* Enter your answers on the bubble sheet. Turn in all sheets. *

This exam is composed of 25 questions on 4 pages (in addition to this cover page).

Go initially through the exam and answer the questions you can answer quickly. Then go back and try the ones that are more challenging to you and/or that require calculations.

As discussed in the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.

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Some common ions:
- \( \text{PO}_4^{3-} \)
- \( \text{CN}^- \)
- \( \text{CH}_3\text{CO}_2^- \)
- \( \text{NO}_2^- \)
- \( \text{NO}_3^- \)
- \( \text{CO}_3^{2-} \)
- \( \text{SO}_3^{2-} \)
- \( \text{SO}_4^{2-} \)

\[ E = \frac{\hbar c}{\lambda} \]
\[ E_n^H\text{-atom} = -\frac{R_H\hbar c}{n^2} \]
1 mL = 1 cm³

\[ h = 6.626 \times 10^{-34} \text{ J s} \]
\[ c = 2.9998 \times 10^8 \text{ m s}^{-1} \]
\[ N = 6.022 \times 10^{23} \text{ mol}^{-1} \]
\[ R_H = 1.097 \times 10^7 \text{ m}^{-1} \]

PERIODIC TABLE OF THE ELEMENTS

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<th>2A</th>
<th>3B</th>
<th>4B</th>
<th>5B</th>
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<td>Uno</td>
<td>108</td>
<td>Une</td>
<td>109</td>
</tr>
</tbody>
</table>

* Update 10/26 ____________________
Identify the choice that best completes the statement or answers the question.

1. Which element is represented by: 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^6\) 3d\(^{10}\) 4s\(^2\) 4p\(^5\)
   a) I   b) Po   c) Te   d) At   e) Br

2. The correct spectroscopic notation for phosphorous ion (P\(^{2-}\)) is:
   a) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^6\)  d) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^5\)
   b) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^2\)  e) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^4\)
   c) 1s\(^2\) 2s\(^2\) 2p\(^6\) 3s\(^2\) 3p\(^3\)

3. How many valence electrons are in the P atom?
   a) 4   b) 6   c) 5   d) 10   e) 0

   1s\(^2\) 2s\(^2\) 2p\(^2\) 3s\(^2\) 3p\(^3\)  \(n=3\) is the valence level. It has 5 valence electrons

4. Which of the following has the shortest bond length?
   a) SiH\(_4\)   b) PH\(_3\)   c) HCl   d) AlH\(_3\)   e) H\(_2\)S

   Cl is the smallest of Al, Si, P, S, and Cl

5. Consider the molecule AsO\(_4\)\(^x\), where \(x\) is the charge on the molecule. Which value of \(x\) (the net charge on the molecule) yields the most stable molecule? (Hint: draw Lewis structures to figure this one out)
   a) 0   b) -1   c) -2   d) +2   e) -3

6. For the AsO\(_4\)\(^x\) molecule, how many equal-energy resonance structures can you draw?
   a) 3   b) 6   c) 4   d) 1   e) 2

   One can construct at least 3 different views of this molecule

   1) \[ \text{As} - \text{O} - \text{O} - \text{O} - \text{O} \]

   2) \[ \text{As} - \text{O} \]

   3) \[ \text{As} - \text{O} - \text{O} - \text{O} - \text{O} \]  plus 5 others

   The top set of 4 resonance structures is best, in that the negative charges are localized on O, which can stabilize charge the most. The second structure is another valid resonance structure, but is higher in energy than the first, as there is more (unnecessary) separation of charge. The last set of structures is still higher in energy in that negative charge is localized on As, which has lower electronegativity than O. So set (1) is the lowest energy set of equal energy resonance structures. Everyone got full credit for any answer.
7. Consider the molecule ClF₅. How many lone pairs are on the central atom?
   a) 0  b) 1  c) 2  d) 3  e) 4

8. Consider the molecule ClF₅. What is the electron pair geometry?
   a) octahedral  b) linear  c) trigonal planar  d) trigonal bipyramidal

9. Consider the molecule ClF₅. What is the molecular geometry?
   a) trigonal planar  b) trigonal bipyramidal  c) tetrahedral

10. The CO bond in the molecule CH₃OH is best described as a:
    a) single bond  b) ionic bond  c) double bond  d) triple bond  e) the molecule doesn’t exist

