Physics 132 Prof. W. Losert

Outline

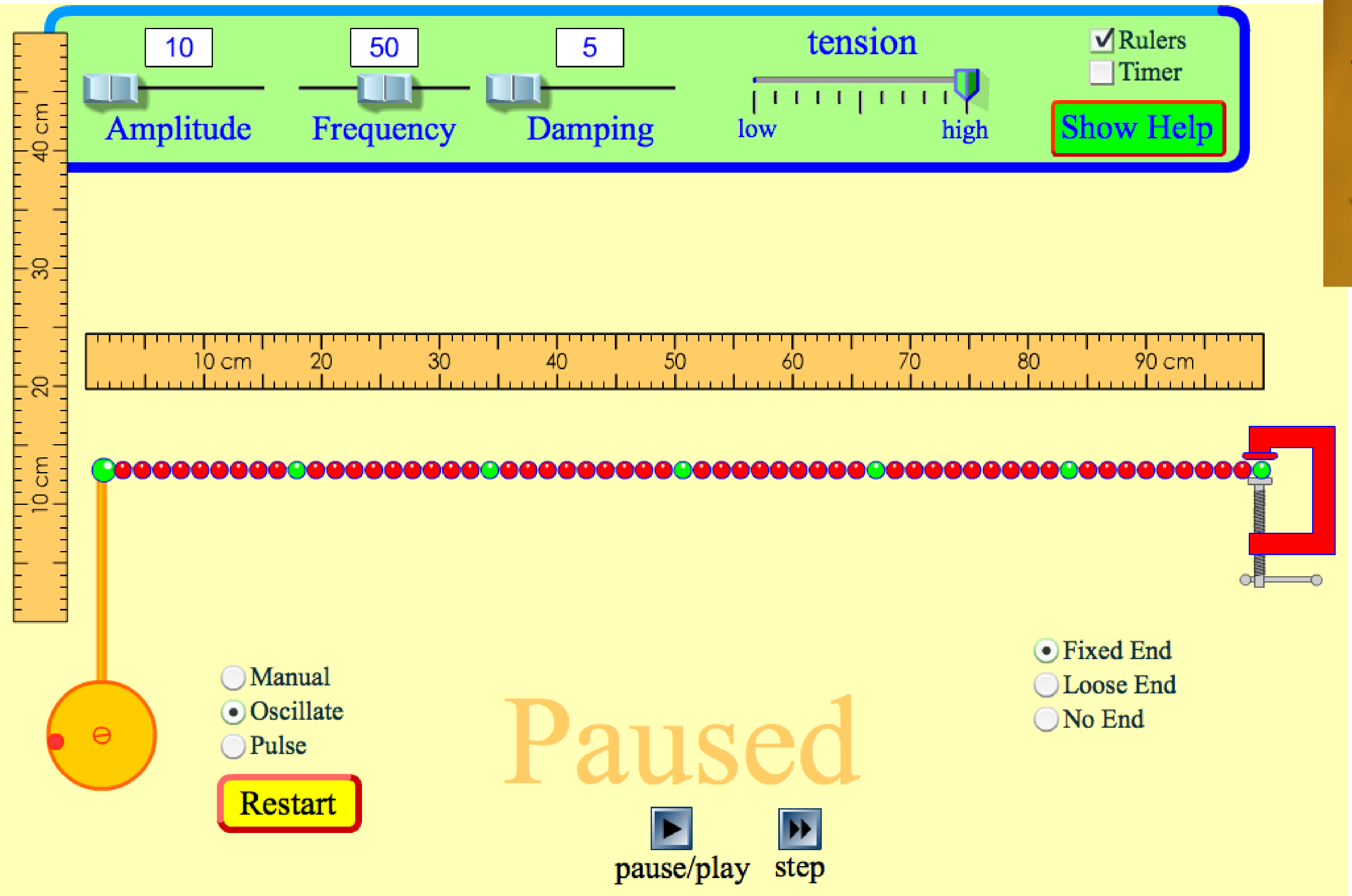
Standing Waves

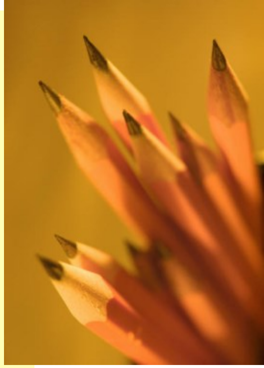
Light

