Chemistry 241-2009
Exam #2

Name: Answer Key

$$E_{in} = \frac{E_s}{4}(1 - \alpha)$$

$E_{out} = \sigma T^4$

$$\frac{E_s}{4}(1-\alpha) = \sigma T^4$$

$\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4

α = Albedo
- Earth = 0.28
- Mars = 0.17
- Jupiter = 0.73
- Venus = 0.71

Es = solar energy input
- Earth = 1380 W/m^2
- Mars = 600
- Venus = 2600

$$T_{calc} = \sqrt[4]{\frac{E_s(1-\alpha)}{4\sigma}}$$

$$\frac{E_s}{4}(1-\alpha) = f\sigma T^4$$

1. For each of the following, determine if a planet would get warmer, colder, or not change if that parameter was to suddenly become larger:

a. E_s	increase	decrease	no change
b. α	increase	decrease	no change
c. f	increase	decrease	no change

1d. Put a ***square*** around the equation that relates to blackbody radiation escaping Earth's surface.

2. A planet has the following parameters:

albedo: 0.64
Solar energy input: 700 W/m2
Actual temperature: 267 K

a. What would the planet's temperature be if it experienced no greenhouse effect?

$$T = \sqrt[4]{\frac{700(1-.64)}{4(5.67\times10^{-8})}} = 183\ K$$

b. What fraction of heat released by the planet is re-radiated back to the planet?

$$f = \frac{700 \rightarrow \frac{E_s}{4}(1-.64)}{5.67\times10^{-8}(267)^4} = 0.22$$ ← fraction escaping

fraction re-radiated = 1 − 0.22 = 0.78 (or 78%)

3. What would the planetary temperature be like if Cl-F were a major constituent of the atmosphere? Assume that Cl-F is completely chemically unreactive.

Explain. Cl-F is polar. When it vibrates, its dipole changes.

∴ Cl-F vibration is IR active.

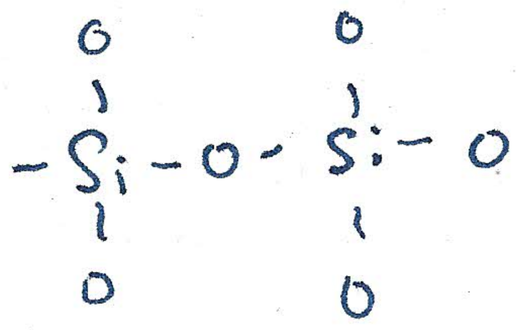
∴ Cl-F is a greenhouse gas.

∴ Cl-F in atmosphere would lead to increased global warming and T↑.

4a. What are the major structural differences between silicates and silicones? Draw structures to show what you mean.

Silicates: Si-O structures

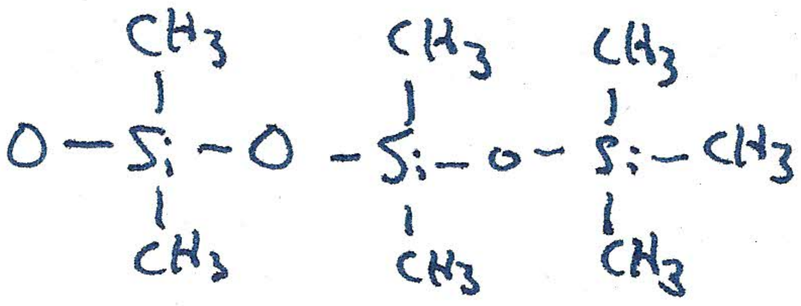
4 Si-O bonds/Si:



Silicones: Si-O structures

4 bonds total; some Si-O

some Si-C



4b. There are three principal reagents used to make silicones. For each, indicate how much you would use to make a liquid silicone with a relatively high boiling point.

Put Reagent formulas down this column	*circle one of these for each reagent*		
R_3SiCl	Use a lot	Use a little	Use none
R_2SiCl_2	Use a lot	Use a little	Use none
$RSiCl_3$	Use a lot	Use a little	Use none

use little R_3SiCl to get longer straight chains, which lead to higher boiling point.

would cause cross-linking to form a solid

5a. What happens to a zeolite's structure when Al atoms replace some Si atoms?

