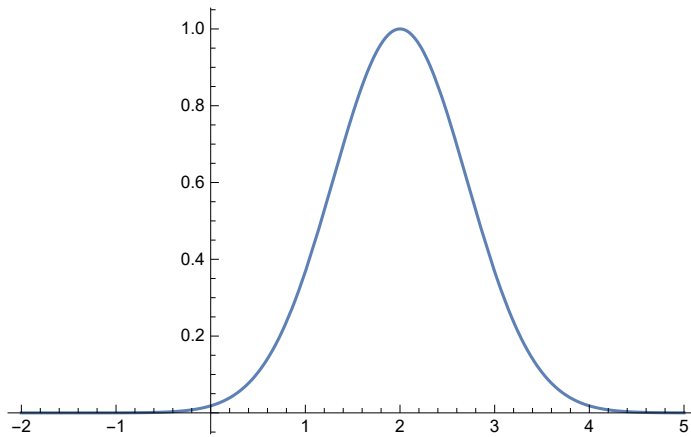


```

In[ ]:= f[x_] := Exp[- (x - a) ^2];          (*Not normalized*)
a = 2;
Plot[f[x], {x, -2, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x], {x, -∞, ∞}]
(*Area under Exp[- (x-a)^2] is  $\sqrt{\pi}$  *)
N[Sqrt[Pi], 8]

```

Out[]:=



Out[]:= 1.77245

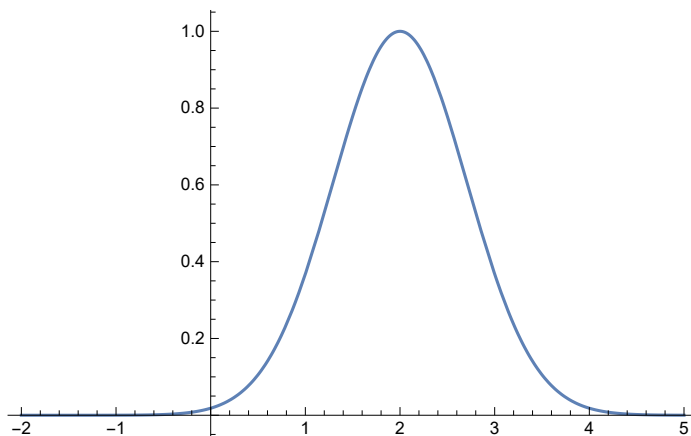
Out[]:= 1.7724539

```

In[ ]:= f[x_] := 2.71828^(- (x - a) ^2);    (*Not normalized*)
a = 2;
Plot[f[x], {x, -2, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x], {x, -∞, ∞}]
(*Area under Exp[- (x-a)^2] is  $\sqrt{\pi}$  *)
N[Sqrt[Pi], 8]

```

Out[]:=



Out[]:= 1.77245

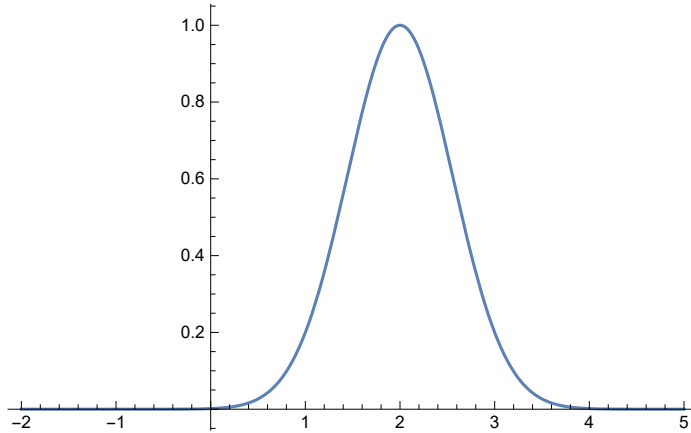
Out[]:= 1.7724539

```

In[ ]:= f[x_] := 5^(-(x-a)^2);                      (*Not normalized*)
a = 2;
Plot[f[x], {x, -2, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x], {x, -∞, ∞}]
(*Area under 5^(-(x-a)^2 *)

```

Out[]:=



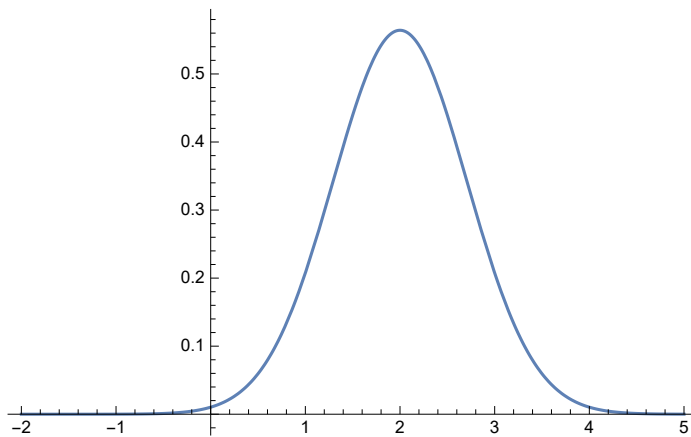
Out[]:= 1.39713

```

In[ ]:= f[x_] := (1/Sqrt[π]) * Exp[-(x-a)^2];      (*Normalized*)
a = 2;
Plot[f[x], {x, -2, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x], {x, -∞, ∞}]

```

Out[]:=

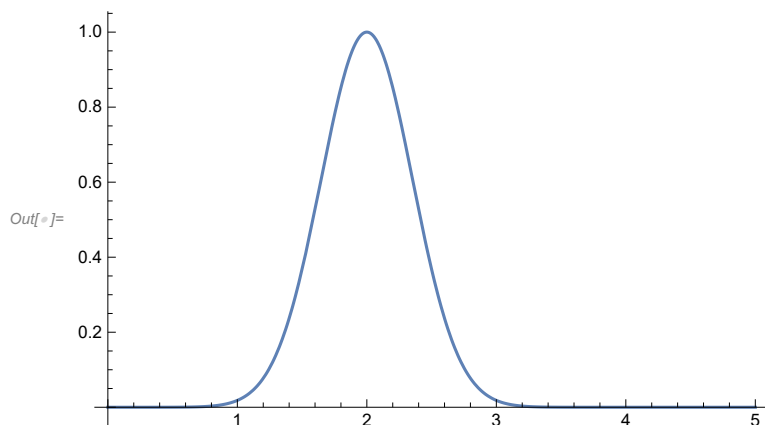


Out[]:= 1.

```

In[ ]:= f[x_, k_] := Exp[- (x - a)^2] / k^2;
(*Not normalized*) (*What does k do in the exponential*)
a = 2;
Plot[f[x, k = 0.5], {x, 0, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x, k = 0.5], {x, -∞, ∞}]
2 * NIntegrate[f[x, k = 0.5], {x, -∞, ∞}]

```



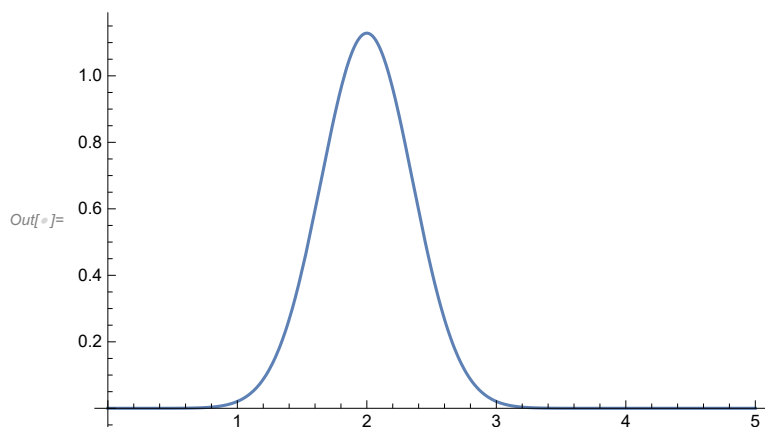
Out[]:= 0.886227

Out[]:= 1.77245

```

In[ ]:= f[x_, k_] := (1 / (k Sqrt[π])) Exp[- (x - a)^2] / k^2; (*Normalized*)
a = 2;
Plot[f[x, k = 0.5], {x, 0, 5}, PlotRange -> Full, PlotLegends -> "Expressions"]
NIntegrate[f[x, k = 0.5], {x, -∞, ∞}]
NIntegrate[f[x, k = 0.05], {x, -∞, ∞}]

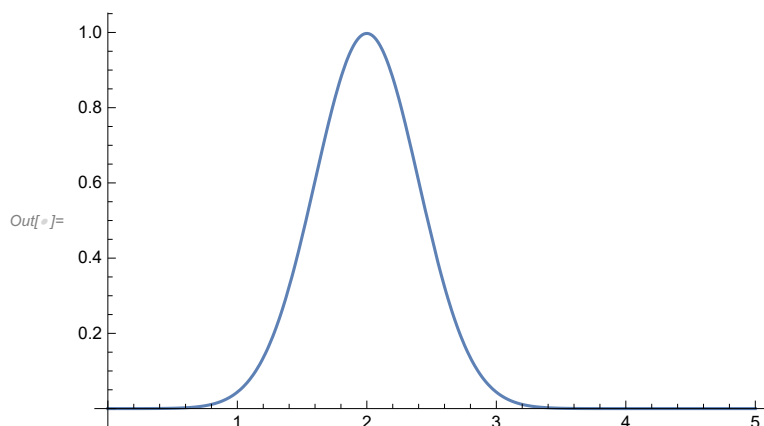
```



Out[]:= 1.

