# Answers - Problem Set 1

## Chapter 1

4
a) Se $[Ar]\ 4s^2\ 3d^{10}\ 4p^4$
b) $Se^{2-}$ $[Ar]\ 4s^2\ 3d^{10}\ 4p^6$
c) V $[Ar]\ 4s^2\ 3d^3$
d) $V^{2+}$ $[Ar]\ 3d^3$
e) Rh $[Kr]\ 4d^8\ 5s^1$
f) $Rh^{3+}$ $[Kr]\ 4d^5\ 5s^1$ or $[Kr]\ 4d^6$

12
a) Ge $[Ar]\ 4s^2\ 3d^{10}\ 4p^2$ → 2 unpaired $e^-$'s
b) Se $[Ar]\ 4s^2\ 3d^{10}\ 4p^4$ → 2 unpaired $e^-$'s
c) Co $[Ar]\ 4s^2\ 3d^7$ → 3
d) $Co^{2+}$ $[Ar]\ 3d^7$ → 3
e) Mo $[Kr]\ 5s^1\ 4d^5$ → 6
f) $Mo^{2+}$ $[Kr]\ 4d^4$ → 4
g) $Mo^{3+}$ $[Kr]\ 4d^3$ → 3

16 All 3 properties (size, stability, electronegativity) correlate with $Z_{eff}$.

$Z_{eff}$ for Ni is less than Cu or $Cu^{2+}$ → one less nuclear charge
$Z_{eff}$ for $Cu^{2+}$ is greater than Cu due to less screening electrons

$Z_{eff}$: $Cu^{2+} > Cu > Ni$
electronegativity: $Cu^{2+} > Cu > Ni$
stability: $Cu^{2+} > Cu > Ni$
size: $Ni > Cu > Cu^{2+}$

19. a) Unp: $[Rn]\,7s^2\,5f^{14}\,6d^3$

b) 115

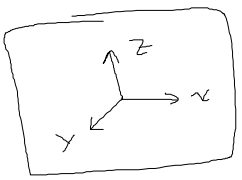
c) 119

20. In general, electronegativity decreases down a group so our first guess might be C > Si > Ge

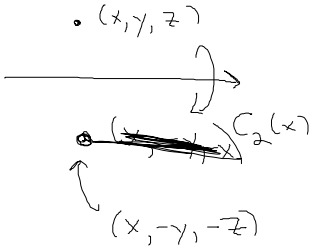
The inverted position of Si and Ge is the result that germanium possess a filled 3d subshell. The 3d electrons do not efficiently screen the nuclear charge that has been built up across the 3d elements causing a higher than anticipated $Z_{eff}$ for Ge. Thus, Ge turns out to be more electronegative than Si!

## Chapter 2

3.

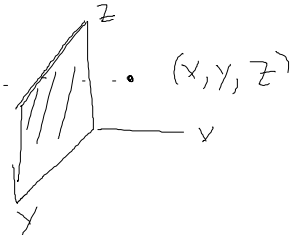


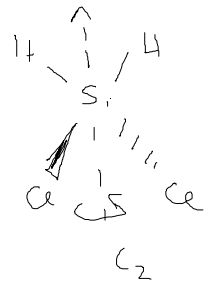

a)




b)


c)

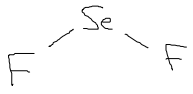


5. a) 

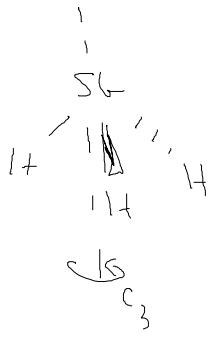
$C_{2v}$

b) Cl – Be – Cl $D_{\infty h}$

c) H – C ≡ N $C_{\infty v}$

d) 

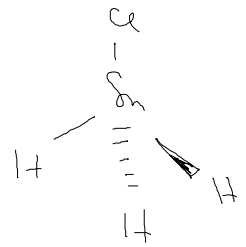
$C_{2v}$

e) 

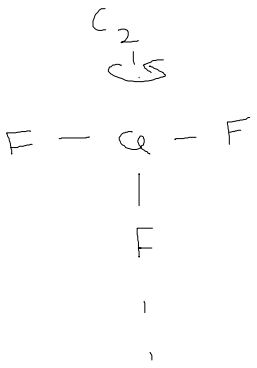
$C_{3v}$

f) 

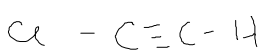
$C_s$

g) 

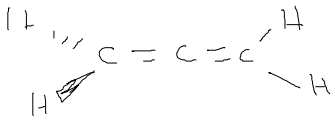
$C_{3v}$

h) 

