Name_____ *Key* _____(print) Name _____(sign)
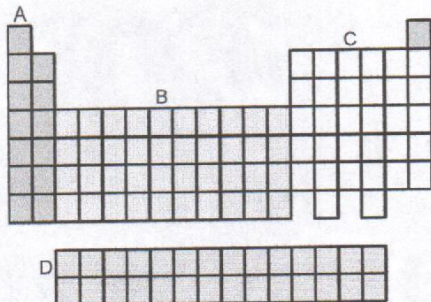Please show work for partial credit and full credit on the Short Answer Questions. Multiple choice questions have no partial credit.
Please write anything you want graded legibly. If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found. (Please count your exam pages and make sure there are   ### pages)

6

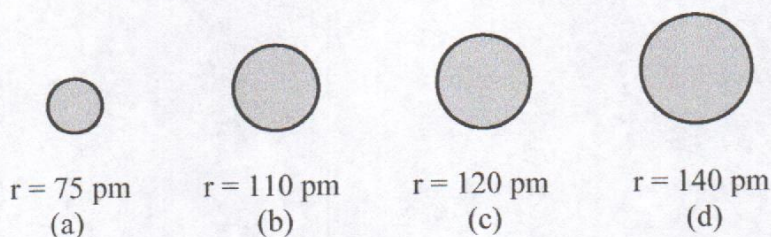## MULTIPLE CHOICE. Choose the one best alternative.

1) Which grouping of elements, indicated by letter on the periodic table above, represents the   1) __C__
   p–block elements?
   A) A   B) B   C) C   D) D

The spheres below represent atoms of Sb, As, P, and N (not necessarily in that order).

r = 75 pm   r = 110 pm   r = 120 pm   r = 140 pm
   (a)   (b)   (c)   (d)

*down group
bigger*

*N
P
As
Sb*

biggest

2) Which one of these spheres represents an atom of Sb?   2) __D__
   A) sphere (a)   B) sphere (b)   C) sphere (c)   D) sphere (d)

3) The greater the energy of light (a photon), the   3) __B__
   A) longer the wavelength and the higher the frequency.
   B) shorter the wavelength and the higher the frequency.
   C) shorter the wavelength and the lower the frequency.
   D) longer the wavelength and the lower the frequency.

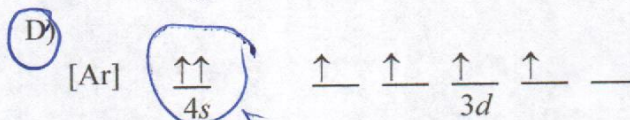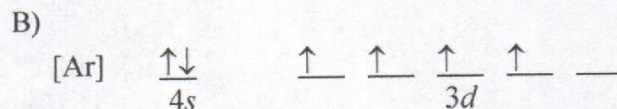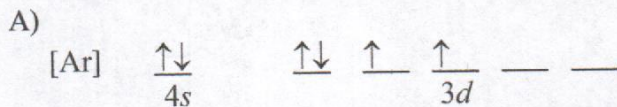$$E = h\nu$$

$$E = \frac{hc}{\lambda}$$

4) What ion is provided when Arrhenius bases dissolve in water?   4) __C__
   A) H+   B) Cl–   C) OH–   D) Na+

5) Which orbital–filling diagram violates the Pauli exclusion principle?   5) _D_

A)

[Ar]   ↑↓   ↑↓ ↑ ↑ __ __
       4s   3d

B)

[Ar]   ↑↓   ↑ ↑ ↑ ↑ __
       4s   3d

C)

[Ar]   ↑   ↑ ↑ ↑ ↑ ↑
       4s   3d

D)

[Ar]   ↑↑   ↑ ↑ ↑ ↑ __
       4s   3d

these have same #
all ē have to
have 4 different
quantum #

6) For an orbital, a node is   6) _D_
   A) the midpoint of the orbital.
   B) a surface inside which there is a 90% chance of finding the electron.
   C) a surface where there is a maximum probability of finding the electron.
   D) a surface where there is no chance of finding the electron.

gp. 6A

7) Which of the following **does not** have the same number of valence electrons?   7) _C_
   A) Po   B) O   C) Ca   D) S

gp. 2A

8) The symbol [Kr] represents   8) _D_
   A) $1s^22s^22p^63s^23p^64s^24p^6$.   B) $4s^24p^6$.
   C) $1s^22s^22p^63s^23p^63d^{10}4s^24p^64d^{10}$.   D) $1s^22s^22p^63s^23p^63d^{10}4s^24p^6$.

9) How many electrons can a single orbital hold?   9) _D_
   A) 8   B) $2l + 1$ C) $2n$ D) 2

10) What is the oxidation number of the sulfur atom in S_8?   10) _C_
   A) -2   B) +8   C) 0   D) +6
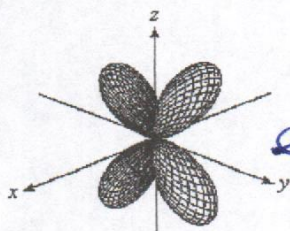
element

11) For the fourth–shell orbital shown below, what are the principal quantum number, n, and the angular momentum quantum number, l?   **11)** _C_

[handwritten: $n = 4$ (fourth shell) $n = 4$]
[handwritten: ← d sub shell – $\overset{0}{s}\,\overset{1}{p}\,\overset{2}{d}\,\overset{3}{f}$ $l = 2$]

A) $n = 4$ and $l = 0$ B) $n = 4$ and $l = 1$ C) $n = 4$ and $l = 2$ D) $n = 4$ and $l = 3$

12) An aqueous solution of H Cl is named   **12)** _C_

A) chlorous acid.   B) hydrochlorous acid.
C) hydrochloric acid.   D) chloric acid.

13) How many H+ ions can the acid, H_2CO_3, donate per molecule?   **13)** _C_

A) 0   B) 1   C) 2   D) 3

14) What is the ground–state valence–shell electron configuration of the group of elements indicated by the shaded portion of the periodic table?   **14)** _B_
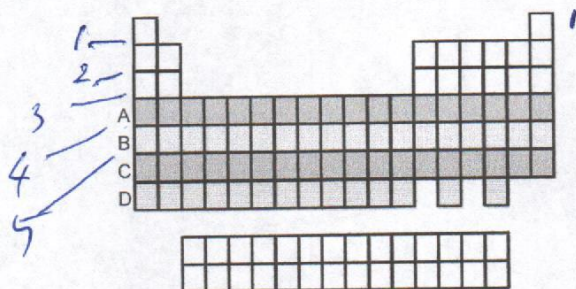
[handwritten: group 4 A]

A) ns^2 B) $ns^2 np^2$ C) $ns^2(n-1)d^2$ D) $ns^2(n-2)f^2$

15) Which period of elements, indicated by letter on the periodic table, has electrons whose highest principal quantum number n is 5?

15) **B**

A) A   B) **B**   C) C   D) D

16) Molybdenum has an anomalous electron configuration. Write the electron configuration of Mo using shorthand notation.

