> *restart*;
> *interface*(*warnlevel* = 0) :          #  **Maple 12**
> *with*(*DynamicSystems*) :

# Chapter 8 Problem 9f

**The probability of $|x_0\rangle$ is given by the following expression**

$$\sin^2\left(\frac{(2 \cdot k_0 + 1) \cdot \theta}{2}\right)$$

**where $\theta$ is the rotation angle**
**$k_0$ is the number of iterations needed**

**Grover(N) is a procedure that plots the probabilities versus the number of iterations of the Grover Algorithm. It also calculates the angle of rotation and the number of iterations needed to perform a 1 out of N search.**

> Grover := **proc**(N)
        **local** θ, k0, k, p0, S, NoI, Pset;
          **if** $N > 1$ **then**

          $\theta := 2 \cdot \arcsin\left(\dfrac{1}{\sqrt{N}}\right)$;      # *rotation angle*

          $k0 := \text{trunc}\left(\dfrac{\pi}{4} \cdot \sqrt{N}\right)$;     # *No. of iterations*

          $p0 := \sin^2\left(\dfrac{(2 \cdot k0 + 1) \cdot evalf(\theta)}{2}\right)$;  # *probability at k0*

          $S := 2 \cdot k0$;
          $\text{NoI} := \text{Vector}(S, k \rightarrow 1 \, k)$;   # *set of iterations from 1 to 2k0*
          $\text{Pset} := \text{Vector}\left(S, k \rightarrow \sin^2\left(\dfrac{(2 \cdot k + 1) \cdot evalf(\theta)}{2}\right)\right)$; # *probability set*

