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McCord CH301

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TTh 9:30 am - 11 am

# Exam 3

Nov 5, 2018

Monday 7:30 - 9:00 PM

A - Mi in BUR 106

Mo - Z in JES A121A

Remember to refer to the Periodic Table handout that is separate from this exam copy.

no calculators

**NOTE:** Please keep this exam copy intact (all pages still stapled - including this cover page). You must turn in ALL the materials that were distributed. This means that you turn in your exam copy (name and signature included), bubble sheet, periodic table handout, and all scratch paper. Please also have your UT ID card ready to show as well.

This print-out should have 25 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

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**Hybridization Theoretical**

**001 4.0 points**

What is the molecular geometry of nitrogen triiodide, NI<sub>3</sub>? Is this molecule polar or non-polar?

1. Trigonal planar, nonpolar
2. Trigonal pyramid, polar
3. Trigonal bipyramid, polar
4. T-shaped, polar
5. Tetrahedral, polar
6. Trigonal pyramid, nonpolar

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**VSEPR Shape Full Description**

**002 4.0 points**

Which of the following fully describes the VSEPR geometry of TeCl<sub>4</sub>?

1. Tetrahedral molecular geometry with zero lone pairs
2. See-saw molecular geometry with one lone pair in the axial position
3. Trigonal bipyramid molecular geometry with one lone pair in the equatorial position
4. See-saw molecular geometry with one lone pair in the equatorial position
5. Square planar molecular geometry with two lone pairs in the equatorial position

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**Nitrite Angle II**

**003 4.0 points**

Which of the following angles is the best choice to describe the bond angle in nitrite NO<sub>2</sub><sup>-</sup>?

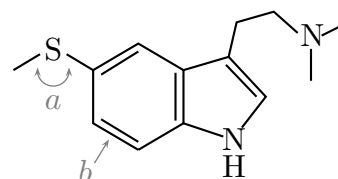
1. 120°
2. slightly less than 120°
3. 180°
4. slightly less than 109.5°
5. slightly less than 180°
6. 109.5°

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**Big Ass Molecule 18**

**004 (part 1 of 3) 4.0 points**

The molecule shown below is a chemical that was discovered to have mild interactions with human HT-2A receptors. Assume all atoms in the structure below obey the octet rule.



What is the correct empirical formula for this compound?

1. C<sub>15</sub>H<sub>17</sub>N<sub>2</sub>S
2. C<sub>13</sub>H<sub>19</sub>N<sub>2</sub>S
3. C<sub>13</sub>H<sub>19</sub>N<sub>2</sub>S
4. C<sub>13</sub>H<sub>12</sub>N<sub>2</sub>S
5. C<sub>12</sub>H<sub>15</sub>N<sub>2</sub>S
6. C<sub>13</sub>H<sub>18</sub>N<sub>2</sub>S

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**005 (part 2 of 3) 4.0 points**

Which of the following best represents the bond angle labeled *a*?

1. 118°
2. 90°
3. 178°

4.  $109.5^\circ$
5.  $180^\circ$
6.  $120^\circ$
7.  $104.5^\circ$

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**006 (part 3 of 3) 4.0 points**

What is the name of the carbon-carbon bond formed from hybrid orbitals on the internuclear axis, labeled by arrow b?

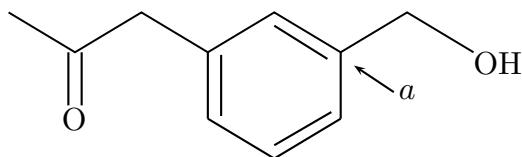
1.  $\pi_{sp^3-sp^3}$
2.  $\sigma_{sp-sp^2}$
3.  $\sigma_{sp^2-sp^2}$
4.  $\sigma_{2p-2p}$
5.  $\pi_{2p-2p}$
6.  $\sigma_{sp-sp}$
7.  $\pi_{sp^2-sp^2}$
8.  $\sigma_{sp^2-2p}$

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**VB Classify Bonds**

**007 (part 1 of 2) 4.0 points**

Consider the organic line structure shown below:



How many sigma and pi bonds are in this molecule?

1.  $\sigma = 24, \pi = 3$
2.  $\sigma = 12, \pi = 3$
3.  $\sigma = 24, \pi = 12$
4.  $\sigma = 26, \pi = 12$

5.  $\sigma = 24, \pi = 4$
6.  $\sigma = 12, \pi = 4$

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**008 (part 2 of 2) 4.0 points**

What is the hybridization around the carbon labelled *a*?

1.  $sp^2$
2.  $sp^4$
3.  $2p$
4.  $sp^3$
5.  $2s$
6.  $sp$

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**Lewis VB Expanded**

**009 4.0 points**

What is the hybridization around krypton in  $\text{KrF}_2$ ?

