Line Spectra and the Bohr Model

Bohr Model

- Since the energy states are quantized, the light emitted from excited atoms must be quantized and appear as line spectra.
- After lots of math, Bohr showed that

$$E_n = \left(-2.178 \times 10^{-18}\ \text{J}\right)\left(\frac{1}{n^2}\right)$$

where n is the principal quantum number (i.e., $n = 1, 2, 3, \ldots$ and nothing else).

Energy and Matter

Size of Matter	Particle Property	Wave Property
Large – macroscopic	Mainly	Unobservable
Intermediate – electron	Some	Some
Small – photon	Few	Mainly

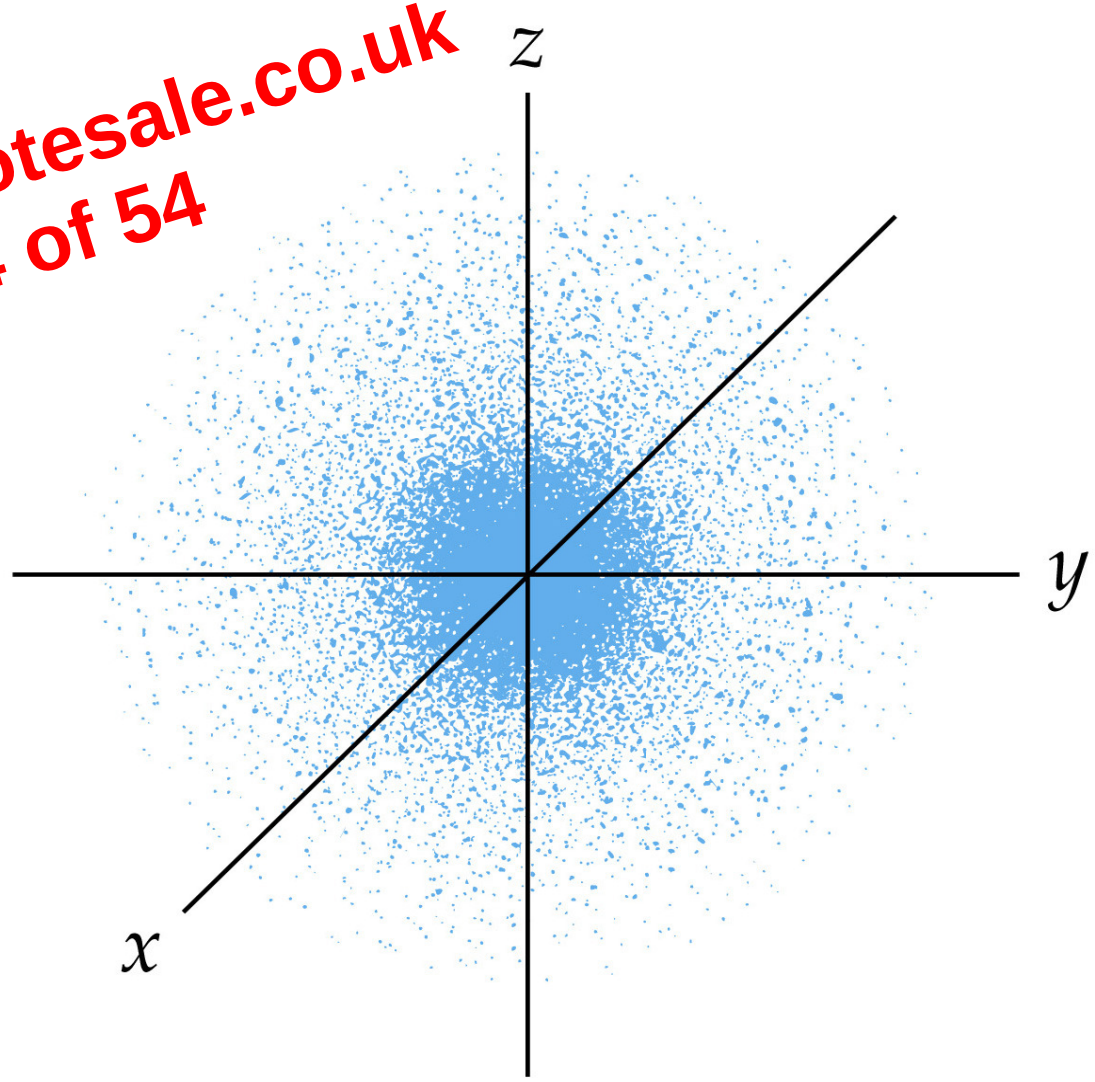
$$E = m c^2$$

Quantum Mechanics and Atomic Orbitals

Solving Schrodinger's Equation gives rise to 'Orbitals'.

These orbitals provide the electron density distributed about the nucleus.

Orbitals are described by quantum numbers.

