

Announcements – Lecture VII – Wednesday, May 27th

1. **Second Lab:** Thursday, May 28th, ISB 155 (A-C)
2. **Exam I:** Friday, May 29th – In Class

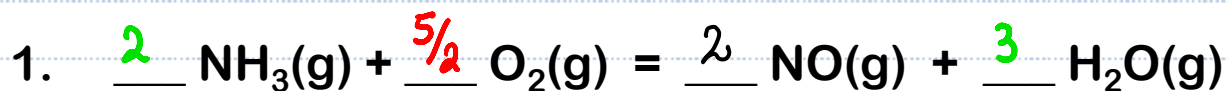


Quiz 5

Class #: _____

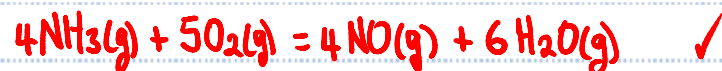
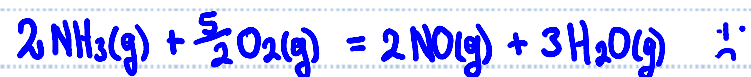
Last Name: _____

Balance the following reactions using the **smallest** possible **integer** coefficients.



N		1	2	2	2
H		3	6	6	6
O		2	2	2	5

N		1	1	2	2
H		2	6	6	6
O		2	4	5	5

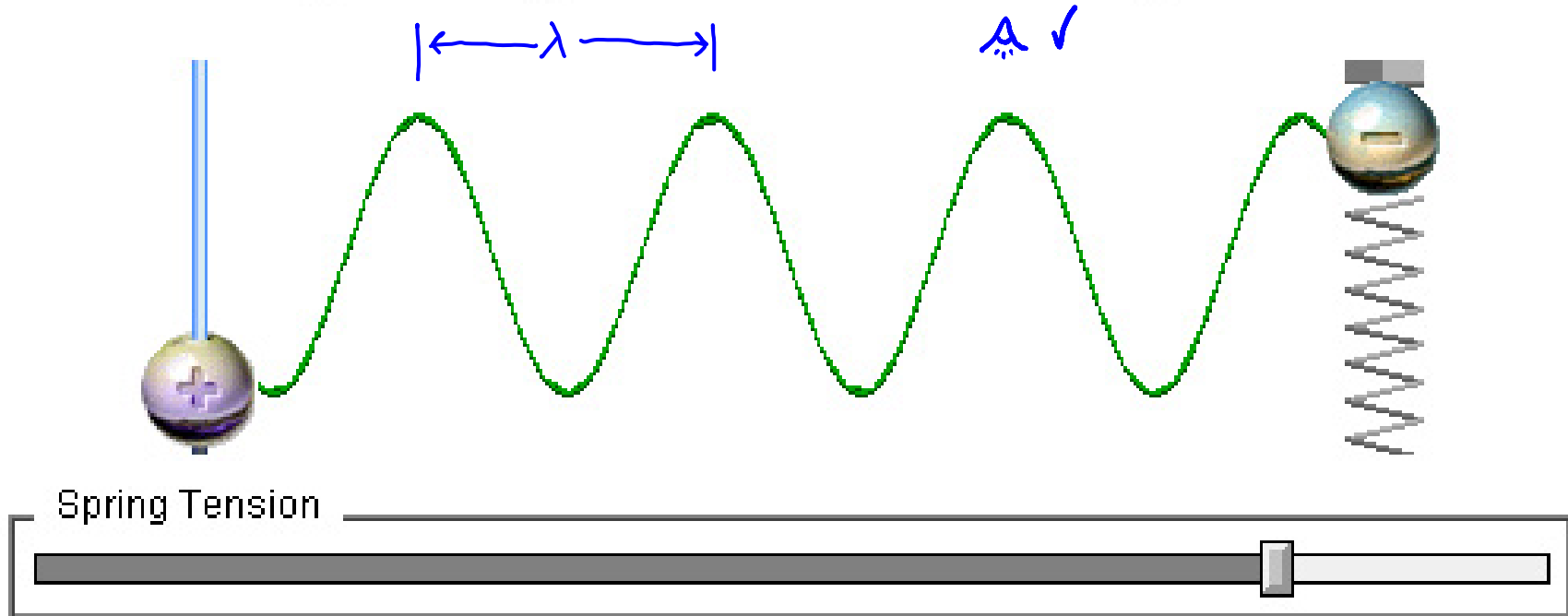


N		1
H		4
Cl		1

N		1
H		4
Cl		1

6.1 Electromagnetic Radiation
a) Wavelength and Frequency

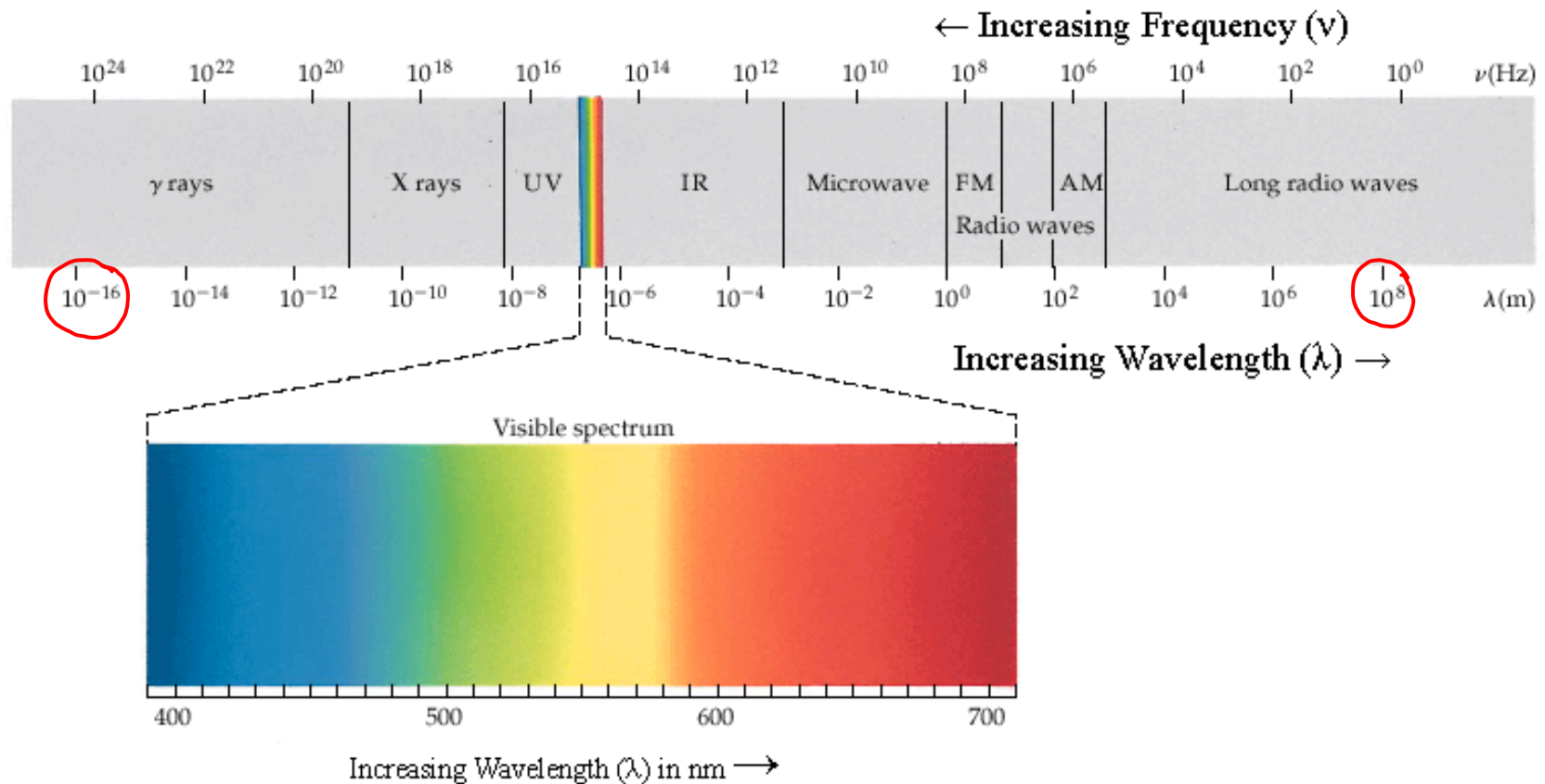
Vibrating Charges and Electromagnetic Waves



	SYMBOL	UNIT
Wavelength	λ	m
Frequency	ν	s^{-1} OR Hz (HERTZ)