16) **D**

A) $[Kr]\ 5s^0\ 4d^6$

B) $[Kr]\ 5s^0\ 4d^0\ 5p^6$

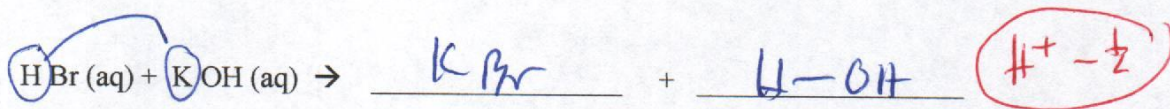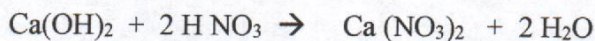C) $[Kr]\ 5s^2\ 4d^4$

D) $[Kr]\ 5s^1\ 4d^5$

normally expect

$[Kr]\ 5s^2,\ 4d^4$ but

stable ½ full $\underline{\underline{d}}$

Part II: Short Answers

1. Complete the following acid base reaction. (you do not need to balance the reaction) (5 pts)

H Br (aq) + K OH (aq) → ___K Br___ + ___H—OH___ $H^+ - \frac{1}{2}$

2. Given the following reaction equations: What volume of 0.325 M $Ca(OH)_2$ is needed to neutralize 72.5 mL of a 2.53 M $H NO_3$ solution ? Show work. (10 pts)

$Ca(OH)_2 + 2 H NO_3 \rightarrow Ca(NO_3)_2 + 2 H_2O$

$$72.5\,ml\;\frac{H NO_3}{} \times \frac{2.53\;mol\;HNO_3}{1000\;ml\;HNO_3\;soln} \times \frac{1\;mol\;Ca(OH)_2}{2\;mol\;HNO_3} \times \frac{1000\;ml\;CaOH_2\;soln}{0.325\;mol\;Ca(OH)_2}$$

2 pt   2 pt   2 pt   2 pt
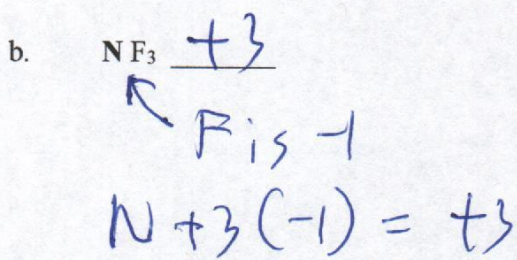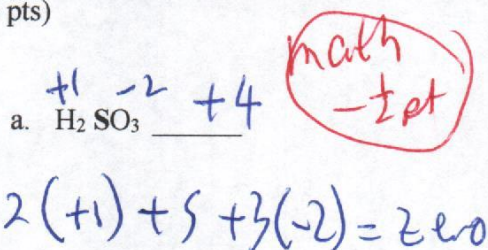
= 282.2 → S.f. 282 ml   2 pt

$$\frac{(72.5)(2.53)}{(0.325)} = 564\,ml$$ −2 pt

math − ½ pt

3. Assign the oxidation states of the following highlighted in bold. Briefly explain why you chose your number. If you need to do some algebra to get the oxidation state, please briefly SHOW your algebra. (6 pts)

a. $H_2 SO_3$ ___+4___   math −½ pt
$+1$ -2

$2(+1) + S + 3(-2) = zero$

b. $N F_3$ +3

F is −1

$N + 3(-1) = +3$

4. Given the oxidation states which I have provided, label as either (a) add electron or (b) remove electron (c) reduction or (d) oxidation (circle 2 parenthesis: (a) or (b) and (c) or (d) (4 pts)

[(a) add e OR (b) remove e] (circle one)
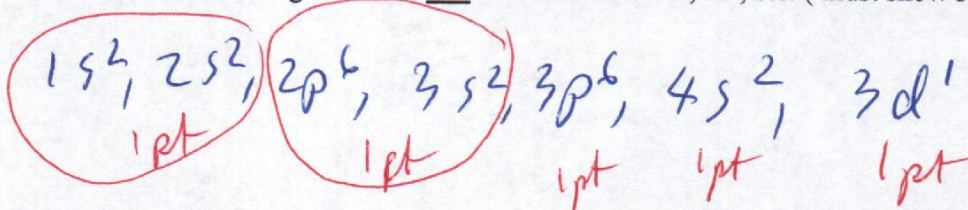
[(c) reduction OR (d) oxidation] (circle one)

$$2 Fe_2O_3 (s) + 3 C(s) \rightarrow 4 Fe(s) + 3 CO_2 (g)$$
$$\qquad\qquad\quad Zero \qquad\qquad\qquad\qquad +4$$
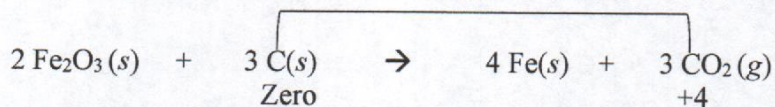
5. If $n = 5$ give ALL possible values of l ? (5 pts)
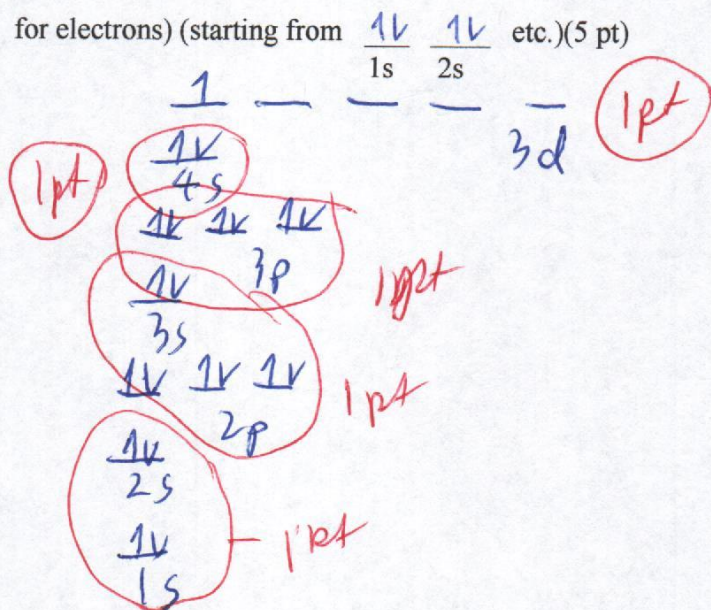
$$(l = 0 \text{ to } n-1) \quad l = 0, 1, 2, 3, 4$$

1 pt each

gave extra 1

6 a. Give the electron configuration of **Sc** in the format $1s^2, 2s^2$, etc. (must show starting with 1s) (5 pts)

$$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1$$
1pt *1pt* *1pt* *1pt* *1pt*

b. Give the **orbital filling diagram** for the element **Sc** using lines to represent orbitals (& arrows for electrons) (starting from ↑↓ ↑↓ etc.)(5 pt)
                            1s   2s

1 — — — — *1pt*
                    3d

↑↓
4s   *1pt*

↑↓ ↑↓ ↑↓
↑↓   3p   *1pt*
3s

↑↓ ↑↓ ↑↓
2p   *1pt*

↑↓
2s

↑↓   — *1pt*
1s

Name_____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found.   (Please count your exam pages and make sure there are #6 pages)   green

MULTIPLE CHOICE. Choose the one best alternative.

1) How many H+ ions can the acid, H_2CO_3, donate per molecule?   1) __C__

   A) 0   B) 1   C) 2   D) 3

2) For the fourth-shell orbital shown below, what are the principal quantum number, n, and the   2) __C__
   angular momentum quantum number, l?
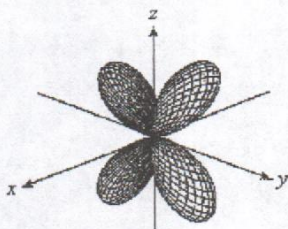
   A) $n = 4$ and $l = 0$ B) $n = 4$ and $l = 1$ C) $n = 4$ and $l = 2$ D) $n = 4$ and $l = 3$

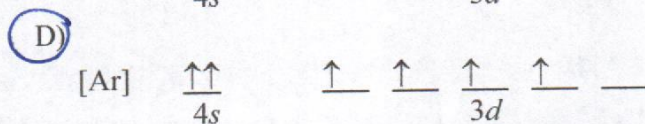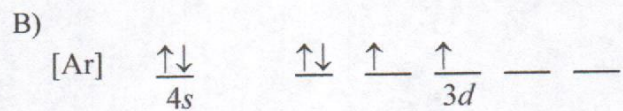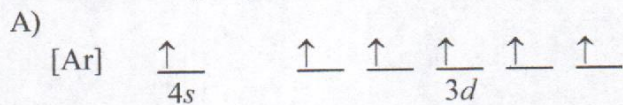3) What ion is provided when Arrhenius bases dissolve in water?   3) __A__

   A) OH–   B) Cl–   C) Na+   D) H+

4) The symbol [Kr] represents   4) __D__
   A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6$.   B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}$.
   C) $4s^2 4p^6$.   D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$.

