

# EXAM 3

# PRACTICE PROBLEMS

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CHEMISTRY 161A // FALL 2019

# PRACTICE PROBLEM 1

Which photon has a greater energy?

Photon A with  $\nu = 2.45 \text{ GHz}$

Photon B with  $\lambda = 965 \text{ nm}$

— *answer* —

## PRACTICE PROBLEM 2.1

Calculate the frequencies (in Hz or  $s^{-1}$ ) associated with the following four electron transitions in the hydrogen atom.

— *answer* —

Electron Transition	
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(a)	$n = 5 \rightarrow n = 4$
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(b)	$n = 4 \rightarrow n = 3$
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(c)	$n = 3 \rightarrow n = 2$
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(d)	$n = 2 \rightarrow n = 1$
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## PRACTICE PROBLEM 2.2

Calculate the wavelength (in nm) of radiation required for the following four absorptions in the hydrogen atom.

— *answer* —

Electron Transition	
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(a)	$n = 1 \rightarrow n = 2$
-----	---------------------------

(b)	$n = 1 \rightarrow n = 3$
-----	---------------------------

(c)	$n = 1 \rightarrow n = 4$
-----	---------------------------

(d)	$n = 2 \rightarrow n = 3$
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## PRACTICE PROBLEM 2.3

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)  $n = 3 \rightarrow n = 2$

— *answer* —

## PRACTICE PROBLEM 3.1

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

— *answer* —

## PRACTICE PROBLEM 3.2

Which of the following sets of quantum numbers is(are) not allowed?

— *answer* —

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

## PRACTICE PROBLEM 4.1

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

— *answer* —

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Atoms	
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(a) Sn, Xe, Rb, Sr

(b) Rn, He, Xe, Kr

(c) Pb, Ba, Cs, At

(d) Ga, N, Cs, P

(e)  $\text{O}^{2-}$ ,  $\text{F}^-$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$

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## PRACTICE PROBLEM 4.2

Arrange the following sets of atoms in order of increasing first ionization energies.

— *answer* —

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Atoms	
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(a)	B, N, Rb
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(b)	Li, C, Si
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(c)	Mg, O, P, Na
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(d)	Te, Cs, Sn, Se
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## PRACTICE PROBLEM 4.3

For each of the following sets of atom/ions, determine which of the set has the \_\_\_\_\_.

— *answer* —

	Set	Property	Answer
(a)	H, He <sup>+</sup> , Li <sup>2+</sup> , Be <sup>3+</sup>	Largest ionization energy?	
(b)	S <sup>2-</sup> , Ca <sup>2+</sup> , K <sup>+</sup> , Cl <sup>-</sup>	Largest size?	
(c)	K <sup>+</sup> , Ca <sup>+</sup> , Ar <sup>+</sup> , Cl <sup>+</sup> , S <sup>+</sup>	Smallest ionization energy?	
(d)	V, Mn <sup>2+</sup> , Ti <sup>2+</sup> , Cu <sup>2+</sup>	Smallest size?	
(e)	Se <sup>2-</sup> , Br <sup>-</sup> , Sr <sup>2+</sup> , Zr <sup>4+</sup> , Rb <sup>+</sup>	Smallest ionization energy?	
(f)	S <sup>2-</sup> , S, S <sup>2+</sup> , Cs <sup>+</sup> , Sr <sup>2+</sup>	Smallest size?	
(g)	S <sup>2-</sup> , S, S <sup>2+</sup> , Cs <sup>+</sup> , Sr <sup>2+</sup>	Largest ionization energy?	

## PRACTICE PROBLEM 5.1

Write the electronic configuration for the following atoms/ions.

— *answer* —

	Atom/Ion	Full Configuration	Noble-Gas Configuration
(a)	Cl <sup>+</sup>		
(b)	V		
(c)	Mn		
(d)	Mn <sup>2+</sup>		
(e)	Ti <sup>2+</sup>		
(f)	Cu		
(g)	Cu <sup>2+</sup>		
(h)	Cu <sup>+</sup>		
(i)	Te <sup>2-</sup>		

## PRACTICE PROBLEM 5.2

Determine the number of unpaired electrons for the following atoms/ions.