1.  $sp^3d$
2.  $sp$
3.  $sp^3$
4.  $sp^2$
5.  $sp^3d^2$

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**Pi Bond Conceptual**

**010 4.0 points**

According to valence bond theory, which of the following best describes the  $\pi$ -bond between the carbon and oxygen in formaldehyde,  $\text{CH}_2\text{O}$ ?

1.  $sp^2$  hybrid orbitals overlap above and below the internuclear axis
2. The  $sp^2$  hybrid orbital of oxygen overlaps with the  $p$ -orbital of carbon on the internuclear axis

3.  $p$ -orbitals overlap above and below the internuclear axis

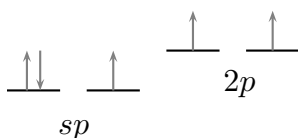
4.  $p$ -orbitals overlap on the internuclear axis

5.  $p$ -orbitals overlap either above or below the internuclear axis

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**VB Challenge 18**  
**011 4.0 points**

Consider the valence bond configuration for a central atom:



This atom belongs to which of the following molecules?

1.  $\text{NH}_3$

2.  $\text{CN}^-$

3.  $\text{CO}_3^{2-}$

4.  $\text{CO}_2$

5.  $\text{NO}_2^-$

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**MO Theory Conceptual Comparison ii**  
**012 4.0 points**

Which of the following is an advantage specific to molecular orbital theory?

1. The magnetic properties of molecules are accurately predicted in molecular orbital diagrams

2. Molecular orbital diagrams prove that  $p$ -electrons can only form pi bonds and  $s$ -electrons can only form sigma bonds

3. Molecular orbital theory provides the hybrid orbitals for localized electrons in a molecule

4. The incredibly complex nature of molecular orbital theory allows for easy navigation of large organic molecules

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**Antibonding Orbitals**  
**013 4.0 points**

According to molecular orbital theory, antibonding orbitals...

1. are lower in energy than bonding orbitals and are therefore populated with electrons prior to bonding orbitals

2. increase the electron density between two bonding atoms when populated with electrons

3. decrease the stability of a bonding region when populated with electrons

4. are higher in energy than bonding orbitals and are therefore populated with electrons prior to bonding orbitals

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**MO Theory Diagrams 18**  
**014 4.0 points**

Consider the MO diagram for  $\text{F}_2^+$ . What is the bond order? Is  $\text{F}_2^+$  paramagnetic or diamagnetic?

1. 2.5, diamagnetic

2. 2, diamagnetic

3. 1.5, paramagnetic

4. 2.5, paramagnetic

5. 1.5, diamagnetic

6. 1, diamagnetic

7. 2, paramagnetic

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**Photovoltaics HOMO LUMO**  
**015 4.0 points**

A solar farm utilizes the cadmium telluride class of photovoltaics ( $\text{CdTe}$ ) because of their

thin size, cost-effectiveness, and efficient photon absorption at around 824 nm. However, the peak efficiency for a solar cell is around 700 nm. Which of the following materials would be a more efficient alternative to CdTe?

1. A crystalline silicon cell with a longer wavelength of absorption than CdTe
2. A mono-silicon cell that has a larger HOMO-LUMO gap than CdTe
3. None of the choices will increase the efficiency of the solar farm
4. An amorphous silicon cell with a smaller frequency of absorption than CdTe
5. A multi-silicon cell that has a smaller HOMO-LUMO gap than CdTe

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**MO Theory HOMO LUMO Diagram**

**016 4.0 points**

The HOMO-LUMO gap of  $C_2$  refers to the energy difference between which two orbitals?

1.  $\sigma_{2p}^*$  and  $\pi_{2p}^*$
2.  $\pi_{2p}^*$  and  $\sigma_{2p}$
3.  $\sigma_{2s}^*$  and  $\pi_{2p}^*$
4.  $\sigma_{2s}$  and  $\pi_{2p}$
5.  $\pi_{2p}$  and  $\sigma_{2p}$
6.  $\sigma_{2s}^*$  and  $\pi_{2p}$

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**What is polarizability**

**017 4.0 points**

Polarizability is...

