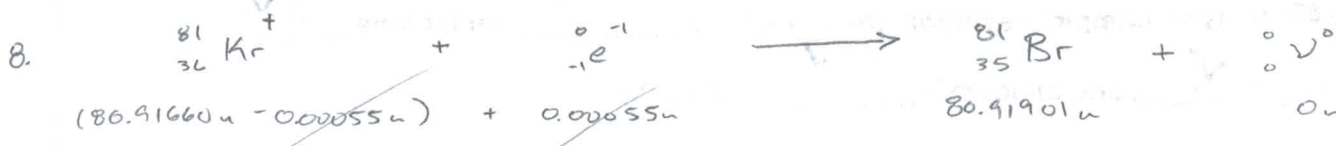


First Examination

Print Name J.R. Powers-Luhn

1. Consider ^{85}Rb . Give complete symbols for an isotope $^{86}_{37}\text{Rb}$, an isotone $^{86}_{38}\text{Sr}$,
an isobar $^{85}_{38}\text{Sr}$, and an isomer $^{85m}_{37}\text{Rb}$. (3 each)
2. The equation for the surface of a sphere is $S = 4\pi R^2$ where R is the radius. The second term of the binding energy equation is $-17.23A^{2/3}$. Do not write beyond the lines provided. (4 each)
- Clearly explain why the term is negative. the nucleons at the surface are less tightly bound
- From where does 17.23 come? It is empirically measured
- Why is A to the 2/3 power? the radius is proportional to $A^{1/3}$, meaning the surface area $\propto (A^{1/3})^2$
3. Bromine has two stable isotopes: ^{79}Br with a mass of 78.91835 mu and an abundance of 50.54%, and ^{81}Br with a mass of 80.91634 mu. On the back, calculate the average weighted mass of Br, and place the answer here. 79.9066 u (6)
4. There are 5 stable nuclides with odd Z and odd N. What is the smallest atomic number below which four of them are located? < 8 ($^1_1\text{H}, ^3_1\text{Li}, ^5_3\text{B}, ^{14}_7\text{N}$) (3)
5. Beyond what element are there no stable radionuclides? beyond ~~Pb~~ Bi (3)
6. Write the complete decay equation for ^{86}Sr . Assume no gamma emission. $^{86}_{38}\text{Sr} \rightarrow \text{stable}$ (9)
7. Write the most probable decay equation for ^{69}As . Assume no gamma emission. $^{69}_{33}\text{As} \rightarrow ^{69}_{32}\text{Ge} + ^0_{-1}\beta^+ + ^0_0\nu$ (9)
8. ^{81}Kr decays by electron capture. ^{81}Kr weighs 80.91660 mu, ^{81}Br weighs 80.91634 mu, ^{81}Rb weighs 80.91901 mu, and the electron weighs 0.00055 mu. On the back calculate the decay energy and place the answer here. 2.24 MeV produced (9)
9. ^{259}No is produced by bombardment of ^{248}Cm with ^{18}O . On the back, calculate the coulomb barrier and place the answer here. 102.7 MeV (9)
10. On the reverse, calculate the reaction energy for $^{14}\text{N}(n,p^+)----$. Masses in mu are ^{14}N (14.003074), n (1.00867), ^1H (1.00783), ^{14}O (14.00860), ^{14}C (14.00324).
Place answer here. 1.95 MeV lost (9)
11. A nuclide with a half-life T of 22 days has an activity of 12,441 c/m. How long will it take for the count to drop to 4077 c/m?
Calculate on the back, and place answer here. 35.43 days (10)
12. ^{247}Cm has a half-life T = 1.6×10^7 years. What is the activity in c/m for 27 g of CmF_3 if the detector has an efficiency of 9.00 %? Avogadro number = 6.022×10^{23} .
Calculate on the back and place the answer here. 3.97 x 10⁸ cpm (9)

$$3. \frac{f_{79} m_{79} + f_{81} m_{81}}{100} = \frac{50.54 + 78.91835u + 49.46 \times 80.91634}{100} = \boxed{79.9066u}$$



$$E = m_d - m_p$$

$$= [80.91901u - (80.91660u)] \times 931 \text{ MeV/u}$$

$$= -0.00241u \times 931 \text{ MeV/u}$$

$$= -2.24371 \text{ MeV}$$

$$9. E_c = 1.11 \frac{A+A'}{A} \frac{ZZ'}{A^{\frac{1}{3}} + A'^{\frac{1}{3}}}$$

$$= 1.11 \frac{(248+18)}{248} \times \frac{96 \times 8}{248^{\frac{1}{3}} + 18^{\frac{1}{3}}}$$

$$= 102.646$$



$$(\sum m_d - \sum m_p) 931 = E$$

$$E = 931 \frac{\text{MeV}}{u} \times [(14.00324u + 1.00783) - (14.0003074 + 1.00867)]$$

$$E = 1.95 \text{ MeV}$$

$$11. \quad A = A_0 \cdot e^{-\lambda t}, \quad \lambda = \frac{\ln 2}{T_{1/2}} = \frac{0.693}{22d} = 0.0315 \text{ d}^{-1}$$

$$\log A - \log A_0 = -0.434 \lambda t \rightarrow t = \frac{\log A - \log A_0}{-0.434 \lambda} = \frac{\log(4077) - \log(12441)}{-0.434 \times 0.0315 \text{ d}^{-1}} = \boxed{35.43 \text{ days}}$$