          $\theta := evalf\left(\dfrac{\theta \cdot 180.0}{\pi}\right)$;    # *converting radians to degrees*
          *printf* (" 1 out of %d search.\n", $N$ );
          *printf* ("   %s is: %4.2f degrees\n", 'θ', θ);
          *printf* ("   k0 is: %d \n", k0);
          *printf* ("   Px0 is: %f\n", p0);
          *DiscretePlot*(NoI, Pset, style = stem, symbol = point, color = blue, labels = ["k", "Prob"], *thickness*
      = 2);
            **else**
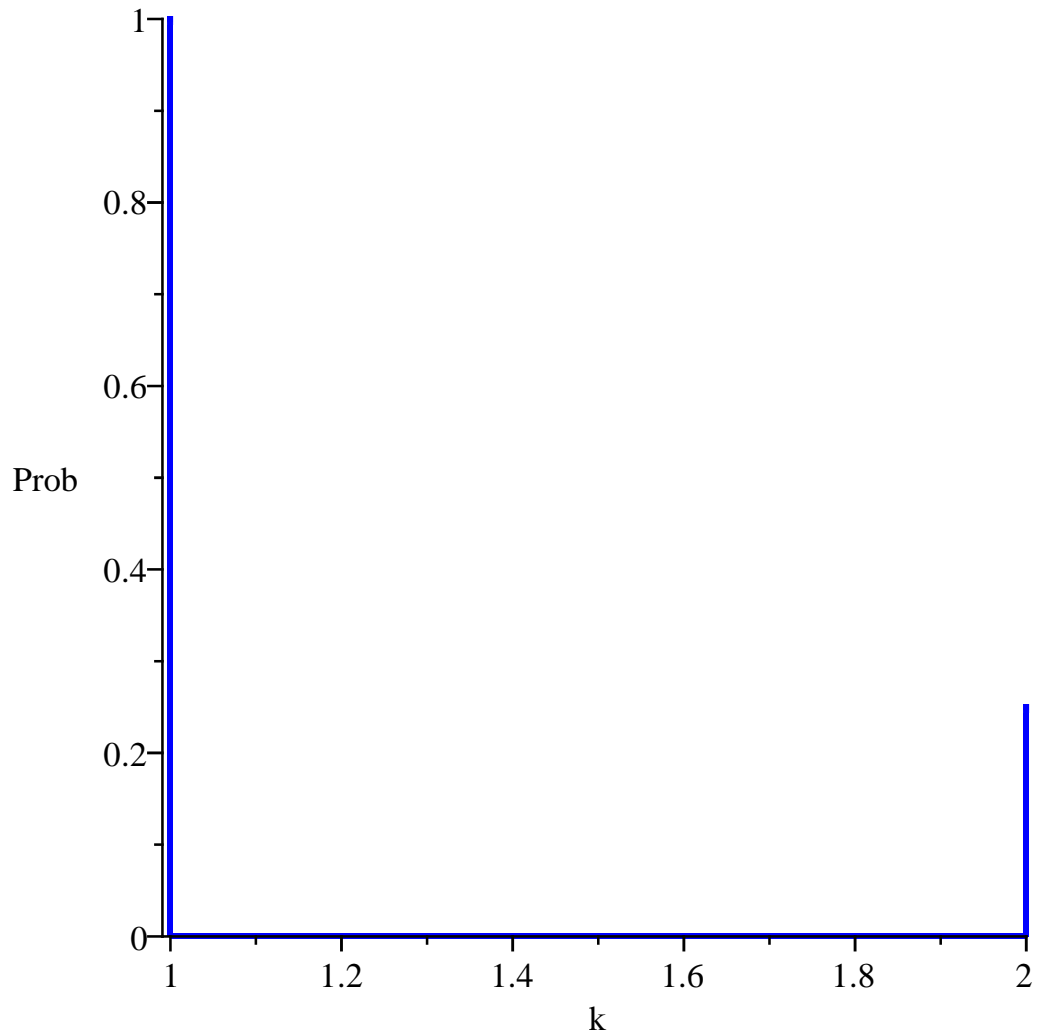             **return** 1
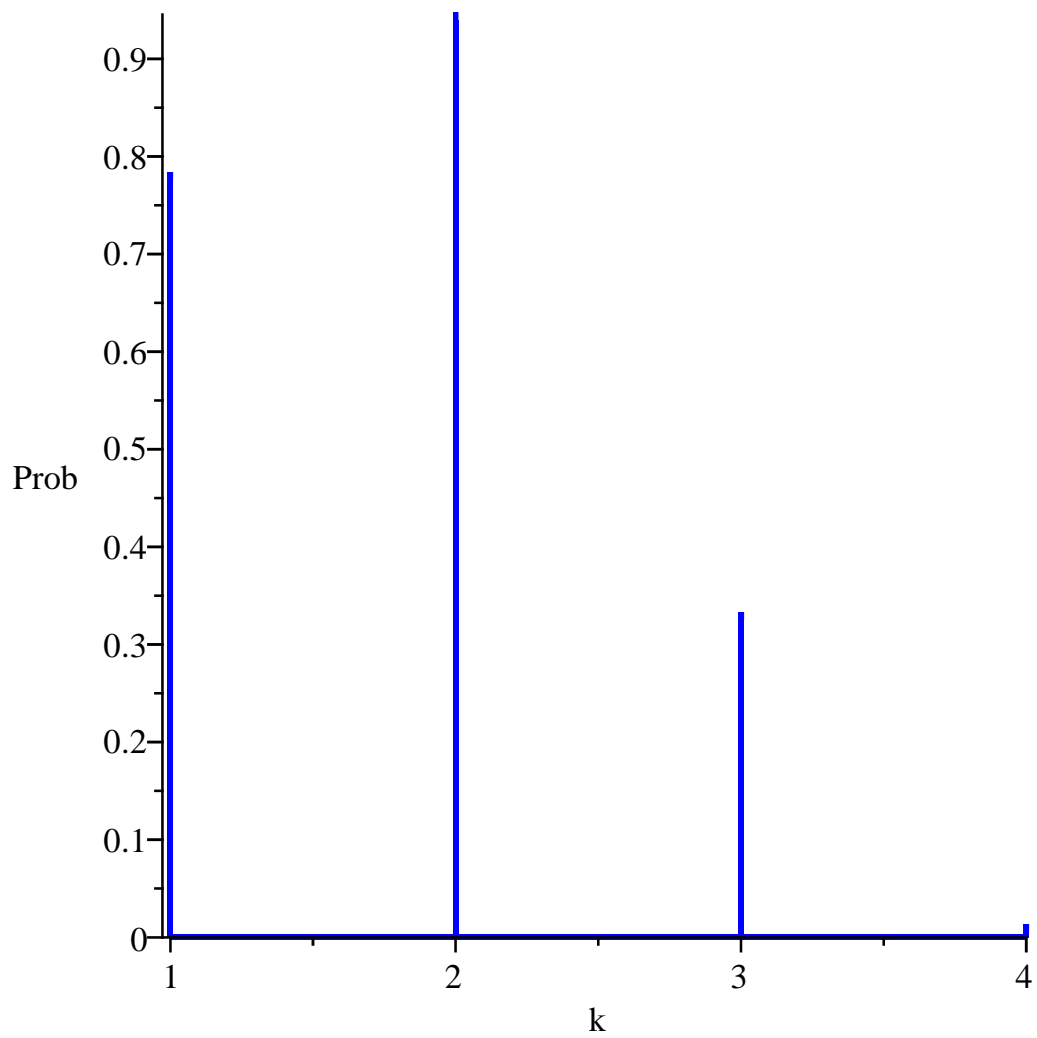            **end if**;
          **end proc**:
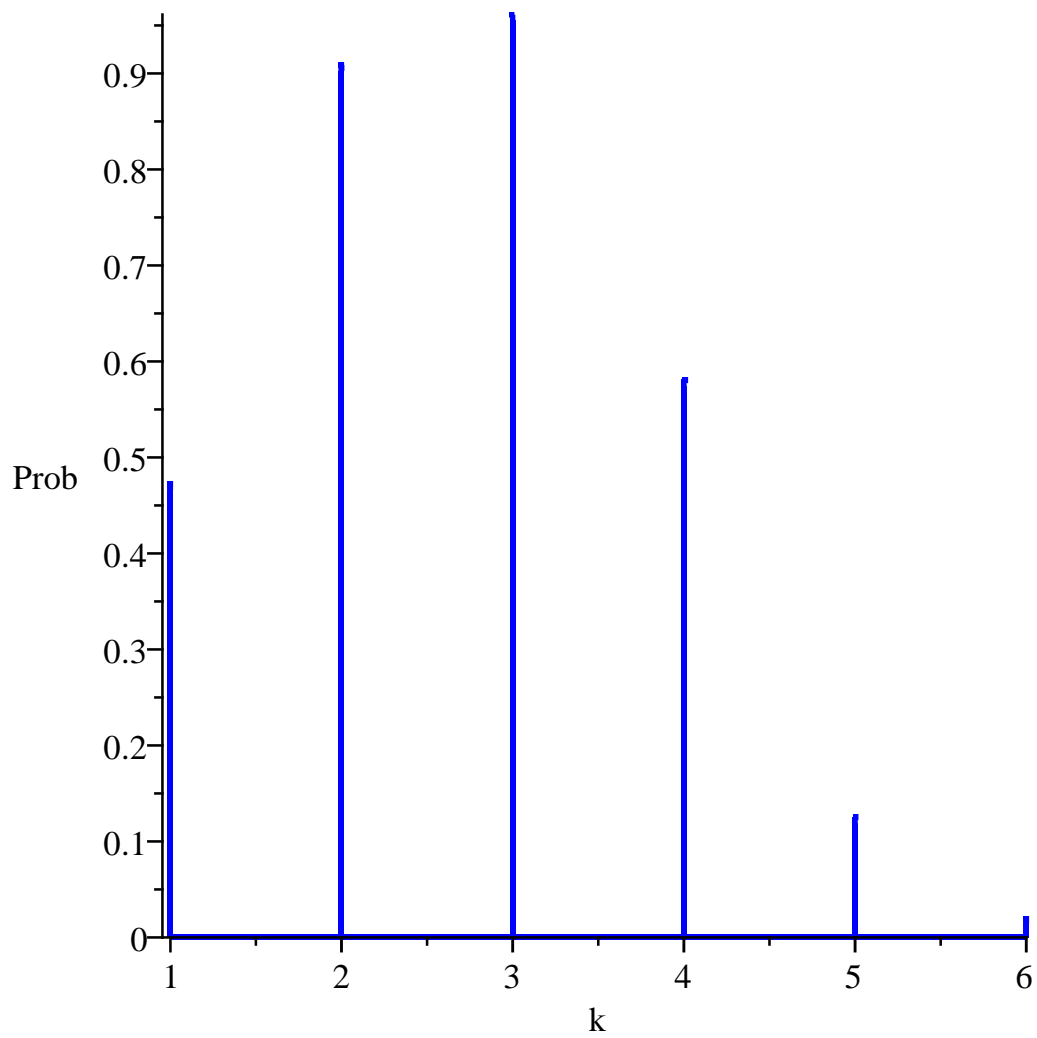
