Define radial wavefunctions (From McIntyre Table 8.1)

In[2]:=
$$R_{10}[r\_] := 2\,\frac{1}{(a_0)^{3/2}} * \text{Exp}[-r / a_0]$$
$$R_{20}[r\_] := 2 * \frac{1}{(2\,a_0)^{3/2}} * \left(1 - \frac{r}{2\,a_0}\right) \text{Exp}[-r / a_0]$$
$$R_{21}[r\_] := \frac{1}{\sqrt{3}} * \frac{1}{(2\,a_0)^{3/2}} * \frac{r}{a_0} \text{Exp}[-r / a_0]$$

Calculate matrix elements

In[7]:=
$$z_{210} = \text{Integrate}[R_{21}[r] * R_{10}[r] * r\,\hat{}\,3,\ \{r, 0, \infty\}]$$

Out[7]=
$$\text{ConditionalExpression}\left[\frac{1}{4}\sqrt{\frac{3}{2}}\ a_0,\ \text{Re}[a_0] > 0\right]$$

Define Constants

In[63]:=
$$e = 1.602 * 10\,\hat{}\,(-19)$$
$$h = 1.054 * 10\,\hat{}\,(-34)$$
$$\omega = (10.2 * 1.60218 * 10\,\hat{}\,(-19)) / h$$
$$k = 8.99 * 10\,\hat{}\,(9)$$
$$a_0 = 0.5 * 10\,\hat{}\,(-10)$$
$$c = 3 * 10\,\hat{}\,8$$

Out[63]= 1.602×10^{-19}

Out[64]= 1.054×10^{-34}

Out[65]= 1.5505×10^{16}

Out[66]= 8.99×10^{9}

Out[67]= $5. \times 10^{-11}$

Out[68]= $300\,000\,000$

Calculate rate and lifetime

In[69]:=
$$W = \frac{1}{18} * \frac{\omega\,\hat{}\,3 * a_0\,\hat{}\,2}{h * c\,\hat{}\,3}\ e\,\hat{}\,2 * k$$

Out[69]= 4.19721×10^{7}

In[70]:=
$$1 / W$$

Out[70]= 2.38254×10^{-8}

Recalculate Transition rate and lifetime for problem 3

In[71]:=
```
Clear[W]
```

In[75]:=
```
W = (2 / 3) * ((3 * 10^(14))^2 * e^2 * k) / (c^3 * (9.11 * 10^(-31)))
```

Out[75]=
```
562 800.
```

In[76]:=
```
1 / W
```

Out[76]=
```
1.77683 × 10^-6
```