Chem 121 Exam 3 Practice Problems. *(They are intended to be a guide and provide you with typical types of questions. The collection is not comprehensive, nor all inclusive, nor a facsimilie of the Exam, but should provide you with an idea of what to expect. Answers are NOT provided. If you have questions regarding the process to solve any of the problems, please see Dr. R.)*

In the following fission reaction, identify the other product:

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{139}_{53}\text{I} + 2\,^{1}_{0}\text{n} + \_\_\_\_\_$$

a) $^{89}_{39}\text{Y}$

b) $^{95}_{39}\text{Y}$

c) $^{95}_{42}\text{Mo}$

d) $^{94}_{42}\text{Mo}$

e) $^{94}_{40}\text{Zr}$

In the following nuclear equation, identify the missing product:

$$^{43}_{20}\text{Ca} + \text{a} \rightarrow \_\_\_\_\_ + ^{1}_{1}\text{H}$$

a) $^{46}_{22}\text{Ti}$

b) $^{46}_{21}\text{Sc}$

c) $^{44}_{22}\text{Ti}$

d) $^{42}_{18}\text{Ar}$

It is desired to determine the concentration of arsenic in a lake sediment sample by means of neutron activation analysis. The nuclide $^{75}_{33}\text{As}$ captures a neutron to form $^{76}_{33}\text{As}$, which in turn undergoes b decay. The daughter nuclide produces the characteristic g rays used for the analysis. What is the daughter nuclide?

a) $^{75}_{34}\text{Se}$

b) $^{76}_{32}\text{Ge}$

c) $^{74}_{31}\text{Ga}$

d) $^{76}_{34}\text{Se}$

e) $^{74}_{34}\text{Se}$

Calculate nuclear energy – mass conversions.
http://chemconnections.org/general/chem121/Problems%20calculating%20mass%20defect.pdf

Electron capture transforms $^{7}_{4}$Be into what nuclide?

a) $^{6}_{3}$Li
b) $^{7}_{5}$B
c) $^{7}_{3}$Li
d) $^{6}_{5}$B
e) $^{12}_{6}$C

Which types of processes are likely when the neutron-to-proton ratio in a nucleus is too low?

I. a decay
II. b decay
III. positron production
IV. electron capture

a) I, II
b) II, III
c) III, IV
d) II, III, IV
e) II, IV

When the Pd-106 nucleus is struck with an alpha particle, a proton is produced along with a new element. What is this new element?

a) Cd-112
b) Cd 109
c) Ag-108
d) Ag-109
e) none of these

A radioactive sample has an initial activity of 2.00×10^{6} cpm (counts per minute), and after 4.0 days, its activity is 9.0×10^{5} cpm. What is its activity after 40 days?

a) 4.5 cpm
b) 6.8×10^{2} cpm
c) 9.0×10^{4} cpm
d) 5.5×10^{3} cpm
e) none of these

If a tree dies and the trunk remains undisturbed for 13,750 years, what percentage of original ^{14}C is still present? (half-life of ^{14}C = 5730 years)

a) 5.20%
b) 19.0%
c) 2.20%
d) 45.0%

A sample of wood from an Egyptian mummy case gives a ^{14}C count of 9.4 cpm/gC (counts per minute per gram of carbon). How old is the wood? (The initial decay rate of ^{14}C is 15.3 cpm/gC, and its half-life is 5730 years.)

a) 6400 yr
b) 4570 yr
c) 4030 yr
d) 3420 yr
e) none of these

A 0.20-mL sample of a solution containing ${}_{1}^{3}H$ that produces 3.7×10^3 cps is injected into the bloodstream of an animal. After allowing circulatory equilibrium to be established, a 0.20-mL sample of blood is found to have an activity of 20 cps. Calculate the blood volume of the animal.

a) 18 mL
b) 37 mL
c) 11 mL
d) 180 mL
e) none of these

The Cs-131 nuclide has a half-life of 30 years. After 120 years, about 3 grams remain. The original mass of the Cs-131 sample is closest to

a) 30 g
b) 40 g
c) 50 g
d) 60 g
e) 70 g

Which statement about fusion is incorrect?

