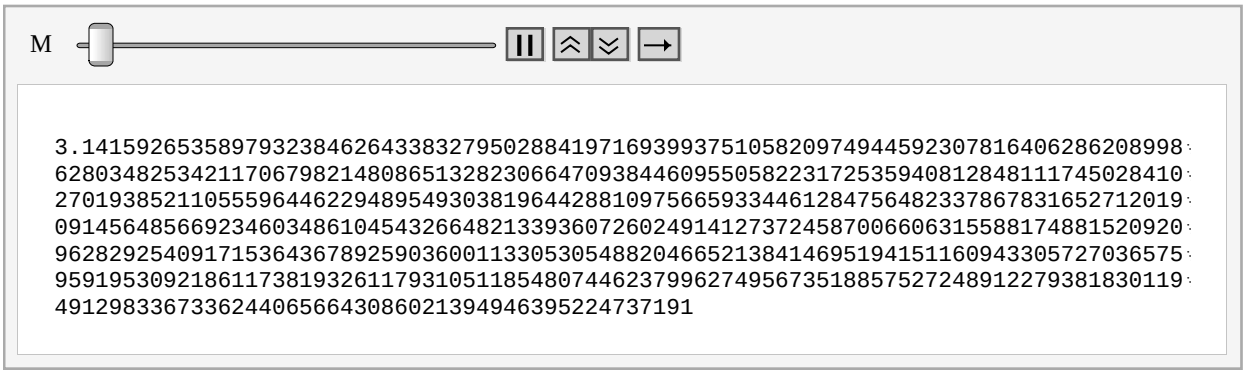
In[6]:=
An approximation to π

Out[6]= An approximation π to

In[7]:=
```
Animate[N[Pi, M], {M, 1, 2500, 1},
 AnimationRepetitions → 1, DefaultDuration → 250, LabelStyle → Medium]
```

Out[7]=



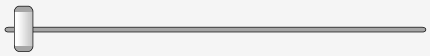

```
3.14159265358979323846264338327950288419716939937510582097494459230781640628620899·
62803482534211706798214808651328230664709384460955058223172535940812848111745028410·
27019385211055596446229489549303819644288109756659334461284756482337867831652712019·
09145648566923460348610454326648213393607260249141273724587006606315588174881520920·
96282925409171536436789259036001133053054882046652138414695194151160943305727036575·
95919530921861173819326117931051185480744623799627495673518857527248912279381830119·
49129833673362440656643086021394946395224737191
```

In[8]:=
Infinite Sums with Alternating Terms

Out[8]=
```
Alternating Infinite Sums Terms with
```

In[9]:=
```
Manipulate[
 N[ Sum[(-1)^(n+1)/n, {n, 1, M}], 1000],
 {M, 1, 1000, 1, Appearance → "Labeled"}, LabelStyle → Medium]
```

Out[9]=

M  1

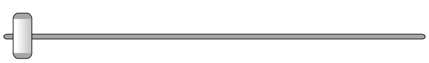
```
1.0000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000
```

In[10]:=
```
axis := Plot[.1, {x, 0, 1}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{.65, .75}, {-1.1, .2}}]
```

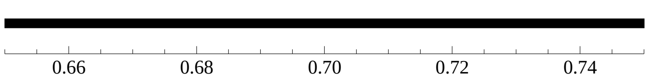
In[11]:=
```
int[a_, b_] := Graphics[{Thickness[.015], Line[{{a, .1}, {b, .1}}]}]
```

In[12]:=
```
upper[M_] := N[Sum[(-1)^(n+1)/n, {n, 1, 2 M - 1}]]
lower[M_] := N[Sum[(-1)^(n+1)/n, {n, 1, 2 M}]]
```

In[14]:=
```
Slider[Dynamic[M], {1, 1000, 1}]
```

Out[14]=


In[15]:=
```
Dynamic[Show[axis, int[lower[M], upper[M]]]]
```



Out[15]=

In[16]:=
Infinite Sums with Alternating Terms

Out[16]= Alternating Infinite Sums Terms with

In[17]:=
```
Manipulate[
 N[Sum[(-1)^(n+1)/n!, {n, 1, M}], 1000],
 {M, 1, 550, 1, Appearance → "Labeled"}, LabelStyle → Medium]
```