Framework gets a negative charge.
Attracts cations and H_2O molecules.

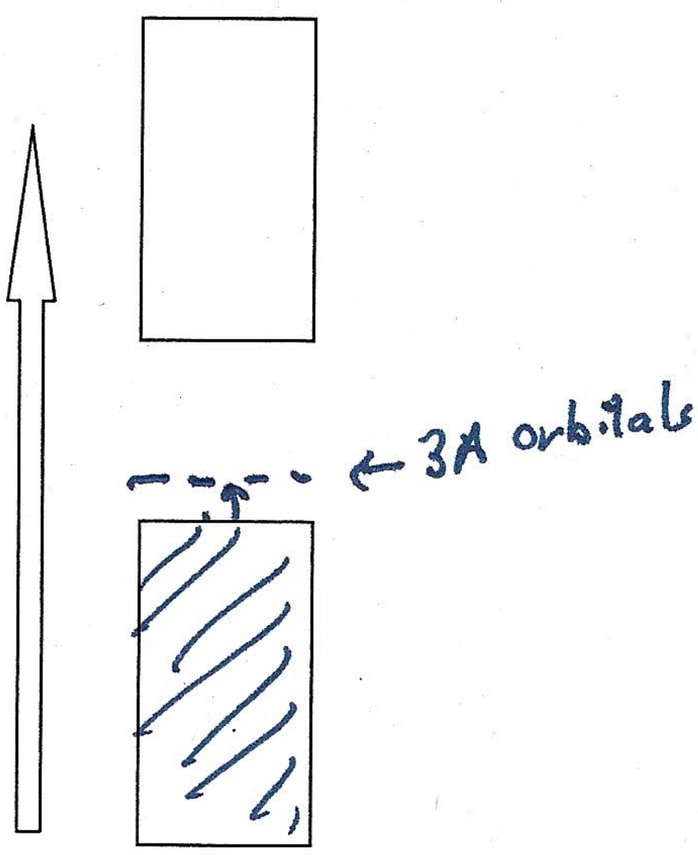
5b. What would happen if, instead, phosphorus (P) atoms replaced some Si atoms?

Framework would get a positive charge.
Would attract anions instead of cations.
Would still attract H_2O molecules.

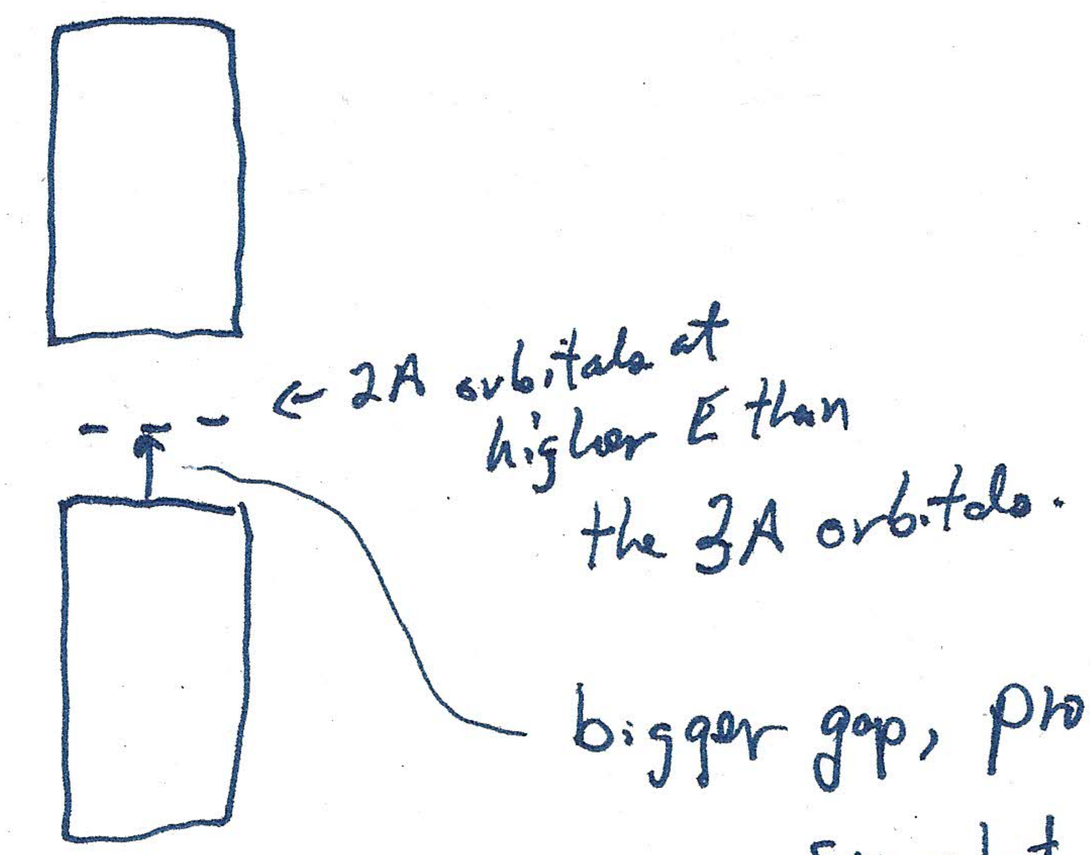
6a. You know what the band structure of a semiconductor that uses Si doped with a group 3A element looks like. You know you do.

