

# EXAM 3

# Review Problems

**DR. MIOY T. HUYNH**  
YALE UNIVERSITY  
CHEMISTRY 161  
FALL 2018

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Photon A has a frequency of 2.45 GHz.  
Photon B has a wavelength of 965 nm.  
Which photon has greater energy?

A red laser emits 630-nm photons at a rate of 1.00 J/s.  
In 5 seconds, how many photons does the laser emit?

Calculate the frequencies for the following four electron transitions in the hydrogen atom.

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Electron Transitions

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$$n = 5 \rightarrow n = 4$$

$$n = 4 \rightarrow n = 3$$

$$n = 3 \rightarrow n = 2$$

$$n = 2 \rightarrow n = 1$$

Calculate the wavelengths of radiation required for the following four absorptions in the hydrogen atom

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Absorptions

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$$n = 1 \rightarrow n = 2$$

$$n = 1 \rightarrow n = 3$$

$$n = 1 \rightarrow n = 4$$

$$n = 2 \rightarrow n = 3$$

Which of the following electron transitions in the hydrogen atom results in the emission of light with the longest wavelength?

A)  $n = 4 \rightarrow n = 3$

B)  $n = 1 \rightarrow n = 2$

C)  $n = 1 \rightarrow n = 6$

D)  $n = 3 \rightarrow n = 2$

What are the possible values of  $m_\ell$  when  $n = 4$ ?

Which of the following sets of quantum numbers are not allowed?

Set I	Set II	Set III	Set IV
$n = 1$	$n = 3$	$n = 1$	$n = 2$
$l = 2$	$l = 0$	$l = 0$	$l = 1$
$m_l = 0$	$m_l = 0$	$m_l = 1$	$m_l = 2$
$m_s = +\frac{1}{2}$	$m_s = -\frac{1}{2}$	$m_s = -\frac{1}{2}$	$m_s = +\frac{1}{2}$



Arrange the following sets of atoms in order of increasing atomic size.

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Sets

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Sn, Xe, Rb, Sr

Rn, He, Xe, Kr

Pb, Ba, Cs, At

Ga, N, Cs, P

$O^{2-}$ ,  $F^{-}$ ,  $Na^{+}$ ,  $Mg^{2+}$

Arrange the following sets of atoms in order of increasing ionization energy.

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Sets

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B, N, Rb

Li, C, Si

Mg, O, P, Na

Te, Cs, F, Sn, Se

For each of the following sets of atoms and/or ions, determine which has the \_\_\_\_\_?

Set	Property	Answer
H, He <sup>+</sup> , Li <sup>2+</sup> , Be <sup>3+</sup>	Highest ionization energy?	
S <sup>2-</sup> , Ca <sup>2+</sup> , K <sup>+</sup> , Cl <sup>-</sup>	Largest size?	
K <sup>+</sup> , Ca <sup>+</sup> , Ar <sup>+</sup> , Cl <sup>+</sup> , S <sup>+</sup>	Smallest ionization energy?	
V, Mn <sup>2+</sup> , Ti <sup>2+</sup> , Cu <sup>2+</sup>	Smallest size?	
Se <sup>2-</sup> , Br <sup>-</sup> , Sr <sup>2+</sup> , Zr <sup>4+</sup> , Rb <sup>+</sup>	Smallest ionization energy?	
S <sup>2-</sup> , S, S <sup>2+</sup> , Cs <sup>+</sup> , Sr <sup>2+</sup>	Smallest size?	
S <sup>2-</sup> , S, S <sup>2+</sup> , Cs <sup>+</sup> , Sr <sup>2+</sup>	Largest ionization energy?	

For each of the following atoms or ions,  
give the electronic configuration.

Atom/Ion	Full configuration	Condensed configuration
Cl <sup>+</sup>		
V		
Mn		
Mn <sup>2+</sup>		
Ti <sup>2+</sup>		
Cu		
Cu <sup>2+</sup>		
Cu <sup>+</sup>		
Te <sup>2-</sup>		

For each of the following atoms or ions,  
determine the number of unpaired electrons.

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Atom/ion

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Cl<sup>+</sup>

V

Mn

Mn<sup>2+</sup>

Ti<sup>2+</sup>

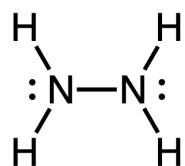
Cu

Cu<sup>2+</sup>

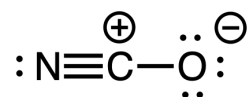
Cu<sup>+</sup>

Te<sup>2-</sup>

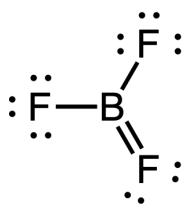
Consider the following seven Lewis structures to the left.  
Assume that the total number of electrons in each structure is correct.