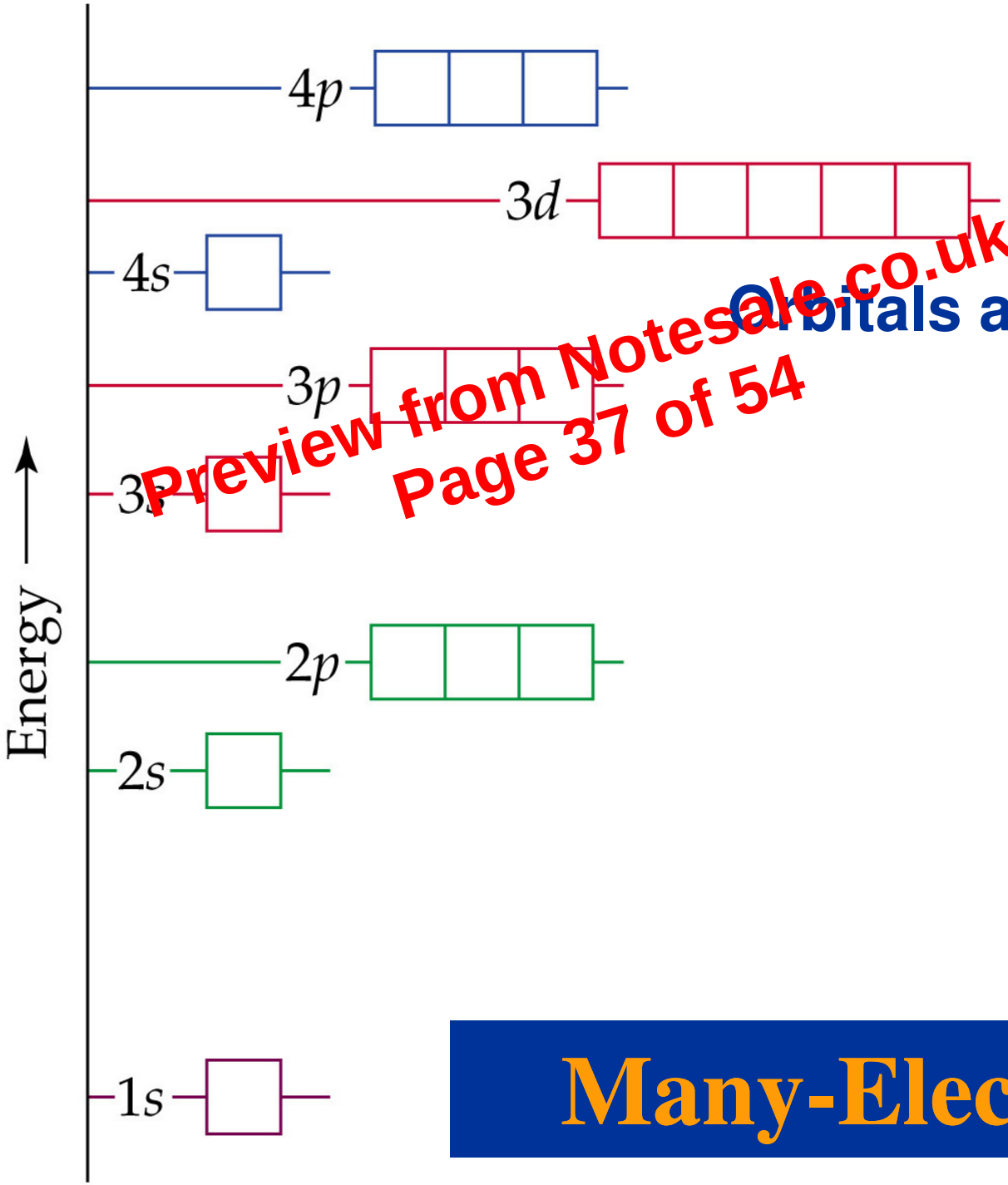


Quantum Mechanics and Atomic Orbitals

Orbitals and Quantum Numbers

TABLE 6.2 Relationship Among Values of n, l, and m_l Through $n = 4$

n	Possible Values of l	Subshell Designation	Possible Values of m_l	Number of Orbitals in Subshell	Total Number of Orbitals in Shell
1	0	1*s*	0	1	1
2	0	2*s*	0	1	
	1	2*p*	1, 0, −1	3	4
3	0	3*s*	0	1	
	1	3*p*	1, 0, −1	3	
	2	3*d*	2, 1, 0, −1, −2	5	9
4	0	4*s*	0	1	
	1	4*p*	1, 0, −1	3	
	2	4*d*	2, 1, 0, −1, −2	5	
	3	4*f*	3, 2, 1, 0, −1, −2, −3	7	16



