Announcements – Lecture VII – Wednesday, May 29th

2ND LAB : THU, MAY 30th, 1:30-4:30

EXAM I : FRI, MAY 31ST, IN class

Quiz 5

Last Name: ______________________________

Balance the following reactions using the smallest possible integer coefficients.

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

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)

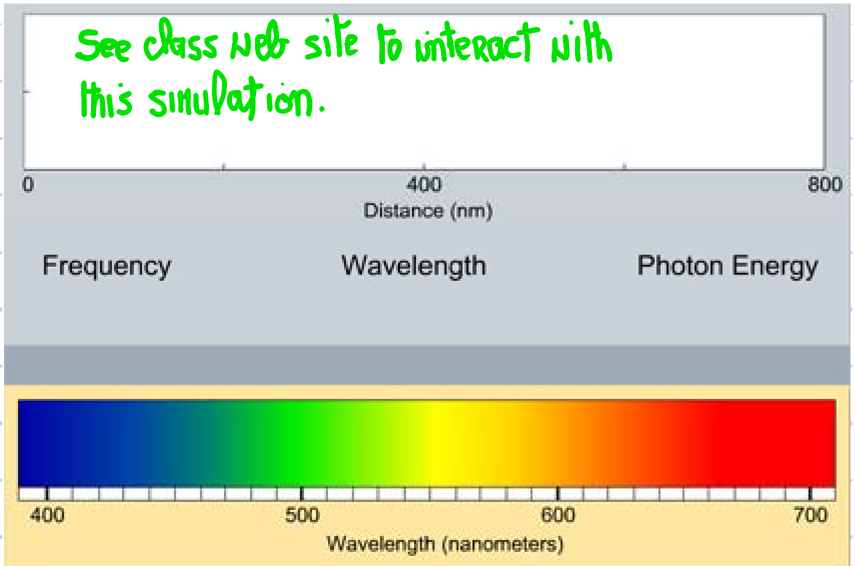
$NH_4Cl(aq) = NH_3(g) + HCl(aq)$ ✓

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

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

$\lambda\nu$ = constant

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

$$\lambda\nu = c$$

E/ν

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

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

E/ν = constant

$6.61 \times 10^{-34}\ J.s$ ... 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. λ = 2,600 nm ,
What is the energy associated with this radiation in $J.mol^{-1}$.
{ $c = 2.98 \times 10^{8}\ m.s^{-1}$, $h = 6.626 \times 10^{-34}$ J.s, $N = 6.023 \times 10^{23}\ mol^{-1}$, $1nm = 1 \times 10^{-9} m$}

a) λ must be in meters.

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

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

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

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

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

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

d) Convert E to the desired units

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

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

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

a) E must be in J

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

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:

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

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

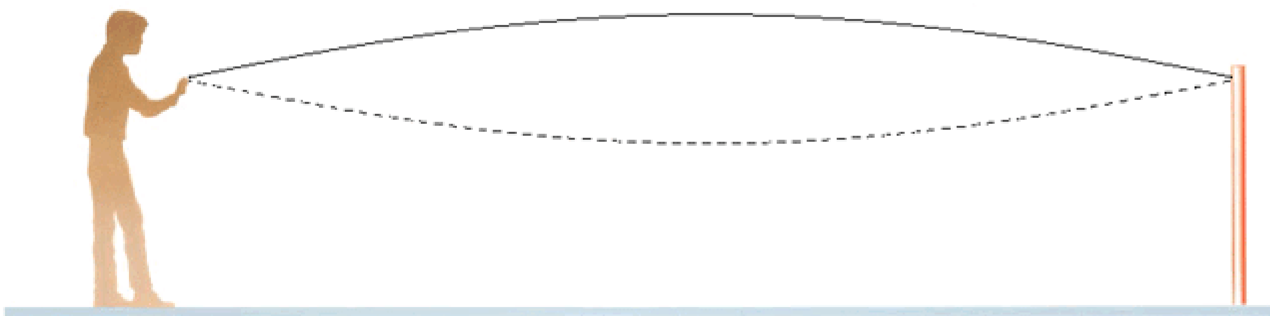
b) Electron:

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