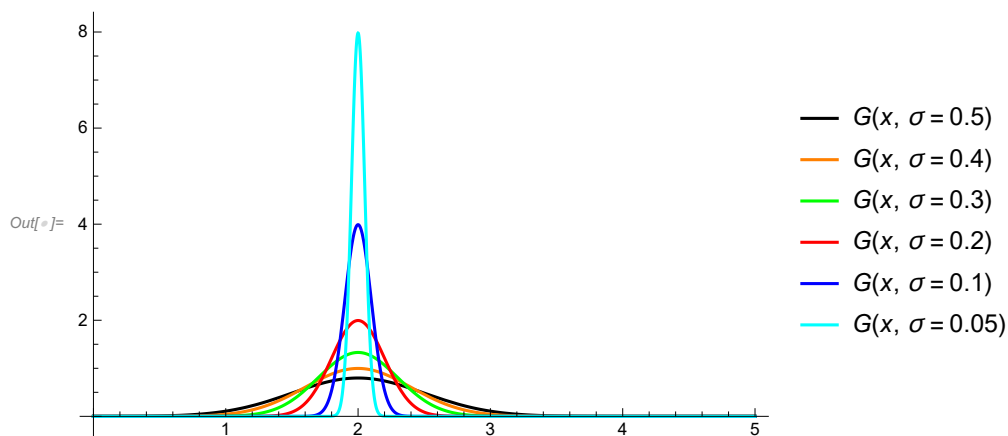
Out[]:= 1.

```
In[ ]:= G[x_] := (1 / (σ * Sqrt[2 Pi])) Exp[- (x - a)^2 / (2 σ^2)];
(*What does σ do in the exponenetial*)
a = 2; σ = 0.4;
Plot[G[x], {x, 0, 5}]
```



```
In[ ]:= G[x_, σ_] := (1 / (σ * Sqrt[2 Pi])) Exp[- (x - a)^2 / (2 σ^2)];
(*What does σ do in the exponenetial*)
a = 2;
Plot[{G[x, σ = 0.5], G[x, σ = 0.4], G[x, σ = 0.3],
      G[x, σ = 0.2], G[x, σ = 0.1], G[x, σ = 0.05]}, {x, 0, 5}, PlotRange → Full,
      PlotStyle → {Black, Orange, Green, Red, Blue, Cyan}, PlotLegends → "Expressions"]
NIntegrate[G[x, σ = 0.5], {x, -∞, ∞}]
NIntegrate[G[x, σ = 0.05], {x, -∞, ∞}]
```

General: Exp[-799.918] is too small to represent as a normalized machine number; precision may be lost.



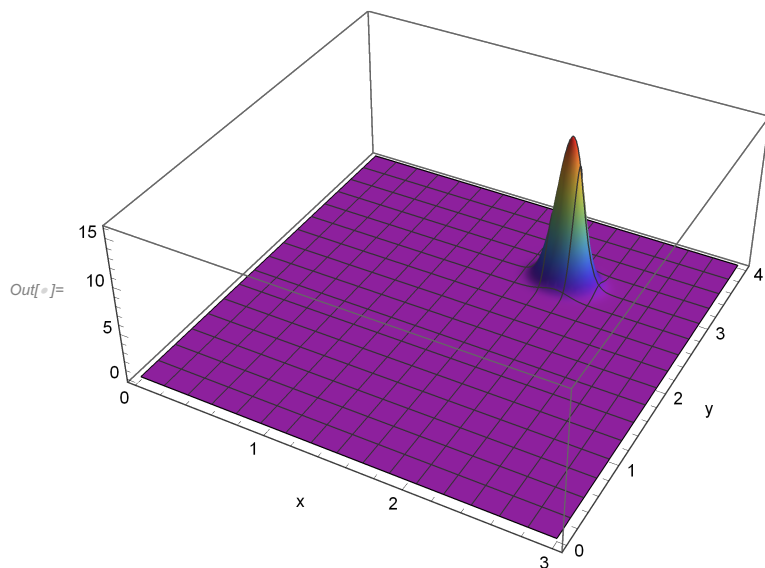
Out[]:= 1.

Out[]:= 1.

```

In[ ]:= G2[x_, y_, σ_] := (1 / (σ^2 * 2 Pi)) Exp[-((x - a)^2 + (y - b)^2) / (2 σ^2)];
a = 2; b = 3;
Plot3D[G2[x, y, σ = 0.1], {x, 0, 3}, {y, 0, 4}, PlotPoints → 100,
  PlotRange → Full, AxesLabel → {"x", "y"}, ColorFunction → "Rainbow"]

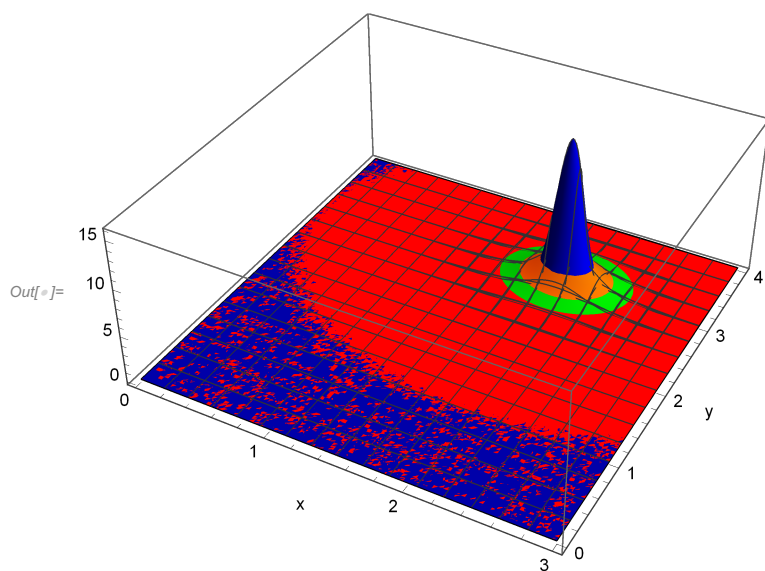
```



```

In[ ]:= G2[x_, y_, σ_] := (1 / (σ^2 * 2 Pi)) Exp[-((x - a)^2 + (y - b)^2) / (2 σ^2)];
a = 2; b = 3;
Plot3D[{G2[x, y, σ = 0.4], G2[x, y, σ = 0.3], G2[x, y, σ = 0.2], G2[x, y, σ = 0.1]},
  {x, 0, 3}, {y, 0, 4}, PlotPoints → 100, PlotRange → Full,
  AxesLabel → {"x", "y"}, PlotStyle → {Red, Green, Orange, Blue, Opacity[0.3]}]

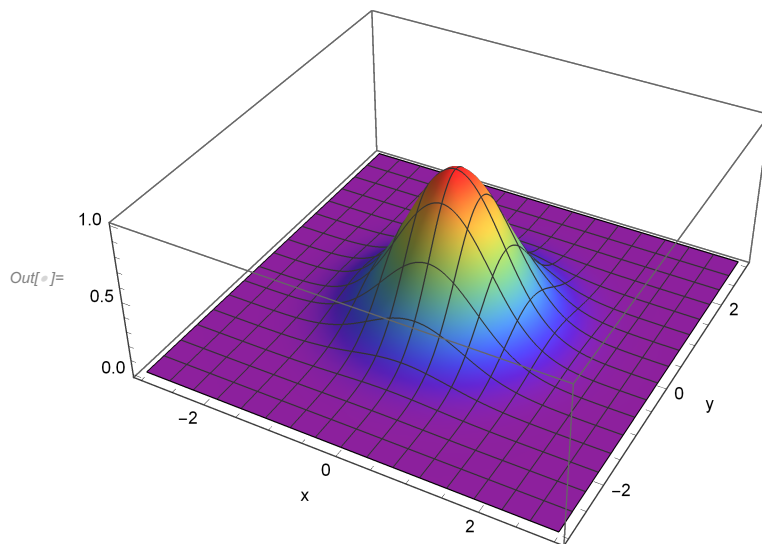
```



```

In[ ]:= g2[x_, y_] := Exp[-((x^2) + (y^2))];
Plot3D[g2[x, y], {x, -3, 3}, {y, -3, 3}, PlotPoints -> 100,
PlotRange -> Full, AxesLabel -> {"x", "y"}, ColorFunction -> "Rainbow"]

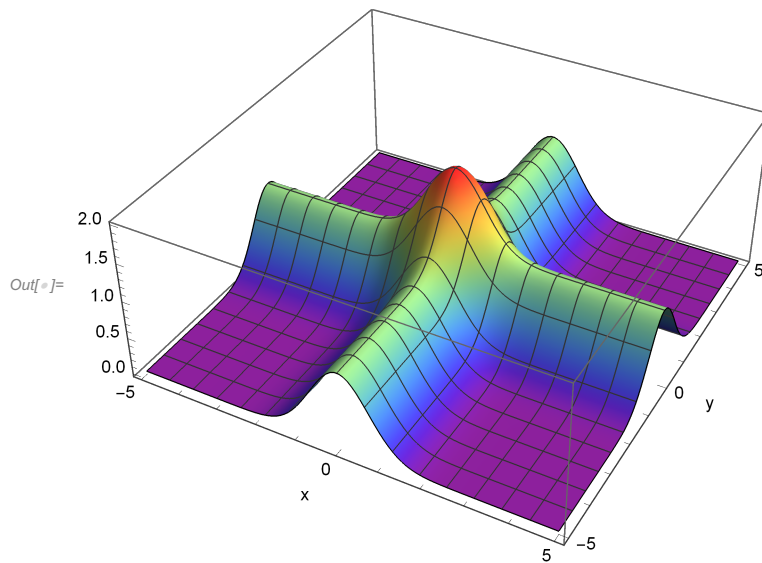
```



```

In[ ]:= g2[x_, y_] := Exp[-x^2] + Exp[-y^2];
Plot3D[g2[x, y], {x, -5, 5}, {y, -5, 5}, PlotPoints -> 100,
PlotRange -> Full, AxesLabel -> {"x", "y"}, ColorFunction -> "Rainbow"]

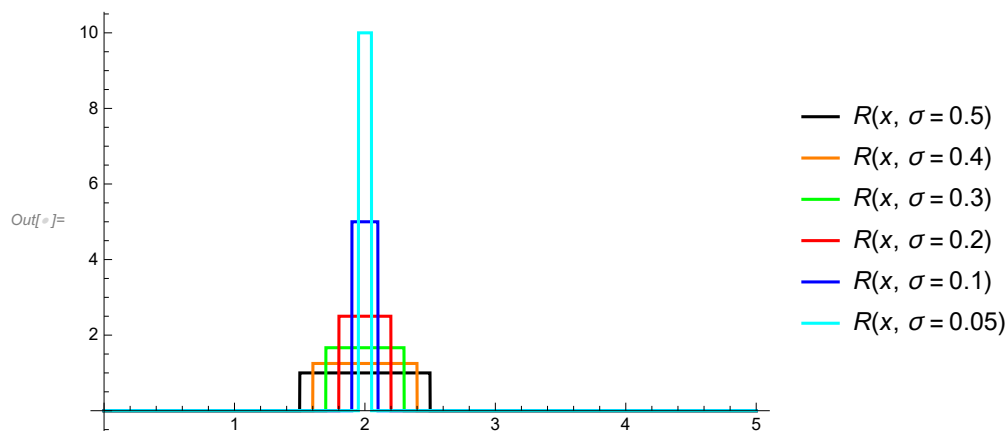
```



```

In[ ]:= R[x_, σ_] := Piecewise[{{1/(2 σ), -σ < x - a < σ}, {0, Modulus[x - a] > σ}}];
(*Rectangular function*)
a = 2;
Plot[{R[x, σ = 0.5], R[x, σ = 0.4], R[x, σ = 0.3],
      R[x, σ = 0.2], R[x, σ = 0.1], R[x, σ = 0.05]}, {x, 0, 5}, PlotRange → Full,
      PlotStyle → {Black, Orange, Green, Red, Blue, Cyan}, PlotLegends → "Expressions"]
NIntegrate[R[x, σ = 0.5], {x, -∞, ∞}]
NIntegrate[R[x, σ = 0.05], {x, -∞, ∞}]

