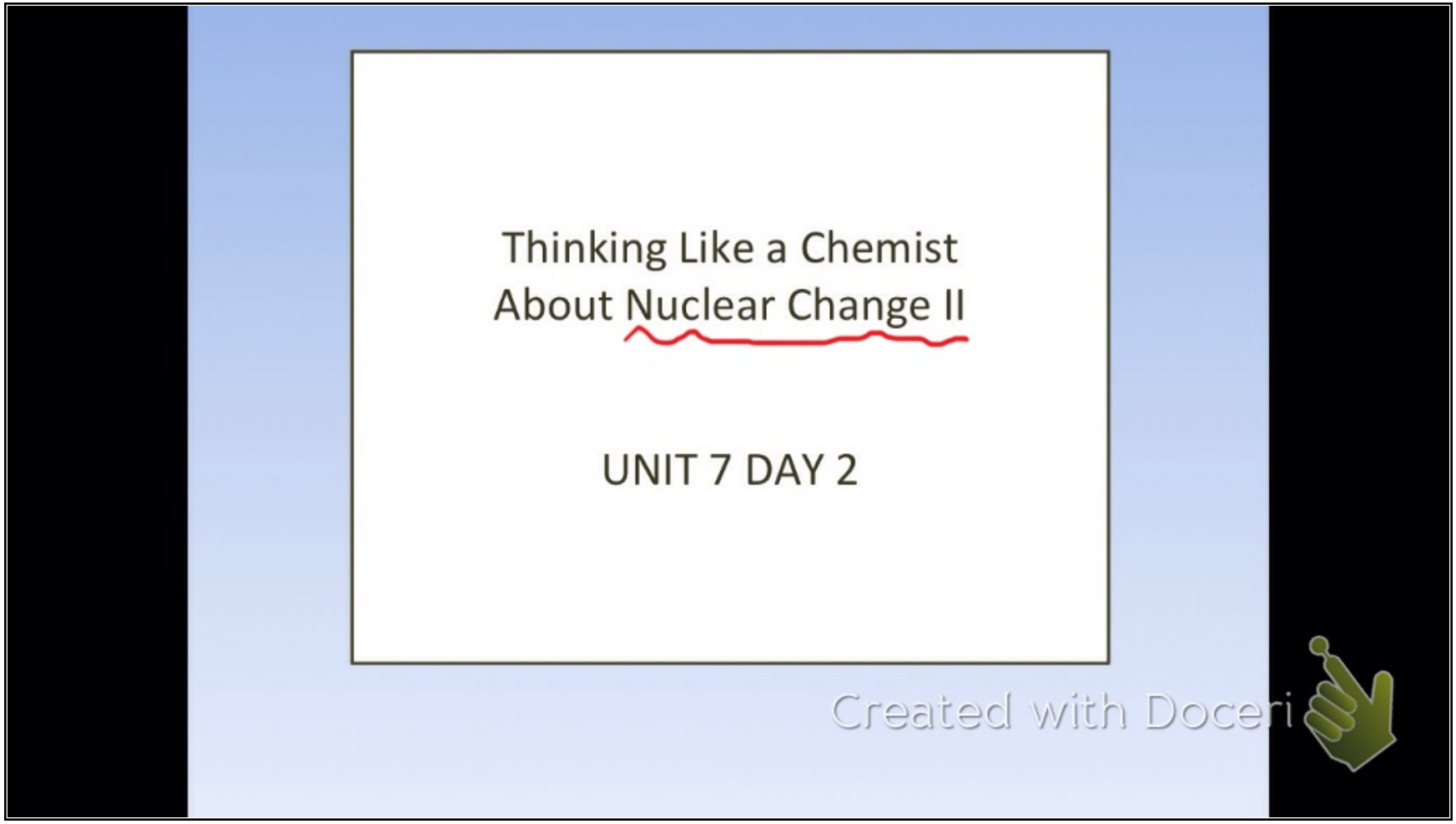
Thinking Like a Chemist
About Nuclear Change II
UNIT 7 DAY 2
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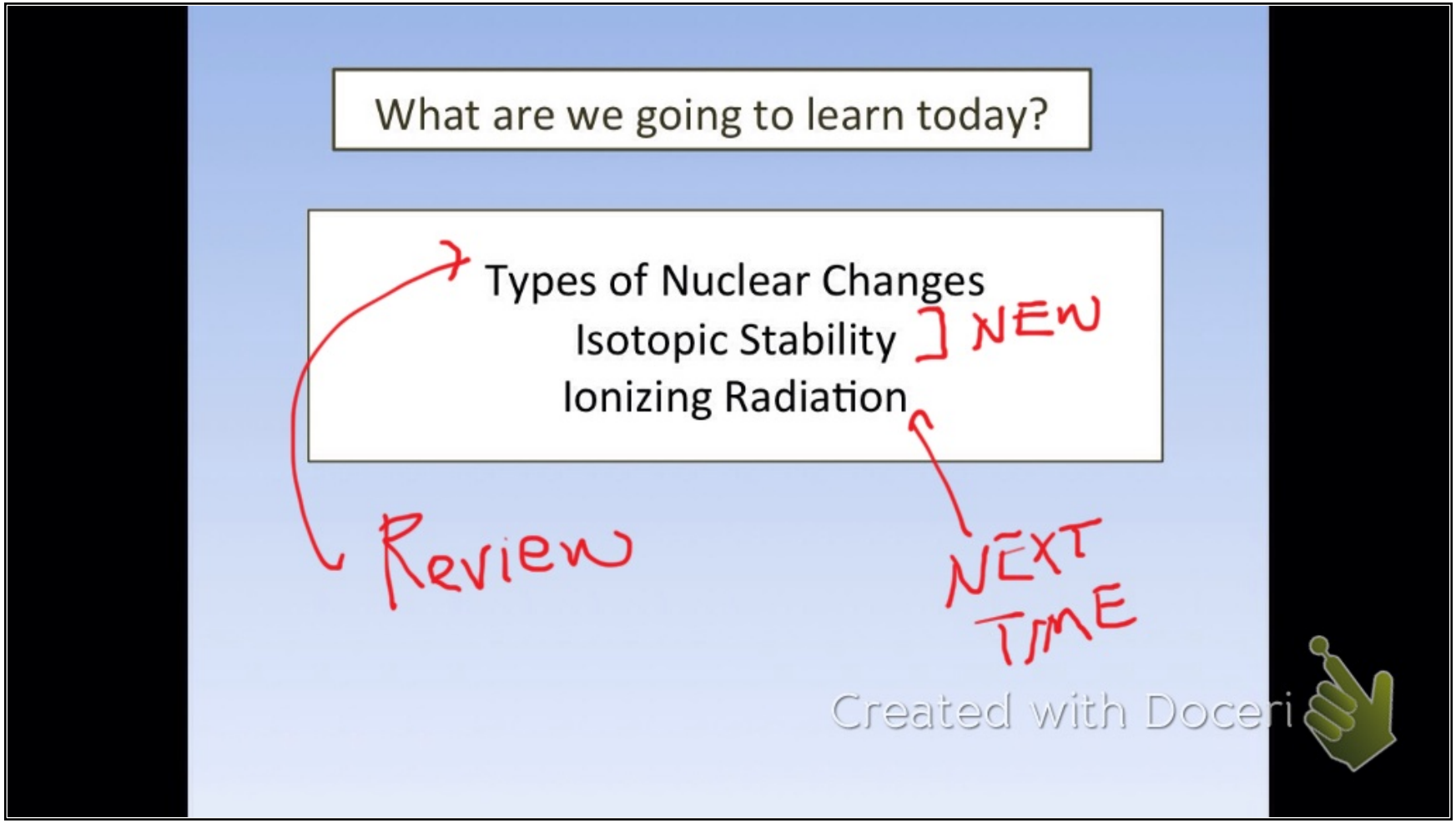
What are we going to learn today?
Types of Nuclear Changes
Isotopic Stability
Ionizing Radiation
NEW
Review
NEXT TIME
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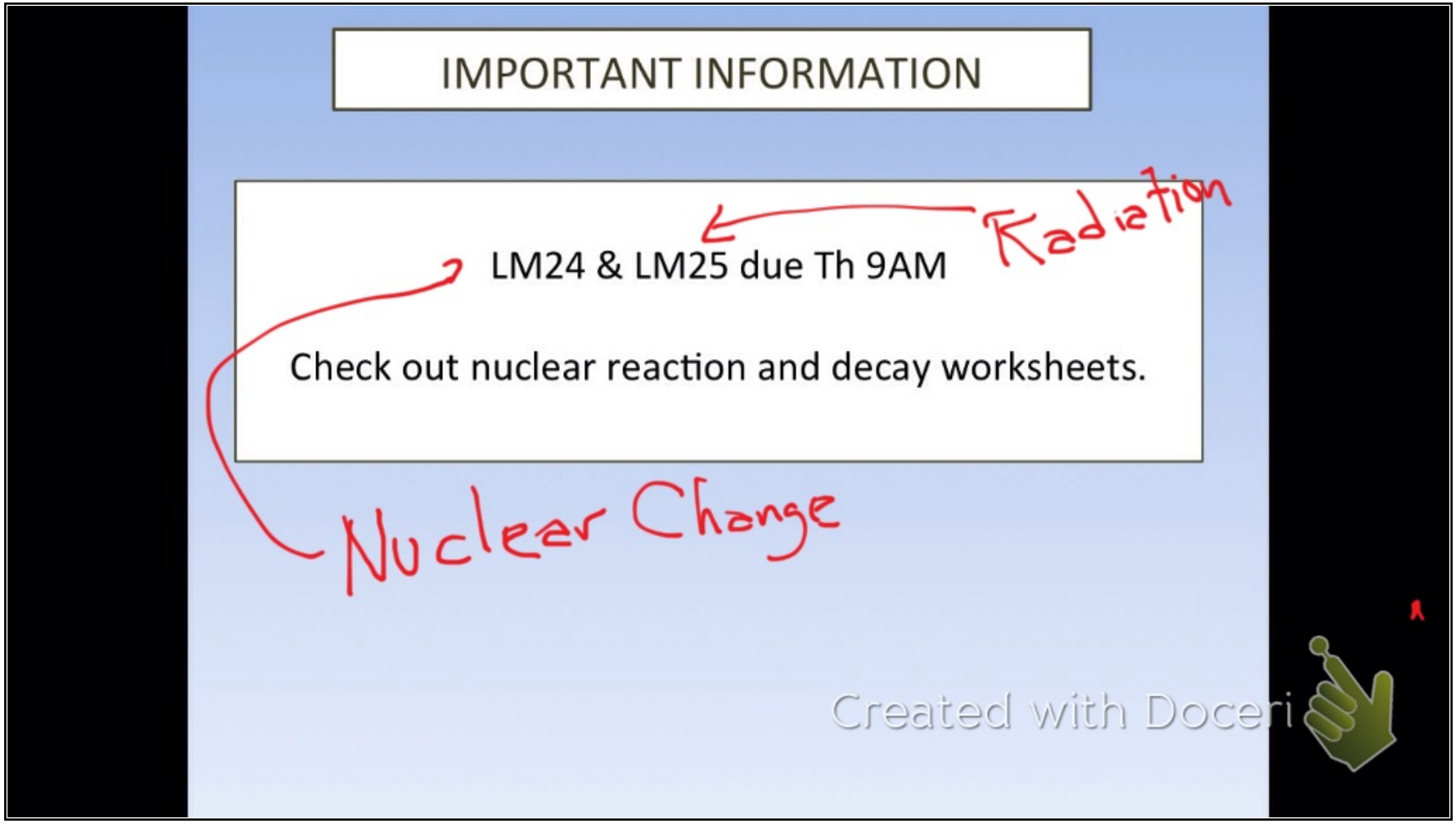
IMPORTANT INFORMATION
LM24 & LM25 due Th 9AM
Radiation
Check out nuclear reaction and decay worksheets.