6.1 Electromagnetic Radiation

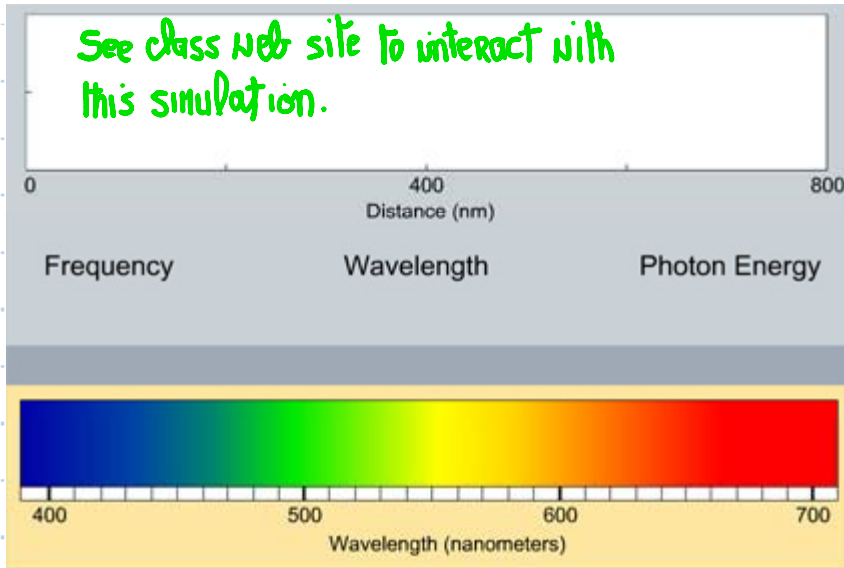
b) The Electromagnetic Spectrum



Let us focus on the visible region particularly the extremes ... Blue vs Red

6.1 Electromagnetic Radiation

Wavelength /Energy /Frequency – Qualitative



Summary:

	Red	vs	Blue
Wavelength	Longest		Shortest
Energy	Smallest		Largest
Frequency	Smallest		Largest



6.1 Electromagnetic Radiation

Wavelength / Energy / Frequency Relationships

	Wavelength λ (m)	Frequency ν (Hz)	Energy E (J)
a)	4.14×10^{-7}	7.21×10^{14}	4.77×10^{-19}
	5.10×10^{-7}	5.85×10^{14}	3.88×10^{-19}
	5.79×10^{-7}	5.15×10^{14}	3.41×10^{-19}
b)	6.93×10^{-7}	4.31×10^{14}	2.85×10^{-19}

$\lambda \nu$

a) $2.98 \times 10^8 \text{ m.s}^{-1}$

b) $2.98 \times 10^8 \text{ m.s}^{-1}$

$\lambda \nu = \text{constant}$

$2.98 \times 10^8 \text{ m.s}^{-1} = \text{speed of light}$

$$\lambda \nu = c$$

E/ν

a) $6.61 \times 10^{-34} \text{ J.s}$

b) $6.61 \times 10^{-34} \text{ J.s}$

$E/\nu = \text{constant}$

$6.61 \times 10^{-34} \text{ J.s} \dots \text{PLANCK'S constant (h)}$

$$E = h\nu$$

6.2 Photons and Photon Energy

a) The Photoelectric Effect

6.2a Example_1

Heat lamps use infra-red radiation to keep food warm. $\lambda = 2,600 \text{ nm}$,
What is the **energy** associated with this radiation in J.mol^{-1} .

{ $c = 2.98 \times 10^8 \text{ m.s}^{-1}$, $h = 6.626 \times 10^{-34} \text{ J.s}$, $N = 6.023 \times 10^{23} \text{ mol}^{-1}$, $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$ }

a) λ must be in meters.

$$\frac{2.6 \times 10^3 \text{ nm}}{1 \text{ nm}} \times 1 \times 10^{-9} \text{ m} = 2.6 \times 10^{-6} \text{ m}$$

b) Calculate frequency

$$\lambda \nu = c$$

$$2.6 \times 10^{-6} \text{ m} (\nu) = 2.98 \times 10^8 \text{ m.s}^{-1}$$

$$\nu = \frac{2.98 \times 10^8 \text{ m.s}^{-1}}{2.6 \times 10^{-6} \text{ m}} = 1.15 \times 10^{14} \text{ s}^{-1}$$

c) Determine E for 1 particle $E = h\nu$

$$E = 6.626 \times 10^{-34} \text{ J.s} (1.15 \times 10^{14} \text{ s}^{-1}) \\ = 7.62 \times 10^{-20} \text{ J}$$

d) Convert E to the desired units

$$E = 7.62 \times 10^{-20} \text{ J} (6.023 \times 10^{23} \text{ mol}^{-1}) \\ = 4.6 \times 10^4 \text{ J.mol}^{-1}$$

6.2 Photons and Photon Energy

a) The Photoelectric Effect

$$1 \text{ kJ} = 1,000 \text{ J}$$

6.2a Example_2

Radio waves lie in the 10 to 1,000 m range.

