground at the same time because gravity acts the same on them.
- When you are in a car and it turns, the "force" you feel pushing out on you really isn't a force, rather its the force of the car on you, seeing as your body wants to keep going straight.
- Why you are "lifted" out of your seat while on a roller coaster
- That Newton's Third Law explains why pushing my skis against the snow causes me to turn in the opposite direction.
- That anti-lock breaks work because the static coefficient of friction is larger than the kinetic.
- Why my dad's company launches rockets from the equator of the earth near the Christmas Islands. It is because there the earth is spinning and has some rotational energy that helps the rocket escape from earth. [Colton: also because geosynchronous orbits must go around the equator.]
- Why your satellite dish can always be pointed in the same direction.

- That satellites (including the moon!) don't fall to the ground because they are in a constant state of free-fall but are moving move forward fast enough that they always 'miss' the earth.
- Why wrenches work better than fingers!
- How the rotation of the wheel helps keep me balanced on my dirtbike.
- That conservation of angular momentum makes an ice-skater's rotation speeds up when she brings in her arms
- That snowshoes prevent a person from sinking into the soft snow because the force on the snow is spread over a larger area—just like a person can withstand a bed of nails because the force is spread over a larger area (the total area of all of the nail points).
- Why pressure is lower at higher altitudes
- That how large a lake is doesn't affect the force on a dam, but rather how deep the lake is.
- That straws work due to atmospheric pressure and not from a "suction force." I also thought it was interesting that the longest straw that one could use would be 10 meters.
- That a hydraulic system can allow a small force to lift a heavy car.
- Why a boat sinks further into the water when more people get on.
- Why it's easier to lift someone inside a swimming pool than on the outside ground.
- Why you will float better in the Great Salt Lake than in a swimming pool (greater buoyant force due to the density of the salt water).

- Why the water shoots out of a hose faster when you put your finger over the opening.
- That chimneys work better on windy days because the wind decreases the pressure above the chimney, allowing the "fluid" (aka soot) to rise easier.
- That the shape of an airplane wing is crucial to the entire reason as to why planes can fly (Bernoulli's principle). The fluid traveling over the tear shaped wing travels faster and thus has a lower pressure than the air beneath it, creating lift.
- How a curveball works.
- That if I ever have something stuck in a metal object with a hole in it, I can heat it up and hopefully remove the stuck object.
- Why double paned windows keep a house warmer/cooler—thermal conductivity of air is less than glass.
- That an electric burner glows red because of the “blackbody radiation” emitted by all hot objects.
- How grandfathers clocks work/what the thing at the bottom is for.
- That sound waves aren't really a separate physical entity, but are caused by the impact of neighboring molecules, and that there is no sound in a vacuum.
- That when my wife yells at me I can jump into a box with her and have a giant vacuum suck the air out and I will not hear her!!!!
- Why my guitar strings change tune when I tighten the tension, and why I can get the strings to play "harmonics" by shortening the wavelength.