Nuclear Change
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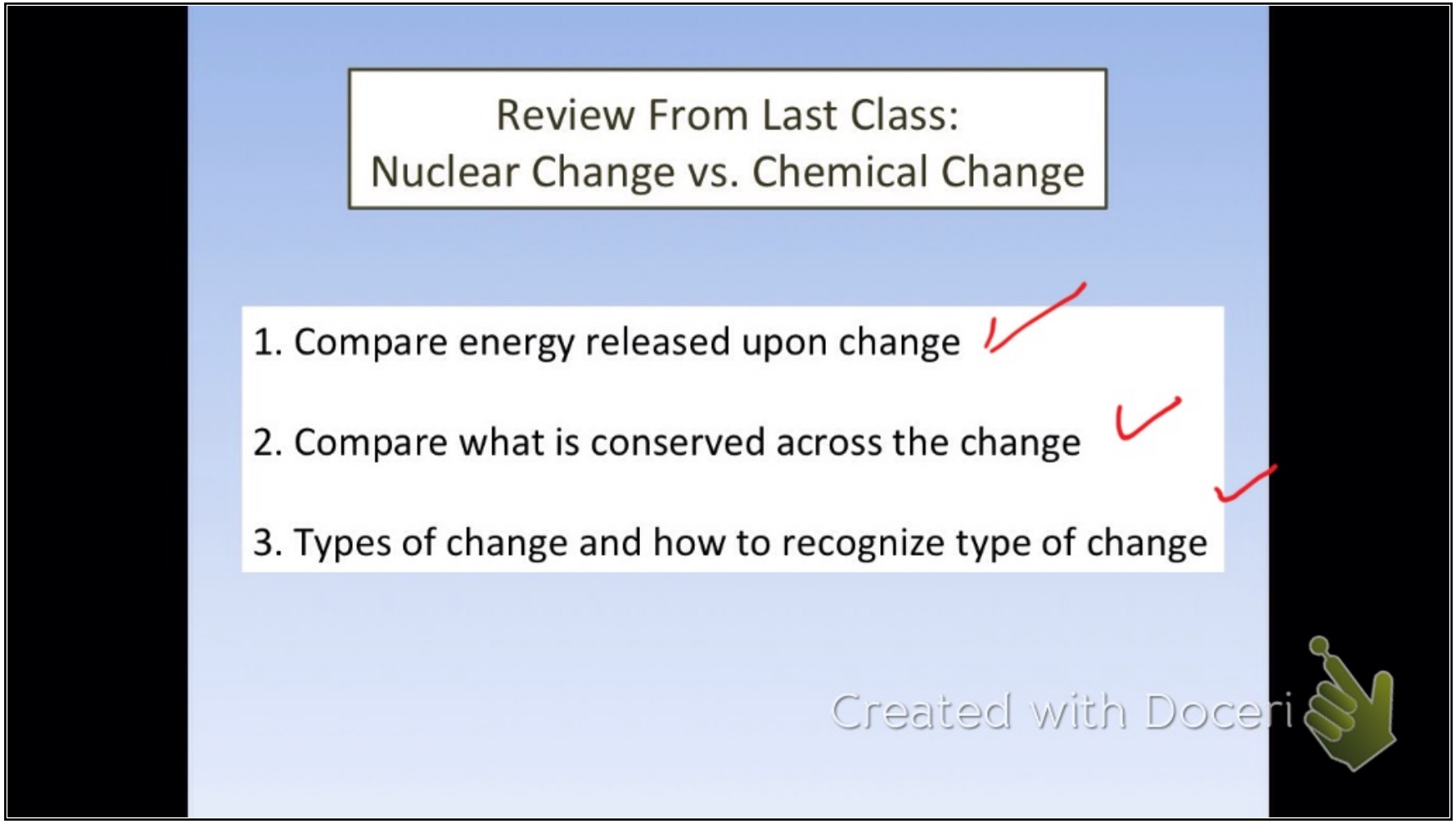
Review From Last Class:
Nuclear Change vs. Chemical Change
1. Compare energy released upon change
2. Compare what is conserved across the change
3. Types of change and how to recognize type of change
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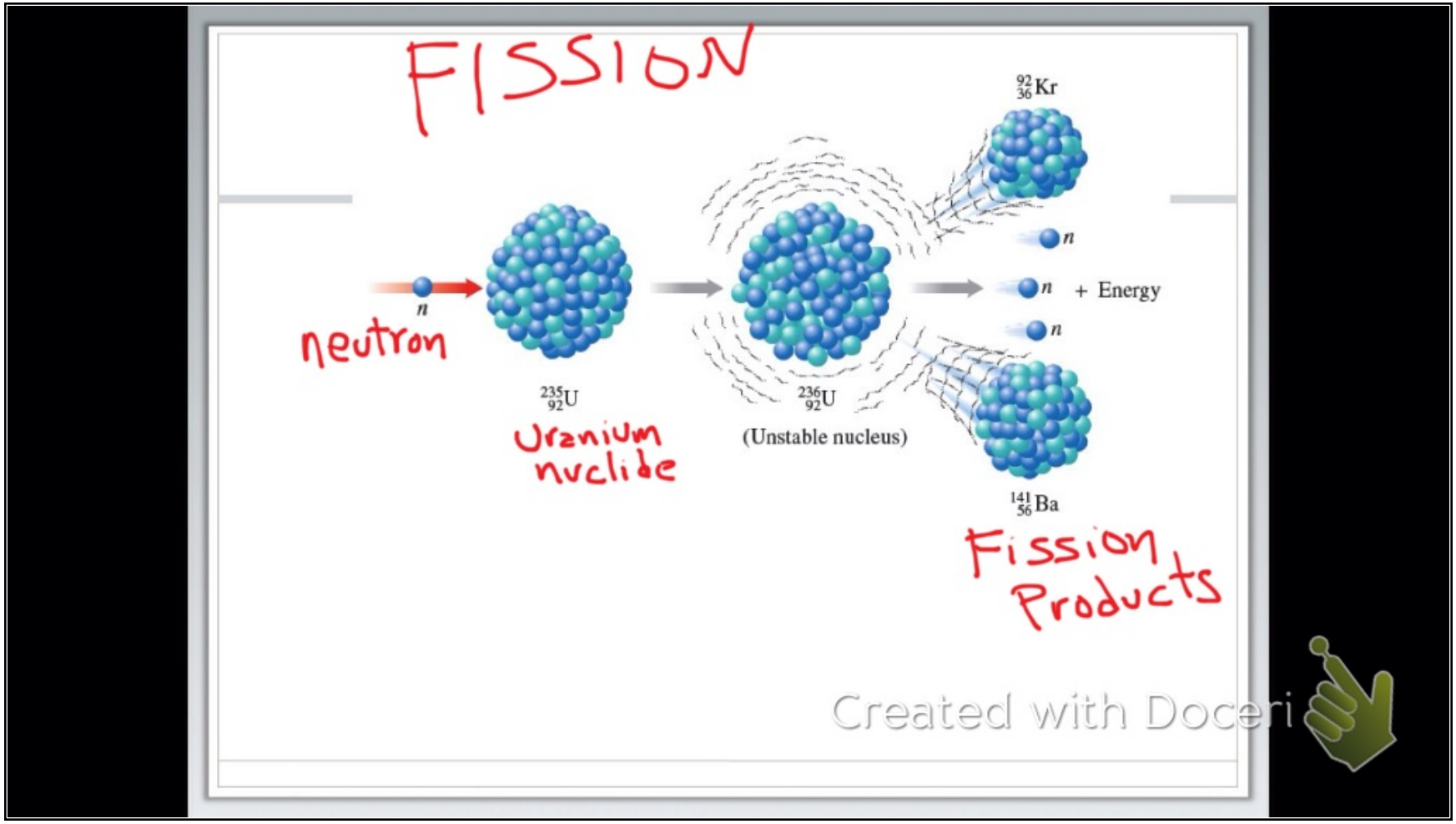
FISSION
$^{92}_{36}$Kr
n
n + Energy
n
n
neutron
$^{235}_{92}$U
Uranium nuclide
$^{236}_{92}$U
(Unstable nucleus)
$^{141}_{56}$Ba
Fission Products
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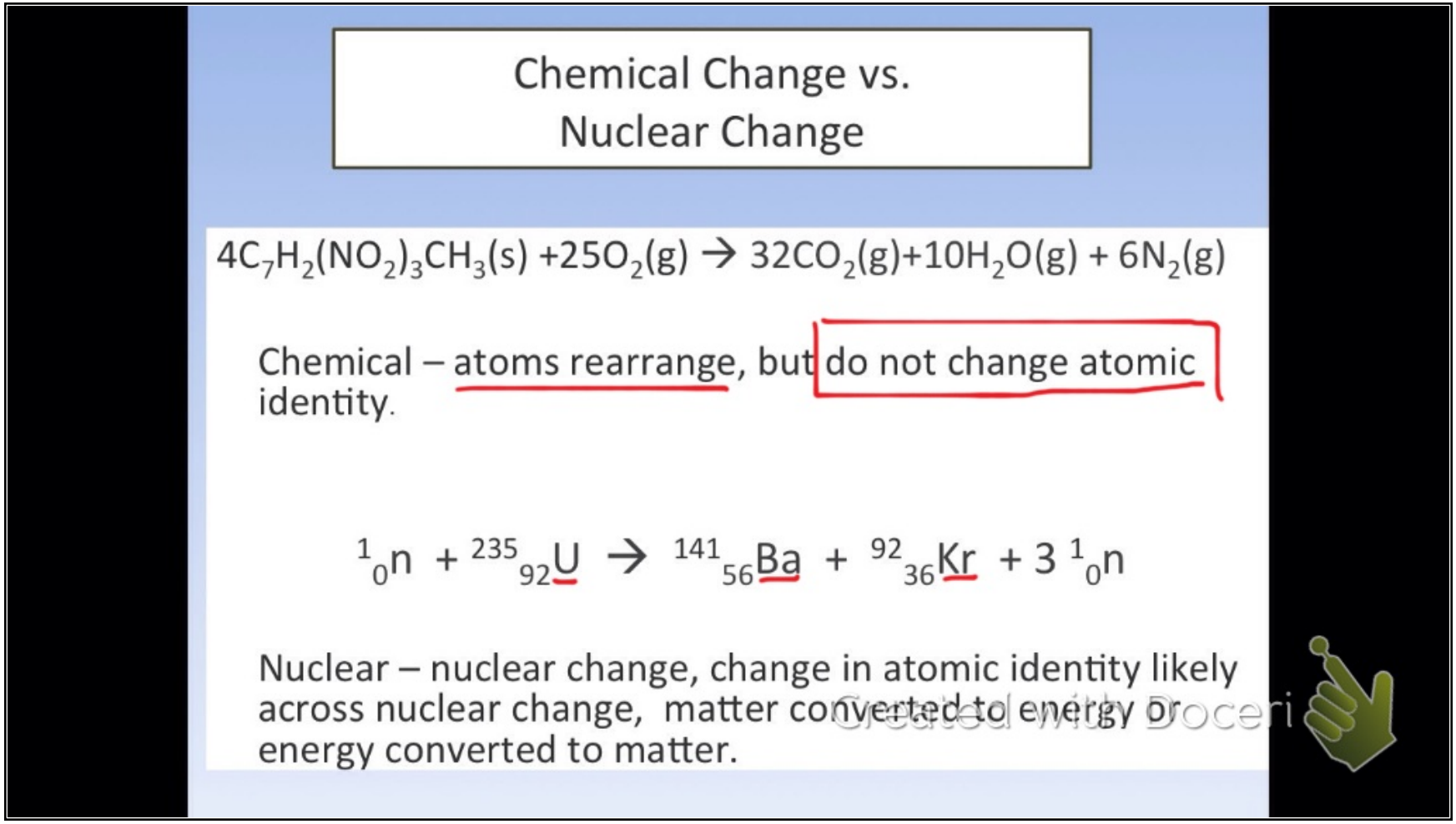