5) Molybdenum has an anomalous electron configuration. Write the electron configuration of Mo   5) __C__
   using shorthand notation.
   A) [Kr] $5s^0 4d^6$ B) [Kr] $5s^2 4d^4$
   C) [Kr] $5s^1 4d^5$ D) [Kr] $5s^0 4d^0 5p^6$

6) Which orbital–filling diagram violates the Pauli exclusion principle? 6) **D**

A)
   [Ar] $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$
         $\overline{4s}$ $\overline{3d}$

B)
   [Ar] $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow$ $\uparrow$ __ __
         $\overline{4s}$ $\overline{3d}$

C)
   [Ar] $\uparrow\downarrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ __
         $\overline{4s}$ $\overline{3d}$

D)
   [Ar] $\uparrow\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ __
         $\overline{4s}$ $\overline{3d}$

7) For an orbital, a node is 7) **C**
   A) a surface inside which there is a 90% chance of finding the electron.
   B) the midpoint of the orbital.
   C) a surface where there is no chance of finding the electron.
   D) a surface where there is a maximum probability of finding the electron.

8) Which of the following **does not** have the same number of valence electrons? 8) **A**
   A) Ca   B) Po   C) S   D) O

9) Which grouping of elements, indicated by letter on the periodic table above, represents the 9) **C**
   p–block elements?
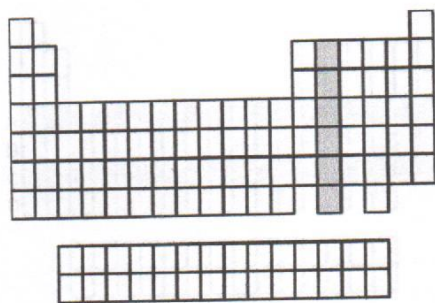   A) A   B) B   C) C   D) D

10) What is the ground–state valence–shell electron configuration of the group of elements indicated by the shaded portion of the periodic table?   10) _B_

A) ns^2 B) ns^2np^2 C) $ns^2(n-1)d^2$ D) $ns^2(n-2)f^2$

11) The greater the energy of light (a photon), the   11) _D_
    A) shorter the wavelength and the lower the frequency.
    B) longer the wavelength and the lower the frequency.
    C) longer the wavelength and the higher the frequency.
    D) shorter the wavelength and the higher the frequency.

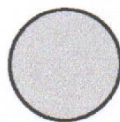The spheres below represent atoms of Sb, As, P, and N (not necessarily in that order).

r = 75 pm   r = 110 pm   r = 120 pm   r = 140 pm
    (a)   (b)   (c)   (d)

12) Which one of these spheres represents an atom of Sb?   12) _D_
    A) sphere (a)   B) sphere (b)   C) sphere (c)   D) sphere (d)

13) How many electrons can a single orbital hold?   13) _D_
    A) $2l + 1$ B) 2   C) $2n$ D) 8

14) What is the oxidation number of the sulfur atom in S_8?   14) _D_
    A) +6   B) -2   C) +8   D) 0

15) An aqueous solution of H Cl is named   15) _D_
    A) hydrochlorous acid.   B) chlorous acid.
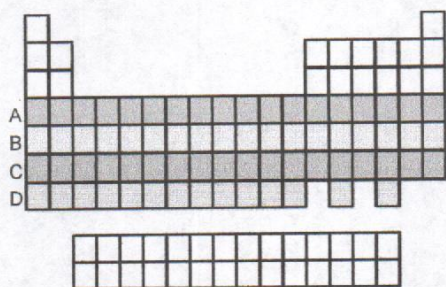   C) chloric acid.   D) hydrochloric acid.

16) Which period of elements, indicated by letter on the periodic table, has electrons whose highest principal quantum number n is 5?

16) ___B___
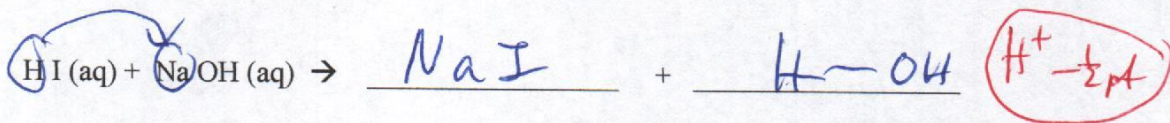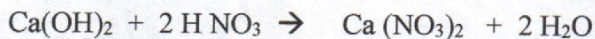
A) A   B) B   C) C   D) D

Part II: Short Answers

1. Complete the following acid base reaction. (you do not need to balance the reaction) (5 pts)

H I (aq) + Na OH (aq) → ___NaI___ + ___H−OH___ ⟨H^+ −2pt⟩

2. Given the following reaction equations: What volume of 1.52 M $Ca(OH)_2$ is needed to neutralize 250.2 mL of a 0.547 M $H NO_3$ solution? Show work. (10 pts)
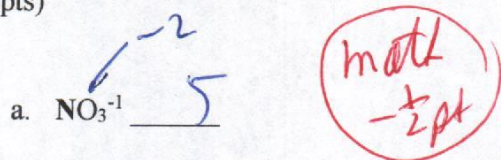
$Ca(OH)_2$ + 2 $H NO_3$ → $Ca(NO_3)_2$ + 2 H_2O

$$250.2 \, ml \times \frac{0.547 \, mol \, HNO_3}{1000 \, ml \, HNO_3} \times \frac{1 \, mol \, Ca(OH)_2}{2 \, mol \, HNO_3} \times \frac{1000 \, ml}{1.52 \, mol \, Ca(OH)_2}$$

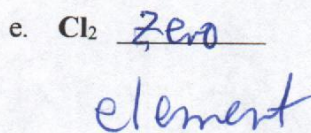2pt   2pt   2pt   Soln. $Ca(OH)_2$ 2pt

45.02 ml

2pt

$$\frac{(250.2)(0.547)}{(1.52)} = 90.04 \quad (-2pt)$$

3. Assign the oxidation states of the following highlighted in bold. Briefly explain why you chose your number. If you need to do some algebra to get the oxidation state, please briefly SHOW your algebra. (6 pts)
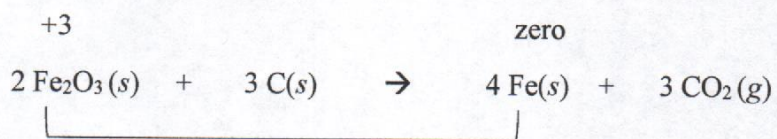
a. NO_3^{-1} ___5___   ⟨math −½pt⟩   e. Cl_2 ___zero___

$$N + 3(-2) = -1$$
$$N = 6 - 1$$

element

Dr. Hahn   General Chemistry I Lecture   Test 3   sect D   form B   Page 5

4. Given the oxidation states which I have provided, label as either (a) add electron or (b) remove electron (c) reduction or (d) oxidation (circle 2 parenthesis (a) or (b) and (c) or (d) (4 pts)

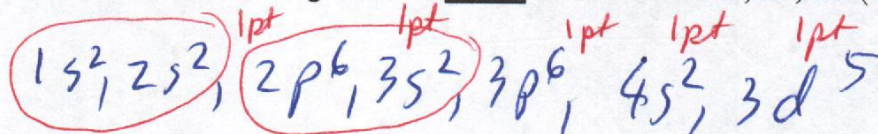+3   zero

$2 Fe_2O_3 (s)$ + $3 C(s)$ → $4 Fe(s)$ + $3 CO_2 (g)$

[(a) add e OR (b) remove e] (circle one)

[(c) reduction OR (d) oxidation] (circle one)