Midterm II Makeup FRIDAY 3pm

Followup to Wed questions

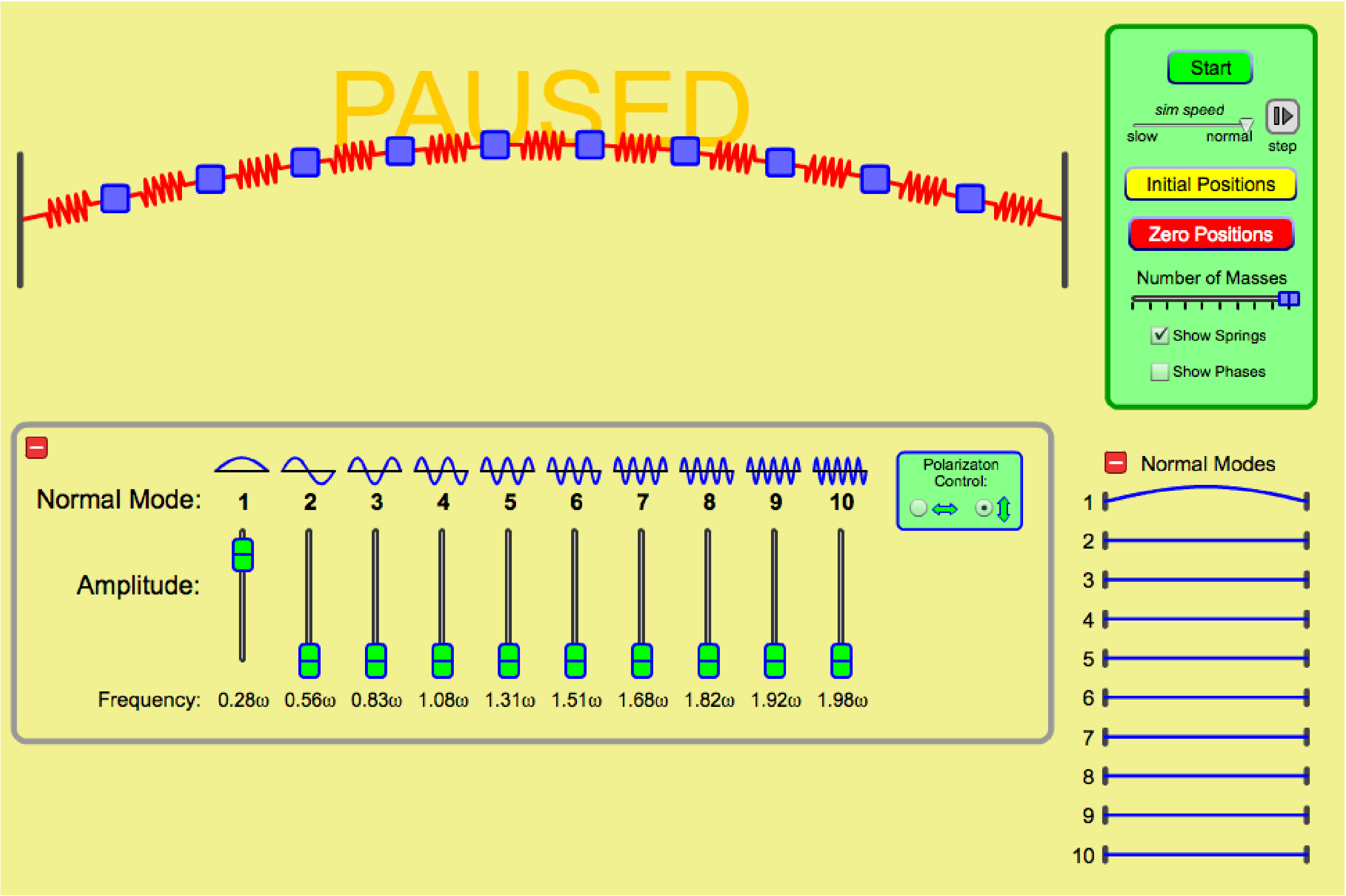
- Accelerating Waves
- Can a wave just stop?