$$12. A(\text{cpm}) = \epsilon \cdot \lambda N = \epsilon \frac{\ln 2}{T_{1/2}} N = \epsilon \frac{\ln 2}{T_{1/2}} N_{\text{cm}} = 0.09 \times \frac{0.693}{8.42 \times 10^2 \text{ min}} \times 5.35 \times 10^{22}$$

$$N_{\text{cm}} = \frac{1 \text{ cm}}{1 \text{ cmF}_2} \frac{27g \times N_A}{m_{\text{cmF}_2}} = 5.35 \times 10^{22}$$

$$T(\text{min}) = T(\text{yr}) \frac{365.241d}{\text{yr}} \times \frac{24h}{1d} \times \frac{60\text{min}}{1h} = 8.42 \times 10^{12} \text{ min}$$

$$A = \lambda N = 3.97 \times 10^8 \text{ cpm}$$

Coulomb Barrier

$$E_C = 1.11 \frac{(A + A')}{A} \frac{Z Z'}{(A^{1/3} + A'^{1/3})} \quad (4)$$

Binding Energy

ng Energy

surface (Coulomb) $n/2$ Coni. eff

$B = 15.56A - 17.23A^{2/3} - 0.72Z^2A^{-1/3} - 23.285(A - 2Z)^2A^{-1} + 11A^{-1/2}$ (1)

$B = 9.31(1.00783Z + 1.00867N - M)$ + surface even (2)

Nuclear Radius

$$R(\text{cm}) = 1.4 \times 10^{-13} A^{1/3}$$

Magic Numbers

2, 8, 20, 28, 50, 82, 126 (also 118 for p^+)

AMU

1 u=931 MeV

Specific Activity

A is mass number, T is half-life in days

$$\frac{\frac{\text{mCi}}{\text{mg}}}{\frac{\frac{1.3 \times 10^8}{\text{AT}}}{\frac{\text{MBq}}{\text{mg}}}} = \frac{4.8 \times 10^6}{\text{AT}}$$

Beta Recoil

$$E_{Max} = E_m \frac{m_e}{m_e + M_D} \quad (5)$$

8/30/20



Periodic Table of the Elements

1 H 1.0079 Hydrogen		2A																2 He 4.0026 Helium																	
3 Li 6.941 Lithium		4 Be 9.0122 Beryllium																		10 Ne 20.1797 Neon															
11 Na 22.9898 Sodium		12 Mg 24.3050 Magnesium		3B 4B 5B 6B 7B 8B 1B 2B																18 Ar 39.948 Argon															
19 K 39.0983 Potassium		20 Ca 40.078 Calcium		21 Sc 44.9559 Scandium		22 Ti 47.867 Titanium		23 V 50.9415 Vanadium		24 Cr 51.9961 Chromium		25 Mn 54.9380 Manganese		26 Fe 55.845 Iron		27 Co 58.9332 Cobalt		28 Ni 58.6934 Nickel		29 Cu 63.546 Copper		30 Zn 65.38 Zinc		31 Ga 69.723 Gallium		32 Ge 72.61 Germanium		33 As 74.9216 Arsenic		34 Se 78.96 Selenium		35 Br 79.904 Bromine		36 Kr 83.80 Krypton	
37 Rb 85.4678 Rubidium		38 Sr 87.62 Strontium		39 Y 88.9059 Yttrium		40 Zr 91.224 Zirconium		41 Nb 92.9064 Niobium		42 Mo 95.96 Molybdenum		43 Tc (97.907) Technetium		44 Ru 101.07 Ruthenium		45 Rh 102.9055 Rhodium		46 Pd 106.42 Palladium		47 Ag 107.8682 Silver		48 Cd 112.411 Cadmium		49 In 114.818 Indium		50 Sn 118.710 Tin		51 Sb 121.760 Antimony		52 Te 127.60 Tellurium		53 I 126.9045 Iodine		54 Xe 131.29 Xenon	
55 Cs 132.9054 Cesium		56 Ba 137.327 Barium		57 La* 138.9055 Lanthanum		72 Hf 178.49 Hafnium		73 Ta 180.9488 Tantalum		74 W 183.84 Tungsten		75 Re 186.207 Rhenium		76 Os 190.2 Osmium		77 Ir 192.22 Iridium		78 Pt 195.084 Platinum		79 Au 196.9666 Gold		80 Hg 200.59 Mercury		81 Tl 204.3833 Thallium		82 Pb 207.2 Lead		83 Bi 208.9804 Bismuth		84 Po (208.98) Polonium		85 At (209.99) Astatine		86 Rn (222.02) Radon	
87 Fr (223.02) Francium		88 Ra (226.0254) Radium		89 Ac** (227.0278) Actinium		104 Rf (261.11) Rutherfordium		105 Db (262.11) Dubnium		106 Sg (263.12) Seaborgium		107 Bh (262.12) Bohrium		108 Hs (265) Hassium		109 Mt (266) Meitnerium		110 Ds (281) Darmstadtium		111 Rg (272) Roentgenium															

Periodic Table of the Elements

Values in parentheses are atomic masses or mass numbers of the most stable isotope of an element.

