Announcements – Lecture XXI – Thursday, Nov 20th

1. **Final Lab – Saturday, November 22nd … 1-4pm … ISB 155/160 (A-E)**

   a) Print lab prior to coming to lab -- use the 'Print Friendly Version' located on the top left hand side of the page – this is the version that contains the 'Data Sheet' that you will hand in upon completing the lab.

   b) The pre-lab quiz associated with this lab is the 'TA Evaluation' that that can be found in your Class Owls. Completing this by Monday, December 1st is equivalent to a perfect quiz score.

2. **Third Exam – Tuesday December 2nd – 1:00-2:15pm – In Class**

   3 or 4 questions will be taken from Lab Owls 3, 4 and 5.

3. **No class on Tuesday, November 25th – I have an appointment in Boston.**

4. 

   iClicker:

   Choose any letter: A-E

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

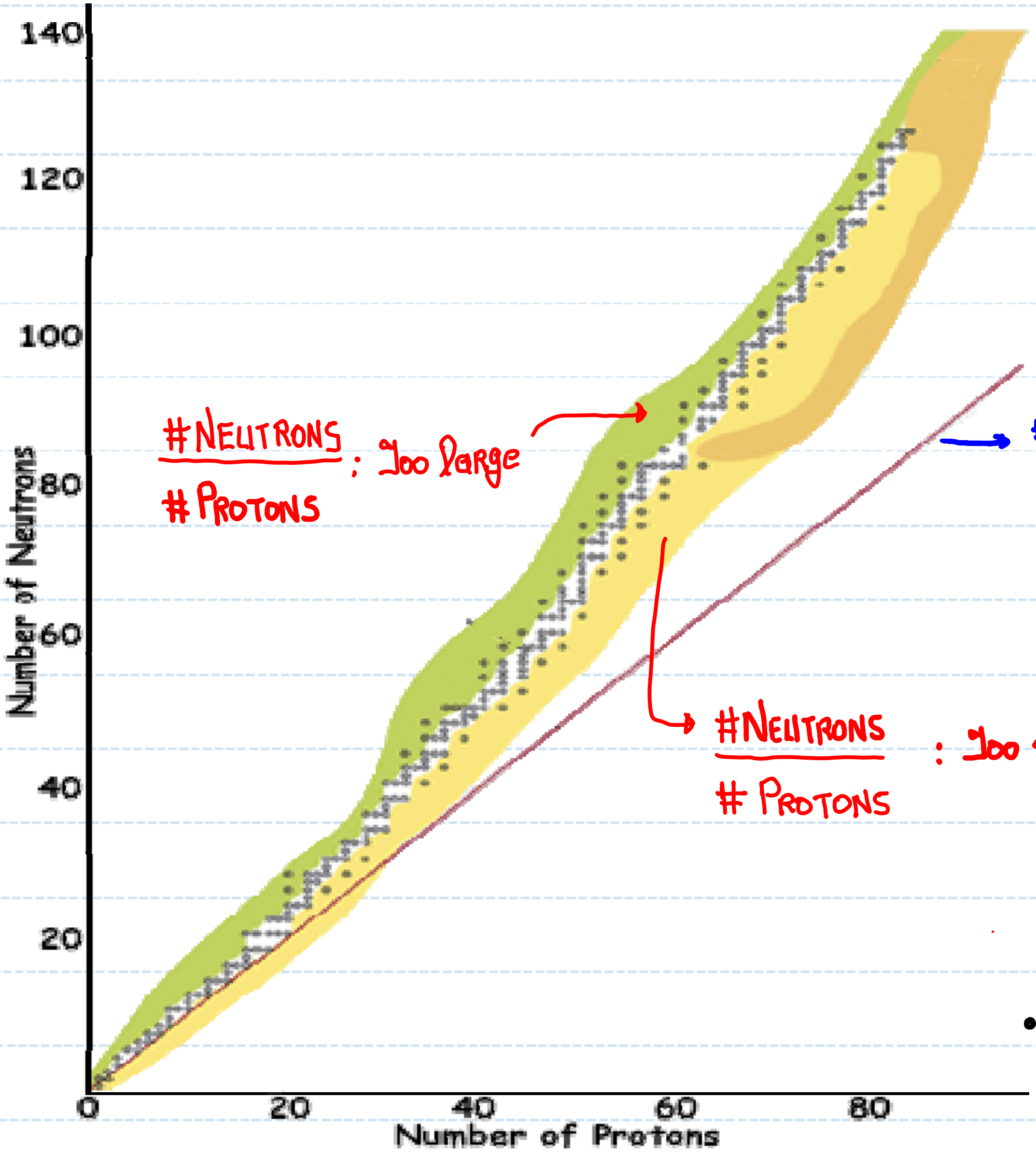
e) How a buffer works :

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

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

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

9.3 Nuclei Stability Zone?



$\frac{\#\text{NEUTRONS}}{\#\text{PROTONS}}$: Too large

$\frac{\#\text{NEUTRONS}}{\#\text{PROTONS}}$: Too small

\# PROTONS = # NEUTRONS

• = Stable Neucli

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?

