Table 1- Nuclear equations

1. Complete and balance the following nuclear reactions. Label the type of radiation, including emission or capture.
   a. $^{1}_{1}H + ^{1}_{1}H \rightarrow ^{2}_{1}H + ^{0}_{+1}\beta$ positron emission
   b. $^{78}_{33}As \rightarrow ^{78}_{34}Se + ^{0}_{-1}\beta$ beta emission
   c. $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$ alpha emission
   d. $^{55}_{26}Fe + ^{0}_{-1}e \rightarrow ^{55}_{25}Mn$ electron capture
   e. $^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n$ neutron emission

2. Write the nuclear equations representing the alpha decay of Einsteinium-255, followed by beta capture.

$^{255}_{99}Es \rightarrow ^{251}_{97}Bk + ^{4}_{2}He$ $\qquad$ $^{251}_{97}Bk + ^{0}_{-1}\beta \rightarrow ^{251}_{96}Cm$

3. Write the nuclear equations representing the neutron capture by Astatine-212, followed by alpha and gamma decay.

$^{212}_{85}At + ^{1}_{0}n \rightarrow ^{209}_{83}Bi + ^{4}_{2}He + \gamma$

Table 2- Effects of decay on the nucleus of an atom

1. Beta decay
   a. Write the nuclear equations representing the beta decay of plutonium-246

   $^{246}_{94}Pu \rightarrow ^{246}_{95}Am + ^{0}_{-1}\beta$

   b. What happens to the number of protons when an element undergoes beta decay? ↑ by 1
   neutrons? ∅ atomic mass? ∅ **(LOOK AT PART a)**

   c. Why would a radioisotope go through beta decay?
   to get closer to being stable or b/c they have too many neutrons compared to protons, trying to lower the n:p ratio

2. Alpha
   a. Write the nuclear equations representing the alpha decay of plutonium-246

   $^{246}_{94}Pu \rightarrow ^{242}_{92}U + ^{4}_{2}He$

   b. What happens to the number of protons when an element undergoes alpha decay? ↓ by 2
   neutrons? ↓ by 2 atomic mass? ↓ by 4 **(LOOK AT PART a)**

   c. Why would a radioisotope go through apha decay?
   the nuclei is too heavy and needs to reduce the n:p ratio to become more stable

Table 3 Fission/Fusion/radiation

a. What happens to an atom during fission? split into lighter nuclei
b. Give an example of where fission is happening? nuclear powerplants, atomic bombs
c. What happens to an atom during fusion? light nuclei fusing to make one heavy
d. Give an example of where fusion is happening? solar fusion - the sun
e. Does fission or fusion release more energy? fusion
f. List the symbols for the following: Alpha particles, beta particles, gamma particles, neutron, positron $^{4}_{2}He$, $^{0}_{-1}\beta$, γ, $^{1}_{0}n$, $^{0}_{+1}H$ or $^{0}_{+1}p$

g. Which particle is the most penetrating and why? gamma. smallest, fastest moving
h. List two positive and two negative uses of radiation.

+: radiation treatment
medical usage
nuclear power plants

-: nuclear meltdowns
can cause cancer

Table 4- sub atomic particles and isotopes

a. Fill in the blanks

Element Name	Nuclear Symbol	Protons	Atomic Mass	Neutrons	Atomic Number	Electrons
Gold	$^{197}_{79}Au$	79	197	118	79	79
Indium	$^{116}_{49}In$	49	116	67	49	49
Rhenium	$^{186}_{75}Re$	75	75	111	75	75

b. What is an isotope and how does it differ from other elements of the same atom?

An isotope is an atom of an element but has a different mass. Neutrons could change, but NEVER protons.

Table 5- Average atomic mass

a. Three isotopes of Honsbergerium exist in nature. Scientists have determined that Ho-267 has a percent abundance of 34%, while Ho-268 exists at 57%, and Ho-270 exists at 9%. Based on this information, calculate Honsbergerium's average atomic mass.

267 (34%) + 9078
268 (57%) + 15276
270 (9%) + 2430

$= \frac{26784}{100} = 267.84$ amu

b. Two isotopes of Halloweenium exist in nature. Scientists have determined that Hw-147 has a percent abundance of 27%, while Hw-142 exists at 73%. Based on this information, calculate Honsbergerium's average atomic mass.

147 x (.27) = 39.69
142 x (.73) + 103.66 = 143.35 amu

c. Explain why the atomic masses on the periodic table are listed as decimal numbers if atoms cannot have partial protons or neutrons in the nucleus?

It's a weighted average of all naturally occurring isotopes. You cannot have partial protons or neutrons!

