Announcements – Lecture XXI – Thursday, Nov 21st

1. Lab 6 – Saturday, November 23rd, 1:00-4:00 pm – ISB 155/160 A-E
   Lab Owl V– Deadline – Saturday, November 23rd, 11:59 pm

2. Exam III – Tuesday, December 3rd – In Class – 12:45-2:15 pm
   3 or 4 questions will be taken from Lab Owls 3, 4 and 5.
   Sunday, December 1st – Review , 3:00-5:00pm – ISB 135

3. Final Exam – Tuesday, December 10th – Marcus 131 – 8:00-10:00 am
   Sunday, December 8th – Review , 3:00-5:00pm – ISB 135

4. 

   iClicker:
   Choose any letter: A-E

8.11 How do We Calculate the pH of a Buffer?

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+ + A^-$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

$$pH = -\log_{10}[H_3O^+]$$

$$[H_3O^+] = K_a\left([HA]/[A^-]\right)$$

$$\log_{10}[H_3O^+] = \log_{10}K_a + \log_{10}[HA]/[A^-]$$

$$-\log_{10}[H_3O^+] = -\log_{10}K_a - \log_{10}[HA]/[A^-]$$

$$pH = pK_a \left(-\log_{10}[HA]/[A^-]\right)$$

Math Magic!

$$pH = pK_a + \log_{10}[A^-]/[HA]$$

HA = weak acid, A^- is HA's conjugate base

Buffer pH: $pH = pK_a + \log_{10}\frac{[\text{Buffer base}]}{[\text{Buffer acid}]}$

↳ HENDERSON-HASSELBACK EQUATION

8.11 How do We Calculate the pH of a Buffer?

MAIN QUESTION

Question

A solution contains the following components

0.208 M HCO_2H ... Acid

0.376 M $NaHCO_2$ ... Base

What is the pH of the solution?

Ka HCO_2H = 1.8×10^{-4}

Answer

Enter a response, then Submit.

