## **Lecture 06 – 29 January 2009**



HWK 2: due 23:59, Tuesday, 03 February 2009

TEST I: Thursday, 05

February 2009

#### • SCIENCE TOPICS:

Waves
What is light?
The Electromagnetic
Spectrum

#### READING

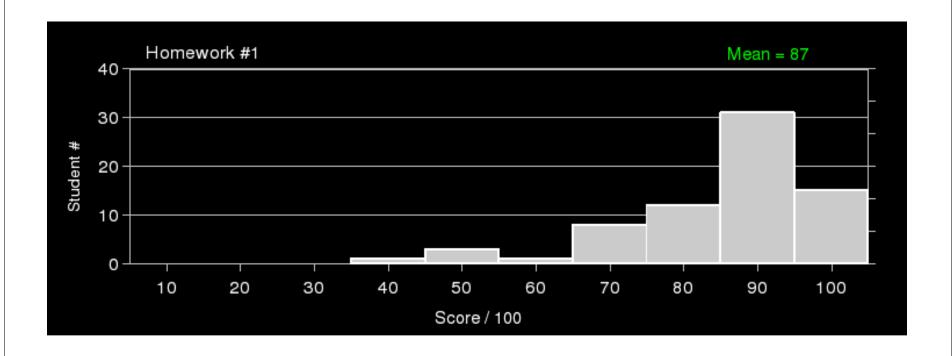
Ch I, Sec. I.3–I.4 Ch 2, Sec 2. I–2.3

#### EXTRA PRACTICE

p.66 Review: 1,4

p.67 Prolems: I-3

#### Homework 01



- N.B. Two questions you could only get right
- Only the highest mark is recorded and shown

#### **About Test I**

- When and Where: Thursday, 05 February 2009 in this classroom, during regular class time.
- Format and Time Limit:
   40 multiple choice questions; I minute per question

#### What to Bring:

- your PSU ID card
- #2 pencils and eraser
- a calculator

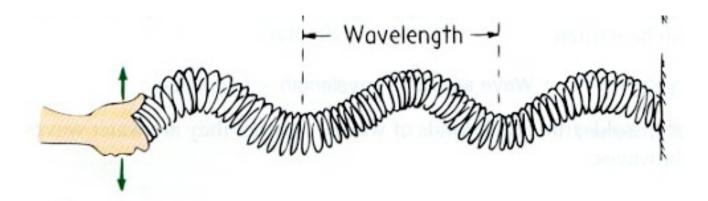
#### Other Rules and Regulations:

- closed book, closed notes
- work on your own
- items other than the above out of sight (especially cellphones)