For what frequencies will I generate a large (resonant) standing wave if I drive it with a small amplitude?

Explore with a simulation



http://phet.colorado.edu/en/simulation/normal-modes

If we start our beaded string off
in a sinusoidal shape

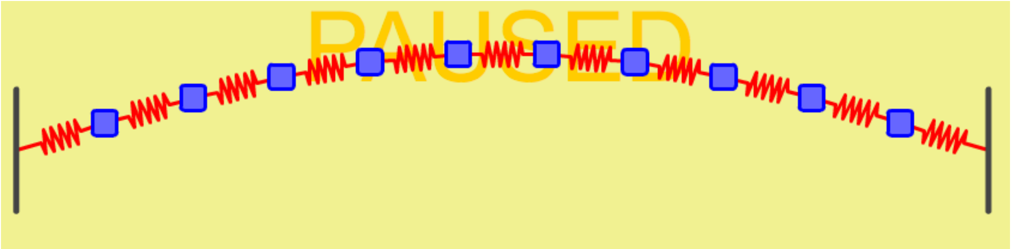
$$y(x) = A \sin(\pi x/L)$$

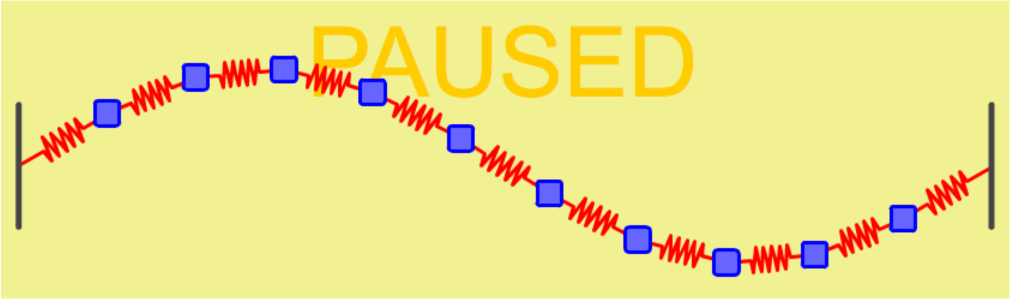
it will oscillate with a frequency f_0.
If we start it out with a shape

$$y(x) = A \sin(2\pi x/L)$$

with what frequency will it oscillate?