Chemical Change vs.
Nuclear Change
$4C_7H_2(NO_2)_3CH_3(s) + 25O_2(g) \rightarrow 32CO_2(g) + 10H_2O(g) + 6N_2(g)$
Chemical – atoms rearrange, but do not change atomic identity.
$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$
Nuclear – nuclear change, change in atomic identity likely across nuclear change, matter converted to energy or energy converted to matter.
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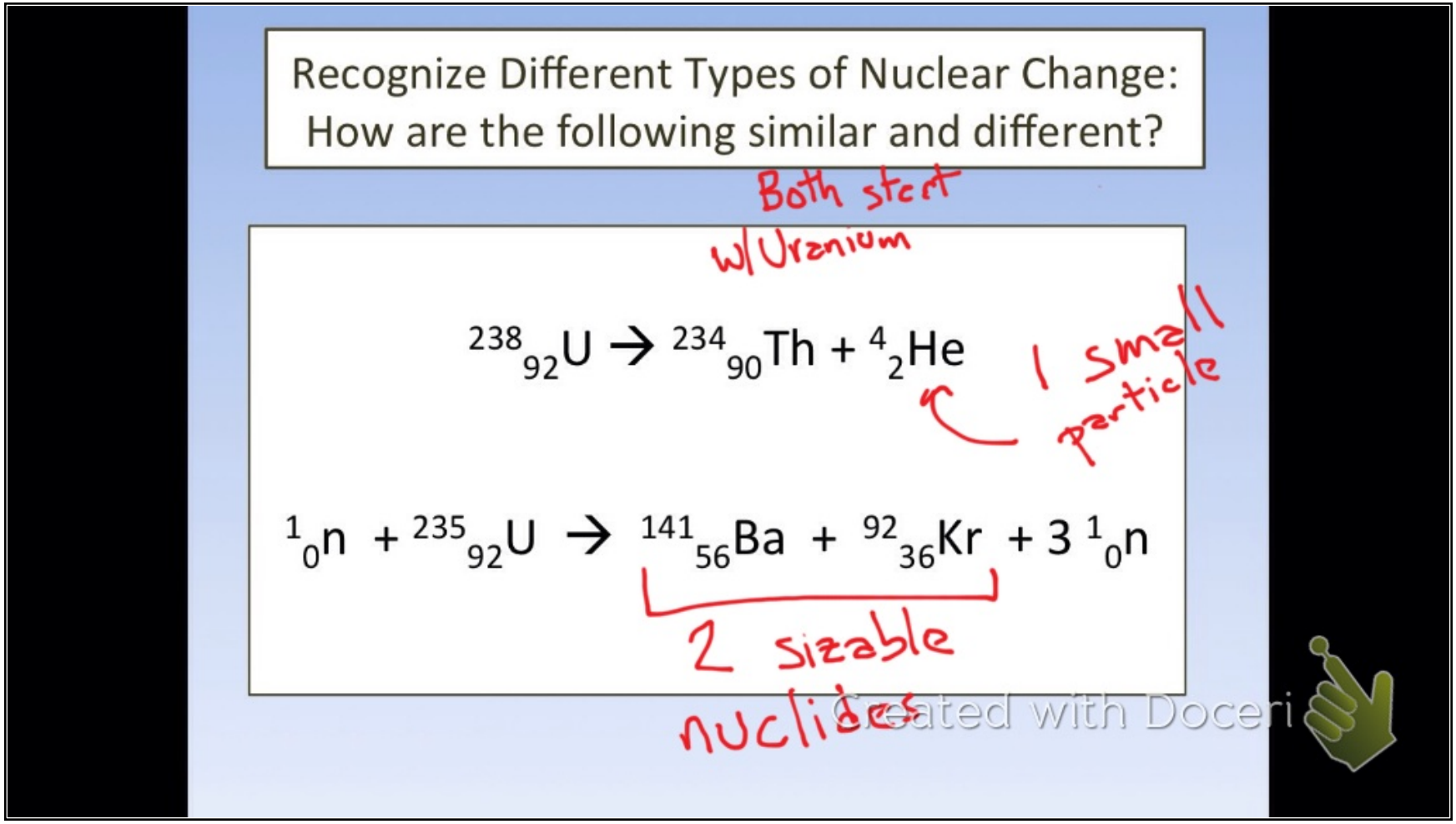
Recognize Different Types of Nuclear Change:
How are the following similar and different?