5. If n = 3   give ALL possible values of l ?   (5 pts)   *2 pt* *2 pt*
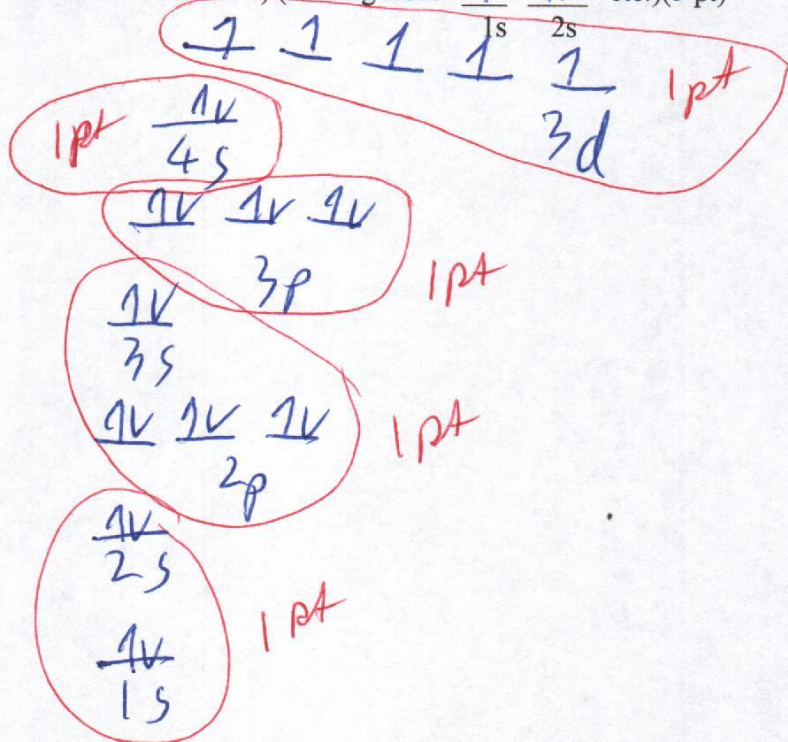
$l = 0$ to $n-1$ $l = 0, 1, 2$ — *1 pt*

(2)

6 a. Give the electron configuration of __Mn__ in the format $1s^2$, $2s^2$, etc. (must show starting with 1s) (5 pts)

$1s^2, 2s^2,$ *1pt* $2p^6, 3s^2,$ *1pt* $3p^6,$ *1pt* $4s^2,$ *1pt* $3d^5$ *1pt*

b. Give the **orbital filling diagram** for the element __Mn__ using lines to represent orbitals (& arrows for electrons) (starting from ↑↓ ↑↓ etc.)(5 pt)
                                                              1s   2s

↑ ↑ ↑ ↑   ↑
                    3d   *1pt*

1pt ↑↓
          4s

↑↓ ↑↓ ↑↓
        3p   *1pt*

↑↓
3s

↑↓ ↑↓ ↑↓   *1pt*
     2p

↑↓
2s

↑↓   *1pt*
1s

Name_____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions. Multiple choice questions have no partial credit.
Please write anything you want graded legibly. If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found. (Please count your exam pages and make sure there are   **#6** pages)

MULTIPLE CHOICE. Choose the one best alternative.

(handwritten: SO_2^{-2})

1) What is the oxidation number of the sulfur atom in SO_2?

    A) –2   B) +2   C) +4   D) –4

1) __C__

(handwritten: $S + 2(-2) = zero$, $S = +4$)
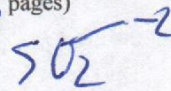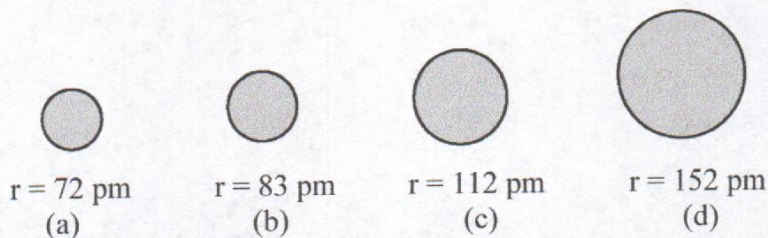
2) An aqueous solution of H Cl is named

    A) hydrochloric acid.   B) chlorous acid.
    C) chloric acid.   D) hydrochlorous acid.

2) __A__

The spheres below represent atoms of Li, Be, B, and F (not necessarily in that order).

(handwritten: period smaller across period F is smallest)

r = 72 pm   r = 83 pm   r = 112 pm   r = 152 pm
(a)   (b)   (c)   (d)

3) Which one of these spheres represents an atom of F?
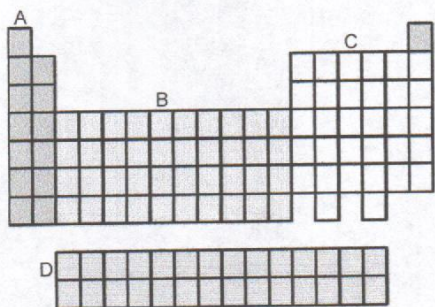
    A) sphere (a)   B) sphere (b)   C) sphere (c)   D) sphere (d)

3) __A__

4) The chemical formula for nitric acid is

    A) $H_2NO_3(aq)$.   B) $H_2NO_2(aq)$.   C) $HNO_3(aq)$.   D) $HNO_2(aq)$.

4) __C__

5) Which grouping of elements, indicated by letter on the periodic table above, represents the
d–block elements?

    A) A   B) B   C) C   D) D

5) __B__

$l = 0$ to $n-1$ (5)

6) How many subshells are there in the shell with $n = 6$? (how many l values are there for n=6)   6) __D__

    A) 36   B) 15   C) 5   D) 6

$0, 1, 2, 3, 4, 5$ — 6 subshells

7) The symbol [Kr] represents   7) __D__

    A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6$.   B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}$.

    C) $4s^2 4p^6$.   D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$.

8) Photochemists use electromagnetic radiation to initiate chemical reactions, often by providing the energy required to break bonds within a molecule. Lowering which of the following will result in electromagnetic radiation having more energy per photon?   8) __A__

    A) wavelength   B) amplitude   C) intensity   D) frequency

$E \alpha \frac{1}{\lambda}$

9) Which of the following compounds is **not** an Arrhenius acid?   9) __B__

    A) HF   B) KOH base   C) HClO   D) H_2SO_3

10) For an orbital, a node is   10) __A__

    A) a surface where there is no chance of finding the electron.

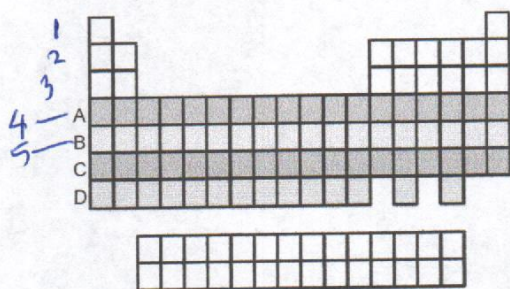   B) a surface inside which there is a 90% chance of finding the electron.

    C) the midpoint of the orbital.

    D) a surface where there is a maximum probability of finding the electron.

11) Which period of elements, indicated by letter on the periodic table, has electrons whose highest principal quantum number n is 5?   11) __B__

    A) A   B) B   C) C   D) D

12) The element Ga has how many valence electrons?   12) __C__
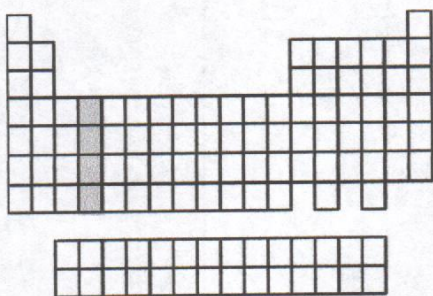
    A) 1   B) 2   C) 3   D) 4

group 3A

13) What is the ground-state valence-shell electron configuration of the group of elements indicated   13) __C__
by the shaded portion of the periodic table?