1 out of 4 search.
  theta is: 60.00 degrees
  k0 is: 1
  Px0 is: 1.000000
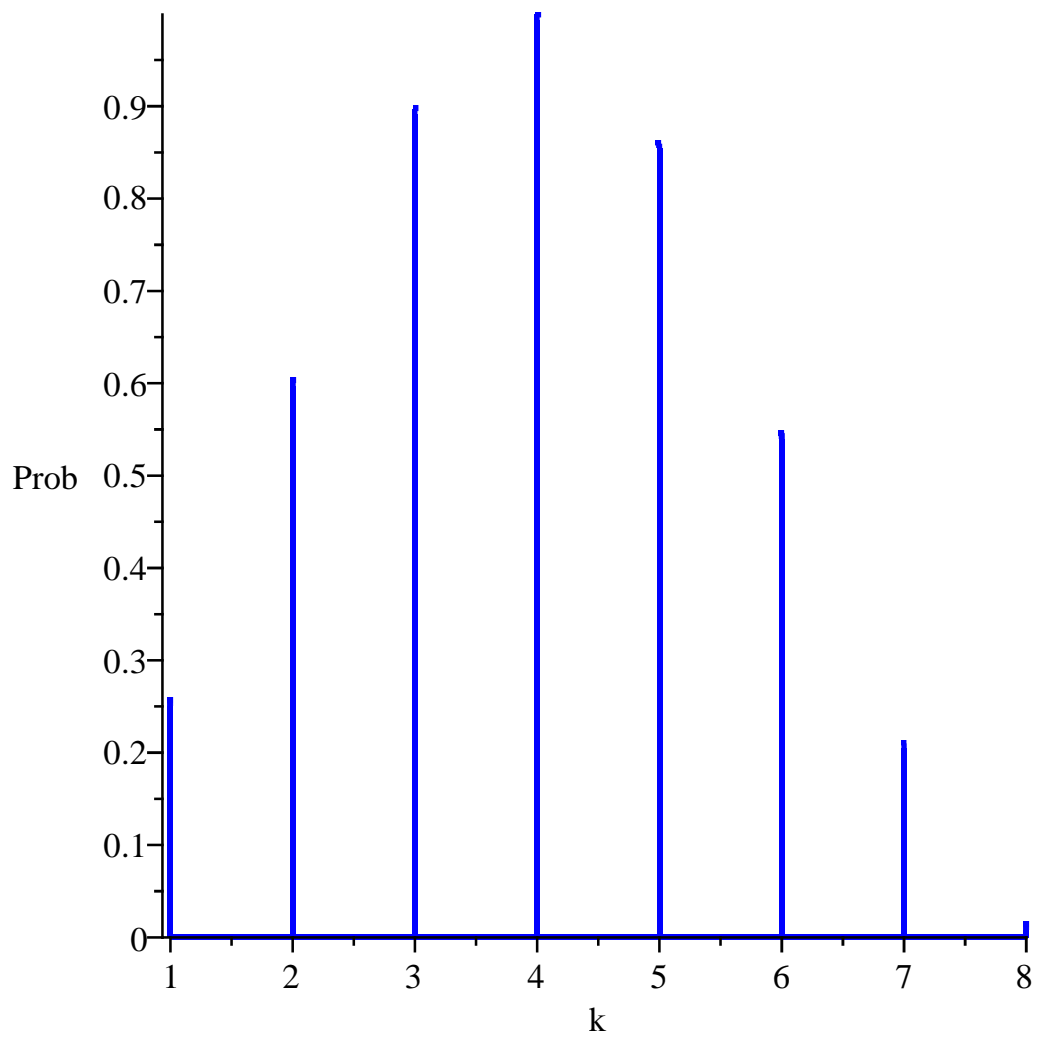
  theta is: 41.41 degrees
  k0 is: 2
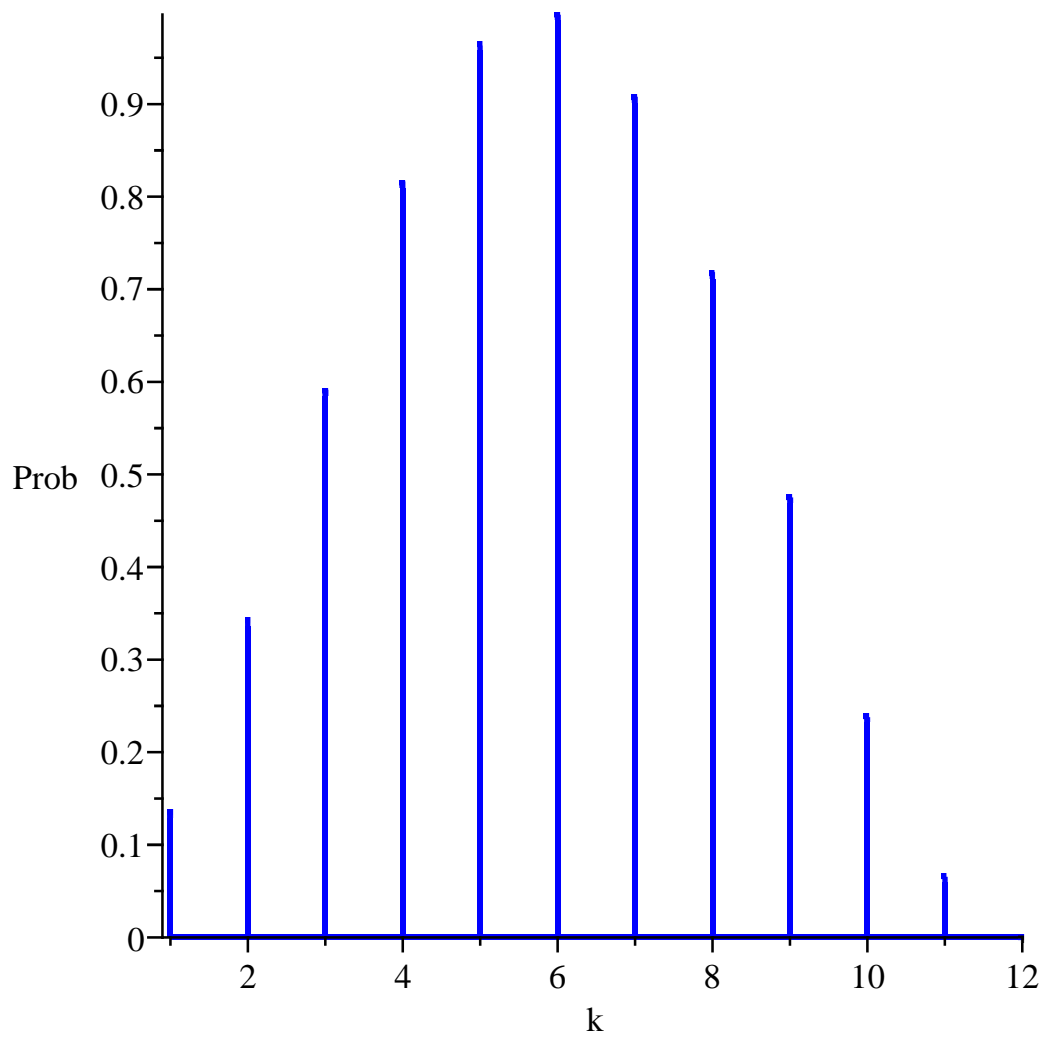  Px0 is: 0.945313