Both start w/Uranium
$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$
1 small particle
$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n$
2 sizable nuclides
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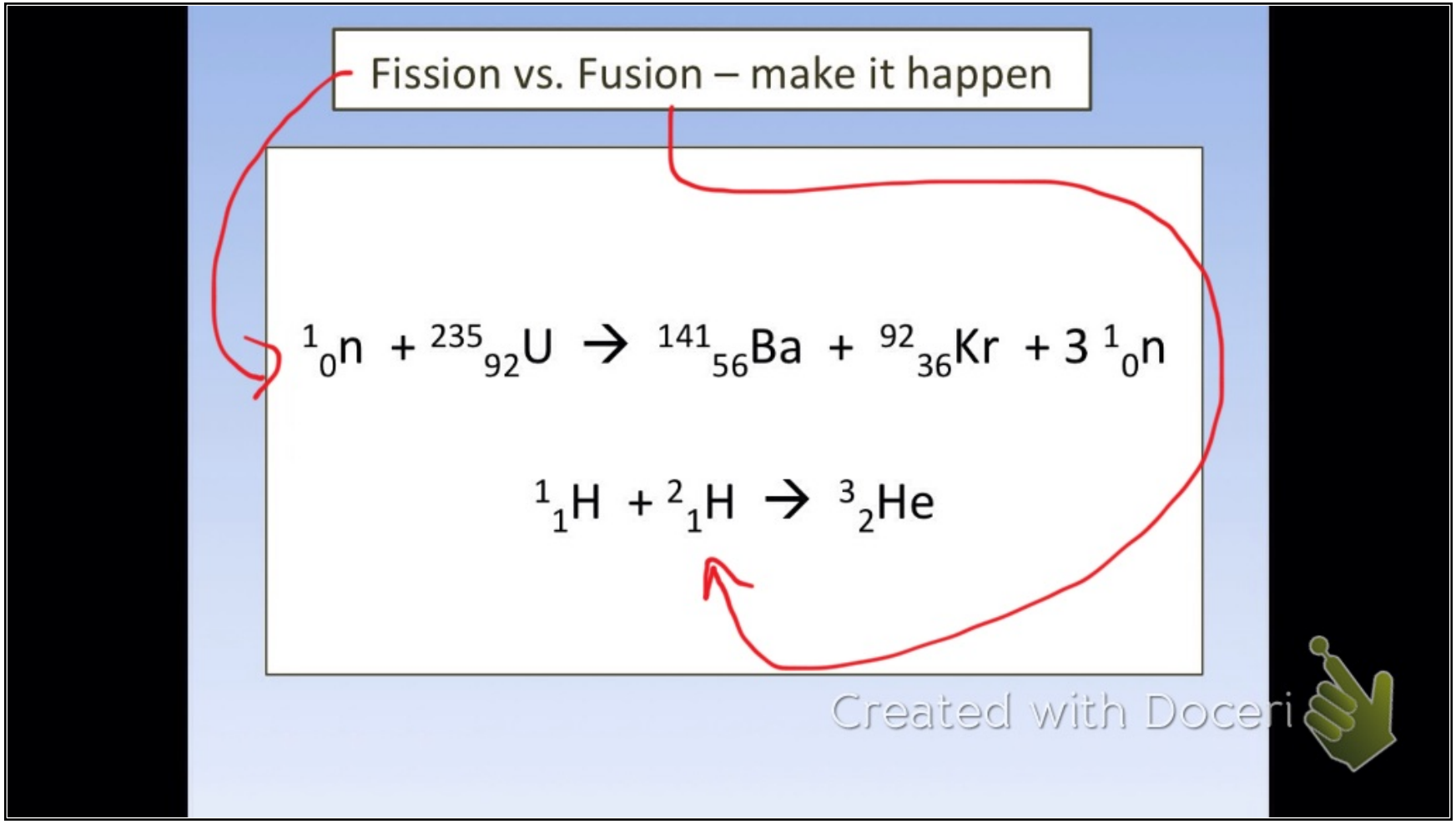
Fission vs. Fusion – make it happen
$^{1}_{0}n + ^{235}_{92}U \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3\,^{1}_{0}n$
$^{1}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He$
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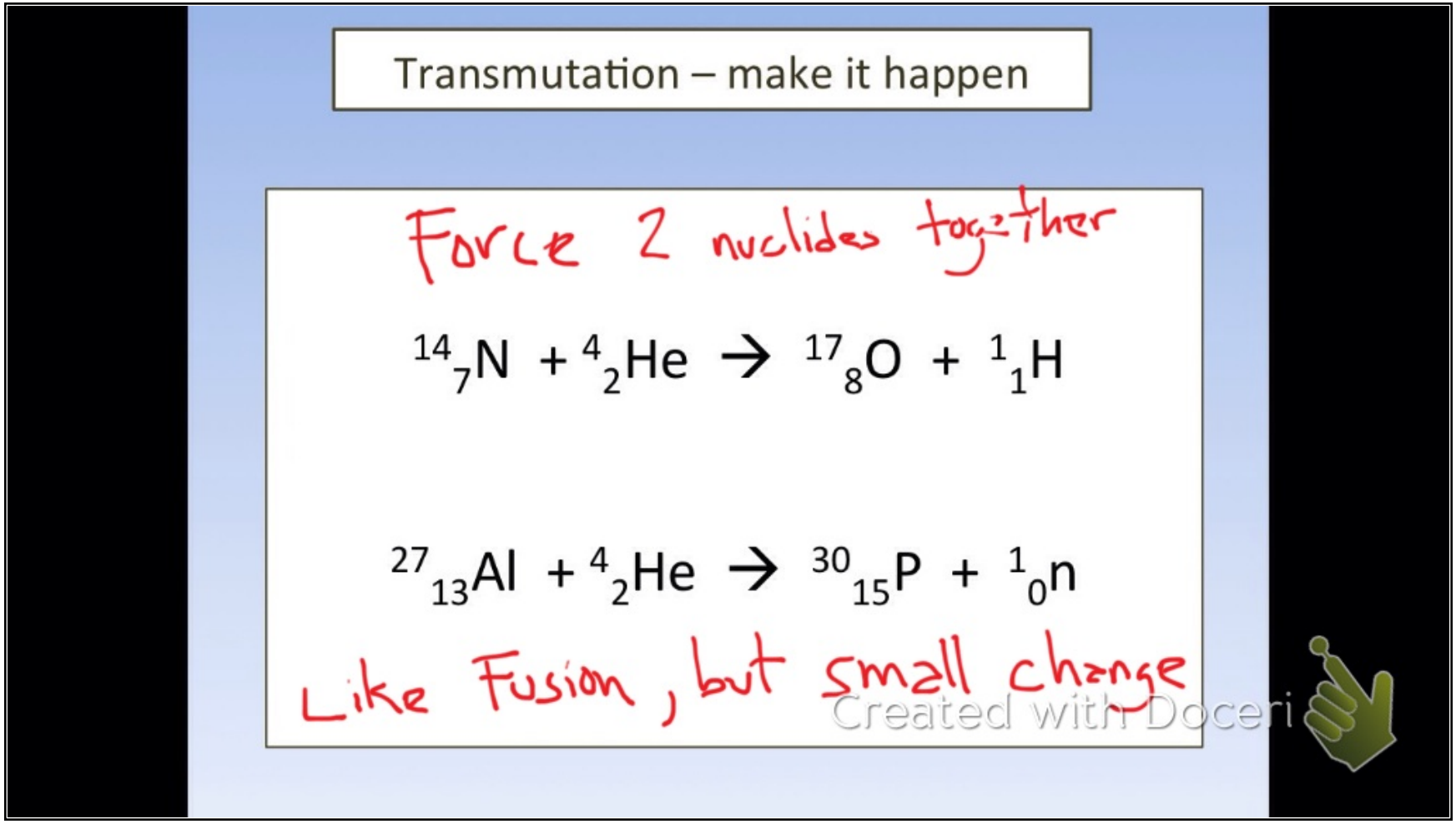
Transmutation – make it happen
Force 2 nuclides together
$^{14}_{7}N + ^{4}_{2}He \rightarrow ^{17}_{8}O + ^{1}_{1}H$
$^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n$
Like Fusion, but small change
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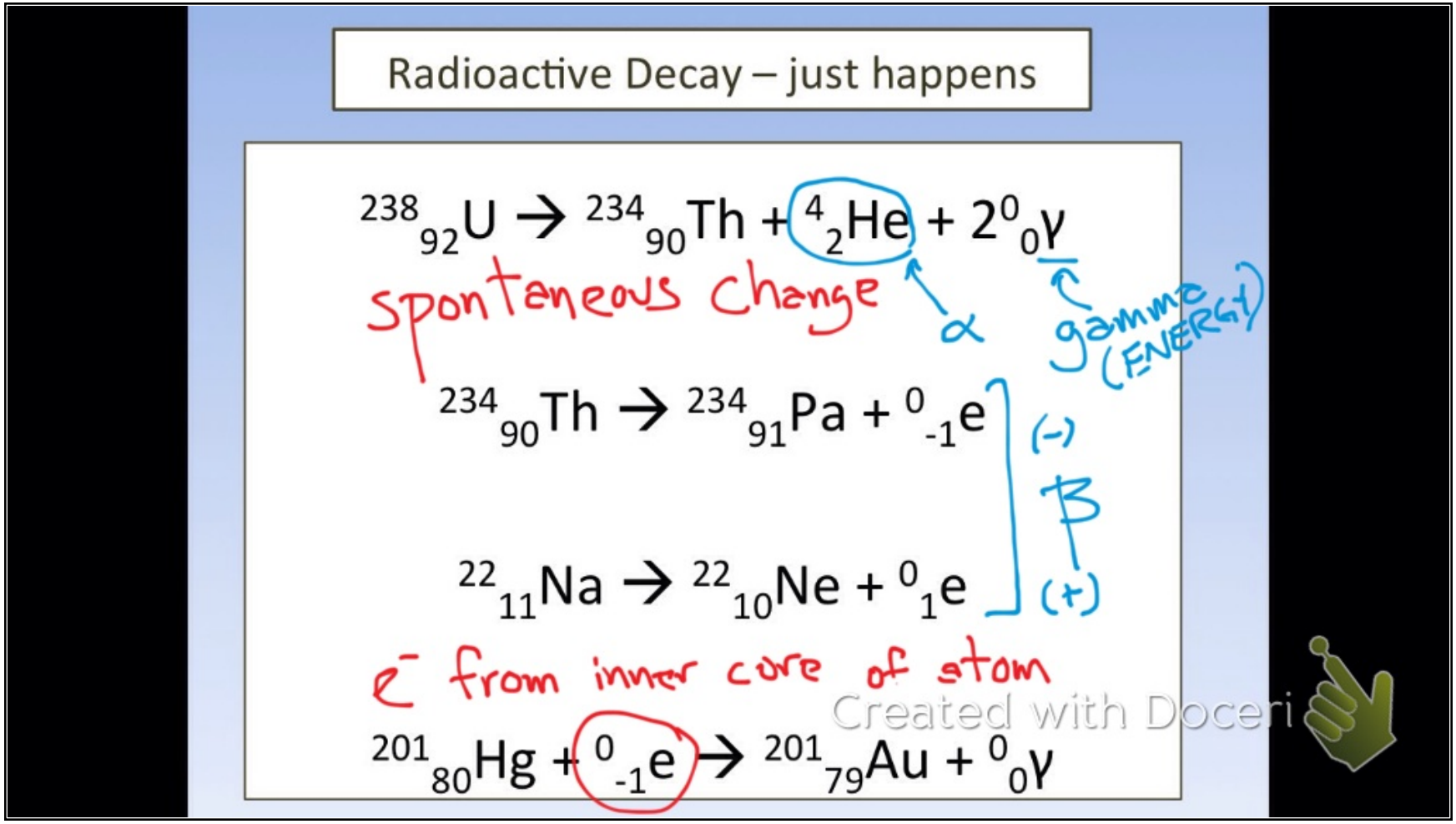
Radioactive Decay – just happens
$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He + 2\,{}^{0}_{0}\gamma$
spontaneous change
α
gamma (ENERGY)
$^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e$
(-)
β
(+)