$C_{2V}$

i) 

$C_{\infty V}$

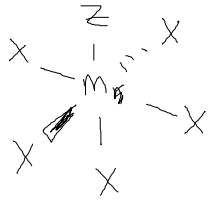
j) 

$D_{2d}$

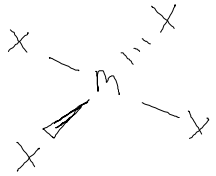
7.

a) 

$C_{4V}$

b) 

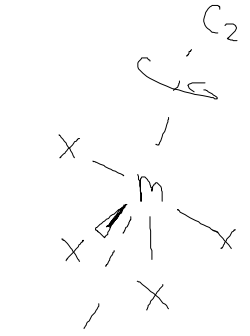
$C_{4V}$

c) 

$D_{4h}$

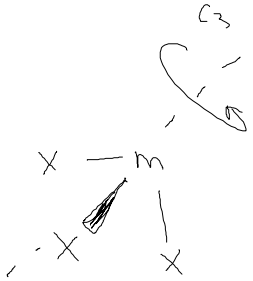
9.

a)



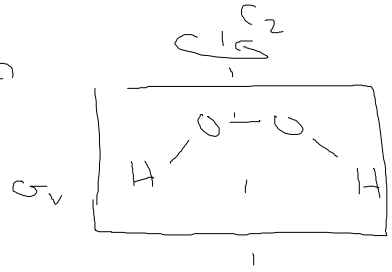

$C_{2v}$

b)



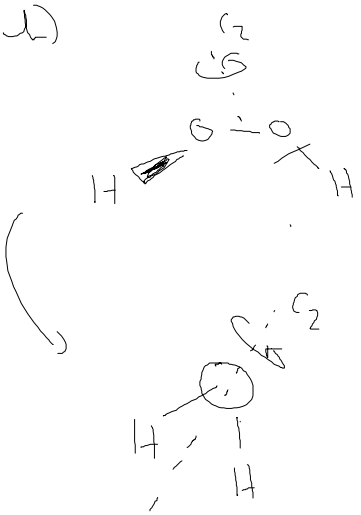

$C_{3v}$

c)




$C_{2v}$

d)




$C_2$

14.

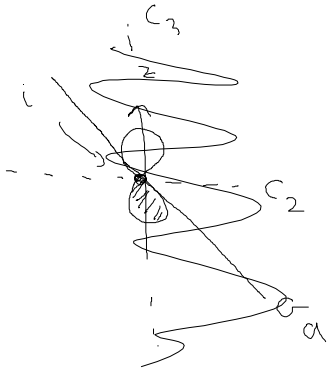
a) 12

b) $\Gamma_1 \rightarrow A_{1g}$
$\Gamma_2 \rightarrow A_{2g}$
$\Gamma_3 \rightarrow E_g$

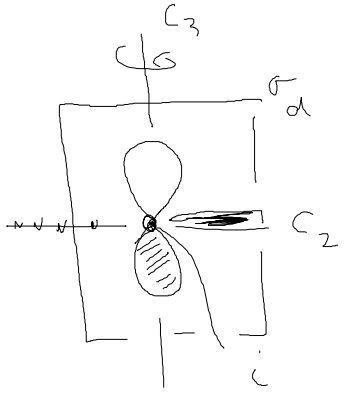
$\Gamma_4 \rightarrow A_{1u}$
$\Gamma_5 \rightarrow A_{2u}$
$\Gamma_6 \rightarrow E_u$

c)

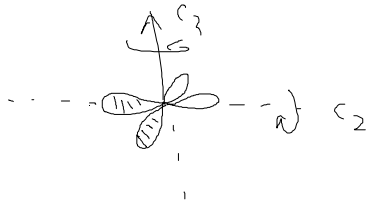
| | E | $2C_3$ | $3C_2$ | i | $2S_6$ | $3\sigma_d$ |
|---|---|---|---|---|---|---|
| $\Gamma_{P(z)}$ | 1 | 1 | −1 | −1 | −1 | 1 |




$\Gamma_{P(z)} = \Gamma_5 = A_{2u}$




d)




$p_x, p_y$ transform together (mixed by $C_3$ operation)

| | E | $2C_3$ | $3C_2$ | i | $2S_6$ | $3\sigma_d$ |
|---|---|---|---|---|---|---|
| $\Gamma_{(p_x,p_y)}$ = | 2 | −1 | 0 | −2 | 1 | 0 |

$= E_u$

See page 62 for explanation