a) Fusion requires starting nuclides that are difficult to find on Earth, which is a problem for scientists.
b) Studying fusion is a worthwhile research endeavor because this process could be used as an alternative energy source.
c) Fusion requires a very high temperature in order to begin, which is a problem for scientists.
d) In fusion, two nuclei must be traveling fast enough to overcome the electrostatic repulsion and "fuse" the particles into a new nucleus.
e) Both a and c are incorrect.

If a molecule demonstrates paramagnetism, then :

I. The substance can have both paired and unpaired electrons.
II. The bond order is not a whole number.
III. It can be determined by drawing a Lewis structure.
IV. It must be an ion.

a) I, II
b) I, II, IV
c) II, III
d) I only
e) All of the above are correct.

Why do transition metals show a lot of chemical similarities within a given period?

a) The valence *s* and *p* electrons affect their chemistry more so than the inner *d* and *f* electrons, which do not participate in bonding as easily.
b) The number of electrons within a given period varies only slightly and is sometimes identical because these metals have more than one ionic form.
c) All elements in a given period, including the representative elements, have a lot of chemical similarities due to the gradual increase in atomic number.
d) The transition metals always fill their *s* and *p* orbitals first before filling their *d* orbitals, which affects their chemistry.
e) None of the above is correct.

Which of the following is incorrect concerning the 3*d*, 4*d*, and 5*d* transition series?

a) There is a significant increase in radius in going from the 3*d* to the 4*d* metals, but the 4*d* and 5*d* metals are similar in size.
b) There is a general decrease in size going from left to right for each of these series due to the increasing nuclear charge.
c) The separation of hafnium and zirconium found together in nature is difficult due to their similarities in chemistry, which is attributed to their virtually identical sizes.
d) Cerium through lutetium exhibits what is referred to as the lanthanide contraction.
e) All of the above are correct.

Which of the following is a d^7 ion?

a) Co(II)
b) Cu(II)
c) Mn(II)
d) Mn(IV)
e) At least two of the above (a-d) are d^7 ions.

T F Co^{2+} in water is blue.

T F The expected electron configuration of Cu^+ is [Ar] $3s^1 3d^9$.

T F The complexes of Zn^{2+} are all diamagnetic.

T F All tetrahedral complex ions are high spin.

In which of the following complexes does the transition metal have a d^8 configuration?

a) $PtCl_4^{2-}$
b) $Cu(H_2O)_6^{2+}$
c) $Ni(CO)_4$
d) $Zn(NH_3)_4^{2+}$
e) $Fe(CN)_6^{3-}$

What is the correct formula for sodium tetrachloronickelate(II)?

a) $Na_2(NiCl_6)$
b) $Na_4(NiCl_4)$
c) $Na(NiCl_4)$
d) $Na_2(NiCl_4)$
e) $Na_3(NiCl_4)$

Consider the following complexes:

I. $Pt(NH_3)_2Cl_2$ (square planar)
II. $Rh(en)_3^{2+}$ (en = $H_2N¾CH_2¾CH_2¾NH_2$ and is bidentate)
III. $CoCl_4^{2-}$ (tetrahedral)

Which can exhibit *cis-trans* isomerism?

a) I
b) II
c) III
d) I, II
e) I, II, III

Which of the following complexes can exhibit optical isomerism? (en = $H_2N¾CH_2¾CH_2¾NH_2$ and is bidentate)

a) *cis*–$Co(NH_3)_4Cl_2$
b) *trans*–$Co(en)_2Br_2$
c) *cis*–$Co(en)_2Cl_2$
d) $Co(NH_3)_3Cl_3$
e) none of these

Which of the following ligands might give linkage isomers?

a) NO_2^-
b) SCN^-
c) $H_2NHC_2CH_2NH_2$
d) A and B
e) A, B, and C

Which has the greatest number of unpaired electrons?

a) The square planar complex $Ni(CN)_4^{2-}$.
b) The tetrahedral complex $FeCl_4^-$.
c) Neither of the above have any unpaired electrons.
d) Both (A and B) have the same number (non-zero) of unpaired electrons.
e) More information is needed.