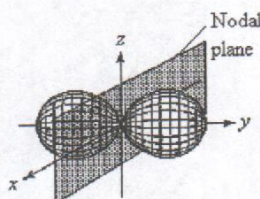A) ns^2 B) ns^2np^2 C) $ns^2(n-1)d^2$ D) $ns^2(n-2)f^2$

14) For the fourth-shell orbital shown below, what are the principal quantum number, n, and the   14) __B__
angular momentum quantum number, l?

$n = 4$ → $l = 1$

$\begin{array}{cccc} 0 & 1 & 2 & 3 \\ s & p & d & f \end{array}$

p subshell

Nodal plane

A) $n = 4$ and $l = 0$ B) $n = 4$ and $l = 1$ C) $n = 4$ and $l = 2$ D) $n = 4$ and $l = 3$
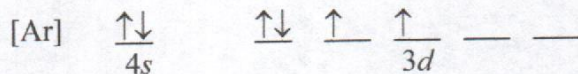
15) Which orbital-filling diagram represents the anomalous ground state of chromium (Cr)?   15) __D__
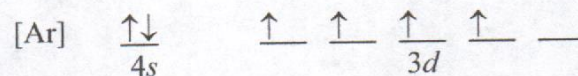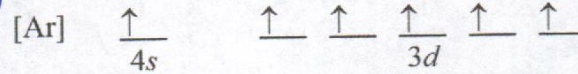
A)
[Ar]   ↑↓   ↑↓ ↑ ↑ __ __
       4s   3d

B)
[Ar]   ↑↑   ↑ ↑ ↑ ↑ __
       4s   3d

C)
[Ar]   ↑↓   ↑ ↑ ↑ ↑ __
       4s   3d

D)
[Ar]   ↑   ↑ ↑ ↑ ↑ ↑
       4s   3d

16) Which orbital–filling diagram violates Hund's rule?

A) ⊗

[Ar] $\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{}$ $\underline{}$
        $4s$ $3d$

should be

$\underline{\uparrow\downarrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{}$
$4s$ $3d$

B)

[Ar] $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$
        $4s$ $3d$

C)

[Ar] $\underline{\uparrow\downarrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{}$
        $4s$ $3d$

D)

[Ar] $\underline{\uparrow\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{\uparrow}$ $\underline{}$
        $4s$ $3d$

Part II: Short Answers

   1.   Complete the following acid base reaction.   (you do not need to balance the reaction)   (5 pts)

HF (aq) + LiOH (aq) → __LiF__ + __H–OH__   *(H⁺ –½)* $H^+ -\frac{1}{2}$

2.   Given the following reaction equations: What volume of 1.52 M Ba (OH)₂ is needed to neutralize 350.2 mL of a 0.256 M H Cl solution ?   Show work.   (10 pts)

$Ba(OH)_2 + 2\,HCl \rightarrow Ba\,Cl_2 + 2\,H_2O$

$$350.2\,mL\ \frac{HCl}{HCl\ Soln.} \times \frac{0.256\ mol\ HCl}{1000\,mL\ HCl\ soln.} \times \frac{1\ mol\ Ba(OH)_2}{2\ mol\ HCl} \times \frac{1000\,mL\ Ba(OH)_2\ soln.}{1.52\ mol\ Ba(OH)_2}$$

2pt   2pt   2pt   2pt

$$\frac{(0.256)(350.2)}{1.52} = 59.0$$ *(–2pt)*

29.5 mL *2pt*

3.   Assign the oxidation states of the following highlighted in bold.   Briefly explain why you chose your number.   If you need to do some algebra to get the oxidation state, please briefly SHOW your algebra.   (6 pts)

   a.   **Fe** __Zero__

element

   b. $\overset{+1}{H_3}\overset{-2}{PO_4}$ __+5__   *(wrong sign –½ pt)*

$$3(+1) + P + 4(-2) = zero$$

$$P = +5$$

gave 5–8 = –3 BA –1½

Dr. Hahn   General Chemistry I Lecture   Test 3   sect F   form A   Page 5

4. Given the oxidation states which I have provided, label as either (a) add electron or (b) remove electron (c) reduction or (d) oxidation (circle 2 parenthesis (a) or (b) and (c) or (d)   (4 pts)

[(a) add e OR   (b) remove e] (circle one)

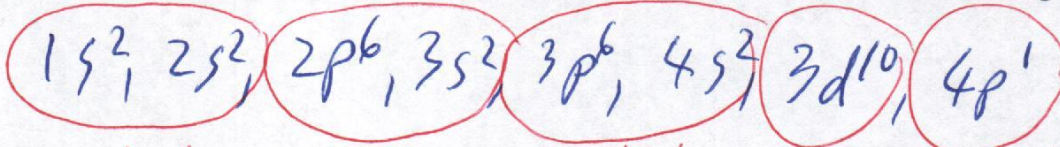[(c) reduction OR (d) oxidation] (circle one)

zero

$Fe(s)$ + $Cu^{2+}(aq)$ → $Fe^{2+}(aq)$ + $Cu(s)$
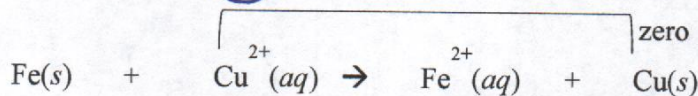
5. If $l = 2$ give ALL possible values of m_l? (5 pts) $m_e = -l \cdots +l$

$-2, -1, 0, +1, +2$

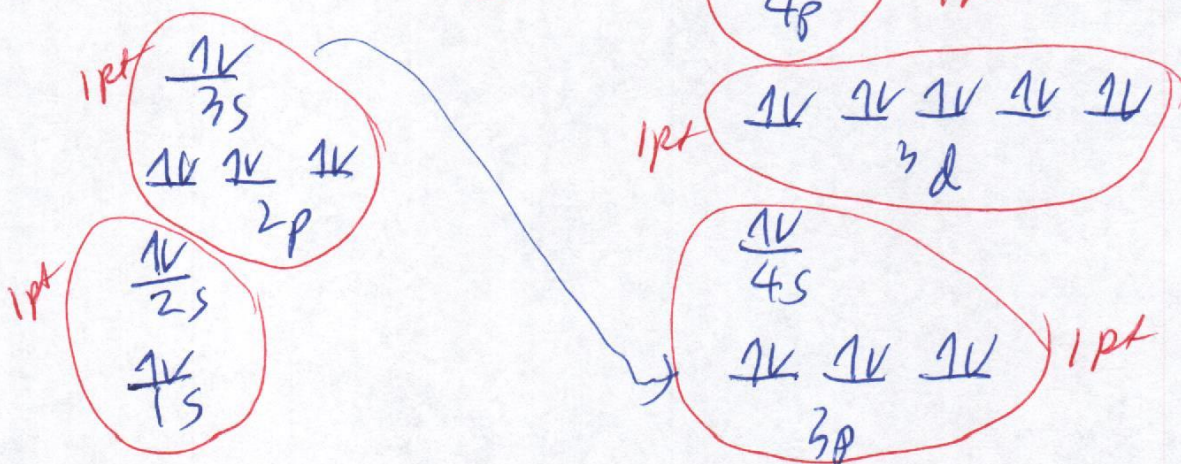(1 pt each)

5 a. Give the electron configuration of **Ga** in the format $1s^2$, $2s^2$, etc. (must show starting with 1s) (5 pts)

$1s^2, 2s^2,$ $2p^6, 3s^2$ $3p^6, 4s^2$ $3d^{10}, 4p^1$

1pt   1pt   1pt   1pt   1pt

b. Give the **orbital filling diagram** for the element **Ga** using lines to represent orbitals (& arrows for electrons) (starting from ↑↓ ↑↓ etc.)(5 pt)
                                              1s   2s

Graded consistent with @

1pt ↑↓
     3s

↑↓ ↑↓ ↑↓
    2p

1pt ↑↓
     2s

↑↓
1s

$\frac{1}{4p}$ 1pt

↑↓ ↑↓ ↑↓ ↑↓ ↑↓
         3d   1pt

↑↓
4s

↑↓ ↑↓ ↑↓ 1pt
    3p

Name_____(print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions.   Multiple choice questions have no partial credit.
Please write anything you want graded legibly.   If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found.   (Please count your exam pages and make sure there are   #6 pages)   *green*
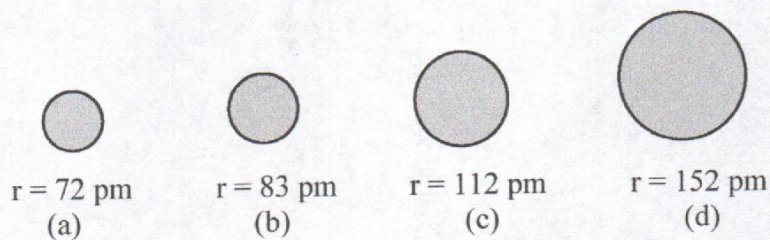
MULTIPLE CHOICE. Choose the one best alternative.

