Appendix:
Solid State Physics , Homework 03

Ahmed Saad Sabit

Integral calculation to compute average $\langle r^2 \rangle$

Define the wavefunction

In[3]:=
```
f[r_] = (Pi * a0^3)^(-1/2) * Exp[-r / a0]
```

Out[3]=

$$\frac{e^{-\frac{r}{a_0}}}{\sqrt{\pi}\,\sqrt{a_0^3}}$$

Check the normalization

In[11]:=
```
4 * Pi * Integrate[r^2 * f[r]^2, {r, 0, Infinity}]
```

Out[11]=

```
1 if Re[a0] > 0
```

Take the integral as required for the problem

In[13]:=
```
4 * Pi * Integrate[r^4 * (f[r])^2, {r, 0, Infinity}]
```

Out[13]=

```
3 a0^2 if Re[a0] > 0
```

Numerical Calculation of Larmor χ

Out[14]=

$$-\frac{h^2 a_0}{2 m^2}$$

In[15]:=
```
h = 1.054571817 × 10^-34
```
Out[15]=

$$1.05457 \times 10^{-34}$$

In[16]:=
```
a_0 = 5.29 × 10^-10
```
Out[16]=

$$5.29 \times 10^{-10}$$

```
m = 9.1093837 × 10^(-31)
```
Out[17]=

$$9.10938 \times 10^{-31}$$

In[20]:=
```
e = 1.602 * 10^-19
```
Out[20]=

$$1.602 \times 10^{-19}$$

In[28]:=
```
μ_0 = 4 Pi * 10^-7
```
Out[28]=

$$\frac{\pi}{2\,500\,000}$$

In[29]:=
```
A_0 = 6.022 * 10^23
```
Out[29]=

$$6.022 \times 10^{23}$$

Computation of χ per atom

In[32]:=
```
-(a_0^2 * e^2 * μ_0)/(2 m)
```
Out[32]=

$$-4.95367 \times 10^{-33}$$