EXAM 3
Review Answers

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

www.mioy.org/chem161

Click on the slide number corresponding to the problem for which you would like the solution:

BACK TO TOC

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

There are three ways you can solve this problem since we can inter-relate energy (*E*), wavelength (*λ*), and frequency (*ν*) via:

$$E = \frac{hc}{\lambda} = h\nu \quad ; \quad \text{where } c = \lambda\nu$$

Comparing Energies

$$E_A = h\nu_A$$
$$= \left(6.626 \times 10^{-34}\ \frac{J}{s}\right)(2.45 \times 10^{9}\ Hz)$$
$$E_A = 1.62 \times 10^{-24}\ J$$

$$E_B = \frac{hc}{\lambda_B}$$
$$= \frac{\left(6.626 \times 10^{-34}\ \frac{J}{s}\right)\left(3.00 \times 10^{8}\ \frac{m}{s}\right)}{965 \times 10^{-9}\ m}$$
$$E_B = 2.06 \times 10^{-19}\ J$$

Photon B has greater energy.

Comparing Wavelengths

$$c = \lambda_A\nu_A$$
$$3.00 \times 10^{8}\ \frac{m}{s} = \lambda_A \times (2.45 \times 10^{9}\ Hz)$$
$$\lambda_A = 0.122\ m$$

$$\lambda_B = 965 \times 10^{-9}\ m$$

Photon B has a shorter wavelength; thus, photon B has greater energy.

Comparing Frequencies

$$\nu_A = 2.45 \times 10^{9}\ Hz$$

$$c = \lambda_B\nu_B$$
$$3.00 \times 10^{8}\ \frac{m}{s} = (965 \times 10^{-9}\ m) \times \nu_B$$
$$\nu_B = 3.11 \times 10^{14}\ Hz$$

Photon B has a larger frequency and shorter wavelength; thus, photon B has greater energy.

BACK TO TOC

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?

First, consider the information we know: the laser emits 1.00 J of energy per second. From this information we can figure out how much energy, in total, is emitted over a span of 5 seconds.

$$1.00\ \frac{\text{J}}{\text{s}} \times 5.00\ \text{s} = 5.00\ \text{J (total energy emitted)}$$

Second, we need to consider that light is composed of photons with equal energy, and that this energy is given by the wavelength. Therefore, we can now determine the energy of a single photon of red laser with wavelength 630 nm.

$$E = \frac{hc}{\lambda} = \frac{\left(6.626 \times 10^{-34}\ \frac{\text{J}}{\text{s}}\right)\left(3.00 \times 10^{8}\ \frac{\text{m}}{\text{s}}\right)}{630 \times 10^{-9}\ \text{m}} = 3.15_5 \times 10^{-19}\ \text{J (per photon)}$$

Finally, we can determine the number of photons emitted in 5.00 seconds since we know the total amount of energy and the amount of energy per photon of red laser:

$$\text{n}_{\text{photons}} = (5.00\ \text{J}) \times \left(\frac{1\ \text{photon}}{3.15_5 \times 10^{-19}\ \text{J}}\right) = 1.58 \times 10^{19}\ \text{photons}$$

Total energy emitted in 5 seconds

Energy per photon

BACK TO TOC

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

For electron transitions in the hydrogen atom, we can apply the Rydberg equation to calculate the wavelength associated with each transition.

$$\frac{1}{\lambda} = \left[1.10 \times 10^{7}\,\frac{1}{\text{m}}\right]\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad ; \quad R_H = 1.10 \times 10^{7}\,\frac{1}{\text{m}}$$

