

Announcements

Wednesday, October 29, 2008

Chapter 8 WebAssign due next Monday, Nov 3

Chapter 9 WebAssign due next Tuesday, Nov 4

Exam 2 Wednesday, Nov 5 (ch 5-9)

- Study guide will be on webpage today

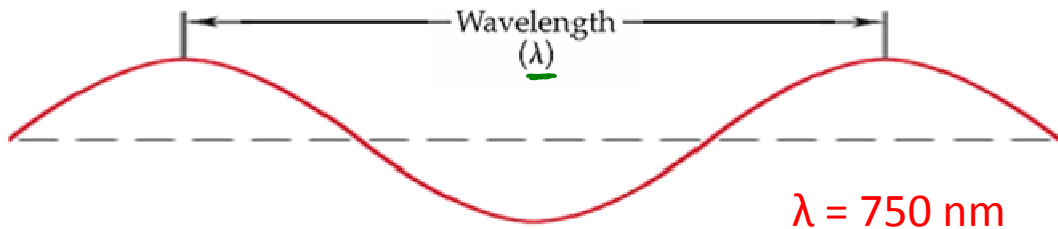
Question sessions in lab next week

- Mon 1:00 pm (note the changed time)
- Wed 8:00 am

Wavelength and color

Red light:

λ : greek lowercase
lambda



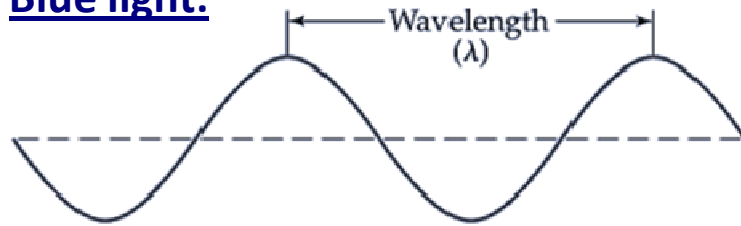
$$\lambda = 750 \text{ nm}$$

$$n = 10^{-9}$$

$$750 \times 10^{-9} \text{ m}$$

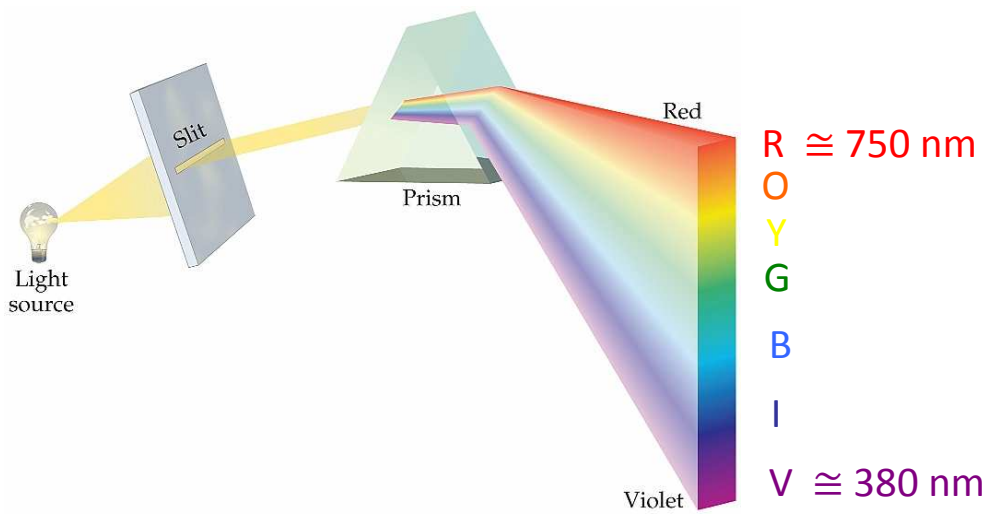
$$7.50 \times 10^{-7} \text{ m}$$

Blue light:



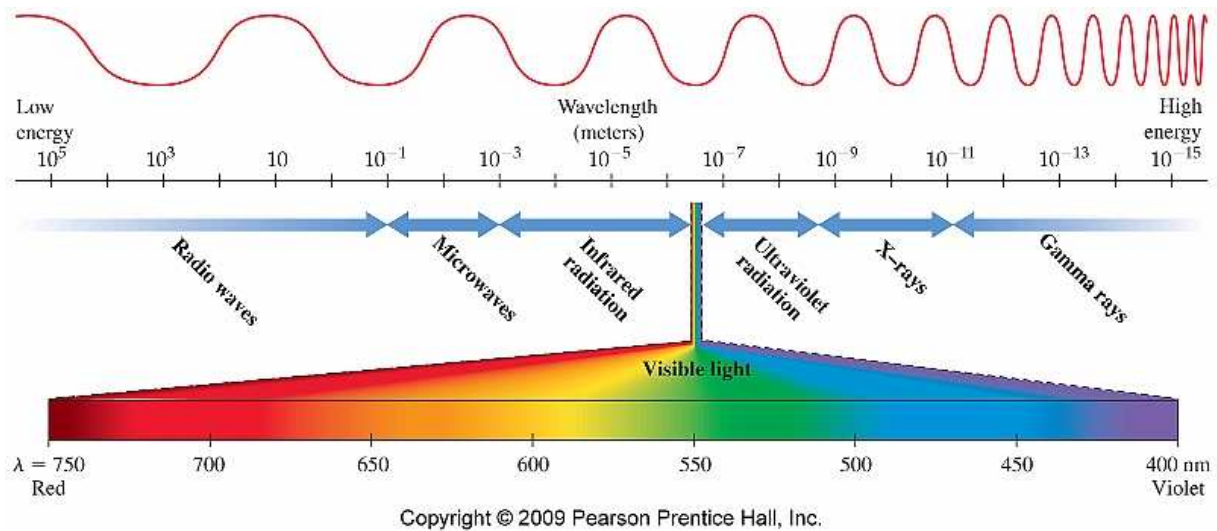
$$\lambda = 450 \text{ nm}$$

The visible spectrum



The electromagnetic spectrum

(all wave lengths)



Energy and wavelength (λ) have what relationship?

inverse relationship: energy $\uparrow$, $\lambda \downarrow$

Radio: long λ , low energy

Microwaves:

Infrared: remote controls, night vision

Visible:

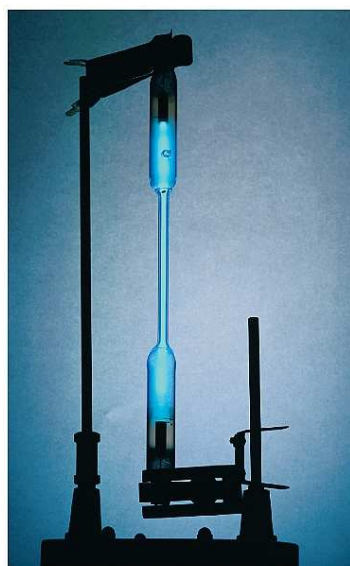
UV: longwave less energy: blacklight
shortwave more energy: sanitizing lamps, sunburn

X-ray:

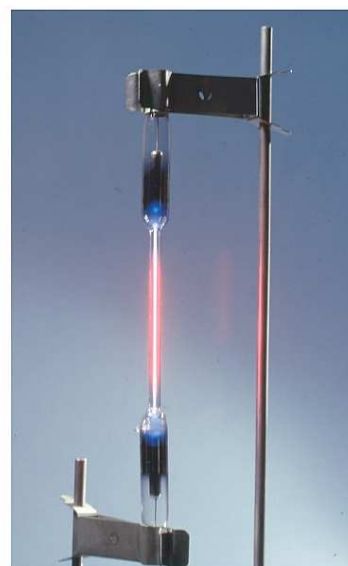
Gamma: highest energy electromagnetic radiation
(shortest λ) radioactivity

Atomic line spectra

A **gas lamp** is a sealed glass tube that contains a gas sample, and **glows** when a high voltage is applied to it.