```



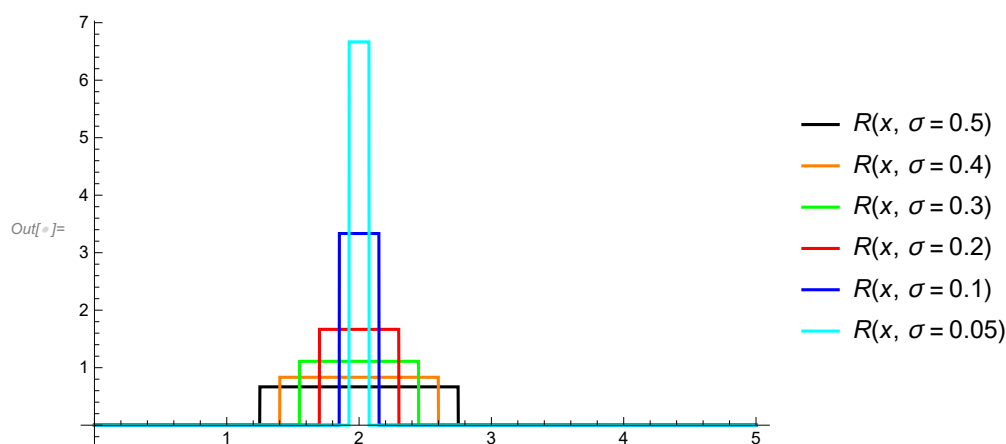
Out[]:= 1.

Out[]:= 1.

```

In[ ]:= R[x_, σ_] := Piecewise[{{1/(3 σ), -3 σ/2 < x - a < 3 σ/2}, {0, Modulus[x - a] > 3 σ/2}}];
a = 2;
Plot[{R[x, σ = 0.5], R[x, σ = 0.4], R[x, σ = 0.3],
      R[x, σ = 0.2], R[x, σ = 0.1], R[x, σ = 0.05]}, {x, 0, 5}, PlotRange → Full,
      PlotStyle → {Black, Orange, Green, Red, Blue, Cyan}, PlotLegends → "Expressions"]
NIntegrate[R[x, σ = 0.5], {x, -∞, ∞}]
NIntegrate[R[x, σ = 0.05], {x, -∞, ∞}]

```



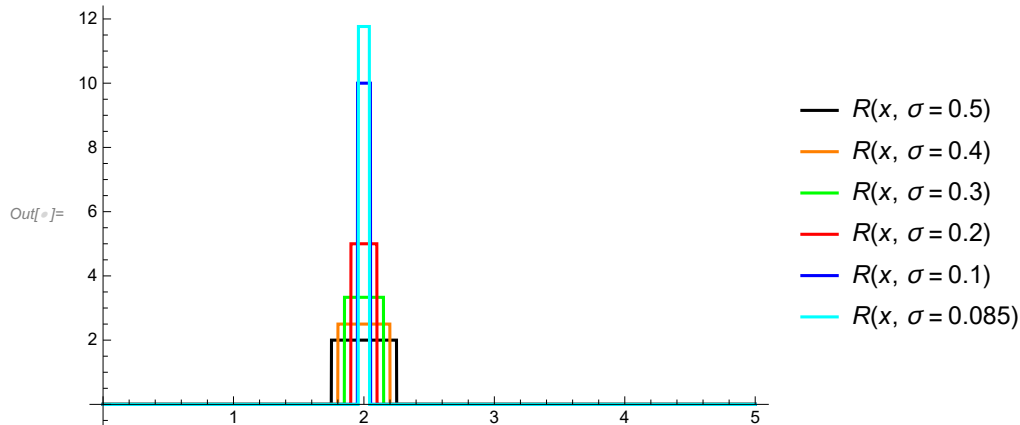
Out[]:= 1.

Out[]:= 1.

```

In[ ]:= R[x_, σ_] := Piecewise[{{1/σ, -σ/2 < x - a < σ/2}, {0, Modulus[x - a] > σ/2}}];
a = 2;
Plot[{R[x, σ = 0.5], R[x, σ = 0.4], R[x, σ = 0.3],
      R[x, σ = 0.2], R[x, σ = 0.1], R[x, σ = 0.085]}, {x, 0, 5}, PlotRange → Full,
      PlotStyle → {Black, Orange, Green, Red, Blue, Cyan}, PlotLegends → "Expressions"]
NIntegrate[R[x, σ = 0.5], {x, -∞, ∞}]
NIntegrate[R[x, σ = 0.085], {x, -∞, ∞}]

```



Out[]:= 1.