1) What is the ground–state valence–shell electron configuration of the group of elements indicated   1) __C__
   by the shaded portion of the periodic table?
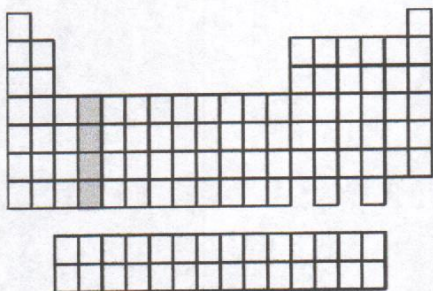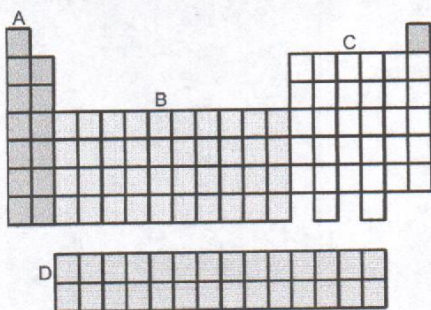
A) ns^2 B) ns^2np^2 C) $ns^2(n-1)d^2$ D) $ns^2(n-2)f^2$

The spheres below represent atoms of Li, Be, B, and F (not necessarily in that order).

r = 72 pm   r = 83 pm   r = 112 pm   r = 152 pm
  (a)   (b)   (c)   (d)

2) Which one of these spheres represents an atom of F?   2) __A__
   A) sphere (a)   B) sphere (b)   C) sphere (c)   D) sphere (d)

3) Which of the following compounds is **not** an Arrhenius acid?   3) __C__
   A) HClO   B) H_2SO_3 C) KOH   D) HF

4) Which grouping of elements, indicated by letter on the periodic table above, represents the *d*–block elements?

    A) A   B) B   C) C   D) D

4) __B__

5) The element Ga has how many valence electrons?

    A) 4   B) 2   C) 1   D) 3

5) __D__

6) For an orbital, a node is

    A) a surface inside which there is a 90% chance of finding the electron.

    B) a surface where there is a maximum probability of finding the electron.

    C) the midpoint of the orbital.

    D) a surface where there is no chance of finding the electron.

6) __D__

7) The symbol [Kr] represents

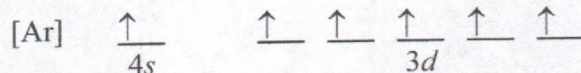   A) $1s^22s^22p^63s^23p^63d^{10}4s^24p^64d^{10}$.   B) $4s^24p^6$.

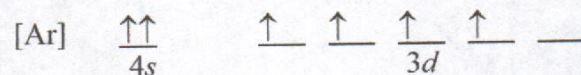   C) $1s^22s^22p^63s^23p^64s^24p^6$.   D) $1s^22s^22p^63s^23p^63d^{10}4s^24p^6$.

7) __D__
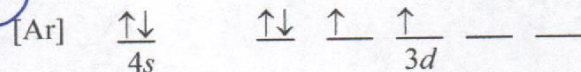
8) Which orbital–filling diagram violates Hund's rule?

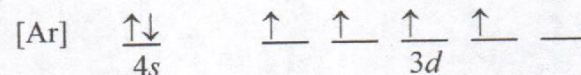A)

    [Ar]   ↑   ↑ ↑ ↑ ↑ ↑
           4s   3d

B)

    [Ar]   ↑↑   ↑ ↑ ↑ ↑ __
           4s   3d

C)

    [Ar]   ↑↓   ↑↓ ↑ ↑ __ __
           4s   3d

D)

    [Ar]   ↑↓   ↑ ↑ ↑ ↑ __
           4s   3d

8) __C__

9) An aqueous solution of H Cl is named   9) _D_

    A) hydrochlorous acid.   B) chloric acid.

    C) chlorous acid.   D) hydrochloric acid.

10) Which orbital–filling diagram represents the anomalous ground state of chromium (Cr) ?   10) _A_

    A) [Ar] ↑ (4s)   ↑ ↑ ↑ ↑ ↑ (3d)

    B) [Ar] ↑↑ (4s)   ↑ ↑ ↑ ↑ _ (3d)

    C) [Ar] ↑↓ (4s)   ↑ ↑ ↑ ↑ _ (3d)

    D) [Ar] ↑↓ (4s)   ↑↓ ↑ ↑ _ _ (3d)

11) What is the oxidation number of the sulfur atom in SO_2?   11) _C_

    A) +2   B) –2   C) +4   D) –4

12) Photochemists use electromagnetic radiation to initiate chemical reactions, often by providing the   12) _C_
energy required to break bonds within a molecule. Lowering which of the following will result in
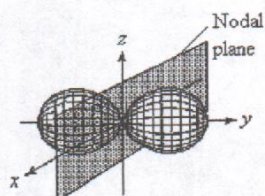electromagnetic radiation having more energy per photon?

    A) intensity   B) frequency   C) wavelength   D) amplitude

13) For the fourth–shell orbital shown below, what are the principal quantum number, n, and the   13) _B_
angular momentum quantum number, l?

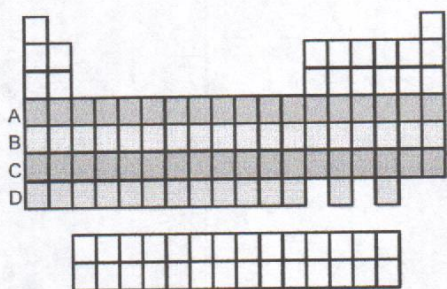   A) $n = 4$ and $l = 0$ B) $n = 4$ and $l = 1$ C) $n = 4$ and $l = 2$ D) $n = 4$ and $l = 3$

14) Which period of elements, indicated by letter on the periodic table, has electrons whose highest principal quantum number n is 5?

14) _B_

A) A   B) B   C) C   D) D

15) How many subshells are there in the shell with $n = 6$? (how many l values are there for n=6)

15) _C_

A) 5   B) 15   C) 6   D) 36

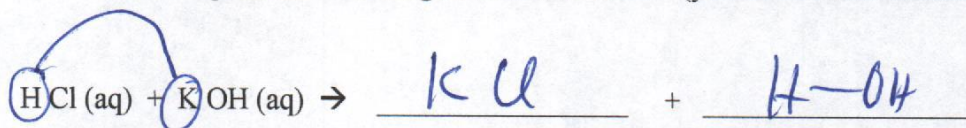16) The chemical formula for nitric acid is

16) _A_

A) $HNO_3(aq)$.   B) $H_2NO_3(aq)$.   C) $HNO_2(aq)$.   D) $H_2NO_2(aq)$.