1. f_0
2. $2f_0$
3. $f_0/2$
4. Something else





If we start our beaded string off in a sinusoidal shape

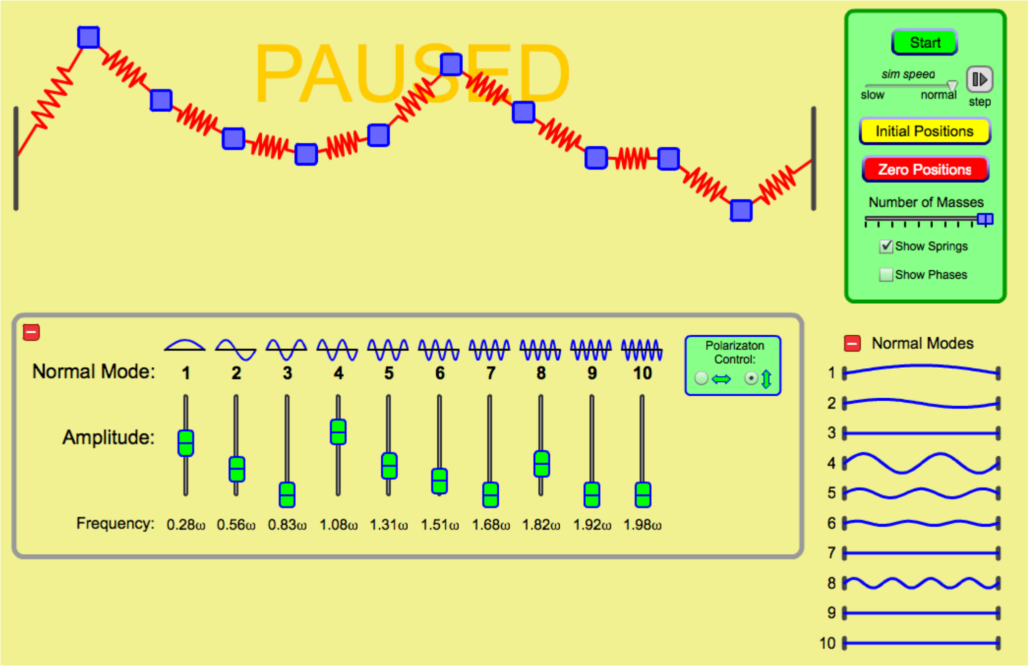
$$y(x) = A \sin(\pi x/L)$$

it will oscillate with a frequency f_0.

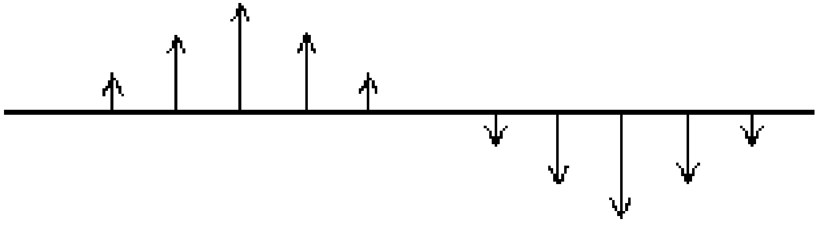
If we start it out with a complex shape (shown) will it ever repeat itself?

If yes, with what frequency?

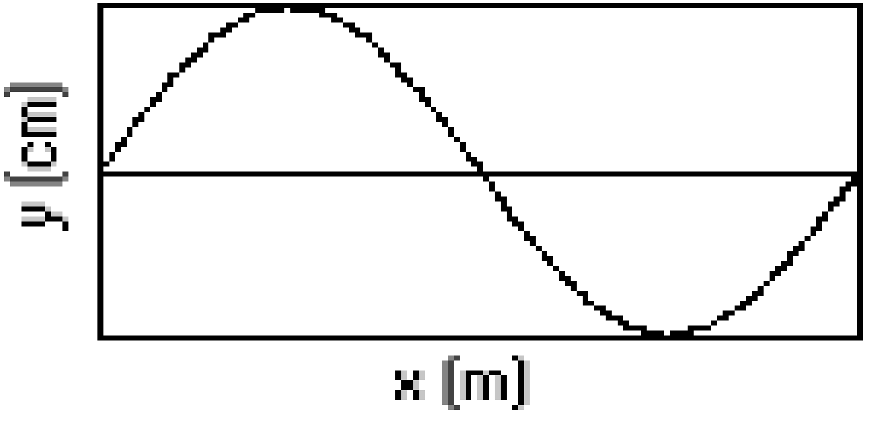
1. No
2. f_0
3. $2f_0$
4. $f_0/2$
5. Something else



In the figure below is shown a picture of a string at a time t_1. The pieces of the string are each moving with velocities indicated by arrows. (Vertical displacements are small and don't show up in the picture.) if the shape of the string at time t_1 is that shown below (displacement magnified by X100) then the motion of the string is



1. Left traveling wave
2. Right traveling wave
3. A standing wave increasing in amplitude
4. A standing wave decreasing in amplitude
5. None of these.



