General Physics II: Oscillations, Waves, Electromagnetism

Instructor: Anand Yethiraj

General Physics II: Oscillations, Waves, Electromagnetism

Lectures, Laboratories and Workshops

Course Website: http://www.physics.mun.ca/~anand/teaching/phys1051ay.html

Lectures: Monday, Wednesday, Friday, 1200-1250 IIC2001 (for the sections below)

* Section numbers 001, 002, 003, 007
* Laboratories: Two hours per week.
* Laboratory schedules will be on the First Year Laboratory website at http://www.mun.ca/physics/ugrad/fylabs/p1051/schedule.php and http://www.physics.mun.ca/~anand/teaching/p1051ay/LabWorkshopSchedule1051_2011.pdf

Workshops: run on off-lab weeks, **first one is week of Jan 11**.

* D2L (Desire2Learn):

- Announcements, grades, e-mail (my email is AYETHIRAJ@online.mun.ca), discussion
- Links to course web page
- Access to CAPA and CAPA-IDs

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Course Outline

Details on course website:
http://www.physics.mun.ca/~anand/teaching/phys1051ay.html

Course Evaluation Scheme:

1. Assignments - 10%
2. Workshops (6) - 5%
3. Term tests (2) - 25%
4. Laboratory Reports - 10%
5. Final - 50%
6. A supplemental exam is available for this course, as outlined in the calender.

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1. Assignments

CAPA Problem Sets

* Opening and closing times on web. There may be overlap.
* Encourages mastery: we expect that you get close to full marks.
* CAPA Ids are on D2L (Grades section)

2. Problem Workshops

* Alternate with labs with some exceptions (see schedule).
* Focus on specific topics.
* You will hand in a few worked problems.
* Goal is mastery of specific concept/technique and assistance will be provided as necessary.
* Workshop total counts as one assignment/problem set.
* Each workshop worth 1 mark toward final grade.

3. Term Tests

* Friday Feb. 11 and Friday Mar. 11, 2011 in class. ID must be presented.
* No make-up tests! Will adjust weighting for missed tests with acceptable notes.

4. Labs

* Start week (January 12) in C2039
* See schedule (roughly alternate weeks)
* Pre-lab questions on D2L
* Need lab workbook

5. Final Exam

* Supplementary exam is available BUT you must apply as soon as results released.
  Conditions: must pass term AND get final mark of 45% -50%

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Motivation

- Why study waves and electromagnetism?
- How are waves, electricity and magnetism related?

Electricity

All matter is composed of atoms: protons, neutrons and electrons.

- The neutron is uncharged
- *The electron has a charge of -1e*
  (we denote the value of the charge of 1 electron as e)
- The proton has a charge of +1e

Amazingly, the number of protons and electrons is exactly the same. So when you stand next to someone, you don't feel any force.

If each of you had 1% more protons than electrons, the repelling force would be strong enough to lift the earth

Electricity

Electrons are point particles.
You can think of electric forces as forces between point objects.

But!

It turns out to be a lot easier to break this up into two parts:

- A charge q_1 gives rises to an electric field *E(x,y,z)* at all points in space that is proportional to q_1
- The second charge q_2 feels a force that is proportional to q_2 *and is proportional to E(x,y,z).*

NOTE: Neither charge can interact with its own field.

Magnetism

Two magnets will also interact with each other. The experience an attracting or repelling force, depending on which poles of the magnet are closest.

Again, it turns out to be better to break this up into two pieces:

- One magnet gives rise to a magnetic field *M(x,y,z)*
- The other magnet feels a force that is proportional to that magnetic field

One of the great discoveries in science is that electricity and magnetism are both manifestations of the same phenomenon: so we now call it the

Electromagnetic Field

Motivation: whats electromagnetism got to do with waves?

- Both can be described by mathematical functions that are oscillation functions of space, and oscillating functions of time.

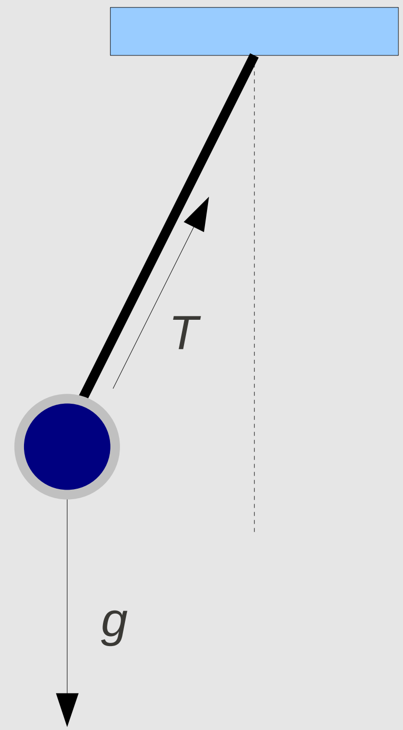
- They can both be described mathematically by spatially varying and time varying (scalar or vector) fields.

- [this is a great time to brush up on your calculus]

Oscillations: Simple Harmonic Motion and Energy

Oscillations: Simple Harmonic Motion and Energy

Ball and massless spring



*Ball experiencing gravity **and** string tension...*

Motion of a particle with mass m attached to a massless spring

Two common types of forces:

- Gravitational force on earth : mg
  Constant force!

- The restoring force of a spring or a rubber band
  Force is proportional to the extension!

Newton's Second Law and the Gravitational Force F_g

$$\sum F = m\,a = m\frac{dv}{dt} = m\frac{d^2x}{dt^2}$$

Apply it to the case where the applied force is the gravitational force

$$\sum F = m\,a = F_g = mg$$

$$a = \frac{d^2x}{dt^2} = g$$

Newton's Second Law and the Spring Force F_s

$$\sum F = m\,a = m\frac{dv}{dt} = m\frac{d^2x}{dt^2}$$

Apply it to the case where the applied force is the force of a spring

$$\sum F = m\,a = F_s = -k\,x$$

Restoring force, increases with extension

k is called the spring constant

The mathematical reprentation is called the Equation of Motion

$$m\frac{d^2x}{dt^2} = -kx$$

We write can write the equation as:

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x = -\omega^2 x$$

where: $\omega^2 = \frac{k}{m}$

Visualize what this equation means!

So far as this equation is concerned,
how tough the spring is,
and how massive the particle is,
do not individually matter.
All that matters is the ratio of the two.

$$\frac{d^2 x}{dt^2} = -\omega^2 x$$

where: $\omega = \sqrt{\frac{k}{m}}$

The solution to this differential equation is:

$$x = A\cos(\omega t + \phi)$$

Where from A, ϕ ?

OK, lets just assume its correct and work out the derivatives. Derivative number 1:

$$dx/dt = -A\omega\sin(\omega t + \phi)$$

Almost all the Greek that physicists know:

	English Equivalents
$\omega : little\ omega$	o
$\Omega : big\ OMEGA$	O
$\phi : little\ phi$	f
$\Phi : big\ PHI$	F
$\lambda : lambda$	l
$\mu : mu$	m
$\epsilon : epsilon$	e
$\pi : pi$	p

... (excepting of course physicists from Greece)