PH 427, 2013

DAY 1

Overview

- HW 1 due on Wednesday
- Office hours, Ethan / Teal
- Policy for final: Make your own eqn sheet.
- The journal club talks
  (note that 15% of grade is equivalent to 2 homeworks)

- Anything else.

Handout images of periodic systems

1. Celtic art
2. Islamic art
3. Modern art
4. Graphene
5. dna crystal lattice
6. nano dot array

} Find a unit cell

Find a translational symmetry operation

TRANSLATIONAL SYMMETRY

(The key property of periodic systems, the reason behind this paradigm)

1-dimensional periodic systems

$x \longrightarrow x + na$ keeps system unchanged

where n is integer

2-d periodic systems

$\vec{r} \longrightarrow \vec{r} + n\vec{a} + m\vec{b}$ keeps system unchanged

where n & m are integer

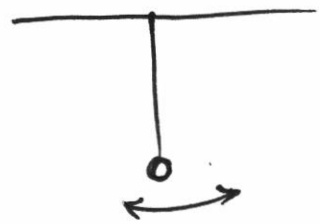
Nother's Theorem Any system with translational symm has an associated momentum conservation law.

For example: An e^- moving thru a perfectly periodic atomic lattice maintains its momentum as if traveling through vacuum.

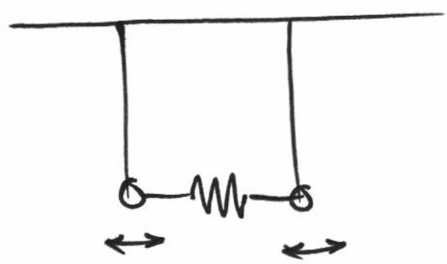
★ Visit website to see some (3) classic examples of physical systems

★ General strategy for understanding a periodic system

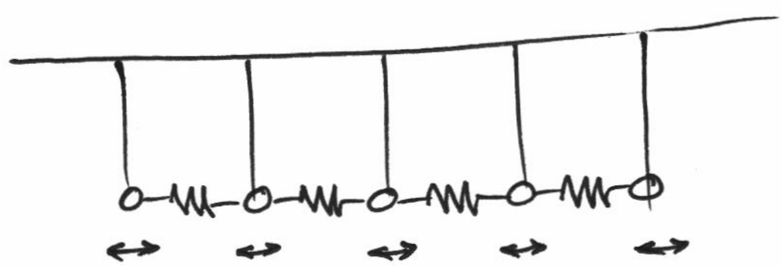
(1) Single unit cell



(2) Double system



(3) Finite number of unit cells



(4) Infinite number of unit cells

Days 1-7:
- Coupled pendulum
- Railroad cars connected by springs
- Coupled LC resonators (HW #1)
- Atoms in a crystal

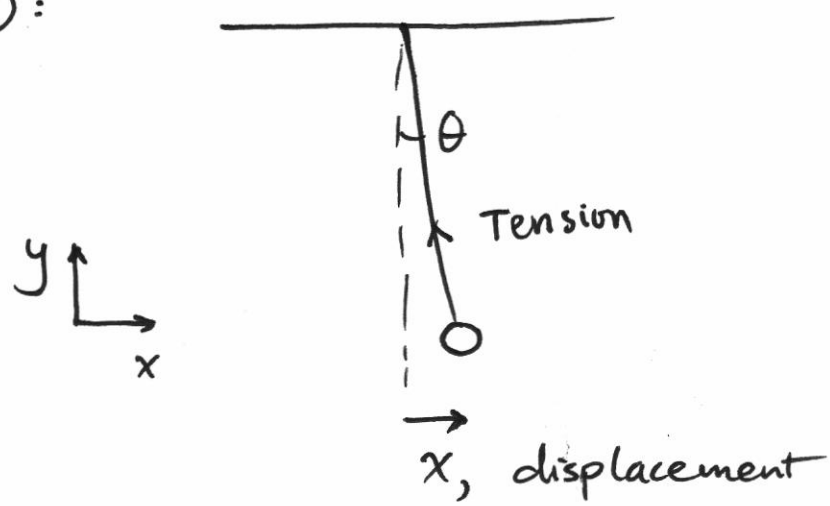
} Analyze mechanical motion.

Days 7-12 : • Quantum wavestates in periodic potentials

Get started right away:

Describe motion of an infinite chain of coupled pendulum. Assume displacement of each pendulum bob from eqb is $\ll$ pendulum length

Step ①:



Tension $\approx mg$

x component of tension $\approx -mg\theta = -mg\frac{x}{L}$

Now, crucial next step...

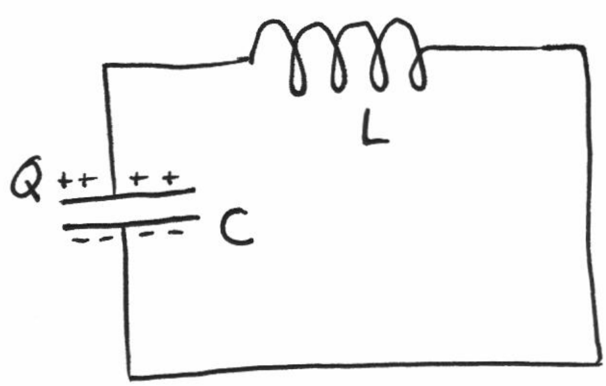
$$m\ddot{x} = -\frac{mg}{L}x$$, allows us to find the time evolution of the system.

$$x(t) = A \sin \omega t \quad \text{where} \quad \omega = \sqrt{\frac{g}{L}}$$

↑ Arbitrary

we will continue with coupled pendulum on Tuesday.

Now, I want to give you a head start on HW #1.



How do I find $Q(t)$ for a single LC circuit?

Voltages around a loop add to zero

$$V_{capacitor} + V_{inductor} = 0$$

$$\frac{Q}{C} + L\frac{dI}{dt} = 0$$

Relate I to Q ... be careful about sign.

$$\frac{Q}{LC} = -\frac{d^2Q}{dt^2}$$

$$\ddot{Q} = \frac{1}{LC} Q$$

Analogous to an eq^n of motion.