RDCH 702 Last Name: Answers 18 Sep 18

Quiz 1

Assigned 10-Sep-18

Due 17-Sep-18, 2nd due date 20-Sep-18 First Name: ____________________

Chart of the nuclides

Use the chart of the nuclides, the readings on the chart of the nuclides, table of the isotopes, and web links to answer the following questions. Use the PDF form to input the answers. Use additional pages to show your work and submit separately.

1. **(10 Points) Select the isotope where the metastable state is longer lived that the ground state.**

- [x] ^{34}Cl
- [x] ^{200}Au
- [x] ^{118}Sb
- [x] ^{102}Rh
- [ ] ^{11}C
- [ ] ^{262}Sg
- [ ] ^{243}Pu
- [x] ^{212}Po
- [x] ^{242}Am
- [ ] ^{239}Pu
- [ ] ^{144}Ce
- [ ] ^{95}Zr

2. **(5 Points) How is ^{14}C naturally produced**

14N(n,p)14C

3. **(10 Points) Which elements have a relatively large number of metastable isotopes**

- [ ] O
- [ ] Ni
- [ ] Yb
- [x] Nb
- [ ] Mo
- [x] Tc
- [ ] Ru
- [x] Rh
- [x] Pd
- [x] Ag
- [x] Sn
- [x] Sb
- [ ] Tm
- [x] Y
- [x] Lu
- [x] Hf

3.1. **Are there any trends in the population of isotopes with metastable states? Consider the number of neutrons and protons and location of the isotopes on the chart of the nuclides**

Tend to be heavy and have an unpaired nucleon. The tend to cluster near each other in the chart. This indicates similar nuclear properties.

4. **(10 Points) Provide the cumulative fission yields for the A isobars listed below for ^{233}U, ^{235}U, and ^{239}Pu.**

A	^{233}U	^{235}U	^{239}Pu
116	0.013	0.013	0.051
95	6.3	6.5	4.82
72	0.0004	0.000026	0.0001
160	0.0003	0.0003	0.01

5. **(15 Points) Provide the ratio of ^{235}U cumulative fission yield to ^{239}Pu cumulative fission yield for the following A values.**

90	2.76	91	2.34	92	2.00	94	1.50	96	1.26
98	1.00	100	0.93	101	0.87	103	0.43	105	0.17
135	0.86	137	0.94	139	1.14	142	1.19	144	1.47
146	1.22	147	1.13	148	1.02	149	0.89	150	0.68

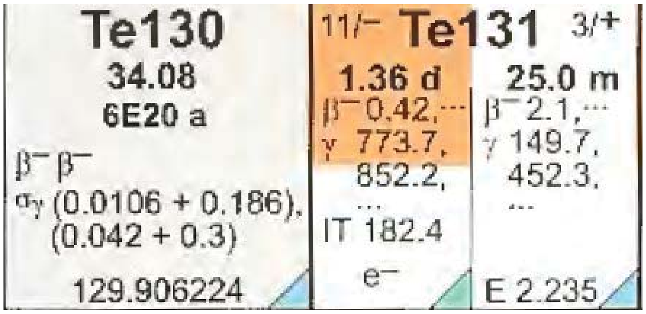
5.1. What are the differences between the higher (135≤A≤150) and lower (90≤A≤105) A set?

The ratio of the higher A set is close to 1; there is not a large difference in the cumulative fission product yield for these isotopes for the fission of 235U and 239Pu. The main difference in the cumulative fission yields for 235U and 239Pu is in the lower A

5.2. What accounts for any differences?

The similarity in the high A set is driven by the doubly magic 132Sn (Z=50, N=82). This enhanced stability leads a tendency for the formation of isotopes in this region. The lower A is based on the remaining nucleons and differs since A is different for 235U and 239Pu.

6. (10 Points) Describe the cross section data presented for ^{130}Te.



6.1. What is the cross section for producing ^{131m}Te with thermal neutrons?

0.0106 barns

6.2. What is the cross section for producing ^{131}Te with thermal neutrons?

0.186 barns

6.3. What is resonance integral cross section for producing ^{131m}Te with neutrons?

0.042 barns

7. (10 Points) Provide the main gamma decay energy (from the Chart of the Nuclides) and the gamma decay intensity for the listed energy for the following isotopes.

Isotope	Main gamma decay energy (keV)	Gamma Intensity (%)
^{56}Ni	158.4, 811.8	98.9, 86.0
^{60}Co	1332.5, 1173.2	99.98, 99.97
^{127}Sb	685.7, 473.6	37, 25.8
^{183}Re	162.3, 46.5	23.3, 7.97
^{241}Am	59.6	35.9
^{128}Cd	247.9, 857	75.7, 71.9

8. **(5 Points) Where was the location of the first man-made reactor, when was it made, who was the primary investigator, and what were some of the reactor characteristics?**
   - **8.1. Reactor Location** University of Chicago
   - **8.2. Primary Investigator** Enrico Fermi
   - **8.3. Reactor Characteristics**

     graphite moderated with natural uranium oxide spheroids as fuel

9. **(5 Points) How were Es and Fm first produced and identified?**

   During Mike thermonuclear test, identified by alpha decay

10. **(10 Points) Provide the spin, parity, decay mode, energy from decay and half-life for the isotopes below**

Isotope	Spin	Parity	Decay Mode	Energy from Decay (MeV)	Half-life
^{208}Pb	0	+	stable	-	-
^{104}Rh	1	+	beta	2.44	42.3 s
^{99m}Tc	1/2	-	IT	0.1427	6.006 h
^{148m}Pm	6	-	beta	0.40	41.3 d
^{162}Dy	0	+	stable	-	-
^{256}Fm	0	+	SF, alpha	6.92	2.63 h
^{195m}Hg	13/2	+	IT	0.112	1.73 d
^{200m}Au	12	-	beta	0.56	18.7 h
^{111}In	9/2	+	EC	0.862	2.8049 d

11. **(10 Points) Provide the number of naturally occurring isotopes for the elements below. This includes long lived radioactive isotopes with a half-life greater than 5E8 years.**

Element	Number of Stable Isotopes
Re	2
V	2
K	3
La	2
Sn	10
Sb	2
In	2
H	2
Pm	0
Lr	0
Ni	5
Tc	0
Eu	2