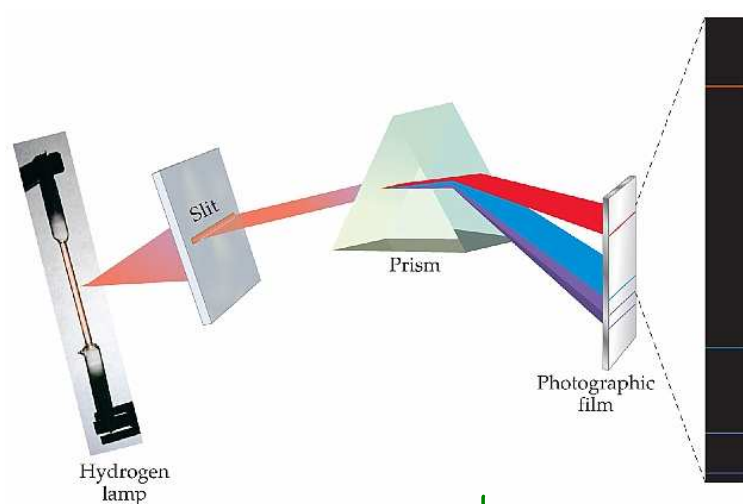
$\text{Hg}(g)$



$\text{H}_2(g)$

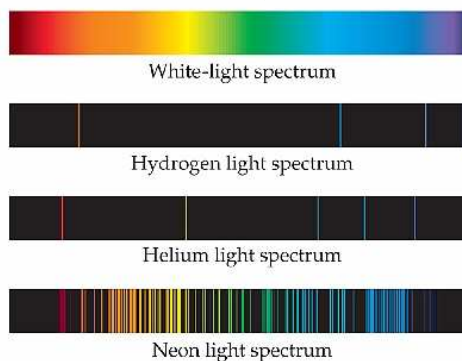
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But **only certain wavelengths** of light are given off by a gas lamp.



Compare with the continuous spectrum given off by a white light source like a light bulb.

line spectra

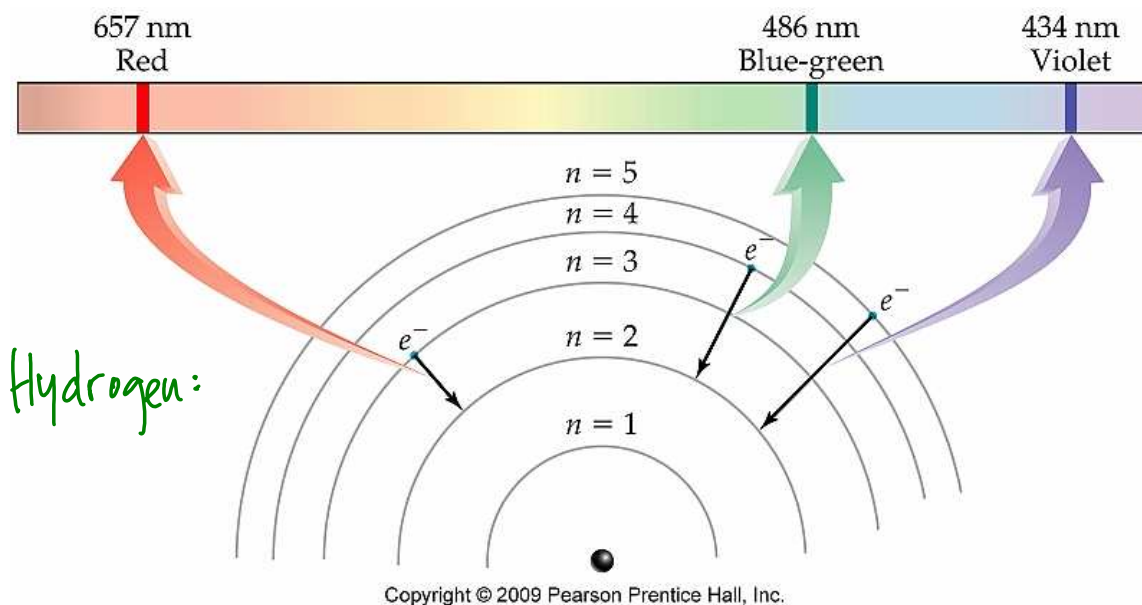
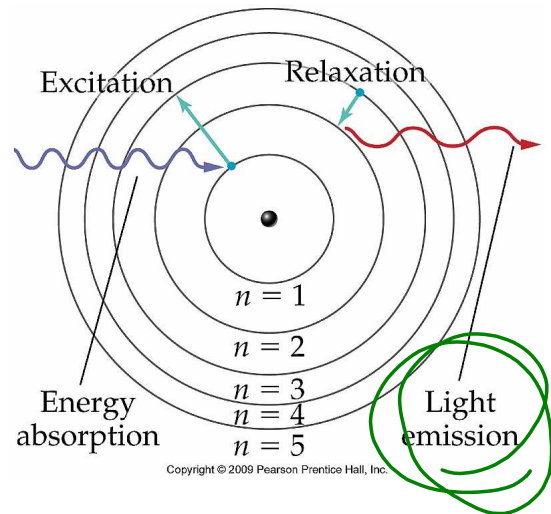


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Why are only **certain** colors of light given off by a pure gas sample?

