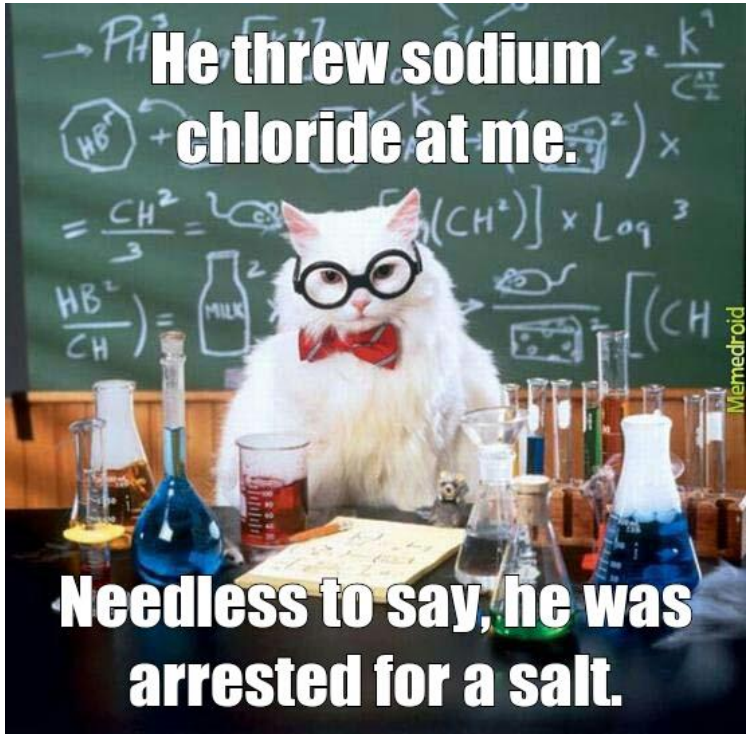
Nov 25-Nov 29 Practice Problems



Due dates:

This week you have Quiz 9

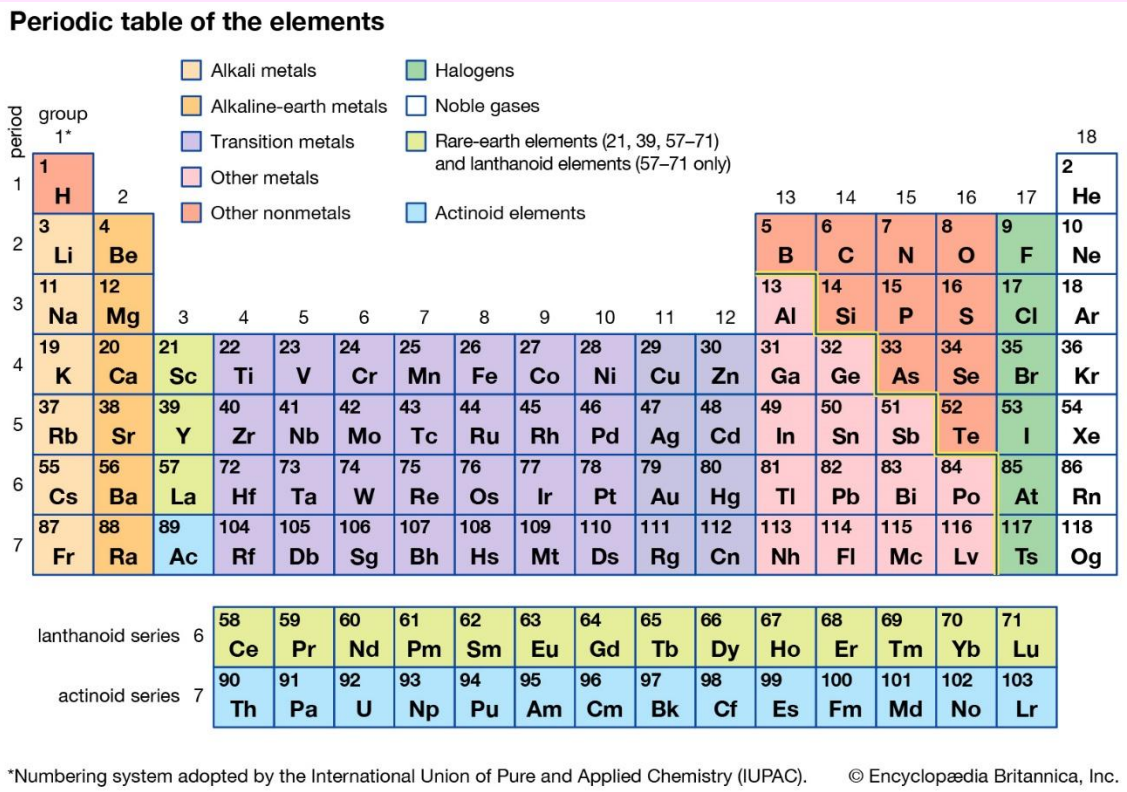
Review end of the week

Mercury course evaluations! Please fill them out!

Office hours: Thursday, November 28 1:30 to 2:30 pm in Pulp and Paper 104

Q1. Write the condensed electron configurations of the following :

	neutral	ion
Zr^{2+}	[Kr] $5s^2$ $4d^2$	[Kr] $4d^2$
V^{3+}	[Ar] $4s^2$ $3d^3$	[Ar] $3d^2$
Cu	[Ar] $4s^1$ $3d^{10}$	
Cu^{2+}	[Ar] $3d^9$	
Fe^{3+}		[Ar] $3d^5$
Mo^{3+}		[Kr] $4d^3$



Q2. What is the oxidation state of Cr in $[Cr(OH)_6]^{3-}$? Is the chromium ion diamagnetic or paramagnetic? Would you expect this complex to be coloured?

Charge of complex = -3

Cr + 6 x (OH) = -3

(OH) has a charge of -1

So

Cr + 6(-1) = -3

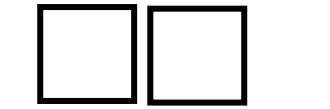
Cr - 6 = -3

Cr = -3 + 6

Cr = +3

Cr: [Ar] $4s^1$ $3d^5$

Cr^{3+}: [Ar] $3d^3$



Paramagnetic (magnetic because unpaired electrons)

Coloured: electrons have a space in the d orbitals to move into

Q3. Calculate the oxidation state of the transition metal in the coordination complexes. What is the coordination number?

	Oxidation state	Coordination number
$[CrCl_2(NH_3)_4]^+$:	x+ 2(-1) + 4(0) = +1 x -2 = 1 x = 1+2 = 3 so +3	6
$[Cr(OH)_2(NH_3)_4]^-$:	x+ 2(-1) + 4(0) = -1 x -2 = -1 x = -1+2 = 1 so +1	6

Anionic Ligand	Name
$Cl^-/I^-/F^-/Br^-$	Chloro/iodo/fluoro/bromo
NO_2^-	Nitro/nitrito
CN^-	cyano
OH^-	hydroxo
$C_2O_4^{2-}$	Oxalato

Neutral Ligand	Name
NH_3	ammine
H_2O	aqua
NO	Nitrosyl
en	Ethylene diamine
CO	carbonyl

TABLE 24.6 Some Common Ligands in Coordination Compounds

Ligand Type	Examples
Monodentate	$H_2\ddot{O}$: Water; $:\ddot{F}:^-$ Fluoride ion; $[:C\equiv N:]^-$ Cyanide ion; $[:\ddot{O}-H]^-$ Hydroxide ion; $:NH_3$ Ammonia; $:\ddot{Cl}:^-$ Chloride ion; $[:\ddot{S}-C\equiv N:]^-$ Thiocyanate ion; $[:\ddot{O}-N=\ddot{O}:]^-$ Nitrite ion
Bidentate	Ethylenediamine (en); Oxalate ion
Polydentate	Diethylenetriamine; Triphosphate ion; Ethylenediaminetetraacetate ion ($EDTA^{4-}$)

Q4. What is the name of $[Cr(H_2O)_5Br]Cl$? What is the formula for barium hexacyanocobaltate(III)?

