

# Groundwater with Darcy and Bernoulli

<https://www.youtube.com/user/MartinRHendriks/videos>



Henry Darcy (1803-1858)



Daniel Bernoulli (1700-1782)

## Importance of groundwater

- effluent seepage
- agriculture (crops)
- drinking water
- industry
- biodiversity

Groundwater needs to be protected from pollution and over-exploitation.





## Groundwater with Bernoulli

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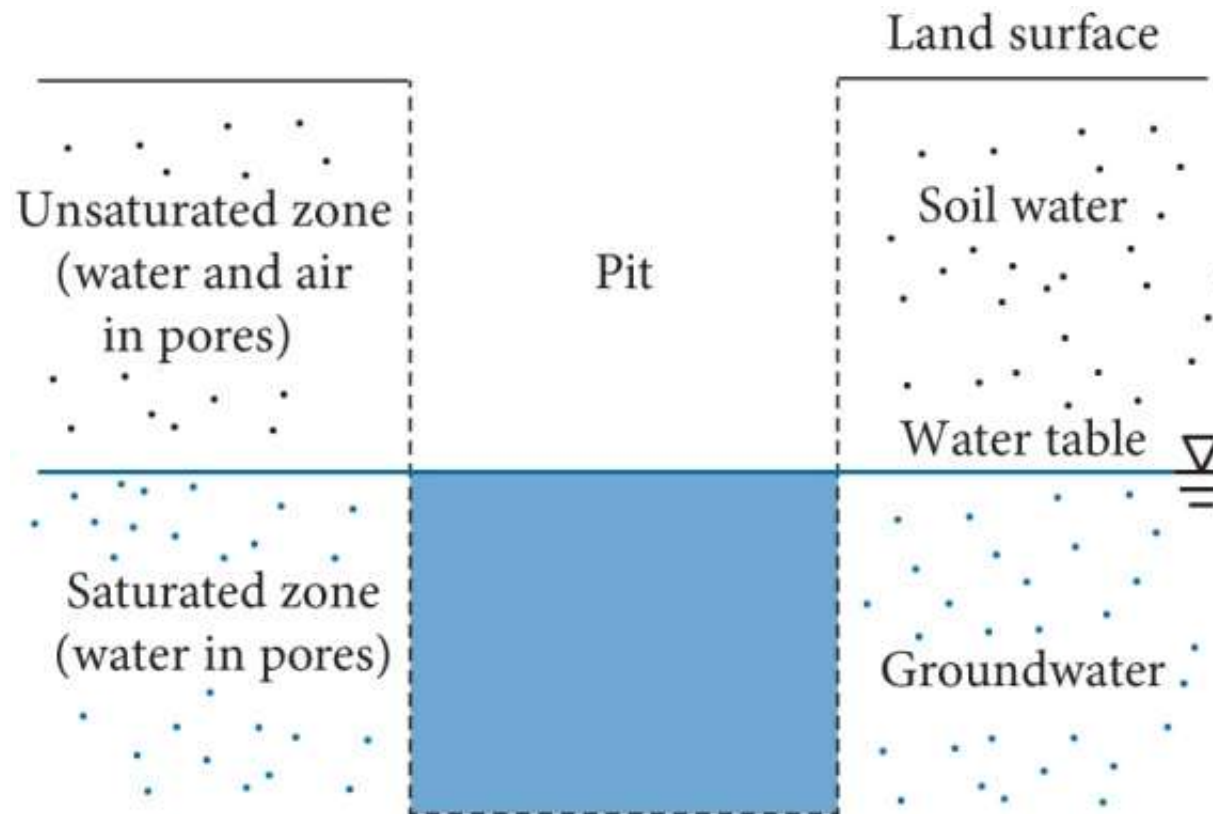
By law of nature, water flows from a higher to a lower

- A. elevation
- B. energy
- C. pressure
- D. All of the above options are true



# Water table

<https://www.youtube.com/user/MartinRHendriks/videos>



# Model between two glass plates

<https://www.youtube.com/user/MartinRHendriks/videos>



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75 cm high  
⇒ 80 m

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1.5 m wide ⇒ 13 km

>





# Model between two glass plates

<https://www.youtube.com/user/MartinRHendriks/videos>



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75 cm high  
⇒ 80 m

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By law of nature, water flows from a higher to a lower ENERGY!

