a) The degree distribution of this network, for any N, is:

Degree	**Probability**
1	(N-1)/N
N	1/N

b) First, calculate the mean degree:

$$\langle k\rangle=\frac{1\times N+(N-1)\times 1}{N}\approx 2\frac{N}{N}=2$$

After that, it's possible to calculate q_k of 1 and N

$$q_1=\frac{kp_k}{\langle k\rangle}=\frac{1\times\frac{N-1}{N}}{2}=\frac{N-1}{2N} \qquad q_N=\frac{kp_k}{\langle k\rangle}=\frac{N\times\frac{1}{N}}{2}=\frac{N}{2N}=\frac{1}{2}$$

As N is much larger than 1, we can assume that $N-1\approx N$ and :

$$q_1=\frac{N}{2N}=\frac{1}{2}$$

Finally, as q_1 and q_N are the same, $q_k=\frac{1}{2}$ for any k in this graph.

c)

$$\sigma^2=\sum_k kq_k^2-[\sum_k kq_k]^2=\frac{(N+1)}{4}-\frac{(N+1)^2}{4}=\frac{(N+1)-(N^2+2N+1)}{4}=\frac{-(N^2+N)}{4}$$

$$r=\sum_{jk}\frac{jk(e_{jk}-q_j q_k)}{\sigma^2}=\frac{1\times 1(e_{11}-q_1 q_1)}{\sigma^2}+\frac{1\times N(e_{1N}-q_1 q_N)}{\sigma^2}+\frac{N\times 1(e_{N1}-q_N q_1)}{\sigma^2}+\frac{N\times N(e_{NN}-q_N q_N)}{\sigma^2}$$

$$r=\frac{1\times 1(\frac{1}{2}-\frac{1}{4})}{\sigma^2}+\frac{1\times N(0-\frac{1}{4})}{\sigma^2}+\frac{N\times 1(0-\frac{1}{4})}{\sigma^2}+\frac{N\times N(\frac{1}{2}-\frac{1}{4})}{\sigma^2}=\frac{\frac{2}{4}-\frac{N}{4}-\frac{N}{4}+\frac{2N^2}{4}}{\sigma^2}$$

As N is much larger than 1, we can assume that $N\rightarrow\infty$ and :

$$r=\frac{\frac{2-2N+2N^2}{4}}{\frac{-(N^2+N)}{4}}=\frac{2(N^2-N+1)}{-(N^2+N)}\Rightarrow\frac{\infty}{-\infty}=-1$$

d) The star network is disassortative, mainly because of two reasons:

- By concept, the network hub connects only with nodes of degree 1, meaning that it prefers to link with low-degree nodes than other main hubs.
- The value of r is minor than 0.