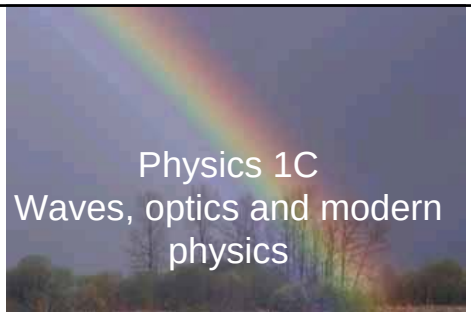

Physics 1C
Waves, optics and modern physics

Instructor: Melvin Okamura
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TA: Mariano Gabitto
email: mgabitto@physics.ucsd.edu

Course Information

Course Syllabus on the web page http://physics.ucsd.edu/students/courses/fall2007/physics1c

Instructor: Mel Okamura – mokamura@physics.ucsd.edu
Office: 1218 Mayer Hall
Office Hrs. Wed , Thu 2-3 pm or by appointment

TA: Mariano Gabitto – mgabitto@physics.ucsd.edu
Office: TBA
Office Hrs: TBA

Text. Physics 1 Serway and Faughn, 7th edition, UCSD custom edition.

Class Schedule

- **Lectures**
  - Mon. Wed. Fri. 12:00-12:50 pm WLH 2001
- **Quizzes**
  - Alternate Fri. 12:00-12:50 pm WLH 2001
- **Problem Session**
  - Thu. 5:00-6:50 pm WLH 2005

Grades

- Bi-weekly quizzes (4) will be held on Friday. You are allowed to drop 1 quizzes. There will be no make-up quizzes.
- Final exam covering the whole course.
- The final grade will be based on
  - Quizzes 60% (best 3 out of 4 quizzes)
  - Final exam 40%
  - Extra credit 5% (clicker responses)

Homework

- Homework will be assigned each week.
- Homework will not be corrected but quiz questions will resemble the homework.
- Solutions to the homework problems will be posted on the web page.

H-ITT Clicker

ID number

Available at the bookstore
Clickers must be registered at http://clickers.ucsd.edu
The ID number is in the battery compartment.

Outline

- weeks 1-2 Oscillations and Waves
- weeks 3-4 Electromagnetic waves and light
- weeks 5-6 Optics
- weeks 7-10 Modern Physics

1.1 Oscillations

- Kinematics - sinusoidal waves
- Dynamics -Newton's law and Hooke's law.
- Energetics – Conservation of Energy
- Mass on a spring
- Pendulum

Oscillations

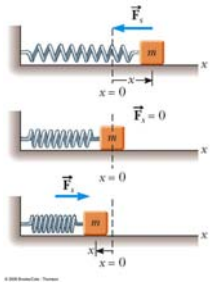
- repetitive displacements with a time period
- provide the basis for measuring time
- serve as the starting point for describing wave motion.
- Example- Mass on a spring

Mass on a spring

Hooke's Law -Force exerted by spring is proportional to the displacement from the equilibrium position.

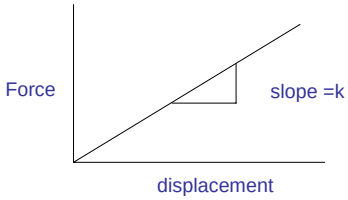
$$\vec{F} = -k\vec{x}$$

k - Force constant
Units N/m



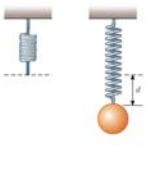
Hooke's Law

(magnitudes) F= kx



Vertical direction

The force of gravity is cancelled by the stretch d. The equilibrium position is at the position of the stretched spring.



Equilibrium position

What is the force on the object when it is displaced upward by a distance y from the equilibrium position?

$$\vec{F}_y = -k\vec{y}$$

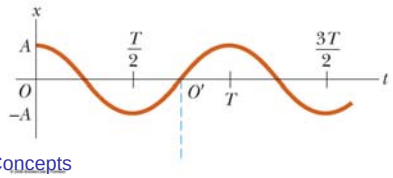
The restoring force is only due to the spring.

Demo

Oscillations of mass on a spring.

How does the displacement vary with time?