$[Cr(H_2O)_5Br]^+ \ Cl^-$

H_2O = aqua — Penta = x 5

Br^- = bromo

pentaaquabromochromium

Overall positive charge so just "chromium" is good

What is the oxidation state of Cr???

Overall = +1
Bromo ligand is -1
Aqua is neutral

+1 = x + (-1)
1+1=x
x= +2
Cr = + 2 (or **II**)

pentaaquabromochromium(II)

Finally add the counter anion (Cl-)
pentaaquabromochromium(II) chloride

barium Ba^{2+}

hexacyanocobaltate (III)

cyano = CN^-

Six cyanos = 6 x (-1) = -6
Cobalt oxidation number = +3

So what is the overall charge of the whole coordination complex poly anion?

Overall charge = +3 + 6(-1)
Overall charge = +3 -6
Overall charge = -3

$[Co(CN)_6]^{-3}$

How do Ba^{2+} and $[Co(CN)_6]^{-3}$ go together?

$Ba_3[Co(CN)_6]_2$

Q5. Which complex, in the following pairs, would you expect to absorb the higher energy visible light? $\Delta E = h\upsilon = hc/\lambda$

Spectrochemical Series (of Ligands)

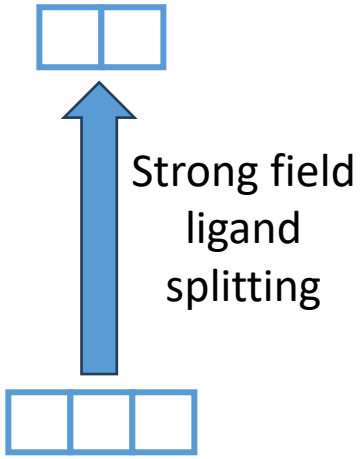
I^-, Cl^-, F^-, HO^-, H_2O, SCN^-, NH_3, en, NO_2^-, NC^-, CO

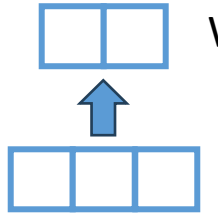
Increasing Field Strength

a) $[V(H_2O)_6]^{3+}$ or $[V(NH_3)_6]^{3+}$

$[V(H_2O)_6]^{3+}$ → H_2O ligand (weak field ligand)

$[V(NH_3)_6]^{3+}$ → NH_3 ligand (stronger field ligand)





b) $[TiCl_6]^{3-}$ or $[Ti(CO)_6]^{3+}$

$[TiCl_6]^{3-}$ → Cl^- ligand is weaker field ligand

$[Ti(CO)_6]^{3+}$ → CO ligand is a stronger field ligand

Q6. Compare the electron configurations of the two iron complexes below. Draw d-orbital energy diagrams to show splitting, predict the number of unpaired electrons, and identify each complex as "high spin" or "low spin". $[Fe(H_2O)_6]^{2+}$ vs. $[Fe(CO)_6]^{2+}$