The **Bohr model** can help explain why:

- Electrons orbit in specific fixed distances from nucleus, called **shells**
- Electrons **jump** to higher, more distant orbits when they **absorb** energy (excitation)
- They **drop** down to lower orbits when they **give off** energy, usually as **light** (relaxation)



Quantum-mechanical model

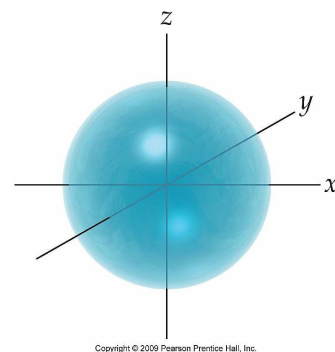
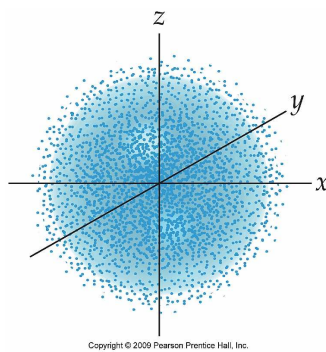
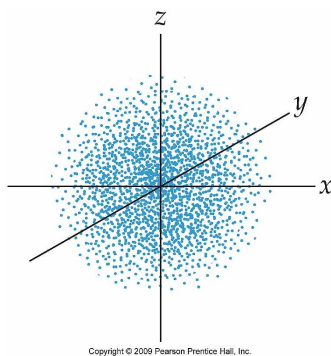
Shortcomings of the Bohr model:

- Can predict the energies of electrons in a hydrogen atom, but not for any other element
- Assumes electrons travel in single circular paths, not likely
- Does not explain periodic table behavior

Quantum mechanical model:

- Assumes electrons can act like particles or waves (supported by experimental evidence)
- Exact position or path of a single electron are impossible to predict
- But, you can predict the probability of finding an electron within a certain space:

Orbital: 3-dimensional shape that defines the **probability** of finding an electron



Shells, subshells, and orbitals

The quantum mechanical model has shells like the Bohr model

- $n = 1, 2, 3, 4, \dots$ (principal quantum number)
- As n increases, energy of the electron increases, and **average** distance from the nucleus increases.

But shells alone cannot explain electron behavior.

Each new row on the periodic table is a new shell, and the major sections (main group, transition, etc) each have their own **subshell**.

Each shell has n subshells:

<u>Shell</u>	<u># subshells</u>	<u>Subshell letters</u>
$n = 1$	1	1s
$n = 2$	2	2s, 2p
$n = 3$	3	3s, 3p, 3d
$n = 4$	4	4s, 4p, 4d, 4f

Electron configurations

Period	H								He
1	(1e ⁻)								(2e ⁻)
Period	Li	Be	B	C	N	O	F	Ne	
2	(3e ⁻)	(4e ⁻)	(5e ⁻)	(6e ⁻)	(7e ⁻)	(8e ⁻)	(9e ⁻)	(10e ⁻)	

If the elements in period 1 have their electrons in the 1s subshell,
the s subshell can hold a maximum of 2 electrons.

Electron configuration: subshell^{# e⁻}

H: 1s¹ **He:** 1s² (filled)

Actually, **every s subshell** can hold a max of 2 electrons
(including 2s, 3s, 4s, 5s, etc)

In period 2, we fill the 2nd shell (2s and 2p subshells)

Li: 1s² 2s¹ **Be:** 1s² 2s² (filled)

When we cross to a new section on the periodic table, a
new subshell is being filled. B-Ne fill into the 2p subshell

B: 1s² 2s² 2p¹ **C:** 1s² 2s² 2p² **N:** 1s² 2s² 2p³
O: 1s² 2s² 2p⁴ **F:** 1s² 2s² 2p⁵ **Ne:** 1s² 2s² 2p⁶ (filled)

Electron configurations and the rest of the periodic table

Available subshells to fill:

1s

2s 2p

3s 3p 3d

4s 4p 4d 4f

5s 5p 5d 5f

6s 6p 6d

7s 7p

Subshell

Max # e⁻

s

2

p

6

d

f

Na: $1s^2 2s^2 2p^6 3s^1$

Ar:

Ca: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ Sc: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

Ba:

Periodic Table of the Elements

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 H 1.008																	2 He 4.003
2	3 Li 6.939	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 99.00	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
6	55 Cs 132.90	56 Ba 137.34	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04		
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (248)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)		

* 57 La 138.91 58 Ce 140.12 59 Pr 140.91 60 Nd 144.24 61 Pm (147) 62 Sm 150.35 63 Eu 151.96 64 Gd 157.25 65 Tb 158.92 66 Dy 162.50 67 Ho 164.93 68 Er 167.26 69 Tm 168.93 70 Yb 173.04

** 89 Ac (227) 90 Th 232.04 91 Pa (231) 92 U 238.03 93 Np (237) 94 Pu (242) 95 Am (243) 96 Cm (247) 97 Bk (248) 98 Cf (251) 99 Es (252) 100 Fm (257) 101 Md (258) 102 No (259)

Reference for elements 106-116: <http://www.webelements.com>