A metal ion in a high-spin octahedral complex has two more unpaired electrons than the same ion does in a low-spin octahedral complex. The metal ion could be:

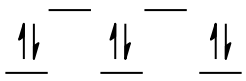
a) V^{2+}
b) Cu^{2+}
c) Mn^{2+}
d) Cr^{3+}
e) Co^{2+}

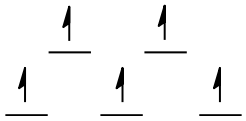
The spectrochemical series is $I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^-$
Which of the following complexes will absorb visible radiation of the highest energy (shortest wavelength)?

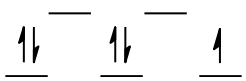
a) $[Co(H_2O)_6]^{3+}$
b) $[Co(I)_6]^{3-}$
c) $[Co(OH)_6]^{3-}$
d) $[Co(en)_3]^{3+}$
e) $[Co(NH_3)_6]^{3+}$

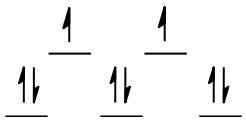
Here are some crystal field representations of *d* electrons in an octahedral complex:

I) 

II) 

III) 

IV) 

V) 

Choose the representation that fits the transition metal atom in the following species:

$[Co(NH_3)_4Br_2]^+$

a) representation I
b) representation II
c) representation III
d) representation IV
e) representation V

$K_4Mn(CN)_6$ (assume strong field)

a) representation I
b) representation II
c) representation III
d) representation IV
e) representation V

Ethylenediamine (en) is a bidentate ligand. What is the coordination number of cobalt in $[Co(en)_2Cl_2]Cl$?

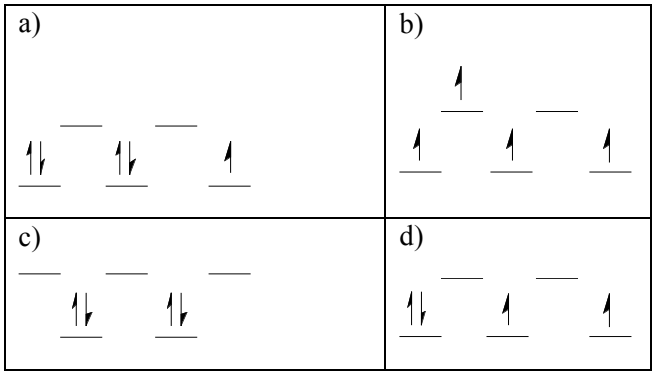
a) four
b) five
c) six
d) eight
e) seven

What are the oxidation numbers of the central transition metal atom in the following coordination compounds? $K_3[Fe(CN)_6]$, $[Cr(NH_3)_4Br_2]Br$, $[Ni(H_2O)_6]Cl_2$

a) 3, 3, 2
b) 3, 3, 3
c) –3, 3, 2
d) –3, 1, 2

Which of the following crystal field diagrams is correct for $Mn(CN)_6^{3-}$? The ligand field strength series is:

$I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^-$



Which of the following complexes would be diamagnetic (all electrons paired)? Assume the strong-field case for all complexes.

a) $[Ni(CN)_6]^{4-}$
b) $[Ti(CN)_6]^{3-}$
c) $[Co(CN)_6]^{3-}$
d) $[Cr(CN)_6]^{3-}$
e) none of these

The iron in hemoglobin is _____ when carrying oxygen to cells, and _____ after releasing the oxygen.

a) diamagnetic Fe^{2+}, paramagnetic Fe^{3+}
b) diamagnetic Fe^{2+}, paramagnetic Fe^{2+}
c) paramagnetic Fe^{2+}, diamagnetic Fe^{3+}
d) paramagnetic Fe^{3+}, diamagnetic Fe^{3+}
e) none of these

