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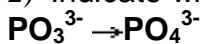
23 Electrochemical Terms (Homework)

Chapter 11 Electrochemistry

Sections 1-2

1) Determine the oxidation state of nitrogen in N_2H_4 .

2) Indicate whether the chemical conversion:



requires an oxidizing agent, a reducing agent, or neither.

oxidizing agent

neither

reducing agent

3) Use the energy level diagrams for the valence electrons of elements X, Y, and Z shown below and assume that the redox orbital energies are the dominant term in the free energies of all reactions to determine which of the following reactions would be spontaneous.

Energy Diagram	Possible Processes	Spontaneous?
	a) $X + Y^{2+} \rightarrow X^{2+} + Y$	
	b) $Z + X^{2+} \rightarrow Z^{2+} + X$	
	c) $Y + Z^{2+} \rightarrow Y^{2+} + Z$	
	d) $Y + X^{2+} \rightarrow Y^{2+} + X$	
	e) $Z + Y^{2+} \rightarrow Z^{2+} + Y$	

best oxidizing agent	best reducing agent	redox couple with the most negative standard reduction potential
<input type="checkbox"/> Z <input type="checkbox"/> Y^{2+}	<input type="checkbox"/> X^{2+} <input type="checkbox"/> Y^{2+}	<input type="checkbox"/> Y^{2+}/Y <input type="checkbox"/> X^{2+}/X

<input type="checkbox"/> X <input type="checkbox"/> X ²⁺ <input type="checkbox"/> Y <input type="checkbox"/> Z ²⁺	<input type="checkbox"/> X <input type="checkbox"/> Z ²⁺ <input type="checkbox"/> Y <input type="checkbox"/> Z	<input type="checkbox"/> Z ²⁺ /Z
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4) Consider the valence electron energy level diagrams for substances A and B:

Energy Diagram	Process	Spontaneous?	Best Oxidant	Best Reductant
	$A + B \rightarrow A^{2+} + B^{2-}$		<input type="checkbox"/> <input checked="" type="checkbox"/> A	<input type="checkbox"/> <input checked="" type="checkbox"/> A
	$A^{2+} + B \rightarrow A + B^{2+}$		<input type="checkbox"/> <input checked="" type="checkbox"/> A ²⁺	<input type="checkbox"/> <input checked="" type="checkbox"/> A ²⁺
	$A + B^{2-} \rightarrow A^{2-} + B$		<input type="checkbox"/> <input checked="" type="checkbox"/> A ⁴⁺	<input type="checkbox"/> <input checked="" type="checkbox"/> A ⁴⁺
	$A^{4+} + B^{2-} \rightarrow A^{2+} + B$		<input type="checkbox"/> <input checked="" type="checkbox"/> B <input type="checkbox"/> <input checked="" type="checkbox"/> B ²⁻ <input type="checkbox"/> <input checked="" type="checkbox"/> B ²⁺	<input type="checkbox"/> <input checked="" type="checkbox"/> B <input type="checkbox"/> <input checked="" type="checkbox"/> B ²⁻ <input type="checkbox"/> <input checked="" type="checkbox"/> B ²⁺

5) Identify the reductant and the number of electrons transferred (n) in each redox reaction below.

Reaction	reductant	n

$3\text{Cl}_2 + 2\text{Fe} \rightarrow 2\text{FeCl}_3$	<input type="checkbox"/> <input type="checkbox"/> Fe <input type="checkbox"/> <input type="checkbox"/> Cl ₂	
$\text{H}_2\text{O} + \text{Hg}^{2+} + \text{NO}_2^{1-} \rightarrow 2\text{H}^{1+} + \text{Hg} + \text{NO}_3^{1-}$	<input type="checkbox"/> <input type="checkbox"/> H ₂ O <input type="checkbox"/> <input type="checkbox"/> Hg ²⁺ <input type="checkbox"/> <input type="checkbox"/> NO ₂ ¹⁻	
$3\text{SO}_3^{2-} + 2\text{MnO}_4^{1-} + \text{H}_2\text{O} \rightarrow 3\text{SO}_4^{2-} + 2\text{MnO}_2 + 2\text{OH}^{1-}$	<input type="checkbox"/> <input type="checkbox"/> SO ₃ ²⁻ <input type="checkbox"/> <input type="checkbox"/> MnO ₄ ¹⁻ <input type="checkbox"/> <input type="checkbox"/> H ₂ O	

24 Redox Reactions (Homework)

Chapter 11 Electrochemistry

Sections 3-6

Instructions

Instructions for writing chemical equations:

- Write all reactions in the sequence given at the top of each table
- Use -> (hyphen + greater than) for yields.
- Write subscripts as numbers with no special character.
- Precede superscripts with a "^", write the number before the sign, and include '1' where appropriate. For example, HCO₃¹⁻ = HCO3^1- and CO₃²⁻ = CO3^2-
- Answers are case sensitive.
- Spaces are ignored, so use them for readability.
- Click on the "eye" symbol to see your formatted response.

