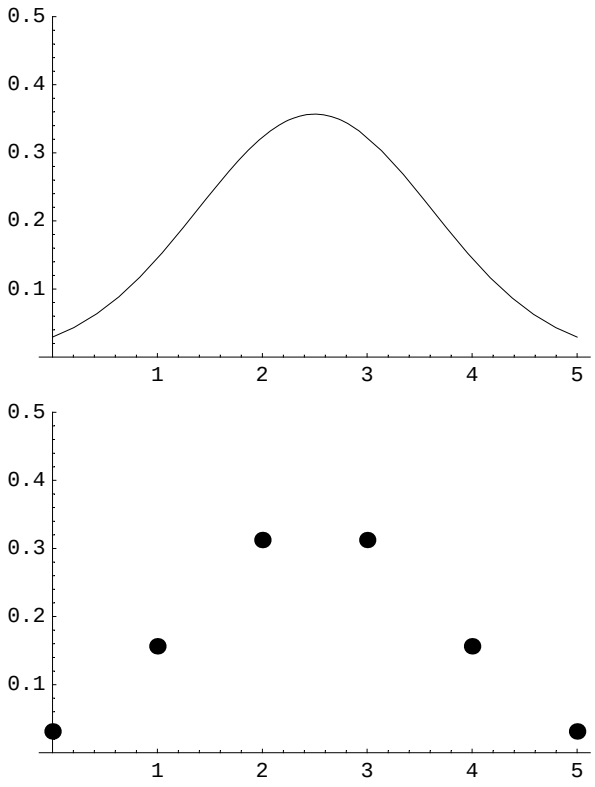
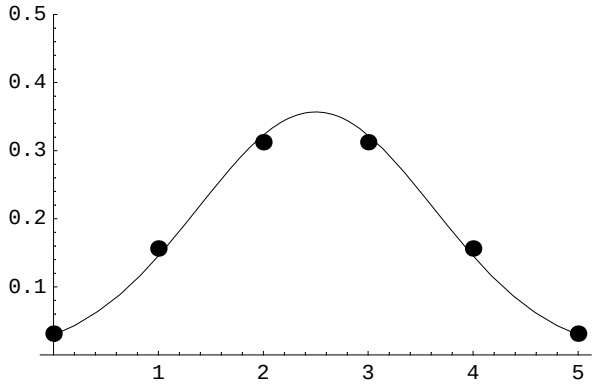
Lösungen / Statistik 2/04

```
Remove["Global`*"]
```

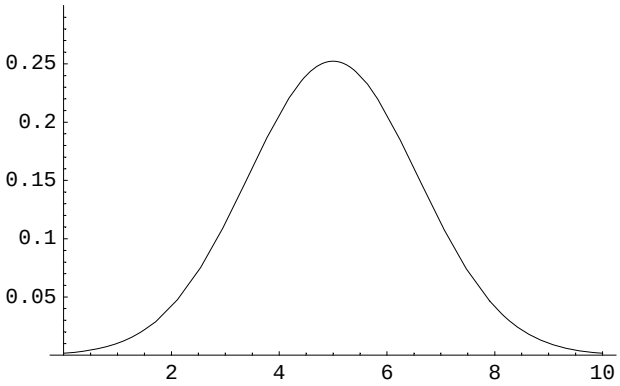
1.

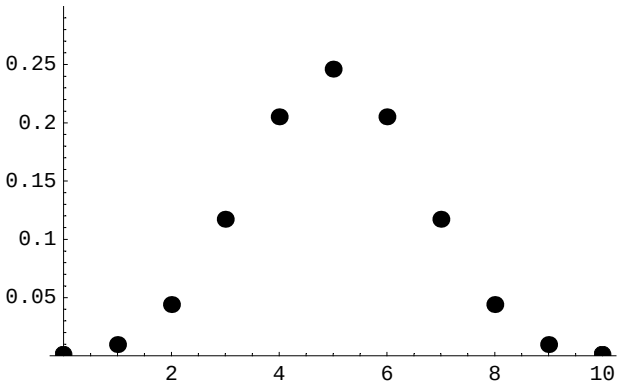
```
q = 1 - p;
z[x_, n_, p_] := (x - n p) / Sqrt[n p (1 - p)];
f[x_, n_, p_] := Binomial[n, x] p^x (1 - p)^(n - x);
φ[z_, n_, p_] := 1 / Sqrt[2 Pi n p (1 - p)] E^(-z^2 / 2);
showPlot[n_, p_, h_] := Show[Plot[φ[z[x, n, p], n, p], {x, 0, n}, PlotRange → {0, h}],
   ListPlot[Table[{x, f[x, n, p]}, {x, 0, n}],
    PlotStyle → {PointSize[0.03]}, PlotRange → {0, h}] ];
showPlot[
  5,
  0.5,
  0.5];
```