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

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?

$${}^{1}_{1}H \rightarrow {}^{1}_{0}n + {}^{0}_{+1}e \longrightarrow \text{Emitted}$$

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

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

Proton Captured electron Neutron

Net result in the neucleus — Proton converted to a neutron

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission ($^{4}_{2}He$)

$^{234}_{92}U$ 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 ($^{4}_{2}He$)

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

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

$\uparrow$

Why is this so dangerous?

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission ($^{4}_{2}He$)

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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.

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

AP

Mr Litvinenko died last week in a London hospital

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.

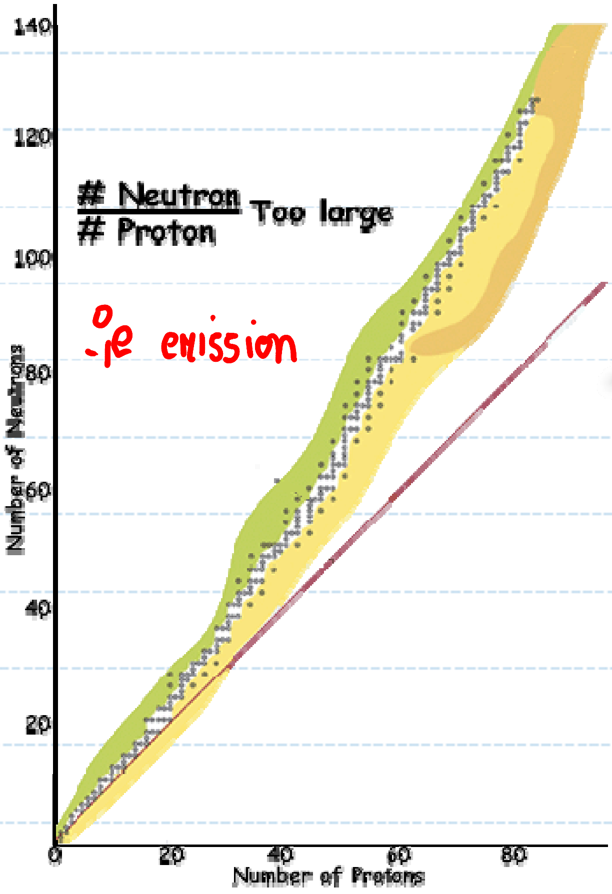
Traces of radioactive polonium-210 were discovered in his body, and more traces of the substance have been found at venues he visited in the capital on 1 November.

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”

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

9.3 What Happens When a Nucleus Emits Radioactivity



$^{60}{}_{27}$Co is one of many radioactive isotopes whose #Neutron/#Proton ratio is too large. Radioactive isotopes on this side of the stability have only one form of radioactive decay available to them –

a) Alpha emission

b) Positron emission

c) Electron capture

[✓ d) Beta emission.]

$^{4}_{2}He$: causes $\frac{\#\text{NEUTRON}}{\#\text{PROTON}}$ to ↑ ✗

$^{0}_{+1}e$: Proton converted to a neutron ✗

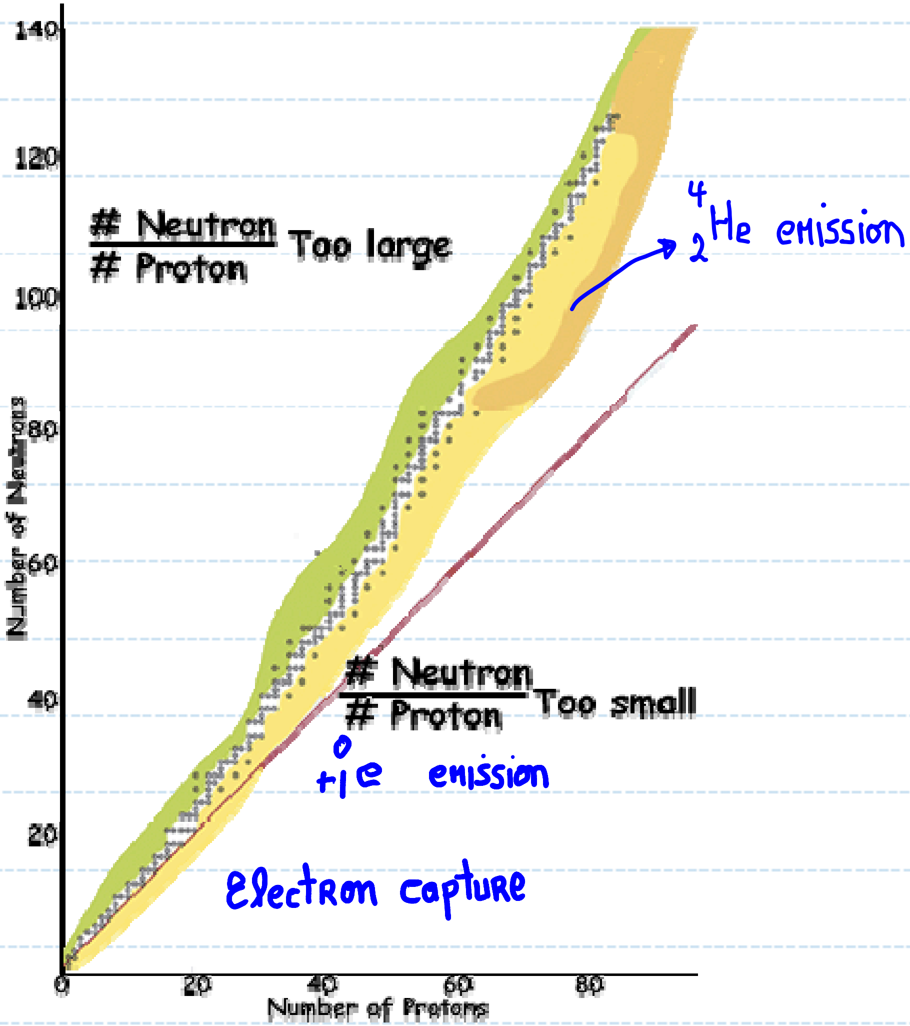
Electron capture : Proton converted to a neutron ✗