1 out of 16 search.
  theta is: 28.96 degrees
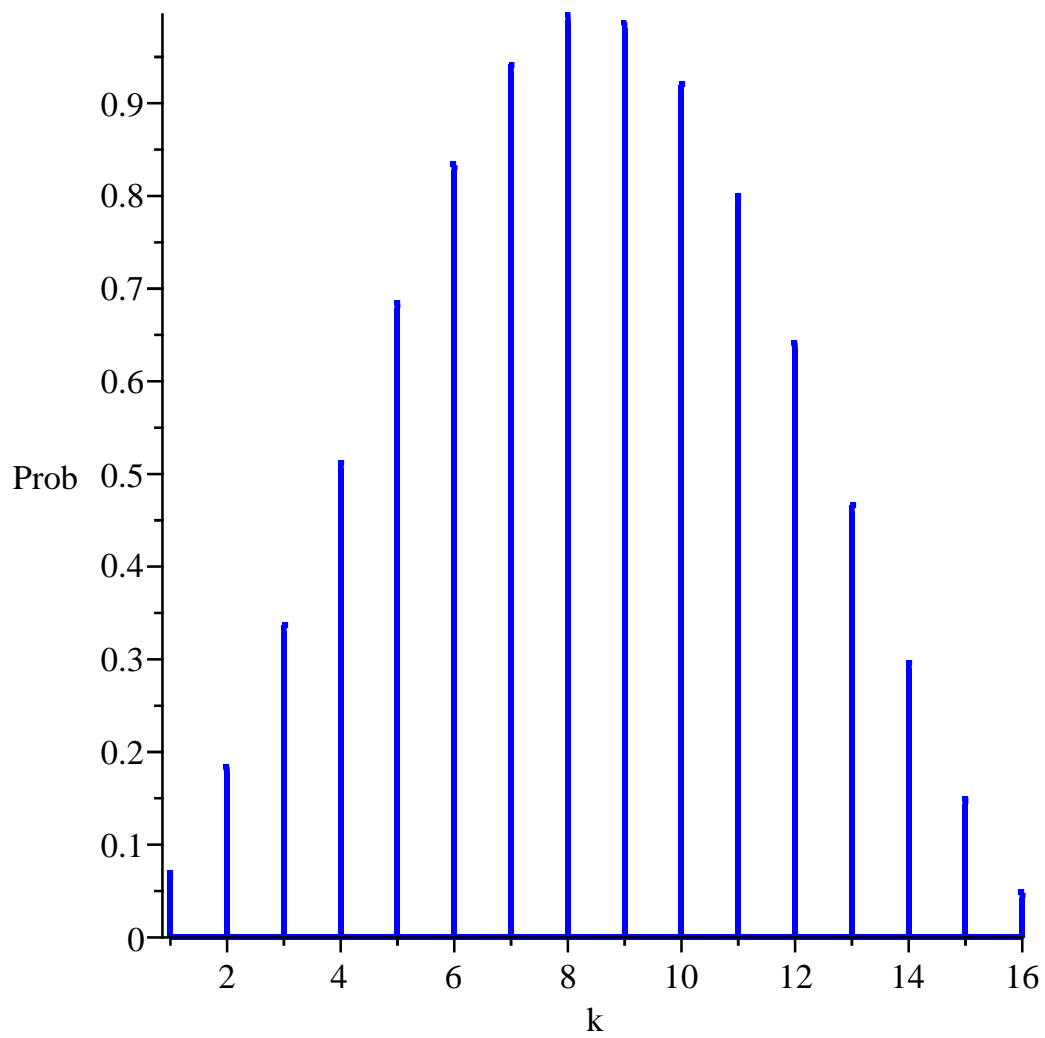  k0 is: 3
  Px0 is: 0.961319