You will also need a [Table of Standard Reduction Potentials](#) (Table 11.1) in the text.

1) Select the strongest oxidant and reductant given that all of the following processes are extensive.

Extensive Processes	best oxidant	best reductant
----------------------------	---------------------	-----------------------

$A + B^{2+} \rightarrow A^{2+} + B$	<input type="checkbox"/> <input type="checkbox"/> A	<input type="checkbox"/> <input type="checkbox"/> A
	<input type="checkbox"/> <input type="checkbox"/> A ²⁺	<input type="checkbox"/> <input type="checkbox"/> A ²⁺
$B + C^{2+} \rightarrow B^{2+} + C$	<input type="checkbox"/> <input type="checkbox"/> B	<input type="checkbox"/> <input type="checkbox"/> B
	<input type="checkbox"/> <input type="checkbox"/> B ²⁺	<input type="checkbox"/> <input type="checkbox"/> B ²⁺
$D + B^{2+} \rightarrow D^{2+} + B$	<input type="checkbox"/> <input type="checkbox"/> C	<input type="checkbox"/> <input type="checkbox"/> C
	<input type="checkbox"/> <input type="checkbox"/> C ²⁺	<input type="checkbox"/> <input type="checkbox"/> C ²⁺
	<input type="checkbox"/> <input type="checkbox"/> D	<input type="checkbox"/> <input type="checkbox"/> D
$A + D^{2+} \rightarrow A^{2+} + D$	<input type="checkbox"/> <input type="checkbox"/> D ²⁺	<input type="checkbox"/> <input type="checkbox"/> D ²⁺

2) Write balanced redox equations and determine both the cell potential and the number of electrons transferred for the spontaneous redox process that occurs when the following couples are connected. See "Instructions for Writing Chemical Equations" in the assignment heading. OX and RED can easily be identified when you realize that all of the half-reactions in the table are in the form $OX + ne^{-1} \rightarrow RED$.

Be sure to enter the substances in the required order. It is different than that given online.			
Couples	OX(1) + RED(2) -> RED(1) + OX(2)	E° (V)	n
H ¹⁺ /H ₂ + Al ³⁺ /Al			
Cu ²⁺ /Cu + Pb ²⁺ /Pb			
I ₂ /I ¹⁻ + Br ₂ /Br ¹⁻			

3) Write net equations for the spontaneous redox reactions that occur during the following or **none** if there is no extensive reaction. See "Writing Chemical Equations" in the Instructions section of the assignment heading.

- Sulfate ion should be treated as a spectator ion.
- The order in this problem is different than that in the question above, so take care in writing the reactions.

Reactants	RED(1) + OX(2) + other -> OX(1) + RED(2) + other
Iron metal is dipped into a NiSO ₄ solution	
Silver metal is added to hydrochloric acid	
A silver wire is dipped into nitric acid	
Potassium metal is added to water	
Chromium metal is added to a solution of MgSO ₄	

25 Batteries, Corrosion, and Electrolysis (Homework)

Chapter 11 Electrochemistry
Sections 6-8

1) Identify the battery that uses each of the following half-reactions:

Half-reaction	Battery
$\text{Ag}_2\text{O} + \text{H}_2\text{O} + 2\text{e}^{-1} \rightarrow 2\text{Ag} + 2\text{OH}^{1-}$	
$2\text{MnO}_2 + \text{H}_2\text{O} + 2\text{e}^{-1} \rightarrow \text{Mn}_2\text{O}_3 + 2\text{OH}^{1-}$	
$\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4 + 2\text{e}^{-1}$	

2) Automobile bodies are galvanized by the addition of zinc. Write the **balanced chemical equations** using smallest whole number coefficients for the following processes:

- Use complete reactions with molecules and atoms; i.e., no ions or half-reactions. For example, $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$.

The corrosion that is prevented by galvanization.

The galvanization reaction that occurs instead of the above corrosion.

