Announcements – Lecture XX – Thursday, Nov 29th

1. Lab 6 … Saturday, December 1st, 1:00-4:00 pm ISB 155/160 A-E

2. Exam III … Thursday, December 6th, ISB 135, 12:45-2:15pm
   3 or 4 questions will be taken from Lab Owls 3, 4 and 5.

3. Final Exam … Wednesday, December 12th, ISB 135, 8:00-10:00am
   Final Review … Sunday, December 9th, ISB 135, 1:00-3:00pm

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

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

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

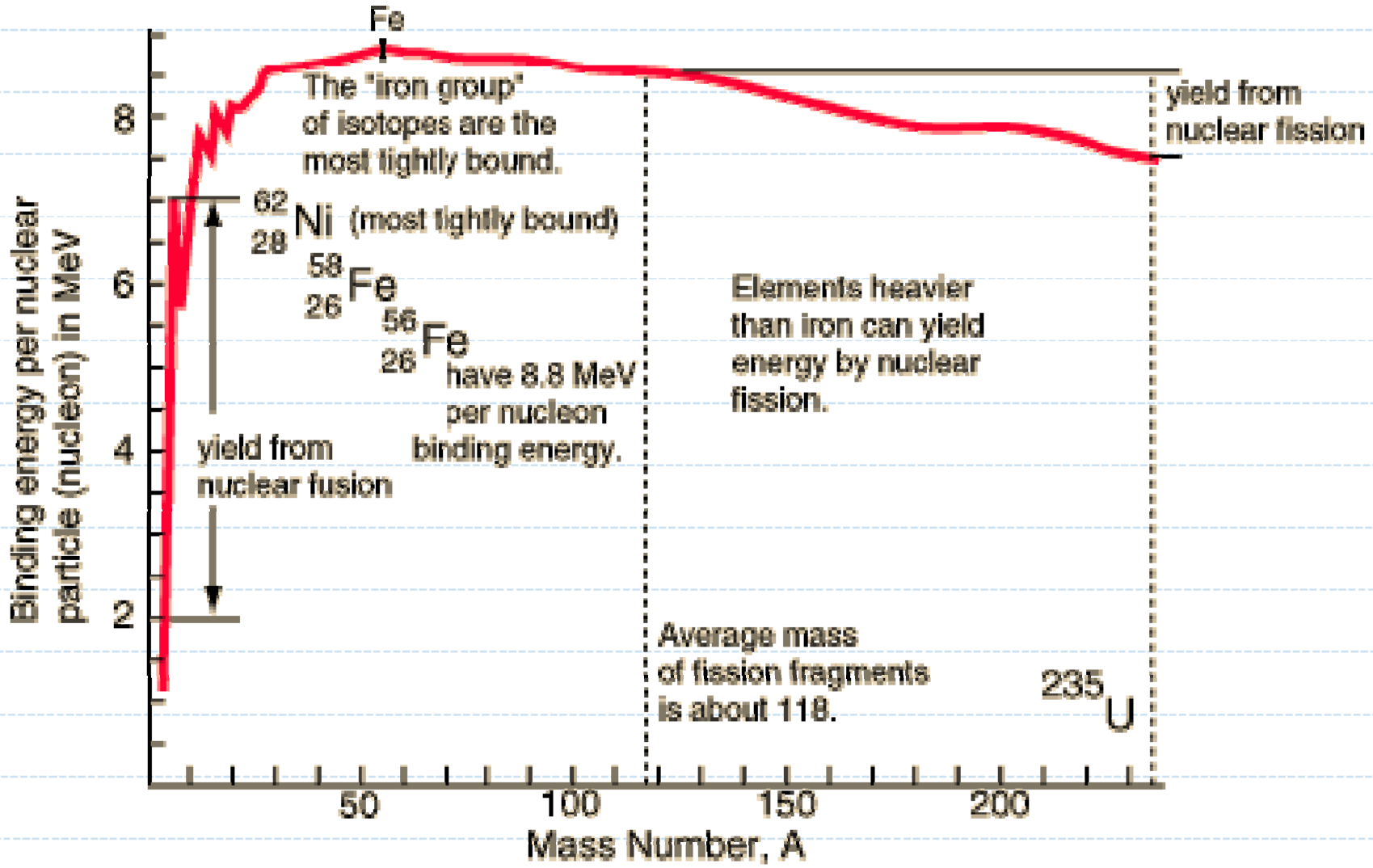
$$pH = 3.745 + \log_{10}\left(\frac{0.376}{0.208}\right)$$