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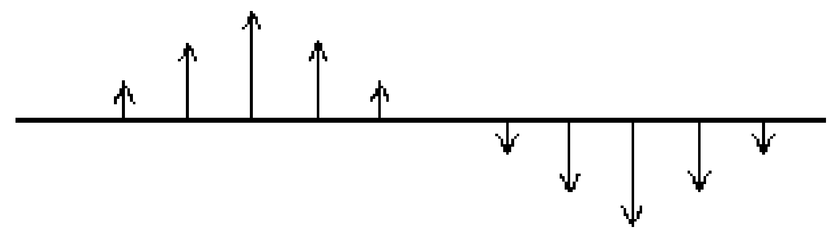

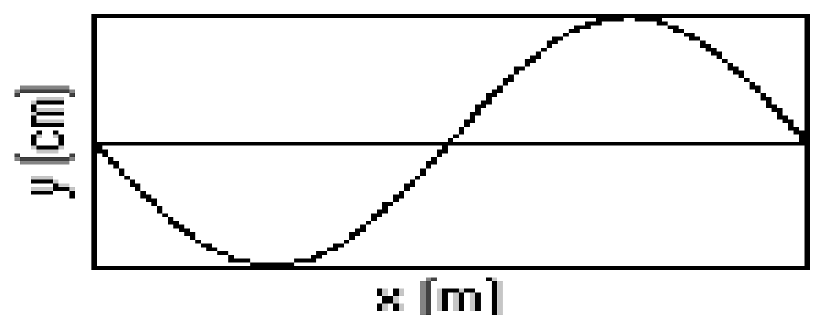

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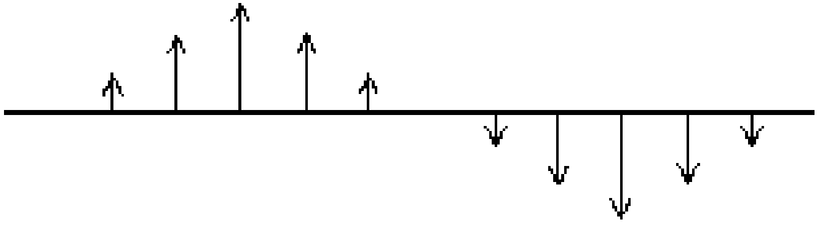
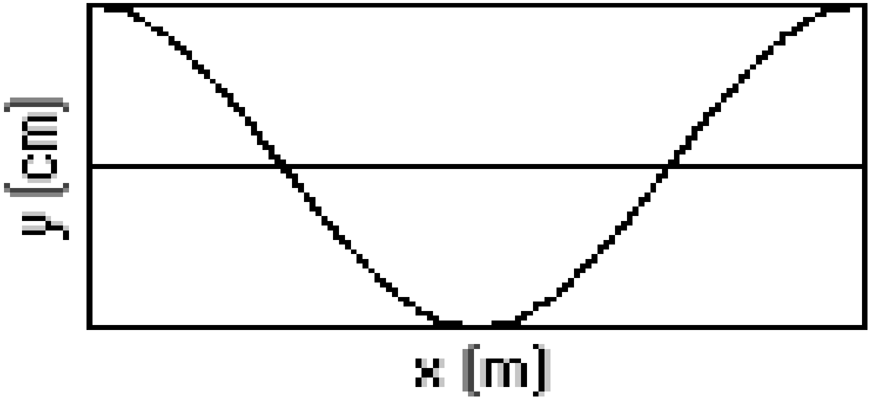