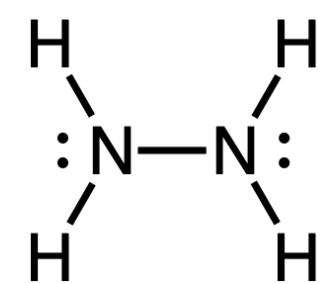
— *answer* —

Atom/Ion	
(a)	Cl <sup>+</sup>
(b)	V
(c)	Mn
(d)	Mn <sup>2+</sup>
(e)	Ti <sup>2+</sup>
(f)	Cu
(g)	Cu <sup>2+</sup>
(h)	Cu <sup>+</sup>
(i)	Te <sup>2-</sup>

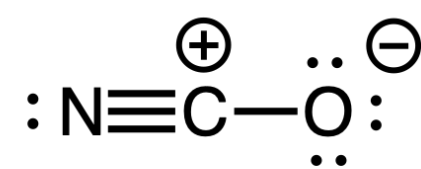
# PRACTICE PROBLEM 6

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

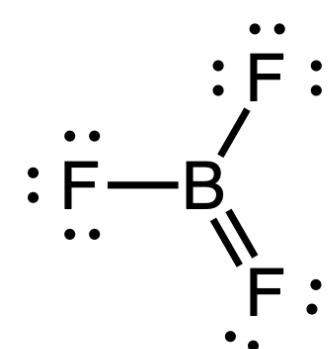
— answer —



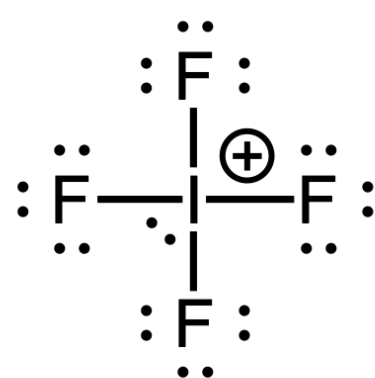
I



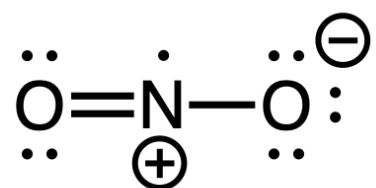
II



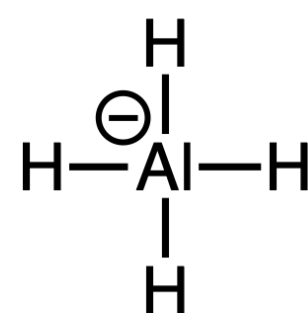
III



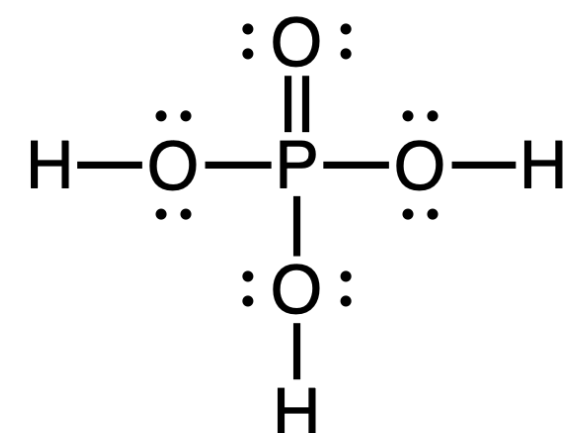
IV



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 a reasonable resonance structure that obeys the octet rule?

(D) If the electronegativities of H and B are equal, which structure has the most polar bond?