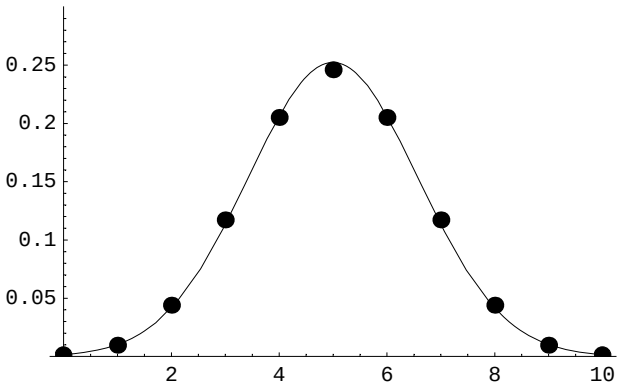




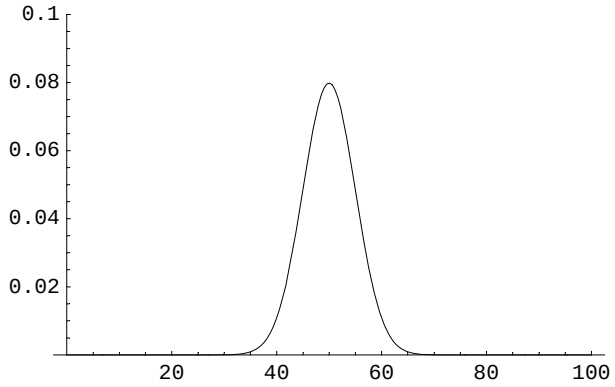

```
showPlot[10, 0.5, 0.3];
```

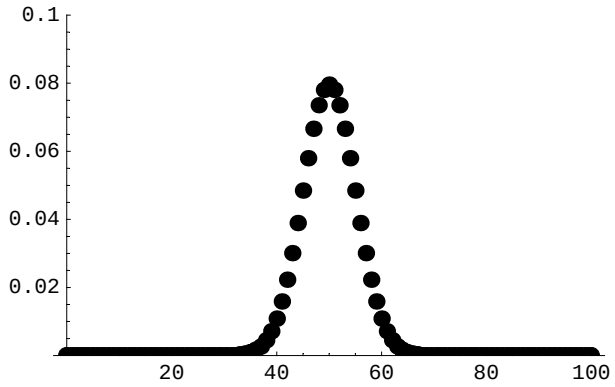


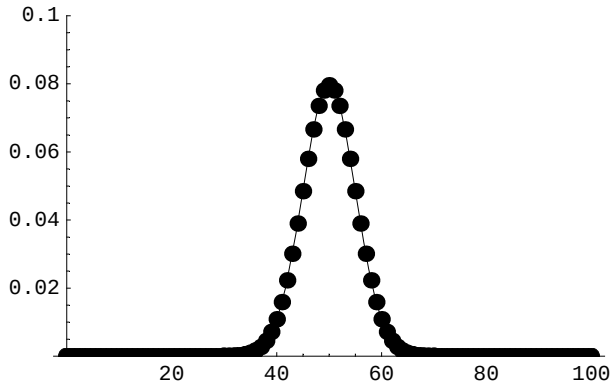




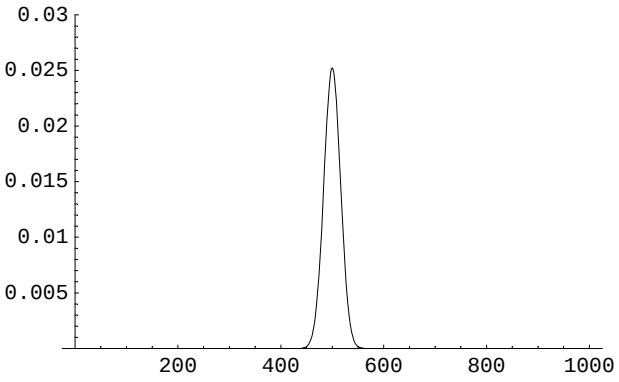

```
showPlot[100, 0.5, 0.1];
```

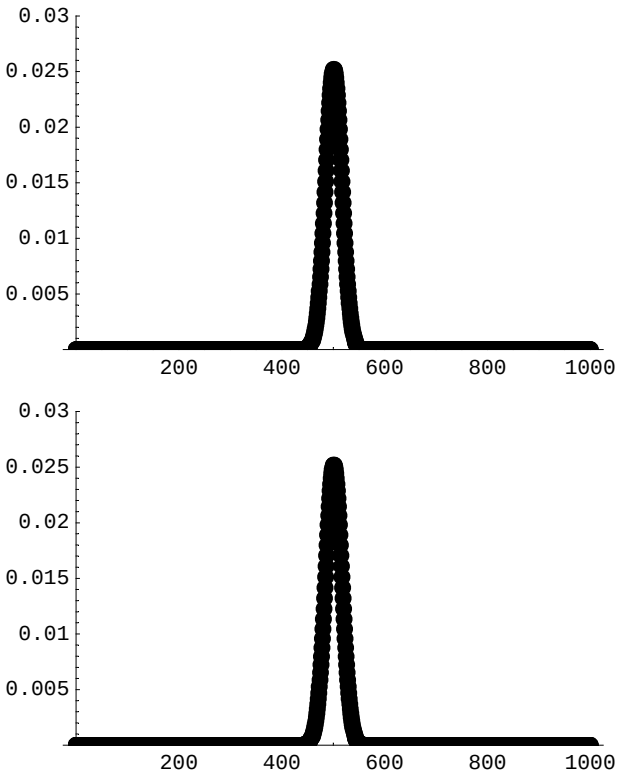







```
showPlot[1000, 0.5, 0.03];
```





