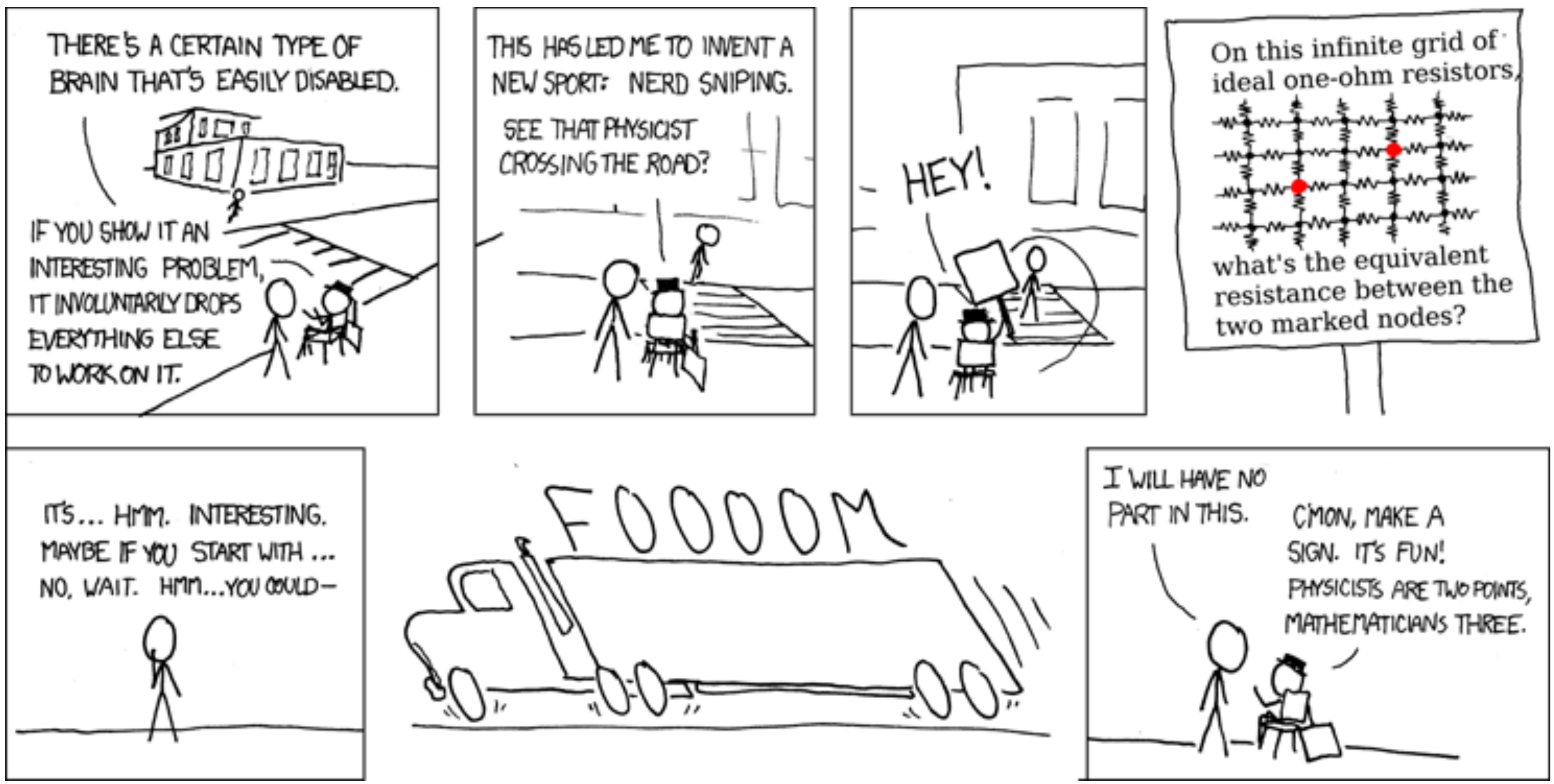
March 11, 2016 Physics 132 Dr. B. Dreyfus

- **<u>Theme Music:</u> John Williams, *March of the Resistance* (from *The Force Awakens*)**
- **<u>Cartoon:</u> Randall Munroe, *xkcd***

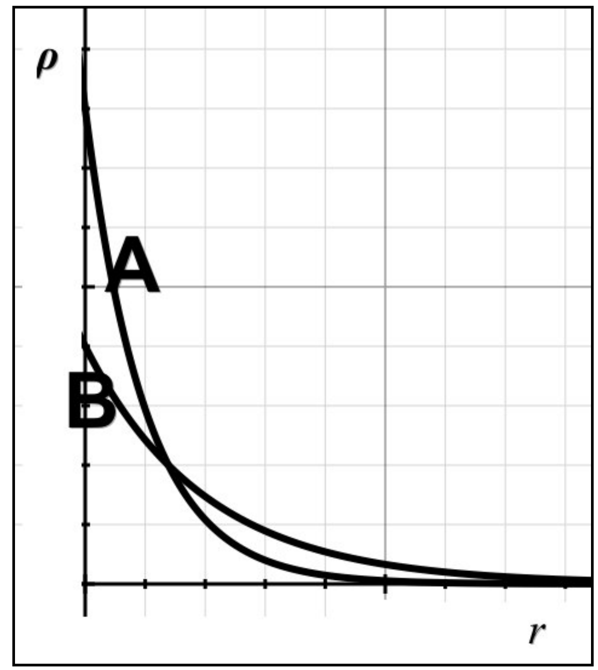


Today

- Going over the exam
- Nernst potential
- Electric current

Exam 1, Question 1.1

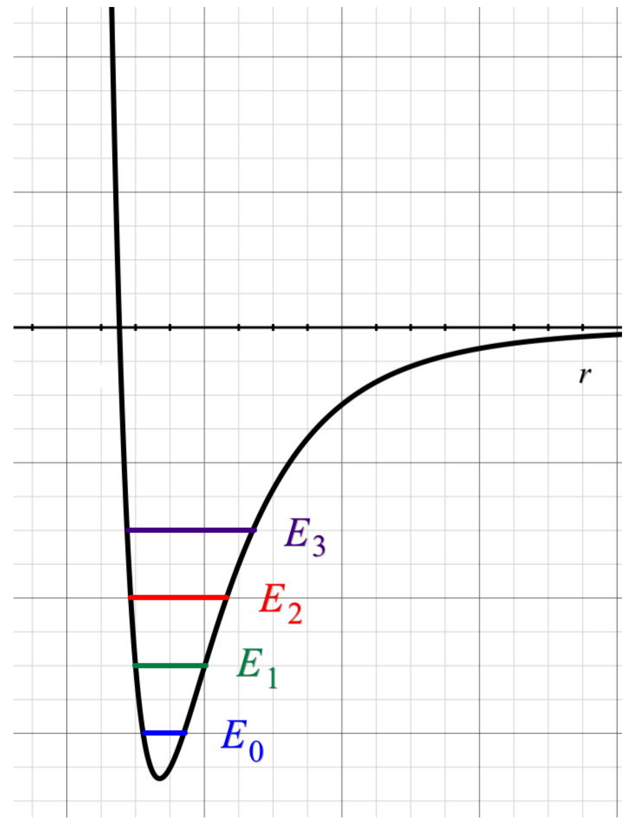
- $\rho \sim e^{-r/\lambda}$
- This is like temperature in the Boltzmann distribution
- B is spread out over a larger length.



Exam 1, Question 1.2

$$z = e^{-\varepsilon/k_B T}$$

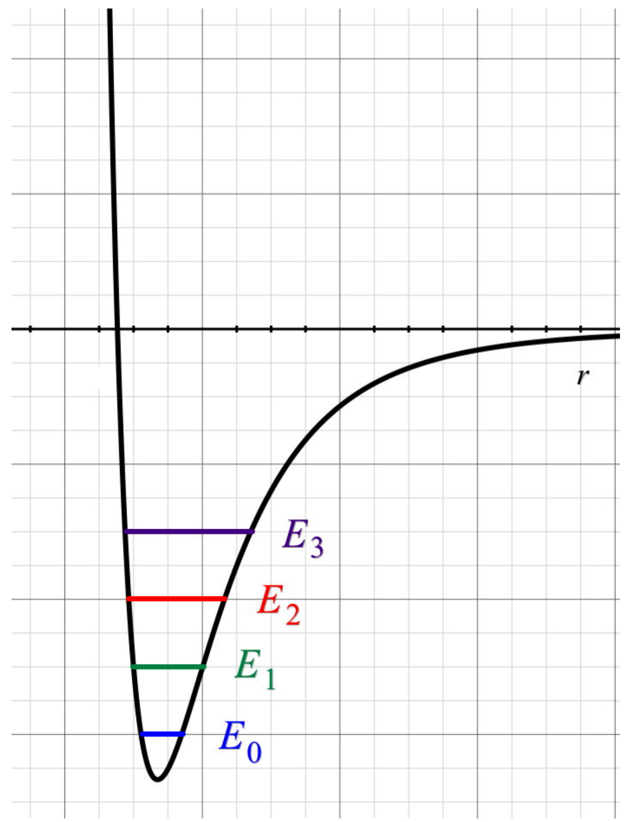
$$E_2 / E_0 = e^{-2\varepsilon/k_B T} = z^2$$



Exam 1, Question 1.3

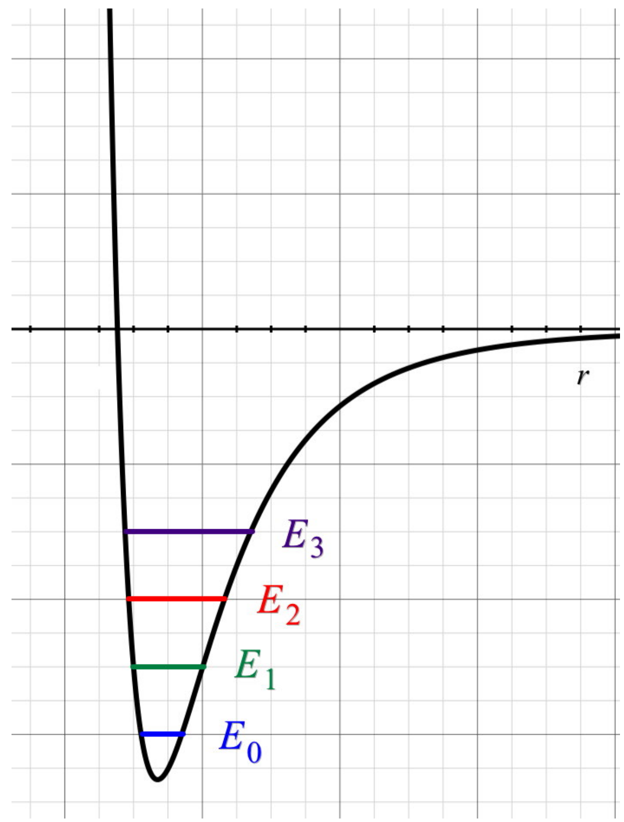
- I don't know!

- (But if it starts out at a low T where almost all molecules are in the ground state, it increases so A was also accepted.)



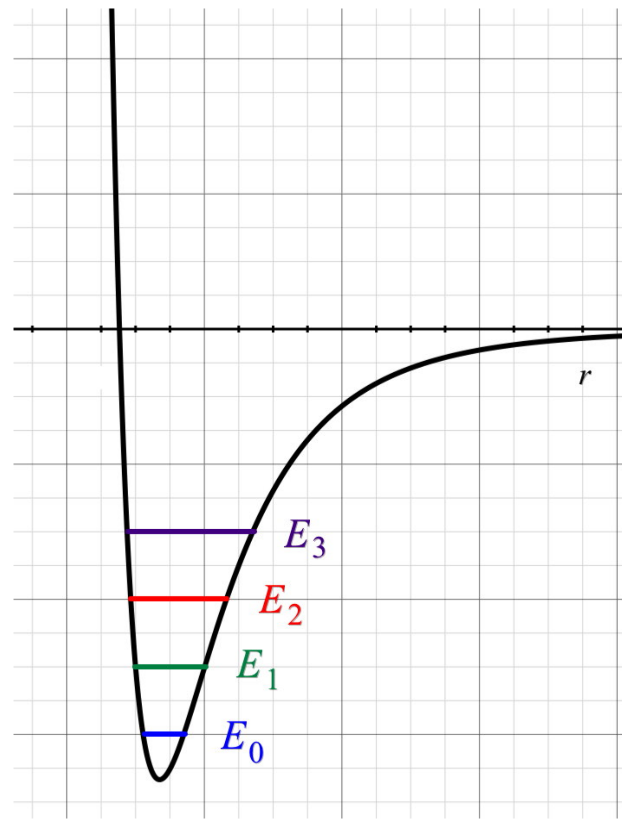
Exam 1, Question 1.4

- Decreases



Exam 1, Question 1.5

$$\frac{1}{1+z+z^2+z^3}$$



Exam 1, Question 2A.1

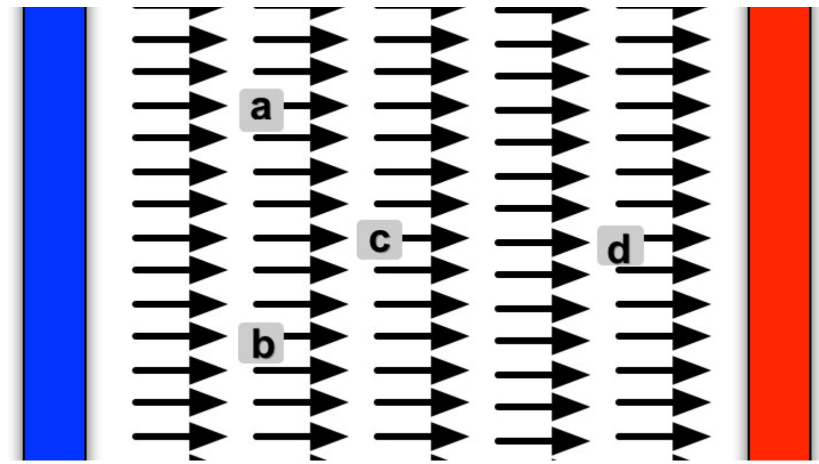
- $[k_C] = ML^3/T^2Q^2$
- $[E] = ML/T^2Q$

Exam 1, Question 2A.2

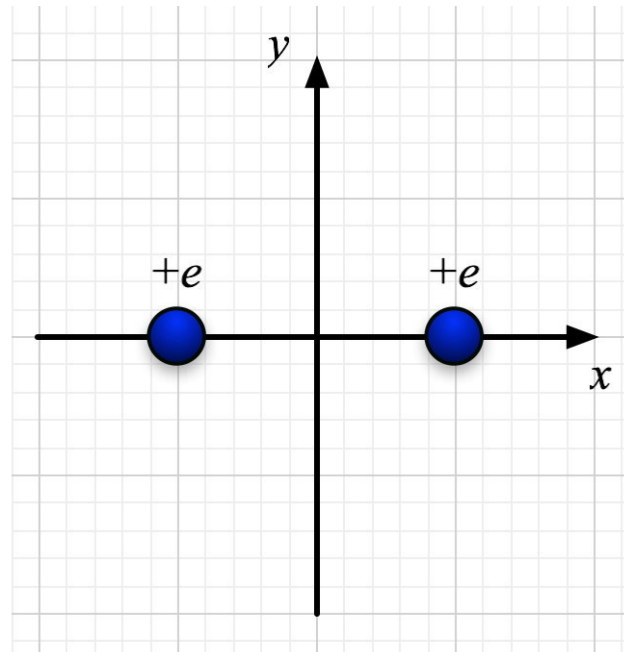
- $n = 1$

Exam 1, Question 2B

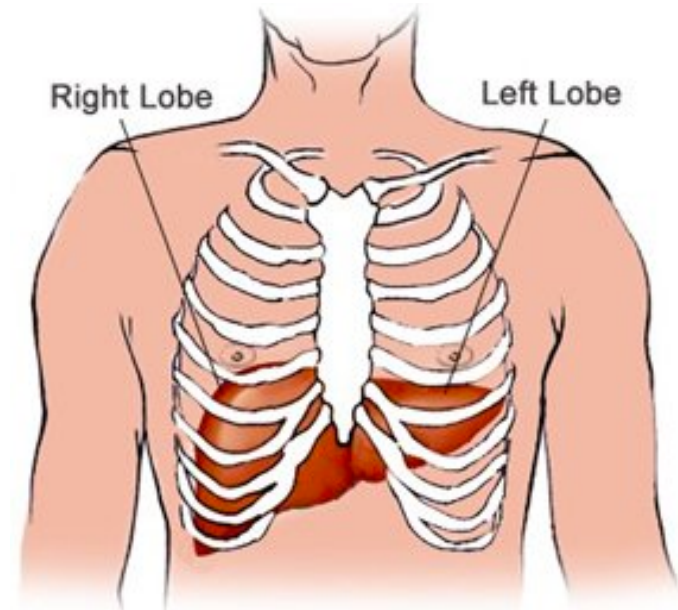
- $V_a = V_b > V_c > V_d$



Exam 1, Question 2C



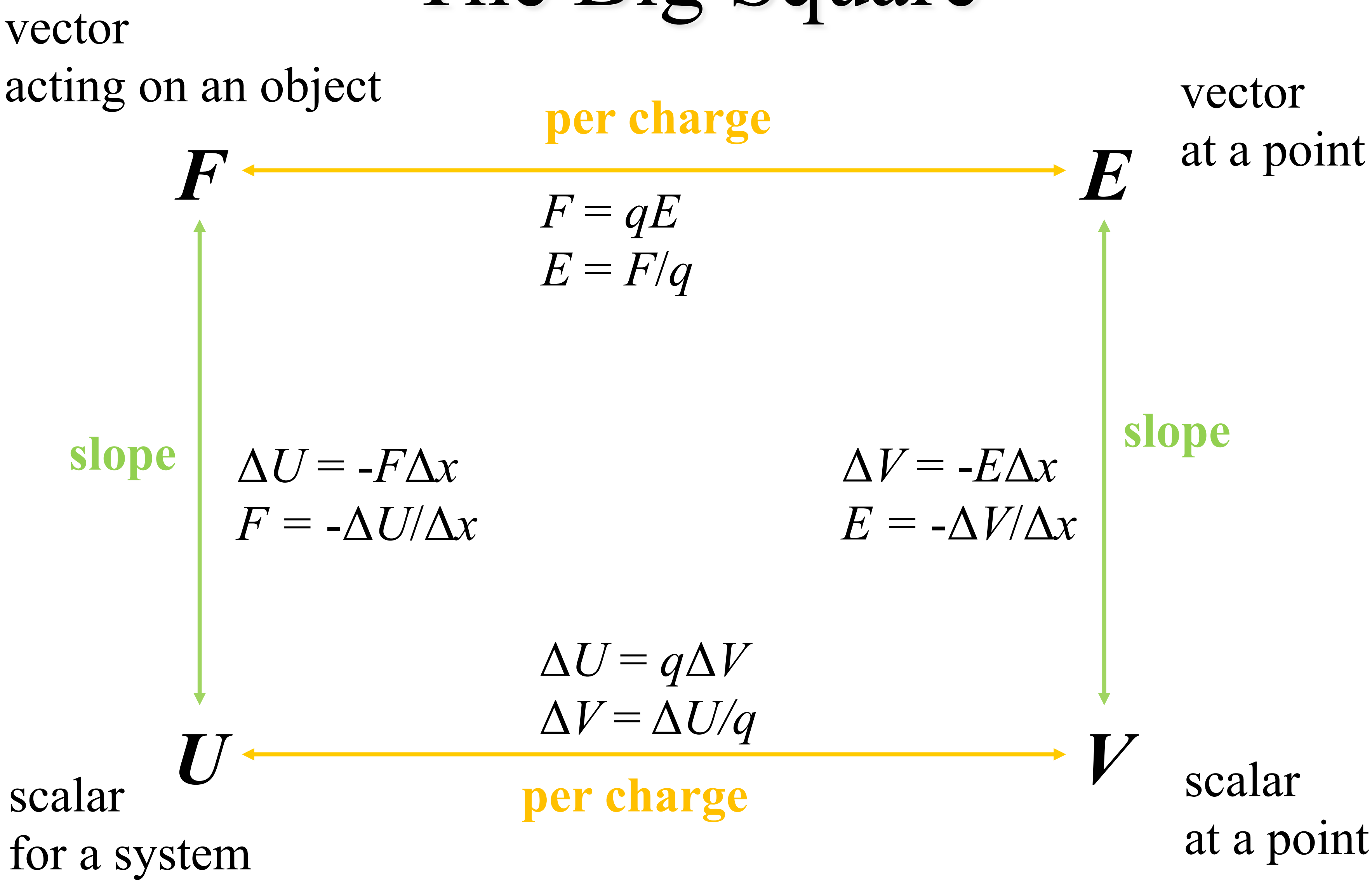
Exam 1, Question 3



- (Example:)
- $V_{\text{liver}} = (20\text{ cm})(10\text{ cm})(5\text{ cm})$
- $= 1000\text{ cm}^3 = 1000\text{ mL} = 1\text{ L}$
- $= 10\text{ dL}$
- Dosage $= (3\ \mu\text{g/dL})(10\text{ dL})$
- $= 30\ \mu\text{g}$

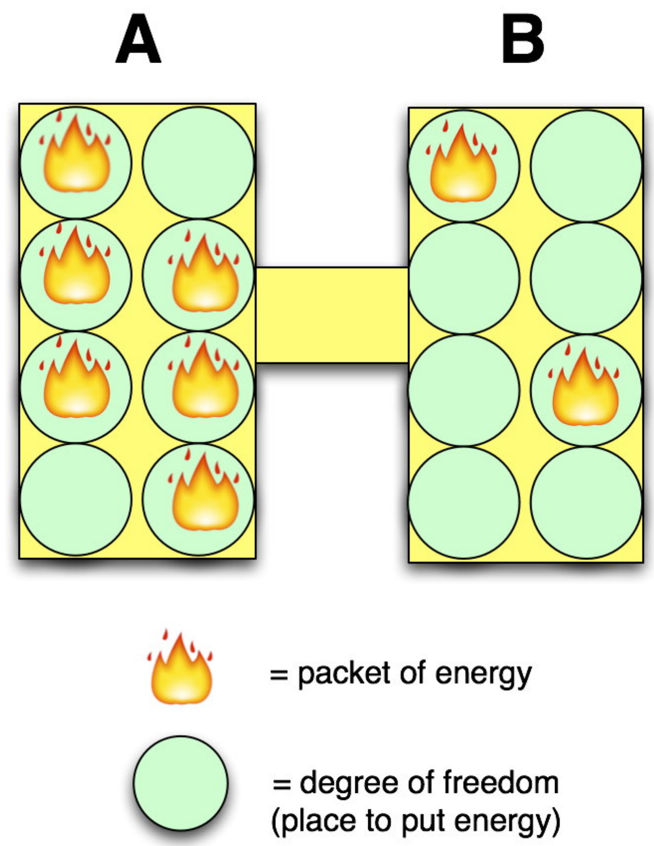
Exam 1, Question 4

“The Big Square”



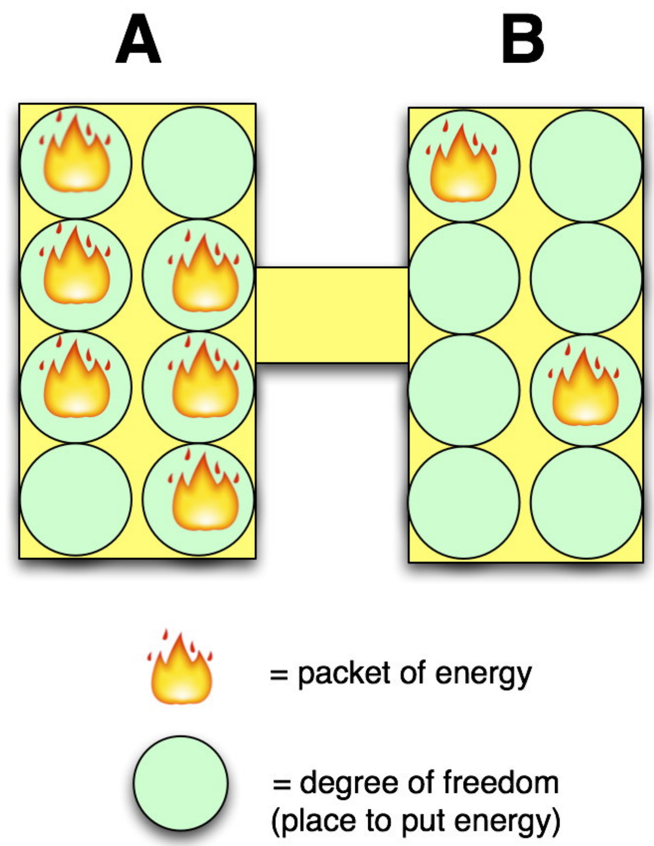
Exam 1, Question 5A

- Only 1 way to do it (filling up all 8 spots)
- $W = 1$
- $S = k_B \ln 1 = 0$



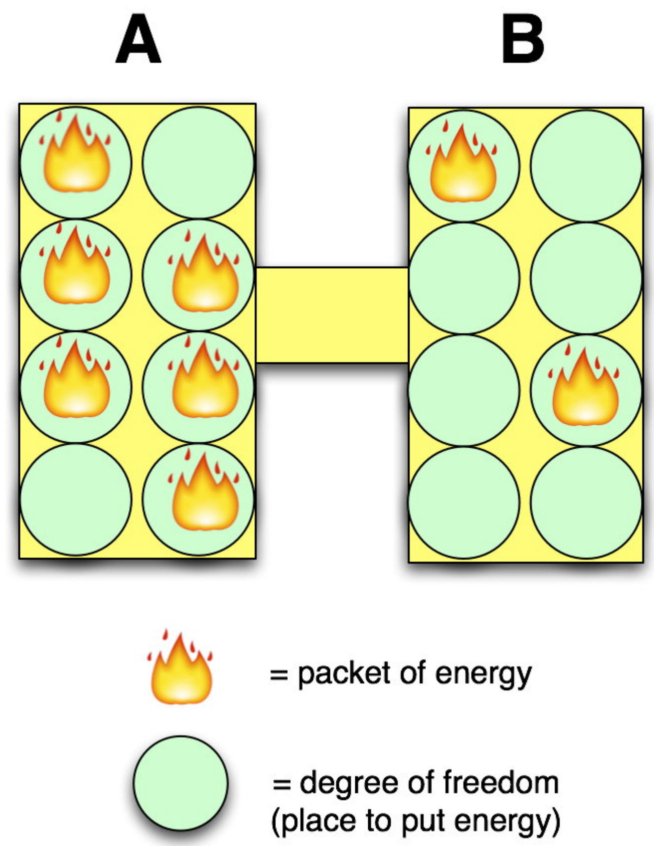
Exam 1, Question 5B1

- $W_A = (8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3)/6!$
  $= 28$
- $W_B = (8 \cdot 7)/2! = 28$
- $S_A = S_B = k_B \ln 28$



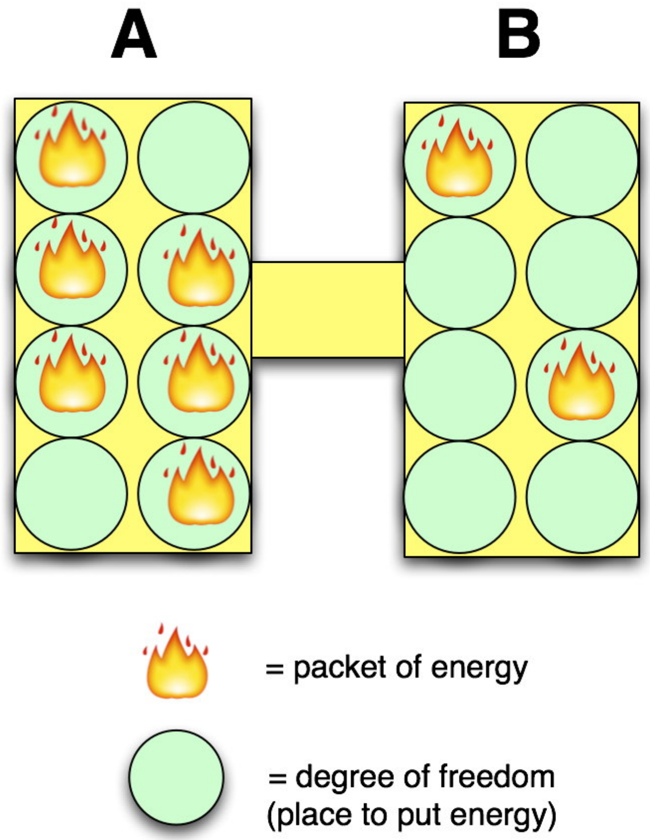
Exam 1, Question 5B2

- $W_{\mathrm{AB}} = W_{\mathrm{A}} W_{\mathrm{B}} = 28^2 = 784$
- $S_{\mathrm{AB}} = 2\ k_B \ln 28$



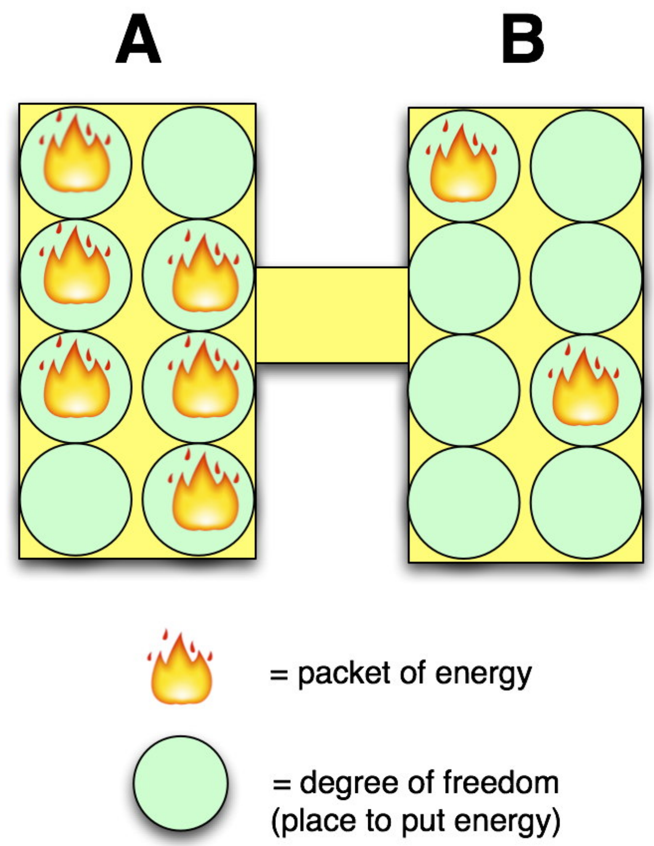
Exam 1, Question 5C

- Both larger
- Spread out more evenly = More entropy



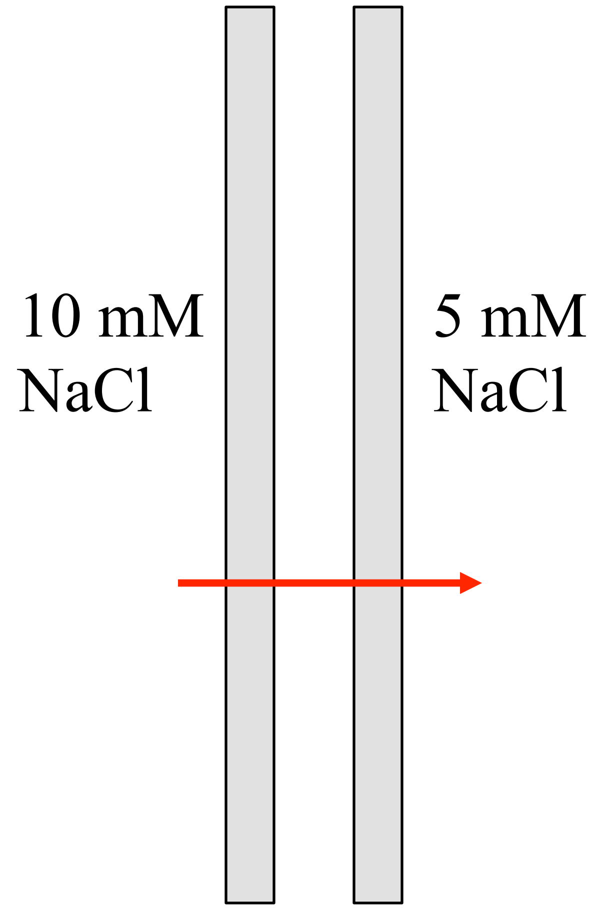
Exam 1, Question 5D

- Microstate = I
- Macrostate = B,C



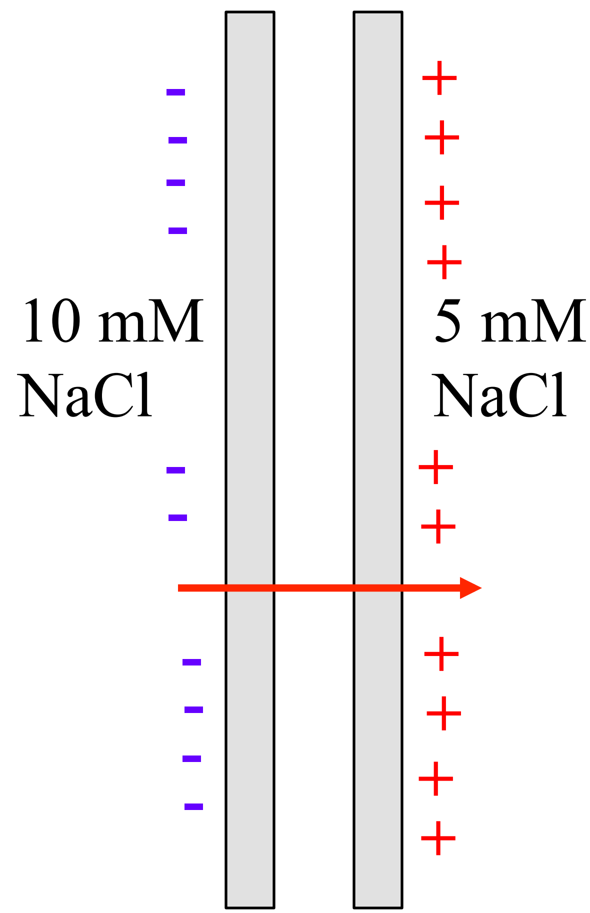
Nernst potential

- Remember diffusion
- There is a net flow from high to low concentration



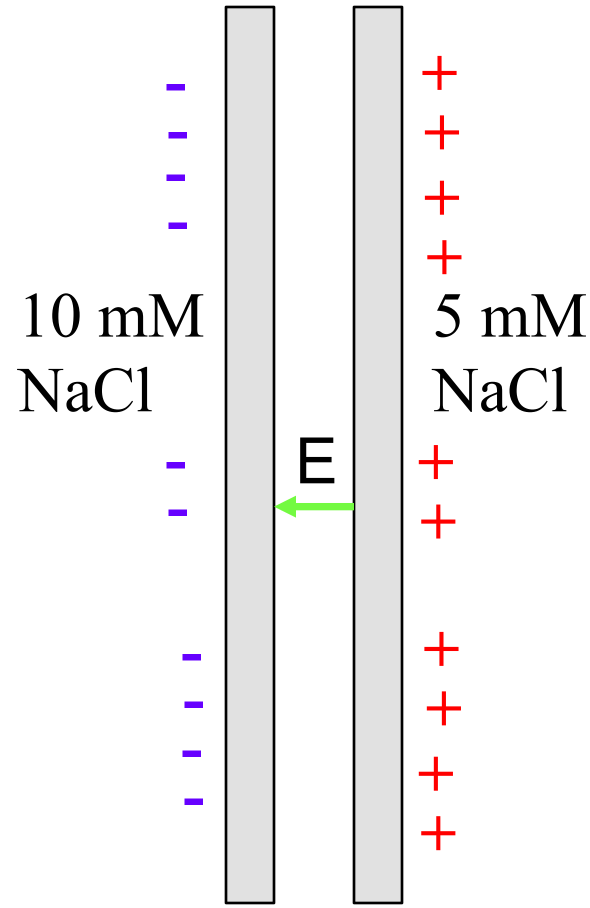
Nernst potential

- What if the membrane is permeable to some ions and not others?
- Then there is a net flow of charge
- Let's say it's permeable to Na^+ but not Cl^-



Nernst potential

- Now there's a potential difference!
- And an electric field!
- The electric field opposes the flow of charge, so the system reaches equilibrium



Nernst potential

- Once again, it's energy vs. entropy!
- Effect of energy (forces):
  - Responding to electric field
- Effect of entropy (random motion):
  - Diffusion from high to low concentration

Nernst potential

- We can find the potential using the Boltzmann distribution
- $c_1/c_2 = e^{-(\Delta U/k_B T)}$
- $-q\Delta V/k_B T = \ln c_1/c_2$
- $\Delta V = k_B T/q \ln c_1/c_2$