Announcements – Lecture VII – Wednesday, May 28th

1. Second Lab: Thursday, May 29th, ISB 155 (A-C)
2. Exam I: Friday, May 30th – In Class

Quiz 5 Class #: ____ Last Name: ____________________

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

1. 2 $NH_3(g)$ + 5/2 $O_2(g)$ = 2 $NO(g)$ + 3 $H_2O(g)$

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

$2NH_3(g) + \frac{5}{2}O_2(g) = 2NO(g) + 3H_2O(g)$:(

$4NH_3(g) + 5O_2(g) = 4NO(g) + 6H_2O(g)$ ✓

2. ___ ammonium chloride (aq) = ___ ammonia (g) + ___ hydrochloric acid(aq)

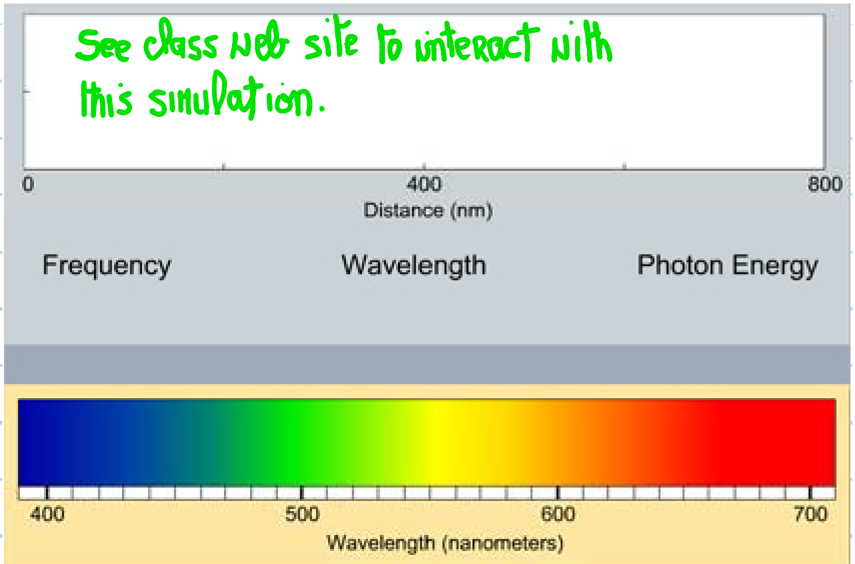
$NH_4Cl(aq) = NH_3(g) + HCl(aq)$ ✓

N	1
H	4
Cl	1

N	1
H	4
Cl	1

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) $2.98\times10^{8}\ m.s^{-1}$

b) $2.98\times10^{8}\ m.s^{-1}$

$\lambda\nu$ = constant

$2.98\times10^{8}\ m.s^{-1}$ = speed of light

$$\lambda\nu = c$$

E/ν

a) $6.61\times10^{-34}\ J.s$

b) $6.61\times10^{-34}\ J.s$

E/ν = constant

$6.61\times10^{-34}\ J.s$ ... 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. $\lambda = 2{,}600$ nm ,
What is the energy associated with this radiation in $J.mol^{-1}$.
{ $c = 2.98x10^{8}$ $m.s^{-1}$, $h = 6.626x10^{-34}$ J.s, $N = 6.023x10^{23}$ mol^{-1}, $1nm = 1x10^{-9}m$}

a) λ must be in meters.

$$\frac{2.6\times10^{3}\,nm \;|\; 1\times10^{-9}\,m}{\quad|\; 1\,nm} = 2.6\times10^{-6}\,m$$

b) Calculate frequency $\qquad \lambda\nu = c$

$$2.6\times10^{-6}\,m\,(\nu) = 2.98\times10^{8}\,m.s^{-1}$$

$$\nu = \frac{2.98\times10^{8}\,m.s^{-1}}{2.6\times10^{-6}\,m} = 1.15\times10^{14}\,s^{-1}$$