Light – many questions in lab

- How do the various filters change the spectrum produced by the hydrogen lamp?
- How is the sun's spectrum different from or similar to those produced by the lamps (H, Na, and Hg)? Is the sun's spectrum still 'quantized'? Why or why not?
- Is the sun's spectrum the same outside the window as it is when the sun has travelled through the window's glass? (Does the glass absorb any light? If so, which frequencies or bands of frequencies are most affected?)
- How do the UV (ultra-violet) and LED light sources compare to the solar spectrum or to the incandescent spectrum? How do the filters change the spectra observed from these sources?
- Does water act as a filter? If so, which frequencies or bands of frequencies are most affected?
- What factors affect the observed color of different reflective surfaces (like your t-shirts or you notebook covers)?
- What frequencies or bands of frequencies are affected by using your sunglasses as a filter? Are all sunglasses the same?

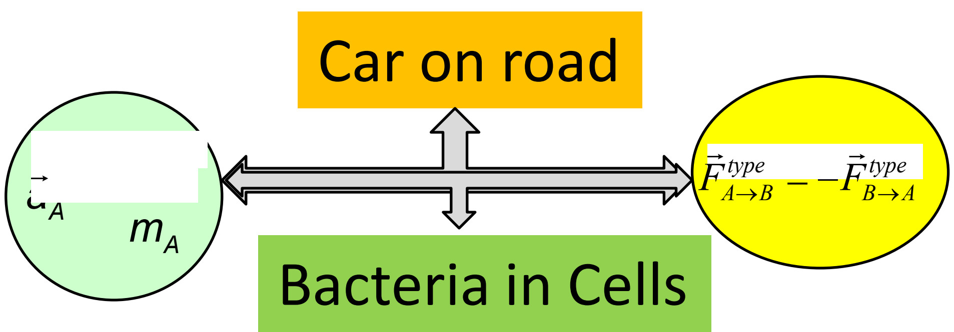
How did we tackle questions involving motion?

- **Knowledge of Foothold ideas:** Through homework, in class activities, labs, and recitations, build experience with physics concepts we can count on in a wide variety of circumstances

$$\vec{F}^{type}_{A\to B} = -\vec{F}^{type}_{B\to A}$$

$\vec{a}_A$ m_A

- **Experience how to connect questions to foothold ideas in a coherent way:** Discussions in class and during HW sessions



Light: Three models

- Newton's particle model (rays)
  - Models light as bits of energy traveling very fast in straight lines. Each bit has a color. Intensity is the number of bits you get.
- Huygens's/Maxwell wave model
  - Models light at waves (transverse EM waves). Color determined by frequency, intensity by square of a total oscillating amplitude. (Allows for cancellation – interference.)
- Einstein's photon model
  - Models light as "wavicles" == quantum particles whose energy is determined by frequency and that can interferer with themselves.