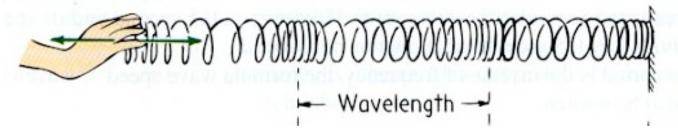
#### **Transverse Waves**

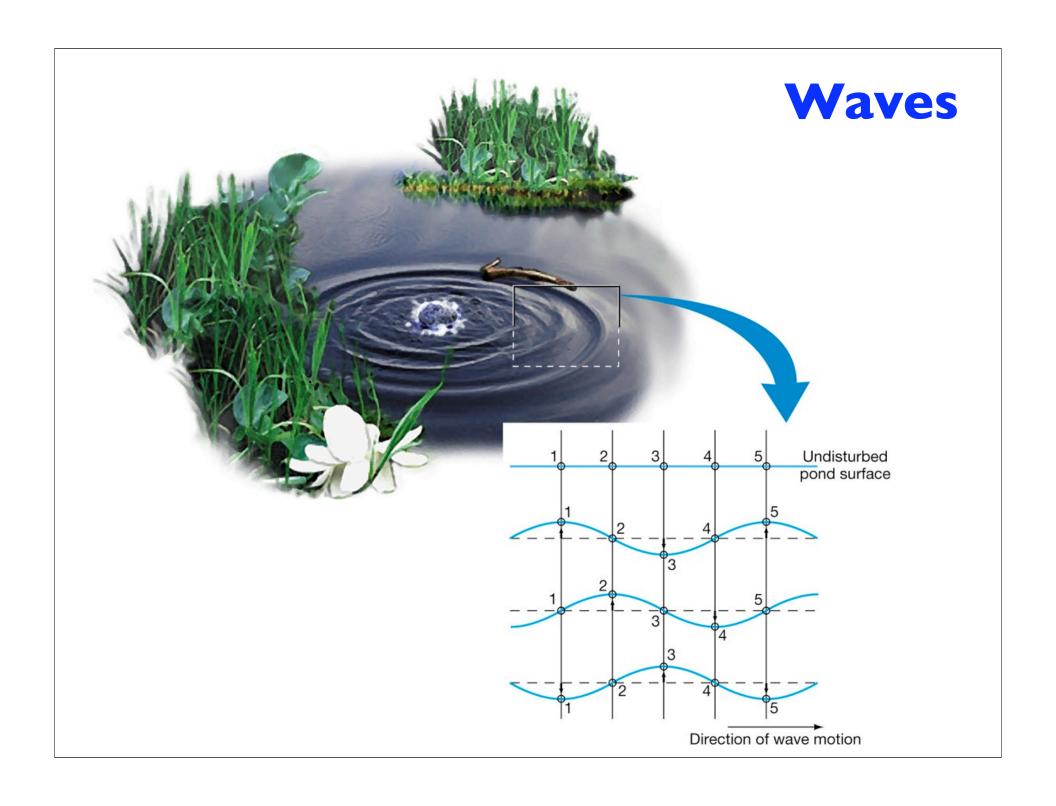
• e.g. light

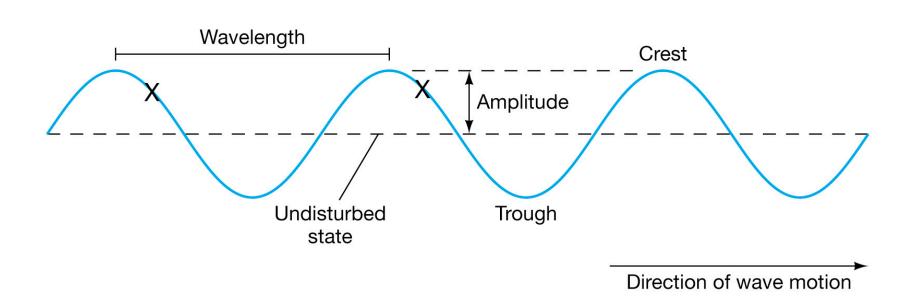


## **Longitudinal Waves**

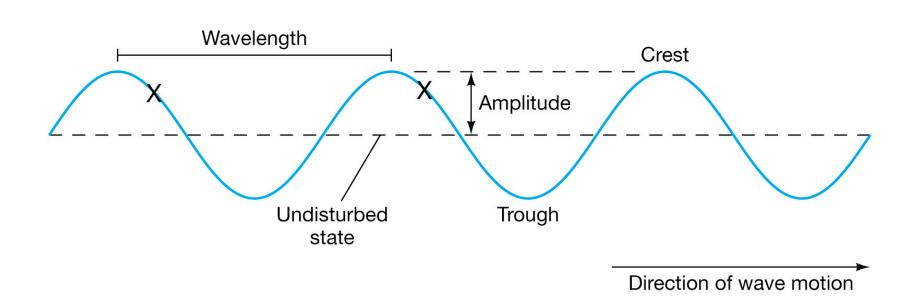
e.g. sound



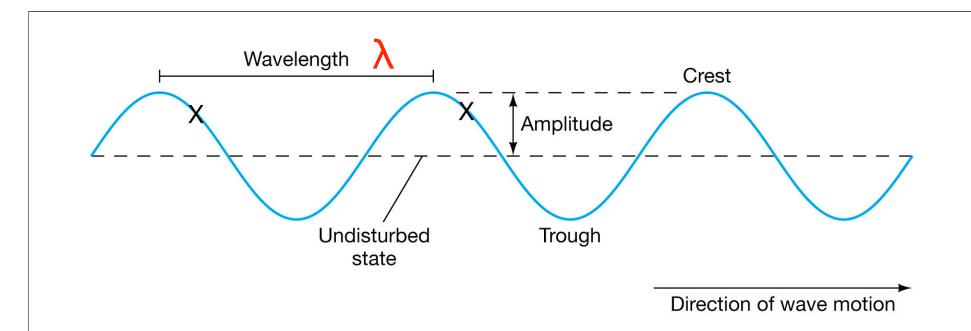




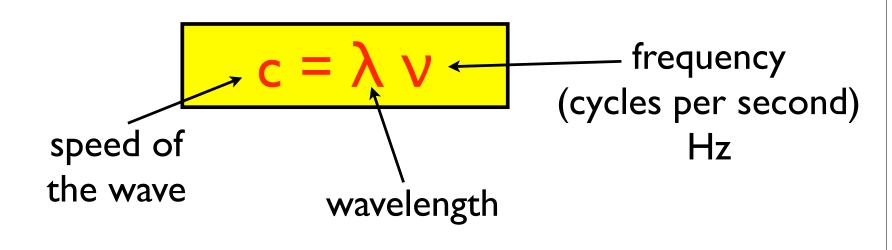
- Wave: A traveling disturbance
- Wavelength: The distance between successive crests or troughs or identical parts of the wave
- Amplitude: The maximum displacement on either side of the equilibrium