4

$$pH = pK_a + \log_{10} \frac{[\text{Buffer base}]}{[\text{Buffer acid}]}$$

$$pH = -\log_{10}(1.8 \times 10^{-4}) + \log_{10} \frac{[HCO_2^-]}{[HCO_2H]}$$

$$pH = 3.745 + \log_{10}\left(\frac{0.376}{0.208}\right)$$

$$= 3.745 + \log_{10}(1.807)$$

$$= 3.745 + 0.257$$

$$= 4.002$$

8.11 Buffers – A Summary

BA = Buffer Acid BB = Buffer Base

a) Buffer : BA + BB — Weak acid / Conjugate base or Weak base / Conjugate acid

b) [BA] = [BB] then the pH of the buffer solution = pKa of the BA

c) Optimal buffer : $[BB]/[BA] \approx 0.1$ to 10

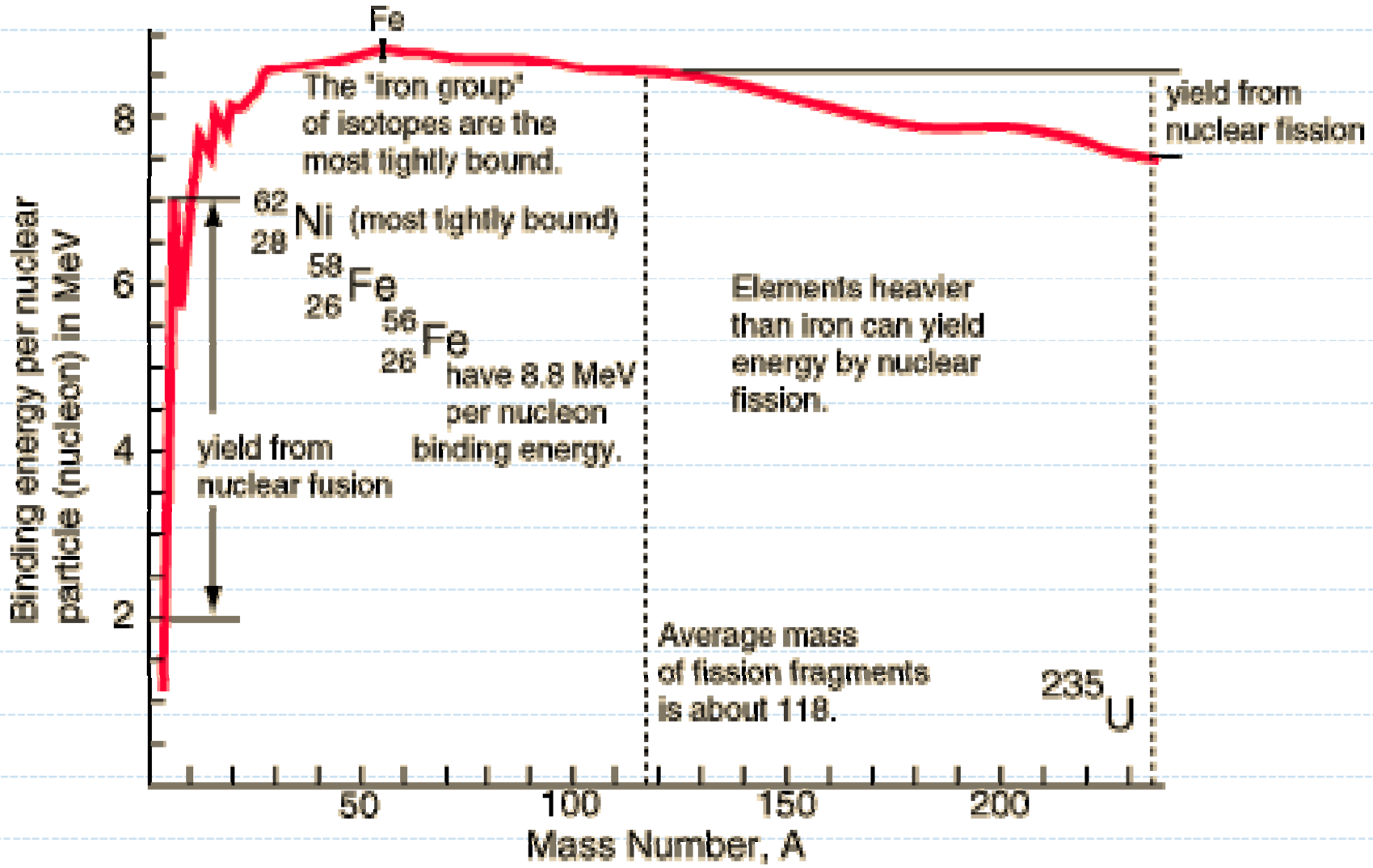
d) Buffer Capacity : [BA] or [BB] = maximum amount of OH^- or H_3O^+ that can be removed without affecting a drastic pH change

e) How a buffer works :

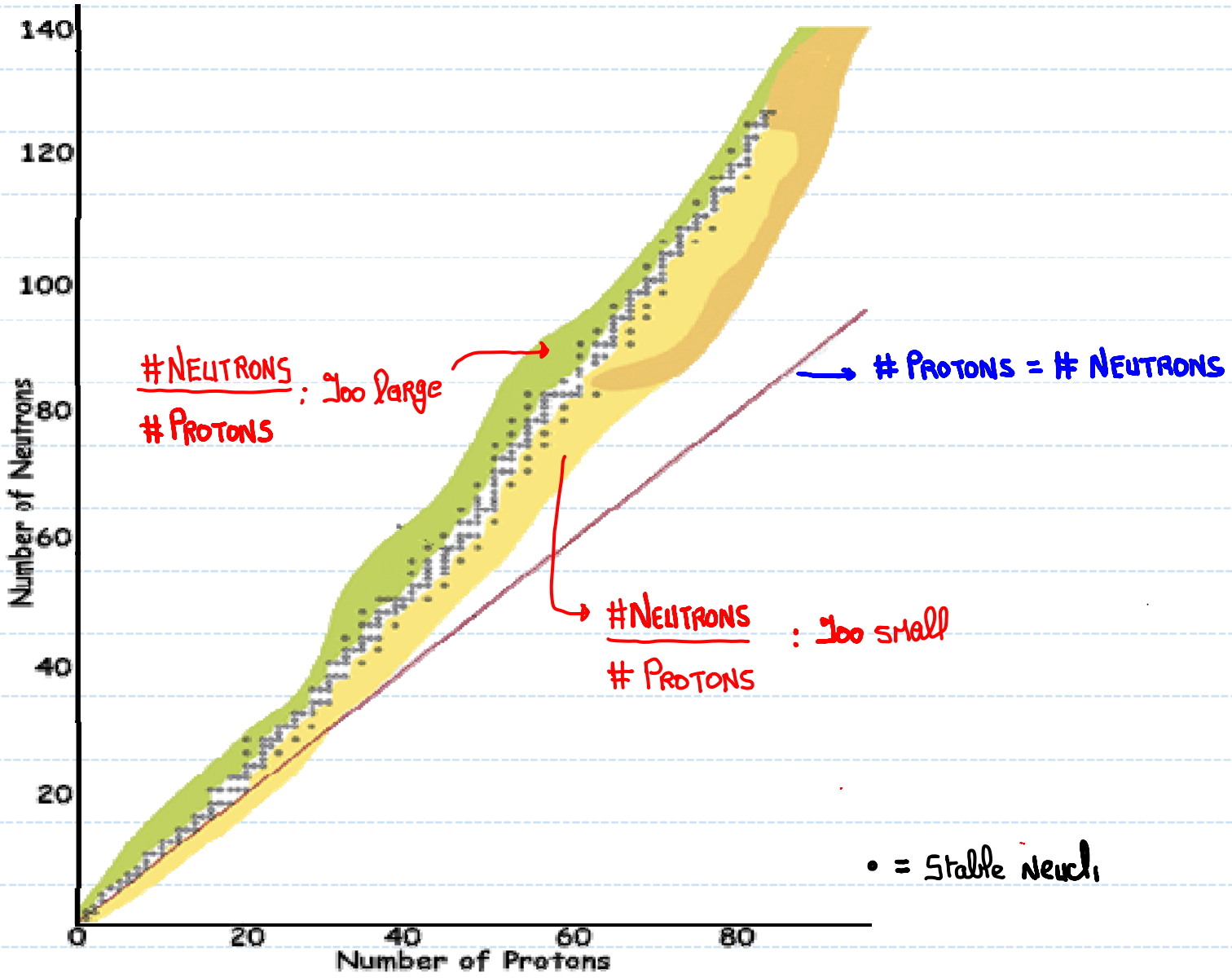
$$OH^- + BA = H_2O(l) + BB$$
$$H_3O^+ + BB = H_2O(l) + BA$$