2.

```
Remove["Global`@*"]
```

```
<< Statistics`DataManipulation`
```

```
? Random
```

```
Random[ ] gives a uniformly distributed pseudorandom Real in the range 0
   to 1. Random[type, range] gives a pseudorandom number of the specified type,
   lying in the specified range. Possible types are: Integer, Real and Complex.
   The default range is 0 to 1. You can give the range {min, max} explicitly;
   a range specification of max is equivalent to {0, max}. Random[distribution]
   gives a random number with the specified statistical distribution. Mehr...
```

```
randListe[n_] := {Table[Random[Integer, {1, 6}], {i, 1, n}], m = n};
rL = randListe[1000]
```

```
{{2, 6, 3, 5, 5, 2, 3, 3, 1, 6, 5, 6, 5, 6, 1, 3, 3, 2, 4, 1, 4, 1, 1, 3, 3, 1, 2, 4, 2, 2, 3,
  1, 2, 3, 1, 1, 3, 1, 5, 4, 3, 1, 5, 6, 4, 2, 1, 2, 4, 4, 5, 6, 2, 4, 2, 2, 4, 1, 4, 5,
  5, 5, 3, 4, 5, 1, 5, 5, 4, 6, 2, 6, 4, 2, 6, 6, 4, 4, 5, 3, 3, 5, 6, 3, 3, 1, 5, 3, 2,
  2, 1, 1, 6, 6, 1, 5, 3, 5, 4, 5, 2, 4, 6, 4, 5, 5, 1, 4, 4, 5, 2, 6, 2, 6, 5, 6, 4, 5,
  5, 6, 6, 5, 2, 2, 1, 6, 2, 1, 1, 1, 5, 2, 4, 5, 5, 3, 6, 4, 1, 3, 5, 4, 1, 1, 3, 3, 3,
  4, 4, 5, 2, 4, 5, 5, 4, 6, 4, 2, 1, 1, 6, 2, 6, 6, 2, 5, 1, 5, 5, 2, 4, 3, 2, 5, 5, 5,
  2, 2, 3, 6, 2, 6, 3, 5, 2, 6, 1, 2, 1, 5, 3, 4, 5, 3, 3, 6, 6, 2, 1, 3, 5, 6, 4, 4, 2,
  6, 4, 4, 3, 4, 5, 3, 1, 5, 3, 4, 2, 6, 1, 3, 3, 1, 3, 6, 4, 2, 6, 4, 4, 4, 6, 5, 4, 1,
  3, 5, 2, 5, 2, 1, 5, 1, 1, 3, 4, 2, 5, 3, 2, 2, 5, 3, 2, 2, 3, 3, 6, 5, 1, 6, 6, 2, 2,
  3, 3, 4, 1, 1, 2, 1, 6, 6, 4, 6, 4, 6, 1, 5, 2, 2, 1, 5, 2, 2, 4, 3, 1, 6, 6, 4, 4, 6,
  4, 1, 5, 2, 3, 5, 3, 3, 4, 3, 1, 6, 1, 6, 2, 2, 1, 6, 1, 3, 5, 6, 5, 4, 4, 1, 1, 4, 1,
  4, 5, 2, 5, 4, 5, 4, 4, 6, 6, 4, 1, 6, 1, 4, 6, 6, 6, 6, 4, 4, 2, 5, 3, 6, 4, 6, 6, 5,
  4, 6, 1, 6, 5, 5, 1, 1, 2, 4, 5, 5, 2, 2, 4, 2, 4, 4, 6, 3, 3, 5, 1, 3, 3, 4, 3, 4, 4,
  6, 6, 5, 5, 2, 1, 4, 1, 2, 4, 5, 1, 6, 1, 1, 4, 4, 3, 5, 5, 1, 2, 2, 2, 3, 6, 6, 4, 2,
  6, 4, 5, 6, 6, 4, 3, 6, 2, 4, 4, 5, 1, 5, 5, 5, 1, 3, 6, 2, 4, 5, 4, 3, 6, 4, 4, 4, 4,
  5, 2, 2, 1, 3, 3, 5, 2, 5, 3, 3, 3, 6, 4, 4, 4, 5, 3, 1, 4, 6, 2, 3, 1, 3, 1, 4, 4, 1,
  5, 1, 2, 3, 5, 4, 2, 4, 5, 6, 1, 6, 3, 4, 6, 4, 1, 4, 6, 6, 4, 6, 2, 5, 1, 1, 4, 3, 6,
  6, 3, 1, 5, 1, 4, 5, 4, 2, 2, 2, 1, 4, 5, 6, 6, 5, 6, 4, 4, 3, 2, 4, 3, 2, 1, 4, 2, 2,
  1, 6, 2, 5, 1, 6, 4, 2, 5, 1, 1, 1, 1, 6, 3, 5, 3, 6, 4, 4, 2, 4, 5, 5, 6, 4, 1, 5, 6,
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  2, 5, 6, 5, 1, 6, 5, 2, 2, 1, 1, 5, 4, 6, 5, 1, 1, 6, 1, 6, 5, 1, 6, 2, 1, 3, 2, 6,
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  2, 3, 2, 4, 5, 1, 6, 1, 3, 4, 5, 6, 4, 1, 3, 1, 5, 2, 1, 6, 5, 5, 2, 3, 3, 3, 2, 5,
  4, 4, 6, 4, 1, 6, 3, 3, 5, 1, 4, 2, 6, 6, 6, 5, 4, 4, 6, 4, 5, 2, 3, 3, 2, 3, 4, 1,
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  6, 3, 1, 4, 6, 4, 6, 3, 1, 3, 1, 3, 4, 2, 5, 4, 1, 1, 3, 5, 2, 1, 6, 2, 6, 4, 4, 4,
  5, 5, 3, 4, 1, 6, 4, 1, 4, 2, 5, 6, 2, 6, 1, 2, 6, 5, 5, 5, 4, 5, 2, 2, 3, 3, 5, 3,
  6, 1, 2, 4, 6, 3, 5, 1, 5, 6, 3, 2, 2, 2, 6, 4, 5, 6, 1, 2, 6, 3, 4, 6, 6, 4}, 1000}
```

```
freq = Frequencies[rL[[1]]]
```

```
{{169, 1}, {148, 2}, {152, 3}, {173, 4}, {171, 5}, {187, 6}}
```

```
tab = Table[freq[[n]][[1]], {n, 1, 6}]
```

```
General::spell1 :
 Possible spelling error: new symbol name "tab" is similar to existing symbol "Tab". Mehr…
```

```
{169, 148, 152, 173, 171, 187}
```

```
{n, m}
```

```
{n, 1000}
```

```
diff = Abs[Table[tab[[n]] / m - 1 / 6, {n, 1, 6}]] // N
```

```
{0.00233333, 0.0186667, 0.0146667, 0.00633333, 0.00433333, 0.0203333}
```

```
rL = randListe[100000];
freq = Frequencies[rL[[1]]];
tab = Table[freq[[n]][[1]], {n, 1, 6}];
diff = Abs[Table[tab[[n]] / m - 1 / 6, {n, 1, 6}]] // N
```

```
{0.000133333, 0.000423333, 0.000593333, 0.000426667, 0.00106667, 0.000343333}
```

3.