Foothold Ideas: The Photon Model

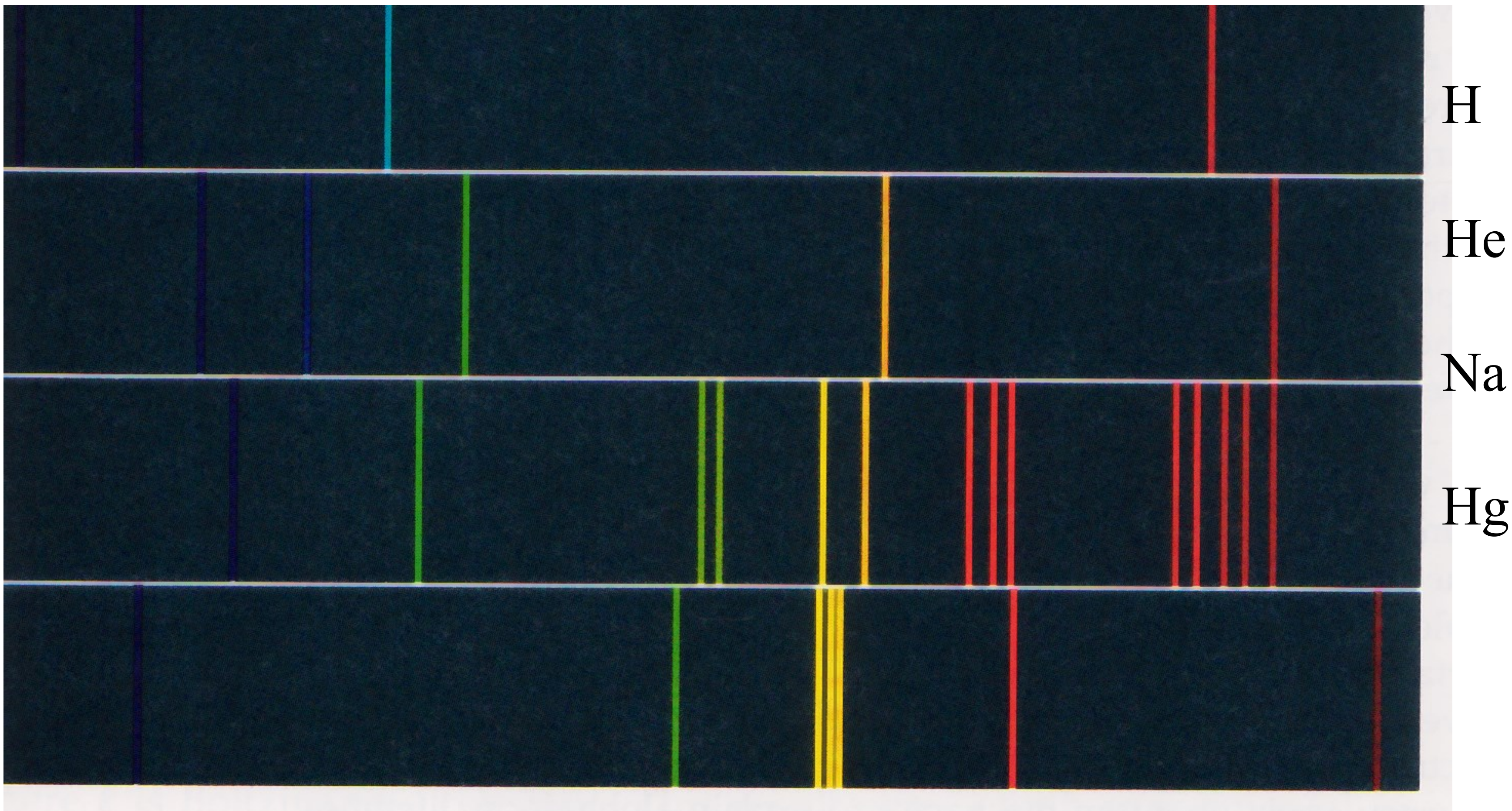
- When it interacts with matter, light behave as if it consisted of packets (photons) that carry both energy and momentum according to:

$$E = hf = \frac{hc}{\lambda} \qquad p = \frac{E}{c} = \frac{h}{\lambda}$$

with hc = 1234 eV-nm.

  - These equations are somewhat peculiar. The left side of the equations look like particle properties and the right side like wave properties.

Line Spectra



Line Spectra

- When energy is added to gases of pure atoms or molecules by a spark, they give off light, but not a continuous spectrum.
- They emit light of a number of specific colors — *line spectra.*
- The positions of the lines are characteristic of the particular atoms or molecules.

Foothold Ideas:
The Nature of Matter

- Atoms and molecules naturally exist in states having specified energies. EM radiation can be absorbed or emitted by these atoms and molecules.
- When light interacts with matter, both energy and momentum are conserved.
- The energy of radiation either emitted or absorbed therefore corresponds to the <u>difference</u> of the energies of states.

Energy Level Diagrams