(answer B)

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1.5 m wide ⇒ 13 km

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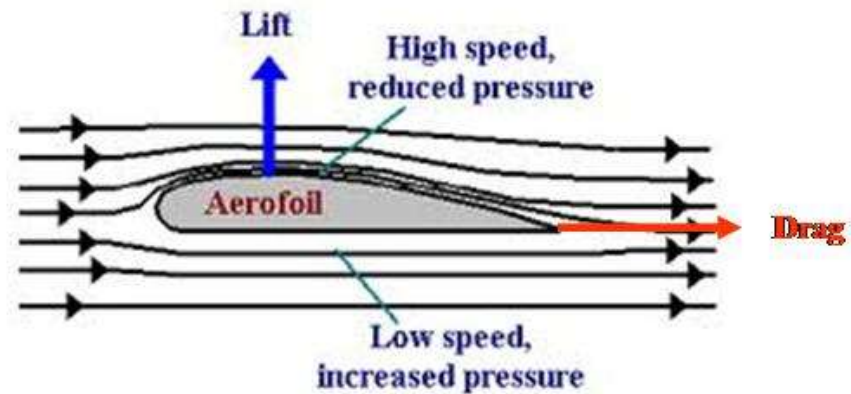
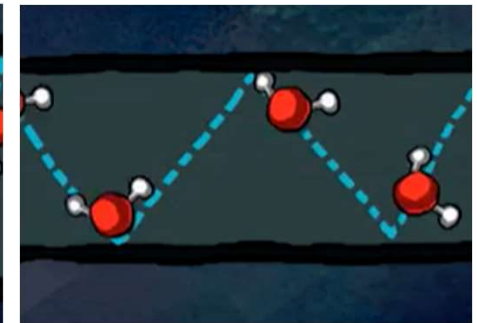
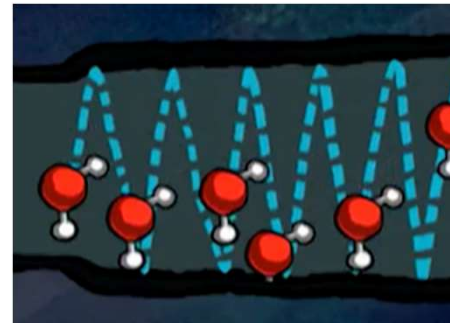


# Daniel Bernoulli (1700-1782)

<https://www.youtube.com/user/MartinRHendriks/videos>



Source: Wikipedia



<https://www.skybrary.aero/articles/bernoullis-principle>





# Leonhard Euler (1707-1783)

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Source: Wikipedia

$$\frac{1}{2}mv^2 + mgz + pV = \text{constant}$$

$$mgz + pV = \text{constant}$$

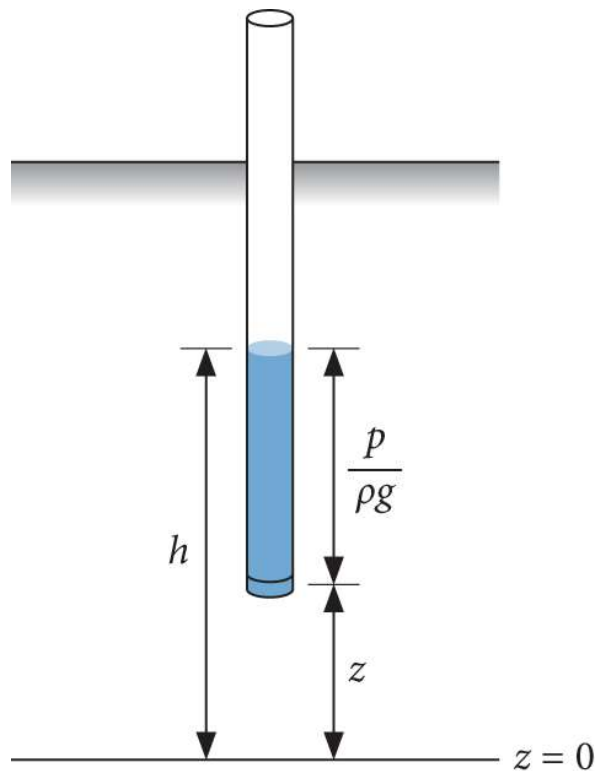
$$\rho gz + p = \text{constant}$$

$$z + \frac{p}{\rho g} = \text{constant}$$



# Bernoulli's law for groundwater

<https://www.youtube.com/user/MartinRHendriks/videos>



piezometer

$$h = z + \frac{p}{\rho g}$$

$h$  = hydraulic head (m)