f) $pH = pKa + \log_{10} \frac{[BB]}{[BA]}$

9.3 Binding Energy – Nuclear Fusion Vs Nuclear Fission



9.3 Nuclei Stability Zone?



9.3 What Happens When a Nucleus Emits Radioactivity

Decay Methods

1) Beta Emission

↳ ${}^{0}_{-1}\beta$ ... ${}^{0}_{-1}e$ .. ONL ${}_{-1}e^{0}$

2) Alpha Emission

↳ ${}^{4}_{2}\alpha$ ... ${}^{4}_{2}He$ ... ONL ${}_{2}He^{4}$

3) Positron Emission

↳ ${}^{0}_{+1}\beta$ ... ${}^{0}_{+1}e$ ... ONL ${}_{+1}e^{0}$

4) Nucleus captures an electron — Electron Capture

↳ ${}^{0}_{-1}e$ ... ONL ${}_{-1}e^{0}$

All four decay methods give off gamma radiation.

9.3 What Happens When a Nucleus Emits Radioactivity

What's happening in the Nucleus – emitting $^{0}_{-1}e$, $^{0}_{+1}e$ and capturing $^{0}_{-1}e$ – a simplistic approach.

a) Nucleus emitting a $^{0}_{-1}\beta$ particle ... an electron ... where does this $^{0}_{-1}e$ come from?

$$^{1}_{0}n \rightarrow {}^{1}_{1}H + {}^{0}_{-1}e \quad \text{(Emitted)}$$

Neutron — Proton — Electron (Beta particle)

Net result in the nucleus — Neutron converted to a Proton.

b) Nucleus emitting a $^{0}_{+1}\beta$ particle ... a positron ... where does this $^{0}_{+1}e$ come from?

$$^{1}_{1}H \rightarrow {}^{1}_{0}n + {}^{0}_{+1}e \quad \text{(Emitted)}$$

Proton — Neutron — Positron

Net result in the nucleus — Proton converted to a Neutron

9.3 What Happens When a Nucleus Emits Radioactivity

What's happening in the Nucleus – emitting $^{0}_{-1}e$, $^{0}_{+1}e$ and capturing $^{0}_{-1}e$ – a simplistic approach.

c) Nucleus capturing an electron ... why? ... What does the nucleus do with an $^{0}_{-1}e$?

$$^{1}_{1}H + ^{0}_{-1}e \rightarrow ^{1}_{0}n$$

Proton Captured electron Neutron

Net result in the nucleus — Proton converted to a Neutron

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission (^4_2He)

$^{234}_{92}U$ undergoes radioactive decay by emitting an alpha particle. As a result of this emission the #Neutron/#Proton ratio –

a) Increases b) Decreases c) Remains the same

$$^{234}_{92}U \rightarrow {}^{4}_{2}He + {}^{230}_{90}Th + \gamma \text{ Rays}$$

$^{234}_{92}U$: 142/92 = 1.543

$^{230}_{90}Th$: 140/90 = 1.556