Part II: Short Answers

1. Complete the following acid base reaction. (you do not need to balance the reaction) (5 pts)

HCl (aq) + KOH (aq) → _____ KCl _____ + _____ $H-OH$ _____

2. Given the following reaction equations: What volume of 5.25 M Ba (OH)₂ is needed to neutralize 92.5 mL of a 5.72 M H Cl solution? Show work. (10 pts)

$Ba(OH)_2 + 2 H Cl → Ba Cl_2 + 2 H_2O$

2pt

$92.5 \, mL \times$

$\dfrac{HCl}{soln.}$

2pt

$\dfrac{5.72 mol \, HCl}{1000 ml \, HCl \, soln.} \times$

2pt

$\dfrac{1 mol \, Ba(OH)_2}{2 mol \, HCl} \times$

Soln.
Ba(OH)₂ 2pt

$\dfrac{1000 ml}{5.25 mol} =$

$Ba Cl_2$ 50.4 mL

2pt

$\dfrac{(92.5)(5.72)}{(5.25)} = 100.8$ —2pt

3. Assign the oxidation states of the following highlighted in bold. Briefly explain why you chose your number. If you need to do some algebra to get the oxidation state, please briefly SHOW your algebra. (6 pts)

a. **H** Cl _____ +1

-1

gp. 1A

(+1)

b. S **O₄**⁻² _____ +6

-2

NO -1↓

$S + (-2)4 = -2$

$S = +6$

4. Given the oxidation states which I have provided, label as either (a) add electron or (b) remove electron (c) reduction or (d) oxidation (circle 2 parenthesis (a) or (b) and (c) or (d) (4 pts)

Zero

$Fe(s)$ + $Cu^{2+}(aq)$ → $Fe^{2+}(aq)$ + $Cu(s)$
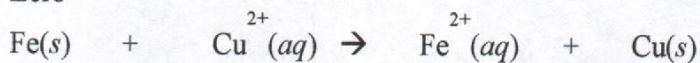
[(a) add e OR (b) remove e] (circle one)

[(c) reduction OR (d) oxidation] (circle one)

5. If $l = 3$ what are the possible values of m_l?   (5 pts) $m_l = -l \cdots +l$

$-3, -2, -1, 0, +2, +3$ (gave 0 to 3)
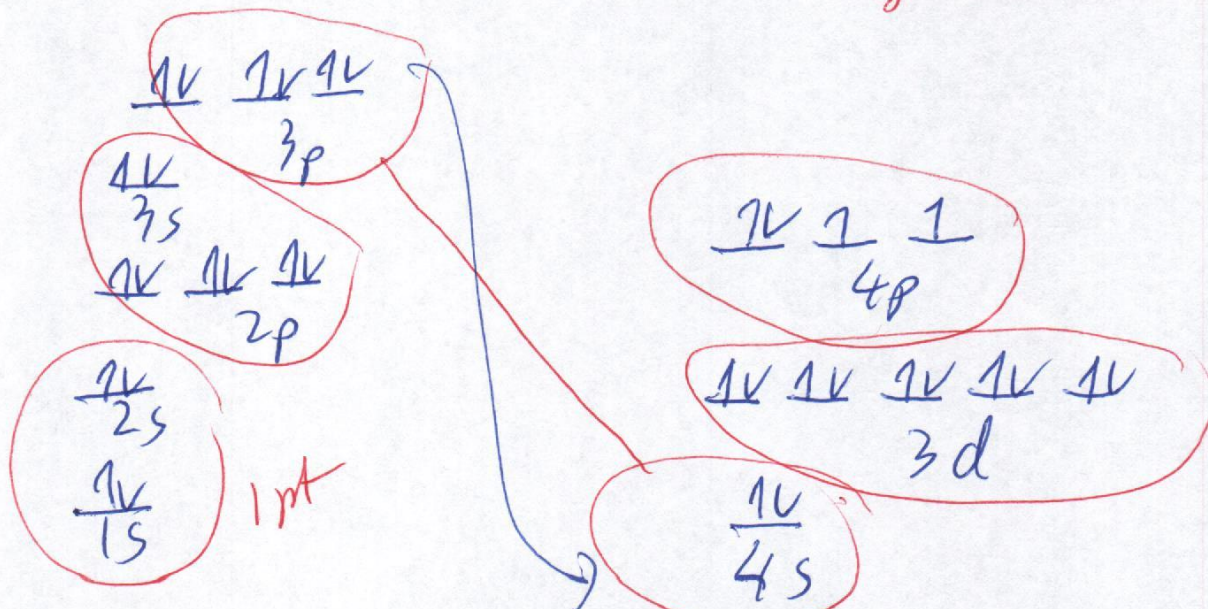 $-2\frac{1}{2}$

6 a. Give the electron configuration of **Se** in the format $1s^2, 2s^2$, etc. (must show starting with 1s) (5 pts)

$1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^4$

1 pt.

b. Give the **orbital filling diagram** for the element   **Se**   using lines to represent orbitals (& arrows for electrons) (starting from ↑↓ ↑↓ etc.)(5 pt)
                                                              1s   2s

graded Consistent

↑↓ ↑↓ ↑↓
      3p

↑↓
3s

↑↓ ↑↓ ↑↓
     2p

↑↓
2s

↑↓   1 pt
1s

↑↓ ↑ ↑
     4p

↑↓ ↑↓ ↑↓ ↑↓ ↑↓
        3d

↑↓
4s

Name _____*Key*_____ (print) Name _____(sign)
Please show work for partial credit and full credit on the Short Answer Questions. Multiple choice questions have no partial credit.
Please write anything you want graded legibly. If you run out of space, continue on the empty back pages but clearly label where the
remaining answers can be found. (Please count your exam pages and make sure there are   ~~8~~ 6 pages)

MULTIPLE CHOICE. Choose the one best alternative.

The spheres below represent atoms of Sb, As, P, and N (not necessarily in that order).
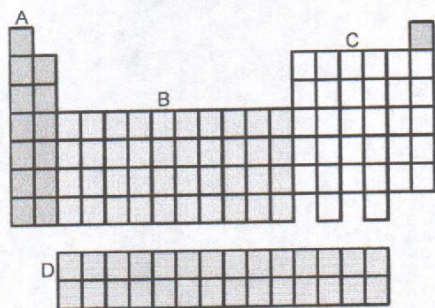
r = 75 pm   r = 110 pm   r = 120 pm   r = 140 pm
   (a)   (b)   (c)   (d)
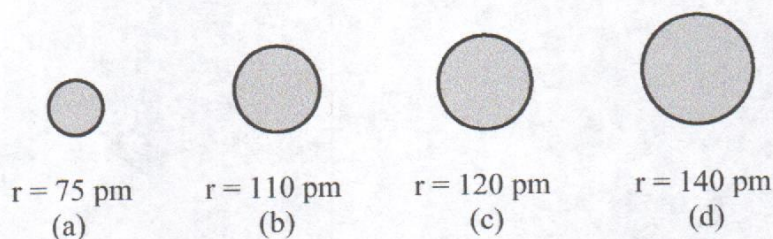
bigger down group
N
P
As
Sb — *biggest*

1) Which one of these spheres represents an atom of Sb?   1) __D__
     A) sphere (a)   B) sphere (b)   C) sphere (c)   D) sphere (d)

2) Which grouping of elements, indicated by letter on the periodic table above, represents the   2) __A__
     s–block elements?
     A) A   B) B   C) C   D) D

3) Which of the following is **not** a strong acid?   3) __B__
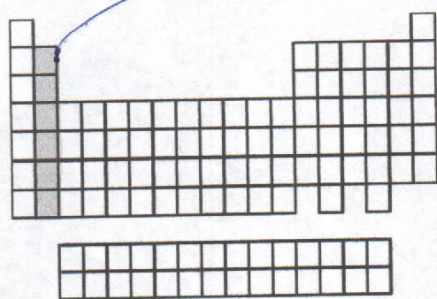   A) HBr   B) HF   C) HCl   D) HI

only
weak acid in HX halogen
acids

4) What is the ground–state valence–shell electron configuration of the group of elements indicated by the shaded portion of the periodic table?   4) __A__