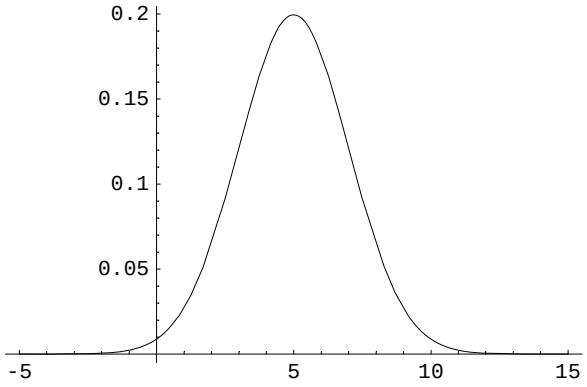
```
Remove["Global`@*"]
```

```
? Log
```

```
Log[z] gives the natural logarithm of z (
   logarithm to base e). Log[b, z] gives the logarithm to base b. Mehr...
```

```
φ1[t_, μ_, σ_] := 1 / (σ Sqrt[2 Pi]) E^(-(t - μ)^2 / (2 σ^2));

h[x_ /; x ≤ 0, a_, μ_, σ_] := 0;
h[x_ /; x > 0, a_, μ_, σ_] := Log[a, E] / x * φ1[Log[a, x], μ, σ];
```

```
Plot[φ1[t, 5, 2], {t, -5, 15}];
```




```
? h
```

```
Global`h
```

```
h[x_ /; x ≤ 0, a_, μ_, σ_] := 0
```

```
h[x_ /; x > 0, a_, μ_, σ_] := Log[a, e] φ1[Log[a, x], μ, σ] / x
```

```
h[x, 7, 5, 2]
```

```
h[x, 7, 5, 2]
```

```
h[3, 10, 5, 2] // Evaluate
```

$$\frac{e^{-\frac{1}{8}\left(-5+\frac{\text{Log}[3]}{\text{Log}[10]}\right)^2}}{6\sqrt{2\pi}\,\text{Log}[10]}$$

```
h[3, 10, 0, 2] // Evaluate
```

$$\frac{e^{-\frac{\text{Log}[3]^2}{8\,\text{Log}[10]^2}}}{6\sqrt{2\pi}\,\text{Log}[10]}$$

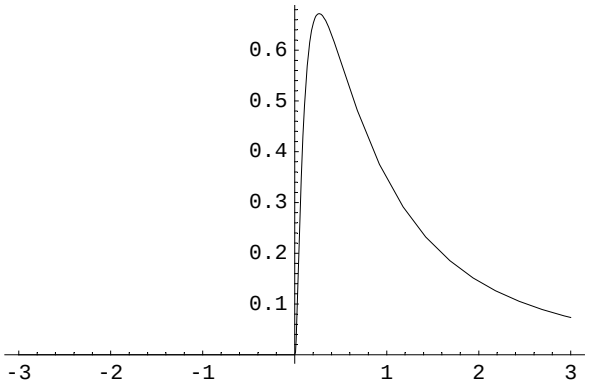
```
h[0.000001, 10, 0, 1]
```

```
0.00263872
```

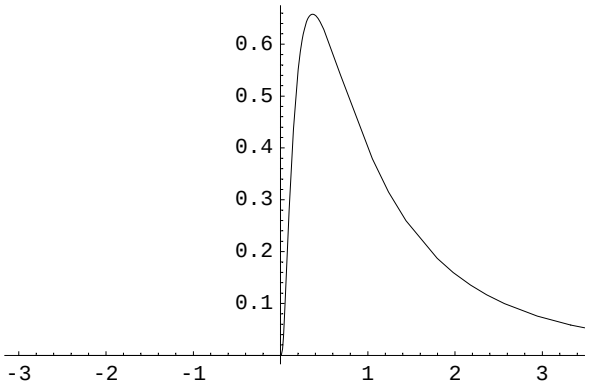
```
h[0.00000000000000000001, 10, 0, 2]
```

```
0.00167086
```

```
Plot[h[x, 10, 0, 0.5], {x, -3, 3}];
```

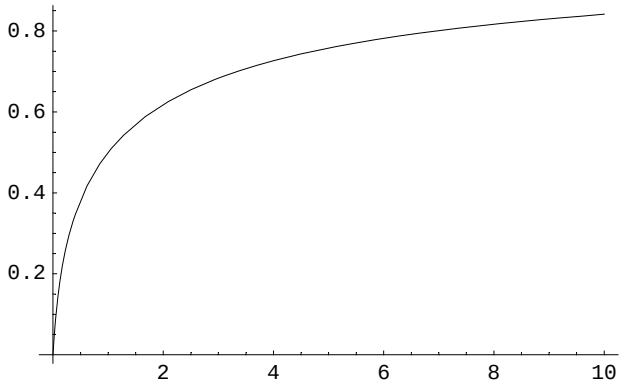



```
Plot[h[x, E, 0, 1], {x, -3, 6}];
```




```
hH[x_, a_, μ_, σ_] := Integrate[Evaluate[h[t, a, μ, σ]], {t, 0, x}];
```

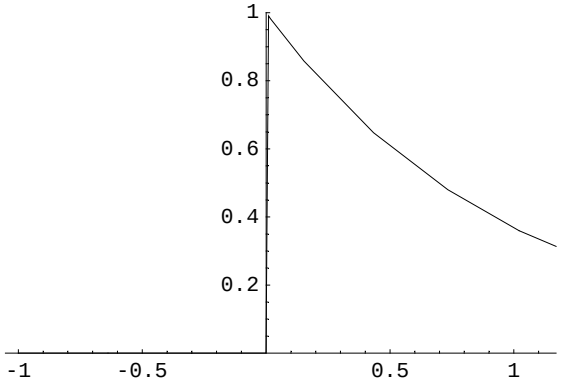
```
Plot[hH[x, 10, 0, 1], {x, 0, 10}];
```