Structure III

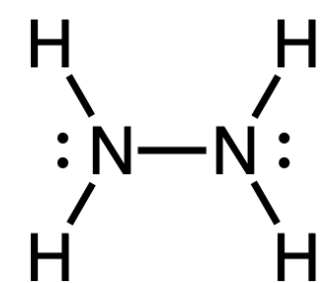
Structure VI

Structure VII

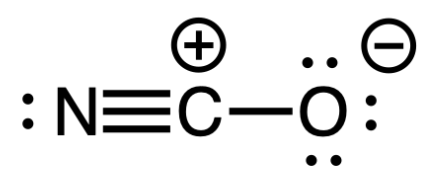
# PRACTICE PROBLEM 7

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

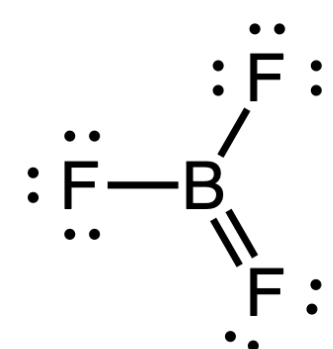
— answer —



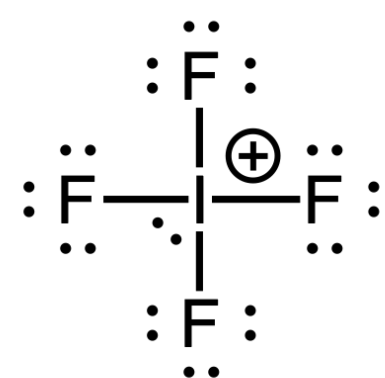
I



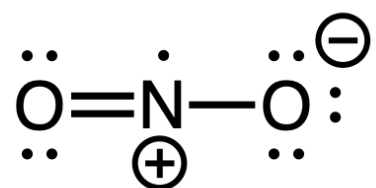
II



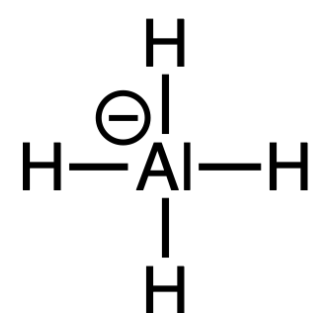
III



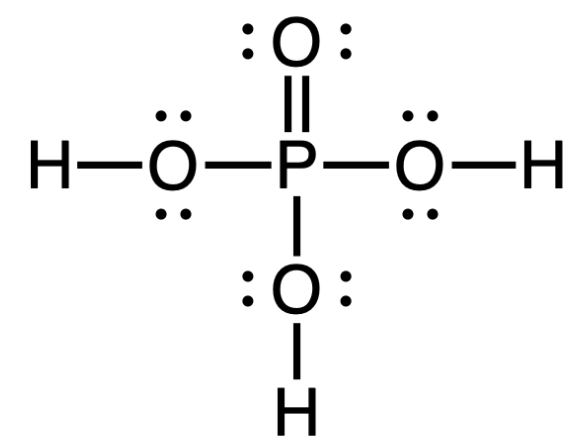
IV



V



VI



VII

(A) Which structures contain only one  $\pi$  bond?

(B) Which structures would be paramagnetic based only on the Lewis structures?

(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  $180^\circ$ ?

## PRACTICE PROBLEM 8.1

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

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

— *answer* —

## PRACTICE PROBLEM 8.2

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

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

— *answer* —



## PRACTICE PROBLEM 8.3

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.