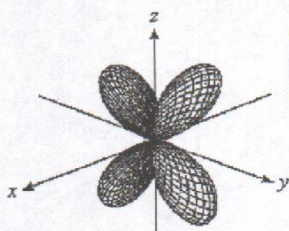*(handwritten: group 2A)*

A) ns^2　　　　B) ns^2np^2　　　　C) $ns^2(n-1)d^2$　　　　D) $ns^2(n-2)f^2$

(A is circled)

5) For the fourth–shell orbital shown below, what are the principal quantum number, n, and the angular momentum quantum number, l?   5) __C__

(handwritten: d subshell; $n = 4 =$ shell; s p d f; 0 1 2 3; $l = 2$)
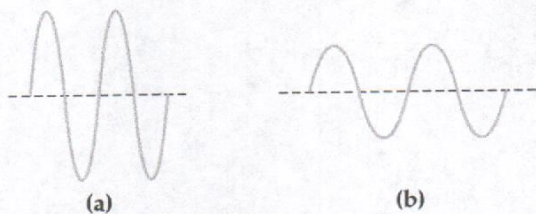
A) $n = 4$ and $l = 0$　　　　B) $n = 4$ and $l = 1$　　　　C) $n = 4$ and $l = 2$　　　　D) $n = 4$ and $l = 3$

(C is circled)

Two electromagnetic waves are represented below.

(a)　　　　　　　　(b)

6) Wave (a) has the   6) __B__
　　A) shorter wavelength and lower energy than wave (b).
　　B) shorter wavelength and higher energy than wave (b).
　　C) longer wavelength and lower energy than wave (b).
　　D) longer wavelength and higher energy than wave (b).

(B is circled)

7) Molybdenum has an anomalous electron configuration. Write the electron configuration of Mo using shorthand notation.   7) __A__
　　A) [Kr] $5s^1 4d^5$　　　　B) [Kr] $5s^0 4d^6$
　　C) [Kr] $5s^2 4d^4$　　　　D) [Kr] $5s^0 4d^0 5p^6$

(A is circled)

(handwritten: mo is normally $5s^2, 4d^4$ — stable half filled d)

8) Which of the following **does not** have the same number of valence electrons?

A) Ca *(handwritten: grp.2A)*

B) S *(circled handwritten: grp. 6A)*

C) Po *(handwritten: element)*

D) O

8) _A_

9) What is the oxidation number of the sulfur atom in S_8?

A) 0

B) -2

C) +6

D) +8

9) _A_

10) An aqueous solution of H Cl is named

A) chloric acid.

B) hydrochloric acid.

C) chlorous acid.

D) hydrochlorous acid.

10) _B_

11) For an orbital, a node is

A) a surface inside which there is a 90% chance of finding the electron.

B) a surface where there is no chance of finding the electron.

C) the midpoint of the orbital.

D) a surface where there is a maximum probability of finding the electron.

11) _B_

12) Which period of elements, indicated by letter on the periodic table, has electrons whose highest principal quantum number n is 5?

12) _B_
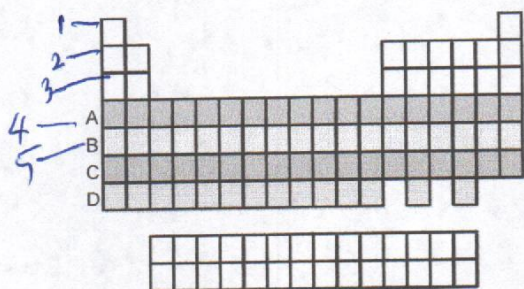
A) A

B) B

C) C

D) D

13) The symbol [Kr] represents

A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6$.

B) $4s^2 4p^6$.

C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$.

D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10}$.

13) _C_

14) Which orbital–filling diagram violates Hund's rule?   14) _B_

A)

[Ar] $\uparrow\downarrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ __
      4s   3d

B)

[Ar] $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow$ $\uparrow$ __   __   → should be $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ __
      4s   3d   3d

C)

[Ar] $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$
      4s   3d

D)

[Ar] $\uparrow\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ $\uparrow$ __
      4s   3d

15) The number of orbitals in a given subshell, such as the 5d subshell, is determined by the number   15) _B_
of possible values of
   A) n.   B) m_l.   C) l.   D) m_s.
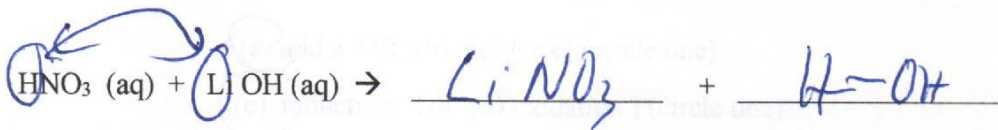
16) How many H+ ions can the acid H3PO4 donate per molecule?   16) _D_
   A) 0   B) 1   C) 2   D) 3

$n = 5, \ l = d^2, \ m_l = -2, -1, 0, +1, +2$

$\underset{0 \ 1 \ 2}{s \ p \ d}$ 5d orbitals

Part II: Short Answers

1.   Complete the following acid base reaction.   (you do not need to balance the reaction)   (5 pts)

HNO_3 (aq) + L OH (aq) → $Li NO_3$ + $H-OH$

2.   Given the following reaction equations: What volume of 2.53 M Na OH is needed to neutralize 523.1 mL of a 0.367 M $H_2 SO_4$ solution ?   Show work.   (10 pts)

$2 Na OH + H_2 SO_4 → Na_2 SO_4 + 2 H_2O$

$$523.1 ml \times \frac{0.367\, mol\; H_2SO_4}{1000\, ml\; H_2SO_4} \times \frac{2\, mol\; NaOH}{1\, mol\; H_2SO_4} \times \frac{1000\, ml\; NaOH}{2.53\, mol\; NaOH}$$

2pt   2pt   2pt   NaOH 2pt

$$\frac{(523.1)(0.367)}{2.53} = 75.9\; ml$$

= 152 ml
2pt

-2pt   BA-5 pt

3.   Assign the oxidation states of the following highlighted in bold.   Briefly explain why you chose your number.   If you need to do some algebra to get the oxidation state, please briefly SHOW your algebra.   (6 pts)
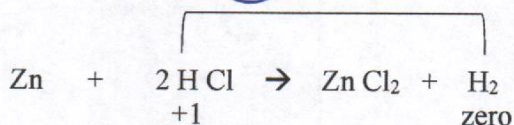
a. H_2 $zero$
     element

BA-1½

b. $\overset{+1\;\; -2}{H N O_3}$ $+5$

$+1 + N + 3(-2) = zero$
$N = +5$

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4. Given the oxidation states which I have provided, label as either (a) add electron or (b) remove electron (c) reduction or (d) oxidation (circle 2 parenthesis (a) or (b) and (c) or (d)   (4 pts)

[(a) add e OR (b) remove e] (circle one)

[(c) reduction   OR (d) oxidation] (circle one)

Zn   +   2 H Cl → Zn Cl$_2$ + H$_2$
                +1   zero

5.   If n = 6   give ALL possible values of l ?   (5 pts) $l = 0$ to n-1

0, 1, 2, 3, 4, 5

1 pt   1 pt

6 a. Give the electron configuration of **Br** in the format 1s^2, 2s^2, etc. (must show starting with 1s) (5 pts)

1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4p^5

1 pt

b. Give the **orbital filling diagram** for the element **Br** using lines to represent orbitals (& arrows for electrons) (starting from ↑↓ ↑↓ etc.)(5 pt)
                                                              1s   2s

↑↓ ↑↓ ↑↓
        3p

↑↓
3s

↑↓ ↑↓ ↑↓
        2p

↑↓
2s

↑↓
1s

↑↓ ↑↓ ↑
        4p

↑↓ ↑↓ ↑↓ ↑↓ ↑↓
              3d   1 pt

↑↓
4s