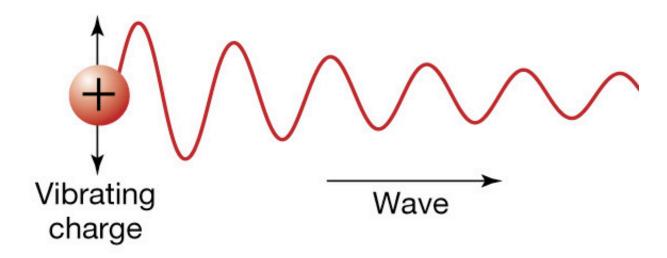
- Period: Time required for a wave to make a complete cylce (measured in seconds)
- Frequency: The number of vibrations per second ("cycles per second" or Hertz; I Hz = I per sec)
- Wave speed: The speed at which a wave passes a particular point



#### Relation between wavelength and frequency

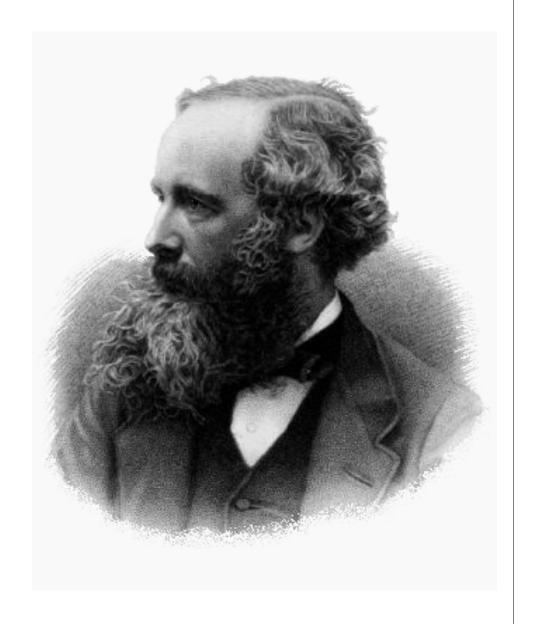


# Generation of Electromagnetic Waves

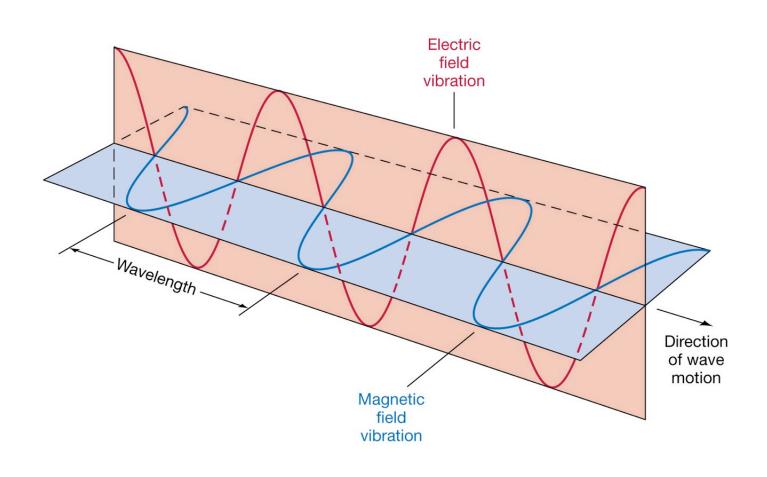


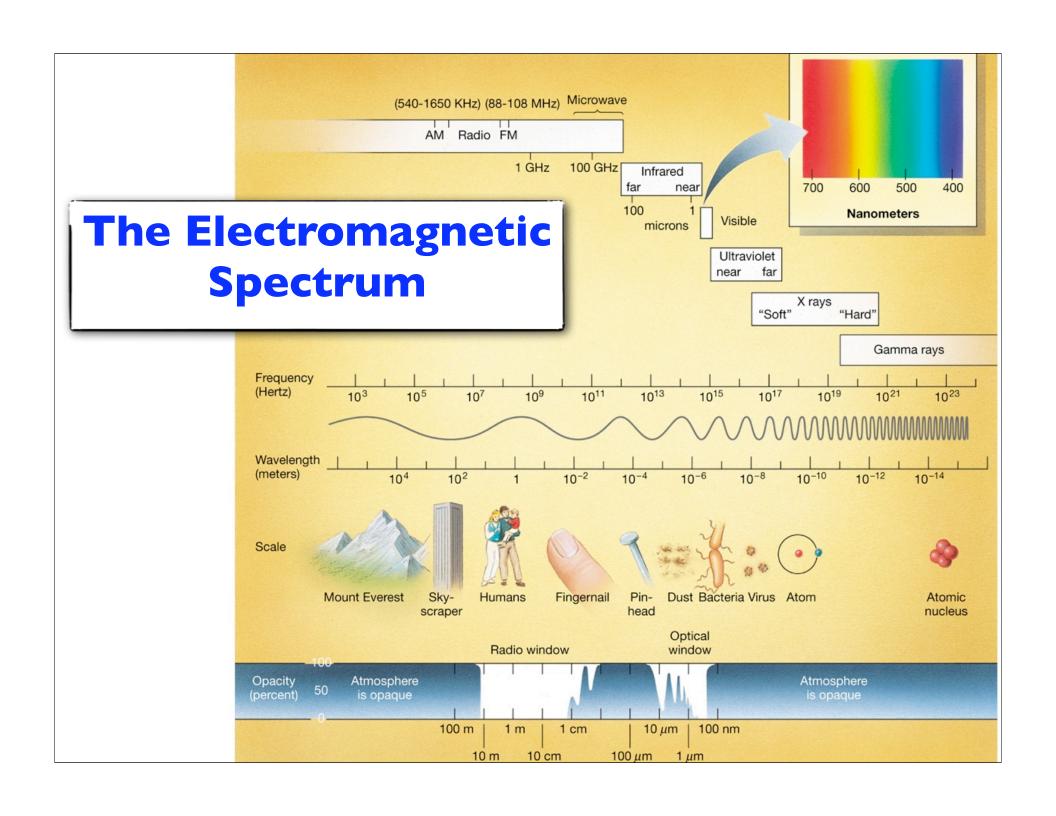
### **James Clerk Maxwell**

- 1831 1879
- Scottish
- Develops theory of electromagnetism ("unifies" electricity and magnetism)
- Maxwell's Equations
- Sets up Einstein to develop Special Relativity

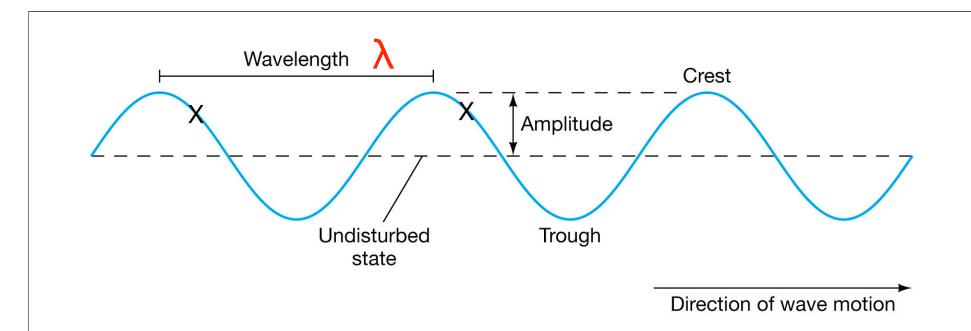


# Electromagnetic Waves

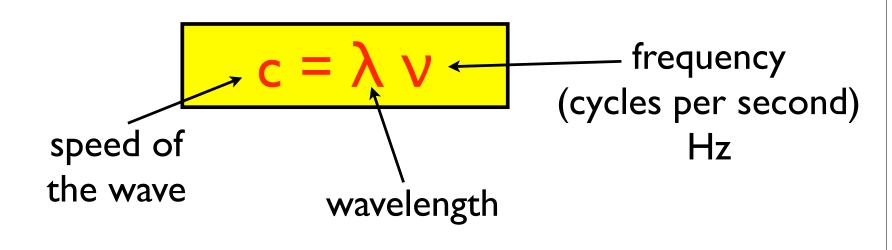




Type of Radiation	<u>Wavelength</u>	<u>Frequency</u>	wavelength x frequency
Radio waves	3m	100 MHz	3×10 <sup>8</sup> m/s
Microwaves	Imm	300 GHz	$3\times10^8$ m/s
Infrared	2 µm	I50 THz	$3\times10^8$ m/s
Optical	550nm	5.45×10 <sup>14</sup> Hz	2.99×10 <sup>8</sup> m/s
Ultraviolet	I00nm	3×10 <sup>15</sup> Hz	$3\times10^8$ m/s
X-rays	0.5 nm	6×10 <sup>17</sup> Hz	3×10 <sup>8</sup> m/s
Gamma rays	I×10 <sup>-12</sup> m	3×10 <sup>20</sup> Hz	3×10 <sup>8</sup> m/s



#### Relation between wavelength and frequency



# All Electromagnetic waves travel at c, the speed of light $3x10^8 \text{ m/s}$

# Light is a wave

# Light is also a particle

## **Wave-Particle Duality of Light**

Light sometimes behaves as a wave and sometimes as a stream of particles.

Energy Packets or "Photons"

Energy of a photon:

