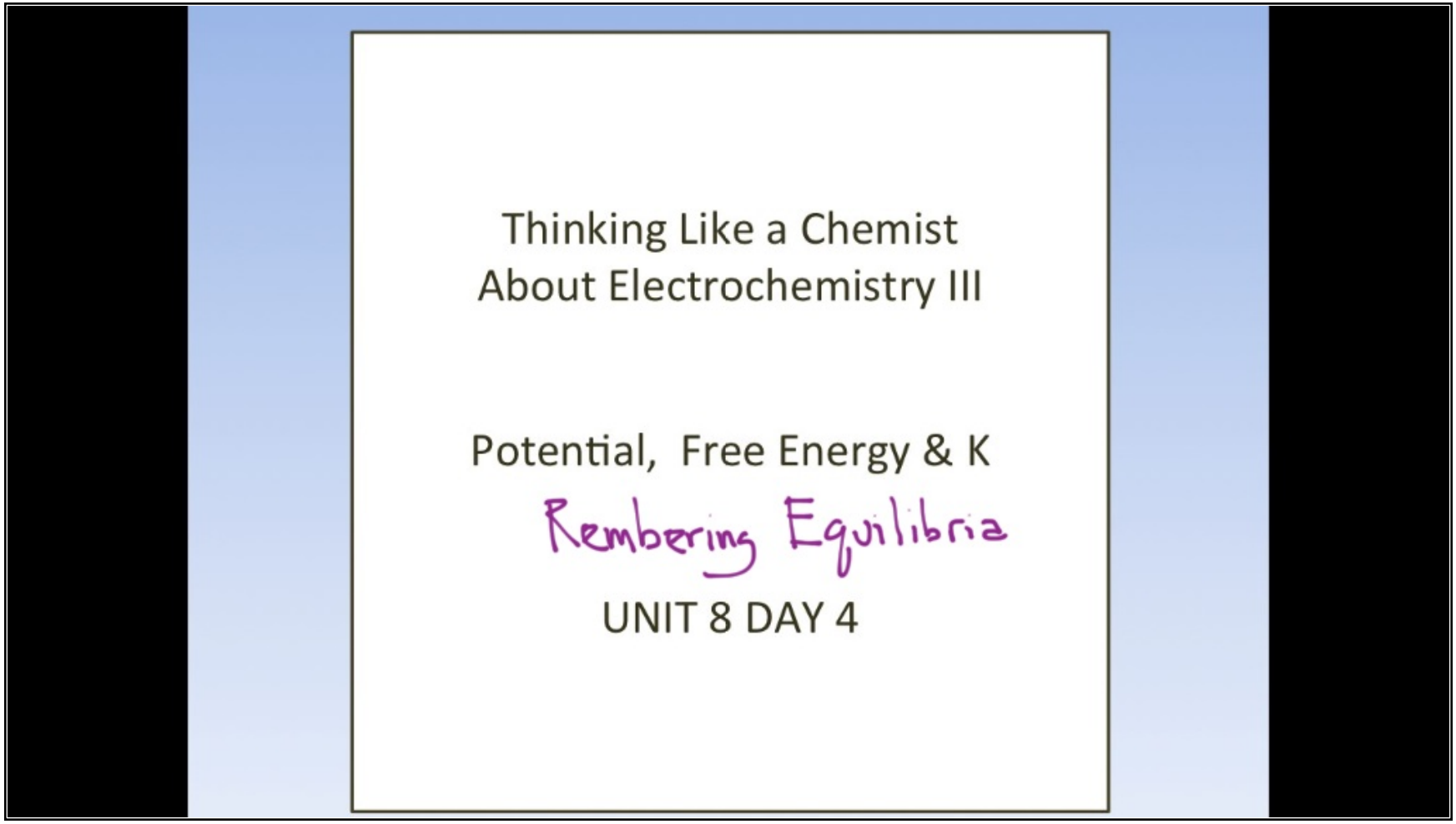
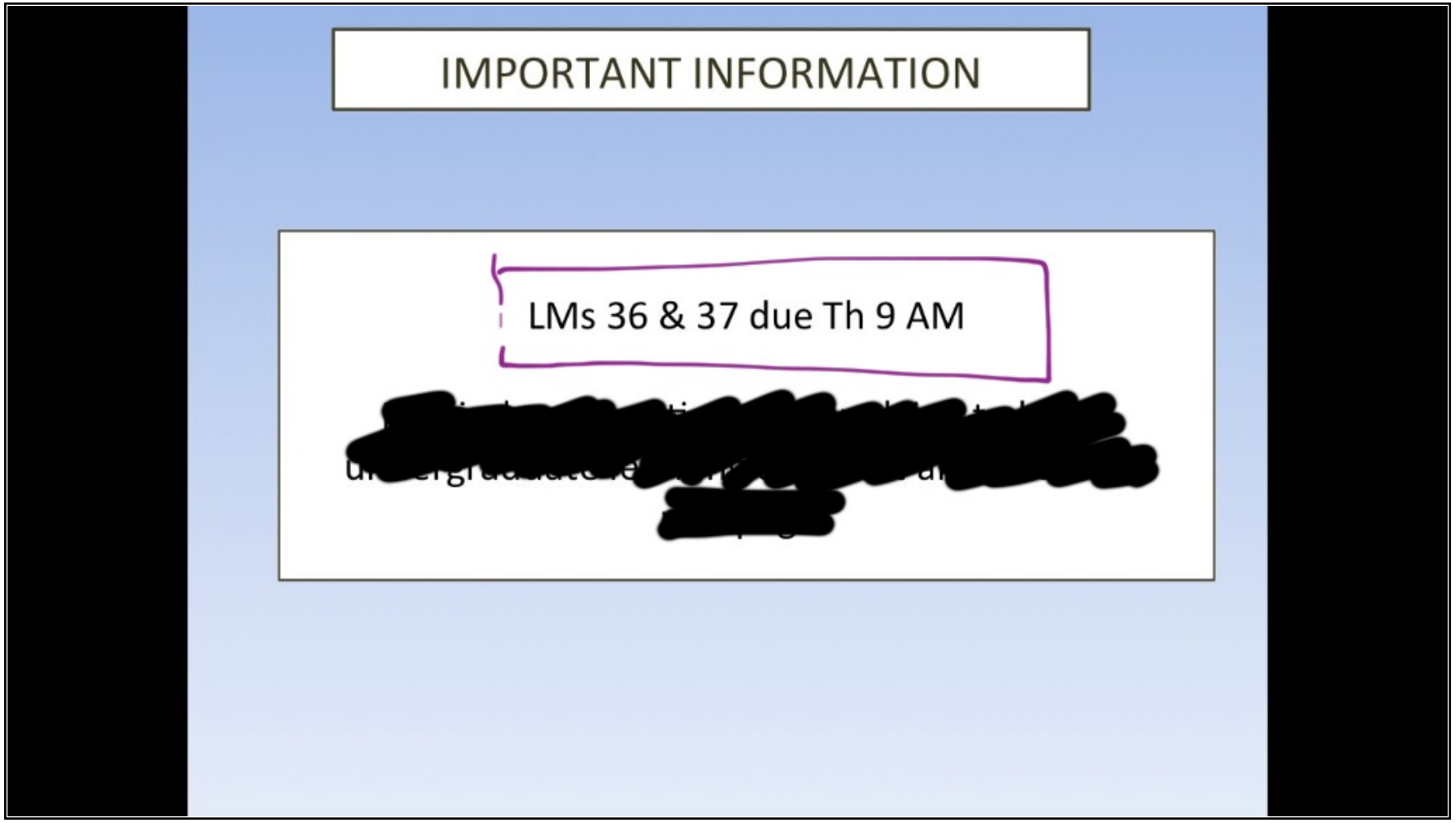
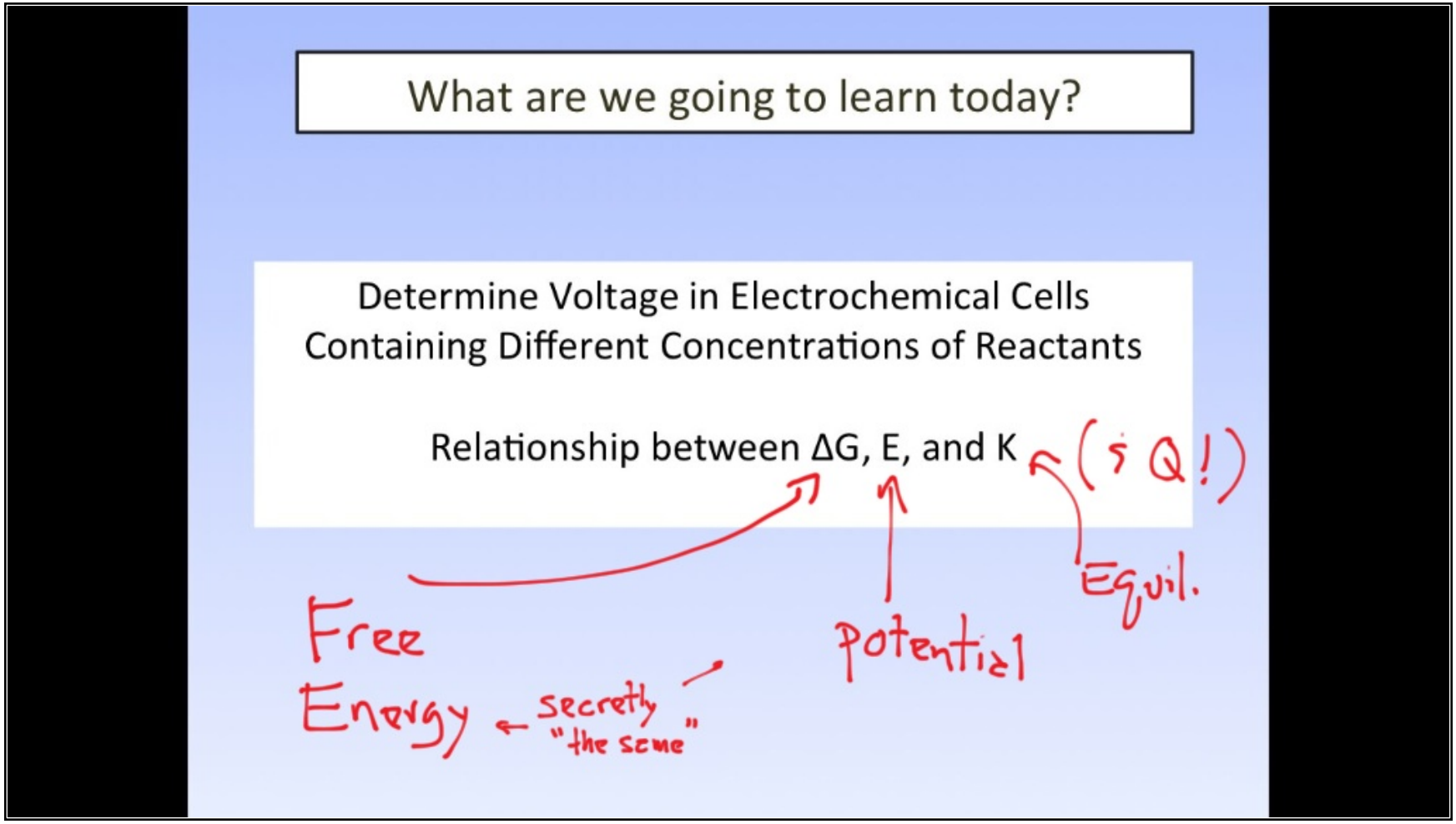
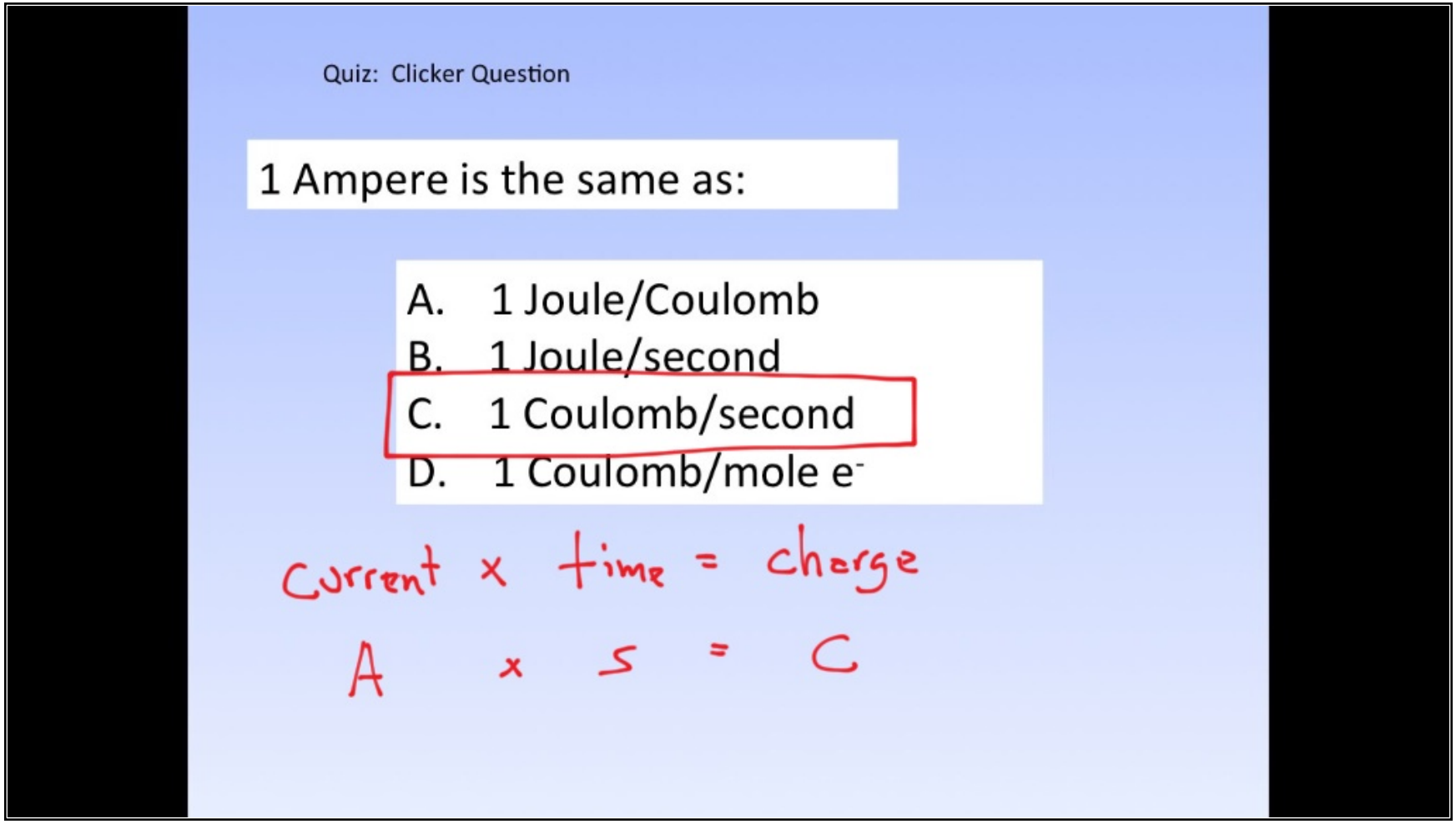
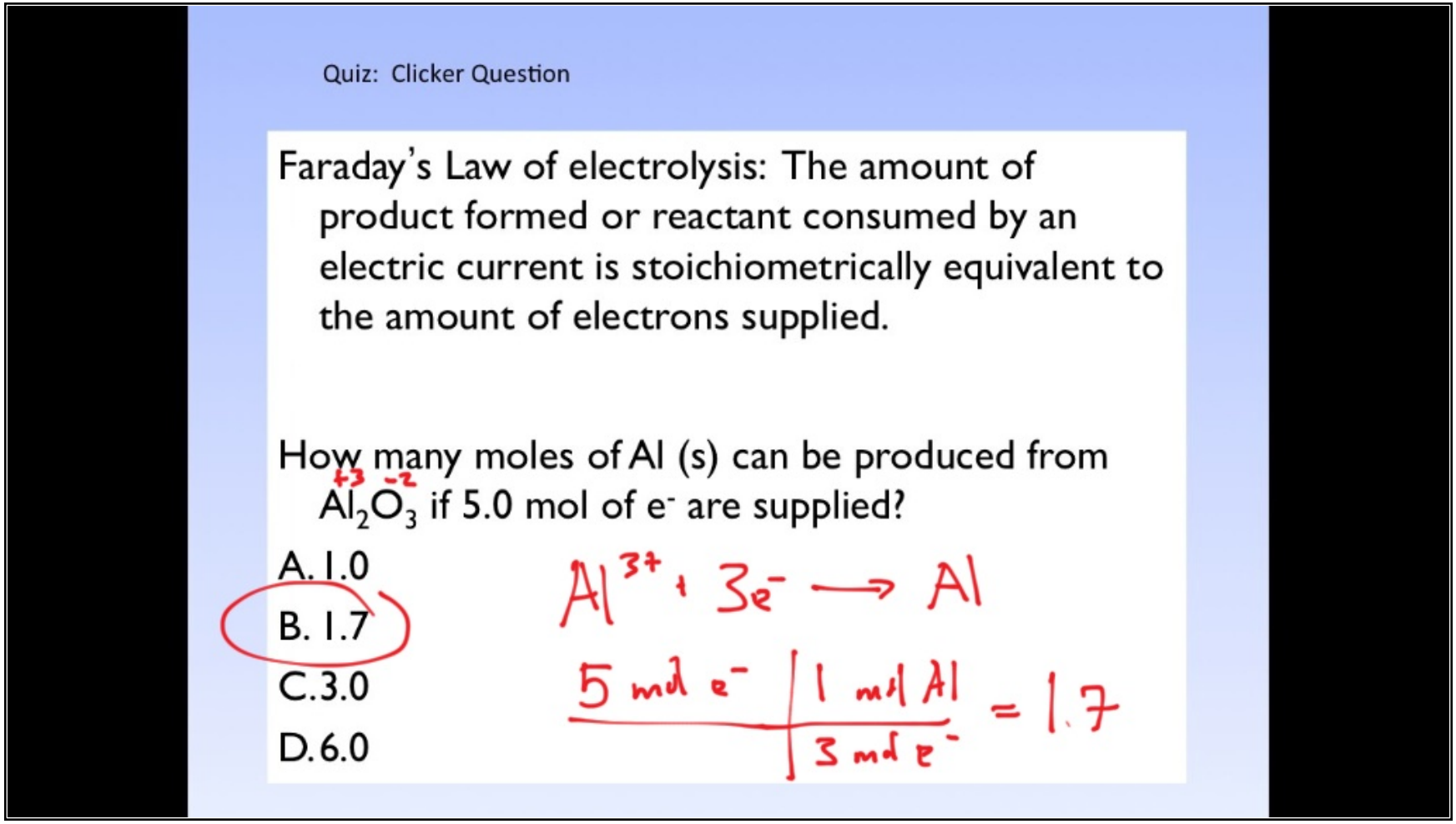
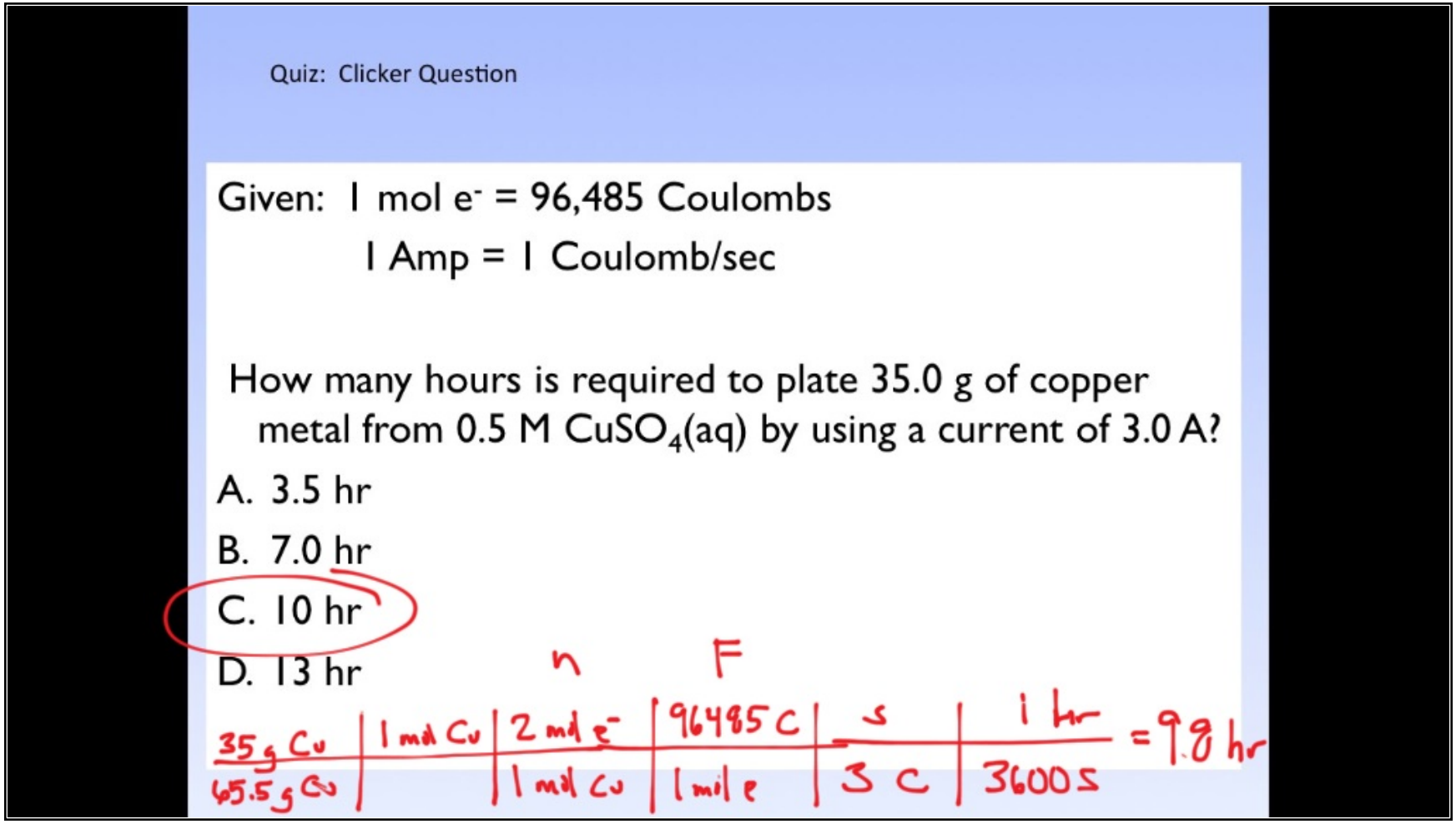

Thinking Like a Chemist
About Electrochemistry III
Potential, Free Energy & K
Rembering Equilibria
UNIT 8 DAY 4


IMPORTANT INFORMATION
LMs 36 & 37 due Th 9 AM

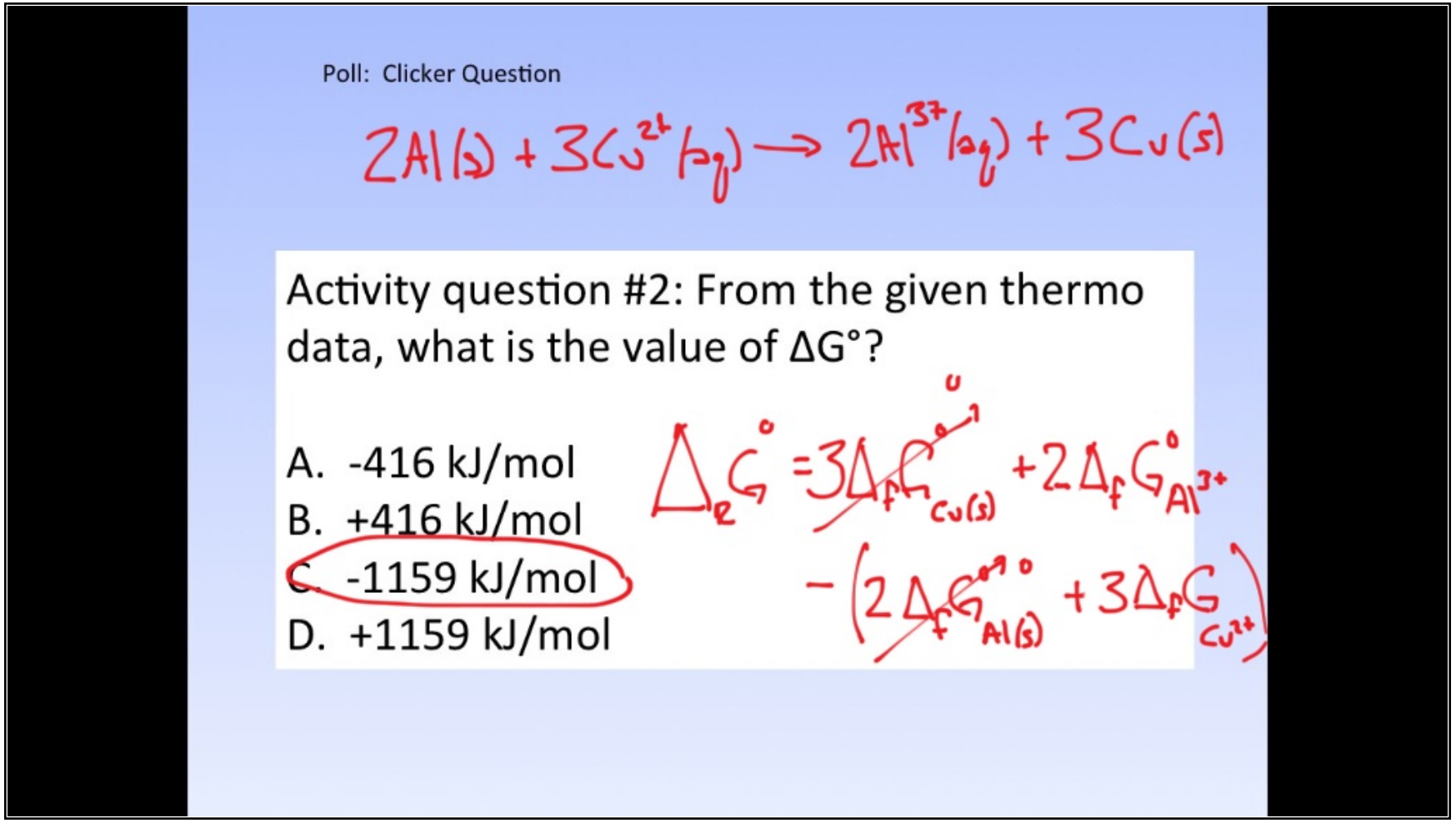

What are we going to learn today?
Determine Voltage in Electrochemical Cells
Containing Different Concentrations of Reactants
Relationship between ΔG, E, and K
(& Q!)
Free
Energy
secretly
"the same"
potential
Equil.

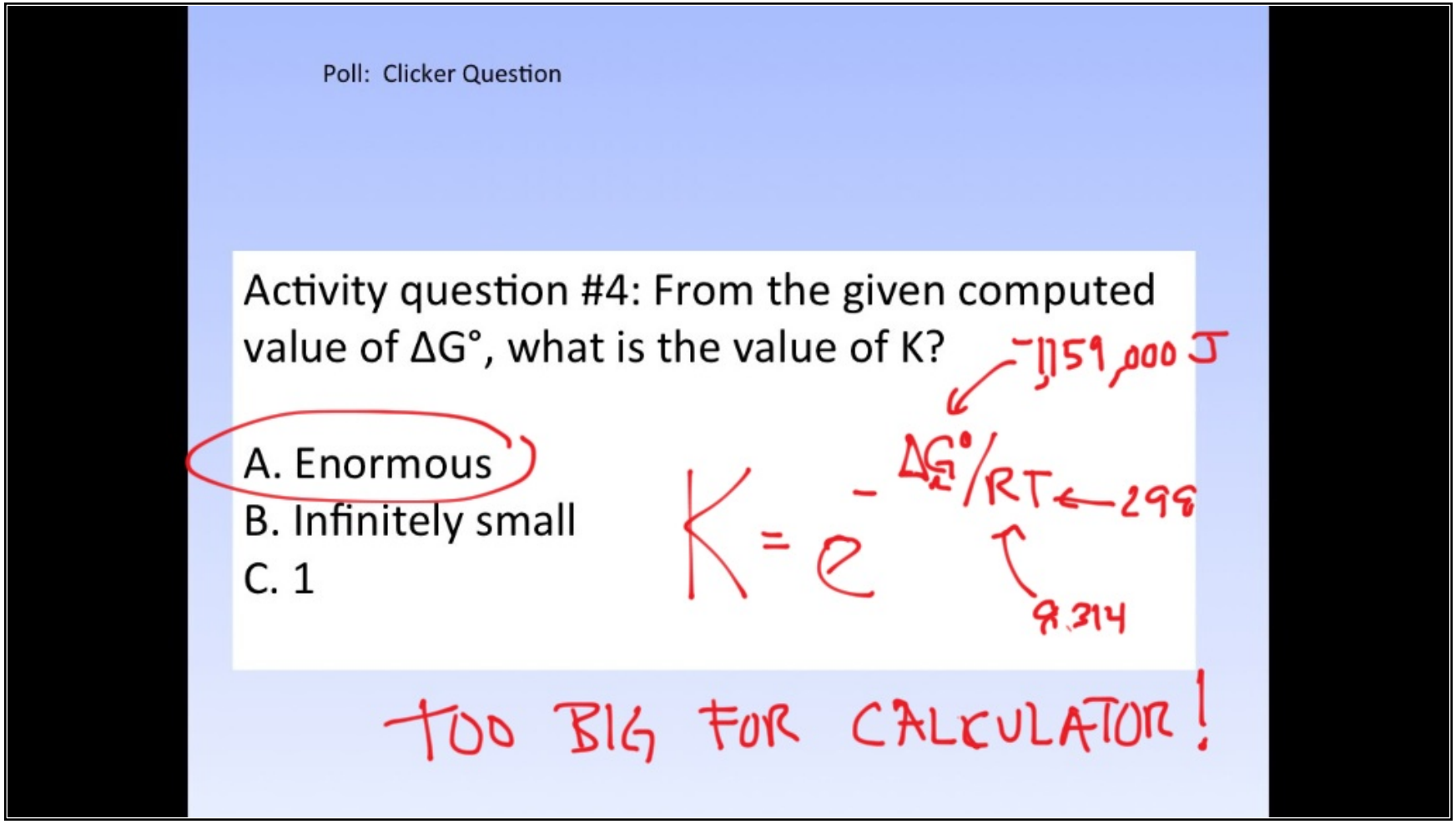

Quiz: Clicker Question
1 Ampere is the same as:
A. 1 Joule/Coulomb
B. 1 Joule/second
C. 1 Coulomb/second
D. 1 Coulomb/mole e-
Current x time = charge
A x s = C

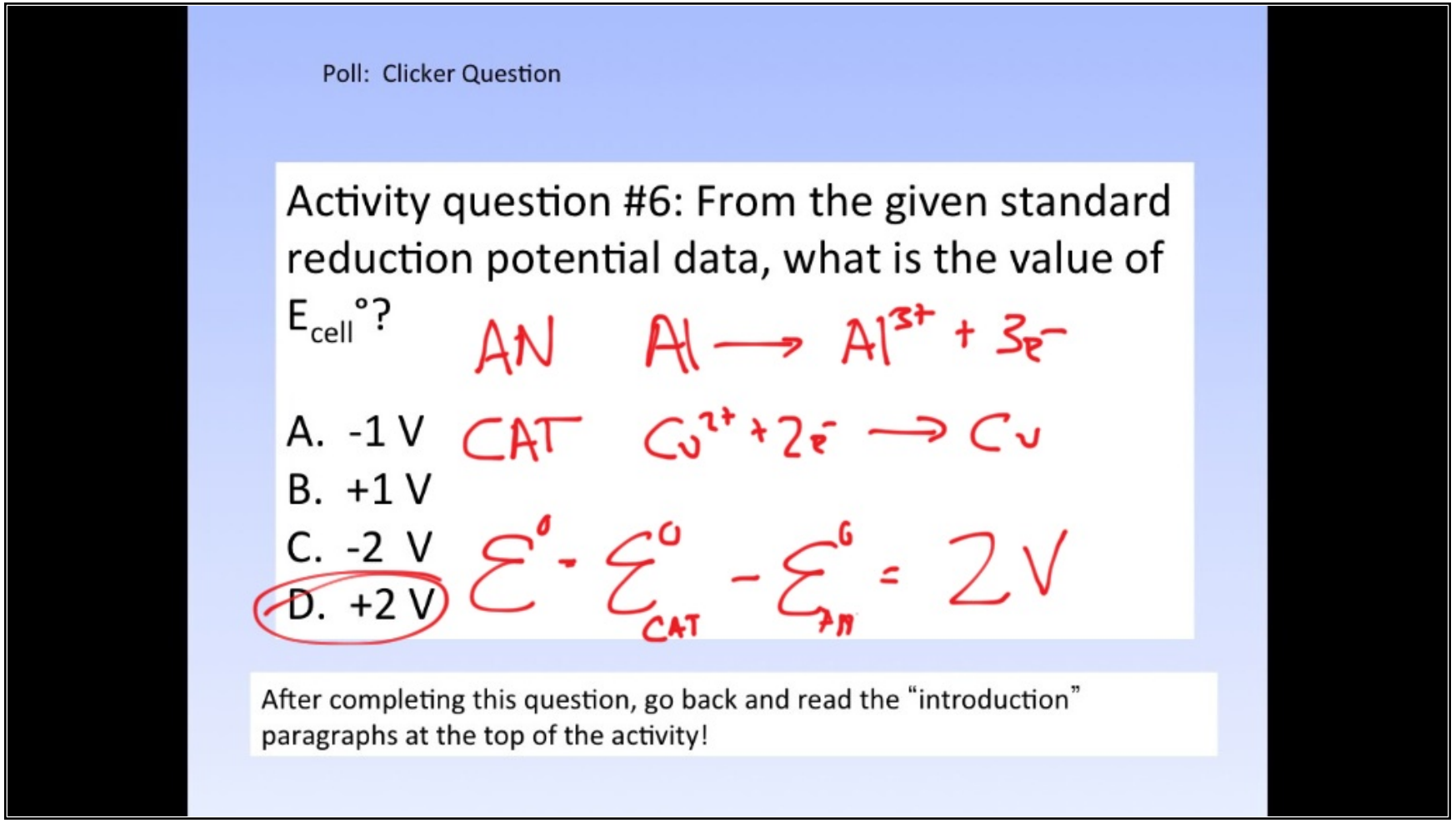

Quiz: Clicker Question
Faraday's Law of electrolysis: The amount of product formed or reactant consumed by an electric current is stoichiometrically equivalent to the amount of electrons supplied.
How many moles of Al (s) can be produced from Al_2O_3 if 5.0 mol of e^- are supplied?
A. 1.0
B. 1.7
C. 3.0
D. 6.0
$Al^{3+} + 3e^- \rightarrow Al$
$\frac{5\ mol\ e^-}{3\ mol\ e^-} \left| \frac{1\ mol\ Al}{} \right. = 1.7$

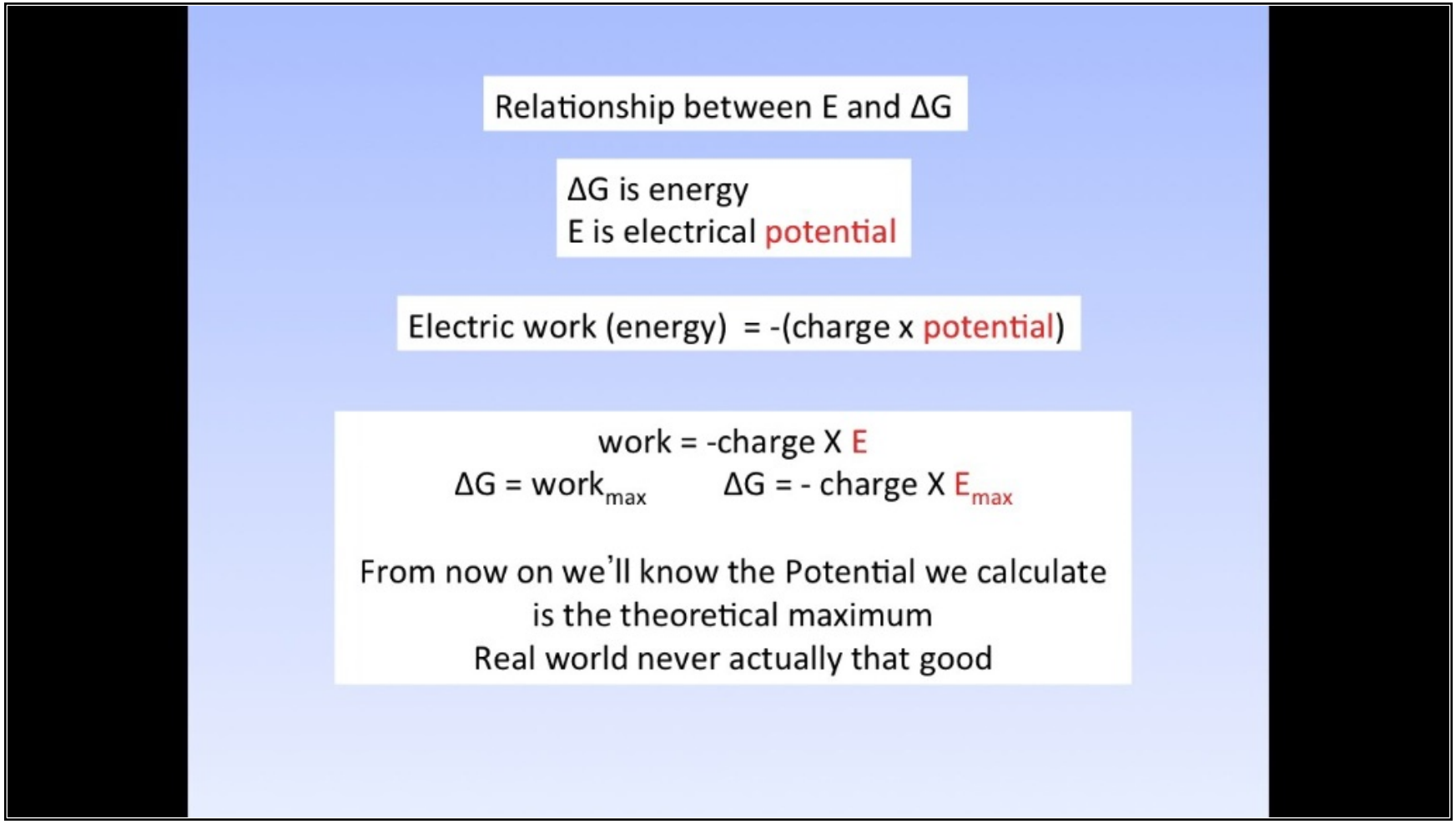

Quiz: Clicker Question
Given: 1 mol e⁻ = 96,485 Coulombs
1 Amp = 1 Coulomb/sec
How many hours is required to plate 35.0 g of copper metal from 0.5 M CuSO4(aq) by using a current of 3.0 A?
A. 3.5 hr
B. 7.0 hr
C. 10 hr
D. 13 hr
n
F
35 g Cu | 1 mol Cu | 2 mol e⁻ | 96485 C | s | 1 hr = 9.8 hr
63.5 g Cu | 1 mol Cu | 1 mol e | 3 C | 3600 s

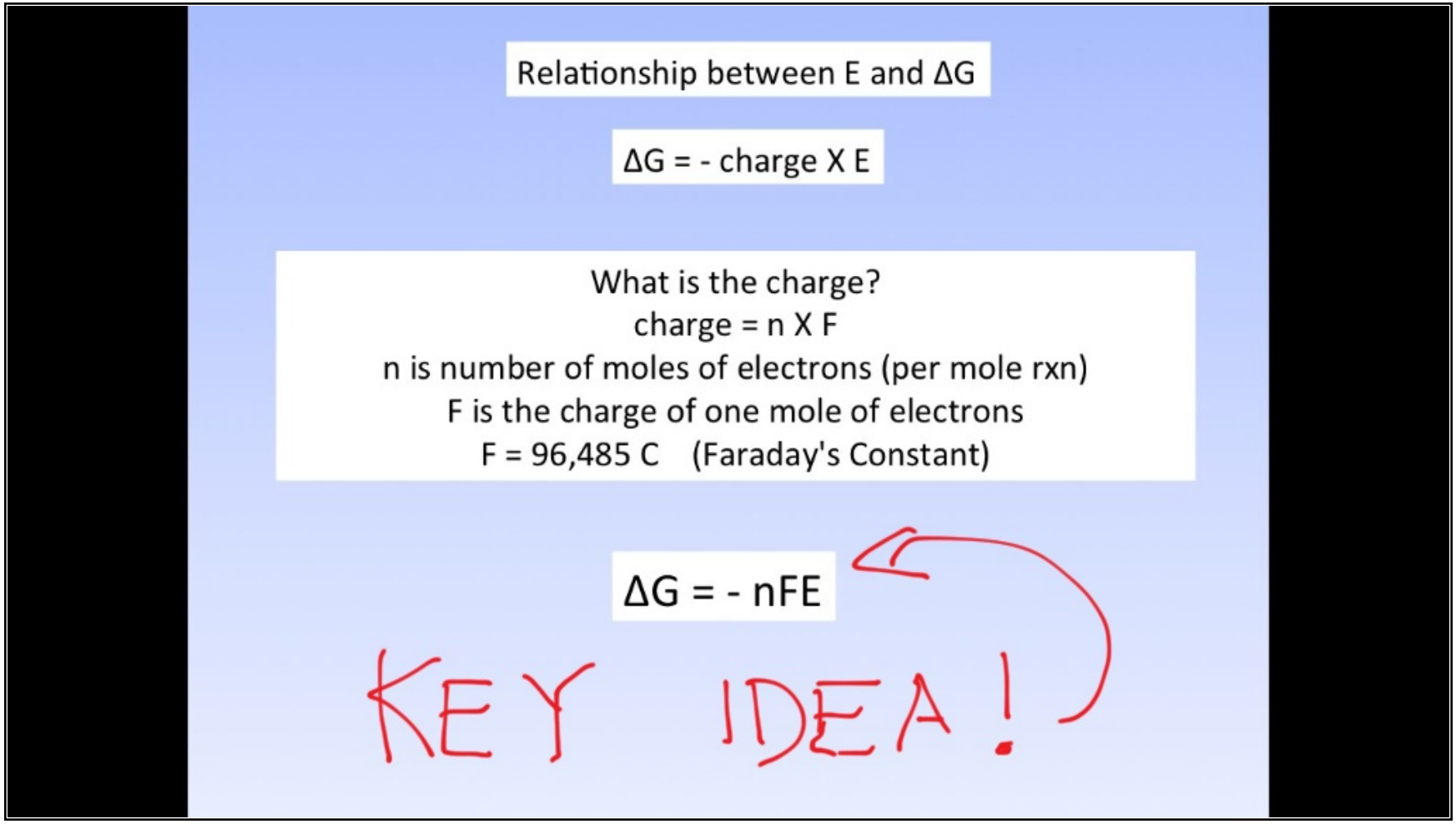

Work on Learning Activity.....
Video to remind you of the experiment: https://www.youtube.com/watch?v=fJwkxD_wZvk

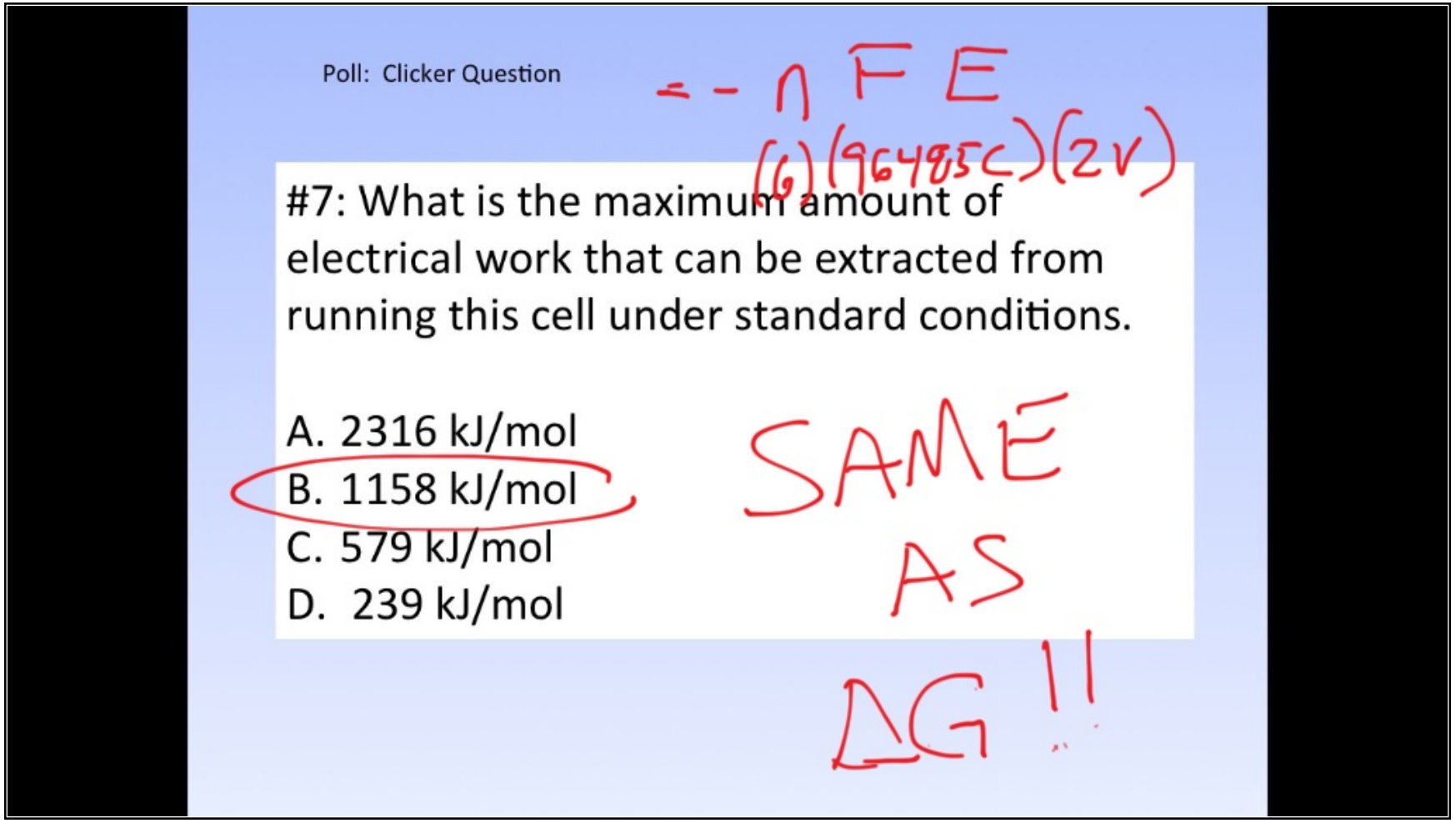

Poll: Clicker Question
$2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$
Activity question #2: From the given thermo data, what is the value of ΔG°?
A. -416 kJ/mol
B. +416 kJ/mol
C. -1159 kJ/mol
D. +1159 kJ/mol
$\Delta_r G^\circ = 3\Delta_f G^\circ_{Cu(s)} + 2\Delta_f G^\circ_{Al^{3+}} - (2\Delta_f G^\circ_{Al(s)} + 3\Delta_f G_{Cu^{2+}})$

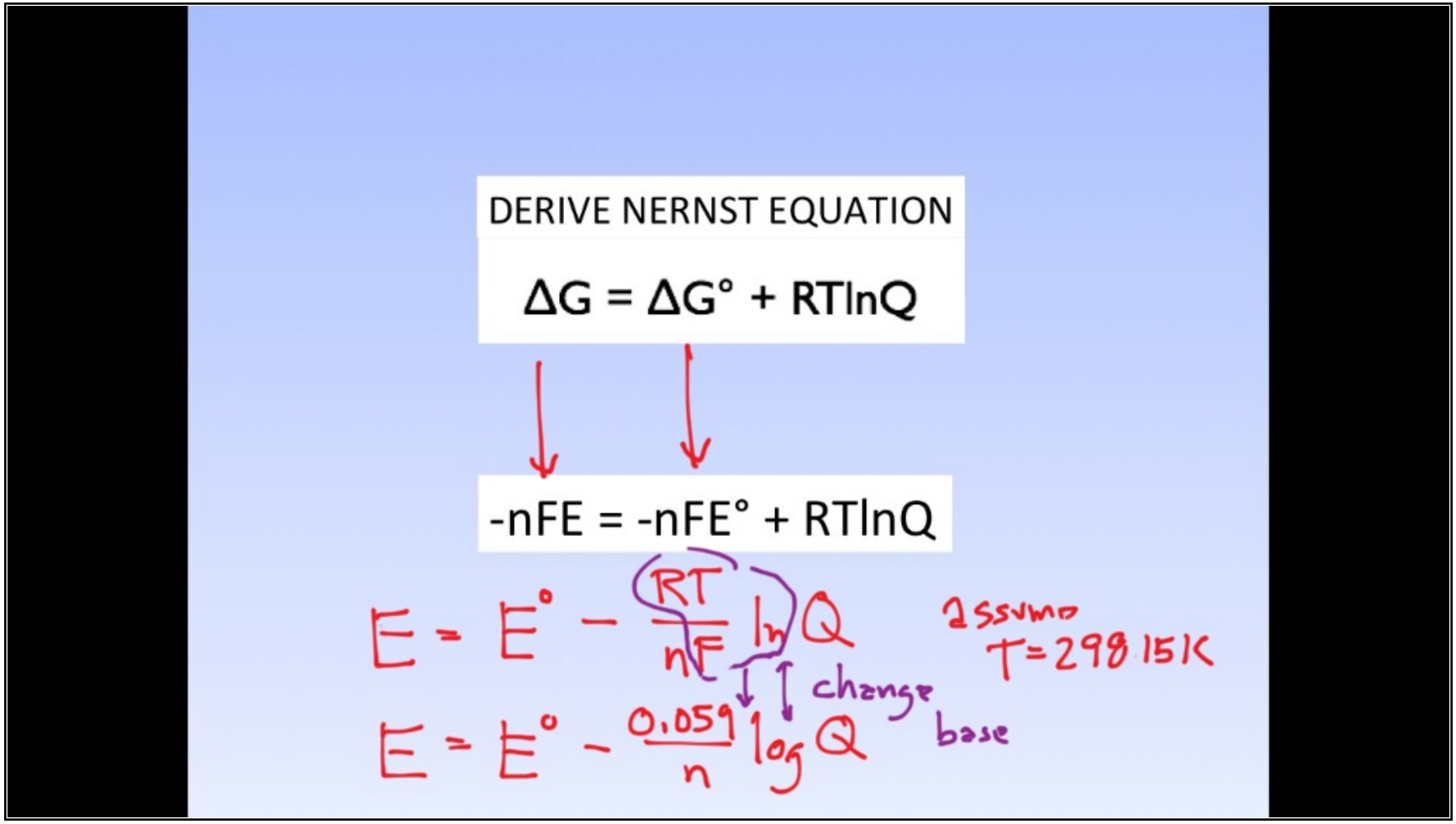

Poll: Clicker Question
Activity question #4: From the given computed value of ΔG°, what is the value of K?
A. Enormous
B. Infinitely small
C. 1
−1159,000 J
$K = e^{-\Delta G^\circ / RT}$
298
8.314
TOO BIG FOR CALCULATOR!

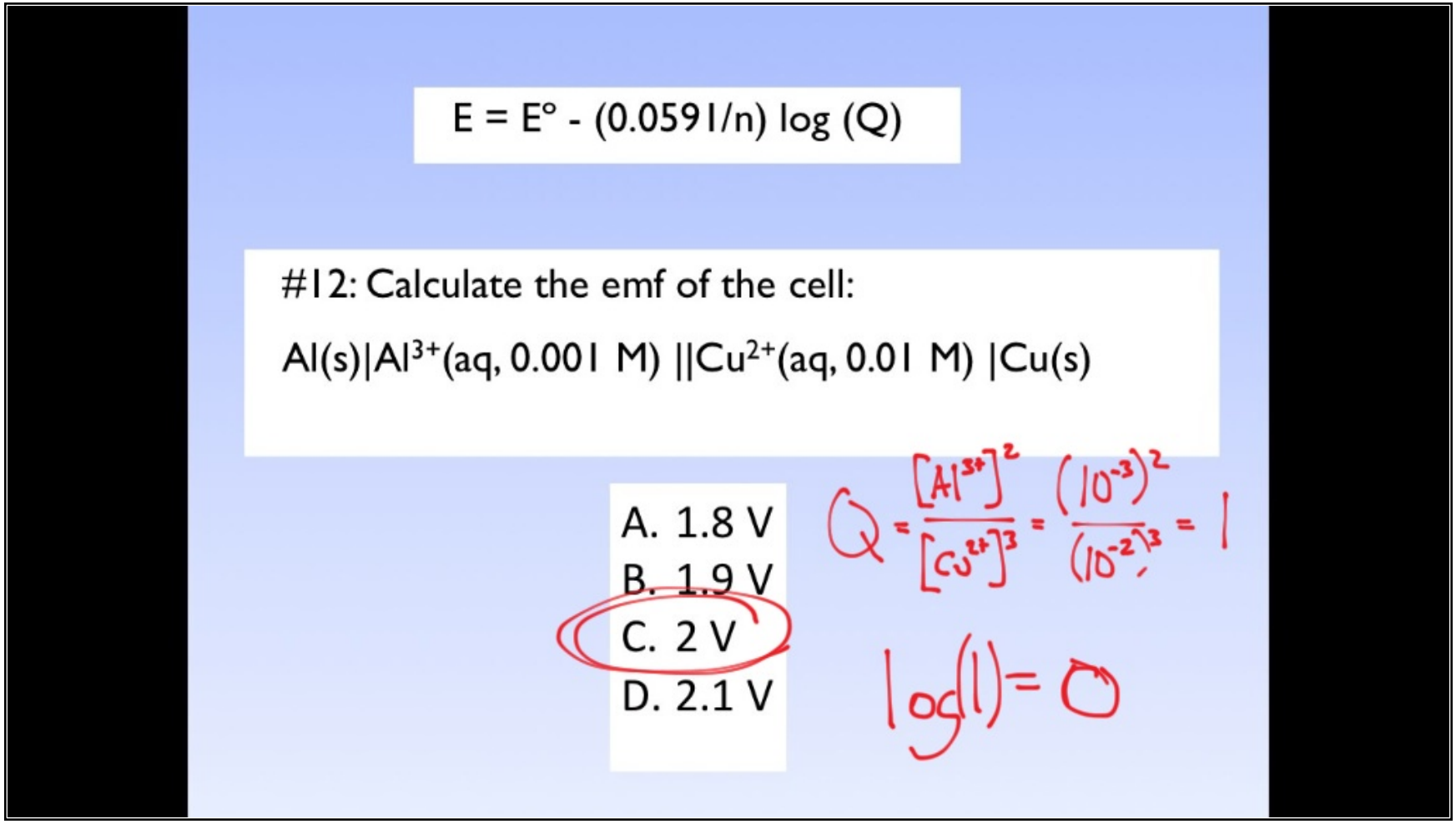

Poll: Clicker Question
Activity question #6: From the given standard reduction potential data, what is the value of $E_{cell}°$?
A. -1 V
B. +1 V
C. -2 V
D. +2 V
AN
CAT
$E^0 - E^0_{CAT} - E^0_{AN} = 2V$
After completing this question, go back and read the "introduction" paragraphs at the top of the activity!

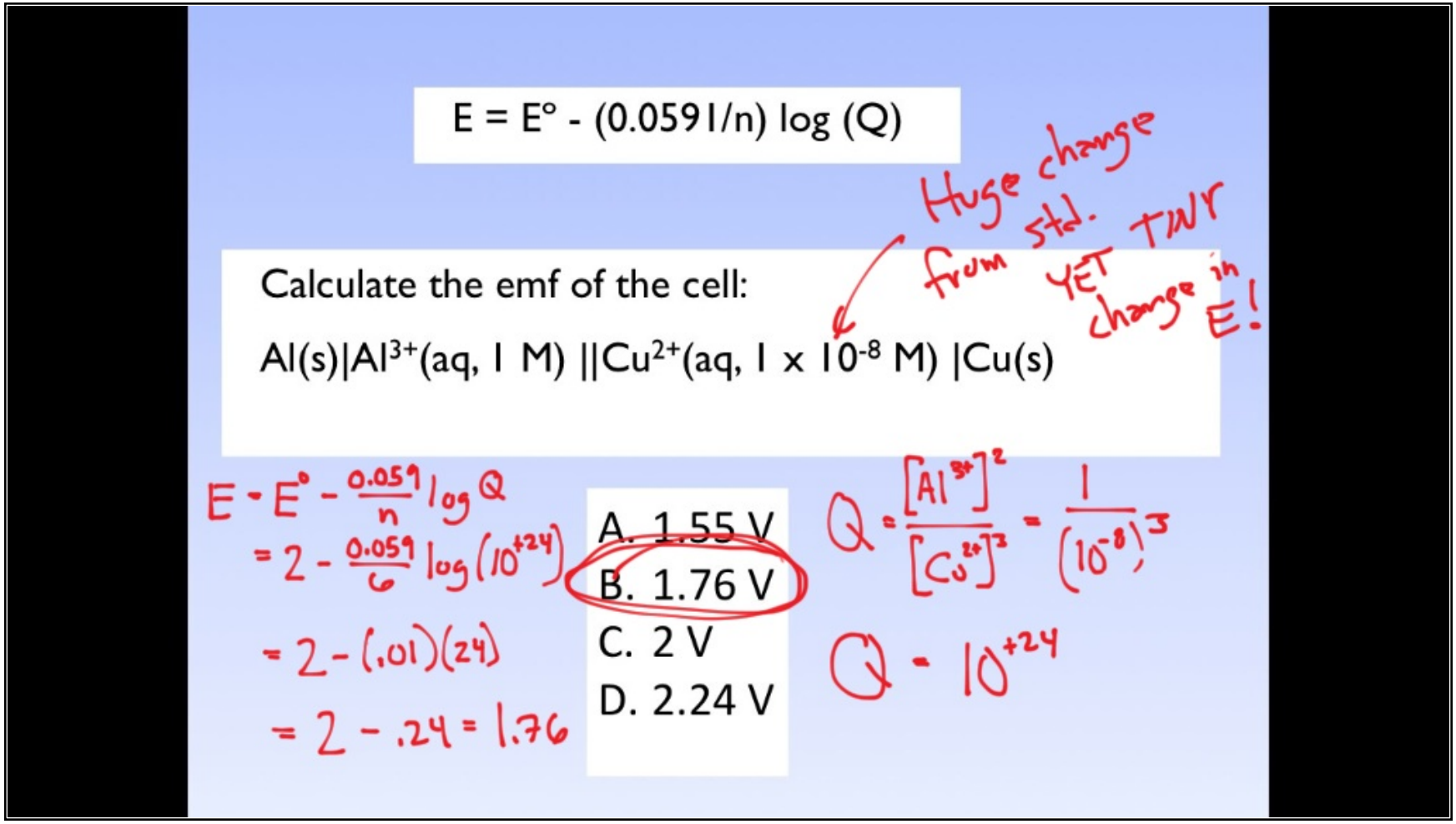

Relationship between E and ΔG
ΔG is energy
E is electrical potential
Electric work (energy) = -(charge x potential)
work = -charge X E
ΔG = work$_{max}$
ΔG = - charge X E$_{max}$
From now on we'll know the Potential we calculate
is the theoretical maximum
Real world never actually that good

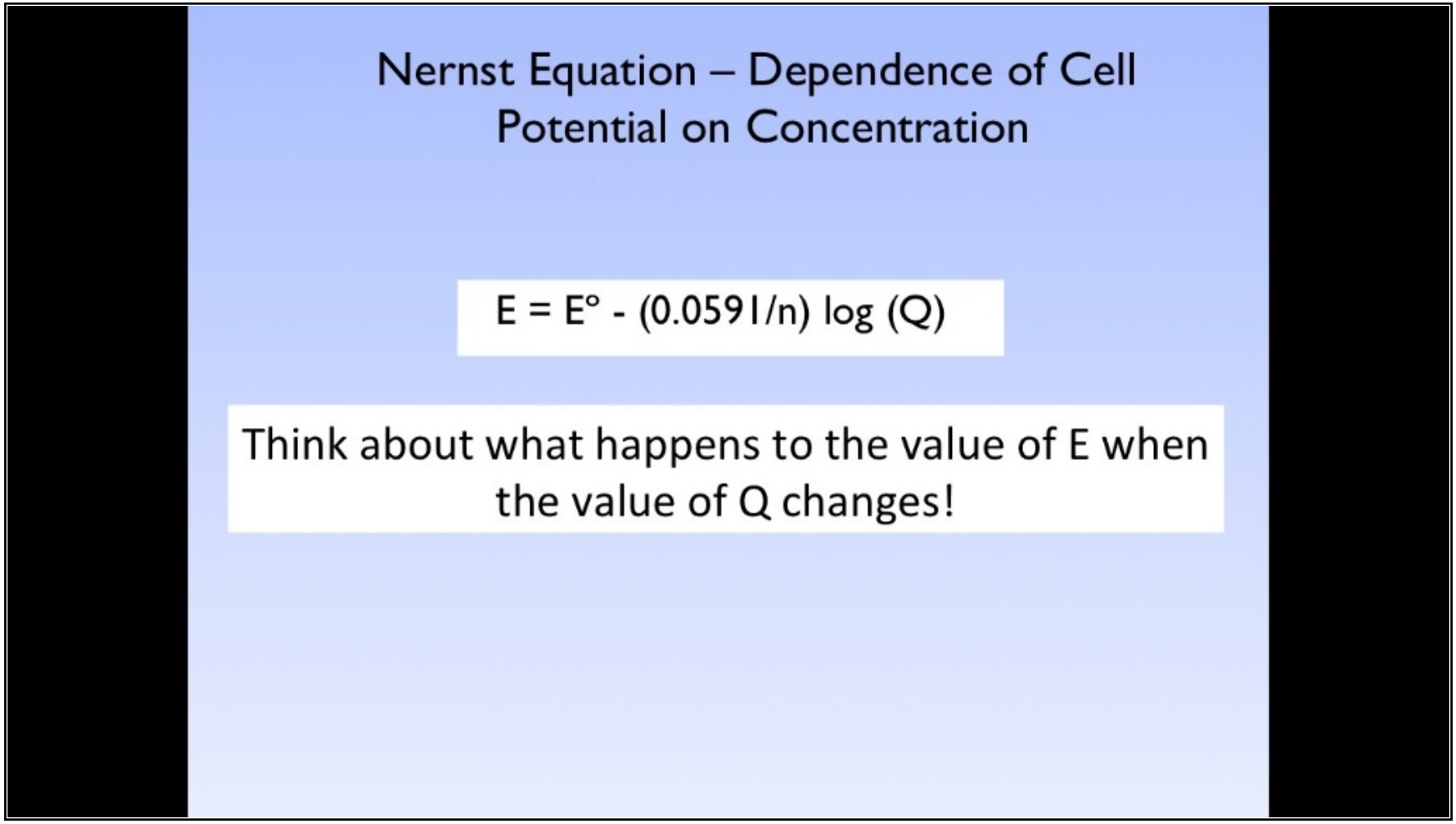

Relationship between E and ΔG
ΔG = - charge X E
What is the charge?
charge = n X F
n is number of moles of electrons (per mole rxn)
F is the charge of one mole of electrons
F = 96,485 C (Faraday's Constant)
ΔG = - nFE
KEY IDEA!


Poll: Clicker Question
= - n F E
(6)(96485C)(2V)
#7: What is the maximum amount of electrical work that can be extracted from running this cell under standard conditions.
A. 2316 kJ/mol
B. 1158 kJ/mol
C. 579 kJ/mol
D. 239 kJ/mol
SAME AS ΔG !!


DERIVE NERNST EQUATION
ΔG = ΔG° + RTlnQ
-nFE = -nFE° + RTlnQ
E = E° − (RT/nF) ln Q
assume T = 298.15K
change base
E = E° − (0.059/n) log Q


E = E° - (0.0591/n) log (Q)
#12: Calculate the emf of the cell:
Al(s)|Al3+(aq, 0.001 M) ||Cu2+(aq, 0.01 M) |Cu(s)
A. 1.8 V
B. 1.9 V
C. 2 V
D. 2.1 V
Q = [Al3+]2 / [Cu2+]3 = (10-3)2 / (10-2)3 = 1
log(1) = 0


E = E° - (0.0591/n) log (Q)
Huge change from std. YET TINY change in E!
Calculate the emf of the cell:
Al(s)|Al3+(aq, 1 M) ||Cu2+(aq, 1 x 10-8 M) |Cu(s)
E = E° - 0.059/n log Q
= 2 - 0.059/6 log (10+24)
= 2 - (.01)(24)
= 2 - .24 = 1.76
A. 1.55 V
B. 1.76 V
C. 2 V
D. 2.24 V
Q = [Al3+]2/[Cu2+]3 = 1/(10-8)3
Q = 10+24


Nernst Equation – Dependence of Cell Potential on Concentration
E = E° - (0.0591/n) log (Q)
Think about what happens to the value of E when the value of Q changes!