```
DateList[]
```

{2009, 10, 22, 0, 17, 7.706985}

P16-1

Definition of the transmition coefficient

$$trans[ene\_, vo\_, a\_, L\_] := \frac{1}{1 + \frac{Sinh\left[\pi\,(a/L)\ \sqrt{vo}\ \sqrt{1-ene/vo}\right]^2}{4\ (ene/vo)\ (1-ene/vo)}}$$

Let's define the units of energy in Joules using the length of the box, L = a

```
ue = (6.626 × 10^(-34))^2 / (8 × 9.10 × 10^(-31) × 81 × 10^(-20)) J
```

7.44537×10^{-20} J

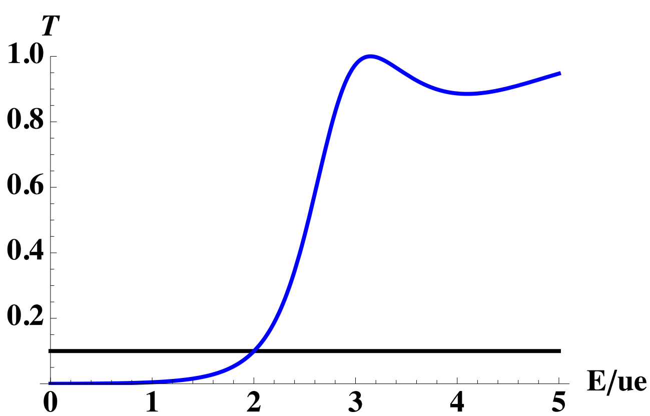
therefore a/L = 1

Now we calculate Vo/ue

```
1.6 × 10^(-19) J / ue
```

2.14899

```
Plot[{.1, trans[x, 2.148, 1, 1]}, {x, 0, 5}, PlotRange → {0, 1}, AxesLabel → {"E/ue", T},
 BaseStyle → {Bold, 14}, PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```




```
trans[2, 2.148`, 1]
```

0.0993678

```
2 ue
```

1.48907×10^{-19} J

Unit of energy with L=10^(-10) m and a/L in 10^(-10) m

```
ue = (6.626 × 10^(-34))^2 / (8 × 9.10 × 10^(-31) × 10^(-20)) J
```

6.03075×10^{-18} J

Vo/ue

```
1.6 × 10^(-19) J / ue
```

```
0.0265307
```

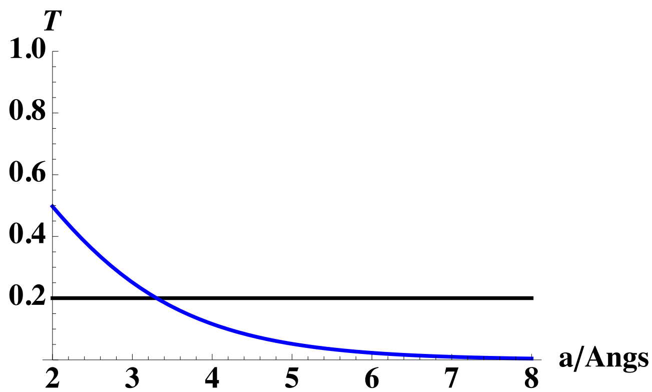
E/ue

```
0.5 × 10^(-19) J / ue
```

```
0.00829084
```

With a in 10^(-10) m

```
Plot[{.2, trans[.00829, 0.026, x, 1]}, {x, 2, 8}, PlotRange → {0, 1}, AxesLabel → {"a/Angs", T},
 BaseStyle → {Bold, 14}, PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```



- **P 16-3**

This definitions and command are usefull to answer all the questions in Problem 16.3

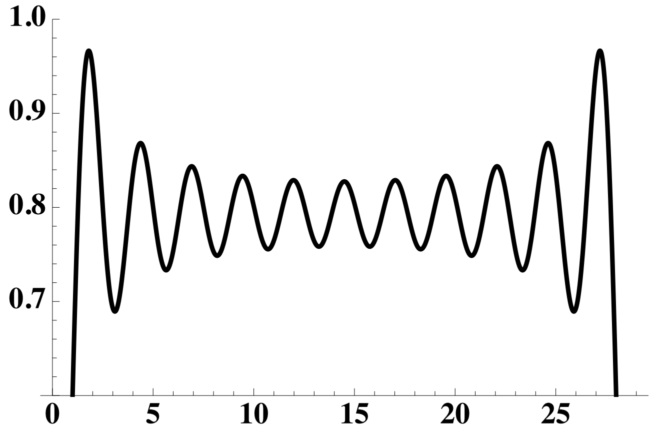
$$\text{probn}[n\_][x\_, a\_] := \frac{2\,\text{Sin}\left[\frac{n\,\pi\,x}{a}\right]^2}{a}$$