Electron Transitions	Wavelengths	Frequencies
$n = 5 \rightarrow n = 4$	$\frac{1}{\lambda_{5\to4}} = \left[1.10 \times 10^{7}\,\frac{1}{\text{m}}\right]\left(\frac{1}{4^2} - \frac{1}{5^2}\right) = 247_{500}\,\frac{1}{\text{m}}$ $\boldsymbol{\lambda_{5\to4} = 4.04 \times 10^{-6}\ \text{m}}$	$c = \lambda_{5\to4}\nu_{5\to4}$ $3.00 \times 10^{8}\,\frac{\text{m}}{\text{s}} = (4.04 \times 10^{-6}\ \text{m}) \times \nu_{5\to4}$ $\boldsymbol{\nu_{5\to4} = 7.43 \times 10^{13}\ \text{Hz}}$
$n = 4 \rightarrow n = 3$	$\frac{1}{\lambda_{4\to3}} = \left[1.10 \times 10^{7}\,\frac{1}{\text{m}}\right]\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = 534_{722}\,\frac{1}{\text{m}}$ $\boldsymbol{\lambda_{4\to3} = 1.87 \times 10^{-6}\ \text{m}}$	$c = \lambda_{4\to3}\nu_{4\to3}$ $3.00 \times 10^{8}\,\frac{\text{m}}{\text{s}} = (1.87 \times 10^{-6}\ \text{m}) \times \nu_{4\to3}$ $\boldsymbol{\nu_{4\to3} = 1.60 \times 10^{14}\ \text{Hz}}$
$n = 3 \rightarrow n = 2$	$\frac{1}{\lambda_{3\to2}} = \left[1.10 \times 10^{7}\,\frac{1}{\text{m}}\right]\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 152_{7777}\,\frac{1}{\text{m}}$ $\boldsymbol{\lambda_{3\to2} = 6.55 \times 10^{-7}\ \text{m}}$	$c = \lambda_{3\to2}\nu_{3\to2}$ $3.00 \times 10^{8}\,\frac{\text{m}}{\text{s}} = (6.54_5 \times 10^{-7}\ \text{m}) \times \nu_{3\to2}$ $\boldsymbol{\nu_{3\to2} = 4.58 \times 10^{14}\ \text{Hz}}$
$n = 2 \rightarrow n = 1$	$\frac{1}{\lambda_{2\to1}} = \left[1.10 \times 10^{7}\,\frac{1}{\text{m}}\right]\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 8250000\,\frac{1}{\text{m}}$ $\boldsymbol{\lambda_{2\to1} = 1.21 \times 10^{-7}\ \text{m}}$	$c = \lambda_{2\to1}\nu_{2\to1}$ $3.00 \times 10^{8}\,\frac{\text{m}}{\text{s}} = (1.21_2 \times 10^{-7}\ \text{m}) \times \nu_{2\to1}$ $\boldsymbol{\nu_{2\to1} = 2.48 \times 10^{15}\ \text{Hz}}$

Energy of transitions (spacing) get smaller as higher transitions occur.