The spectrochemical series is

$$I^- < Br^- < Cl^- < F^- < OH^- < H_2O < NH_3 < en < NO_2^- < CN^-$$

A solution of which complex of the five choices given below will absorb visible radiation of the highest energy, which is ~ 420 nm? It will appear yellow-orange.

a) $[Co(H_2O)_6]^{3+}$
b) $[Co(I)_6]^{3-}$
c) $[Co(OH)_6]^{3-}$
d) $[Co(en)_3]^{3+}$
e) $[Co(NH_3)_6]^{3+}$

Which of the following is not a structural isomer of 1-pentene?

a) 2-pentene
b) 2-methyl-2-butene
c) cyclopentane
d) 3-methyl-1-butene
e) 1-methyl-cyclobutene

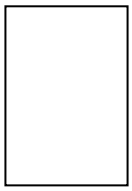
Which of the following functional groups does *not* contain a doubly bonded oxygen (C=O)?

a) Aldehyde.
b) Carboxyl.
c) Ketone.
d) Carboxylic acid.
e) All contain a double bond.

A carboxylic acid will react with an alcohol to form a(n) _____ and a water molecule.

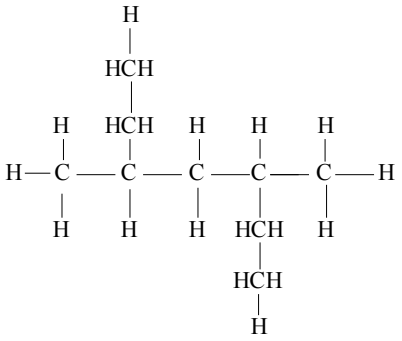
a) ester
b) amine
c) polymer
d) ketone
e) aldehyde

The structure below can be best described as _____ having a molecular formula of _____.



a. an amide; $C_{10}H_{20}$
b. an alkene; $C_{11}H_{22}$
c. an alkane; $C_{11}H_{22}$
d. an alkyne; $C_{10}H_{18}$
e. an alkane; $C_{10}H_{22}$

Match the name to the structure.

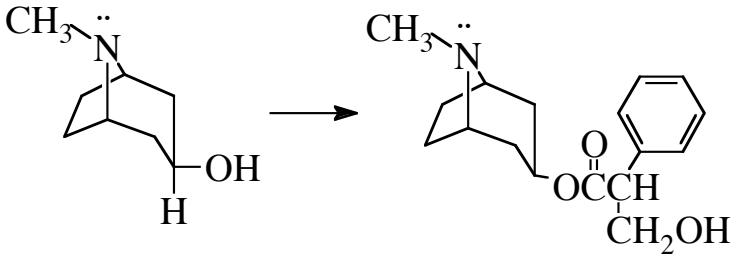


a) 2,4-diethylpentane
b) 2-ethyl-4-methylhexane
c) 3,5-dimethylheptane
d) 2,3-dimethyl-2,3-diethylpropane

Provide a line drawing for 1-chloro-2,3-dimethylcyclopentane.

Match functions to structures.

Identify all of the functional groups in compound (I) and Atropine (II) which can be prepared from it.



(I) (II) Atropine

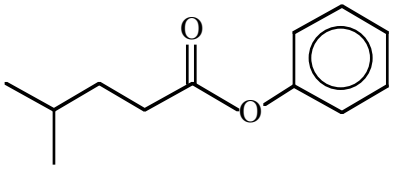
Draw the following condensed formula as a line-angle formula.

$C_6H_5CH_2CH_2CH_2COOH$

Name the oxygen containing function _____

Provide appropriate structures:

_____
Bond-Line Structural Formula



Condensed Structural Formula

Predict oxidation-reduction and esterification reaction products.

Identify chiral carbon atoms and calculated the number(s) of possible stereiosmers.