What is the oxidation number?
(overall = + 2)
All ligands are neutral
So Fe = +2

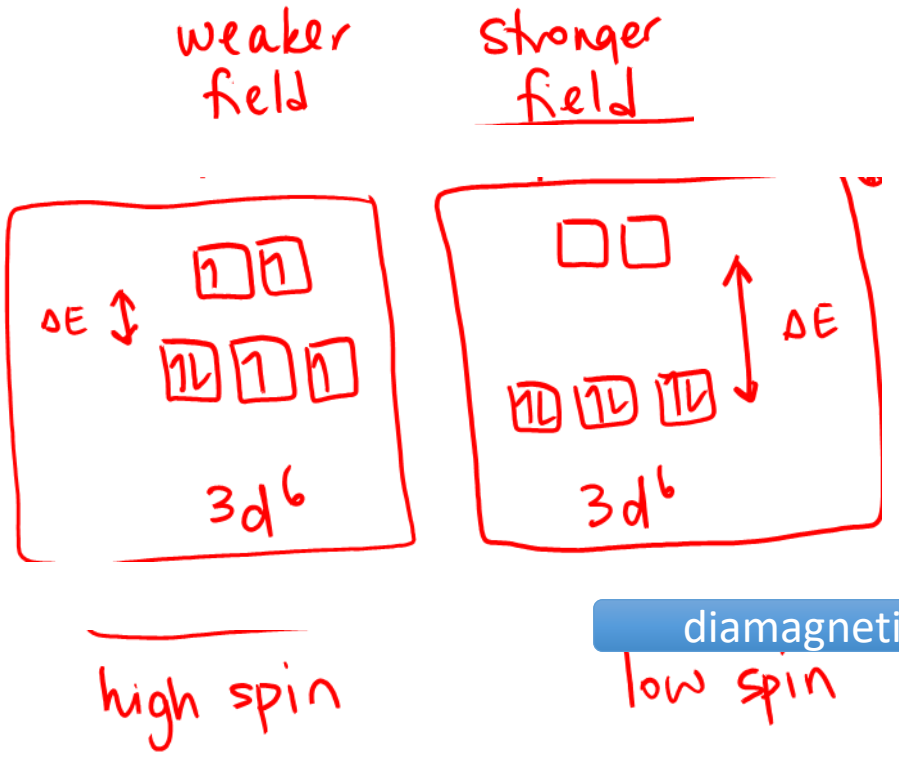
Fe $4s^2 3d^6$
Fe^{2+} $3d^6$

Spectrochemical Series (of Ligands)

I^-, Cl^-, F^-, HO^-, H_2O, SCN^-, NH_3, en, NO_2^-, NC^-, CO

Increasing Field Strength

$[Fe(H_2O)_6]^{2+}$ vs. $[Fe(CO)_6]^{2+}$



Slido Question

- **What shape (geometry) are these coordination complexes?**
- **$[CuCl_2]^-$ and $[Co(NH_3)_6]Cl_3$**

1)Linear and Tetrahedral

2)Octahedral and Tetrahedral

3)No geometry and Octahedral

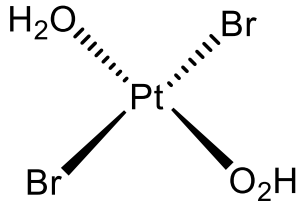
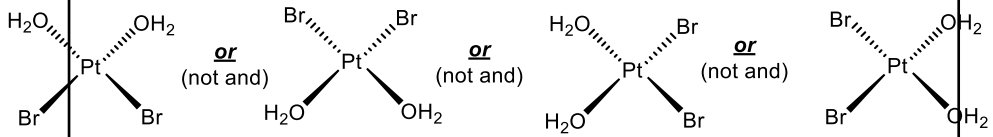
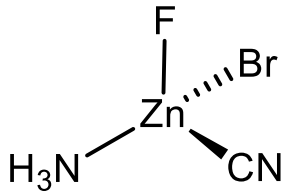
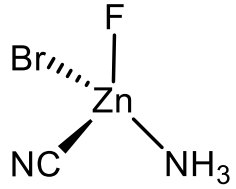
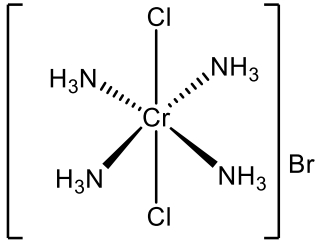
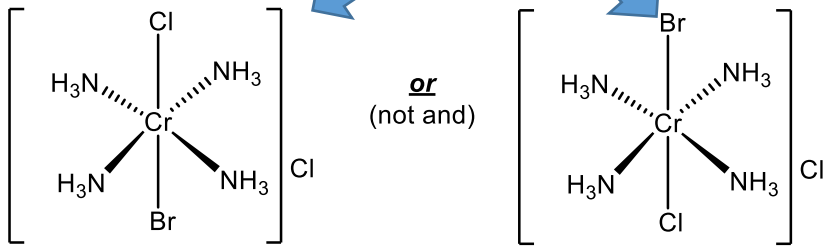
4)Linear and Octahedral

5)Square Planar and Tetrahedral

Q7. **Draw** an example of the isomer listed for each of the complexes indicated.

