1) What is the most common means for a heavy, unstable nucleus to become stable?
Alpha decay – heavy and unstable refers to elements with an atomic number greater than 83

2) Which of the following have the same net effect?
   A) Gamma emission and positron emission
   B) Alpha decay and beta decay
   C) Electron capture and positron emission
   D) Beta decay and electron capture
   E) Alpha decay and positron emission

3) Which of the following nuclides would you predict to be stable and which radioactive: (a) $^{18}_{10}Ne$; (b) $^{32}_{16}S$; (c) $^{236}_{90}Th$; (d) $^{123}_{56}Ba$? Give a brief explanation for your answer to be eligible to partial credit.
a) Radioactive -> N/Z = 0.8, only hydrogen and helium are stable with N/Z < 1
b) stable -> N/Z = 1
c) radioactive -> Z > 83 automatically undergoes alpha decay
d)radioactive -> N/Z = 1.20. This doesn't give us enough information, so look at the atomic mass. 123 >> 137, so positron emission/ e- capture

4) Use the <u>atomic mass</u> of the element to predict the mode(s) of decay of the following radioactive nuclides: (a) $^{12}_{5}B$; (b) $^{234}_{92}U$; (c) $^{81}_{33}As$; (d) $^{127}_{57}La$

   a) Periodic table mass = 10.81, so this isotope is too heavy. Too many neutrons = beta decay
   b) Z > 83, alpha decay
   c) Periodic table mass = 74.92, so this isotope is too heavy. Too many neutrons = $beta^-$ decay
   d) Periodic table mass = 138.91, so this isotope is too light. Too few neutrons = positron emission or e- capture

5) True or false: All radioactive emissions cause ionization which can form free radicals.
True

6) Why is it assumed that mass is conserved for chemical reactions?
   A) Because mass cannot be created or destroyed
   B) Because mass and energy have no relation to one another
   C) Because the chemical reactions we study are only theoretical
   D) Because the change in energy from breaking and forming bonds is so small
   E) It is not assumed that mass is conserved for chemical reactions

7) ^{237}Np is the parent nuclide of a decay series that starts with alpha emission, followed by $beta^-$ decay, and then two more alpha emissions. Write a balanced nuclear equation for each step.
Step 1: Np becomes Pa
Step 2: Pa becomes U
Step 3: U becomes Th

Step 4: Th becomes Ra

8) What is the specific activity (in Ci/g) if 1.65 mg of an isotope emits 1.56×10^{6} alpha particles per second? Show your work to be eligible for partial credit.
2.56×10^{-2} Ci/g

9) If 1.00×10^{-12} mol of ^{135}Cs emits 1.39×10^{5} beta^{-} particles in 1.00 yr, what is the decay constant? Include units with your answer and show your work to be eligible for partial credit.
2.31×10^{-7} yr^{-1}

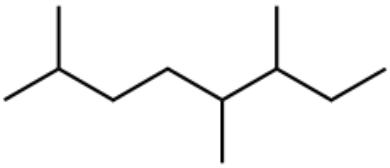
10) The isotope $^{212}_{83}Bi$ has a half-life of 1.01 yr. What mass (in mg) of a 2.00-mg sample will remain after 3.75×10^{3} h? Show your work to be eligible for partial credit.
1.49 mg

11) Which compounds exhibit geometric isomerism? Draw and name the two isomers in each case:
(a) propene (b) 3-hexene (c) 1,1-dichloroethene
   a) No geometric isomers because at least one of the carbons in the double bond has two of the same substituents
   b) *Cis*-3-hexene and *trans*-3-hexene
   c) No geometric isomers because at least one of the carbons in the double bond has two of the same substituents

12) How many of the following is/are named correctly?

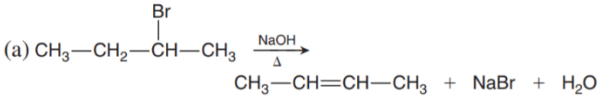
1-methyl-2-bromocyclohexane

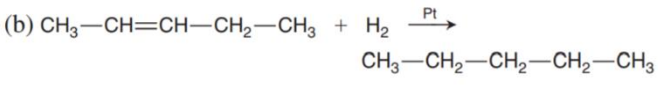

1,1,2-trimethylpentane


3,4,7-trimethyloctane

A) Zero B) One C) Two D) Three

13) Determine the type of each of the following reactions:



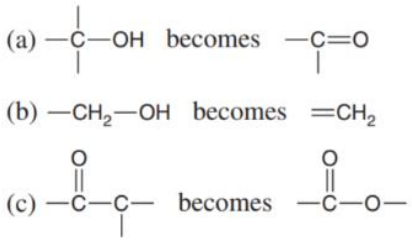


A) Hydrogenation; Addition
B) Addition; Elimination
C) Substitution; Elimination

D) Elimination; Addition

E) Hydrogenation; Substitution

14) Based on the number of bonds and the nature of the bonded atoms, state whether each of the following changes is an oxidation or a reduction:



Oxidized, reduced, oxidized

15) Draw the following functional groups: (a) ketone (b) amide (c) aldehyde (d) amine