same $T$ yields same gradient at well bore
different $S$ yields different volume drawdown cone
smaller $S$ yields proportionally larger cone

Steady state:
$T$ differences persist
$S$ differences do not

Hydraulic Diffusivity $D = \frac{T}{S}$
relative rate at which the drawdown cone advances from the well
THINK in 3 Dimensions! … plan view:

Explore the influence of pumping and the gradient on the flow field using a groundwater flow model.

The area is surrounded by contours 42 and 44, thus heads must be between these values.

s vs. log r - is a straight line, if assumptions are met, drawdown decreases logarithmically with distance from the well because gradient decreases linearly with increasing area (2\pi rh).

\[ s = \log r \]

\[ Q = \frac{2\pi T (h_2 - h_1)}{\ln(r_2/r_1)} \]

**Theim Eqtn**

**T** = transmissivity \([L^2/T]\)

**Q** = discharge from pumped well \([L^3/T]\)

**r** = radial distance from the well \([L]\)

**h** = head at \(r\) \([L]\)

Plot before applying equations:

- to verify conditions are appropriate for application of equations
- to identify data problems

and rearranging to get \(T\) from field data:

\[ T = \frac{Q}{2\pi (h_2 - h_1) \ln \left( \frac{r_2}{r_1} \right)} \]
In an unconfined aquifer, \( T \) is not constant. If drawdown is small relative to saturated thickness, confined equilibrium formulas can be applied with only minor errors. Otherwise, call on Dupuit assumptions and use:

\[
Q = \pi K \frac{(h_2^2 - h_1^2)}{\ln(r_2/r_1)}
\]

or, to determine \( K \) from field measurements of head:

\[
K = \frac{Q \ln\left(\frac{r_2}{r_1}\right)}{\pi (h_2^2 - h_1^2)}
\]

\( Q \) = pumping rate [L\(^3\)/T]  
\( K \) = permeability [L/T]  
\( h_i \) = head @ a distance \( r_i \) from well [L]  

using the aquifer base as datum.

The aquifer base must be the datum because the head not only represents the gradient but also reflects the aquifer thickness, hence the flow area.

**Predict Drawdown Using Theis Equation**

Class picks:  
\( T \)  
\( S \)  
\( r \)  
\( t \)  
\( Q \)  

1x10\(^{-3}\)m\(^2\)/s  
1x10\(^{-5}\)  
2m  
year  
0.01m/s  

Take 3 minutes to calculate:  
\( s \)

\[
s = h_o - h = \frac{Q}{4\pi T} W(u)  
\]

\[
u = \frac{r^2 S}{4T}  
\]

USE table of \( W(u) \) from 3 slides back.

\[
W(u) = \int_0^u \frac{e^{-u}}{u} du = [-0.5772 - \ln u + \frac{u^2}{2 \cdot 2!} - \frac{u^3}{3 \cdot 3!} + \frac{u^4}{4 \cdot 4!} + \ldots]  
\]

What value did you get for \( s \)?  
\(~15m\)