$^{22}_{11}Na \rightarrow {}^{22}_{10}Ne + {}^{0}_{1}e$
e⁻ from inner core of atom
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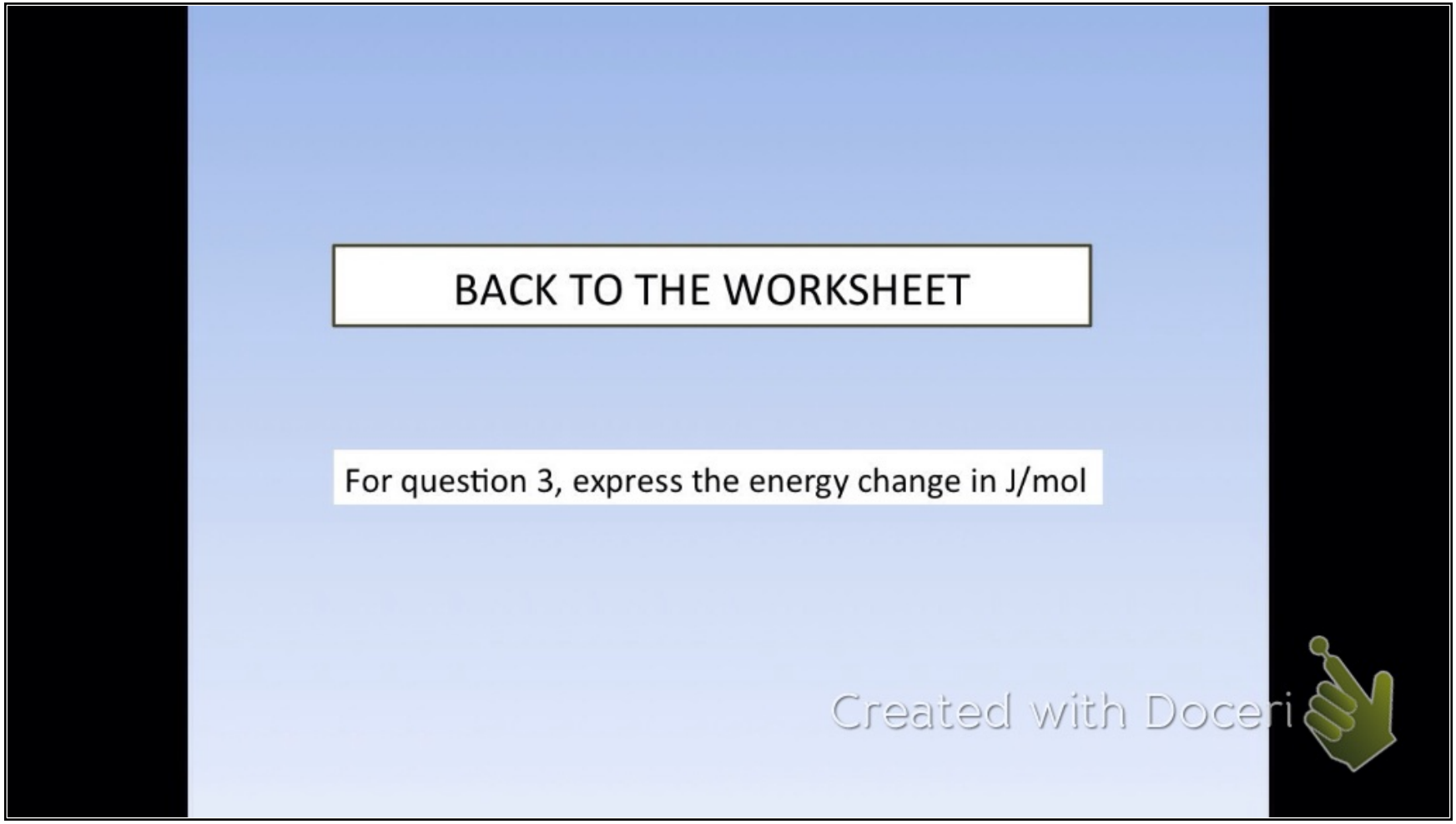
$^{201}_{80}Hg + {}^{0}_{-1}e \rightarrow {}^{201}_{79}Au + {}^{0}_{0}\gamma$


BACK TO THE WORKSHEET
For question 3, express the energy change in J/mol
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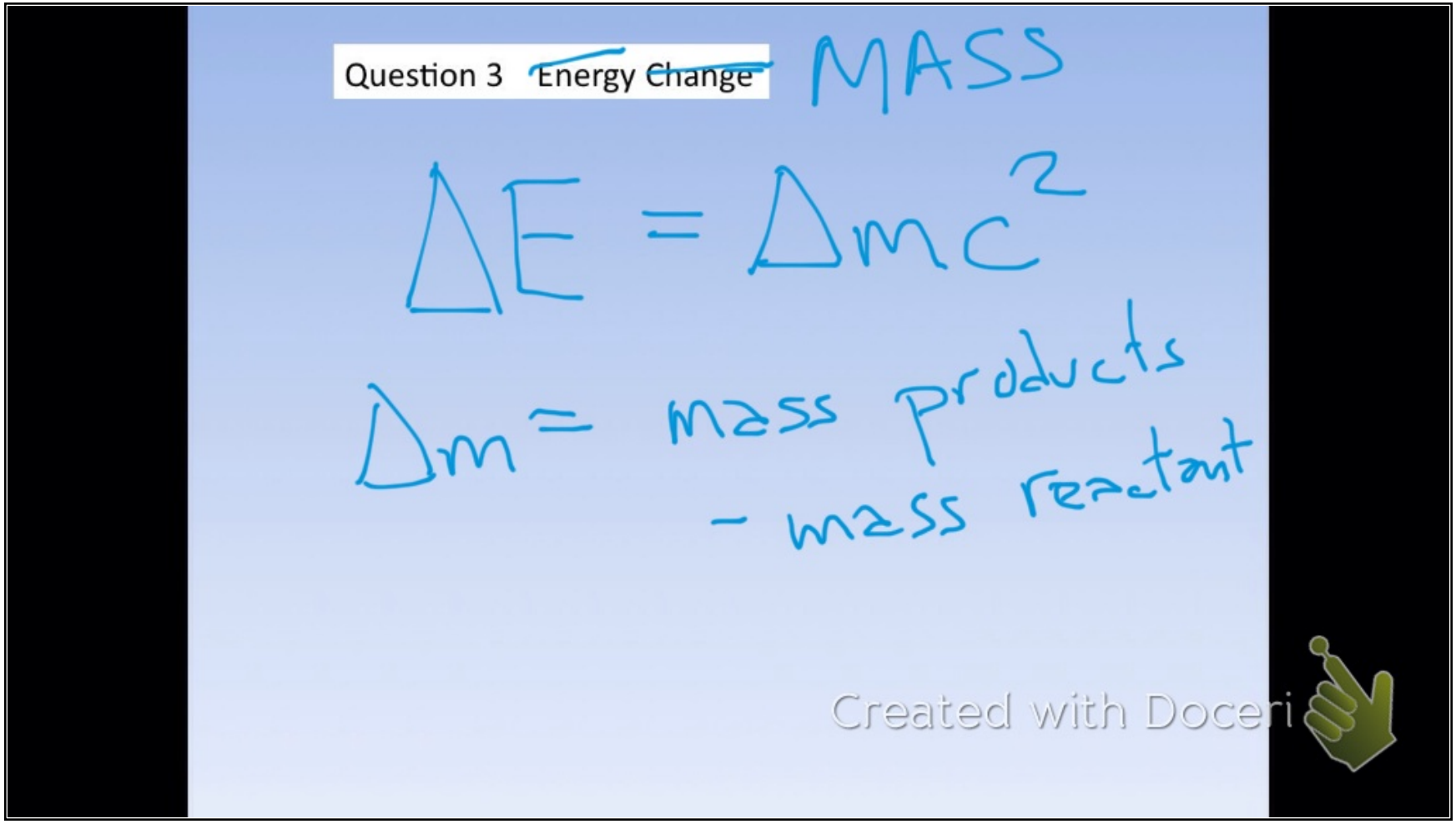
Question 3 Energy Change
MASS
$\Delta E = \Delta m c^2$
Δm = mass products
- mass reactant
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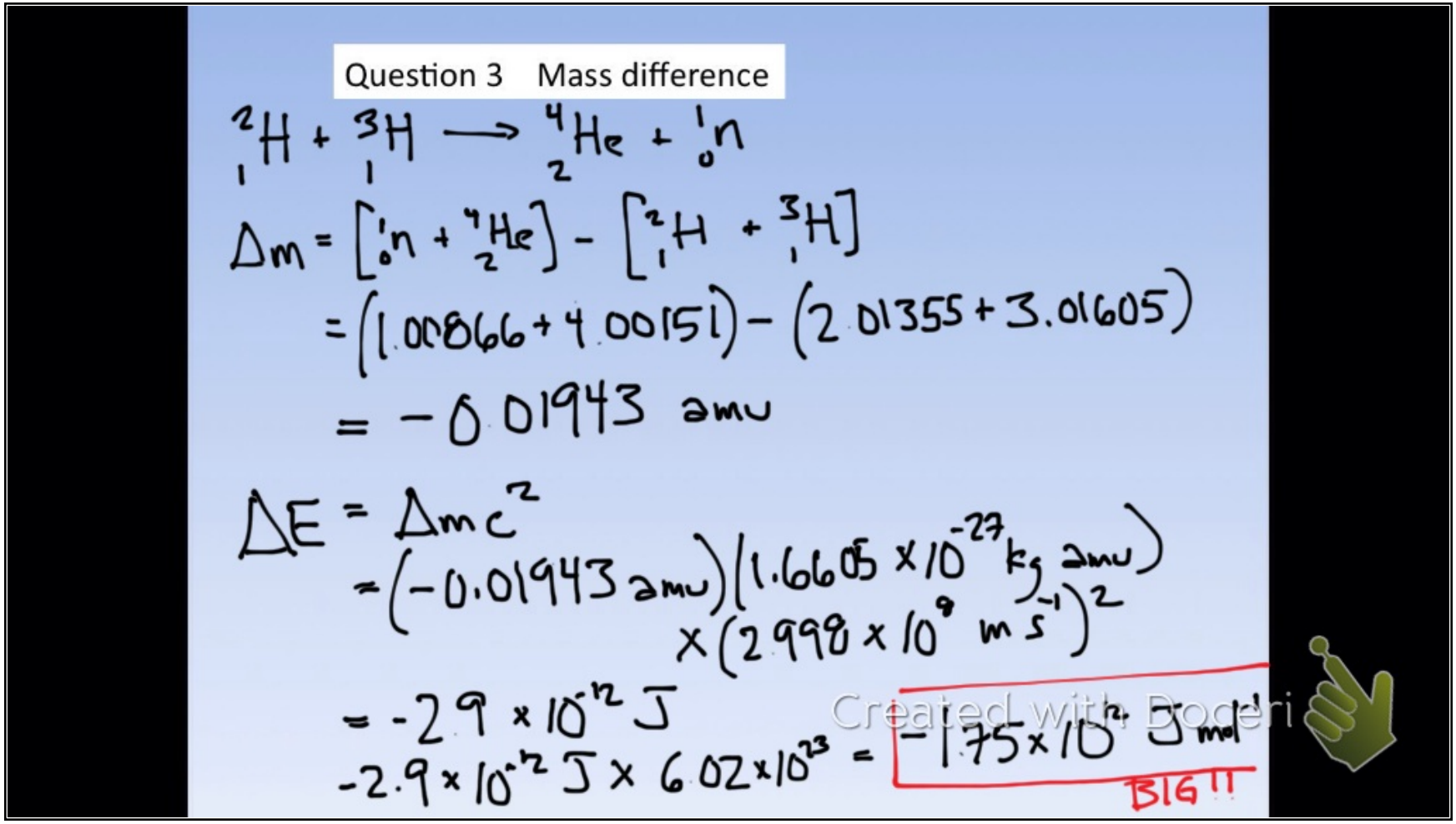
Question 3 Mass difference
$^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n$
$\Delta m = [^{1}_{0}n + ^{4}_{2}He] - [^{2}_{1}H + ^{3}_{1}H]$
$= (1.00866 + 4.00151) - (2.01355 + 3.01605)$
$= -0.01943$ amu
$\Delta E = \Delta m c^2$
$= (-0.01943 \text{ amu})(1.6605 \times 10^{-27} \text{ kg amu}^{-1}) \times (2.998 \times 10^{9} \text{ m s}^{-1})^2$
$= -2.9 \times 10^{-12}$ J
-2.9×10^{-12} J $\times$ 6.02×10^{23} = -1.75×10^{12} J mol^{-1}
BIG!!
