

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

This exam is composed of **25 questions** on 7 pages total.

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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Signature

$E = hv = \frac{hc}{\lambda}$ $E_n^{H-atom} = -\frac{R_H hc}{n^2}$ $1 \text{ mL} = 1 \text{ cm}^3$	<b>Some common ions:</b> $\text{PO}_4^{3-}$ $\text{CN}^-$ $\text{CH}_3\text{CO}_2^-$ $\text{NO}_2^-$ $\text{NO}_3^-$ $\text{CO}_3^{2-}$ $\text{SO}_3^{2-}$ $\text{SO}_4^{2-}$	$h = 6.626 \times 10^{-34} \text{ J s}$ $c = 2.9998 \times 10^8 \text{ m s}^{-1}$ $N = 6.022 \times 10^{23} \text{ mol}^{-1}$ $R_H = 1.097 \times 10^7 \text{ m}^{-1}$
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a

**PERIODIC TABLE OF THE ELEMENTS**

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 <b>H</b> 1.008																	2 <b>He</b> 4.003
3 <b>Li</b> 6.939	4 <b>Be</b> 9.012											5 <b>B</b> 10.81	6 <b>C</b> 12.01	7 <b>N</b> 14.01	8 <b>O</b> 16.00	9 <b>F</b> 19.00	10 <b>Ne</b> 20.18
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.31											13 <b>Al</b> 26.98	14 <b>Si</b> 28.09	15 <b>P</b> 30.97	16 <b>S</b> 32.07	17 <b>Cl</b> 35.45	18 <b>Ar</b> 39.95
19 <b>K</b> 39.10	20 <b>Ca</b> 40.08	21 <b>Sc</b> 44.96	22 <b>Ti</b> 47.90	23 <b>V</b> 50.94	24 <b>Cr</b> 52.00	25 <b>Mn</b> 54.94	26 <b>Fe</b> 55.85	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.71	29 <b>Cu</b> 63.55	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.92	34 <b>Se</b> 78.96	35 <b>Br</b> 79.90	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.47	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.91	40 <b>Zr</b> 91.22	41 <b>Nb</b> 92.91	42 <b>Mo</b> 95.94	43 <b>Tc</b> (99)	44 <b>Ru</b> 101.1	45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.4	47 <b>Ag</b> 107.9	48 <b>Cd</b> 112.4	49 <b>In</b> 114.8	50 <b>Sn</b> 118.7	51 <b>Sb</b> 121.8	52 <b>Te</b> 127.6	53 <b>I</b> 126.9	54 <b>Xe</b> 131.3
55 <b>Cs</b> 132.9	56 <b>Ba</b> 137.3	57 <b>La</b> 138.9	72 <b>Hf</b> 178.5	73 <b>Ta</b> 181.0	74 <b>W</b> 183.8	75 <b>Re</b> 186.2	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.1	79 <b>Au</b> 197.0	80 <b>Hg</b> 200.6	81 <b>Tl</b> 204.4	82 <b>Pb</b> 207.2	83 <b>Bi</b> 209.0	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> 226.0	89 <b>Ac</b> 227.0	104 <b>Unq</b> (261)	105 <b>Unp</b> (262)	106 <b>Unh</b> (263)	107 <b>Uns</b> (262)	108 <b>Uno</b> (265)	109 <b>Une</b> (266)									

a

**Solubility Rules for some ionic compounds in water****Soluble Ionic Compounds**

- All sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), and ammonium ( $\text{NH}_4^+$ ) salts are SOLUBLE.
- All nitrate ( $\text{NO}_3^-$ ), acetate ( $\text{CH}_3\text{CO}_2^-$ ), chlorate ( $\text{ClO}_3^-$ ), and perchlorate ( $\text{ClO}_4^-$ ) salts are SOLUBLE.
- All chloride ( $\text{Cl}^-$ ), bromide ( $\text{Br}^-$ ), and iodide ( $\text{I}^-$ ) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) ( $\text{Pb}^{2+}$ ,  $\text{Ag}^+$ ,  $\text{Hg}_2^{2+}$ ) which are NOT soluble.
- All sulfate ( $\text{SO}_4^{2-}$ ) salts are SOLUBLE -- EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead ( $\text{Ca}^{2+}$ ,  $\text{Ag}^+$ ,  $\text{Hg}_2^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Pb}^{2+}$ ) which are NOT soluble.

**Not Soluble Ionic Compounds**

- Hydroxide ( $\text{OH}^-$ ) and oxide ( $\text{O}^{2-}$ ) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ba}^{2+}$ ) which are soluble.
- Sulfide ( $\text{S}^{2-}$ ) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$ ,  $\text{Ba}^{2+}$ ) which are soluble.
- Carbonate ( $\text{CO}_3^{2-}$ ) and phosphate ( $\text{PO}_4^{3-}$ ) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$ ), which are soluble.

Identify the choice that best completes the statement or answers the question.

