Group I

I-1

39-32 Splittings as small as 10^{-17} m $= 10^{-8}$ nm can be seen.

a. We could use the splitting and the Zeeman effect to learn about magnetic fields even if we are not present.

b. They can learn about the magnetic fields inside stars.

c. $n=2$ to $n=1$ transition has a splitting of 1.0×10^{-5} nm. What was the magnetic field in the photosphere? Of course the wavelength of the $2 \to 1$ transition is much larger. This is merely the splitting. We know

$$\Delta E = m \mu_B B$$

and $\mu_B = 5.79 \times 10^{-5}$ eV/T. Thus, with $m=1$ we find

$$B = \Delta E / \mu_B$$

Now $\Delta E = \Delta(hc/\lambda) = \Delta\lambda \frac{hc}{\lambda^2}$, so

$$B = \frac{\Delta\lambda}{\lambda} \frac{E}{\mu_B}$$

where $E = hc/\lambda = 10.2$ eV, the energy difference, and $\lambda = hc/E = 121.6$ nm

$$B = \frac{1.0 \times 10^{-5}\text{ nm}}{121.6\text{ nm}} \times \frac{10.2\text{ eV}}{5.79 \times 10^{-5}\text{ eV/T}} = 0.0145\text{ T} = 14.5

I-2

39-37 The hydrogen atom has three quantum numbers: n, ℓ, m. What effect on

a. helium. This has $n = 2$, so $\ell = 1$ or 0 and possible projections are $1, 0, -1, 0$. Both e^- are in the s-state.

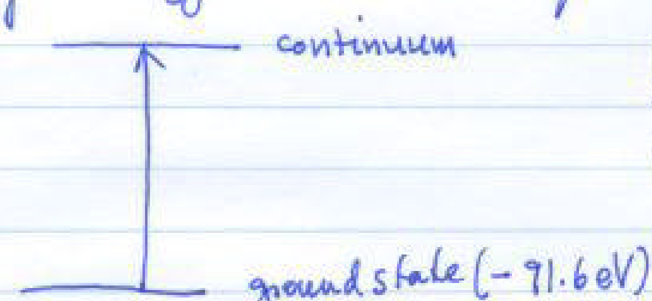
b. nitrogen. This has 7 protons, and thus 7 electrons. They will fill the 7 lowest states. Here we find p-state electrons. There are 2s × 2 and 3 p electrons

c. neon. This has 10 protons and thus 10 electrons. They fill the lowest 10 states... 2(2s) and 6 p electrons.

I-3

39-40 A nucleus has Z protons and just one electron (it is a hydrogenic aion). Electrons of energy 91.6 eV are finally noticed. Photons

a.



from outside send electrons free of the atom.

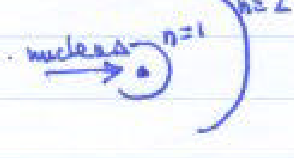
b. $\lambda = hc/E = 1240\,\text{eV nm}/91.6\,\text{eV} = 13.54\ \text{nm}$

c. $E = Z^2\left(-\frac{13.6\text{eV}}{n^2}\right)$ so $\frac{91.6\text{eV}}{13.6\text{eV}} = 6.74 \approx 7$

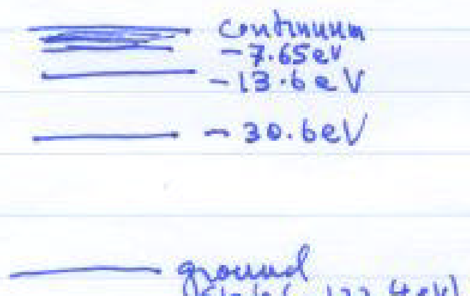
$Z \approx 2-3$. Obviously interactions occur.

I-4

39-41 Li has 3 protons and thus 3 electrons



a. If the Bohr model works, the energies are $9 \times (-13.6\,eV/n^2) = -122.4\,eV/n^2$. The first two electrons are in $n=1$, and the third in $n=2$.



b. Treating the outer electron as if it were the lowest electron in a Bohr model as it goes to the lowest unoccupied state, the $n=3$ to $n=2$ transition is

$$\frac{z^2\,13.6\,eV}{4} - \frac{z^2\,13.6\,eV}{9} = \frac{5}{36} z^2\,13.6\,eV$$

$$= 2.00\,eV$$

$$z^2 = 36 \times 2.00\,eV / 5 \times 13.6\,eV = 1.06$$

so $z = 1$

c. If it went from $n=4$ to $n=3$ (take $z=1$)

$13.6\,eV/9 - 13.6\,eV/16 = 0.66\,eV$; $\lambda = \frac{hc}{E} = 1876\,nm$

d. For $n=6$ to $n=4$ $= 13.6\,eV/16 - 13.6\,eV/36 = 0.47\,eV$

so $\lambda = hc/E = 2626\,nm$

e. $n=2$ to $n=6$ would take $\frac{13.6\,eV}{4} - \frac{13.6\,eV}{36} = 3.02\,eV$