1. how easily a molecule maintains a permanent dipole based on its geometry
2. a measurement of the total resonance in a molecule
3. how easily a molecule maintains a perma-

nent dipole based on the size of its electron clouds

4. how easily a molecule induces a dipole based on the size of its electron clouds
5. the net formal charge on a bonding atom

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**ID the IMFs Multi 18ii**

**018 4.0 points**

State the dominant intermolecular force possible for each compound, respectively:

$O_3$  ,  $SF_6$  ,  $NH_3$  ,  $C_6H_6$

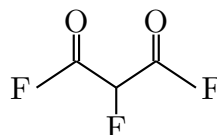
1. dipole-dipole, dispersion, hydrogen-bonding, dispersion
2. dispersion, dipole-dipole, dipole-dipole, dispersion
3. dipole-dipole, dipole-dipole, dipole-dipole, hydrogen-bonding
4. dispersion, dispersion, hydrogen-bonding, dispersion
5. dipole-dipole, dispersion, hydrogen-bonding, dipole-dipole
6. dispersion, dipole-dipole, hydrogen-bonding, dispersion

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**ID the IMFs 18**

**019 4.0 points**

What types of intermolecular forces are present in a homogenous mixture of the molecule shown below?



1. dispersion forces only
2. hydrogen bonding only
3. dispersion forces, dipole-dipole

4. dispersion forces, dipole-dipole, ion-dipole

5. dispersion forces, dipole-dipole, hydrogen bonding

6. dispersion forces, hydrogen bonding

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**IMF Hbond ID**  
**020 4.0 points**

Which of the following can form hydrogen bonds with another molecule of itself?

I.  $\text{CH}_3\text{F}$

II.  $\text{CH}_3\text{CH}_2\text{OH}$

III.  $\text{CH}_3\text{OCH}_3$

IV.  $\text{CH}_2\text{O}$

1. I, III, and IV only

2. II only

3. I and II only

4. I only

5. I, II, III, and IV

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**Vapor Pressure IMF Comparison**  
**021 4.0 points**

Consider the two molecules:  $\text{H}_2\text{S}$  and  $\text{SiH}_4$ . Which of these hydrides has the higher vapor pressure and why?

1.  $\text{H}_2\text{S}$ , because it is less polarizable

2.  $\text{SiH}_4$ , because it is more polarizable

3.  $\text{H}_2\text{S}$ , because it is more polar

4.  $\text{H}_2\text{S}$ , because it can hydrogen bond

5.  $\text{SiH}_4$ , because it is a symmetrical molecule with only dispersion forces

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**IMF Concept Halogens**  
**022 4.0 points**

Consider the following boiling point data:

$\text{HBr}, T_b = -66^\circ\text{C}$

$\text{HI}, T_b = -35^\circ\text{C}$

Which of the following explains why HI has a higher boiling point than HBr?

1. HI is more polarizable than HBr

2. The highly polarizable dispersion forces of HBr are stronger than the dipole-dipole forces of HI

3. The dipole-dipole forces of HBr are stronger than the dipole-dipole forces of HI

4. The highly polar dipole-dipole forces of HI are stronger than the dipole-dipole forces of HBr

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**Liquid Prop Adhesion Cohesion**  
**023 4.0 points**

A liquid poured into a graduated cylinder has stronger cohesive forces than adhesive forces. Which of the following best describes the meniscus formed?

1. The meniscus is concave because the forces between the liquid and the walls of the container are stronger than forces between the liquid molecules

2. The meniscus is convex because the forces between the liquid and the walls of the container are stronger than forces between the liquid molecules

3. The meniscus is convex because the liquid molecules on the surface are more attracted to each other than the walls of the container

4. The meniscus is concave because the liquid molecules on the surface are more attracted to each other than the walls of the container

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**Consider a solid**  
**024 4.0 points**

Consider a solid that has a molar mass of

180.2 g/mol and a melting point of 423 K. This solid is a terrible electrical conductor, even when fully dissolved in an aqueous medium. What type of solid is this compound?

1. Molecular
2. Metallic
3. Ionic
4. Covalent network

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**MP Order 18**

**025 4.0 points**

Arrange the following substances in order from lowest to highest theoretical melting point:

$\text{SiO}_2$  ,  $\text{H}_2\text{O}$  ,  $\text{NaNO}_3$  ,  $\text{LiF}$  ,  $\text{BCl}_3$

1.  $\text{H}_2\text{O} < \text{NaNO}_3 < \text{BCl}_3 < \text{LiF} < \text{SiO}_2$
2.  $\text{BCl}_3 < \text{H}_2\text{O} < \text{NaNO}_3 < \text{LiF} < \text{SiO}_2$
3.  $\text{BCl}_3 < \text{H}_2\text{O} < \text{LiF} < \text{NaNO}_3 < \text{SiO}_2$
4.  $\text{BCl}_3 < \text{SiO}_2 < \text{LiF} < \text{NaNO}_3 < \text{H}_2\text{O}$
5.  $\text{SiO}_2 < \text{LiF} < \text{H}_2\text{O} < \text{BCl}_3 < \text{NaNO}_3$