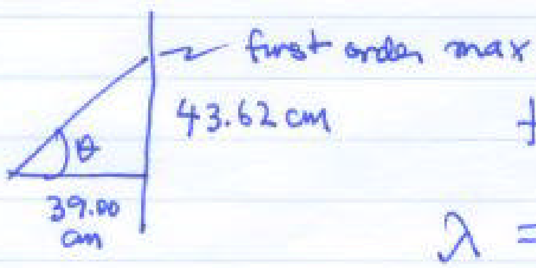
Group II

II − 1

39−34 12000 lines per centimeter means the grating spacing is $\frac{1\ \text{cm}}{12{,}000} = 833\ \text{nm}$

A plate is 39.00 cm from the grating. The first-order interference is 43.62 cm from the central maximum. What is the relative velocity of Earth to this star?



$$\tan\theta = \frac{43.62\text{cm}}{39.00\text{cm}} \Rightarrow 48.2^\circ = \theta$$

$$\lambda = d \sin\theta$$
$$= 621.23\ \text{nm}$$

$$\Rightarrow f = c/\lambda = 4.83 \times 10^{14}\ \text{Hz}$$

The wavelength for the normal longest Balmer wavelength is that corresponding to 1.89 eV, which is 656.1 nm

$$\frac{\Delta f}{f} = \frac{\Delta\lambda}{\lambda} \simeq v/c,$$

so $$v/c \sim \frac{34.87\ \text{nm}}{656.1\ \text{nm}} = 0.053$$

$$v \sim 15{,}944\ \text{km/s},$$

the relative speed of Earth and the star.

IX - 2

39-36 If $n=2$ to $n=1$ transition in mercury is 4.9 eV, and we assume $E = \frac{E_0}{n^2}$

$$\frac{3}{4} E_0 = 4.9\,\text{eV} \quad \text{or} \quad E_0 = 6.53\,\text{eV}$$

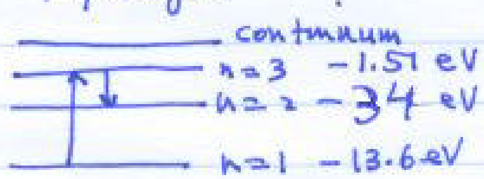
This would be the ionization energy.

IX - 3

39-39 We have $E_n = -Z^2(13.6\,\text{eV})/n^2$

a, b. $n=3 \rightarrow n=2$.

Hydrogen



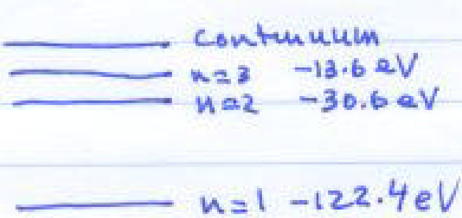
$E_{2\to1} = -3.4\,\text{eV} - (-13.6\,\text{eV})$
$= 10.2\,\text{eV}$ $2\to1$

$E_{3\to2} = -1.51\,\text{eV} - (-3.40\,\text{eV})$
$= 1.89\,\text{eV}$ $3\to2$

$\lambda_{3\to2} = \frac{hc}{E_{3\to2}} = 656.1\,\text{nm}$

c, d $n=3 \rightarrow n=2$

Twice-ionized Lithium



$E_{3\to2} = 30.6\,\text{eV} - 13.6\,\text{eV}$
$= 17.0\,\text{eV}$

$\lambda_{3\to2} = \frac{hc}{E_{3\to2}} = 72.9\,\text{nm}$

II-4

39-33 An electron is confined around the circumference of a circle of radius $r = 1.20$ nm. The only way this can possibly fit is for it to have an integer number of wavelengths make up the circumference.

a. $2\pi r = n\lambda$, so $r = n\lambda/2\pi$ or $\lambda = 2\pi r/n$

Now $p = \hbar k = 2\pi\hbar/\lambda = 2\pi\hbar \cdot \frac{n}{2\pi r} = n\hbar/r$.

For an electron, $E = p^2/2m_e = \frac{n^2\hbar^2}{2m_e r^2} = n^2\,(4.23\times10^{-21}\,\text{J})$
$= n^2\,(0.026\,\text{eV})$

b.

c. $\Delta E = (4-1)(3.18\times10^{-11}\,\text{eV}) = 0.079$ V

$\lambda = hc/\Delta E = \frac{1240\,\text{eVnm}}{0.079\,\text{eV}} = 15619$ nm

$= 15.62\,\mu\text{m}$

II - 5

40-11 $\vec{S} = \vec{3/2}$ This has $2(\frac{3}{2})+1 = 4$ possible states with distinct S_z.

a. Assuming the Pauli Exclusion Principle still holds, there are 4 distinct electron states for each n, l, m value.

$n=1,\ l=0,\ m=0$	4 states	4 total	$n=1: 4$
$n=2,\ l=0,\ m=0$	4 states	4 total	$n=2: 16$
$n=2,\ l=1,\ m=\pm1, 0$	4x3 states	12 total	
$n=3,\ l=0,\ m=0$	4 states	4 total	$n=3: 36$
$n=3,\ l=1,\ m=\pm1, 0$	4x3 states	12 total	
$n=3,\ l=2,\ m=\pm2, \pm1, 0$	4x5 states	20 total	

b. The periods would be longer 4, 16, 16, etc.

II - 6

40-8 All electrons would go into the lowest state - the ground state has the lowest energy. There would be no reason (besides electric repulsion, which would act) to have only two electrons in every state.