What type of semiconductor is that: intrinsic n-type (p-type)

6b. Finish drawing the band structure of that 3A semiconductor, and right next to it, draw one for a semiconductor that uses a group 2A element instead. Be precise about the relative energy levels of the two. And, will the structure with the 2A element conduct better or worse than that with the 3A element. Give a one-sentence explanation.



3A semiconductor



2A semiconductor

7. Consider the chemistry of silanes, which are named after carbon-based alkanes, which have similar structures. Which of these, silanes or alkanes, are *less* stable.

silanes or alkanes

What is the principal reason why the less stable ones are less stable? (One sentence is sufficient.)

Si-Si bonds are weaker than C-C bonds and Si-O bonds are much stronger than Si-Si bonds

8. A large variety of silicate and structures exist. One crucial aspect of their structure depends on the ratio of O atoms to Si atoms in the formula. As the ratio of O to Si decreases, what happens to the nature of the structures?

as $\frac{\#O}{\#Si}$ ↓ structures become more interlinked and complex.

Why does that happen? (You may have answered this in the first part, and if so, no need to repeat it here.)

Si always has 4 bonds to O. As there are fewer O per Si, more O atoms need to be bridging.

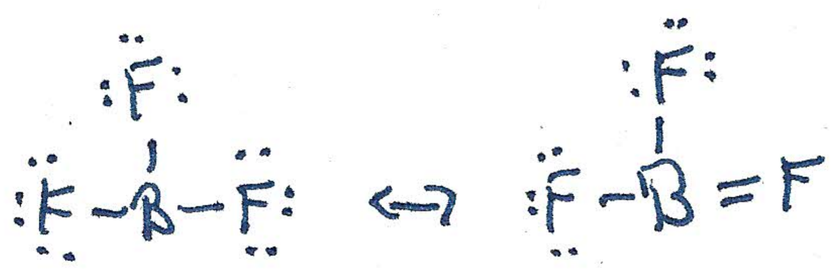
∴ more interlinked.

9. B_2H_6, BF_3, and Al_2Cl_6 are all: electron rich or electron deficient ← circle one

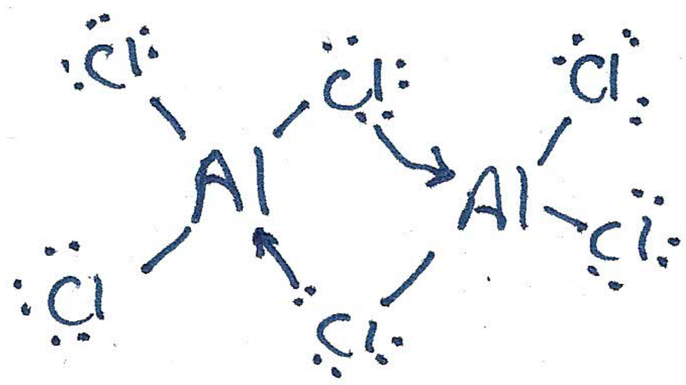
For each, tell how it handles, or alleviates its richness or deficiency:

B_2H_6 Form 3-center, 2-e⁻ bonds ~only 2 electrons!