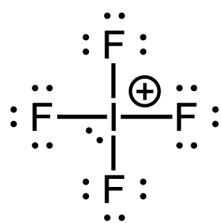
I



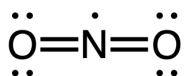
II



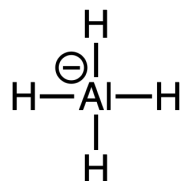
III



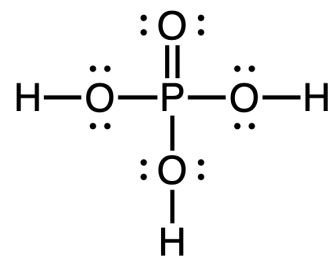
IV



V



VI



VII

A. Which structures have an atom that breaks the octet rule?

B. Which structures have an incorrect formal charge assignment?

C. Which structures could have another reasonable resonance structure that obeys the octet rule?

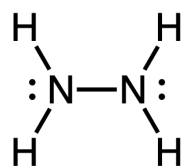
D. Given that the electronegativities of H and B are equal, which structure has the most polar bond?

Structure III

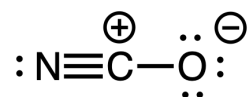
Structure VI

Structure VII

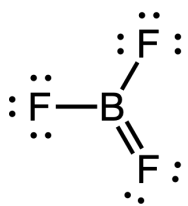
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Assume that the total number of electrons in each structure is correct.



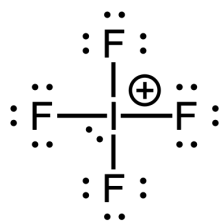
I



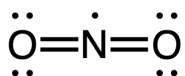
II



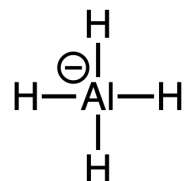
III



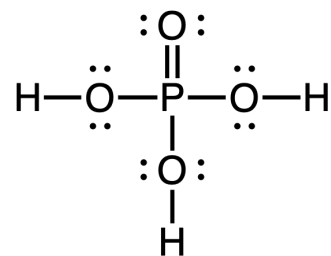
IV



V



VI



VII

A. Which structures have only one  $\pi$  bond?

B. Which structures would be paramagnetic?

C. Which structures contain an  $sp$ -hybridized atom?

D. Which structures contain an  $sp^2$ -hybridized atom?

E. Which structures have a bond angle that is  $180^\circ$ ?

Consider the molecular ion:  $[\text{GeCl}_3]^-$

- A. Draw the Lewis structure including any lone pairs and formal charges.
- B. Give the molecular geometry at the central atom.
- C. State the hybridization at the central atom.
- D. Determine if the molecule is polar or nonpolar.



