Chapter 9 - Problem 1

9.1 For a pillbox-shaped cavity with metallic walls, find the lowest energy five cylindrically symmetric wavefunctions. The height of the pill box is 2 nm and its radius is 1 nm.

In[1824]:=
```
ClearAll["Global`*"];
h = 6.62607004 * 10^-34; (* Plankton's Constant *)
mo = 9.10938 * 10^-31; (* Effective mass of an electron *)
ħ = h/(2 * π);
nano = 1 * 10^-9;
e = 1.60217 * 10^-19;
a = 1 * nano;
L = 2 * nano;
```

Find the Zeros of the J_0 bessel function

In[1832]:=
```
besselzeros = Table[N[BesselJZero[n, m]], {m, 1, 5}, {n, 0, 0}]
```

Out[1832]= {{2.40483}, {5.52008}, {8.65373}, {11.7915}, {14.9309}}

We have the formula for energy given to us in a pillbox:

$E_p = \frac{\hbar^2}{2\,\mathrm{me}}\left[\left(\frac{\zeta_{np}}{a}\right)^2 + \left(\frac{p\pi}{L}\right)^2\right]$ where n is the order of the Bessel function and p is our energy state number.

For the five lowest energy values:

In[1833]:=
```
p = {1, 2, 3, 4, 5};

En = N[ħ^2/(2 * mo) * ((besselzeros/a)^2 + ((p * π)/L)^2)]
```

Out[1834]= $\{\{5.03638\times10^{-20}\}, \{2.46251\times10^{-19}\}, \{5.92685\times10^{-19}\}, \{1.08973\times10^{-18}\}, \{1.73738\times10^{-18}\}\}$

Convert the Energy values (En) to electron volts by dividing by e.

In[1835]:=
```
EnEv = En / e
```

Out[1835]= {{0.314347}, {1.53699}, {3.69927}, {6.80156}, {10.8439}}

In[1844]:=
```
For[i = 1, i < 5, i++,
 Print["Five lowest Energy Levels are: \n\t".EnEv[[i]], " eV \t ", En[[i]], "J"]]
```

```
Five lowest Energy Levels are:
    .{0.314347} eV      {5.03638×10^-20}J
Five lowest Energy Levels are:
    .{1.53699} eV      {2.46251×10^-19}J
Five lowest Energy Levels are:
    .{3.69927} eV      {5.92685×10^-19}J
Five lowest Energy Levels are:
    .{6.80156} eV      {1.08973×10^-18}J
```