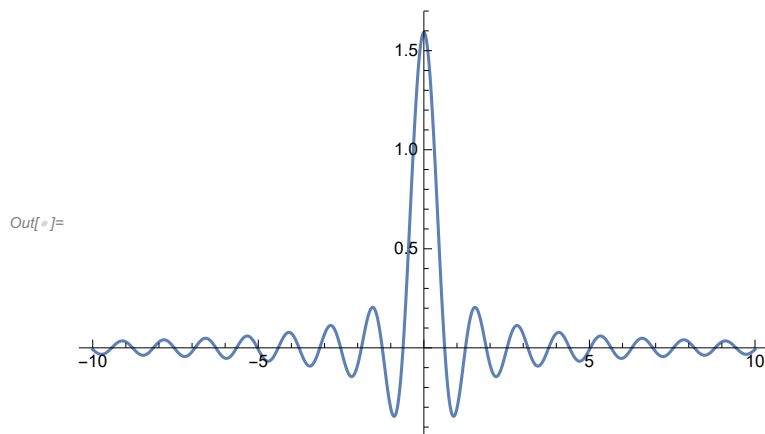
Out[]:= 1.

```

In[ ]:= s[x_] := Sin[g x] / (π x);
Limit[s[x], x → 0]
g = 5;
Plot[s[x], {x, -10, 10}, PlotRange → Full]

```

Out[]:= $\frac{g}{\pi}$

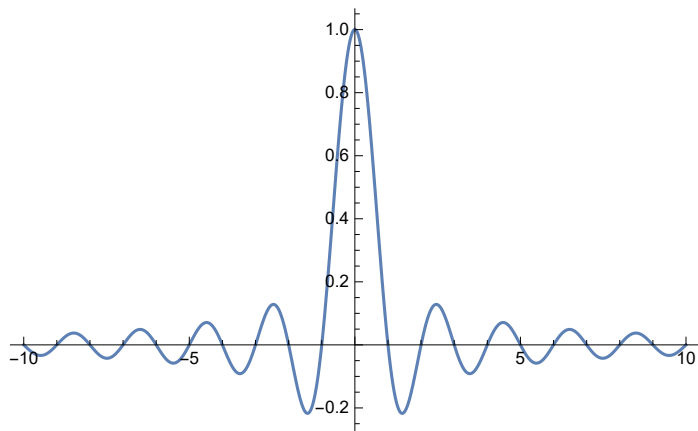



```

In[ ]:= s[x_] := Sin[ $\pi$  x] / ( $\pi$  x);
Limit[s[x], x  $\rightarrow$  0]
Plot[s[x], {x, -10, 10}, PlotRange  $\rightarrow$  Full]

```

Out[]:= 1

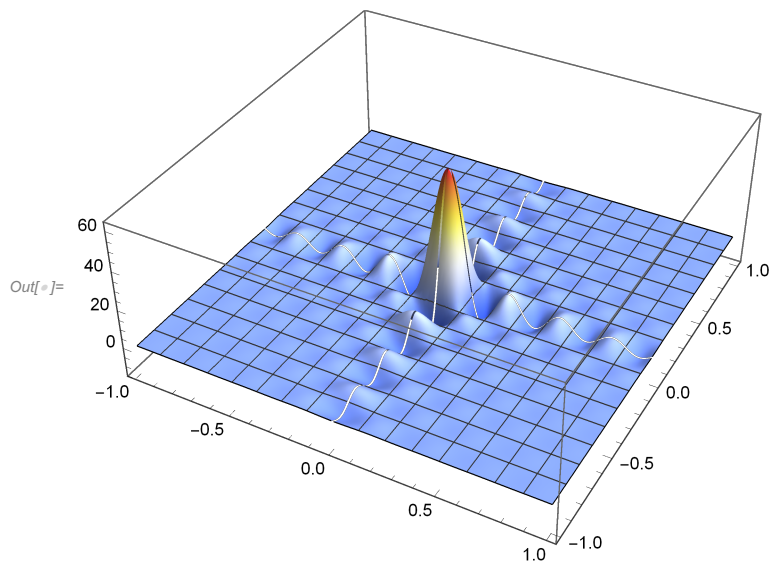


```

In[ ]:= s[x_, y_] := (Sin[g x] / ( $\pi$  x)) (Sin[g y] / ( $\pi$  y));
Limit[s[x], x  $\rightarrow$  0]
g = 25;
Plot3D[s[x, y], {x, -1, 1}, {y, -1, 1}, PlotPoints  $\rightarrow$  100,
  PlotRange  $\rightarrow$  Full, ColorFunction  $\rightarrow$  "TemperatureMap"]

```

Out[]:= 1



```

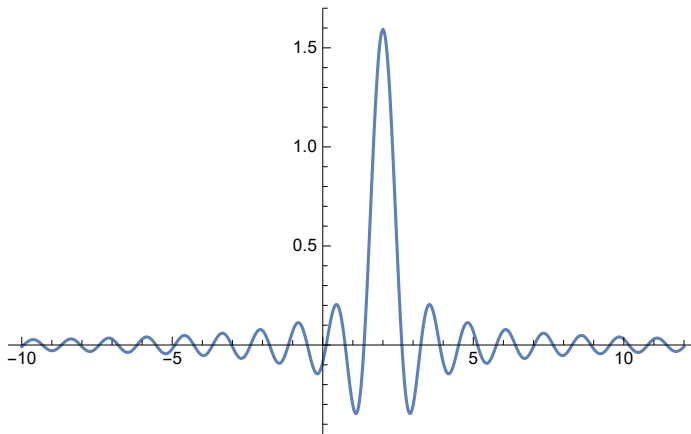
In[ ]:= s[x_] := Sin[g (x - a)] / (π (x - a));
Limit[s[x], x → 0]
a = 2; g = 5;
Plot[s[x], {x, -10, 10 + a}, PlotRange → Full, PlotLegends → "Expressions"]

```

Out[]:=

$$\frac{\sin[50]}{2\pi}$$

Out[]:=



```

In[ ]:= S[x_, p_] := Sin[p (x - b)] / (π (x - b));
Limit[S[x, p], x → 0]
Limit[S[x, p], p → ∞]

```

Out[]:=

$$\frac{\sin[3p]}{3\pi}$$

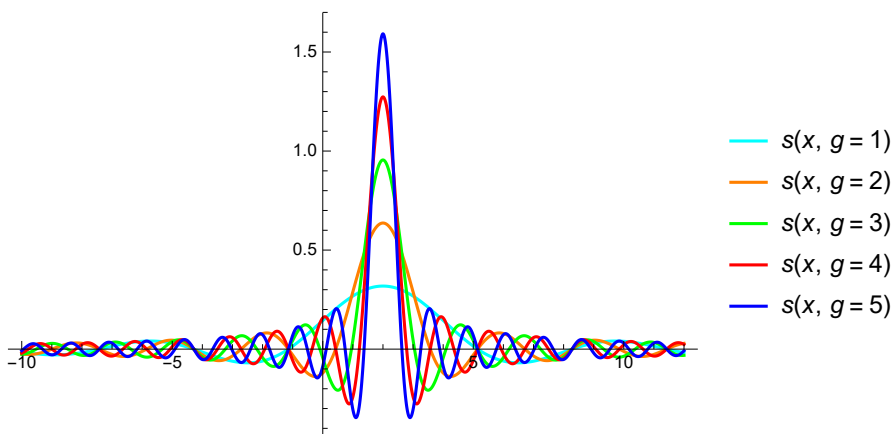
Out[]:= ConditionalExpression[Indeterminate, x ∈ ℝ]

```

In[ ]:= s[x_, g_] := Sin[g (x - a)] / (π (x - a));
a = 2;
Plot[{s[x, g = 1], s[x, g = 2], s[x, g = 3], s[x, g = 4], s[x, g = 5]}, {x, -10, 10 + a},
PlotRange → Full, PlotStyle → {Cyan, Orange, Green, Red, Blue}, PlotLegends → "Expressions"]

```

Out[]:=

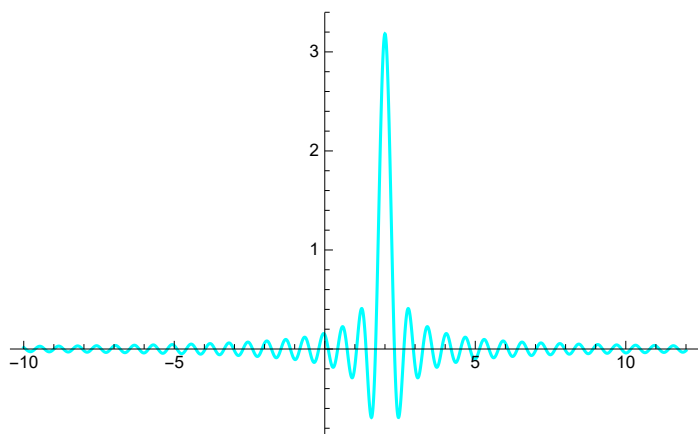


```

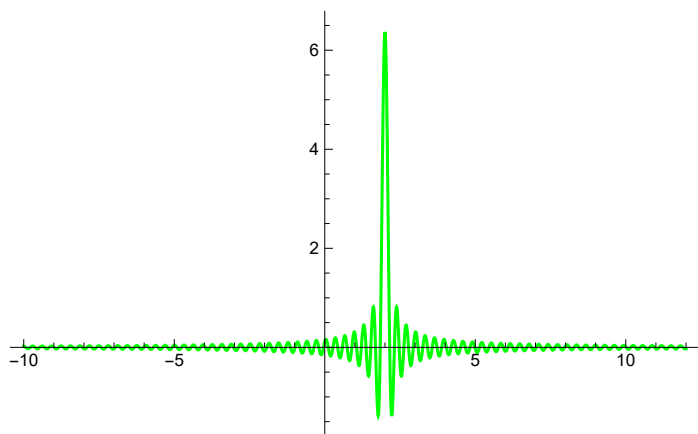
In[ ]:= s[x_, g_] := Sin[g (x - a)] / (π (x - a));
a = 2;
Plot[s[x, g = 10], {x, -10, 10 + a}, PlotRange → Full,
  PlotStyle → Cyan, PlotLegends → "Expressions"]
Plot[s[x, g = 20], {x, -10, 10 + a}, PlotRange → Full, PlotStyle → Green]
Plot[s[x, g = 50], {x, -10, 10 + a}, PlotRange → Full, PlotStyle → Blue]
Plot[s[x, g = 100], {x, -10, 10 + a}, PlotRange → Full, PlotStyle → Orange]
Plot[s[x, g = 1000], {x, -10, 10 + a}, PlotRange → Full, PlotStyle → Purple]
Plot[s[x, g = 1000], {x, -10, 10 + a}, PlotRange → Full, PlotStyle → Red]

