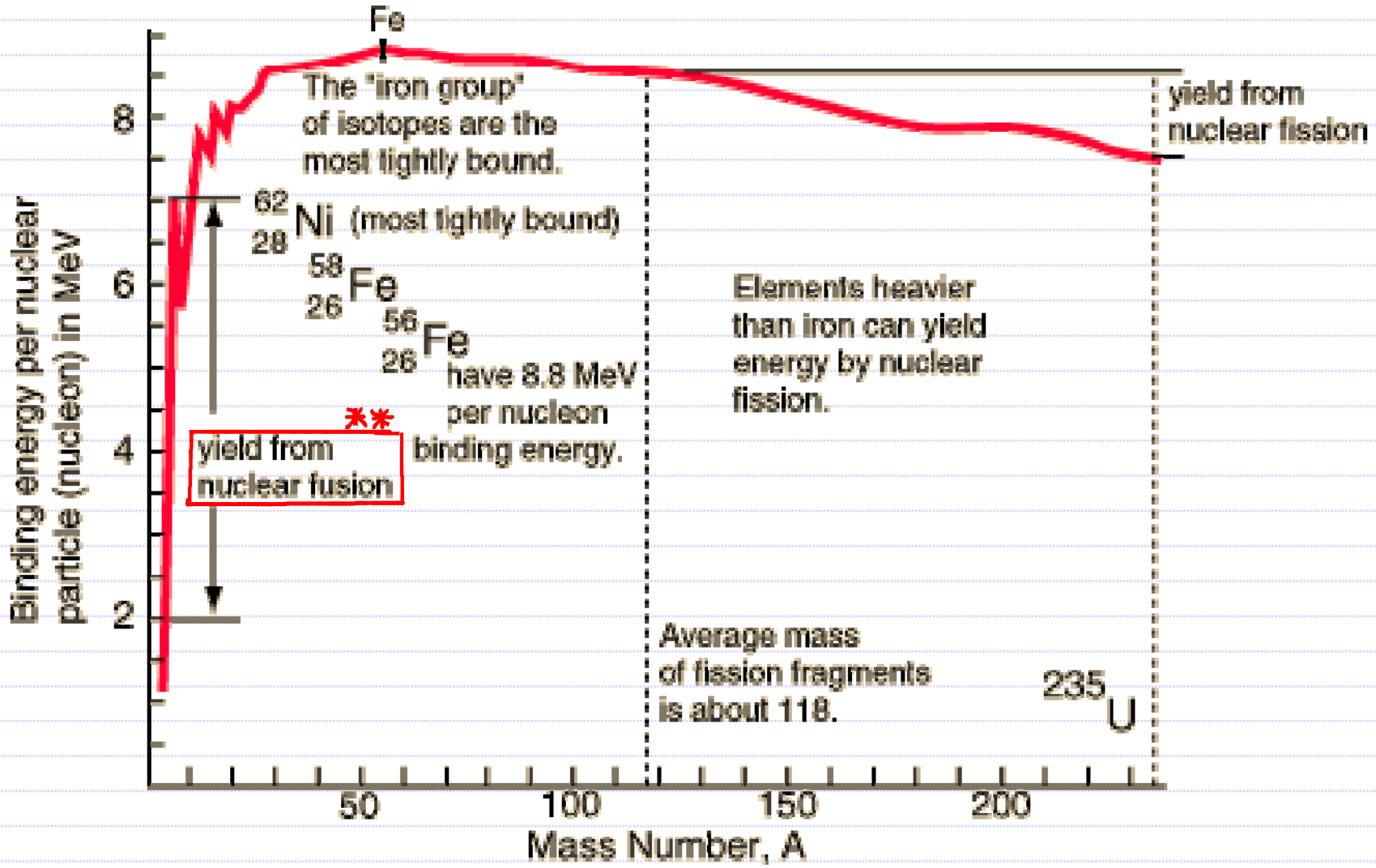
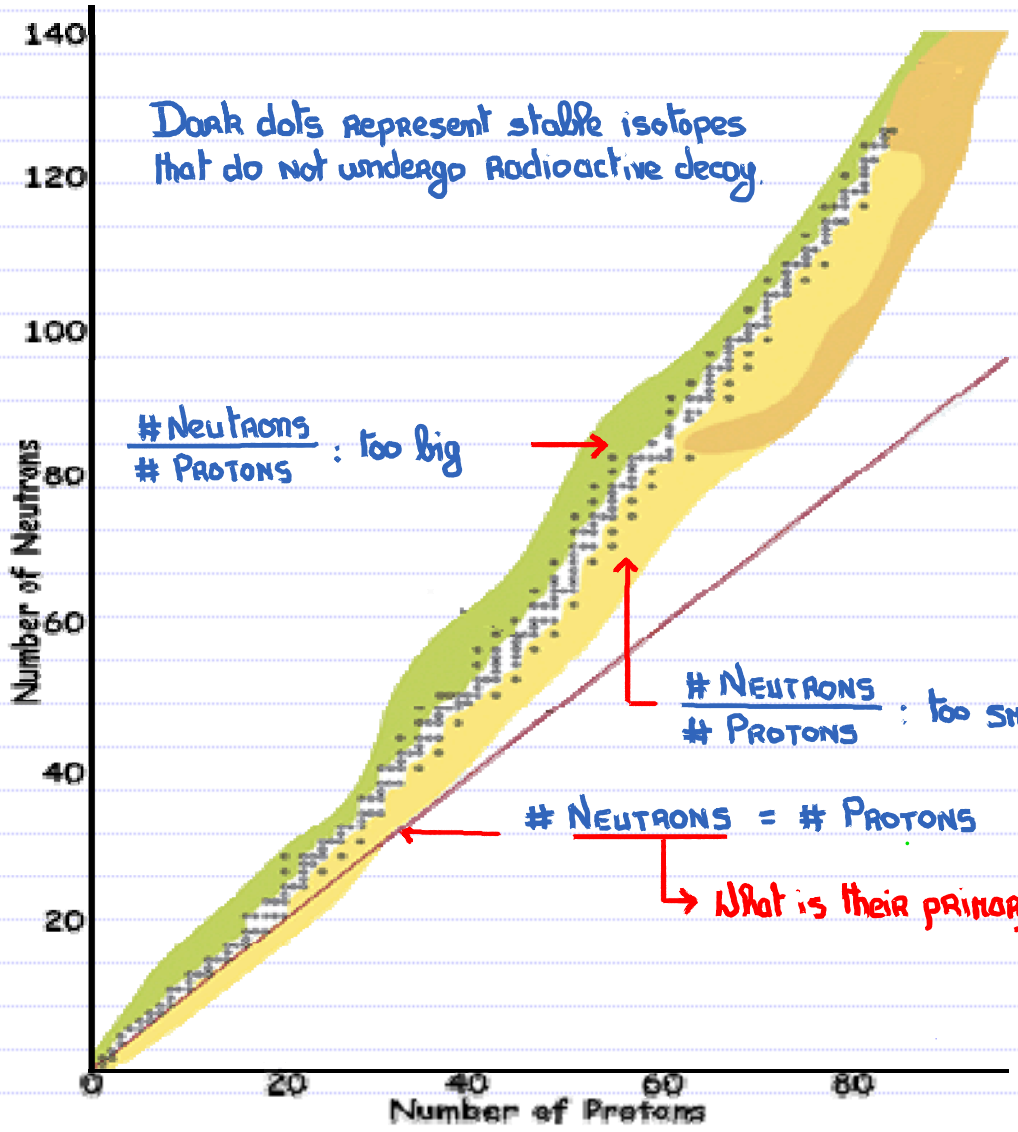
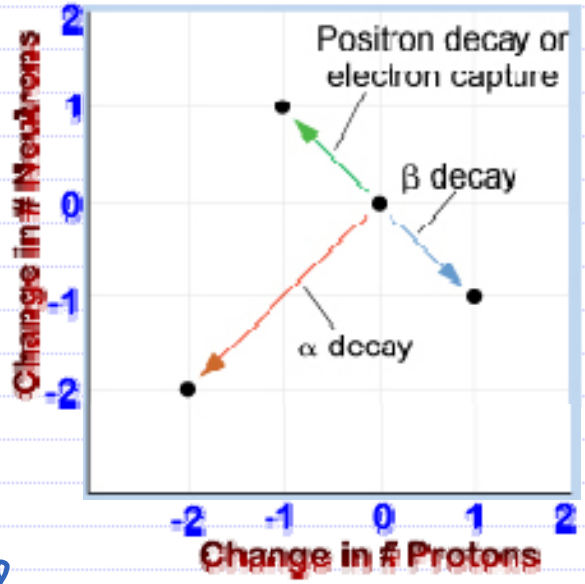
9.3 Binding Energy – Nuclear Fusion Vs Nuclear Fission