Consider the molecular ion:  $[\text{FH}_2]^+$

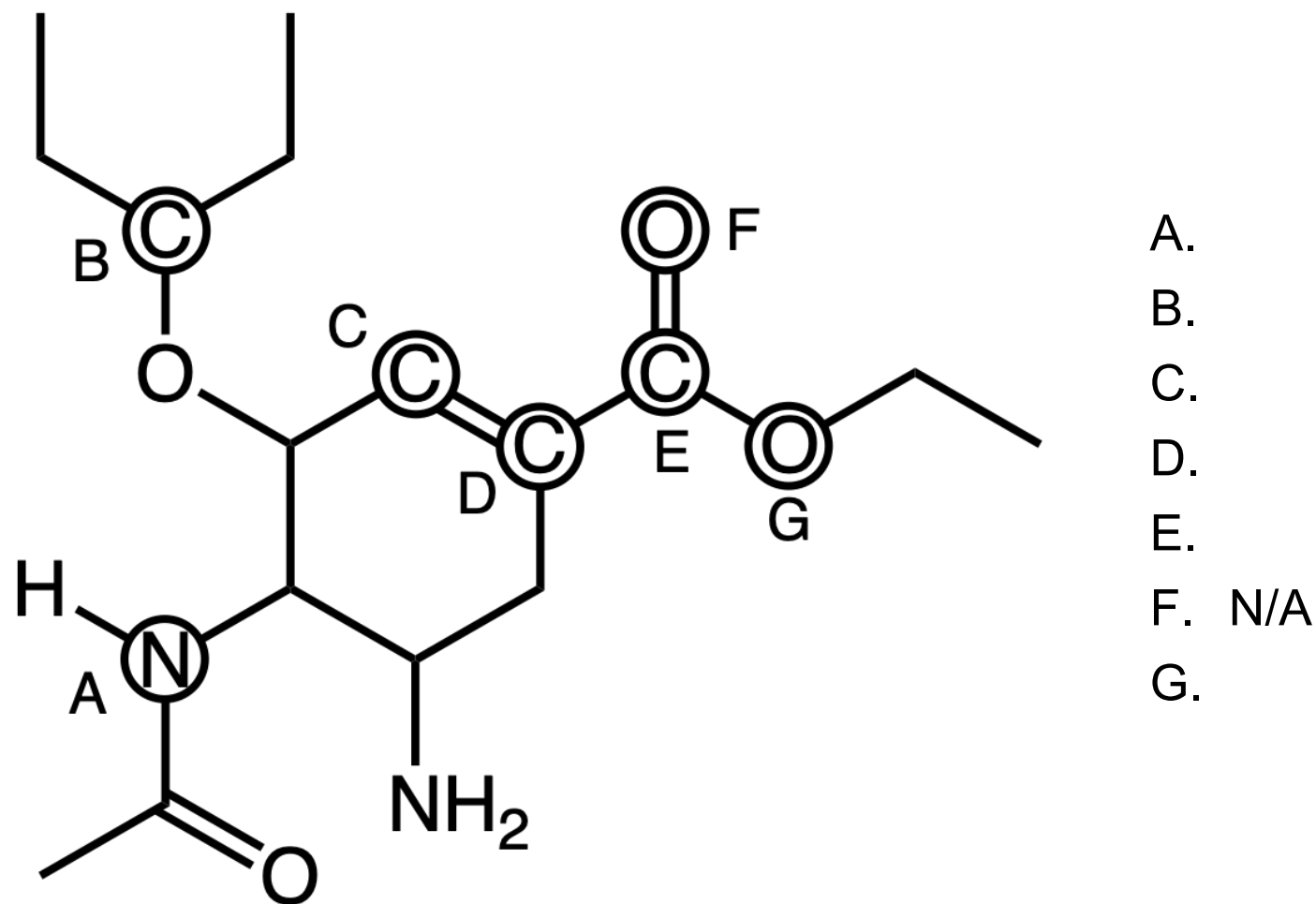
- A. Draw the Lewis structure including any lone pairs and formal charges.
- B. Give the molecular geometry at the central atom.
- C. State the hybridization at the central atom.
- D. Determine if the molecule is polar or nonpolar.