```

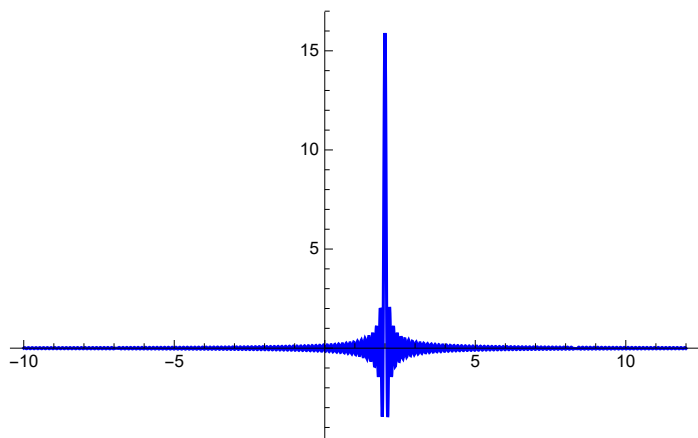
Out[]:=

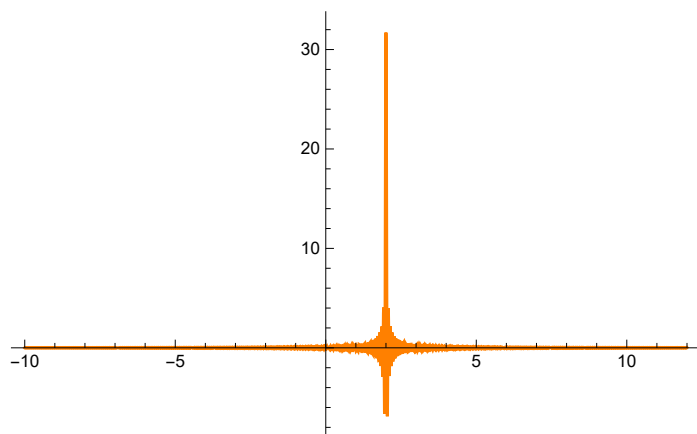
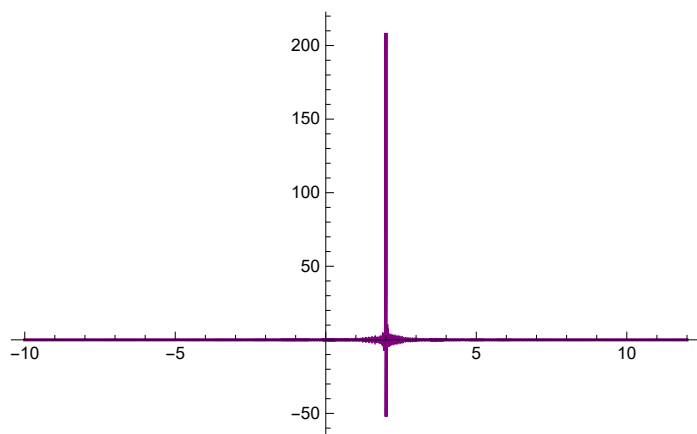
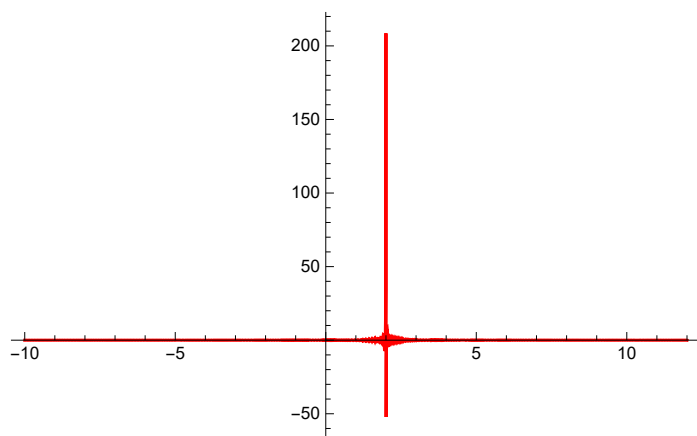


Out[]:=



Out[]:=

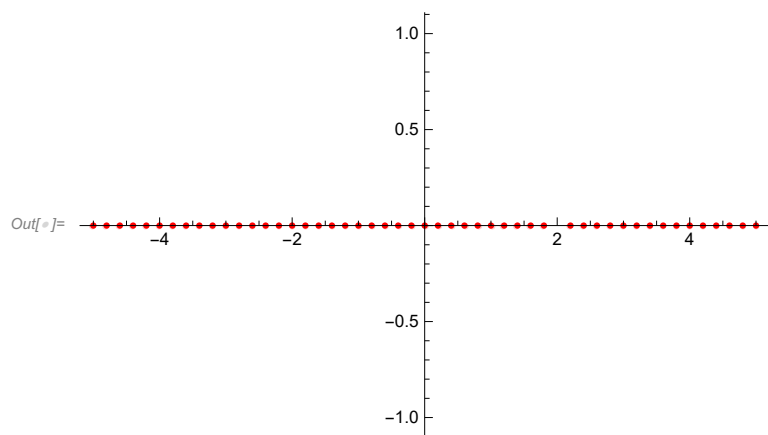


$Out[] =$  $Out[] =$  $Out[] =$ 

```

In[ ]:= f[x_] := DiracDelta[x - a];
a = 2;
DiscretePlot[f[x], {x, -5, 5, 0.2}, PlotStyle -> {Red, Thick}]

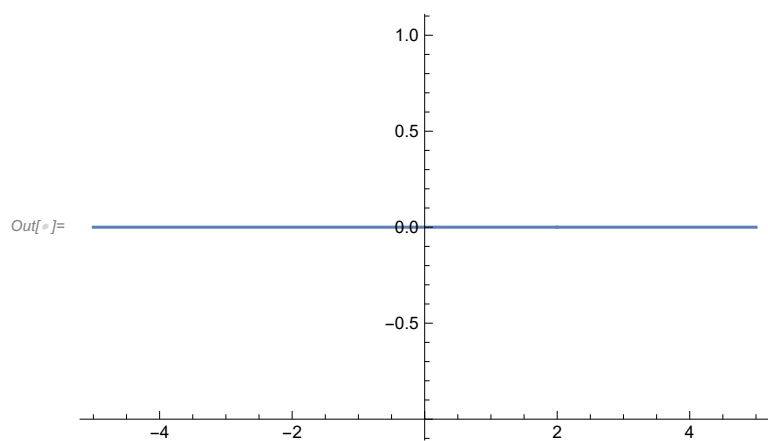
```



```

In[ ]:= f[x_] := DiracDelta[x - a];
a = 2;
Plot[f[x], {x, -5, 5}, AxesOrigin -> {0, -1}]

```



```

In[ ]:= Exit

```

```

In[ ]:= math

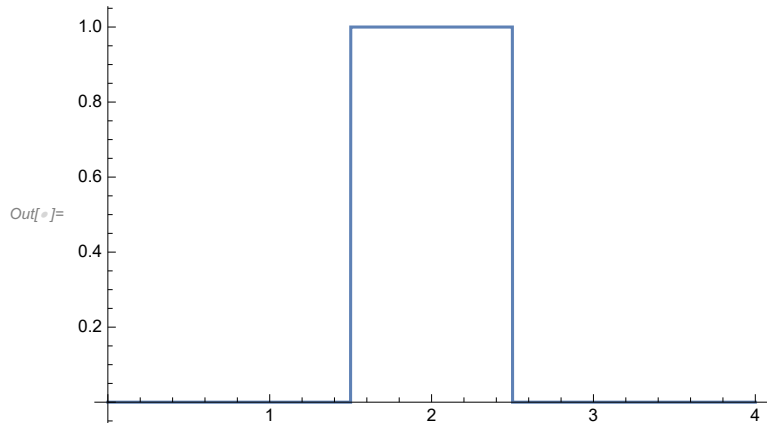
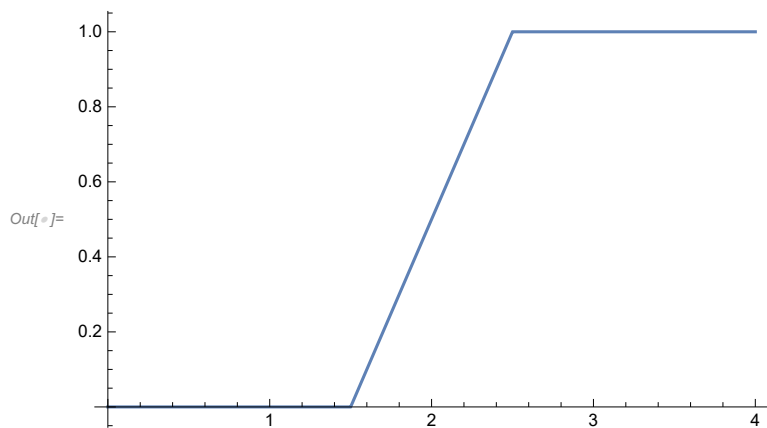
```