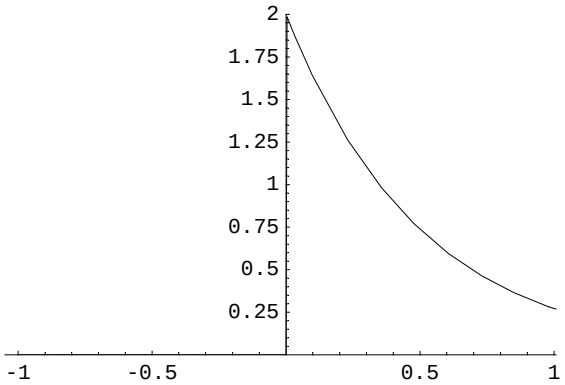
4.

```
Remove["Global`@*"]
```

```
f[x_ /; x < 0, α_] := 0;
f[x_ /; x ≥ 0, α_] := α E^(-α x);

Plot[f[x, 1], {x, -1, 6}, PlotRange → {0, 1}];
```

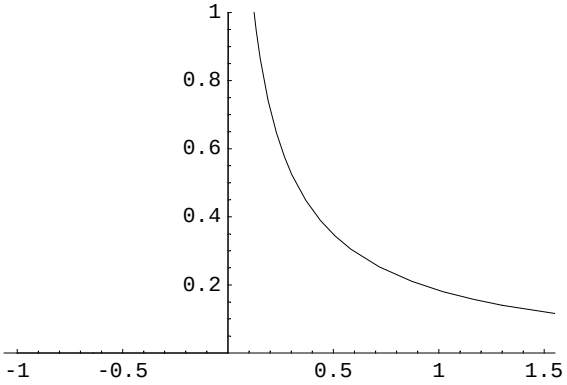



```
Plot[f[x, 2], {x, -1, 2}, PlotRange → {0, 2}];
```

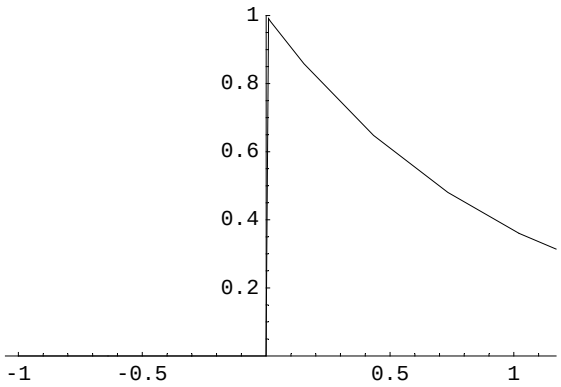


5.

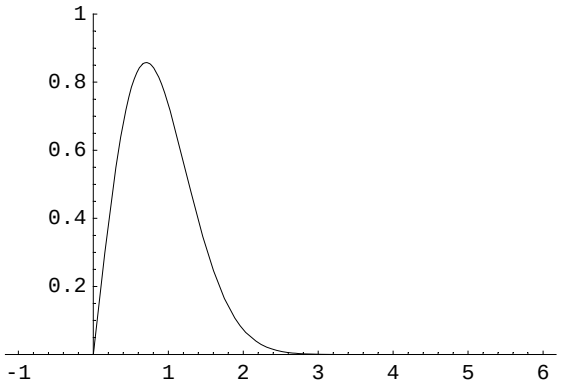
```
Remove["Global`@*"]

f[x_, a_, b_, c_ /; x ≤ c] := 0;
f[x_, a_, b_, c_ /; x > c] := b / a ((x - c) / a)^(b - 1) E^(-((x - c) / a)^b)

Plot[f[x, 1, 1 / 2, 0], {x, -1, 6}, PlotRange → {0, 1}];
```



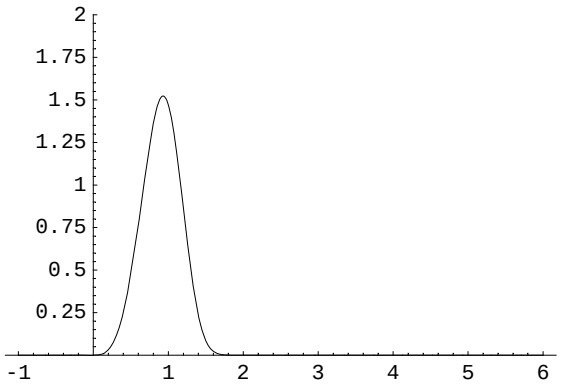
```
Plot[f[x, 1, 1, 0], {x, -1, 6}, PlotRange → {0, 1}];
```



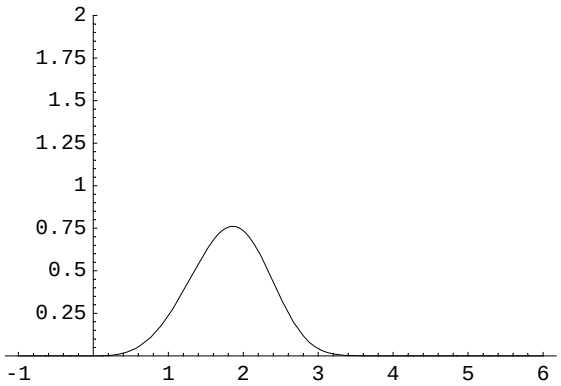

```
Plot[f[x, 1, 2, 0], {x, -1, 6}, PlotRange → {0, 1}];
```



