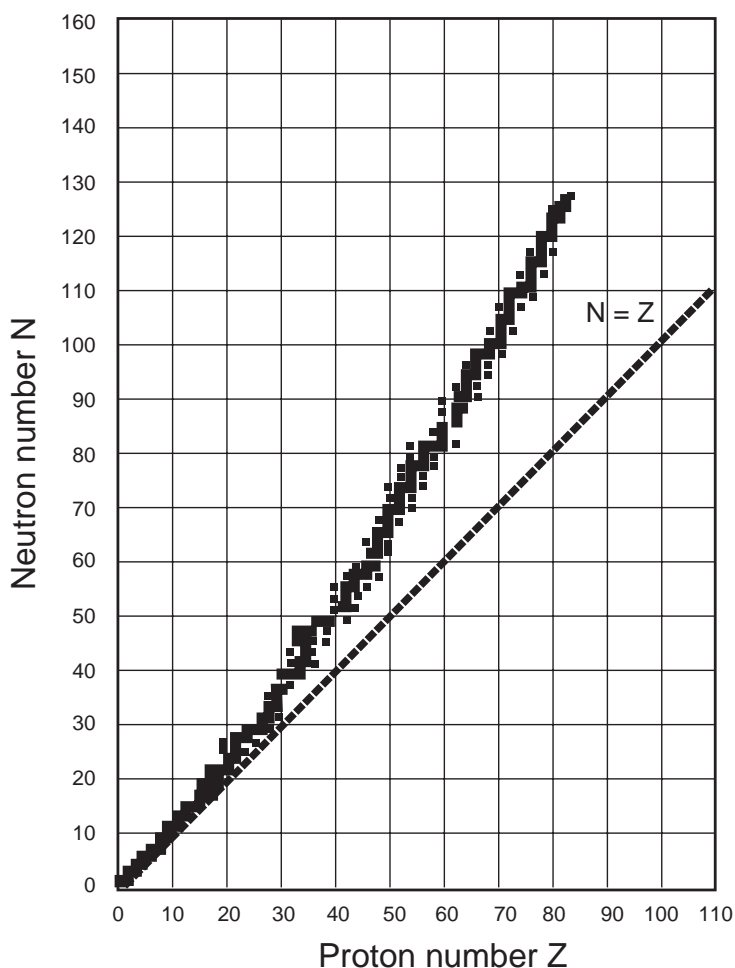


Chapter 9: Chemical Energy

3) Nuclear Reactions

- How can an atom of one element change into an atom of a different element?
- Write the equation for the nuclear reaction that occurs when a neutron emits an electron and becomes a proton.
- Write the equation for the nuclear reaction that occurs when a proton emits an antielectron and becomes a neutron.
- A nucleus of iron-56 (${}^{56}_{26}\text{Fe}$) has how many protons? _____
 How many neutrons does this nucleus have? _____
 How many nucleons does the nucleus have? _____

4) Graph of Stable Nuclei



- According to the graph, would a nucleus with 70 protons and 70 neutrons be stable? Why or why not?
- Would a nucleus with 80 neutrons and 40 protons be stable? If not, what change could make this nucleus stable?
- Would a nucleus with 70 neutrons and 50 protons be stable? If not, what change could make this nucleus stable?

Chapter 10: Ionizing Radiation I

5) Summary of ionizing radiation

Fill in the table below, which summarizes the properties of the types of ionizing radiation.

Radiation	Particle emitted	A = # of nucleons	Z = # of protons	Electric Charge
alpha (α)				
beta (β^-)				
beta (β^+)				
gamma (γ)				

6) Decay of unstable isotopes

- a) Potassium-40 (${}^{40}_{19}\text{K}$) is unstable. Why is this nucleus unstable?

What change in nucleons could make this nucleus stable?

Write the nuclear reaction that shows this nucleus decaying to a stable nucleus.

- b) Thorium-232 (${}^{232}_{90}\text{Th}$) is unstable. Why is this nucleus unstable?

What change could make this nucleus more stable?

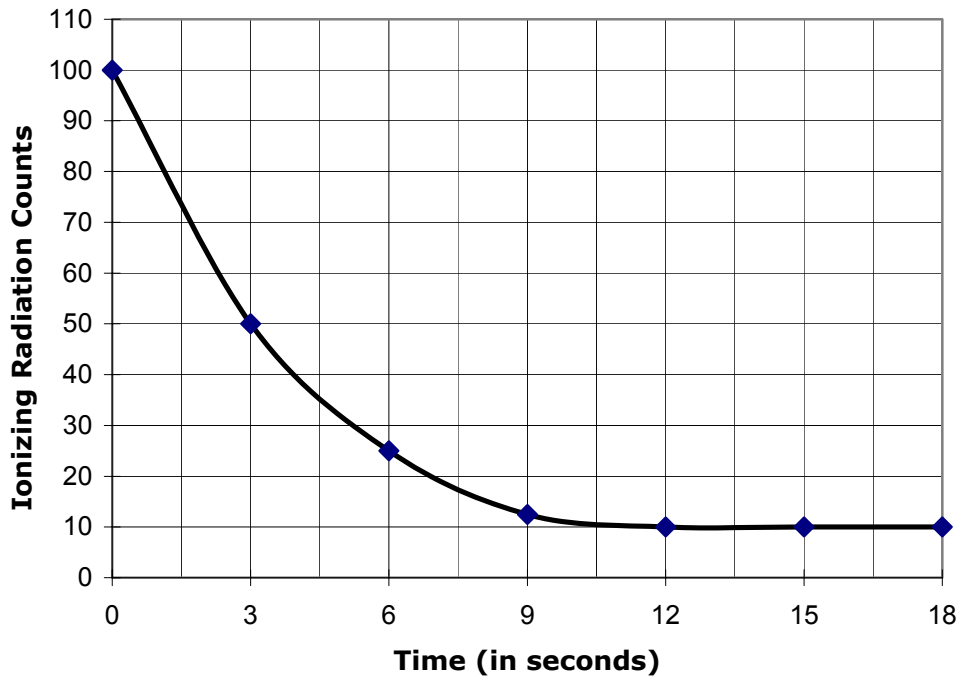
Write an equation that describes this nuclear reaction.