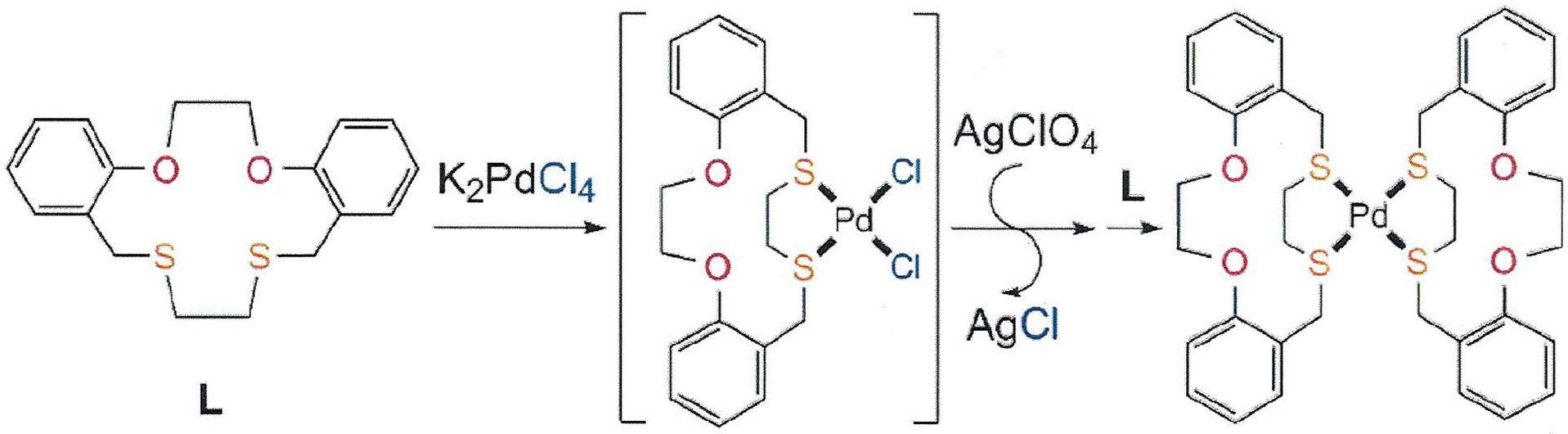
BF_3 Form weak pi bonds



Al_2Cl_6 Act as Lewis Acid + Lewis Base



10. In the current edition of the journal Inorganic chemistry, the following (unbalanced, as written) reaction takes place.



Given that both O and S have (unshown) lone electron pairs, what is the maximum *possible* denticity of the ligand L?

tetradentate (4)

For the compound in the middle:

What is the coordination number for Pd?

4

Describe the denticity of the ligands.

bidentate S-using L

two monodentate Cl ligands

For the compound on the far right:

What is the coordination number for Pd?

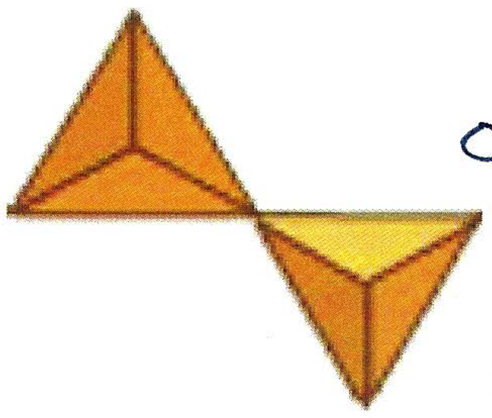
tetradentate (4)

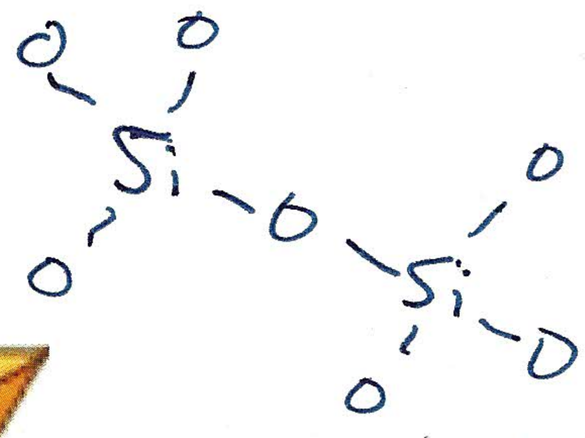
Describe the denticity of the ligands.