Orbitals and Their Energies

Orbitals CD

Many-Electron Atoms

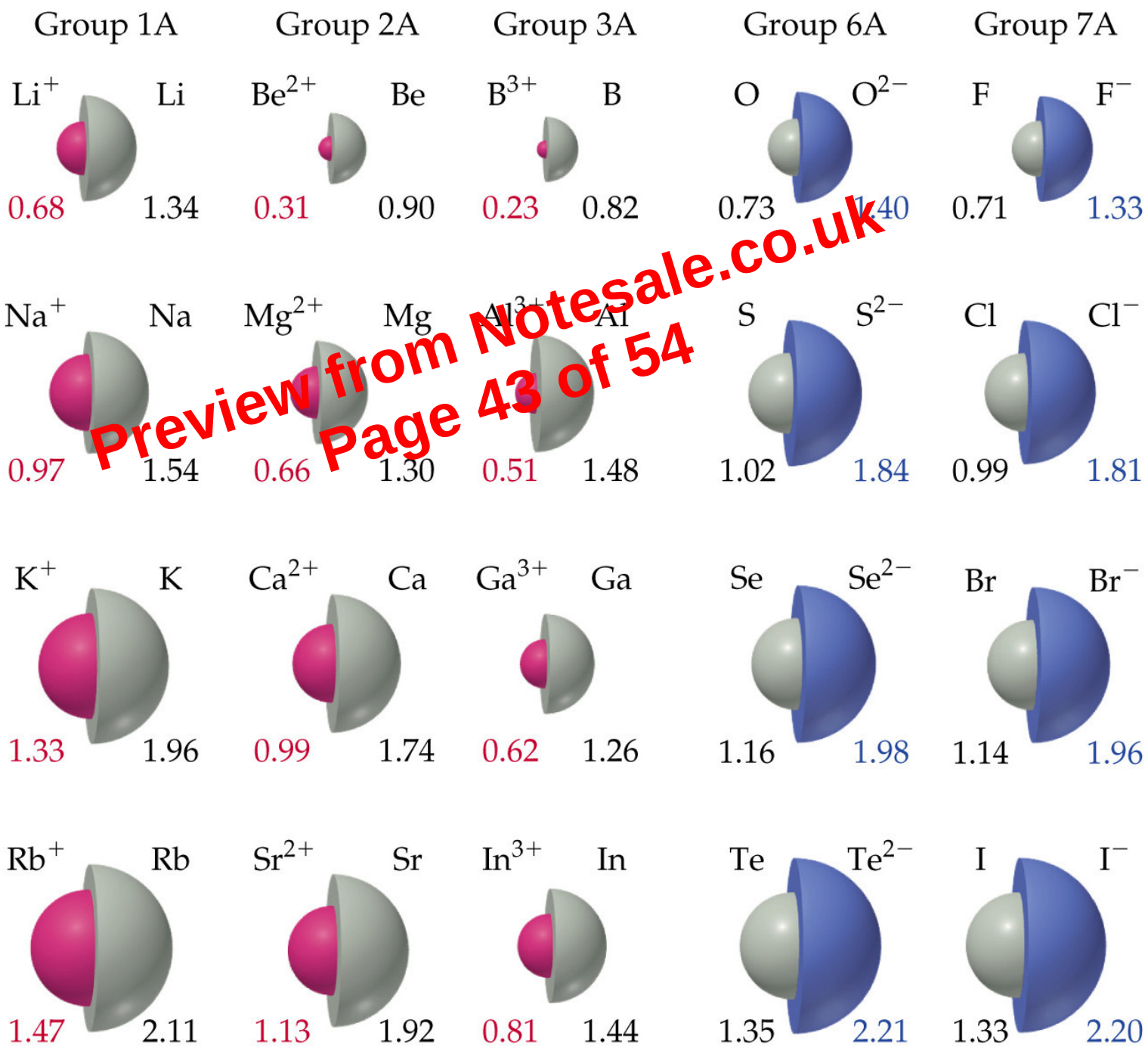


Figure 7.6

Group Trends for the Active Metals

Group 2A: The Alkaline Earth Metals

TABLE 7.5 Some Properties of the Alkaline Earth Metals

Element	Electron Configuration	Melting Point (°C)	Density (g/cm^3)	Atomic Radius (Å)	I_1 (kJ/mol)
Beryllium	$[He]2s^2$	1287	1.85	0.90	899
Magnesium	$[Ne]3s^2$	650	1.74	1.30	738
Calcium	$[Ar]4s^2$	842	1.54	1.74	590
Strontium	$[Kr]5s^2$	777	2.63	1.92	549
Barium	$[Xe]6s^2$	727	3.51	2.15	503

Group Trends for Selected Nonmetals

Group 7A: The Halogens

TABLE 7.7 Some Properties of the Halogens

Element	Electron Configuration	Melting Point (°C)	Density	Atomic Radius (Å)	I_1 (kJ/mol)
Fluorine	$[He]2s^2 2p^5$	−220	1.69 g/L	0.71	1681
Chlorine	$[Ne]3s^2 3p^5$	−102	3.21 g/L	0.99	1251
Bromine	$[Ar]3d^{10} 4s^2 4p^5$	−7.3	3.12 g/cm^3	1.14	1140
Iodine	$[Kr]4d^{10} 5s^2 5p^5$	114	4.93 g/cm^3	1.33	1008

Group Trends for the Active Metals

Group 2A: The Alkaline Earth Metals

- Alkaline earth metals are harder and more dense than the alkali metals.
- The chemistry is dominated by the loss of two *s* electrons:

$$M \rightarrow M^{2+} + 2e^{-}.$$

$$Mg(s) + Cl_2(g) \rightarrow MgCl_2(s)$$

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

- Be does not react with water. Mg will only react with steam. Ca onwards:

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$$