Consider the molecule:  $\text{XeF}_4$

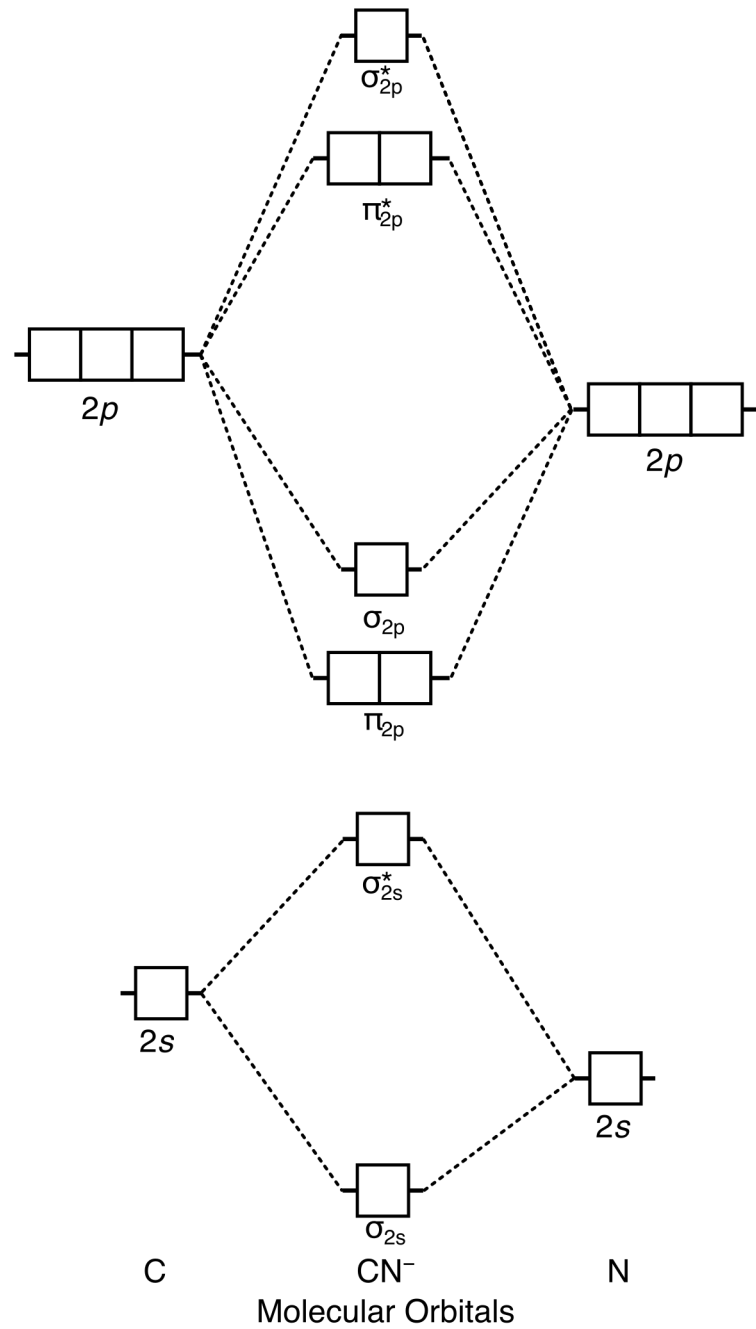
- A. Draw the Lewis structure including any lone pairs and formal charges.
- B. Give the molecular geometry at the central atom.
- C. State the hybridization at the central atom.
- D. Determine if the molecule is polar or nonpolar.

Consider the molecule Tamiflu, shown below.  
For each of the circled atoms (labeled A–F), do the following:

- Give the molecular geometry at the central atom.
- State the hybridization at the central atom.



Consider the cyanate ion,  $\text{CN}^-$ , and its molecular orbital diagram shown to the left.



- A. Using the diagram on the left, fill in the electrons for the molecular orbitals of  $\text{CN}^-$ .  
*You do not need to fill in the electrons for the atomic orbitals.*
- B. Determine the bond order for  $\text{CN}^-$  based on your diagram.
- C. Do you expect  $\text{CN}^-$  to be paramagnetic or diamagnetic?
- D. Do you expect neutral  $\text{CN}$  to be paramagnetic or diamagnetic?
- E. Do you expect  $\text{CN}^{3-}$  to be paramagnetic or diamagnetic?

