

## Lecture 8.

### 1. Energy Carried by EM radiation

Short wavelength radiation carries more energy than long wavelength radiation.

$$E = \frac{hc}{\lambda} = hf$$

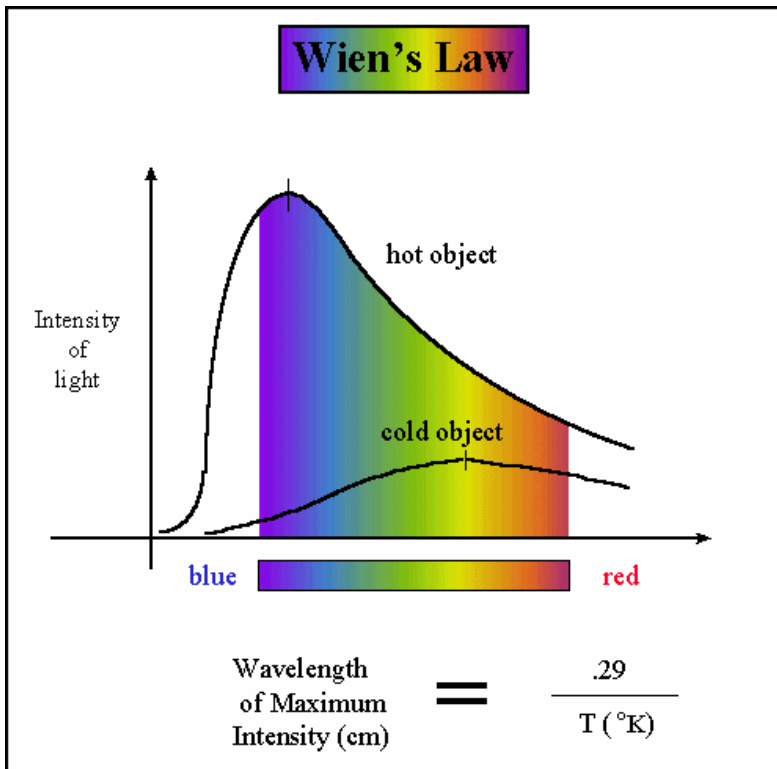
Here  $h$  is Planck's constant, and  $c$  – is speed of light.  
Thus radio waves carry less energy than X-rays.

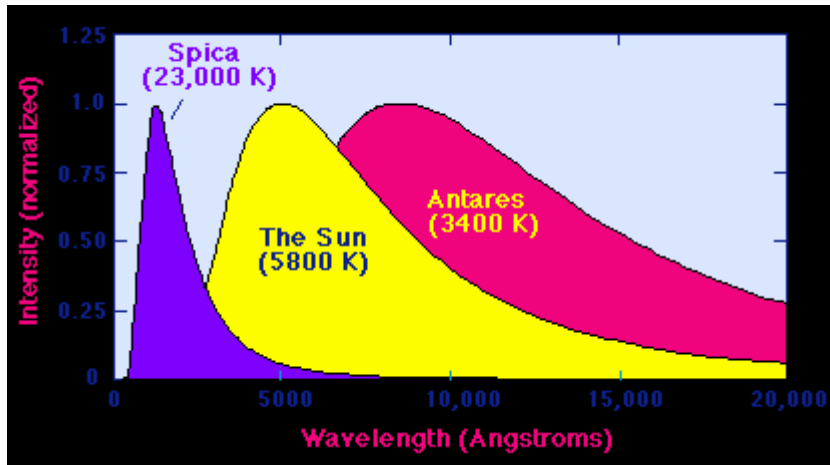
### 2. Radiation and Temperature

Wien's Law tells us that objects of different temperature emit spectra that peak at different wavelengths.

- Hotter objects emit most of their radiation at **shorter** wavelengths; hence they will appear to be **bluer**.
- Cooler objects emit most of their radiation at **longer** wavelengths; hence they will appear to be **redder**.

Furthermore, at any wavelength, a hotter object radiates more (is more luminous) than a cooler one.





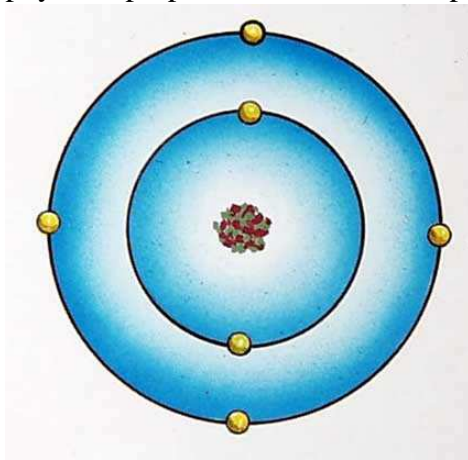
### 3. Structure of atoms

Atoms are composed of three type of particles: protons, neutrons, and electron. Protons and neutrons are responsible for most of the atomic mass e.g in a 150 person 149 lbs, 15 oz are protons and neutrons while only 1 oz. is electrons. The mass of an electron is very small ( $9.108 \times 10^{-28}$  grams).

Both the protons and neutrons reside in the nucleus. Protons have a positive (+) charge, neutrons have no charge --they are neutral. Electrons reside in orbitals around the nucleus. They have a negative charge (-).

It is the number of protons that determines the atomic number, e.g., H = 1. The number of protons in an element is constant (e.g., H=1, Ur=92) but neutron number may vary, so mass number (protons + neutrons) may vary.

The same element may contain varying numbers of neutrons; these forms of an element are called isotopes. The chemical properties of isotopes are the same, although the physical properties of some isotopes may be different. Some isotopes are radioactive--meaning they "radiate" energy as they decay to a more stable form, perhaps another element half-life: time required for half of the atoms of an element to decay into stable form. Another example is oxygen, with atomic number of 8 can have 8, 9, or 10 neutrons.



#### 4. Periodic table

All matter is made up of elements which are fundamental substances which cannot be broken down by chemical means. There are 92 elements that occur naturally. The elements hydrogen, carbon, nitrogen and oxygen are the elements that make up most living organisms. Some other elements found in living organisms are: magnesium, calcium, phosphorus, sodium, potassium.

By the late 1800's many elements had already been discovered. The scientist Dmitri Mendeleev, a Russian chemist, proposed an arrangement of know elements based on their atomic mass. The modern arrangement of the elements is known as the Periodic Table of Elements and is arranged according to the atomic number of elements.

**PERIODIC CHART OF THE ELEMENTS**

IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES		
1 H 1.00797														2 He 4.0026			
3 Li 6.939	4 Be 9.0122										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183	
11 Na 22.9898	12 Mg 24.312										13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948	
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
55 Cs 132.905	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	†89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)						

* Lanthanide Series													
58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97

† Actinide Series													
90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

Atomic number Z tells us the number of electrons and number of protons in the atom.

Atomic mass A tells us the number of neutrons N ( $N=A-Z$ )

For example, for Fe:  $Z=26$  (26 electrons, 26 protons),  $A= 56$  ( $N=56-26=30$  neutrons)