1 out of 32 search.
  theta is: 20.36 degrees
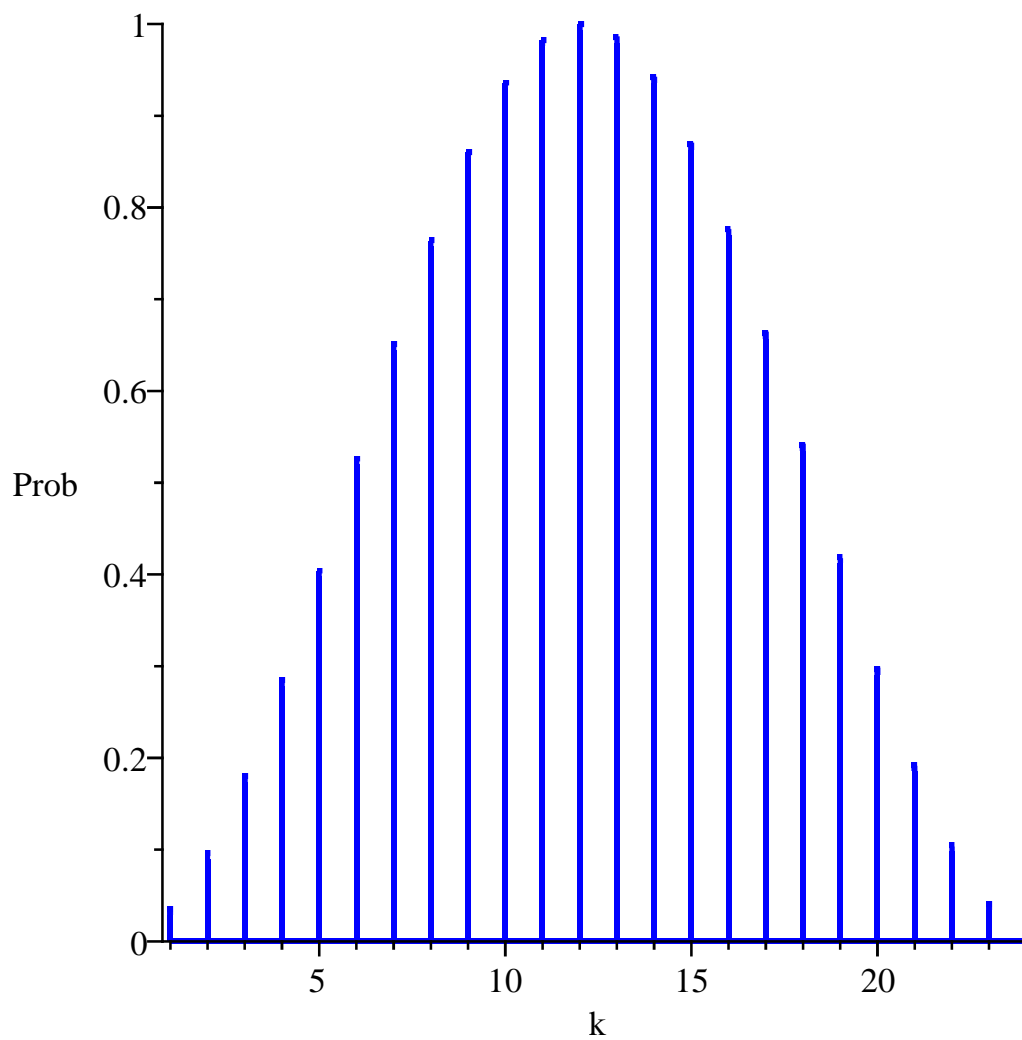  k0 is: 4
  Px0 is: 0.999182