Out[]:= math

```

In[ ]:= F[x_, σ_] := Piecewise[{{0, x < a - σ}, {(1/(2 σ)) (x - a + σ), -σ < x - a < σ}, {1, x > a + σ}}];
(*Ramp function*)
der[x_, σ_] =
  D[F[x, σ], x];
(*Derivative of Ramp function is Rectangular function R*)
a = 2;
Plot[F[x, σ = 0.5], {x, 0, 4}, PlotRange → Full]
Plot[der[x, σ = 0.5], {x, 0, 4}, PlotRange → Full]

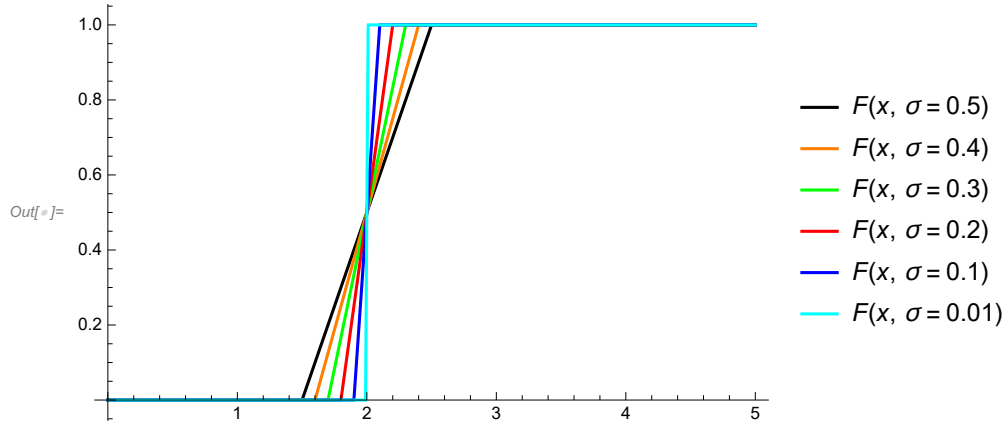
```



```

In[ ]:= F[x_, σ_] := Piecewise[{{0, x < a - σ}, {(1/(2 σ)) (x - a + σ), -σ < x - a < σ}, {1, x > a + σ}}];
a = 2;
Plot[{F[x, σ = 0.5], F[x, σ = 0.4], F[x, σ = 0.3],
      F[x, σ = 0.2], F[x, σ = 0.1], F[x, σ = 0.01]}, {x, 0, 5}, PlotRange → Full,
      PlotStyle → {Black, Orange, Green, Red, Blue, Cyan}, PlotLegends → "Expressions"]

```



```

In[ ]:= Exit

```

```

In[ ]:= F[x_, σ_] := Piecewise[{{0, x < a - σ}, {(1/(2 σ)) (x - a + σ), -σ < x - a < σ}, {1, x > a + σ}}];
H[x_, a_] =
  Limit[F[x, σ], σ → 0];
(*For limit σ→0 Ramp function becomes Heaviside unit step function*)
H[x, a]
delta[x_, a_] =
  D[H[x, a], x];
(*Derivative of discontinuous Heaviside unit step function is Dirac delta function*)
delta[x, a]
Integrate[delta[x, a = 2], {x, -5, 5}]

```

```

Out[ ]:= {
  1      a < x
  0      a > x
  Indeterminate True
}

```

```

Out[ ]:= {
  0      a - x < 0 || a - x > 0
  Indeterminate True
}

```

```

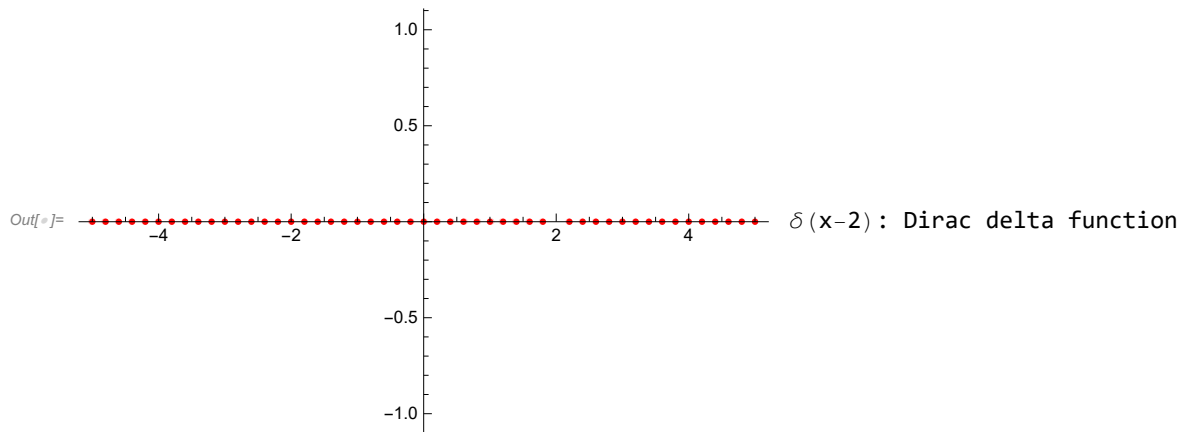
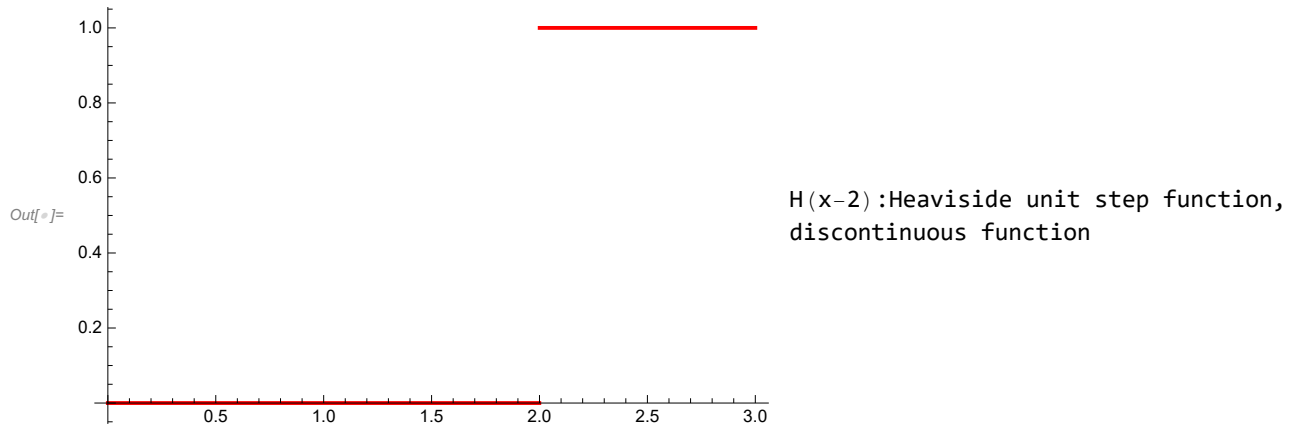
Out[ ]:= 0

```

```

In[ ]:= a = 2;
Plot[H[x, a], {x, 0, 3}, PlotStyle -> {Red, Thick},
PlotLegends -> "H(x-2):Heaviside unit step function,\ndiscontinuous function"]
DiscretePlot[delta[x, a], {x, -5, 5, 0.2}, PlotStyle -> {Red, Thick},
PlotLegends -> "\delta(x-2): Dirac delta function"]

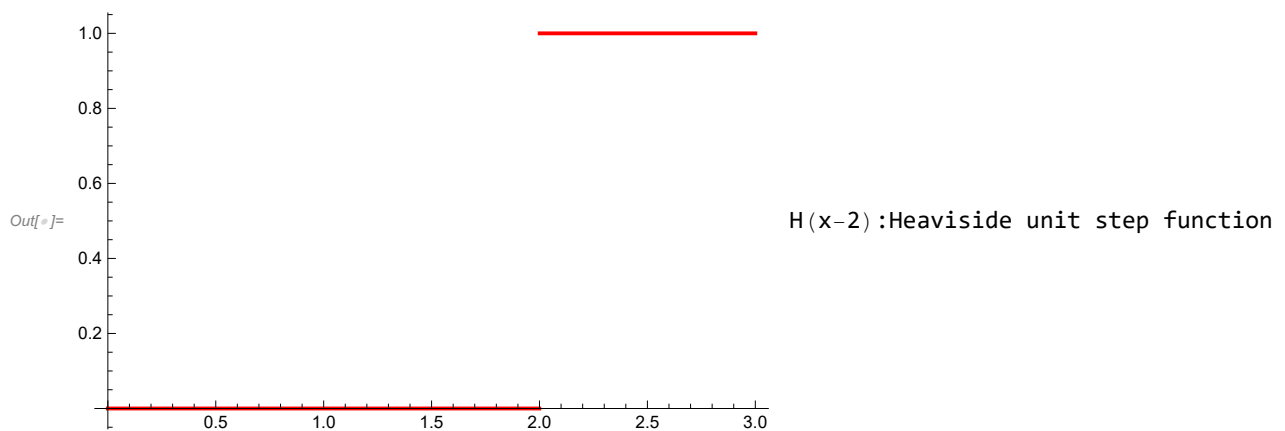
```



```

In[ ]:= Plot[UnitStep[x - 2], {x, 0, 3}, PlotStyle -> {Red, Thick},
PlotLegends -> "H(x-2):Heaviside unit step function"]