Period , Frequency



Key Concepts

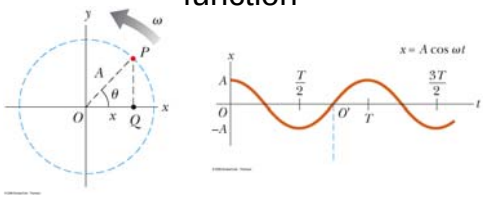
A -Amplitude

T=Period (s)

$f = \frac{1}{T}$ = Frequency , cycles/s (Hz)

$\omega = 2\pi f$ = Angular Frequency (radians /s)

Motion model with a sinusoidal function

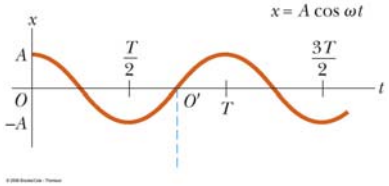


The projection of the vector A on the x axis gives

$$x = A\cos(\frac{2\pi}{T}t) = A\cos(2\pi ft) = A\cos(\omega t)$$

This function is periodic.
i.e. Maxima occur at t=0,T, 2T, 3T..... = nT
where n is an integer.

Kinematics

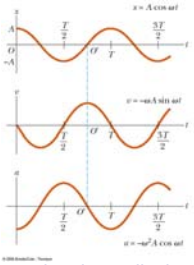


Where is the magnitude of the force the greatest?
Where is the force zero?
Where is the speed of the mass greatest?
Where is the speed of the mass zero?

displacement, velocity, acceleration

$v = \frac{dx}{dt}$

$a = \frac{dv}{dt}$



The acceleration is proportional to – displacement.

Newtons Law and Hooke's Laws are obeyed
ma=-kx

This is the reason that the displacement is sinusoidal!!!

relation between oscillation frequency, force constant and mass.

Newton's Law $F = ma$

Hooke's Law $F = -kx$

$ma = -kx$

for harmonic motion $m(-\omega^2 A\cos\omega t) = -kA\cos\omega t$

canceling gives $\omega^2 = \frac{k}{m}$

$\omega = \sqrt{\frac{k}{m}}$ radians/s

$\frac{1}{T} = f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ cycles/s (Hz)

Demo

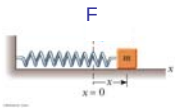
How does the period of oscillation depend on mass, on the force constant?

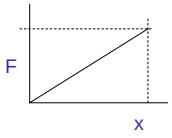
Calculate the period for the mass spring system.

Energy

Energy required to stretch (compress) a spring by a displacement x

$$E = \frac{1}{2}kx^2$$





Work = $F_{average}$ x

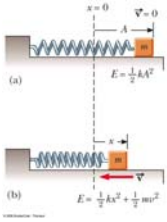
$F_{average}$ =½ kx

Note the energy depends on x^2 so it is independent of the sign of x, i.e. same for compression and stretch.

Conservation of Energy

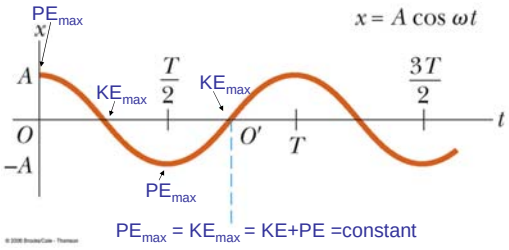
Stretched spring

Released



What is the kinetic energy at x=0 ?
What is the potential energy at x=0?

Oscillation between KE and PE



$PE_{max} = KE_{max}$ = KE+PE =constant

$$\frac{1}{2}kA^2 = \frac{1}{2}mv_{max}^2 \quad \Rightarrow \quad v_{max} = \sqrt{\frac{k}{m}}A = \omega A$$

Pendulum

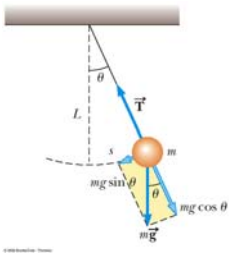
The restoring force is proportional to the displacement for small displacements.

$$F = -mg\sin\theta$$

$$F = -mg\theta \quad \text{for small } \theta$$

$$F = -\frac{mg}{L}s$$

Hookes Law with k=mg/L



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

The period is dependent on L but independent of m

Demo

Pendulum oscillations.

How does the period depend on L?