What is wavelength of a Radio wave that has an energy of $1.07 \times 10^{-30} \text{ kJ}$

{ $c = 2.98 \times 10^8 \text{ m.s}^{-1}$, $h = 6.626 \times 10^{-34} \text{ J.s}$, $N = 6.023 \times 10^{23} \text{ mol}^{-1}$, $1 \text{ nm} = 1 \times 10^{-9} \text{ m}$ }

a) E must be in J

$$\frac{1.07 \times 10^{-30} \text{ kJ}}{1 \text{ kJ}} \times 1000 \text{ J} = 1.07 \times 10^{-27} \text{ J}$$

b) Calculate the frequency

$$E = h\nu$$

$$1.07 \times 10^{-27} \text{ J} = 6.626 \times 10^{-34} \text{ J.s } (\nu)$$

$$\nu = \frac{1.07 \times 10^{-27} \text{ J}}{6.626 \times 10^{-34} \text{ J.s}} = 1.61 \times 10^6 \text{ s}^{-1}$$

c) Calculate the wavelength

$$\lambda \nu = c$$

$$\lambda (1.61 \times 10^6 \text{ s}^{-1}) = 2.98 \times 10^8 \text{ m.s}^{-1}$$

$$\lambda = \frac{2.98 \times 10^8 \text{ m.s}^{-1}}{1.61 \times 10^6 \text{ s}^{-1}} = 184 \text{ m}$$

d) Convert λ to desired units.

No need to here. ↓

6.4 Quantum Theory of Atomic Structure

Louis de Broglie (1892-1987)

All objects have a wavelength:

$$\lambda = \frac{h}{mv}$$

Planck's constant

Mass

velocity

a) Baseball:

$$m = 0.144 \text{ kg}$$
$$v \sim 90 \text{ mph}$$

$$\lambda = 1.2 \times 10^{-34} \text{ m}$$

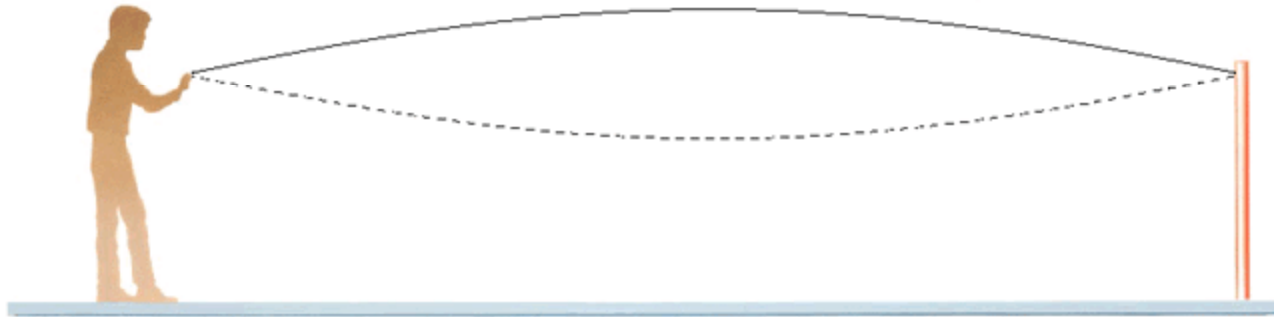
b) Electron:

$$m = 9.109 \times 10^{-31} \text{ kg}$$
$$v \sim \frac{1}{2}c$$

$$\lambda = 6.61 \times 10^{-16} \text{ m}$$

6.5 Modern Quantum Mechanics

Standing Waves



ALLOWED WAVELENGTHS:

$$\left. \begin{array}{l} \frac{1}{2} \lambda \quad \dots \quad 1 (\lambda/2) \\ \lambda \quad \dots \quad 2 (\lambda/2) \\ \frac{3}{2} \lambda \quad \dots \quad 3 (\lambda/2) \\ 2 \lambda \quad \dots \quad 4 (\lambda/2) \\ \frac{5}{2} \lambda \quad \dots \quad 5 (\lambda/2) \end{array} \right\} \dots n (\lambda/2)$$

where $n = 1, 2, 3, 4 \dots$ etc

Quantized
 n ... a quantum number