```



```

In[ ]:= Exit

```



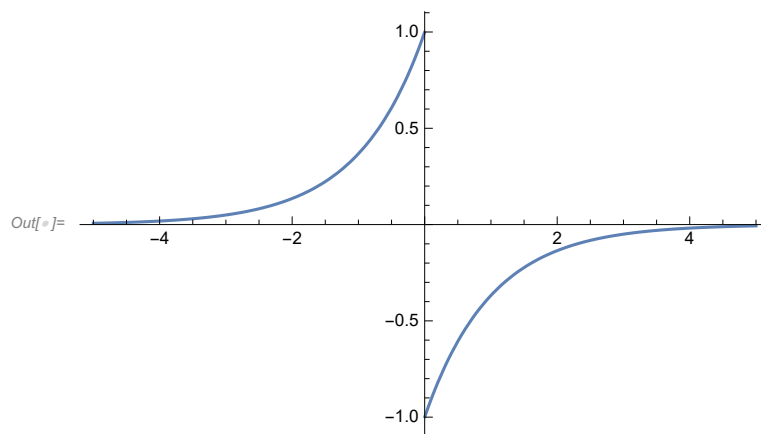
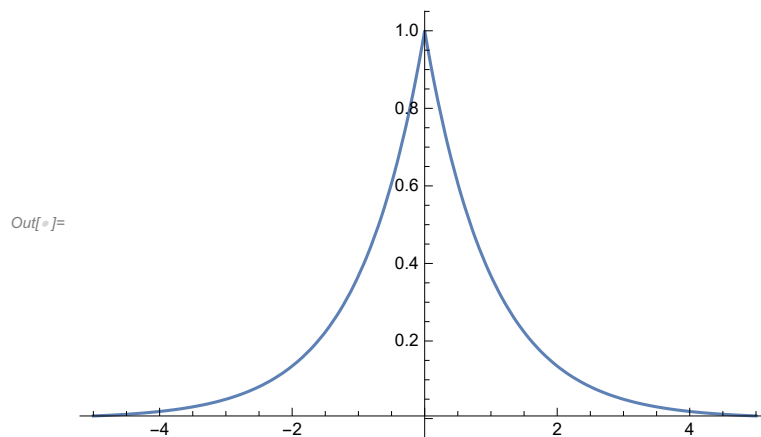
```

In[ ]:= (*psi[x_]:=Exp[-Abs[x]] ;*)
psi[x_] := Piecewise[{{Exp[-(x)], x >= 0}, {Exp[-(-x)], x < 0}}];
derpsi[x_] = D[psi[x], x]
derderpsi[x_] = D[derpsi[x], x]
Plot[psi[x], {x, -5, 5}, PlotRange -> Full]
Plot[derpsi[x], {x, -5, 5}, PlotRange -> Full]
Plot[derderpsi[x], {x, -5, 5}, PlotRange -> Full, PlotStyle -> {Red, Thick}]
    
```

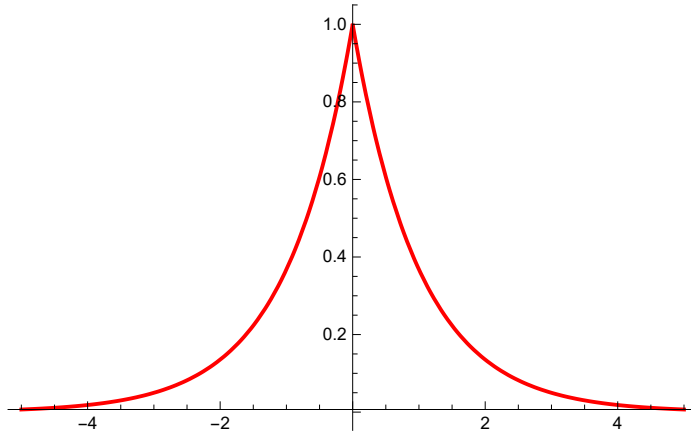
Out[]:=

$$\begin{cases} e^x & x < 0 \\ -e^{-x} & x > 0 \\ \text{Indeterminate} & \text{True} \end{cases}$$

Out[]:=

$$\begin{cases} e^x & x < 0 \\ e^{-x} & x > 0 \\ \text{Indeterminate} & \text{True} \end{cases}$$


Out[]=



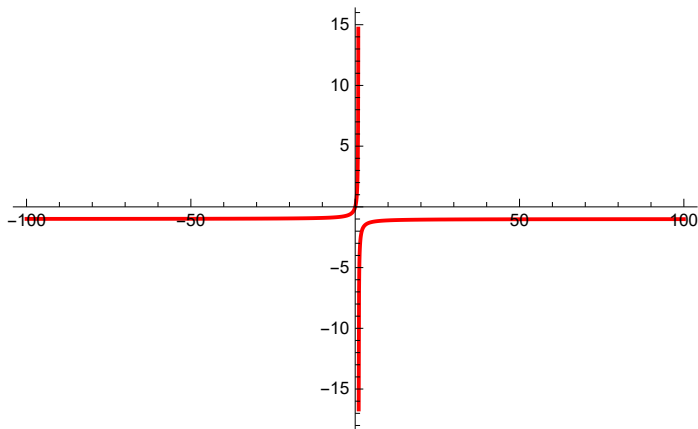
```

In[ ]:= f[z_] := z / (1 - z);
der2[z_] = D[f[z], z]
Plot[f[z], {z, -100, 100}, PlotRange -> Full, PlotStyle -> {Red, Thick}]
Plot[der2[z], {z, -100, 100}, PlotRange -> Full, PlotStyle -> {Red, Thick}]
Plot[der2[z], {z, -1, 1}, PlotRange -> Full, PlotStyle -> {Red, Thick}]
Plot[der2[z], {z, -0.1, 0.1}, PlotRange -> Full, PlotStyle -> {Red, Thick}]

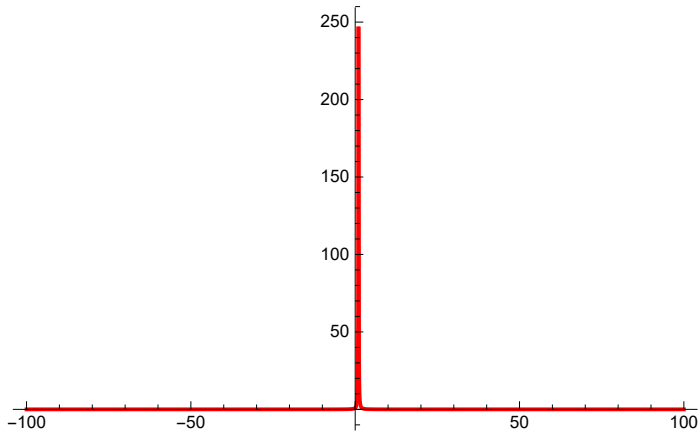
```