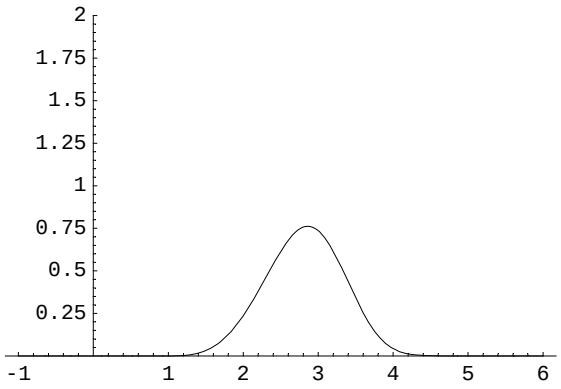

```
Plot[f[x, 1, 4, 0], {x, -1, 6}, PlotRange → {0, 2}];
```




```
Plot[f[x, 2, 4, 0], {x, -1, 6}, PlotRange → {0, 2}];
```



```
Plot[f[x, 2, 4, 1], {x, -1, 6}, PlotRange → {0, 2}];
```

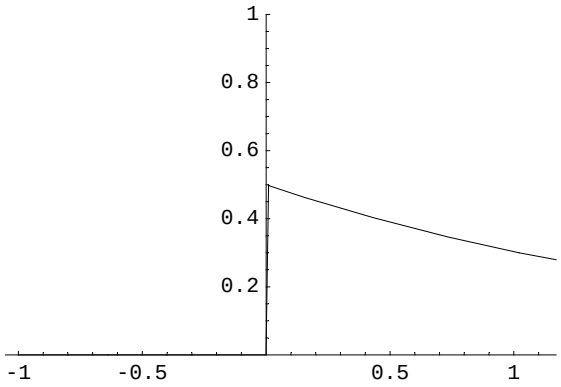


6.

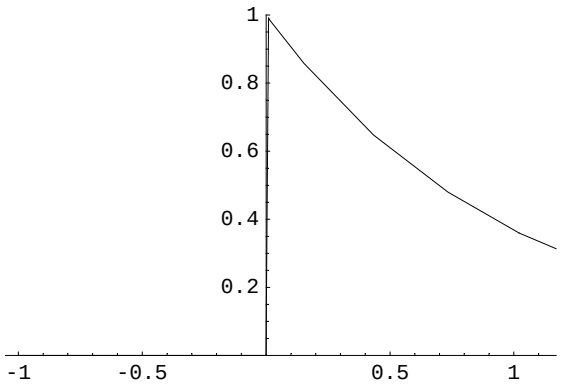
```
Remove["Global`@*"]
```

```
f[x_ /; x ≤ 0, b_, p_] := 0; f[x_ /; x > 0, b_, p_] := b^p / Gamma[p] x^(p - 1) E^(-b x);
```

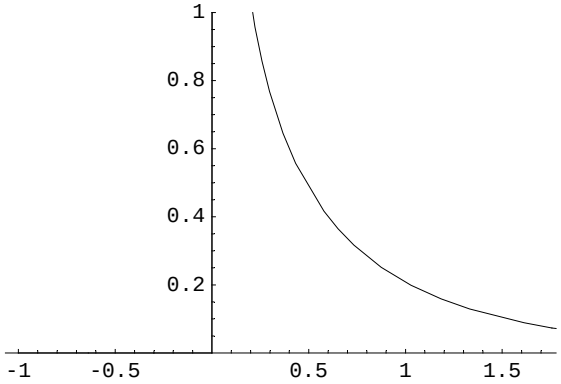
```
Plot[f[x, 0.5, 1], {x, -1, 6}, PlotRange → {0, 1}];
```



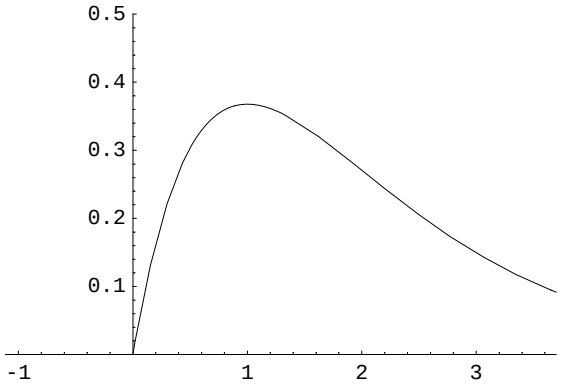

```
Plot[f[x, 1, 1], {x, -1, 6}, PlotRange → {0, 1}];
```



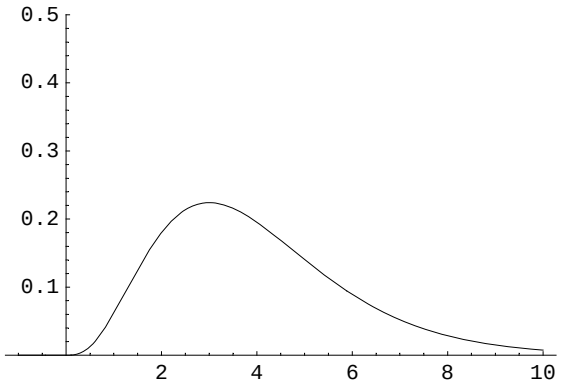
```
Plot[f[x, 1, 0.5], {x, -1, 6}, PlotRange → {0, 1}];
```




```
Plot[f[x, 1, 2], {x, -1, 6}, PlotRange → {0, 0.5}];
```




```
Plot[f[x, 1, 4], {x, -1, 10}, PlotRange → {0, 0.5}];
```



7.

```
Remove["Global`*"]
```

```
points = {{0, 2}, {1, 1}, {2, 2}, {3, 1}, {4, 2}, {5, 3}};
```

■ a

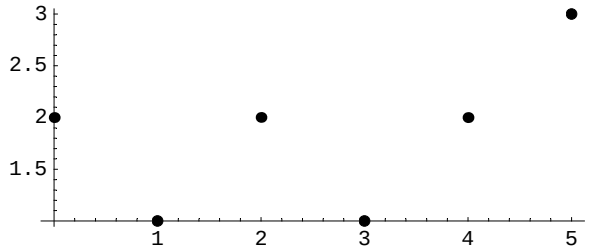
```
f1 = FindFit[points, a + b x, {a, b}, x]
```

```
{a → 1.33333, b → 0.2}
```