- What is the hybridization of the xenon atom in  $\text{XeF}_2$ ?  
 a.  $sp$                       b.  $sp^2$                       c.  $sp^3$                       d.  $sp^3d$                       e.  $sp^3d^2$

**ANS: D TOP: 9.2 Valence Bond Theory**

- For which of the following molecules and ions does the central nitrogen atom have  $sp^3$  hybridization?  
 a.  $\text{NO}_2^-$                       b.  $\text{HNO}_3$                       c.  $\text{NOBr}$                       d.  $\text{NBr}_3$                       e.  $\text{HNO}_2$

**ANS: D TOP: 9.2 Valence Bond Theory**

- What is the molecular geometry around a central atom that is  $sp^3$  hybridized and has two lone pairs of electrons?  
 a. bent    c. trigonal-planar    e. trigonal-bipyramidal  
 b. linear    d. trigonal-pyramidal

**ANS: A TOP: 9.2 Valence Bond Theory**

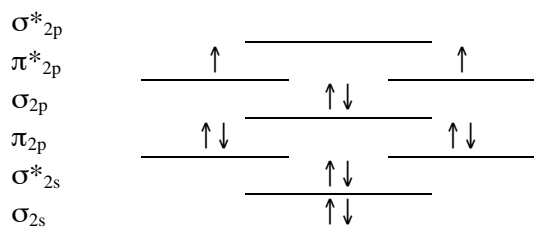
- Which of the following characteristics apply to  $\text{SO}_2$ ?  
 1. polar bonds  
 2. nonpolar molecule  
 3. linear molecular shape  
 4.  $sp$  hybridized  
 a. 1 only    d. 1, 2, and 3  
 b. 1 and 2    e. 1, 2, 3, and 4  
 c. 3 and 4

**ANS: A TOP: 9.2 Valence Bond Theory**

5. A molecular orbital that decreases the electron density between two nuclei is said to be .
- hybridized
  - bonding
  - antibonding
  - pi-bonding
  - nonpolar

**ANS: C TOP: 9.3 Molecular Orbital Theory**

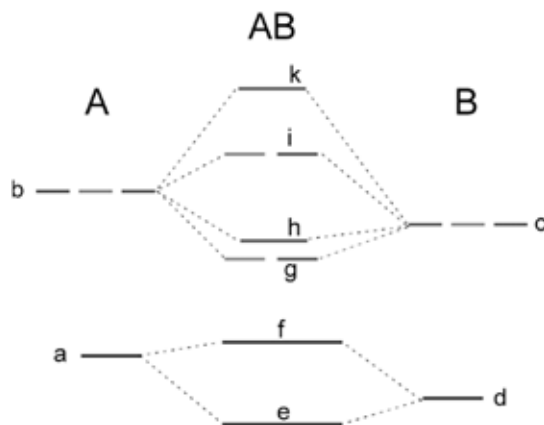
6. The following valence molecular orbital energy level diagram is appropriate for which one of the listed species?



- $B_2^{2-}$
- $C_2^{2-}$
- $N_2^{2-}$
- $O_2^{2-}$
- $F_2^{2-}$

**ANS: C TOP: 9.3 Molecular Orbital Theory**

7.



Which picture best represents the electronic distribution in orbital “h”?

- 
- 
- 
- 
- 

**ANS: B**

8. The diatomic AB above is  $CN^+$ . What is the overall bond order?

- 1.0
- 1.5
- 2.0
- 2.5
- 3.0

**ANS: C**



14. Which of the following statements is/are correct?

1. Water soluble ionic compounds, such as NaCl, are strong electrolytes.
2. Some molecular compounds, such as HCl, are strong electrolytes.
3. Some molecular compounds, such as acetic acid, are weak electrolytes.

- a. 1 only                                      c. 3 only                                      e. 1, 2, and 3  
 b. 2 only                                      d. 1 and 2

**ANS: E      TOP: 3.5 Ions and Molecules in Aqueous Solutions**

15. Which one of the following compounds is a nonelectrolyte when dissolved in water?

- a. O<sub>2</sub>    c. MgCl<sub>2</sub>                                      e. KI  
 b. MgBr<sub>2</sub>                                      d. Zn(NO<sub>3</sub>)<sub>2</sub>

**ANS: A      TOP: 3.5 Ions and Molecules in Aqueous Solutions**

16. A precipitate will form when aqueous nickel(II) chloride is added to an aqueous solution of

- a. SrI<sub>2</sub>    c. KOH    e. NaF  
 b. Cu(NO<sub>3</sub>)<sub>2</sub>                                      d. Na<sub>2</sub>SO<sub>4</sub>

