

The following data is from “Note on the spectral lines of hydrogen” by J. J. Balmer dated 1885. The numerical values are wavelengths in units of  $10^{-10}$  meter.

	$H_\alpha$	$H_\beta$	$H_\gamma$	$H_\delta$	$H_\epsilon$	$H_\zeta$	$H_\eta$	$H_\theta$	$H_\iota$
Van der Willigen	6565.6	4863.94	4342.80	4103.8	—	—	—	—	—
Angstrom	6562.10	4860.74	4340.10	4101.2	—	—	—	—	—
Mendenhall	6561.2	4860.16	—	—	—	—	—	—	—
Mascart	6560.7	4859.8	—	—	—	—	—	—	—
Ditscheiner	6559.5	4859.74	4338.60	4100.0	—	—	—	—	—
Huggins	—	—	—	—	—	3887.5	3834	3795	3767.5
Vogel	—	—	—	—	3969	3887	3834	3795	3769 <sup>†</sup>

(<sup>†</sup>The value given in the paper is 6769 which is an obvious typo.)

From this data, Balmer determined that

$$\hat{y} = \frac{m^2}{m^2 - 2^2} \times 3645.6 \times 10^{-10} \text{ meter}$$

where  $\hat{y}$  is the predicted wavelength and  $m$  is determined by the hydrogen line according to the following table.

$$m = \begin{matrix} & H_\alpha & H_\beta & H_\gamma & H_\delta & H_\epsilon & H_\zeta & H_\eta & H_\theta & H_\iota \\ & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{matrix}$$

Let us use linear modeling in R to verify the model coefficient.

```
x = c(1.8,1.8,1.8,1.8,1.8,
1.33333,1.33333,1.33333,1.33333,1.33333,
1.19048,1.19048,1.19048,
1.125,1.125,1.125,
1.08889,
1.06667,1.06667,
1.05195,1.05195,
1.04167,1.04167,
1.03419,1.03419)

y = c(6565.6,6562.1,6561.62,6560.7,6559.5,
4863.94,4860.74,4860.16,4859.8,4859.74,
4342.8,4340.1,4338.6,
4103.8,4101.2,4100,
3969,
3887.5,3887,
3834,3834,
3795,3795,
3767.5,3769)
```

```
lm(y ~ 0 + x)
```

The result is

```
Call:
lm(formula = y ~ 0 + x)
```

Coefficients:

```
x
3645
```

The actual value is now known to be

$$3645.07 \times 10^{-10} \text{ meter}$$