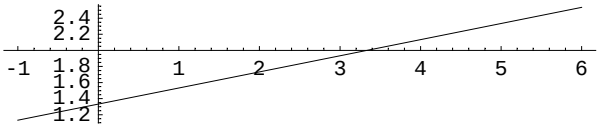
```
fg1[x_] := a + b x /. f1;  fg1[x]
```

```
1.33333 + 0.2 x
```

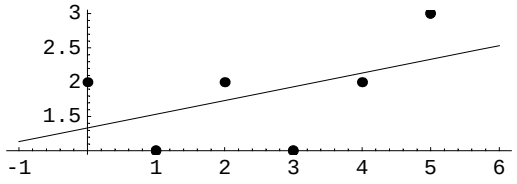
```
plotpoints = ListPlot[points, PlotStyle → PointSize[0.02], AspectRatio → Automatic];
```




```
pl1 = Plot[fg1[x], {x, -1, 6}, AspectRatio → Automatic];
```




```
Show[pl1, plotpoints, AspectRatio → Automatic];
```



■ b

```
points // MatrixForm
```

$$\begin{pmatrix} 0 & 2 \\ 1 & 1 \\ 2 & 2 \\ 3 & 1 \\ 4 & 2 \\ 5 & 3 \end{pmatrix}$$

```
trp = Transpose[points]; trp // MatrixForm
```

$$\begin{pmatrix} 0 & 1 & 2 & 3 & 4 & 5 \\ 2 & 1 & 2 & 1 & 2 & 3 \end{pmatrix}$$

```
xListe = trp[[1]]
```

```
{0, 1, 2, 3, 4, 5}
```

```
yListe = trp[[2]]
```

```
{2, 1, 2, 1, 2, 3}
```

```
<< Statistics`MultiDescriptiveStatistics`
```

```
Correlation[xListe, yListe]
```

$$\sqrt{\frac{21}{85}}$$

```
N[%]
```

```
0.49705
```

```
Covariance[xListe, yListe]
```

$$\frac{7}{10}$$

```
N[%]
```

```
0.7
```

■ C

```
points // MatrixForm
```

$$\begin{pmatrix} 0 & 2 \\ 1 & 1 \\ 2 & 2 \\ 3 & 1 \\ 4 & 2 \\ 5 & 3 \end{pmatrix}$$

```
pointsT = {Transpose[points][[2]], Transpose[points][[1]]} // Transpose;
pointsT // MatrixForm
```

$$\begin{pmatrix} 2 & 0 \\ 1 & 1 \\ 2 & 2 \\ 1 & 3 \\ 2 & 4 \\ 3 & 5 \end{pmatrix}$$

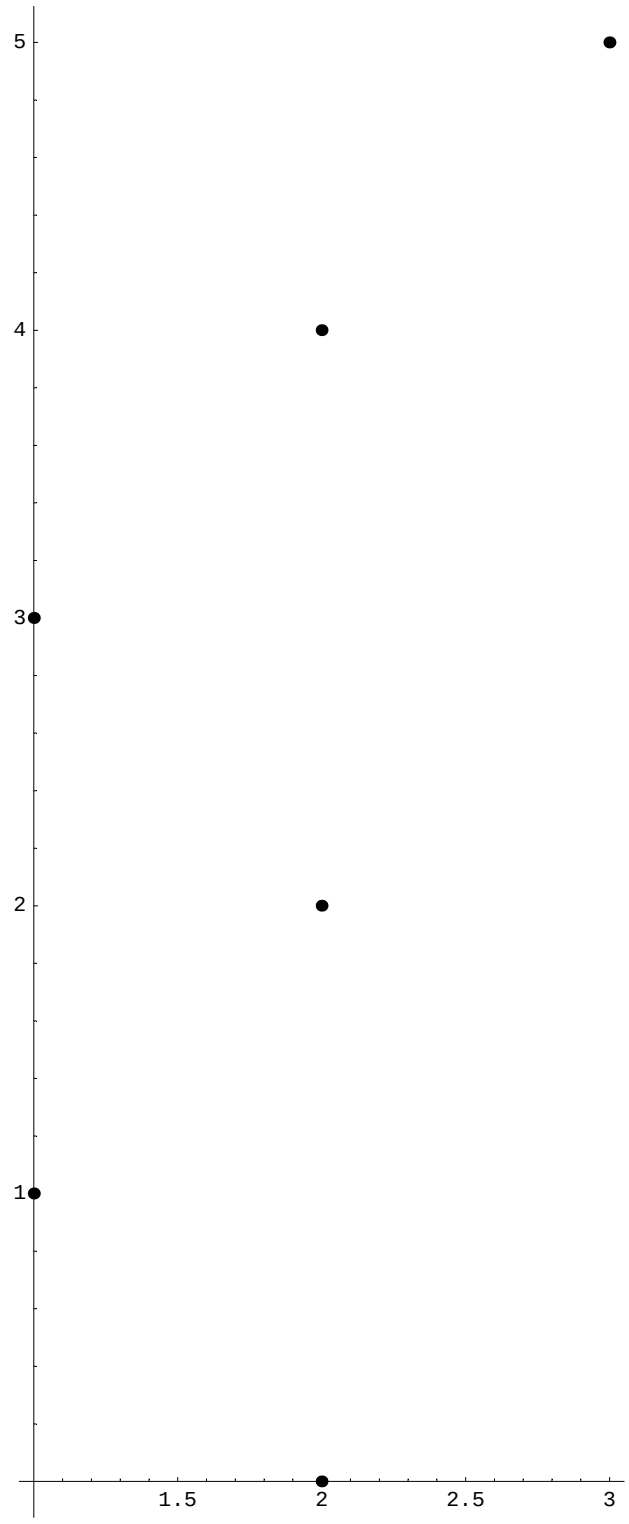
```
f2 = FindFit[pointsT, c + d x, {c, d}, x]
```

```
{c → 0.235294, d → 1.23529}
```