9.3 Nuclei Stability Zone?





9.3 What Happens When a Nucleus Emits Radioactivity

Decay Methods

1) **Alpha Emission:** ${}^{4}_{2}\alpha$ or ${}^{4}_{2}He$ ... Only ${}_{2}He^{4}$

2) **Beta Emission:** ${}^{0}_{-1}\beta$ or ${}^{0}_{-1}e$ ... Only ${}_{-1}e^{0}$

3) **Positron Emission:** ${}^{0}_{+1}\beta$ or ${}^{0}_{+1}e$ ... Only ${}_{+1}e^{0}$

4) **Electron Capture:** ${}^{0}_{-1}e$

↳ The Nucleus captures an electron.

Note: 4) causes the biggest error in Exams. In 1), 2) and 3) the particle is emitted and is thus a **product**. With 4) the electron is captured and thus is a **reactant**.

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.

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

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

↳ Formation of a Beta particle which is then ejected.

Note: The net result in the Nucleus is that a NEUTRON is converted to a PROTON.

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

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

↳ Formation of a Positron which is then ejected.

Note: The net result in the Nucleus is that a PROTON is 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.

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

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

Note: The net result in the neucleus is that a proton is 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

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

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

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

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission (^4_2He)

PROBLEM:

a) Radon is a gas, thus readily inhaled.

b) $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + {}^{4}_{2}He + \gamma$ RAYS

↳ Adheres to lung tissue

$^{218}_{84}Po \rightarrow {}^{214}_{82}Pb + {}^{4}_{2}He + \gamma$ RAYS

SIMPLE SOLUTION:

a) Ventilate the basement .. fans.

b) Use a sealant on floor to seal any cracks.

SAFETY:

Install a Radon detector in your basement, they are inexpensive.

9.3 What Happens When a Nucleus Emits Radioactivity

C – Alpha Emission (^4_2He)

BBC NEWS

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.

Earlier, an inquest into the death of Mr Litvinenko was

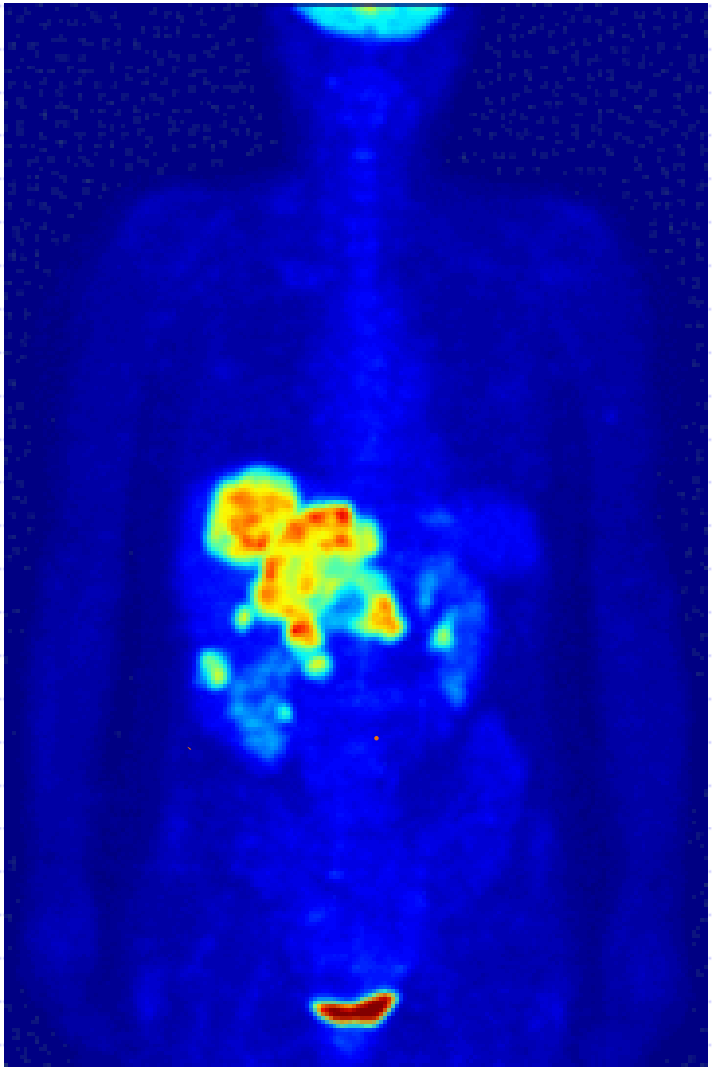
See class web sites for links to inquest held in UK in 2015. Be warned that some of the images prior to his death are horrific.

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

See previous slide.

9.3 What Happens When a Nucleus Emits Radioactivity

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



SHORT LIVED ISOTOPES:

$^{11}_{6}C$: ~ 20 minutes.

$^{13}_{7}N$: ~ 10 minutes.

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

$^{18}_{9}F$: ~ 110 minutes.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