EXAM and KEYS are on the class web page
Let’s review that now

Leaky Aquifers

subscript 1 = pumped zone
subscript 2 = unpumped aquifer
prime = aquitard
Q = pumping rate
b = thickness
K = hydraulic conductivity
S = specific storage

assume:
- no head change in unpumped aquifer
- horizontal flow in aquifers
- vertical flow in aquitards
- aquifer extends far enough to intercept enough leakage to satisfy Q
- Theis assumptions (other than impermeable aquitard) apply

What conditions justify assuming no head change in the unpumped aquifer?
A sufficiently permeable unpumped aquifer so flow to the "disk" above the drawdown cone is low enough to require nearly zero gradient.

Average = 81.7

<table>
<thead>
<tr>
<th></th>
<th>#students</th>
<th>%students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&gt;90</td>
<td>16</td>
</tr>
<tr>
<td>B</td>
<td>80-90</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>70-80</td>
<td>12</td>
</tr>
<tr>
<td>D</td>
<td>60-70</td>
<td>5</td>
</tr>
<tr>
<td>F</td>
<td>50-60</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>&lt;50</td>
<td>3</td>
</tr>
</tbody>
</table>
What will happen that did not occur in the completely confined aquifer?

Vertical leakage, first from storage in the aquitard, then from the shallow aquifer.

What do we expect regarding the magnitude of leakage?
Greatest leakage where head difference is largest, decreasing away from the well.

What will be the maximum extent of drawdown?
Drawdown will be limited to the radius at which the entire $Q$ leaks from the upper aquifer to the lower.

What controls the rate of drawdown cone development?
S & T of aquifer AND S and Kv of the aquitard

Will drawdown vs time at the red observation well look more like? .....
At the start all heads are 100, then decrease at the well

Contour Interval = 0.5ft

Major interval RED
Minor interval BLUE

K = $1 \times 10^{-1}$ ft/day
K' = $1 \times 10^{-6}$ ft/day
S & S' = $1 \times 10^{-5}$
b = 10 ft  b' = 5 ft
Q = 0.2 GPM
head in shallow aquifer = 100ft

W(u,r/B)=0.6  (r/B=1.0)
s=0.08m

1/u=0.8  150 sec

Calculate
$K_1 S_{s1} K'$

Q=0.004 m$^3$/sec  b$_1$=30.5m
r=55m  b'=3.05m
Q = 0.004 m³/sec  \quad b_1 = 30.5 m
r = 55 m  \quad b' = 3.05 m
W(u, r/b) = 0.6  \quad (r/B = 1.0)  \quad 1/u = 0.8  \quad u = 1.25
s = 0.08 m

\begin{align*}
s &= 0.004 m^3/sec \\ T &= 0.004 m^3/sec \\ & \cdot 0.6 \\ &= 2.4 \times 10^{-3} m^2/sec \\
K_1 &= T/b = 7.8 \times 10^{-5} m/sec \\
K' &= (1/55m)^2 \times 7.8 \times 10^{-5} m/sec \times 30.5m \times 3.05m \\
&= 2.4 \times 10^{-6} m/sec \\
S &= (1.25 \times 4 \times 2.4 \times 10^{-3} m^2/sec \times 150 sec)/(55m)^2 \\
&= 6 \times 10^{-4} \\
S' &= S/b = 2 \times 10^{-5} m^{-1} \\
\end{align*}