The extar "2" represents 2 electrons in each state

$$\text{prob}[x\_, a\_] := \sum_{n=1}^{11} 2\,\text{probn}[n][x, a]$$

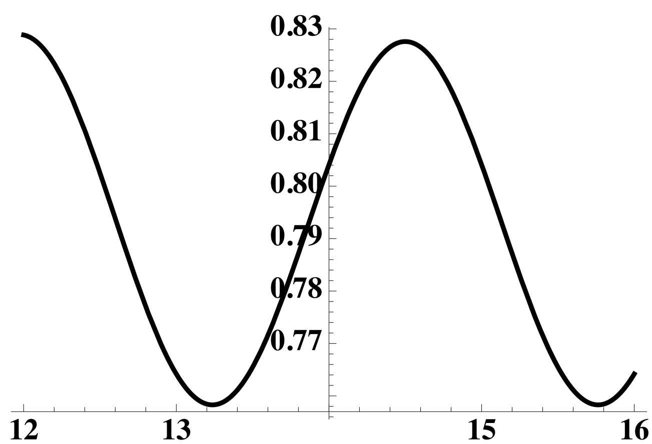
Plot the total probability

```
Plot[prob[x, 29], {x, 0, 29}, PlotRange → {0.6, 1}, BaseStyle → {Bold, 14},
 PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```



Plot the total probability between 12 and 16 nm

```
Plot[prob[x, 29], {x, 12, 16}, AxesOrigin → {14, 2 × 0.3785}, BaseStyle → {Bold, 14},
 PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```



Determine the difference between the max and the min

```
deltaP = 0.8276 - 0.7578
```

```
0.0698
```

The average of the total probability between 12 and 16 nm

```
Integrate[prob[x, 29], {x, 12., 16}] / (16 - 12)
```

```
0.790968
```

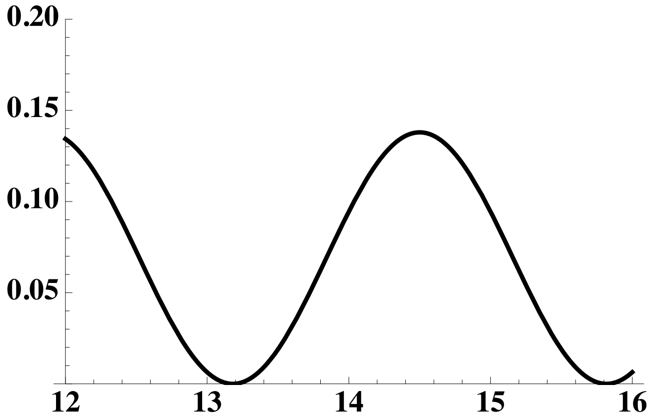
The ratio deltaP/average

```
deltaP / 0.7909
```

```
0.0882539
```

The same question but now we are looking only at 2 electrons in the HOMO level

```
Plot[2 (2 / 29) Sin[11 π x / 29] ^2, {x, 12, 16}, PlotRange → {0, .2}, BaseStyle → {Bold, 14},
 PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```




```
Integrate[2 (2 / 29) Sin[11 π x / 29] ^2, {x, 12., 16}] / 4
```

```
0.063618
```

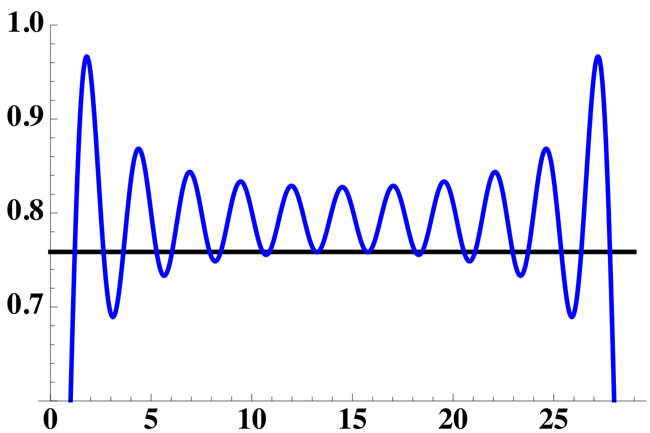
```
0.1381 / 0.0636
```

```
2.17138
```

```
Integrate[prob[x, 29], {x, 0, 29}] / 29.
```

```
0.758621
```

```
Plot[{0.758621, prob[x, 29]}, {x, 0, 29}, PlotRange → {0.6, 1}, BaseStyle → {Bold, 14},
 PlotStyle → {{Black, Thickness[0.0075]}, {Blue, Thickness[0.0075]}}]
```



■ P 16 - 7

Solution of the transcendental equation fro a finite box of depth Vo

```
f1[u_] := u
f2[n_][u_, yo_] := (1 / π) ArcCos[2 u^2 / yo^2 - 1] + (n - 1)
```

whrere u = $\sqrt{E/\mathrm{ue}}$ and yo=$\sqrt{\mathrm{Vo}/\mathrm{ue}}$, and

$$ue = \frac{h^2}{8\, m\, L^2}.$$

Using this energy scaling, u varies from 0 to yo

In part a) we have