— *answer* —

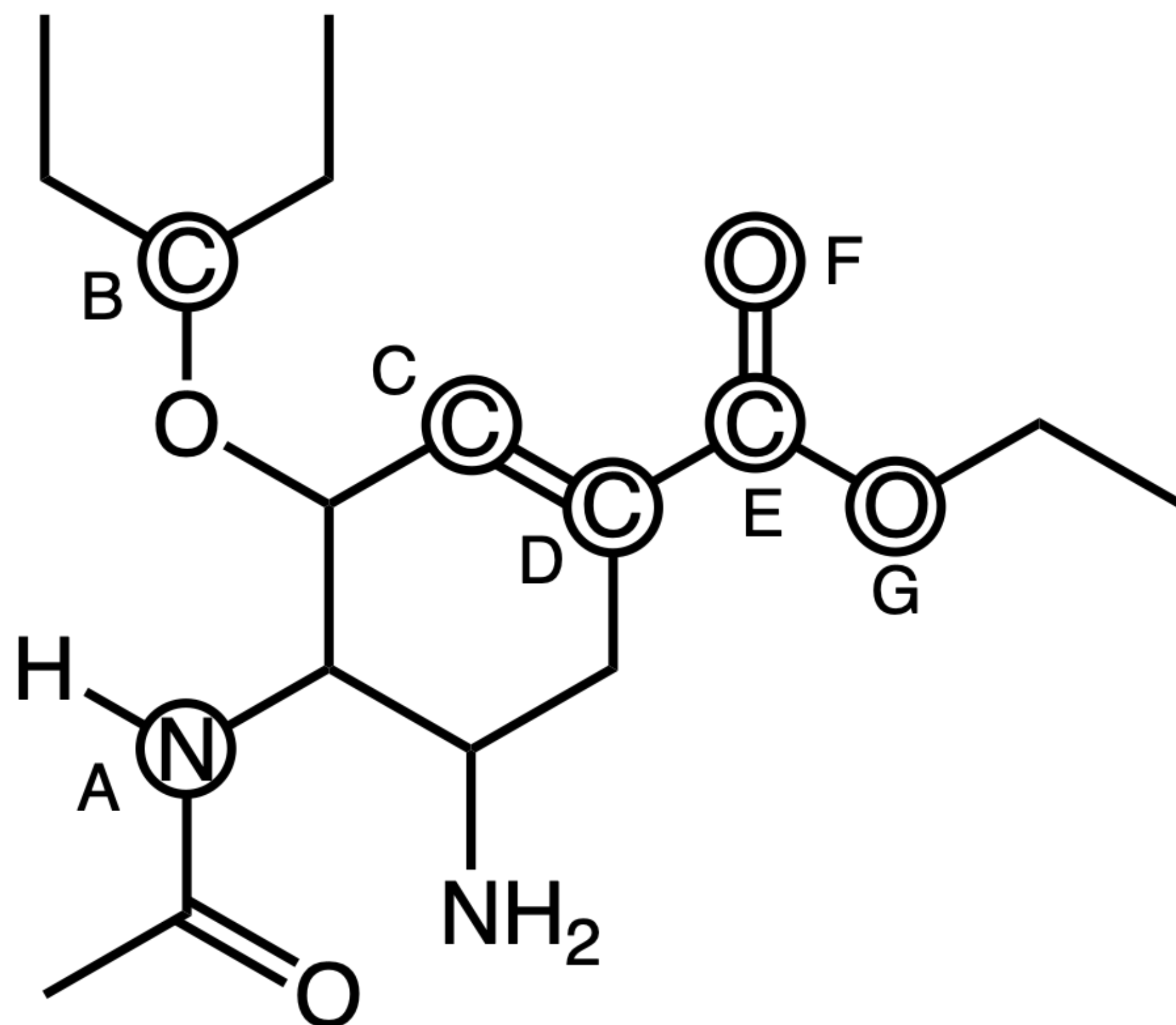
## PRACTICE PROBLEM 9

Consider the molecule Tamiflu shown below. For each circled atom (labeled A-G), give the ...