1 out of 64 search.
  theta is: 14.36 degrees
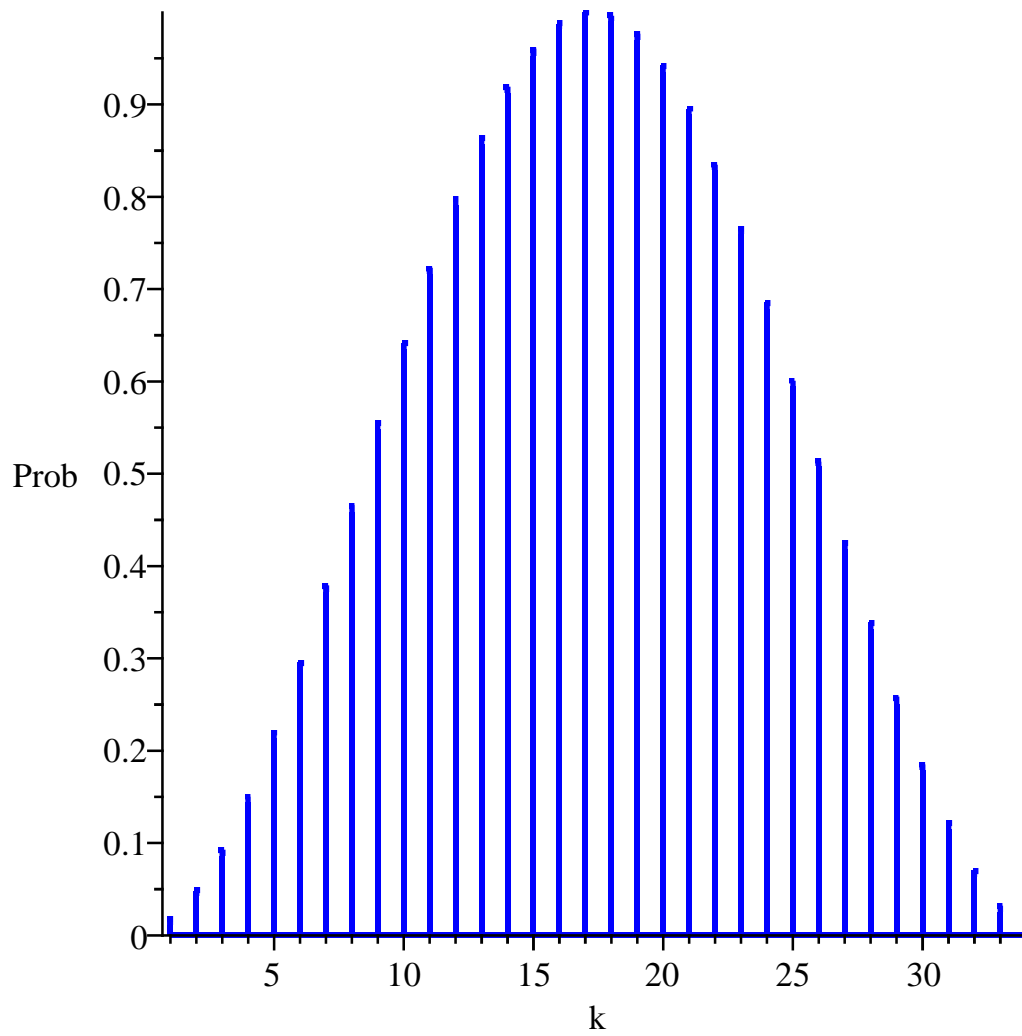  k0 is: 6
  Px0 is: 0.996586

1 out of 128 search.
  theta is: 10.14 degrees
  k0 is: 8
  Px0 is: 0.995620

1 out of 256 search.
  theta is: 7.17 degrees
  k0 is: 12
  Px0 is: 0.999947

1 out of 512 search.
  theta is: 5.07 degrees
  k0 is: 17
  Px0 is: 0.999448

1 out of 1024 search.
theta is: 3.58 degrees
k0 is: 25
Px0 is: 0.999461