```
ue = (6.626 × 10^(-34))^2 / (8 × 9.109 × 10^(-31) (10 × 10^(-10))^2) J
```

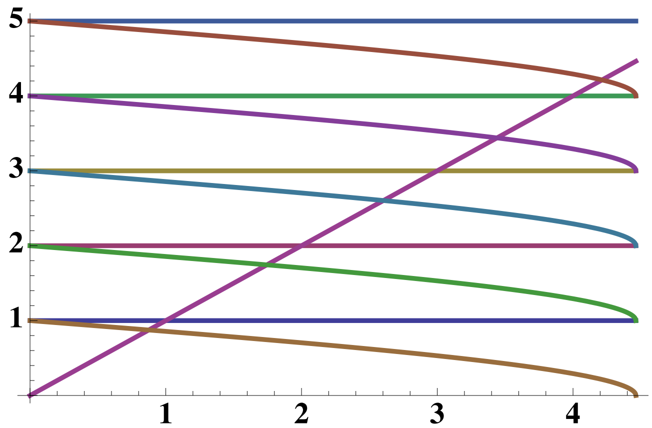
6.02479×10^{-20} J

```
yo = Sqrt[1.20 × 10^(-18) J / ue]
```

4.46292

This value implies 5 bound states

```
Plot[{1, 2, 3, 4, 5, u, f2[1][u, yo], f2[2][u, yo], f2[3][u, yo], f2[4][u, yo], f2[5][u, yo]},
 {u, 0, yo}, BaseStyle → {Bold, 14}, PlotStyle → Thickness[0.0075]]
```




```
e1 = (.88)^2 ue
e2 = (1.74)^2 ue
e3 = (2.6)^2 ue
e4 = (3.44)^2 ue
e5 = (4.2)^2 ue
```

4.6656×10^{-20} J

1.82407×10^{-19} J

4.07276×10^{-19} J

7.1295×10^{-19} J

1.06277×10^{-18} J

We can calculate the wavelength as:

$$\frac{\lambda}{a} = \frac{h}{\sqrt{2\, m\, E}}$$

```
lam1A = (6.626 * 10^(-34) / Sqrt[2 * 9.9 * 10^(-31) * e1 / J]) / (10 * 10^(-10))
lam2A = (6.626 * 10^(-34) / Sqrt[2 * 9.9 * 10^(-31) * e2 / J]) / (10 * 10^(-10))
lam3A = (6.626 * 10^(-34) / Sqrt[2 * 9.9 * 10^(-31) * e3 / J]) / (10 * 10^(-10))
lam4A = (6.626 * 10^(-34) / Sqrt[2 * 9.9 * 10^(-31) * e4 / J]) / (10 * 10^(-10))
lam5A = (6.626 * 10^(-34) / Sqrt[2 * 9.9 * 10^(-31) * e5 / J]) / (10 * 10^(-10))
```

```
2.18004

1.10255

0.737861

0.557685

0.456771
```

For an infinite well, λ/a = 2/n

```
{2 / 1, 2 / 2, 2 / 3., 2 / 4., 2. / 5} // TableForm
```

```
2
1
0.666667
0.5
0.4
```

In part b) we have

```
ue = (6.626 × 10^(-34))^2 / (8 × 9.109 × 10^(-31) (9 × 10^(-10))^2) J
```

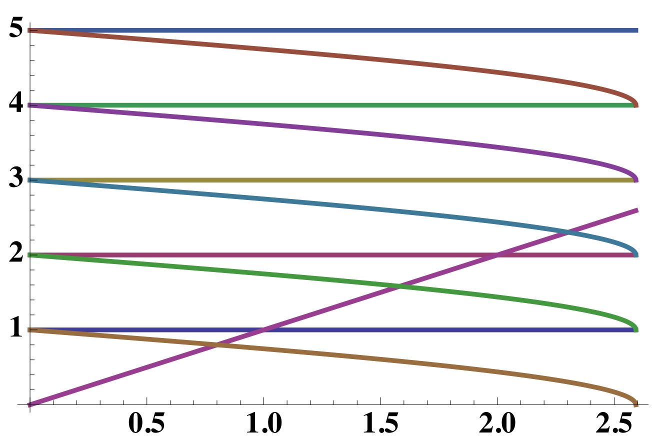
7.43802×10^{-20} J

```
yo = Sqrt[5.00 × 10^(-19) J / ue]
```

```
2.59272
```

This value implies 5 bound states

```
Plot[{1, 2, 3, 4, 5, u, f2[1][u, yo], f2[2][u, yo], f2[3][u, yo], f2[4][u, yo], f2[5][u, yo]},
 {u, 0, yo}, BaseStyle → {Bold, 14}, PlotStyle → Thickness[0.0075]]
```



```
(.79)^2 ue
(1.57)^2 ue
(2.3)^2 ue
```

4.64207×10^{-20} J

1.8334×10^{-19} J

3.93471×10^{-19} J