(a) Molecular geometry

(b) Hybridization

— answer —

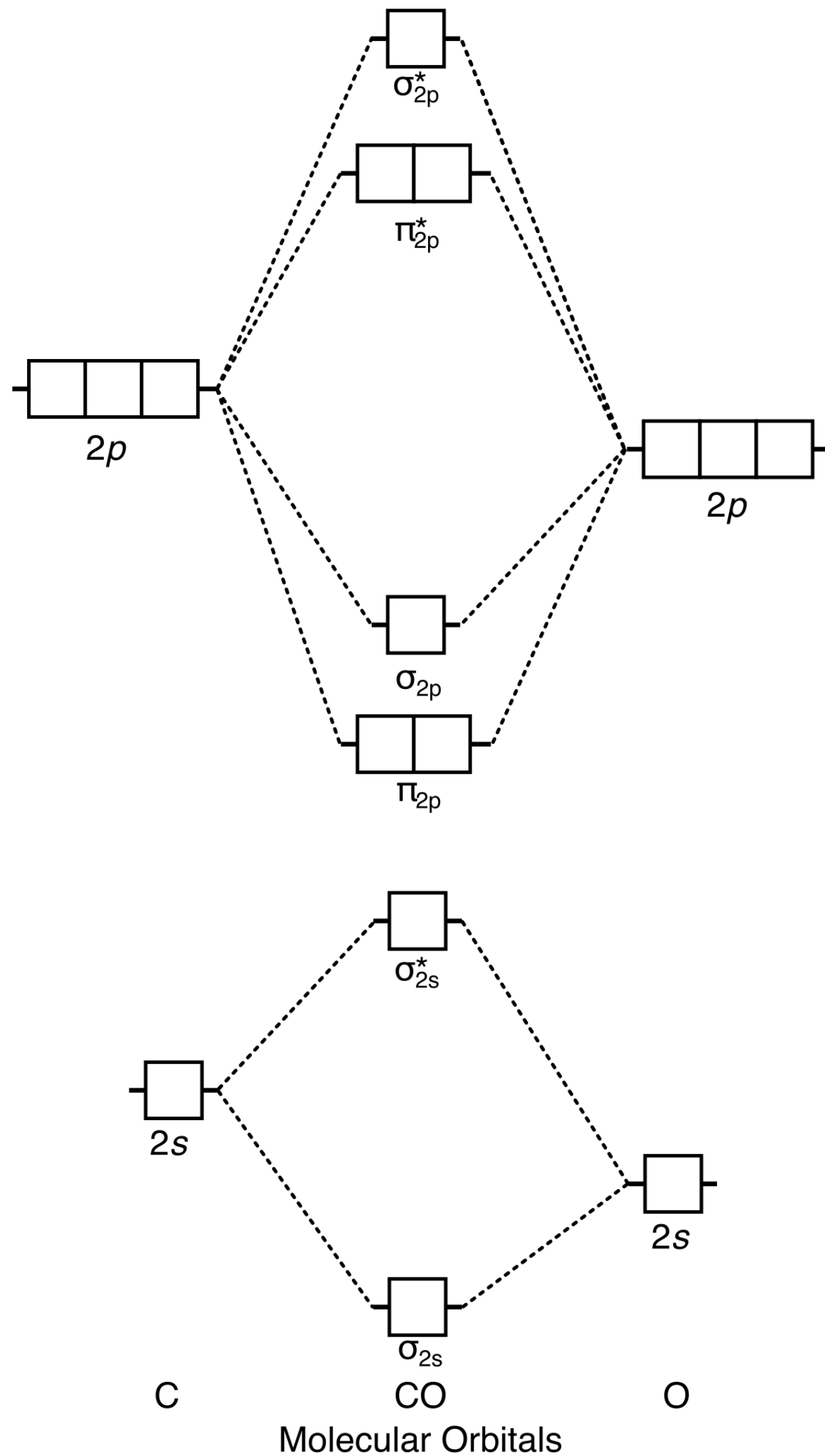


Atom Label	Geometry	Hybridization
A		
B		
C		
D		
E		
F	N/A	
G		

# PRACTICE PROBLEM 10

Consider carbon monoxide (CO) and its molecular orbital diagram below.

— answer —



- (A) Using the diagram on the left, fill in the electrons for the molecular orbitals of CO.
- (B) Determine the bond order for CO based on your diagram.
- (C) Do you expect CO to be paramagnetic or diamagnetic?
- (D) Do you expect  $\text{CO}^{4+}$  to be paramagnetic or diamagnetic?
- (E) Do you expect  $\text{CO}^{2-}$  to be paramagnetic or diamagnetic?