~~tetr~~ two bidentate S-using ligands

11. Draw the letter-line structure of this silicate.

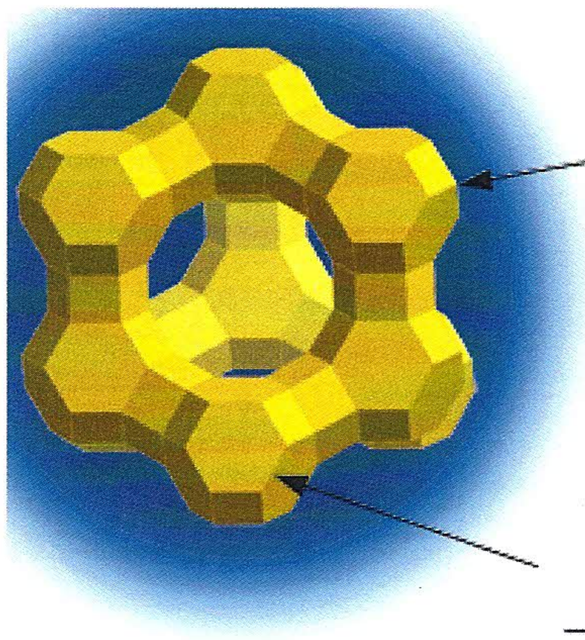
What is its charge?

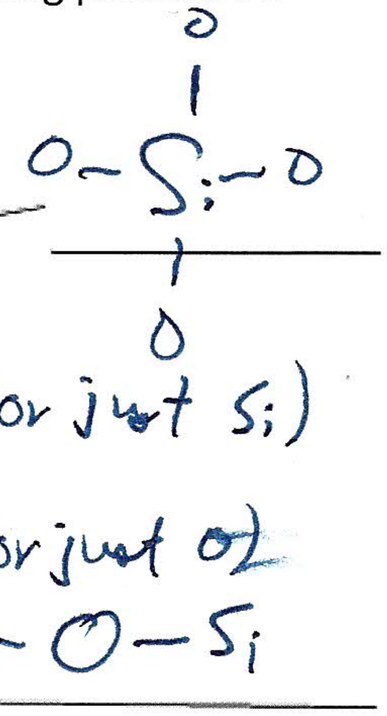




Charge = +8 − 14 = −6

12. This is a zeolite structure: what's being pointed at?





Chemistry 241-2009

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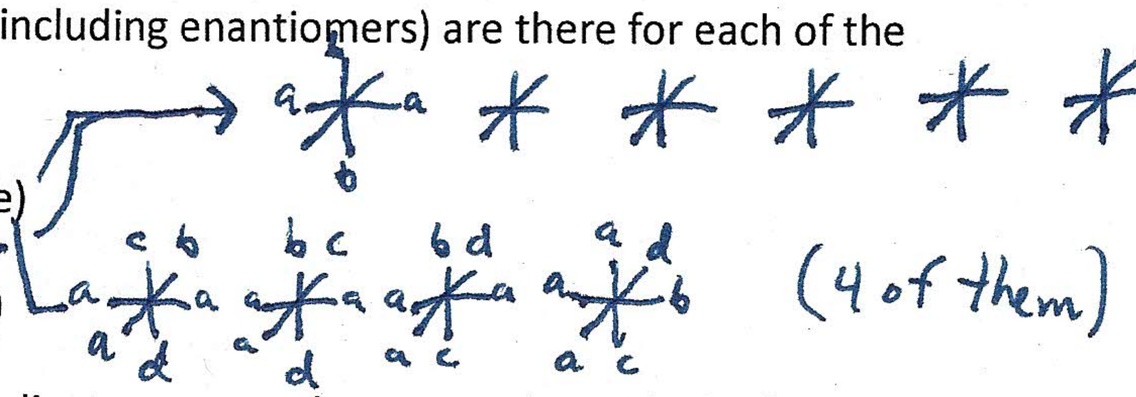
Exam #2, Take Home Portion