11. Which of the following has the highest effective nuclear charge as seen by its outermost valence electrons?
    a) As  b) Si  c) N  d) S  e) F

12. Which of the following has the lowest electron affinity?
    a) S  b) Si  c) Al  d) Cl  e) P

13. For the SO₃²⁻ molecule, how many equal-energy resonance structures can you draw?
    a) 6  b) 1  c) 3  d) 0  e) 2

14. Which of the following correctly compares atomic radii?
    a) O < N < C < Be < Ne  d) Ne < O < N < C < Be
    b) Li < B < C < N < Ne  e) none of the above
    c) Ne < Li < B < C < N

15. Which compound below does not exist?
    a) CaF₄  b) BeF₂  c) KCl  d) MgO  e) BCl₃
16. Draw the Lewis structure for \( \text{NO}_2^- \). For any one of the most stable resonance forms, your resulting molecule has a total of:
   a) one double and one triple bond
   b) one single and one double bond
   c) two double bonds
   d) two single bonds
   e) two triple bonds

17. Draw a lowest energy Lewis structure for \( \text{NO}_2^- \). In this structure, the formal charge on N is
   a) -2
   b) -1
   c) 0
   d) +1
   e) +2

18. The molecule carbon tetrachloride \( \text{CCl}_4 \) has what molecular structure?
   a) tetrahedral
   b) trigonal planar
   c) bent
   d) octahedral
   e) trigonal bipyramidal

19. Which resonance form of \( \text{OCN}^- \) contributes most to the real molecule?
   a) A
   b) B
   c) C
   d) A and C same
   e) all same

   Choice C is bad in that it places a double negative charge on N and a positive charge on O. This distribution is the opposite of what we’d want based on electronegativity.

20. How many lone pairs of electrons are assigned to the sulfur atom in \( \text{H}_2\text{S} \)?
   a) 0
   b) 1
   c) 2
   d) 3
   e) 4

21. Which of the following are possible Lewis structures for \( \text{C}_2\text{H}_6\text{O} \)?

   a) 1
   b) 2
   c) 3
   d) 2 and 3
   e) 1, 2, and 3

22. Which of the following are resonance structures for nitrite ion, \( \text{NO}_2^- \)?
23. Electronegativity is a measure of
   a) the charge on a polyatomic cation.
   b) the charge on a polyatomic anion.
   c) the ability of a substance to conduct electricity.
   d) the oxidation number of an atom in a molecule or polyatomic anion.
   e) the ability of an atom in a molecule to attract electrons to itself.

24. Three possible structures of C₂H₂Cl₂ are shown below. Which of these molecules are polar?

   a) 1 only     c) 1 and 3     e) 2 and 3
   b) 2 only     d) 3 only

25. What course is this?
   a) Math 3.14159      c) Chem 111      e) Spy 007
   b) Sports 01         d) Bio 152
MULTIPLE CHOICE

1. ANS: E PTS: 1
2. ANS: D PTS: 1
3. ANS: C
   \[1s^2 2s^2 2p^2 3s^2 3p^3\] n=3 is the valence level. It has 5 valence electrons
   PTS: 1
4. ANS: C PTS: 1
5. ANS: E PTS: 1
6. ANS: C PTS: 1
7. ANS: B PTS: 1
8. ANS: A PTS: 1
9. ANS: D PTS: 1
10. ANS: A
    From OWL units 9-1d and 9-2b. See Study Questions 13-14, Chapter 9 of K&T.
    PTS: 1
11. ANS: E PTS: 1
12. ANS: C PTS: 1
13. ANS: B PTS: 1
14. ANS: D PTS: 1
15. ANS: A PTS: 1
16. ANS: B PTS: 1
17. ANS: C PTS: 1
18. ANS: A PTS: 1
19. ANS: A PTS: 1
20. ANS: C PTS: 1 TOP: 8.2 Covalent Bonding and Lewis Structures
21. ANS: D PTS: 1 TOP: 8.2 Covalent Bonding and Lewis Structures
22. ANS: A PTS: 1 TOP: 8.4 Resonance
23. ANS: E PTS: 1 TOP: 8.7 Bond Polarity and Electronegativity
24. ANS: C PTS: 1 TOP: 8.8 Bond and Molecular Polarity
25. ANS: C PTS: 1