[TP] Identify the correct statement about the redox reaction
$Zn^{2+}(aq) + Cu(s) \rightleftharpoons Cu^{2+}(aq) + Zn(s)$.

17% 1. $Zn^{2+}(aq)$ is the reducing agent because it gains electrons
17% 2. $Cu(s)$ is the reducing agent because it gains electrons
17% 3. $Zn^{2+}(aq)$ is the reducing agent because it loses electrons
17% 4. $Cu(s)$ is the reducing agent because it loses electrons
17% 5. $Zn^{2+}(aq)$ is the reducing agent because it is reduced
17% 6. $Cu(s)$ is the reducing agent because it is reduced

Lecture 21 CH101 A1 (MWF 9:05 am)

Wednesday, October 25, 2017

For today ...
- To memorize: Table 6.13, p 194: Common acids and bases
- Balancing oxidation-reduction equations
- Complexation as Lewis acid-base reaction

Begin ch7: Chemical reactions and energy flows
- First law of thermodynamics

Next lecture: System vs. surroundings; Detecting heat; Predicting sign of heat; Detecting work; Amount of heat depends on whether there is work

Memorize: Table 6.13: Common acids and bases

Strong Acids (Strong electrolytes)		Strong Bases (Strong electrolytes)	
HCl	Hydrochloric acid	LiOH	Lithium hydroxide
HBr	Hydrobromic acid	NaOH	Sodium hydroxide
HI	Hydroiodic acid	KOH	Potassium hydroxide
HNO_3	Nitric acid		
$HClO_4$	Perchloric acid		
H_2SO_4	Sulfuric acid		
Weak Acids (Weak electrolytes)*		**Weak Bases (Weak electrolytes)***	
H_3PO_4	Phosphoric acid	NH_3	Ammonia
H_2CO_3	Carbonic acid	$CH_3CH_2NH_2$	Ethylamine
CH_3COOH	Acetic acid		
$H_2C_2O_4$	Oxalic acid		
$H_2C_4H_4O_6$	Tartaric acid		
$H_3C_6H_5O_7$	Citric acid		
$HC_9H_8O_4$	Aspirin		

* These are just a few common examples of the very many weak acids and weak bases.

Redox reactions: Competition for e^-

Oxidation-reduction reactions are a competition for electrons

Species that gives up e^- →
is oxidized →
It makes possible reduction →
and so is called the reducing agent

Redox reactions: Competition for e⁻

Redox reactions are a competition for electrons

$$2\,Ag^{+}(aq) + Cu(s) \rightleftharpoons 2\,Ag(s) + Cu^{2+}(aq)$$

Oxidation "half reaction"?

Redox reactions: Competition for e⁻

Oxidation-reduction reactions are a competition for electrons

Species that accepts e⁻ →
is reduced →
It makes possible oxidation →
and so is called the oxidizing agent

Redox reactions: Competition for e⁻

Redox reactions are a competition for electrons

$$2\,Ag^{+}(aq) + Cu(s) \rightleftharpoons 2\,Ag(s) + Cu^{2+}(aq)$$

Reduction "half-reaction"?

Getting balanced redox (full) reaction

$$2\,Ag^{+}(aq) + Cu(s) \rightleftharpoons 2\,Ag(s) + Cu^{2+}(aq)$$

First, get the balanced half-reactions

Then, combine the half-reactions so that the electrons released in the oxidation are exactly consumed in the reduction …

[TP] Identify the correct statement about the redox reaction
$Zn^{2+}(aq) + Cu(s) \rightleftharpoons Cu^{2+}(aq) + Zn(s)$.

17% 1. $Zn^{2+}(aq)$ is the reducing agent because it gains electrons
17% 2. $Cu(s)$ is the reducing agent because it gains electrons
17% 3. $Zn^{2+}(aq)$ is the reducing agent because it loses electrons
17% 4. $Cu(s)$ is the reducing agent because it loses electrons
17% 5. $Zn^{2+}(aq)$ is the reducing agent because it is reduced
17% 6. $Cu(s)$ is the reducing agent because it is reduced

Lewis alternative definition of acids and bases

Brønsted-Lowry acid is the source of a proton

$$HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

Brønsted-Lowry base is destination of proton

$$NH_4^+(aq) + OH^-(aq) \rightarrow H_2O(aq) + NH_3(aq)$$

Lewis alternative definition of acids and bases

Lewis acid "accepts" a pair of electrons to form a covalent bond

Lewis base has a pair of electrons to form a covalent bond

$$Co^{3+}(aq) + :NH_3(aq) \rightarrow [Co(:NH_3)]^{3+}(aq)$$

Result is acid-base adduct

Complexation as Lewis acid-base reaction

lone pair source = Lewis base or ligand.

what bonds to lone pair = Lewis acid.