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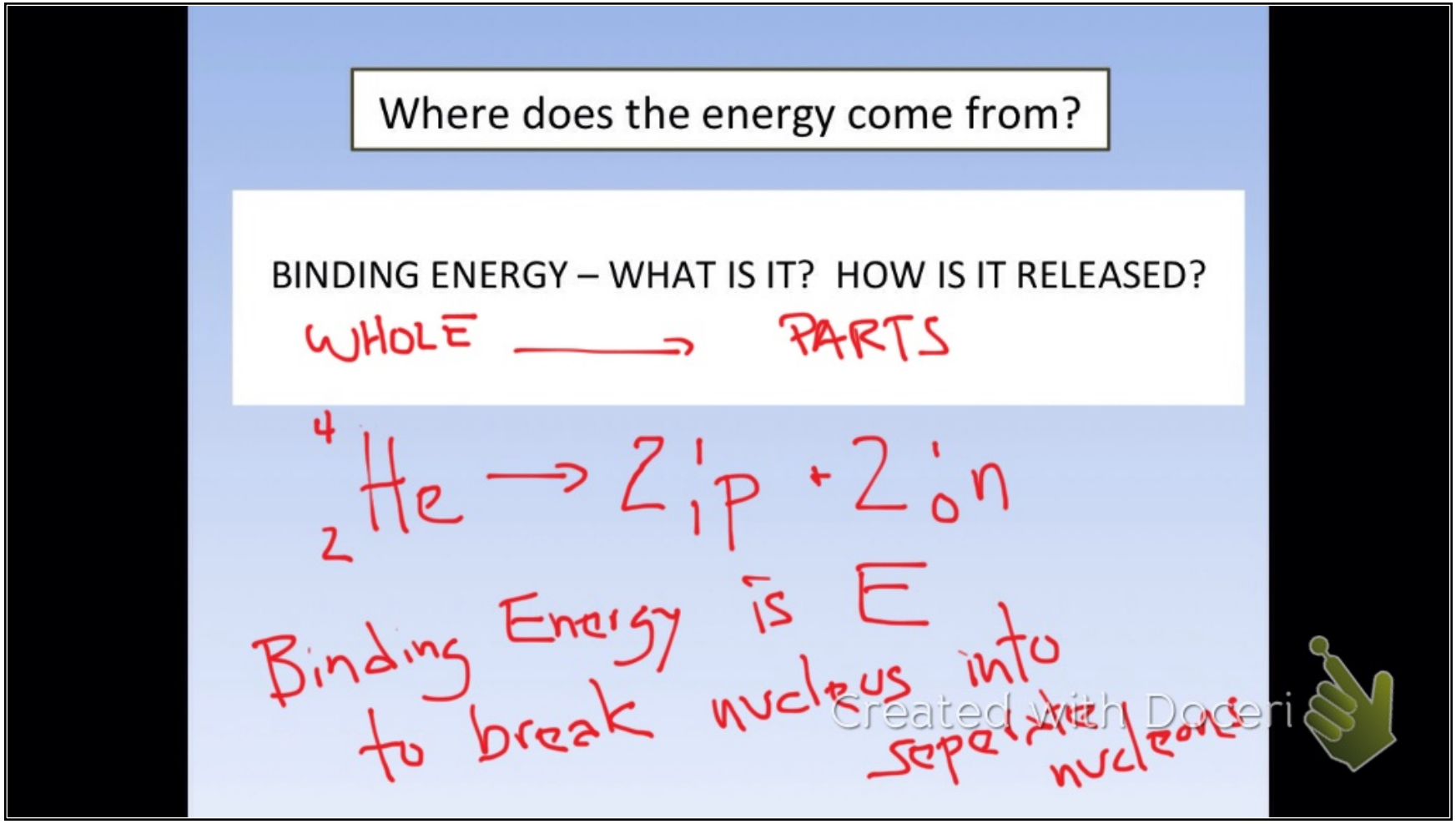
Where does the energy come from?
BINDING ENERGY – WHAT IS IT? HOW IS IT RELEASED?
WHOLE
PARTS
$_2^4He \rightarrow 2_1^1p + 2_0^1n$
Binding Energy is E
to break nucleus into
seperate nucleons
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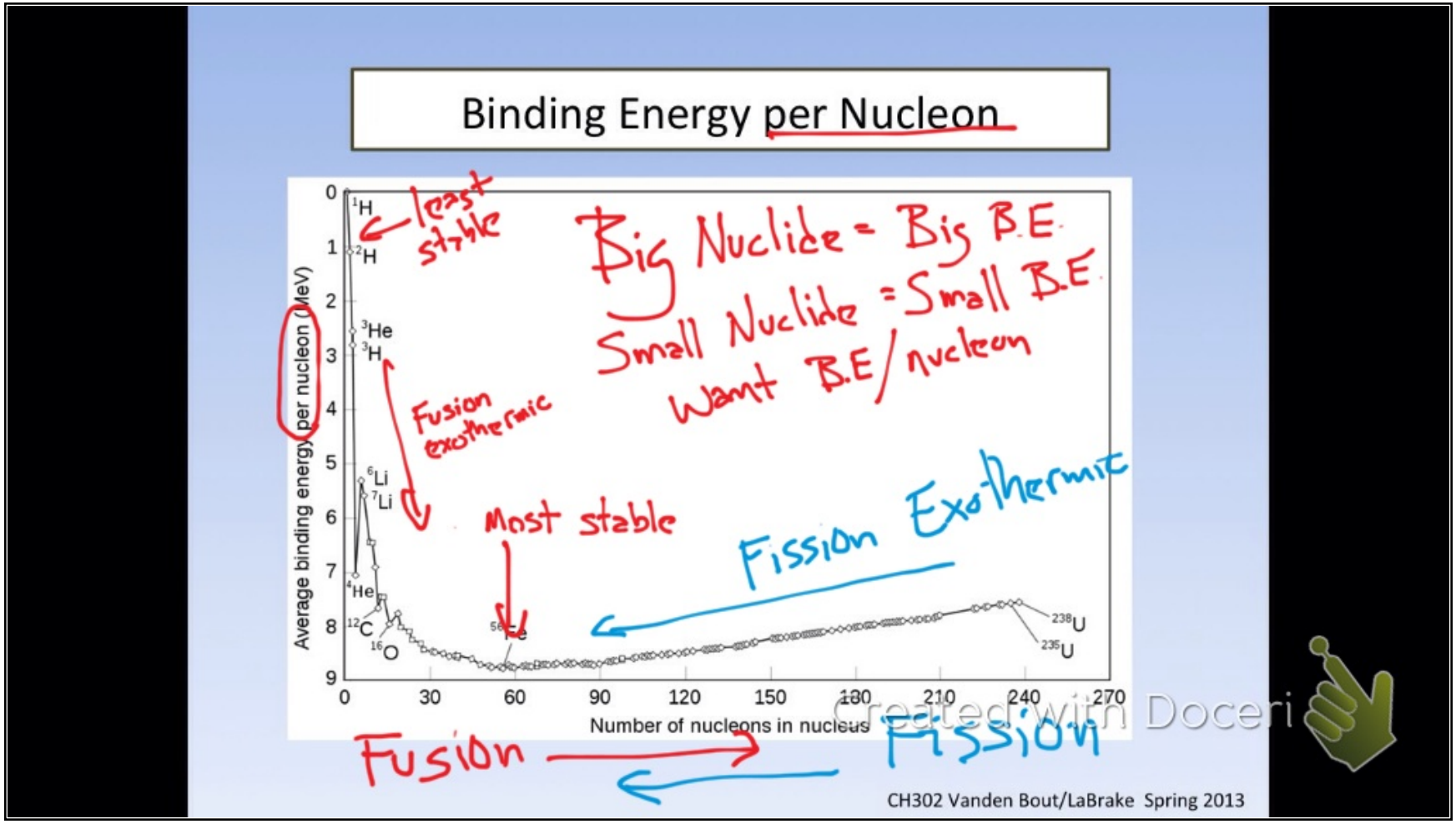
Binding Energy per Nucleon
Least stable
Big Nuclide = Big B.E.
Small Nuclide = Small B.E.