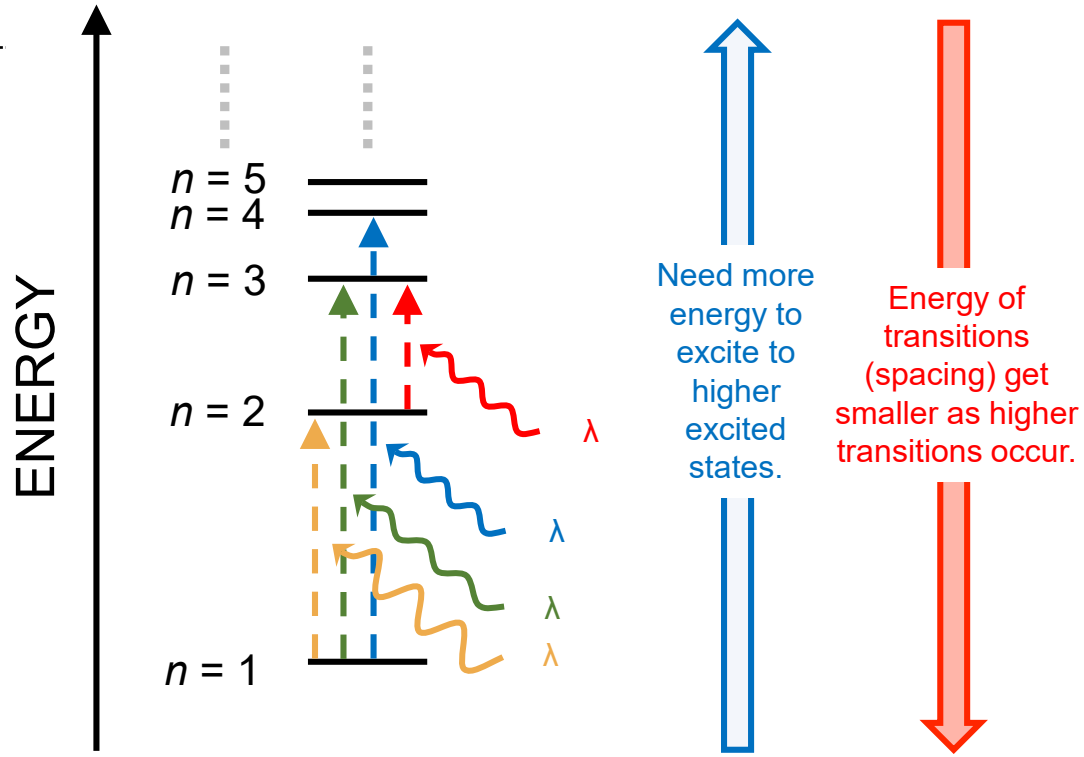
BACK TO TOC

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

We can still apply the Rydberg equation to calculate the wavelengths, but this corresponds to *absorptions* now, not emissions.

$$\frac{1}{\lambda} = \left[1.10 \times 10^7 \frac{1}{\text{m}}\right]\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad ; \quad R_H = 1.10 \times 10^7 \frac{1}{\text{m}}$$

Absorptions	Wavelengths
$n = 1 \rightarrow n = 2$	$\frac{1}{\lambda_{2\rightarrow1}} = \left[1.10 \times 10^7 \frac{1}{\text{m}}\right]\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 8250000 \frac{1}{\text{m}}$ $\boldsymbol{\lambda_{2\rightarrow1} = 1.21 \times 10^{-7}\ \text{m}}$
$n = 1 \rightarrow n = 3$	$\frac{1}{\lambda_{3\rightarrow1}} = \left[1.10 \times 10^7 \frac{1}{\text{m}}\right]\left(\frac{1}{1^2} - \frac{1}{3^2}\right) = 977_{7777} \frac{1}{\text{m}}$ $\boldsymbol{\lambda_{3\rightarrow1} = 1.03 \times 10^{-7}\ \text{m}}$
$n = 1 \rightarrow n = 4$	$\frac{1}{\lambda_{4\rightarrow1}} = \left[1.10 \times 10^7 \frac{1}{\text{m}}\right]\left(\frac{1}{1^2} - \frac{1}{4^2}\right) = 103_{12500} \frac{1}{\text{m}}$ $\boldsymbol{\lambda_{4\rightarrow1} = 9.70 \times 10^{-8}\ \text{m}}$
$n = 2 \rightarrow n = 3$	$\frac{1}{\lambda_{3\rightarrow2}} = \left[1.10 \times 10^7 \frac{1}{\text{m}}\right]\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 152_{7777} \frac{1}{\text{m}}$ $\boldsymbol{\lambda_{3\rightarrow2} = 6.55 \times 10^{-7}\ \text{m}}$



BACK TO TOC

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) $n = 3 \rightarrow n = 2$

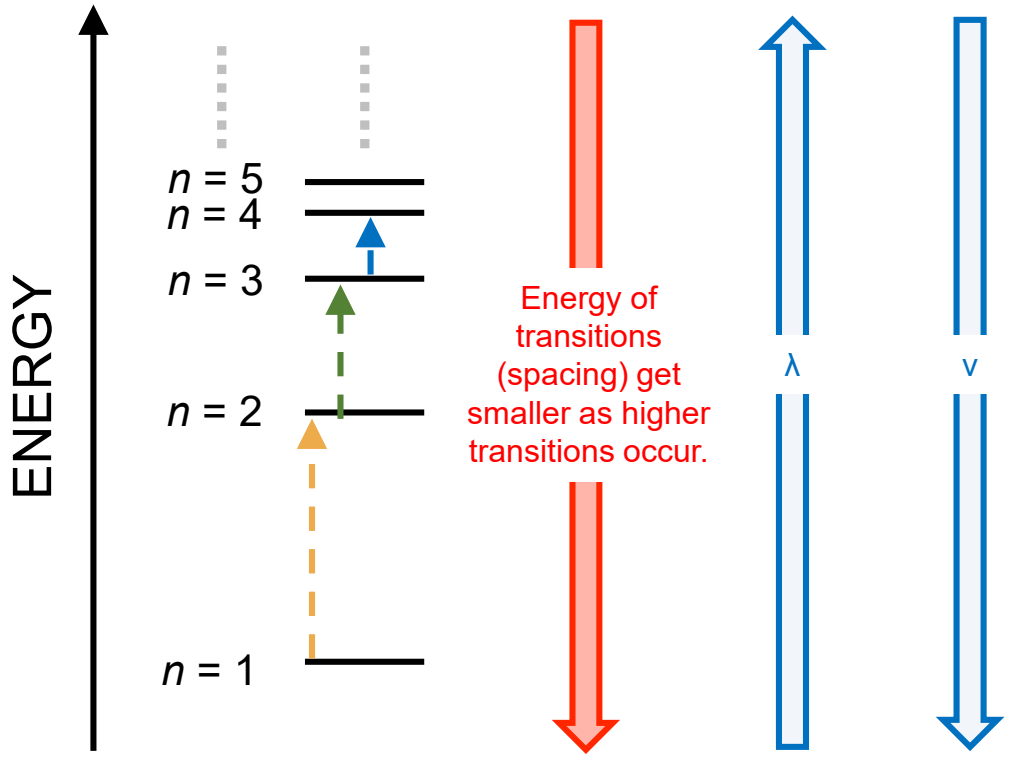
This problem should not require any calculations—even though you will get the right answer, it will take you too long to do.