M 1

Out[17]=
```
1.0000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000000
00000000000000000000000000000
```

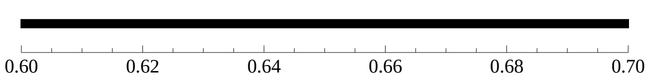
In[18]:=
```
axis1 := Plot[.1, {x, 0, 1}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{.6, .7}, {-1.1, .2}}]
```

In[19]:=
```
upper1[M_] := N[Sum[(-1)^(n+1)/n!, {n, 1, 2M-1}]]
lower1[M_] := N[Sum[(-1)^(n+1)/n!, {n, 1, 2M}]]
```

In[21]:=
```
Slider[Dynamic[M1], {1, 10, 1}]
```

Out[21]= 

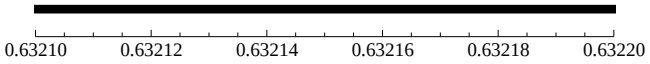
In[22]:=
```
Dynamic[Show[axis1, int[lower1[M1], upper1[M1]]]]
```



Out[22]=

In[23]:=
```
axis11 := Plot[.1, {x, 0, 1}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{.6321, .6322}, {-1.1, .2}}]
```

In[24]:=
```
Dynamic[Show[axis11, int[lower1[M1], upper1[M1]]]]
```



Out[24]=

Mapping intervals

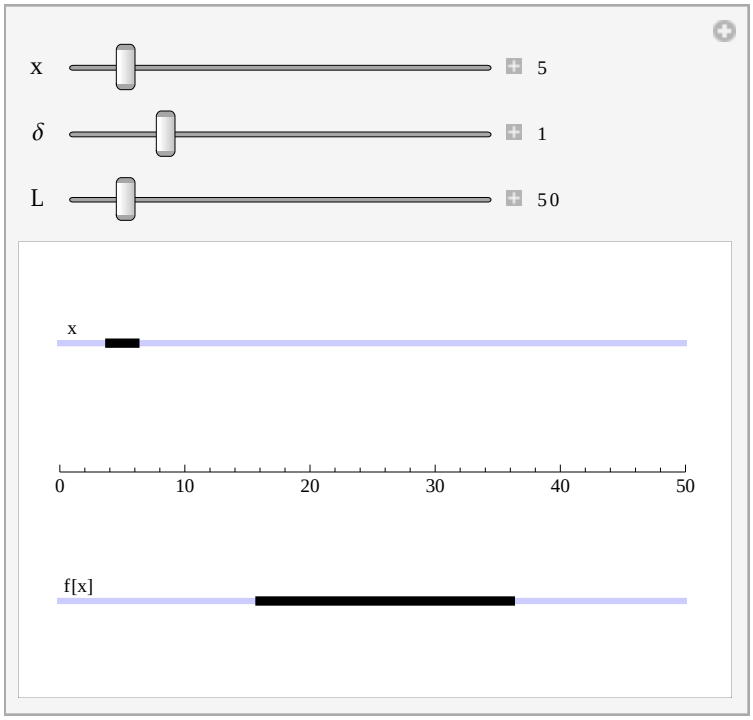
In[25]:=
```
axis21[L_] := Plot[1, {x, 0, L}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{0, L}, {-1.5, 1.5}}]
```

In[26]:=
```
axis2[L_] := Plot[-1, {x, 0, L}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{0, L}, {-1.5, 1.5}}]
```