Want B.E/nucleon
Fusion exothermic
Most stable
Fission Exothermic
Average binding energy per nucleon (MeV)
Number of nucleons in nucleus
Fusion
Fission
CH302 Vanden Bout/LaBrake Spring 2013
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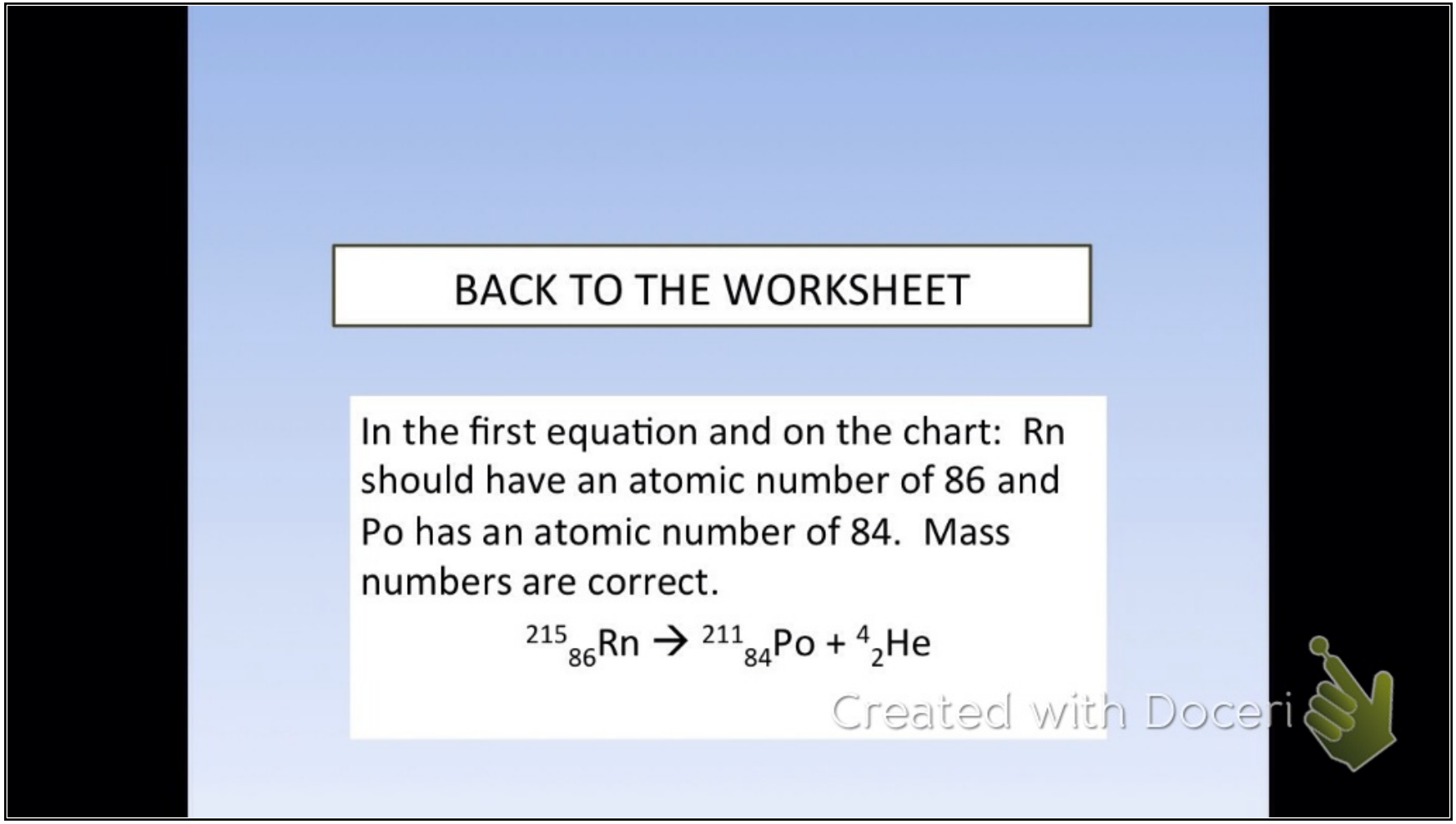
BACK TO THE WORKSHEET
In the first equation and on the chart: Rn should have an atomic number of 86 and Po has an atomic number of 84. Mass numbers are correct.
$^{215}_{86}Rn \rightarrow {}^{211}_{84}Po + {}^{4}_{2}He$
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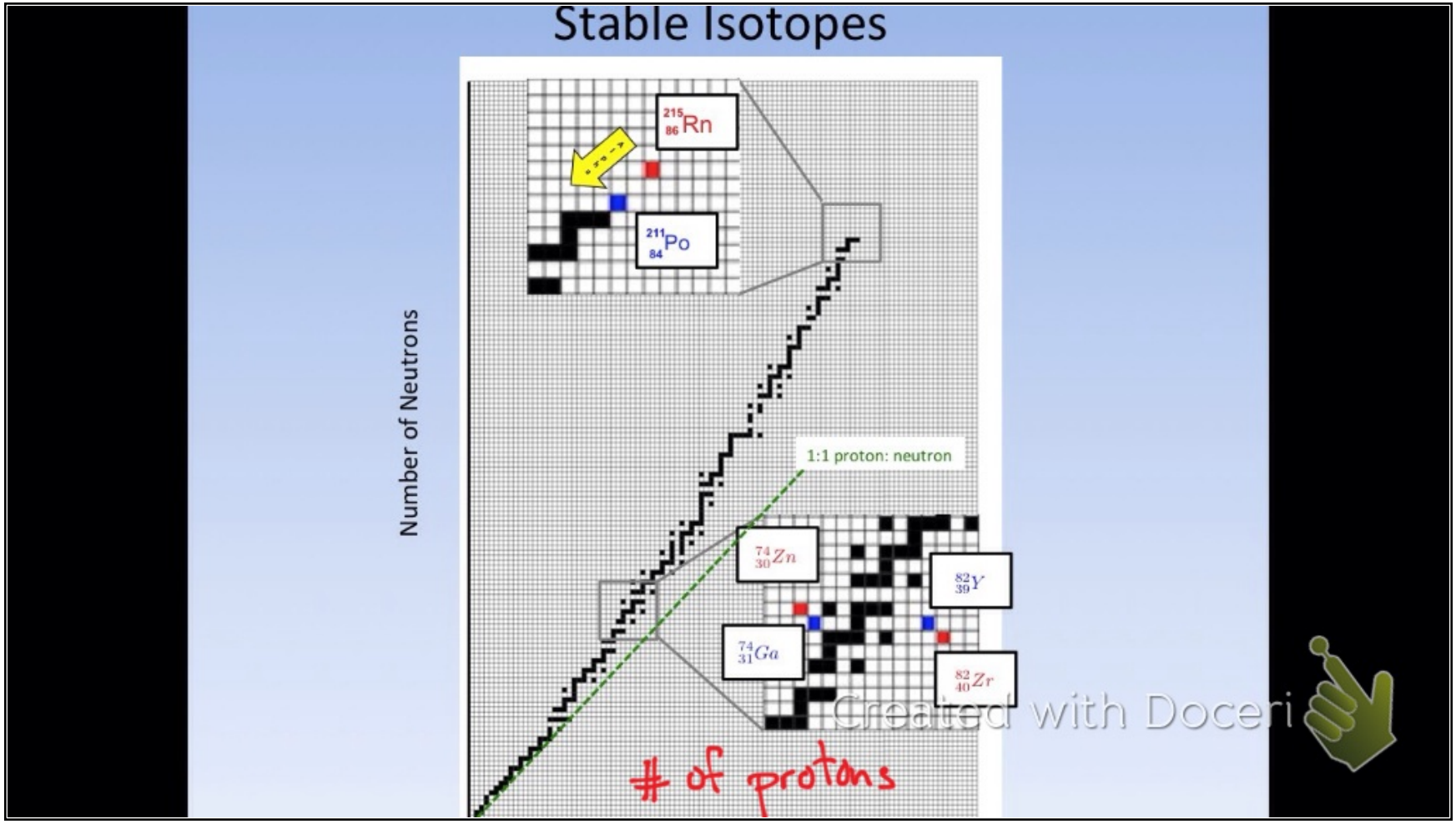
Stable Isotopes
$^{215}_{86}Rn$
$^{211}_{84}Po$
Number of Neutrons
1:1 proton: neutron
$^{74}_{30}Zn$
$^{82}_{39}Y$
$^{74}_{31}Ga$
$^{82}_{40}Zr$
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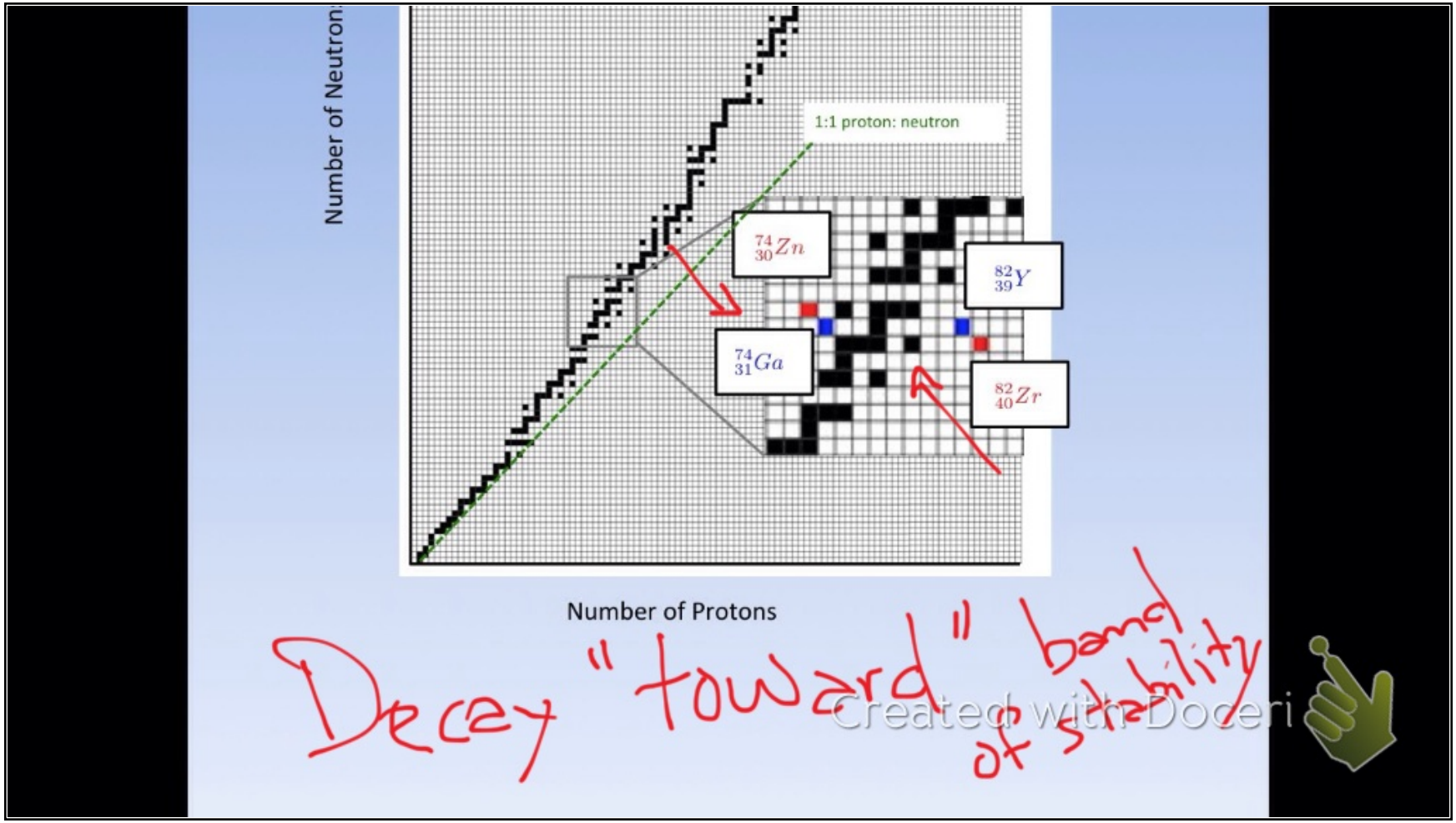
# of protons


Number of Neutrons
1:1 proton: neutron
$^{74}_{30}Zn$
$^{82}_{39}Y$
$^{74}_{31}Ga$
$^{82}_{40}Zr$
Number of Protons
Decay "toward" band of stability
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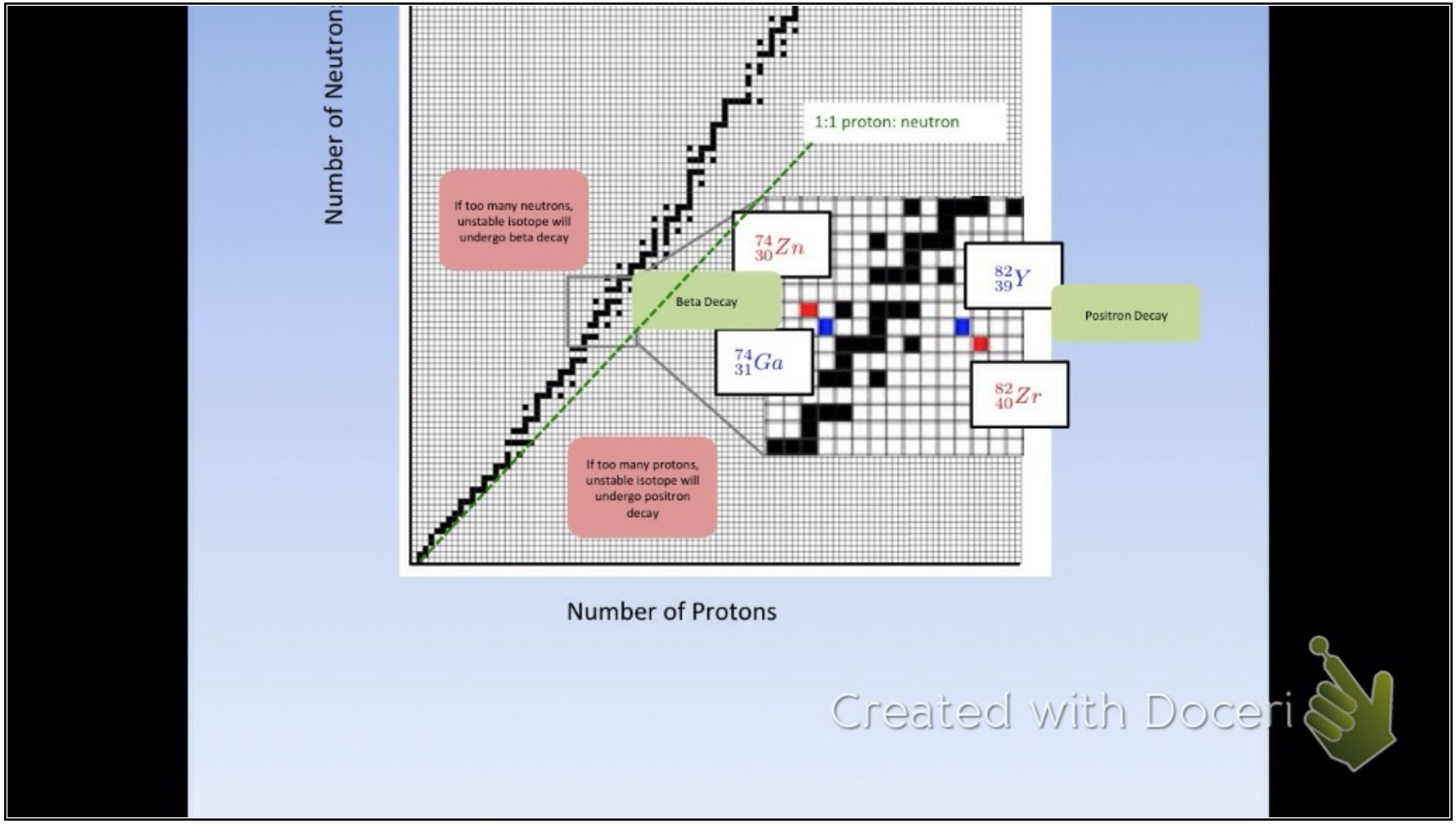