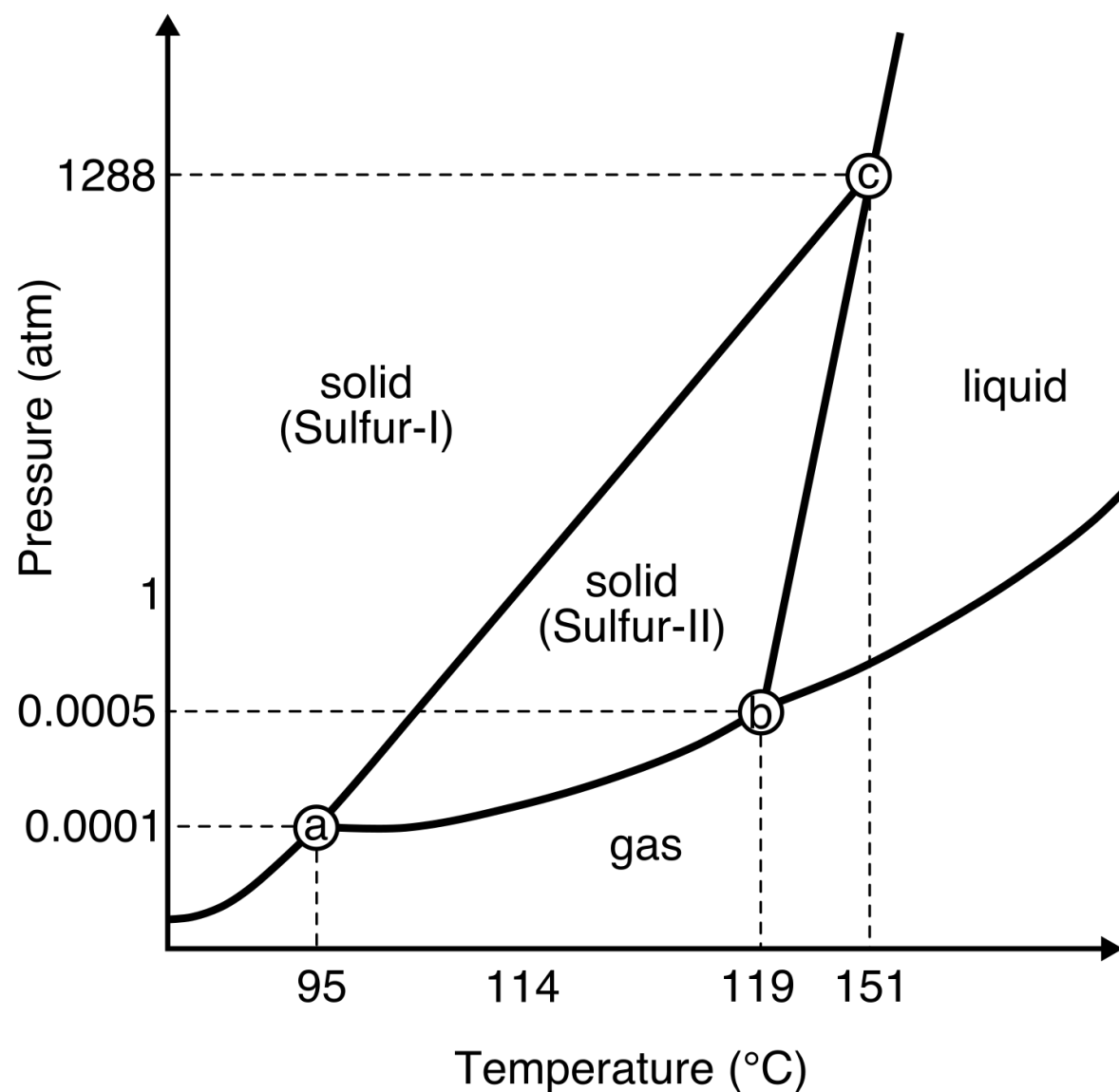
Arrange the following sets of compounds in order of increasing \_\_\_\_\_.

Set	Property	Ordered Set
$\text{CH}_3\text{CH}_2\text{OH}$ , $\text{CH}_3\text{OCH}_3$ , $\text{CH}_3\text{CH}_2\text{CH}_3$	Vapor pressure at 298 K	
$\text{O}_2$ , $\text{CuCl}$ , $\text{Br}_2$ , $\text{CH}_3\text{OH}$	Solubility in water	
$\text{BaCl}_2$ , $\text{H}_2$ , $\text{CO}$ , $\text{Kr}$ , $\text{HF}$	Boiling point	
$\text{CH}_3\text{OH}$ , $\text{Cl}_2$ , $\text{N}_2$ , $\text{CH}_3\text{Cl}$	Melting point	
$\text{N}_2$ , $\text{KBr}$ , $\text{O}_2$ , $\text{HCN}$	Boiling point	
$\text{FeO}$ , $\text{NaCl}$ , $\text{CF}_4$ , $\text{CH}_3\text{OH}$	Melting point	
$\text{CH}_3\text{OH}$ , $\text{CH}_3\text{CH}_3$ , $\text{H}_2\text{CO}$	Surface Tension	

For each of the following molecules, determine the main intermolecular interactions:

Molecule	Intermolecular interactions with <b>itself</b>	Intermolecular interactions with <b>water (H<sub>2</sub>O)</b>	Intermolecular interactions with <b>methane (CH<sub>4</sub>)</b>
NH <sub>3</sub>			
CCl <sub>4</sub>			
C <sub>6</sub> H <sub>5</sub> OH			
CH <sub>3</sub> CH <sub>2</sub> OCH <sub>2</sub> CH <sub>3</sub>			
Kr			
CO <sub>2</sub>			
(CH <sub>3</sub> ) <sub>2</sub> NH			

Consider the phase diagram for sulfur ( $S_8$ ), which has three triple points.



- A. At each triple point, determine which phases would exist in equilibrium.  
(a):  
(b):  
(c):
- B. At which triple point will solid Sulfur-II float on top of liquid sulfur?
- C. Which of the two solid phases, Sulfur-I or Sulfur-II, is less dense?
- D. Can either of the two solid states sublime at atmospheric pressure? Which?