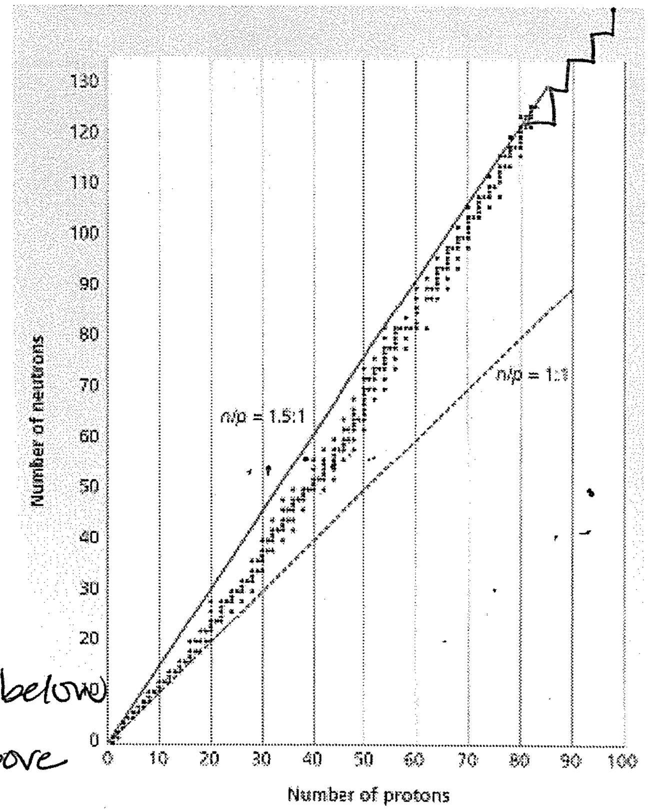
Table 6- Radioactive vs. stable Isotopes

1. What is the neutron to proton ratio in Es-254?

155 : 99 = 1.6 : 1 ration

2. Is this isotope radioactive or not? radioactive

3. Why? greater than 1.5:1 ratio



4. Use the band of stability graph to the right to identify which following isotopes are stable:

a. $^{14}_{7}N$ 1:1 stable

b. $^{220}_{88}Ra$ 1.5:1 stable

c. $^{230}_{90}Th$ unstable

5. Explain why they are stable using the neutron:proton ratio:

1:1 ratio is stable for atomic # 30 or below

1.5:1 ratio is stable for atomic #30 or above

Table 7- Atomic theory

1. Explain what each scientist is known for:
   - Bohr – planetary model, electrons move in a circular orbit at constant speed
   - Schrodinger – Quantum mechanical model / electron cloud
   - Dalton – atomic theory
   - Rutherford – goldfoil experiment, + nucleus, empty space
   - Thomson – electrons, plum pudding, cathode-ray exp.

2. What 2 parts of Dalton's atomic theory have we changed to match our current knowledge of the atom? – atoms cannot be broken down (in ordinary chemical rxns)
   – atoms are identical in size, mass, etc. (isotopes make this incorrect!)

3. The current model of the atom:

   What are the 2 names of this model?

   Quantum mechanical or electron cloud

   Who developed it?

   Shrodinger

   What is it based on?

   Heisenburg's uncertainty principle → probability!

4. Draw the current model, include protons, electrons, neutrons, and the nucleus.

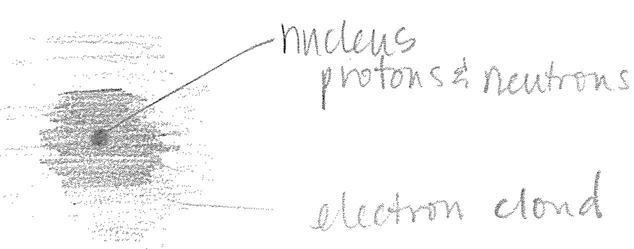


Table 8- half-life

1. If 100.0 g of carbon-14 decays until only 25.0 g of carbon is left after 11460 yr, what is the half-life of carbon-14? 100 → 50 → 25

   $3 = \frac{11460yr}{x}$ = half-life = 3820 yrs

2. If the half-life of iodine-131 is 8.10 days, how long will it take a 50.0 g sample to decay to 6.25 g? 50 →(1) 25 →(2) 12.5 →(3) 6.25

   $3 = \frac{t}{8.10 days}$ = 24.3 days

3. All isotopes of technetium are radioactive, but they have widely varying half-lives. If an 800.0 g sample of technetium-99 decays to 100.0 g of technetium-99 in 639,000 yrs, what is its half-life? 800 →(1) 400 →(2) 200 →(3) 100

   $3 = \frac{639,000 yrs}{h}$ = 213,000 yrs

4. Thallium-208 has a half-life of 3.053 min. How long will it take for 120.0 g to decay to 7.50 g?

   120 →(1) 60 →(2) 30 →(3) 15 →(4) 7.5

   $4 = \frac{t}{3.053 min}$ = 12.212 mins

5. Os-182 has a half-life of 21.5 hours. How many grams of a 10.0 gram sample would have decayed after exactly three half-lives? 10 →(1) 5 →(2) 2.5 →(3) 1.25 remain

   10 − 1.25 = 8.75g would have decayed

6. The half-life of Zn-71 is 2.4 minutes. If one had 100.0 g at the beginning, how many grams would be left after 7.2 minutes has elapsed?

   $\frac{2.4}{7.2}$ = 3 half-lives

   100 →(1) 50 →(2) 25 →(3) 12.5g