Exam 4a
Chem 1141
Fall 2008

Name: KEY

MULTIPLE CHOICE. [3 pts ea.] Circle the best response.

Q1. How many valence electrons does an atom of carbon contain?
a) 1 b) 2 c) 3 d) 4 e) 5

Q2. How many core electrons does an atom of carbon contain?
a) 1 b) 2 c) 3 d) 4 e) 5

Q3. The electron configuration of S^{2-} is:
a) $1s^2$ b) $1s^22s^2$ c) $1s^22s^22p^63s^2$ d) $1s^22s^22p^63s^23p^6$ e) $1s^22s^22p^63s^23p^64s^2$

Q4. The relative sizes of carbon, oxygen, and selenium atoms would be:
a) C < O < Se b) Se < O < C c) O < Se < C d) Se < C < O e) O < C < Se

Q5. An element has the following ionization energies: I_1 = 212 kJ/mol, I_2 = 422 kJ/mol, I_3 = 630 kJ/mol, I_4 = 13100 kJ/mol. Which element is it be most likely to be?
a) Si b) Al c) Mg d) Na e) Ne

Q6. The chemical equation corresponding to the first electron affinity of sodium is:
a) $Na(g) \rightarrow Na^+(g) + e^-$
b) $Na(s) \rightarrow Na^+(aq) + e^-$
c) $e^- + Na(g) \rightarrow Na^-(g)$
d) $e^- + Na(s) \rightarrow Na^+(s)$

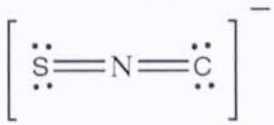
Q7. The total number of valence electrons in the NO^- anion is:
a) 16 b) 14 c) 12 d) 11 e) 10

Q8. The type of bond formed by the sharing of 2 electrons is:
a) Ionic b) Polar covalent c) single bond d) double bond e) triple bond

Q9. The number of lone pairs on a hydrogen sulfide molecule, H_2S is:
a) 0 b) 1 c) 2 d) 3 e) 4

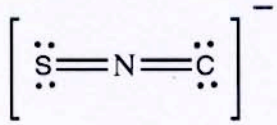
Q10. Which bond would be the most polar: C—N or C—O?
a) C—N b) C—O c) Impossible to tell

Q11. The formal charge on the sulfur atom in the following polyatomic ion is:



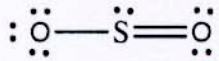
a) –2 b) –1 c) 0 d) +1 e) +2

Q12. The formal charge the nitrogen atom in the following polyatomic ion is:



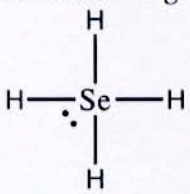
a) –2 b) –1 c) 0 d) +1 e) +2

Q13. The molecular geometry of the following molecule is:



a) Linear b) Bent c) Square Planar d) Tetrahedral e) Trigonal bipyramidal

Q14. The molecular geometry of the following molecule is:



a) Octahedral b) Bent c) See-saw d) Tetrahedral e) Trigonal bipyramidal

Short Response.

Show ALL work to receive credit. Use the conversion factor method for all problems to receive full credit.

Q15. [8 pts.] Write full electron configurations for the following ions:

a) Cr^+ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

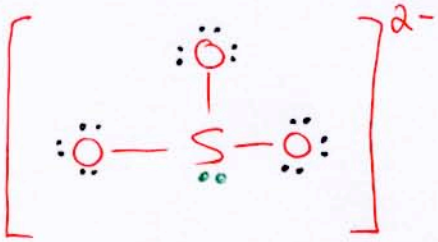
b) Mg^{2+} $1s^2 2s^2 2p^6$

c) V^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

d) O^{2-} $1s^2 2s^2 2p^6$

Q16. [6 pts.] Draw a valid Lewis structure for the sulfite ion, SO_3^{2-}

$6 + 3\times6 + 2 = 26$ valence e⁻s.

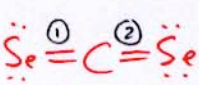


26
−6
20
−6
−6
−6
2e⁻
−2
0

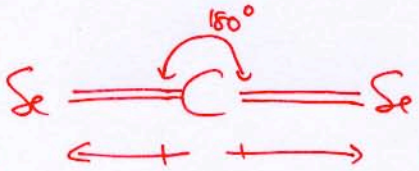
Q17. [6 pts.] Draw all possible resonance structures for S_3.

→ 3×6 = 18 e⁻

Q18. [6 pts.] Is CSe_2 polar or non-polar? Explain.

Lewis: 

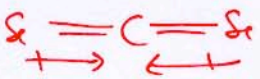
VSEPR: 2 repulsions ⇒ Linear.



if Se is more electronegative than C:

bond dipoles cancel out ⇒ NON-POLAR !