$z$  = elevation head (m)

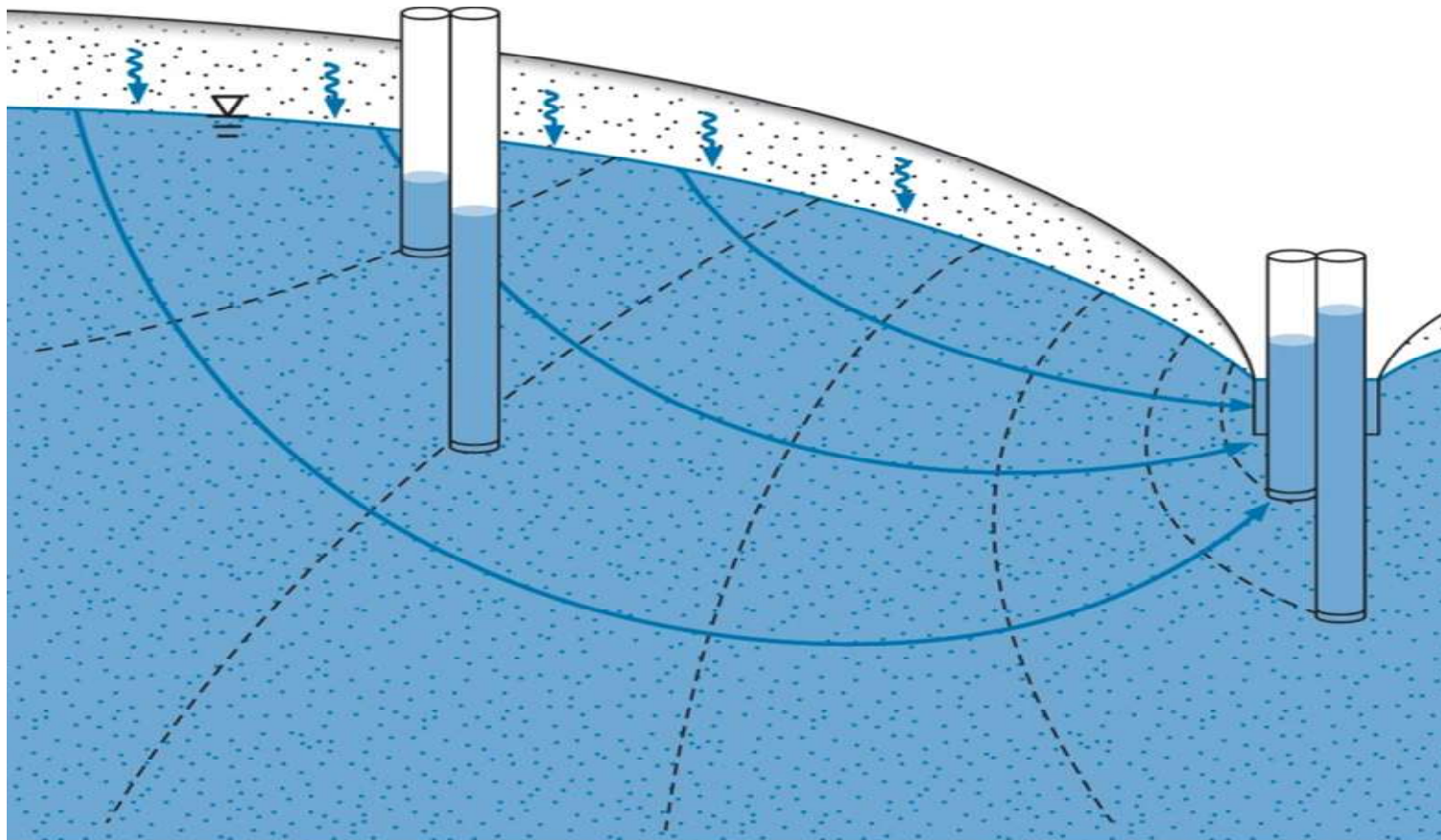
$\frac{p}{\rho g}$  = pressure head (m)





# Unconfined groundwater

<https://www.youtube.com/user/MartinRHendriks/videos>



Groundwater flow is in the direction of the lower hydraulic head!