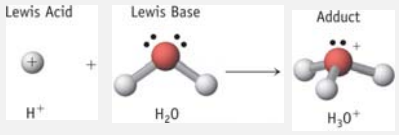
product of acid-base reaction = acid-base adduct.

Complexation as Lewis acid-base reaction

lone pair source = Lewis base or ligand.

what bonds to lone pair = Lewis acid.

product of acid-base reaction = *acid-base adduct*.



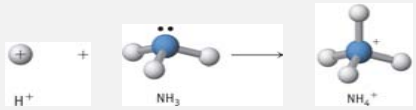
BOSTON UNIVERSITY

Complexation as Lewis acid-base reaction

lone pair source = Lewis base or ligand.

what bonds to lone pair = Lewis acid.

product of acid-base reaction = *acid-base adduct*.



BOSTON UNIVERSITY

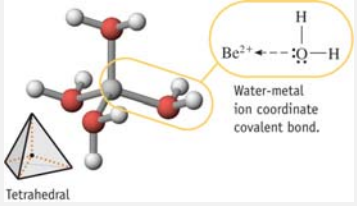
Complexation as Lewis acid-base reaction

lone pair source = Lewis base or ligand.

what bonds to lone pair = Lewis acid.

product of acid-base reaction = *acid-base adduct*.

$$Be^{2+}(aq) + 4\ H_2O(l) \rightarrow [Be(H_2O)_4]^{2+}(aq)$$



BOSTON UNIVERSITY

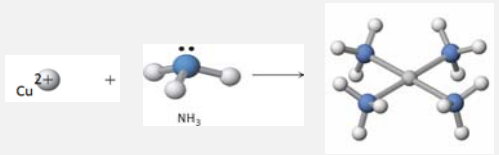
Complexation as Lewis acid-base reaction

lone pair source = Lewis base or ligand.

what bonds to lone pair = Lewis acid.

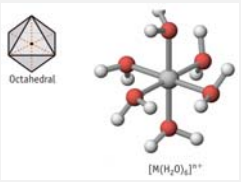
product of acid-base reaction = *acid-base adduct*.

$$Cu^{2+}(aq) + 4\ NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+}(aq)$$



BOSTON UNIVERSITY

Complexes have characteristic colors



[TP] In the reaction

$$[Cu(:OH_2)_6]^{2+}(aq) + 4\ :Cl^-(aq) + 2\ :NH_3(aq) \rightarrow [Cu(:NH_3)_2:Cl_4]^{2-}(aq) + 6\ :OH_2(l)$$

the number of Lewis acids is ...

17% 1. 0
17% 2. 1
17% 3. 2
17% 4. 3
17% 5. 4
17% 6. 5

Ch 7: Chemical Reactions and Energy Flows

First law of thermodynamics

Energy, U, is exchanged between system and surroundings as heat, q, and work, w,

$\Delta U = q + w$

Positive values increase energy of system

$\Delta U = q + w$

q = heat flow into the system

w = done on the system

[TP] In a certain chemical reaction, 10 kJ of heat flow into the system and the system does 21 kJ of work on the surroundings.
This means $\Delta U =$ ...

13% 1. +31 kJ
13% 2. +21 kJ
13% 3. +11 kJ
13% 4. +10 kJ
13% 5. −10 kJ
13% 6. −11 kJ
13% 7. −21 kJ
13% 8. −31 kJ

BOSTON UNIVERSITY 38

First law of thermodynamics

In a certain chemical reaction, 10 kJ of heat flow into the system and the system does 21 kJ of work on the surroundings. Sketch the energy diagram showing q, w, and ΔU for this reaction. Indicate the initial and final energy by horizontal lines labeled U_i and U_f, respectively.

BOSTON UNIVERSITY 39