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

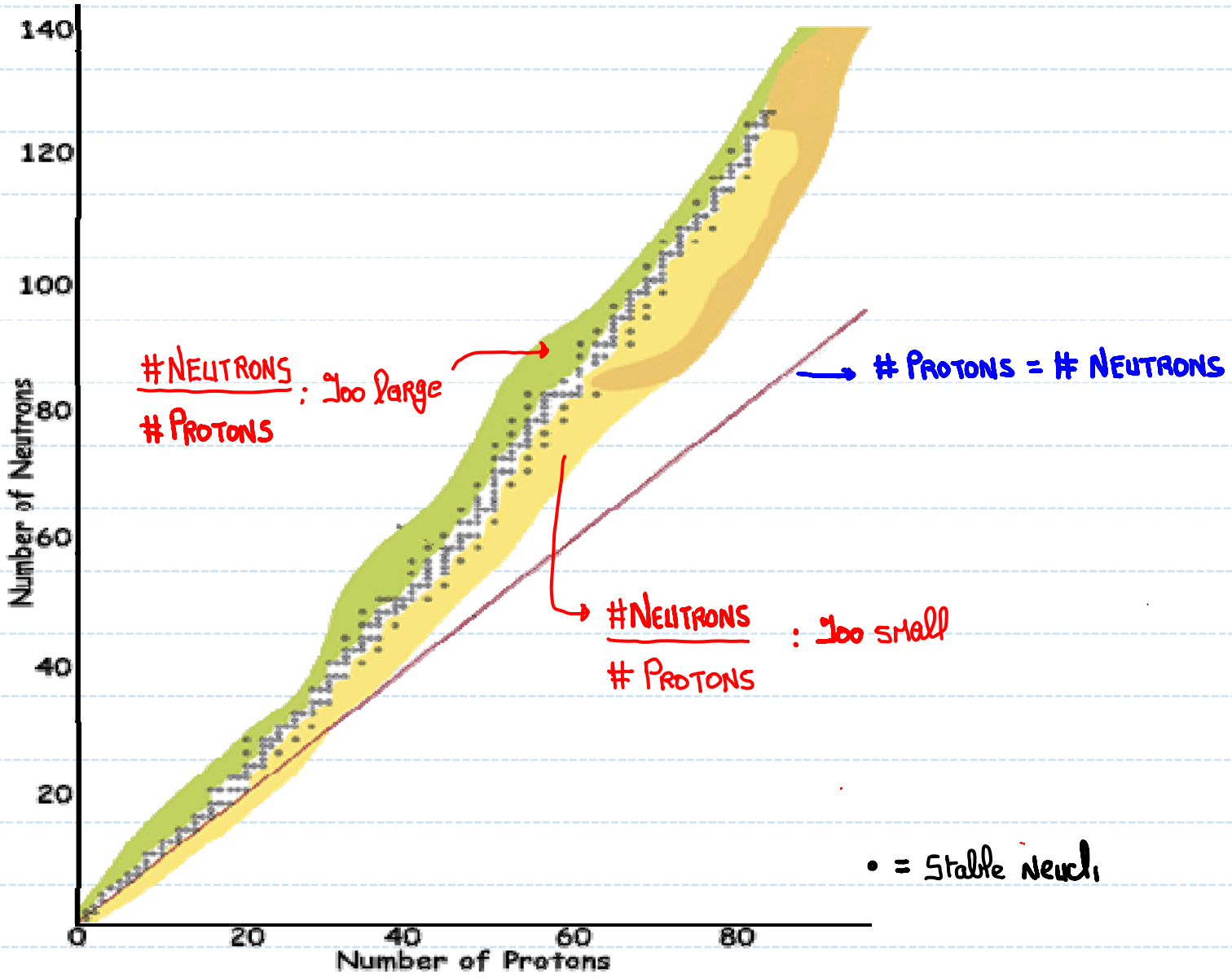
$$= 3.745 + 0.257$$

$$= 4.002$$

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

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission (^4_2He)

Because of the short range of absorption, alphas are not, in general, dangerous to life. Large enough doses can cause any or all of the symptoms of radiation poisoning. It is estimated that chromosome damage from alpha particles is anywhere from 10 to 1000 times greater than that caused by an equivalent amount of gamma or beta radiation.

From Wikipedia

$$^{222}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{218}_{84}Po + \gamma \text{ rays}$$

Why is this so dangerous?

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission (^4_2He)

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Last Updated: Thursday, 30 November 2006, 21:26 GMT

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Radiation found at 12 locations

Experts probing the death of former Russian spy Alexander Litvinenko have found traces of radioactivity at 12 locations, the home secretary has said.

Mr Litvinenko died last week in a London hospital

Among them are two British Airways (BA) planes. A third one is awaiting checks.

Home Secretary John Reid told Parliament that two Russian aircraft, one of which is currently at Heathrow airport, were also of interest.

The Health Protection Agency said 24 people had been referred to a specialist clinic for tests.

BA is contacting 33,000 passengers from 221 flights. But Mr Reid stressed the public health risk was low.

Mr Litvinenko, an ex-KGB officer and a fierce critic of Russian President Vladimir Putin, died last week of radiation poisoning.

Traces of radioactive polonium-210 were discovered in his body, and more traces of the substance have been found at venues he visited in the capital on 1 November.

HAVE YOUR SAY

"I work in the one of the office buildings where polonium-210 has been detected, and we have had no assistance at all from the authorities..."

$$^{210}_{84}Po \rightarrow {}^{4}_{2}He + {}^{206}_{82}Pb$$