Number of Neutrons
1:1 proton: neutron
If too many neutrons, unstable isotope will undergo beta decay
$^{74}_{30}Zn$
$^{82}_{39}Y$
Beta Decay
Positron Decay
$^{74}_{31}Ga$
$^{82}_{40}Zr$
If too many protons, unstable isotope will undergo positron decay
Number of Protons
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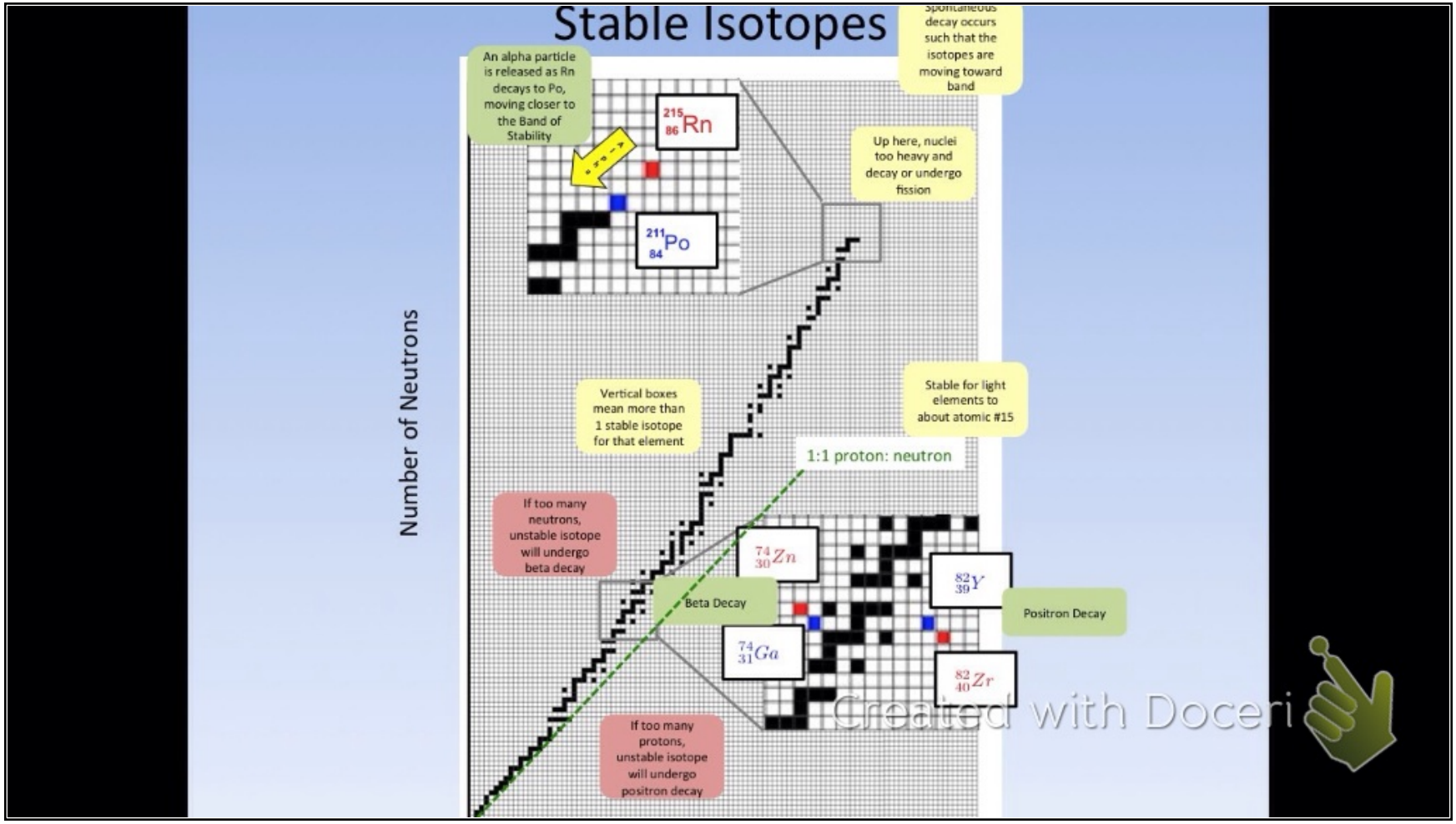
Stable Isotopes
An alpha particle is released as Rn decays to Po, moving closer to the Band of Stability
decay occurs such that the isotopes are moving toward band
$^{215}_{86}Rn$
$^{211}_{84}Po$
Up here, nuclei too heavy and decay or undergo fission
Number of Neutrons
Vertical boxes mean more than 1 stable isotope for that element
Stable for light elements to about atomic #15
1:1 proton: neutron
If too many neutrons, unstable isotope will undergo beta decay
$^{74}_{30}Zn$
$^{82}_{39}Y$
Beta Decay
Positron Decay
$^{74}_{31}Ga$
$^{82}_{40}Zr$
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If too many protons, unstable isotope will undergo positron decay