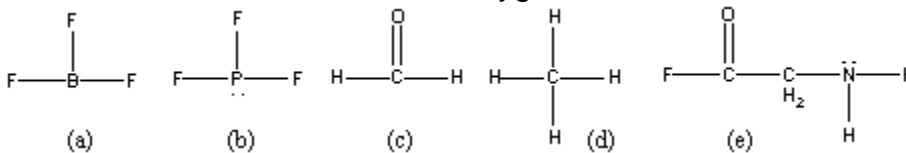
3) Indicate whether each reaction could form the basis of a galvanic cell or require an electrolytic cell to be accomplished.

Reactants	Cell Type
$\text{Cu} + \text{Ni}^{2+} \rightarrow \text{Cu}^{2+} + \text{Ni}$	
$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$	
$2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$	

26 Acids & Bases (Homework)

Chapter 12 Acids and Bases
Sections 1-3

1) Lone pairs are shown only on central atoms in the following Lewis structures. Assume that the double bonded oxygen atoms are neither acidic or basic.



Select all species that are Lewis acidic

- a
 b
 c
 d
 e

Select all species that are Lewis basic

- a
 b
 c
 d
 e

2) Give the conjugate base or acid in each case. Enter subscripts normally. For example, NH_4^{1+} would be entered as NH_4^{1+} or, since spaces are ignored, as $\text{NH}_4\ 1+$. The answers are case sensitive.

acid	conjugate base
------	----------------

HClO	
NH ₃	
H ₃ PO ₄	
HSO ₃ ¹⁻	
	OH ¹⁻
	F ¹⁻
	S ²⁻
	NH ₃

27 Acid Strengths (Homework)

Chapter 12 Acids and Bases
Sections 3-5

1) Select the stronger base or acid in each pair (A or B). Note that CH₃ and CH₂ groups are electron donating groups, i.e., they place electron density on the atoms to which they are attached.

Select the stronger base.

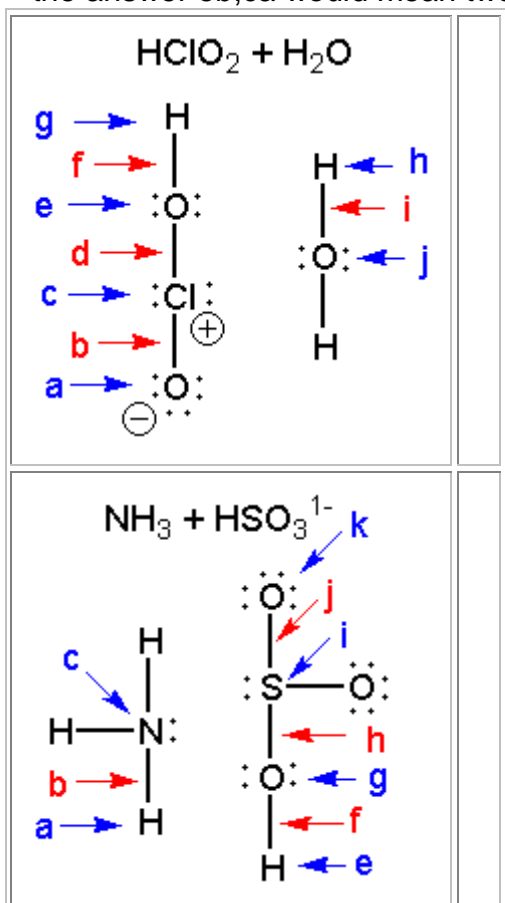
A	B	Stronger base
CH ₃ NH ₂	NH ₃	
NCl ₃	NF ₃	
ClO ₂ ¹⁻	ClO ¹⁻	

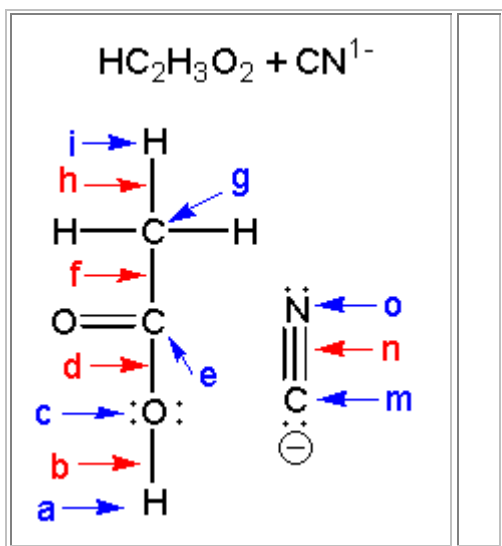
Select the stronger acid

A	B	Stronger acid
H ₂ SeO ₄	H ₂ SeO ₃	

HOCl	HOBr	
HOH	CH ₃ OH	

2) Indicate the direction of curved arrows for the mechanisms of the following acid-base reactions. Each curved arrow consists of two letters: the letter corresponding to the start of the curved arrow followed by the letter corresponding to end of the arrow. Blue letters and arrows are used for atoms, while red arrows and letters are used for bonding pairs in the figures below. Separate the letter pairs corresponding to the arrows with commas. For example, the answer eb,ca would mean two arrows: one from e to b and one from c to a.