If C is more e/neg than Se



Bond dipoles cancel out ⇒ NON-POLAR

⇒ Must be a non-polar molecu

Q19. [9 pts.] Name the following compounds:

a) $Mg(NO_2)_2$ magnesium nitrate

b) FeO iron(II) oxide

c) $Na_2SO_4 \cdot 4H_2O$ Sodium sulfate tetrahydrate

Q20. [12 pts.] Predict the *molecular* geometry of H_2S using VSEPR theory. Be sure to include (1) a valid Lewis structure, (2) a sketch of the molecular geometry, (3) the name of the molecular geometry, and (4) approximate bond angles.

H_2S

$2\times1+1\times6=8$ valence e⁻s

⇒ LEWIS: H—S—H (S has two lone pairs)

VSEPR: H①—S②③—H ④

4 repulsions ⇒ e⁻ geom = tetrahedral!

molecular geometry = Bent

↑ where atoms are!

Q21. [6 pts.] 24.5 mL of 0.100 M $AgNO_3(aq)$ was mixed with 13.4 mL of 0.350 M $MgCl_2(aq)$. A white precipitate is formed which weighs 0.283 g. Calculate the percent yield of the reaction.

$2AgNO_{3(aq)} + MgCl_{2(aq)} \longrightarrow 2AgCl_{(s)} + Mg(NO_3)_{2(aq)}$

AgCl
1×Ag = 107.9
1×Cl = 35.45
143.4

$24.5\,mL \left| \frac{10^{-3}\,L}{mL} \right| \frac{0.100\,mol\,AgNO_3}{1\,L} \left| \frac{2\,mol\,AgCl}{2\,mol\,AgNO_3} \right| \frac{143.4\,g\,AgCl}{1\,mol\,AgCl} = 0.351\,g\,AgCl$

$13.4\,mL \left| \frac{10^{-3}\,L}{mL} \right| \frac{0.350\,mol\,MgCl_2}{1\,L} \left| \frac{2\,mol\,AgCl}{1\,mol\,MgCl_2} \right| \frac{143.4\,g\,AgCl}{1\,mol\,AgCl} = 1.35\,g\,AgCl$

$\%\ yield = \frac{0.283\,g}{0.351\,g} \times 100\% = \boxed{80.6\%}$

Q22. [5 pts.] One of the most commonly used white pigments in paint is a compound of titanium and oxygen that contains 59.9% Ti by mass. Determine the empirical formula of this compound.

100 g sample

$59.9\,g\,Ti \times \frac{1\,mol\,Ti}{47.88\,g\,Ti} = 1.25\,mol\,Ti$

$40.1\,g\,O \left| \frac{1\,mol\,O}{16.00\,g\,O} \right. = 2.51\,mol\,O$

$\frac{1.25\,mol\,Ti}{1.25} : \frac{2.51\,mol\,O}{1.25}$

$\Rightarrow 1.00\,Ti : 2.01\,O$

$\approx 1\,Ti : 2O$

$\Rightarrow TiO_2$

BONUS: (A) Predict $\Delta H°$ for the reaction:

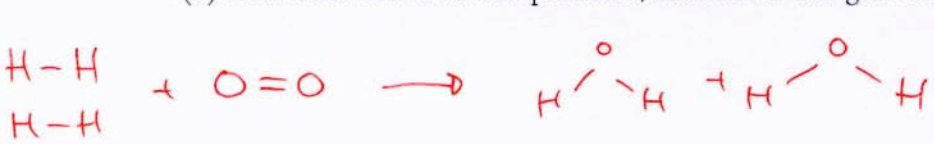
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

Given the following table of bond energies:

Type of Bond	Bond Energy / kJ mol^{-1}
H–H	436.4
O=O	498.7
O–H	460.

(B) How much heat would be produced/absorbed if 12.0 g of water was formed?

(a)



Break: $2 \times H-H + 1 \times O=O = \oplus 2 \times 436.4 \oplus 1 \times 498.7 = \oplus 1371.5\,kJ/mol$

Make: $4 \times O-H = \ominus 4 \times 460 = -1840\,kJ/mol$

$\Rightarrow \Delta H = +1371.5\,kJ/mol - 1840\,kJ/mol = -469\,kJ/mol$

(b) $12.0\,g\,H_2O \left| \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \right| \frac{-469\,kJ}{2\,mol\,H_2O} = -156\,kJ$ (released, exothermic!)

H_2O
$2 \times H = 2 \times 1.01 = 2.02$
$1 \times O = 1 \times 16.00 = 16.00$
18.02