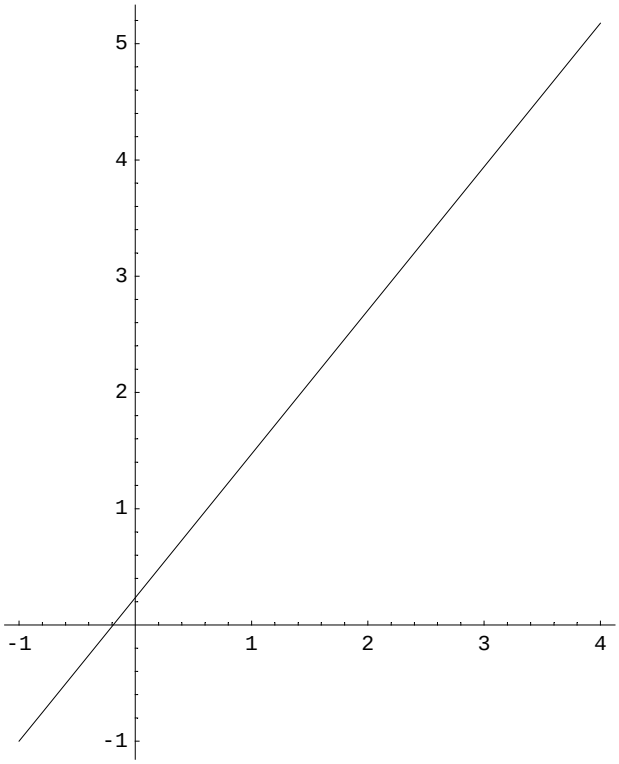
```
fg2[x_] := c + d x /. f2;  fg2[x]
```

```
0.235294 + 1.23529 x
```

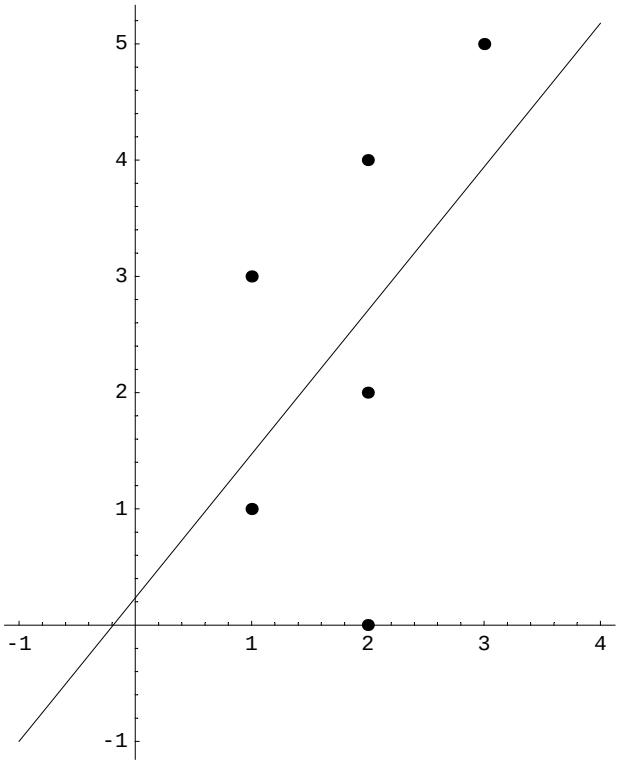
```
plotpoints1 = ListPlot[pointsT, PlotStyle → PointSize[0.02], AspectRatio → Automatic];
```



```
pl2 = Plot[fg2[x], {x, -1, 4}, AspectRatio → Automatic];
```




```
Show[pl2, plotpoints1, AspectRatio → Automatic];
```



■ d

Ueberhaupt nicht senkrecht!

8.

```
M1 = {{0.0, 0.0}, {0.1, 1.0}, {1.0, 0.0}, {0.9, 1.1}};
M2 = {{0.0, 0.0}, {1.0, 0.1}, {2.0, -0.1}, {3.0, 0.0}};
```

■ a

```
M1 // MatrixForm
```

$$\begin{pmatrix} 0. & 0. \\ 0.1 & 1. \\ 1. & 0. \\ 0.9 & 1.1 \end{pmatrix}$$

```
trp1 = Transpose[M1]; trp1 // MatrixForm
```

$$\begin{pmatrix} 0. & 0.1 & 1. & 0.9 \\ 0. & 1. & 0. & 1.1 \end{pmatrix}$$

```
xListe1 = trp1[[1]]
```

```
{0., 0.1, 1., 0.9}
```

```
yListe1 = trp1[[2]]
```

```
{0., 1., 0., 1.1}
```

```
<< Statistics`MultiDescriptiveStatistics`
```

```
Correlation[xListe1, yListe1]
```

```
0.0419741
```

```
Covariance[xListe1, yListe1]
```

```
0.0133333
```

■ b

```
M2 // MatrixForm
```

$$\begin{pmatrix} 0. & 0. \\ 1. & 0.1 \\ 2. & -0.1 \\ 3. & 0. \end{pmatrix}$$

```
trp2 = Transpose[M2]; trp2 // MatrixForm
```

$$\begin{pmatrix} 0. & 1. & 2. & 3. \\ 0. & 0.1 & -0.1 & 0. \end{pmatrix}$$

```
xListe2 = trp2[[1]]
```

```
{0., 1., 2., 3.}
```

```
yListe2 = trp2[[2]]
```

```
{0., 0.1, -0.1, 0.}
```

```
<< Statistics`MultiDescriptiveStatistics`
```

```
Correlation[xListe2, yListe2]
```

```
-0.316228
```

```
Covariance[xListe2, yListe2]
```

```
-0.0333333
```

■ C

Schwache Korrelation