First, eliminate choices B and C since those are both *absorptions*.

Second, you need to understand that the spacing between the states gets smaller and smaller as the value of *n* increases (i.e. higher excited states). So the largest energy spacing will occur for the $n = 2 \rightarrow n = 1$ transition, which results in the shortest wavelength and highest frequency of light.

Every successive emission has smaller ΔE, longer λ, and higher v.

So, the answer is A.



BACK TO TOC

What are the possible values of m_ℓ when n = 4?

Remember the general, ordered scheme for assigning/generating quantum numbers:

1. Start with n, the principal quantum number

2. Then assign ℓ, the angular momentum quantum number.
   The values of ℓ range from 0 to (n – 1) in integers.
   The value of ℓ determines the orbital shape (s, p, d, or f).

3. Next assign m_ℓ, which is the magnetic quantum number.
   m_ℓ can take on integer values ranging from –ℓ to + ℓ.
   The number of possible m_ℓ values determines how many orbitals exist.

4. Finally, assign m_s, the spin quantum number.
   m_s can only take on two values: +½ and –½.
   This tells us that only two electrons can occupy an orbital.

n	⇨	ℓ	⇨	m_ℓ	⇨	m_s
4		0 (s)		0	1	+½ or –½
		1 (p)		–1	3	+½ or –½
				0		+½ or –½
				+1		+½ or –½
		2 (d)		–2	5	+½ or –½
				–1		+½ or –½
				0		+½ or –½
				+1		+½ or –½
				+2		+½ or –½
		3 (f)		–3	7	+½ or –½
				–2		+½ or –½
				–1		+½ or –½
				0		+½ or –½
				+1		+½ or –½
				+2		+½ or –½
				+3		+½ or –½

BACK TO TOC

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

Set I	Set II	Set III	Set IV
$n = 1$ $\ell = 2$ $m_\ell = 0$ $m_s = +½$	$n = 3$ $\ell = 0$ $m_\ell = 0$ $m_s = –½$	$n = 1$ $\ell = 0$ $m_\ell = 1$ $m_s = –½$	$n = 2$ $\ell = 1$ $m_\ell = 2$ $m_s = +½$
⇧		⇧	⇧
For $n = 1$, the only possible value of ℓ is 0. Therefore, Set I is not allowed.		For $n = 1$, the only possible value of ℓ is 0. But, for $\ell = 0$, the only possible value of m_ℓ is 0. Therefore, Set III is not allowed.	For $n = 2$, the possible values of ℓ are 0 and 1. For $\ell = 1$, the possible values of m_ℓ are –1, 0, +1. Therefore, Set IV is not allowed.

Remember the general, ordered scheme for assigning/generating quantum numbers:

1. Start with n, the principal quantum number
2. Then assign ℓ, the angular momentum quantum number.
   The values of ℓ range from 0 to $(n – 1)$ in integers.
3. Next assign m_ℓ, which is the magnetic quantum number.
   m_ℓ can take on integer values ranging from $–\ell$ to $+\ell$.
4. Finally, assign m_s, the spin quantum number.
   m_s can only take on two values: +½ and –½.

