Problem Set 4 Chem 142 Key

1. Write complete balanced nuclear equations for the following processes.
2. Radium-226 decays by alpha particle emission.



1. Scandium-43 is produced by electron capture.



1. Selenium-91 decays into selenium-90.



1. Which of the following nuclides are likely to radioactive and which are likely to be stable. Explain your choice and in the case of radioactivity predict the most likely mode of radioactive decay.
2. Nitrogen-12









1. Lead-208



(c) Thorium-233



1. The half-life of cobalt-60 is 5.26 years.
2. What is the rate constant for the decay of cobalt-60?





1. How much of a 71.8 g sample of cobalt-60 remains after eighteen (18.00) years?





1. 131I (as Na131I) is used to treat hyperthyroid disease. It decays to Xenon by first order kinetics. The half-life of 131I is 8.0 days. If you are given 3 ng of Na131I, how many days will it take for 99.99% of it to decay, that is, for there to be only 0.003 ng left? (8 pts)

ln[**131I**]start/[**131I**]end = kt

t½ = ln2/k

k = ln2/t½ = 0.693/8.0 days = 8.66 x 10-2 days-1

ln([**131I**]start/[**131I**]end) = ln(3 ng/0.003 ng) = ln1000 = 6.91 = kt= (8.66 x 10-2 days-1)t

t = 79.8 days

1. The atomic mass of 127I is 126.9004 g/mol. Calculate the nuclear binding energy of this nucleus (in kJ/mol). The mass of a proton is 1.007825 g/mol and the mass of a neutron is 1.008665 g/mol.

127-I has 53 protons and 74 neutrons:

mass = 53(1.007825) + 74(1.008665) = 128.055935

mass = 126.9004-128.055935 = -1.15535 g or -1.15535 x 10-3 kg

E = mc2 = (-1.15535 x 10-3kg)(3.00 x 108 m/s)2

E = -1.0399815 x 1014 J/mol or -1.04 x 1011 kJ/mol

1. Given the information below, answer the following question:

Mass of proton 1.00728 amu Mass of neutron 1.00866 amu Mass of electron 5.485799 x 10–4 amu

Mass of 919*F =*18.998403 amu/atom Velocity of light (c) 2.998 x 108 m s–1

Mass-energy conversion 1 amu = 931.5 MeV

1. Calculate the mass deficiency of 919*F* in amu/atom.

Theoretical mass = 9 (1.00728) + 10 (1.00866) + 9 (0.0005485799) amu/atom

Theoretical mass = 19.157057 amu/atom

Mass deficiency = Theoretical mass – Actual mass

Mass deficiency = 19.157057 amu/atom – 18.998403 amu/atom = 0.158654 amu/atom

1. Determine the mass deficiency of 919*F* in g mol–1.

0.158654 g mol–1

1. Calculate the binding energy (BE) of 919*F* in kJ mol–1.

BE = ∆mc2

BE = (0.158654 g/mol) (2.998 x 108 m s–1)2(1 kg/103 g)

BE = 1.431 x 1013 kg m2 s–2 mol–1

BE = 1.431 x 1013 J mol–1

BE = 1.431 x 1010 kJ mol–1

1. Calculate the binding energy of 919*F* in MeV/atom

Since 1 amu = 931.5 MeV,

(0.158654 amu/atom)(931.5 MeV/amu) = 147.8 MeV/atom

1. Calculate the binding energy of 919*F* per nucleon in MeV/nucleon.

19 nucleons: (147.8 MeV/atom)(1 atom/19 nucleons) = 7.778 MeV/nucleon

1. One component of oseltamivir phosphate, otherwise known as Tamiflu®, is pictured at right. This is one of the drugs that the World Health Organization has identified as an effective treatment for the H5N1 strain of influenza A, which is more commonly referred to as “bird flu”. (10 pts)



Choices to consider: alkane, alkene, alkyne, aromatic hydrocarbon, alcohol, ether, carboxylic acid, aldehyde, ketone, ester, amine, amide, amino acid.

Identify the functional groups indicated by the letters

A. \_\_\_\_Amide\_\_\_\_\_\_\_                     B. \_\_\_\_\_Ester\_\_\_\_\_\_                      C. \_\_\_\_\_Alkene\_\_

D. \_\_\_Ether\_\_\_\_\_                     E. \_\_\_\_\_Amine\_\_\_\_

1. Draw the 4 isomers in line notation of C4H8 including geometric isomers and name them



1. Name the following compounds (6 pts)



Name\_\_\_4-methyl-2-propyl-1-hexene\_\_\_\_ Name\_\_3,7-dichloro-3,6,6trimethyldecane\_\_

1. From each of the following pairs, choose the nuclide that is radioactive. (One is known to be radioactive, the other stable.)
2. 8034Se or 8134Se

8134Se Even-odd nucleus less stable than even-even nucleus.

1. 20983Bi or 21083Bi

21083Bi Odd-odd nucleus is unstable.

1. Briefly explain why “magic numbers” are important for understanding nuclear structures, i.e., define “magic number”.

Nuclei with a “magic number” of neutrons or protons have additional stability relative to ther nuclei.

1. Write the IUPAC name for each of the following compounds:



3-methyl-4-ethyl octane 1, 2-dimethyl cyclopentane 3, 4, 4-trimethyl-7-isopropyl decane



3, 4-dimethyl-7-cyclopentyl nonane 2, 2, 3, 3, 5-pentamethyl-4-ethyl heptanes

Complete the following reactions:









1. Write the full and condensed structural formulas for the following substances:

 3, 4-dimethyl-4-ethyl octane 4-t-butyl heptane



 cis-1, 3-diethyl cyclohexane 3-isopropyl hexane



 1, 1-dimethyl cyclopentane 3, 4, 5, 6- tetramethyl nonane



Write the IUPAC name for each of the following compounds.



2-methyl-2-butene 3, 4-dibromo-1-cyclohexene

 4, 5, 6-trimethyl-2-octene





4-bromo-3-methyl-1-hexyne

5, 5-dichloro-3-nonene 1, 1-dichloro-2-ethyl cyclopentane

**CHM 112 WORKSHEET FOR ALKENES, ALKYNES AND HALOCARBONS**

# Spring 2002

1. Explain, based on the appropriate IMFs, why the melting points and boiling points of alkenes and alkynes are so low.

Since the bonding in these molecules is non-polar covalent, the forces between molecules are weak dispersion forces and the crystals they form are molecular crystals with weak interactions between lattice points. Weaker forces require less energy to overcome. Therefore, the melting points and boiling points are lower.

1. Explain why double and triple carbon-carbon bonds are planar while a single C-C bond is not.

For single bonds, carbon forms sp3 hybrid orbitals that arrange themselves 109.5o away in three-dimensional space. Carbon in a double bond forms sp2 hybrid orbital and these are arranged at 120o on a plane while carbon in a triple bond undergoes sp hybridization and the resulting orbitals are180o apart, in a line.

3. Write the IUPAC name for each of the following compounds.



2-methyl-2-butene 3, 4-dibromo-1-cyclohexene

 4, 5, 6-trimethyl-2-octene





4-bromo-3-methyl-1-hexyne

5, 5-dichloro-3-nonene 1, 1-dichloro-2-ethyl cyclopentane