Out[]= $\frac{1}{1-z} + \frac{z}{(1-z)^2}$

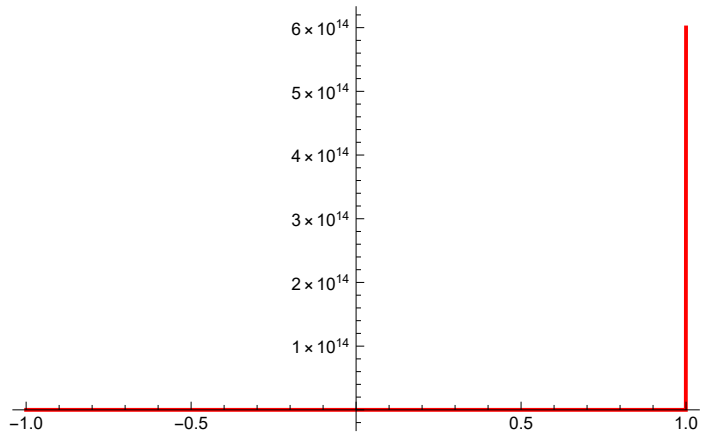
Out[]=



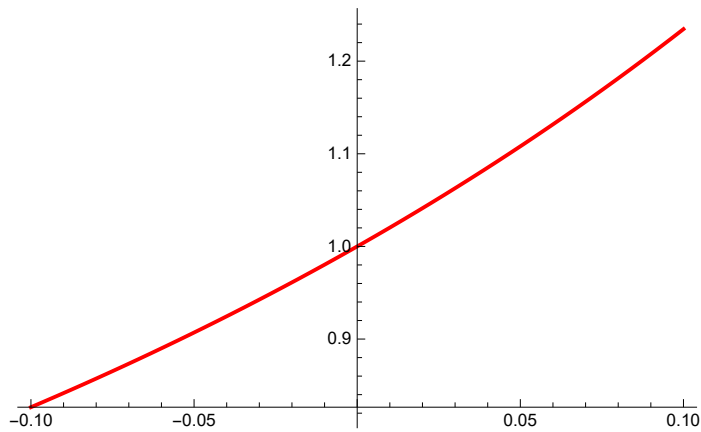
Out[]=



Out[]=



Out[]=



```

In[ ]:= h[x_] := Piecewise[{{-x, x < 0}, {x, x ≥ 0}}];
derh[x_] = D[h[x], x]
derderh[x_] = D[derh[x], x]
Plot[h[x], {x, -5, 5}]
Plot[derh[x], {x, -5, 5}, PlotRange → Full, PlotStyle → {Red, Thick}]
DiscretePlot[derderh[x], {x, -5, 5, 0.2},
  AxesOrigin → {0, -0.2}, PlotRange → Full, PlotStyle → {Red, Thick}]

```

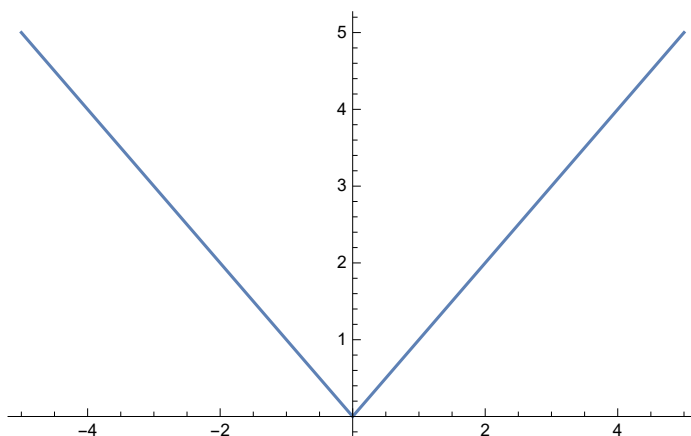
Out[]=

$$\begin{cases} -1 & x < 0 \\ 1 & x > 0 \\ \text{Indeterminate} & \text{True} \end{cases}$$

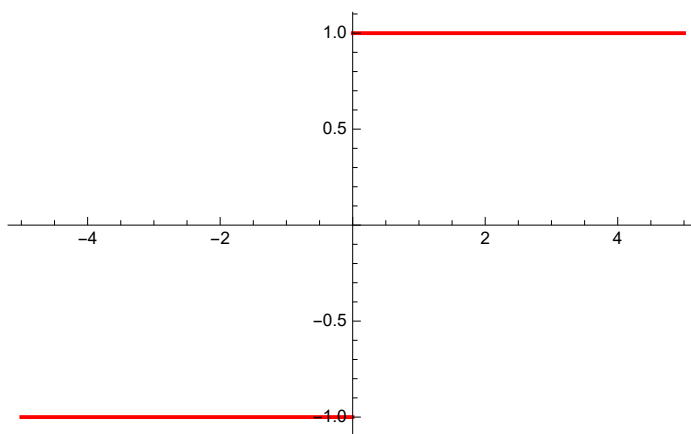
Out[]=

$$\begin{cases} 0 & x < 0 \mid x > 0 \\ \text{Indeterminate} & \text{True} \end{cases}$$

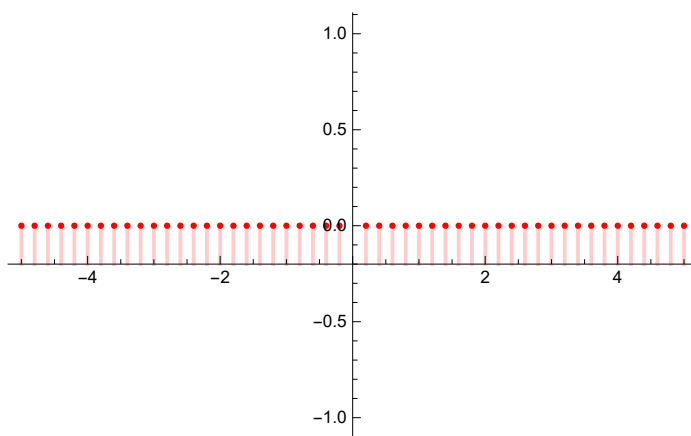
Out[]=



Out[]=



Out[]=



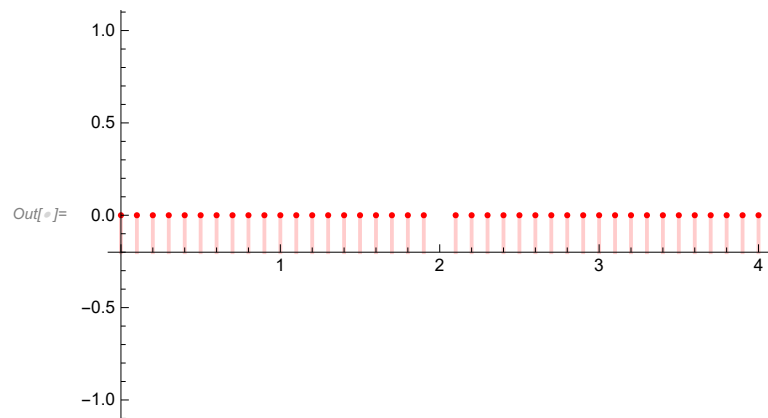
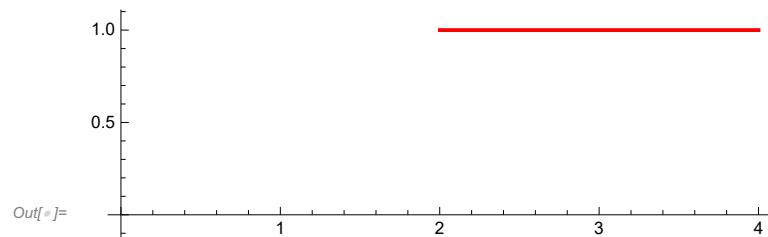
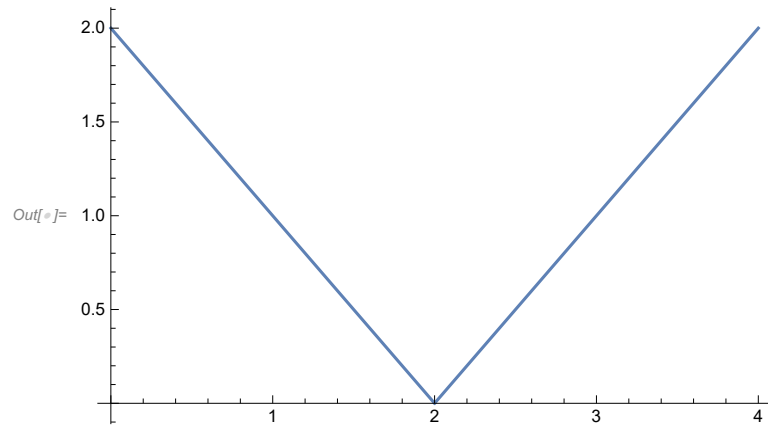
```

In[ ]:= h[x_] := Piecewise[{{-x + a, x < a}, {x - a, x ≥ a}}];
a = 2;
derh[x_] = D[h[x], x]
derderh[x_] = D[derh[x], x]
Plot[h[x], {x, 0, 4}]
Plot[derh[x], {x, 0, 4}, PlotRange → Full, PlotStyle → {Red, Thick}]
DiscretePlot[derderh[x], {x, 0, 4, 0.1},
  AxesOrigin → {0, -0.2}, PlotRange → Full, PlotStyle → {Red, Thick}]

```

```
Out[ ]:= { -1      x < 2
           1      x > 2
           Indeterminate True
```

```
Out[ ]:= { 0      x < 2 || x > 2
           Indeterminate True
```



```
In[ ]:= Exit
```

```
f[x_] := x^2;
Integrate[f[x] * DiracDelta[x - 2], {x, -5, 5}]
```

```
Out[ ]:= 4
```

```

In[1]:= G3[x_, y_, z_] :=
  (1 / ((σ^3) * (2 Pi)^(3/2))) Exp[-((x - a)^2 + (y - b)^2 + (z - x)^2) / (2 σ^2)];
a = 2; b = 3; c = 2, σ = 0.1;
ContourPlot3D[G3[x, y, z], {x, 0, 5},
  {y, 0, 5}, {z, 0, 5}, PlotPoints → 100, PlotRange → Full]

```