28 Acid-Base Reactions (Homework)

Chapter 12 Acids and Bases
Sections 6-8

1) Write net chemical equations for the acid-base reactions that occur when aqueous solutions of the following are mixed. Indicate the extent of reaction with single or double arrows (single arrow if $K > 1000$ double arrow otherwise). See the Instructions section of the assignment header for writing equations.

Reactants	ACID(1) + BASE(2) \rightarrow or \leftrightarrow BASE(1) + ACID(2)
a) $\text{HNO}_2 + \text{NaOH}$	
b) $\text{NH}_4\text{Cl} + \text{Na}_2\text{SO}_3$	
c) $\text{NaClO} + \text{NaH}_2\text{PO}_4$	
d) $\text{HBr} + \text{NH}_3$	
e) $\text{HF} + \text{NaCN}$	
f) $\text{NaC}_2\text{H}_3\text{O}_2 + \text{H}_3\text{PO}_4$	
g) $\text{HClO}_4 + \text{NaH}_2\text{PO}_4$	

2) Given the following K_a 's:

- $K_a(\text{HF}) = 7.2 \times 10^{-4}$
- $K_a(\text{HC}_2\text{H}_3\text{O}_2) = 1.8 \times 10^{-5}$
- $K_a(\text{HClO}) = 3.5 \times 10^{-8}$
- $K_a(\text{HCN}) = 4.0 \times 10^{-10}$

determine the equilibrium constant for each reaction and indicate whether a single or double arrow would be more appropriate. **Express the equilibrium constants to only two significant figures.**

Reaction	K	Arrows
$\text{HC}_2\text{H}_3\text{O}_2 + \text{CN}^{1-} \rightarrow \text{C}_2\text{H}_3\text{O}_2^{1-} + \text{HCN}$		
$\text{HClO} + \text{CN}^{1-} \rightarrow \text{ClO}^{1-} + \text{HCN}$		
$\text{HCN} + \text{ClO}^{1-} \rightarrow \text{CN}^{1-} + \text{HClO}$		
$\text{HF} + \text{CN}^{1-} \rightarrow \text{F}^{1-} + \text{HCN}$		

29 pH & pKa (Homework)

Chapter 12 Acids and Bases
Section 9

1) Calculate the **pH** of a strong acid solution of $2.1 \times 10^{-3} \text{ M HCl}$. Express your answer to the nearest 0.1 pH unit.

pH =

2) Use the [acid-base table](#) to determine the pK_a of the weak acid H_2O . Express your answer to two decimal places.

$\text{pK}_a =$

3) Indicate whether each of the following solutions is acidic, basic, or neutral.

0.1 M HNO_2	
pH = 7	
$[\text{OH}^{1-}] = 10^{-4} \text{ M}$	
$[\text{OH}^{1-}] = 10^{-8} \text{ M}$	

$[\text{H}_3\text{O}^{1+}] = 10^{-4} \text{ M}$	
$[\text{H}_3\text{O}^{1+}] = 10^{-9} \text{ M}$	

4) Indicate which solution in each pair has the **lower pH**.

A	B	lower pH
0.1 M HClO_2	0.2 M HClO_2	
0.1 M NaClO_2	0.2M NaClO_2	
0.1 M HF	0.1 M HNO_2	
0.1 M NaOH	water	

5) Consider the following four solutions:

- a) 0.10 M HA
- b) 0.10 M KA (potassium salt of A^{1-})
- c) 0.10 M HB
- d) 0.10 M KB

Assume that pK_a of HA is greater than that of HB to answer the following questions.

The solution with the highest pH is _____.

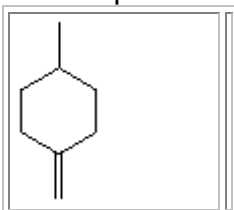
The solution with the lowest pH is _____.

