Which quantum numbers give rise to the transitions in the Balmer series for hydrogen as presented in lecture? The first four lines of the Balmer series are 656.5 nm, 486.3 nm, 434.2 nm and 410.3 nm.

A. Provide the quantum numbers for the Balmer emission lines

Solution: There are series, which the final state is $n_f = 1$, $n_f = 2$, $n_f = 3$, etc.
The Rydberg series is:

$$\tilde{\nu} = \tilde{R}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

In terms of wavelength it is:

$$\lambda = \frac{10^7}{\tilde{\nu}} = \frac{10^7}{\tilde{R}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)}$$

We can see that the Balmer series is n = 2 to n = 3, 4, 5 and 6….

$2 \rightarrow 3$

$$\lambda = \frac{10^7}{109{,}690\left(\frac{1}{4} - \frac{1}{9}\right)} = 656.6\ nm$$

$2 \rightarrow 4$

$$\lambda = \frac{10^7}{109{,}690\left(\frac{1}{4} - \frac{1}{16}\right)} = 486.2\ nm$$

$2 \rightarrow 5$

$$\lambda = \frac{10^7}{109{,}690\left(\frac{1}{4} - \frac{1}{25}\right)} = 434.2\ nm$$

$2 \rightarrow 6$

$$\lambda = \frac{10^7}{109{,}690\left(\frac{1}{4} - \frac{1}{36}\right)} = 410.3\ nm$$

B. Predict the wavelength of the next transition in the Balmer series.

$2 \rightarrow 7$

$$\lambda = \frac{10^7}{109{,}690\left(\frac{1}{4} - \frac{1}{49}\right)} = 397.1\ nm$$

Wavelength = __________397.1 nm_______.