- c) Oxygen-14 (${}^{14}_8\text{O}$) is unstable. Why is this nucleus unstable?

What change in nucleons could make this nucleus more stable?

Write the nuclear reaction that shows this nucleus decaying to a stable nucleus.

7) Graph of radioactive decay of an unstable isotope



- How large is the background radiation illustrated by the graph? _____
- What is the half life of this unstable isotope?
 - Pick a point on the graph:
 - Subtract the background counts:
 - Divide the result by 2:
 - Add the background counts:
 - Find this point on the graph and read off the time elapsed.

8) Carbon Dating

The carbon-14 level in a sample of charcoal found at an archeological site is $\frac{1}{8}$ of what it was when the wood that formed the charcoal was living. How old is this site? (The half life of carbon-14 is 5,730 years.)

Chapter 11: Ionizing Radiation II

9) Formation of nucleons

- a) Nucleons consist of quark trios. The electric charge of an up quark = $+ 2/3$, and the charge of a down quark = $- 1/3$.

Which 3 quarks could combine to form a proton?

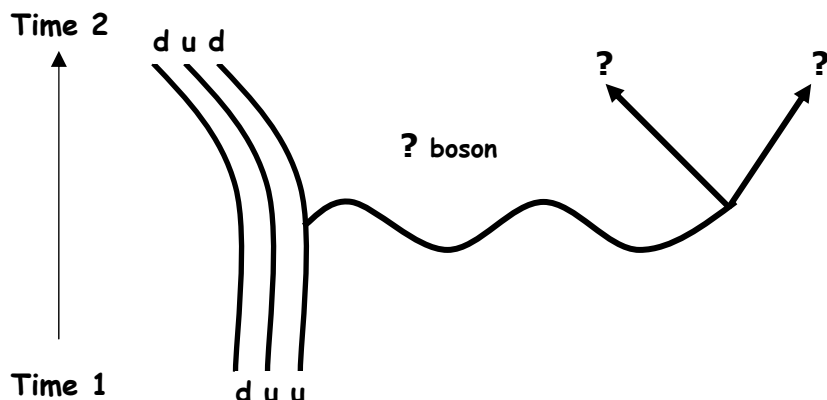
Which 3 quarks could combine to form a neutron?

- b) The intrinsic spin of each quark = $1/2$. The spins of two quarks of the same type must point in opposite directions.

Draw a diagram showing the quarks that make up a proton and their spins.

Draw a diagram showing the quarks that make up a neutron and their spins.

10) **Feynman Diagram of a Beta Decay** Beta decays can be represented by a Feynman diagram.



a) In the diagram above, which type of nucleon existed at Time 1?

Which type existed at Time 2?

b) Write the nuclear reaction that illustrates the change of nucleon from Time 1 to Time 2.

c) Which type of beta decay is this?

d) Which gauge boson is involved in this type of decay?

11) **Fundamental Forces and bosons** Fill in the chart with information on bosons.

Fundamental Force	Exchange Boson	Purpose
Strong Nuclear		
Electromagnetic		
Weak Nuclear		
Gravitational		

Chapter 12: Nuclear Reactions

12) Binding energy calculations

When protons and neutrons bind into a nucleus, the mass of the nucleus is slightly less than the mass of the protons and neutrons that make up that nucleus. This difference is the mass that has been converted into energy: $E = mc^2$. This is the binding energy of the nucleus.

a) An iron nucleus (${}^{56}_{26}\text{Fe}$) has a mass of 92.8596×10^{-27} kg. Find the binding energy of this nucleus.

1. Find the mass of the protons that make up this nucleus. proton mass =
 $M_p = 1.6726 \times 10^{-27}$ kg

Find the mass of the neutrons that make up this nucleus. neutron mass =
 $M_n = 1.6749 \times 10^{-27}$ kg

2. Find the total mass of the nucleons that make up the nucleus.

3. Subtract the known mass, 92.8596×10^{-27} kg, from the total mass of the nucleons you calculated. This difference in mass is the amount of mass that was converted into energy when the nucleus formed.

4. Find the binding energy, using $E = Mc^2$. The variable M is the difference in mass calculated in step #3.

13) Hertzsprung-Russell (H-R) diagram

- a) On an H-R diagram, why does the color of the main sequence stars change as one moves from the left to the right of the diagram?

- b) What are the large red stars in the upper right corner of the diagram? What is formed when these stars explode?

Chapter 13: Astrophysics**14) Evolution of the Universe**

Arrange the following events in the early Universe in chronological order starting with the earliest event:

- _____ sudden expansion of the Universe
- _____ condensation of quarks and leptons
- _____ formation of protons and neutrons
- _____ condensation of the fundamental forces
- _____ the Big Bang
- _____ fusion of deuterium (helium nuclei)
- _____ formation of photons

15) The expansion and age of the Universe

- a) What is meant by the red shift of starlight?

- b) What does the red shift of light from galaxies tell us about the motion of galaxies and the size of the Universe?

- c) How can the Hubble constant be found? How is the Hubble constant used to estimate the age of the Universe?