Modern Physics

$E_{photon} = hf = \frac{hc}{\lambda}$

$E_{photon} = E_i - E_f$

$E = mc^2$

• $1 \text{ Å} = 10^{-10} \text{ m}$

$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

c = speed of light in a vacuum $= 3 \times 10^8$ m/s

E = energy

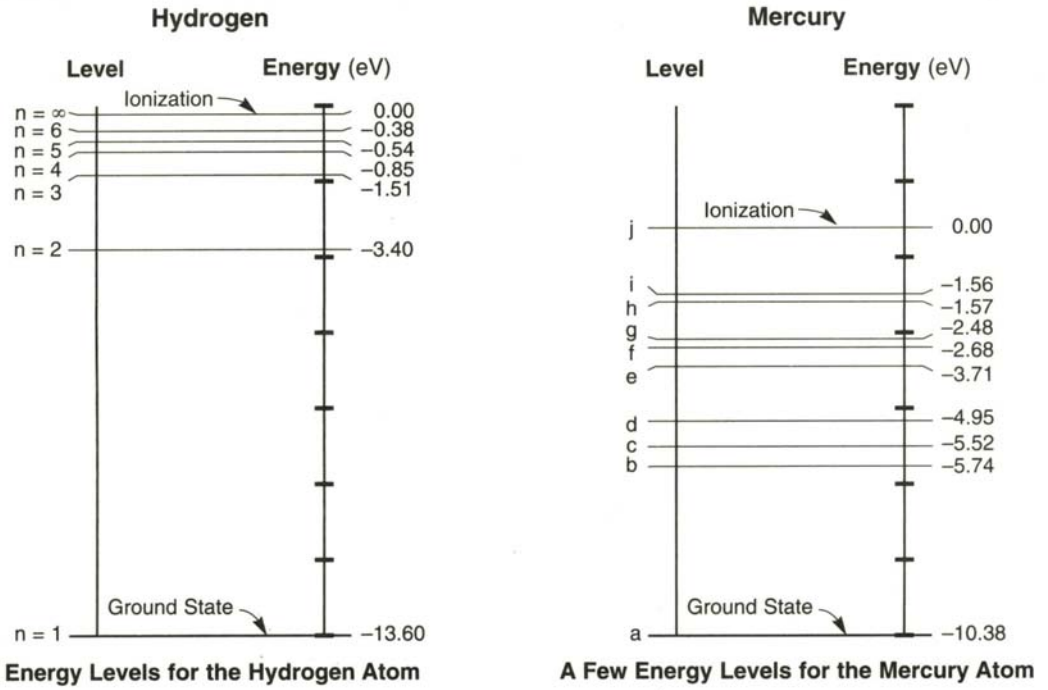
f = frequency

h = Planck's constant $= 6.63 \times 10^{-34}$ Js

m = mass

λ = wavelength

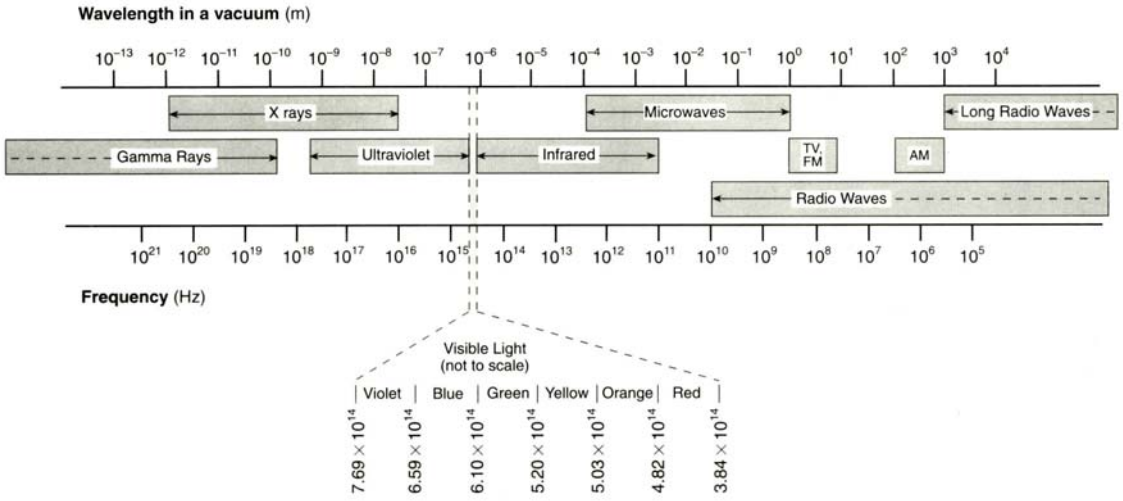
Energy Level Diagrams



Energy Levels for the Hydrogen Atom

A Few Energy Levels for the Mercury Atom

The Electromagnetic Spectrum



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Periodic Table and X-Ray Energies

Alkali Metals
Alkaline Earth Metals

Key To Energy Values: Kα Kβ LL Lα Mz Mα

IA	IIA	IIIB	IVB	VB	VIB	VIIB	—VII—	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
H 1															He 2
Li 3	Be 4									B 5	C 6	N 7	O 8	F 9	Ne 10
Na 11	Mg 12									Al 13	Si 14	P 15	S 16	Cl 17	Ar 18
K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35	Kr 36
Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	Tc 43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53	Xe 54
Cs 55	Ba 56	La 57	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	At 85	Rn 86
Fr 87	Ra 88	Ac 89															

Noble Gases Nonmetals Transition Metals Other Metals

Lanthanide Series	Ce 58	Pr 59	Nd 60	Pm 61	Sm 62	Eu 63	Gd 64	Tb 65	Dy 66	Ho 67	Er 68	Tm 69	Yb 70	Lu 71
Actinide Series	Th 90	Pa 91	U 92	Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100			

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X-ray Diffraction Activity

Background Information

The X-ray powder Diffractometer uses different X-ray source tubes to produce consistent streams of characteristic X-rays which are then used for the analysis of samples. The tube generates these X-rays in a fashion similar to an electron microscope. A beam of high energy electrons interacts with a metal sample, causing inner orbital electrons to be ejected, leaving the metal atoms in an excited state. Outer orbital electrons then transition down to fill in the lower energy level (remember, atoms prefer to be in the ground state with all energy levels closest to the nucleus filled). When this de-excitation occurs, characteristic X-rays are emitted from the metal atoms.

Purpose

In this activity, you will be given the wavelength of the X-ray photons being given off by a source tube in the X-ray Powder Diffractometer. You will use this information, along with your modern physics equations, to determine what metal is in the source tube.

Procedure

1. Record the wavelength of the characteristic X-rays being given off from the source tube.

   λ = _____

2. Determine the energy of one of these photons in Joules (be careful with your units!). Show all your work below.

3. Convert your answer from procedure 2 into KeV. This will correspond to the Kα energy of the X-rays.

4. Use the "Periodic Table and X-ray Energies" to determine the name of the metal giving off these characteristic X-rays.

   Metal = _____

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