$^{0}_{-1}e$: Neutron converted to a proton ✓

$$^{60}_{27}Co \rightarrow {}^{0}_{-1}e + {}^{60}_{28}Ni + \gamma \text{ Rays}$$

9.3 What Happens When a Nucleus Emits Radioactivity

Positron Emission – Electron Capture – Alpha Emission



ELECTRON CAPTURE

$^{41}_{20}Ca + \underline{\underline{^{0}_{-1}e}} \rightarrow ^{41}_{19}K + \gamma$ Rays

Reactant

POSITRON EMISSION

$^{18}_{9}F \rightarrow ^{0}_{+1}e + ^{18}_{8}O + \gamma$ Rays

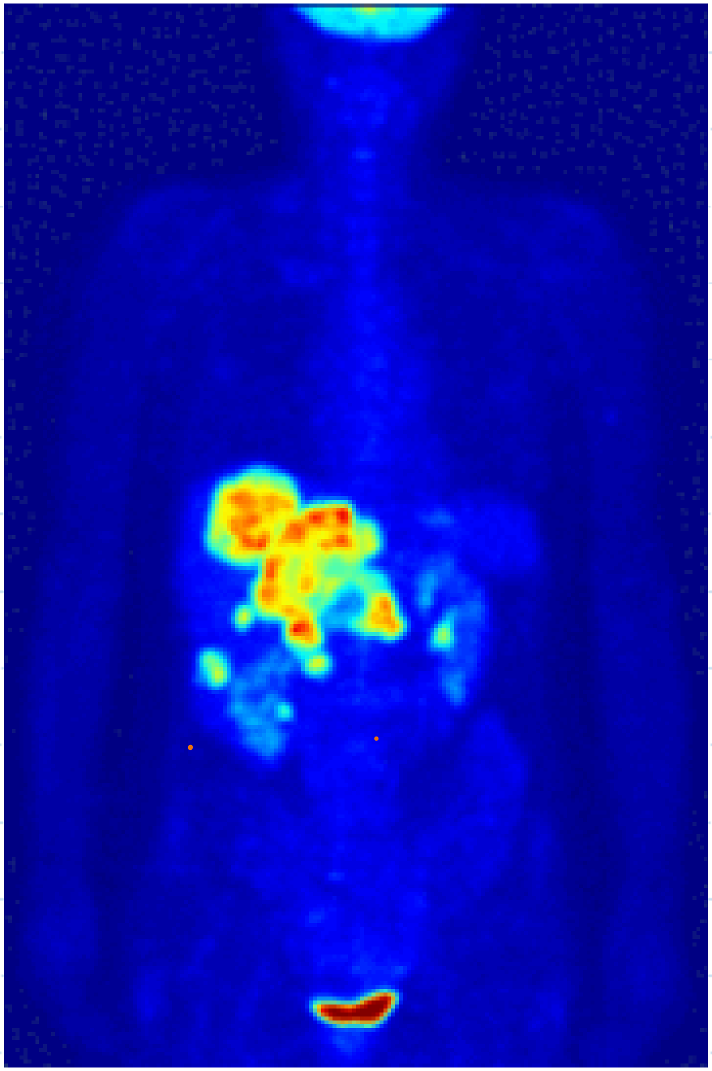
↑

Used in PET

↳ Positron emission Tomography

9.3 What Happens When a Nucleus Emits Radioactivity

D – Positron Emission (${}^{0}_{+1}e$) – Positron emission tomography



Short lived

${}^{11}_{6}C$: ~ 20 Minutes

${}^{13}_{7}N$: ~ 10 Minutes

${}^{15}_{8}O$: ~ 2 minutes

${}^{18}_{9}F$: ~ 110 Minutes


MAVIC
880
Discovery
Discovery