**ANS: C      TOP: 3.6 Precipitation Reactions**

17. What is the net ionic equation for the reaction of aqueous calcium acetate and aqueous sodium carbonate?

- a. Ca<sup>2+</sup>(aq) + 2 CH<sub>3</sub>CO<sub>2</sub><sup>-</sup>(aq) → Ca(CH<sub>3</sub>CO<sub>2</sub>)<sub>2</sub>(s)  
 b. Na<sup>+</sup>(aq) + CH<sub>3</sub>CO<sub>2</sub><sup>-</sup>(aq) → NaCH<sub>3</sub>CO<sub>2</sub>(aq)  
 c. Na<sup>+</sup>(aq) + CH<sub>3</sub>CO<sub>2</sub><sup>-</sup>(aq) → NaCH<sub>3</sub>CO<sub>2</sub>(s)  
 d. Ca<sup>2+</sup>(aq) + CO<sub>3</sub><sup>2-</sup>(aq) → CaCO<sub>3</sub>(s)  
 e. Ca<sup>2+</sup>(aq) + 2 Na<sup>+</sup>(aq) → CaNa<sub>2</sub>(s)

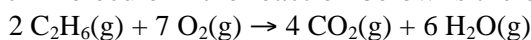
**ANS: D      TOP: 3.6 Precipitation Reactions**

18. Write a balanced net ionic equation for the reaction of aqueous solutions of baking soda (NaHCO<sub>3</sub>) and acetic acid.

- a. HCO<sub>3</sub><sup>-</sup>(aq) + CH<sub>3</sub>CO<sub>2</sub>H(aq) → CH<sub>3</sub>CO<sub>2</sub><sup>-</sup>(aq) + H<sub>2</sub>O(l) + CO<sub>2</sub>(g)  
 b. 2 NaHCO<sub>3</sub>(aq) + CH<sub>3</sub>CO<sub>2</sub>H(aq) → 2 Na<sub>2</sub>CO<sub>3</sub>(aq) + CH<sub>4</sub>(aq) + 2H<sub>2</sub>O(l) + CO<sub>2</sub>(g)  
 c. NaHCO<sub>3</sub>(aq) + H<sup>+</sup>(aq) → H<sub>2</sub>CO<sub>3</sub>(s) + Na<sup>+</sup>(aq)  
 d. HCO<sub>3</sub><sup>-</sup>(aq) + H<sup>+</sup>(aq) → H<sub>2</sub>O(l) + CO<sub>2</sub>(g)  
 e. HCO<sub>3</sub><sup>-</sup>(aq) + H<sup>+</sup>(aq) → H<sub>2</sub>CO<sub>3</sub>(aq)

**ANS: A      TOP: 3.8 Gas-Forming Reactions**

19. Which molecule in the reaction below is the oxidizing agent?



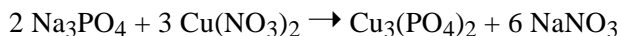
- a. C<sub>2</sub>H<sub>6</sub>    c. CO<sub>2</sub> and C<sub>2</sub>H<sub>6</sub>                                      e. None  
 b. O<sub>2</sub>    d. CO<sub>2</sub>

**ANS: B      TOP: 3.9 Oxidation-Reduction Reactions**

20. What is the oxidation number of iodine in sodium periodate,  $\text{NaIO}_4$ ?
- a. -1                      b. 0                      c. +3                      d. +7                      e. +8

**ANS: D      TOP: 3.9 Oxidation-Reduction Reactions**

21. Consider the reaction

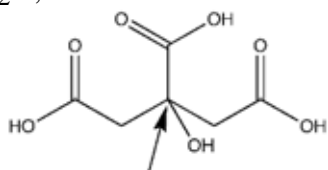


This reaction is best classified as

- a. oxidation-reduction                      d. acid-base  
 b. gas-evolving                              e. gas-evolving and acid-base  
 c. precipitation

**ANS: C**

22. Alka seltzer is a combination of citric acid,  $\text{C}_6\text{H}_8\text{O}_7$ , and  $\text{NaHCO}_3^-$ . They react in your glass to form  $\text{C}_6\text{H}_7\text{O}_7^-$ ,  $\text{H}_2\text{O}$ , and  $\text{CO}_2$ .



What is the oxidation number of the carbon pointed to by the arrow?

- a. 4                      b. 3                      c. 2                      d. 1                      e. 0

**ANS: D**

23. Mixing  $\text{Pb}(\text{NO}_3)_2$  with  $\text{CaCl}_2$  in water leads to precipitation of
- a. a  $\text{NO}_3^-$  salt                              d. nothing precipitates  
 b. A  $\text{Ca}^{2+}$  salt                              e. everything precipitates  
 c. a  $\text{Pb}^{2+}$  salt

**ANS: C**

24. What is the oxidation number of tin in  $\text{SnO}_3^{2-}$ ?
- a. +2                      c. +6                      e. 0  
 b. +4                      d. -4

**ANS: B**

25. What course is this?
- a) Bio 152                      c) Sports 01                      e) Election 08  
 b) Chem 111                      d) Math 3.14159

**ANS: B**