In[27]:=
```
f[x_] := x^2
```

In[28]:=
```
Manipulate[
 Show[
  axis21[L], axis2[L],
  Graphics[{Thickness[.015], Line[{{x - ϵ, 1}, {x + ϵ, 1}}]}],
  Graphics[{Thickness[.015], Line[{{f[x - ϵ], -1}, {f[x + ϵ], -1}}]}],
  Graphics[Text["x", {1, 1.1}]],
  Graphics[Text["f[x]", {1.5, -.9}]]
 ],
 {{x, 5, x}, 0, L, Appearance → "Labeled"}, {{ϵ, 1, δ}, 0, 5, Appearance → "Labeled"},
 {{L, 50}, .1, 500, Appearance → "Labeled"}, LabelStyle → Medium]
```

Out[28]=



Uncertainty in Energy

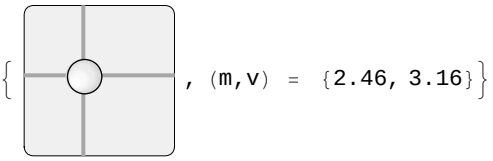
In[29]:=
```
axis31 := Plot[0, {x, 0, 10}, Axes → {True, True},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{0, 5}, {0, 5}}]
```

In[30]:=
```
axis3 := Plot[.1, {x, 0, 100}, Axes → {True, False},
  PlotStyle → {RGBColor[0, 0, 1], Thickness[.01], Opacity[.2]},
  PlotRange → {{0, 100}, {-1.1, 1.2}}]
```

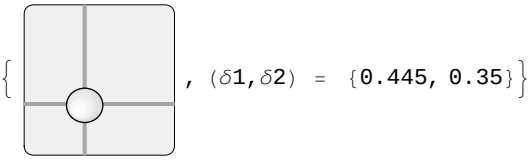
In[31]:=
```
En[m_, v_] := (1 / 2) m v^2
```

In[32]:=
```
{Slider2D[Dynamic[{m, v}], {1, 5}], "(m,v) = " Dynamic[{m, v}]}
{Slider2D[Dynamic[{δ1, δ2}], {.1, 1}], "(δ1,δ2) = " Dynamic[{δ1, δ2}]}
Dynamic[Show[axis31,
   Graphics[{
    Rotate[Text[Style["Mass", FontSize → 24, FontColor → Red], {.25, 2.5}], Pi / 2],
    Text[Style["Velocity", FontSize → 24, FontColor → Red], {2.5, .35}],
    Polygon[ {{m - δ1, v - δ2}, {m - δ1, v + δ2},
       {m + δ1, v + δ2}, {m + δ1, v - δ2}}]]]]
Dynamic[Show[axis3,
  Graphics[{Text[Style["Energy", FontSize → 24, FontColor → Red], {50, -.3}],
    Thickness[.015], Line[{{En[m - δ1, v - δ2], .1}, {En[m + δ1, v + δ2], .1}}]}]]]
Dynamic[{En[m - δ1, v - δ2], En[m + δ1, v + δ2]}]
```

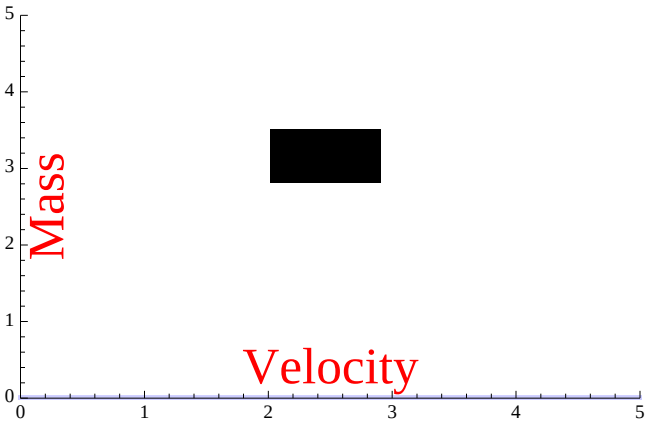
Out[32]=



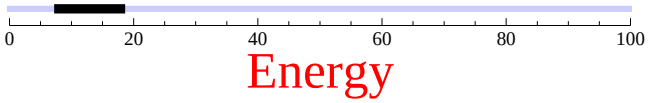
Out[33]=



Out[34]=



Out[35]=



Out[36]= {7.95532, 17.8949}