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

$$E = 6.626\times10^{-34}\,J.s\,(1.15\times10^{14}\,s^{-1})$$
$$= 7.62\times10^{-20}\,J$$

d) Convert E to the desired units

$$E = 7.62\times10^{-20}\,J\,(6.023\times10^{23}\,mol^{-1})$$
$$= 4.6\times10^{4}\,J.mol^{-1}$$

6.2 Photons and Photon Energy

a) The Photoelectric Effect

1 kJ = 1,000 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 1.07×10^{-30} kJ

{ $c = 2.98\times10^{8}\ m.s^{-1}$, $h = 6.626\times10^{-34}$ J.s, $N = 6.023\times10^{23}\ mol^{-1}$, $1nm = 1\times10^{-9}m$ }

a) E must be in J

$$\frac{1.07\times10^{-30}\,kJ}{} \Big| \frac{1000\,J}{1\,kJ} = 1.07\times10^{-27}\,J$$

b) Calculate the frequency $E = h\nu$

$$1.07\times10^{-27}\,J = 6.626\times10^{-34}\,J.s\,(\nu)$$

$$\nu = \frac{1.07\times10^{-27}\,J}{6.626\times10^{-34}\,J.s} = 1.61\times10^{6}\,s^{-1}$$

c) Calculate the wavelength $\lambda\nu = c$

$$\lambda(1.61\times10^{6}\,s^{-1}) = 2.98\times10^{8}\,m.s^{-1}$$

$$\lambda = \frac{2.98\times10^{8}\,m.s^{-1}}{1.61\times10^{6}\,s^{-1}} = 184\,m$$

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:

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

h: Planck's constant; m: Mass; v: Velocity

a) Baseball:

$m = 0.144$ kg

$v \sim 90$ mph

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

b) Electron:

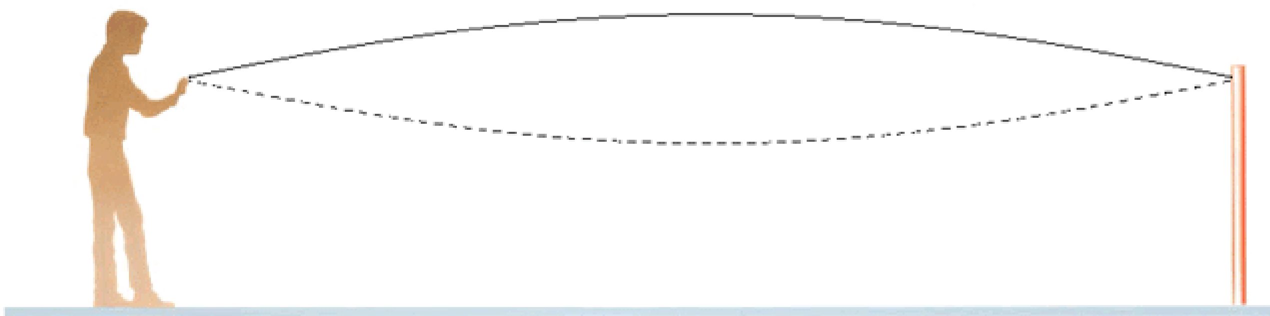
$m = 9.109 \times 10^{-31}$ kg

$v \sim \frac{1}{2}c$

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

6.5 **Modern Quantum Mechanics**

Standing Waves



ALLOWED WAVELENGTHS:

$\frac{1}{2}\lambda$ ... $1(\lambda/2)$
λ ... $2(\lambda/2)$
$\frac{3}{2}\lambda$ ... $3(\lambda/2)$
2λ ... $4(\lambda/2)$
$\frac{5}{2}\lambda$ ... $5(\lambda/2)$

... $n(\lambda/2)$
where $n = 1, 2, 3, 4 \ldots$ etc

Quantized

n ... a quantum number