These 4 are the same molecule (either option is accepted but not BOTH options)

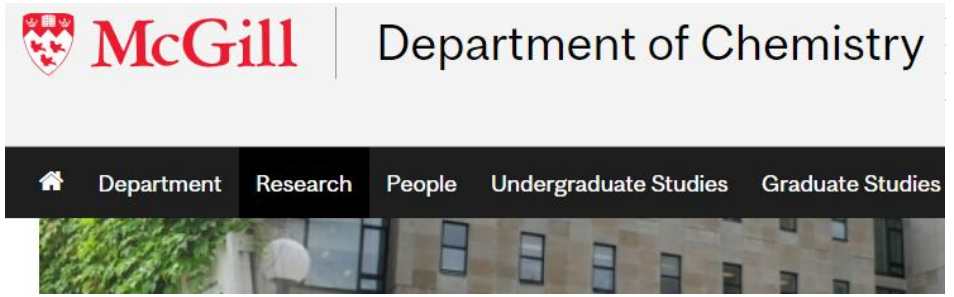
These 2 are the same molecule (either option is accepted but not BOTH options)

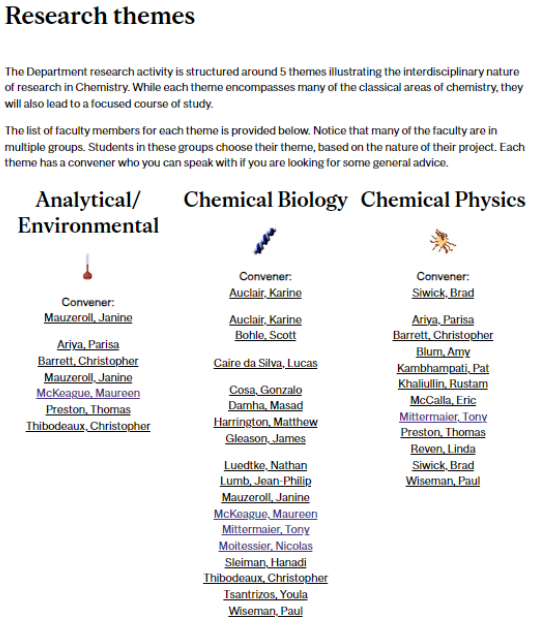
Isomer Type	Complex	Your isomer
Geometric isomer		
Enantiomer		
Coordination isomer		

My perspective on: *How to get into research?*

Why bother?

- Research can be impactful
- Try new things NOW
- Reference letters





How to find a research group:

- Figure out what you are interested in
  - Don’t limit yourself to your exact program
  - https://www.mcgill.ca/science/research/undergraduate-research/finding-opportunities
- Read websites (at least a bit!)
- Send 2-5 short but *personalized* emails
  - Attach your CV and transcript
  - Write 3-4 sentences at most in email (personalized)

How might the research take place?

Course credit (typical)

- 1-semester 396 “research course” e.g., CHEM396, COMP 396, ENVR396, etc
- Many programs require an “honors project” in your last year

  https://www.mcgill.ca/science/research/undergraduate-research/researchcourses

Paid

- Straight up research assistant: Rare in many departments
- Work-study (possible)
- Scholarship (external or internal)

Volunteer

How to get a professor to answer your email!

#1 Suggest a path that allows you to be in the lab for 1 year (or more) so that the resources and time to train you also pay off for the lab/research

- Offer to apply for scholarships for working in the summer

  e.g., McGill SURA and NSERC USRA applications due end of January

- Offer to volunteer (if you can) ***or*** note if you are eligible for work study
- Attend group meetings

- #2 Meet in-person (naturally) in class, at a seminar/event (e.g, Soup & Science)

https://www.mcgill.ca/science/research/undergraduate-research/soupscience

Notes:

- You *can* follow up once ~2-4 weeks later
- If they reply, reply fast
- You might have to contact dozens (think about supply/demand of department)
- **Start early** (>1 semester in advanced)