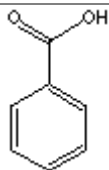
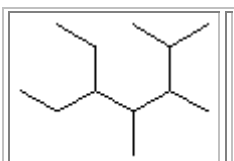
30 Organic Chemistry (Homework)

Chapter 13 Organic Chemistry


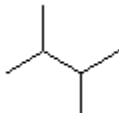
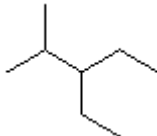


Sections 1-4

1) Determine the **molecular formula** of the following molecules. *Place the atoms in alphabetical order (C,H,N,O)*, and use no special characters for subscripts. For example, $\text{C}_6\text{H}_{22}\text{O}_{11} = \text{C}_6\text{H}_{22}\text{O}_{11}$

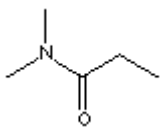
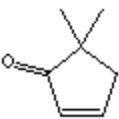
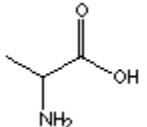




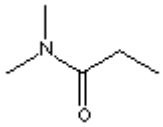
2) Name the following organic compounds:

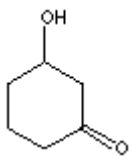
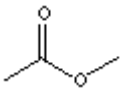
	
	
	
	
	
<p>* Note that there are two isomers of the above compound, so your name must indicate which isomer.</p>	

3) Which of the following **functional groups** is/are present in each compound?

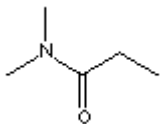
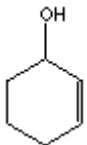

	<input type="checkbox"/> <input checked="" type="checkbox"/> amide <input type="checkbox"/> <input checked="" type="checkbox"/> alkene <input type="checkbox"/> <input checked="" type="checkbox"/> alcohol <input type="checkbox"/> <input checked="" type="checkbox"/> carboxylic acid
	<input type="checkbox"/> <input checked="" type="checkbox"/> carbonyl & alkene <input type="checkbox"/> <input checked="" type="checkbox"/> carboxylic acid & alkane <input type="checkbox"/> <input checked="" type="checkbox"/> alcohol & alkene <input type="checkbox"/> <input checked="" type="checkbox"/> carbonyl & diacid
	<input type="checkbox"/> <input checked="" type="checkbox"/> amide <input type="checkbox"/> <input checked="" type="checkbox"/> amino acid <input type="checkbox"/> <input checked="" type="checkbox"/> carboxylic acid & amide <input type="checkbox"/> <input checked="" type="checkbox"/> alcohol, carbonyl, & amine

4) Identify a **Lewis acid site** in each molecule. Note lone pairs are not shown, but C, N, and O all obey the octet rule.


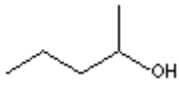
	<input type="checkbox"/> <input checked="" type="checkbox"/> oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-oxygen double bond <input type="checkbox"/> <input checked="" type="checkbox"/> carbon double-bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> nitrogen
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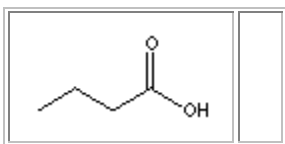
	<input type="checkbox"/> <input checked="" type="checkbox"/> oxygen double-bonded to carbon <input type="checkbox"/> <input checked="" type="checkbox"/> hydrogen bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-oxygen double bond <input type="checkbox"/> <input checked="" type="checkbox"/> oxygen in the hydroxyl group
	<input type="checkbox"/> <input checked="" type="checkbox"/> oxygen double-bonded to carbon <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-oxygen double bond <input type="checkbox"/> <input checked="" type="checkbox"/> carbon double-bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> oxygen bonded to two carbons

5) Identify the **Lewis basic site** in each molecule. Lone pairs are not shown, but C, N, and O all obey the octet rule.

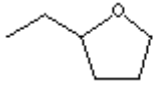
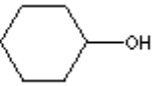

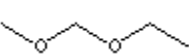
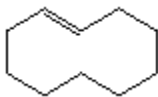
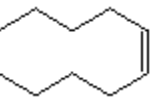
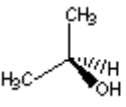
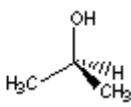

	<input type="checkbox"/> <input checked="" type="checkbox"/> nitrogen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon double-bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon bonded to nitrogen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-oxygen double bond
	<input type="checkbox"/> <input checked="" type="checkbox"/> carbon bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> hydrogen bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-oxygen single bond
	<input type="checkbox"/> <input checked="" type="checkbox"/> carbon double-bonded to oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> oxygen <input type="checkbox"/> <input checked="" type="checkbox"/> carbon-carbon bond <input type="checkbox"/> <input checked="" type="checkbox"/> hydrogen bonded to carbon

6) Name the following organic compounds:



7) Indicate whether the following pairs of compounds are constitutional isomers, stereoisomers, or identical molecules.

	and		
	and		
	and		
	and		
	and	