1. How many discrete octahedral isomers (not including enantiomers) are there for each of the following? Sketch them.

a. $[Pt(NH_3)_3ClBrI]^-$ (that last ligand is an iodine)

b. $[Pt(NH_3)_2Cl_2BrI]^{2-}$ (last ligand is again iodine)

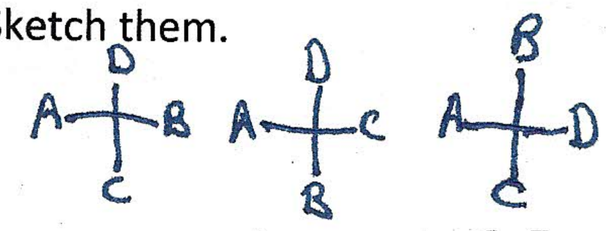
ab. pairs below



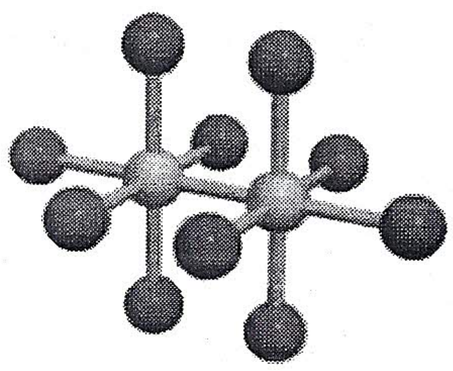
See below

(4 of them)

1c. How many isomers are possible for a 4-coordinate, square planar complex with the formula $[Pt(NH_3)ClBrI]^-$? Sketch them.

Three: 

2. What are all the symmetry elements for S_2F_{10}:



rotations: C_4, 4 different C_2

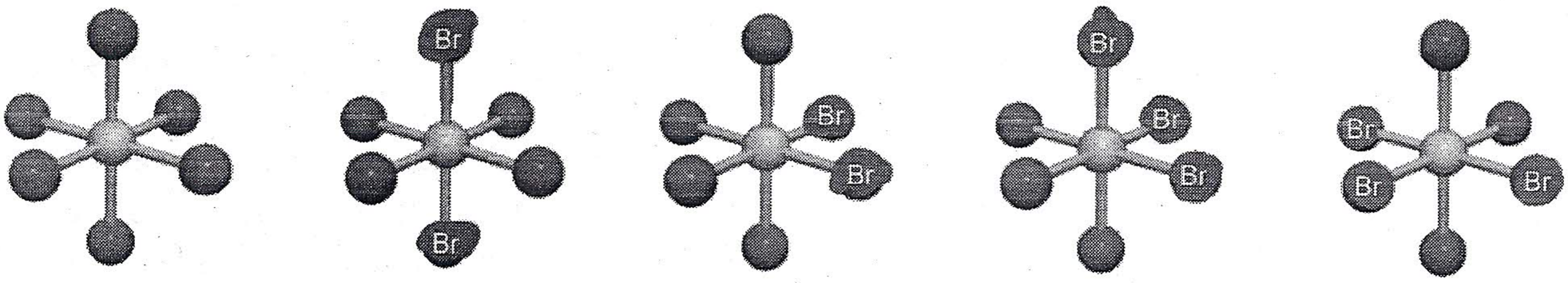
planes $4\sigma_v$ (actually $2\sigma_v + 2\sigma_d$) + σ_h

inversion center, i

identity, E

(+ ~~S_4~~ I won't count)

3. What are the point groups for the following:



SCl6 trans-SCl4Br2 cis-SCl4Br2 fac-SCl3Br3 mer-SCl3Br3

O_h D_{4h} C_{2v} C_{3v} C_{2v}

#1

①	②
aa	ab cd
aa	ac bd
aa	ad bc
ab	ac ad

①	②
aa	bb cd
aa	bc bd
ab	ab cd
ab	ac bd
ab	ad bc
ac	ad bb