BACK TO TOC

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

Sets	Ordered Sets
Sn, Xe, Rb, Sr	Xe < Sn < Sr < Rb
Rn, He, Xe, Kr	
Pb, Ba, Cs, At	
Ga, N, Cs, P	
O^{2-}, F^{-}, Na^{+}, Mg^{2+}	

Size increases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction from the positively charged nucleus.

Size decreases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus).

For the ions, consider that each ion has 10 electrons, but a different number of protons. As the number of protons increases, the size decreases.

BACK TO TOC

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

Sets	Ordered Sets
Sn, Xe, Rb, Sr	Xe < Sn < Sr < Rb
Rn, He, Xe, Kr	He < Kr < Xe < Rn
Pb, Ba, Cs, At	
Ga, N, Cs, P	
O^{2-}, F^{-}, Na^{+}, Mg^{2+}	

Size increases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction from the positively charged nucleus.

Size decreases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus).

For the ions, consider that each ion has 10 electrons, but a different number of protons. As the number of protons increases, the size decreases.

BACK TO TOC

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

Sets	Ordered Sets
Sn, Xe, Rb, Sr	Xe < Sn < Sr < Rb
Rn, He, Xe, Kr	He < Kr < Xe < Rn
Pb, Ba, Cs, At	At < Pb < Ba < Cs
Ga, N, Cs, P	
O^{2-}, F^{-}, Na^{+}, Mg^{2+}	

Size increases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction from the positively charged nucleus.

Size decreases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus).

For the ions, consider that each ion has 10 electrons, but a different number of protons. As the number of protons increases, the size decreases.

BACK TO TOC

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

Sets	Ordered Sets
Sn, Xe, Rb, Sr	Xe < Sn < Sr < Rb
Rn, He, Xe, Kr	He < Kr < Xe < Rn
Pb, Ba, Cs, At	At < Pb < Ba < Cs
Ga, N, Cs, P	N < P < Ga < Cs
O^{2-}, F^{-}, Na^{+}, Mg^{2+}	

Size increases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction from the positively charged nucleus.

Size decreases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus).

For the ions, consider that each ion has 10 electrons, but a different number of protons. As the number of protons increases, the size decreases.

BACK TO TOC

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

Sets	Ordered Sets
Sn, Xe, Rb, Sr	Xe < Sn < Sr < Rb
Rn, He, Xe, Kr	He < Kr < Xe < Rn
Pb, Ba, Cs, At	At < Pb < Ba < Cs
Ga, N, Cs, P	N < P < Ga < Cs
O^{2-}, F^{-}, Na^{+}, Mg^{2+}	$Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

Size increases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction from the positively charged nucleus.

Size decreases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus).

For the ions, consider that each ion has 10 electrons, but a different number of protons. As the number of protons increases, the size decreases.

BACK TO TOC

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

Sets	Ordered Sets
B, N, Rb	Rb < B < N
Li, C, Si	
Mg, O, P, Na	
Te, Cs, F, Sn, Se	

IE decreases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction (more screening) from the positively charged nucleus

→ easier to remove electron!

IE increases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus)

→ harder to remove electron!

BACK TO TOC

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

Sets	Ordered Sets
B, N, Rb	Rb < B < N
Li, C, Si	Li < Si < C
Mg, O, P, Na	
Te, Cs, F, Sn, Se	

IE decreases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction (more screening) from the positively charged nucleus

→ easier to remove electron!

IE increases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus)

→ harder to remove electron!

BACK TO TOC

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

Sets	Ordered Sets
B, N, Rb	Rb < B < N
Li, C, Si	Li < Si < C
Mg, O, P, Na	Na < Mg < P < O
Te, Cs, F, Sn, Se	

IE decreases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction (more screening) from the positively charged nucleus

→ easier to remove electron!

IE increases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus)

→ harder to remove electron!

BACK TO TOC

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

Sets	Ordered Sets
B, N, Rb	Rb < B < N
Li, C, Si	Li < Si < C
Mg, O, P, Na	Na < Mg < P < O
Te, Cs, F, Sn, Se	Cs < Sn < Te < Se < F

IE decreases down a column:

- Adding electrons to larger and larger energy levels (*n*).
- Electrons are farther and farther from the nucleus.
- Less attraction (more screening) from the positively charged nucleus

→ easier to remove electron!

IE increases across a row:

- Adding electrons to the same energy level (*n*).
- But also adding more and more protons (positive charge).
- Electrons are pulled more tightly by the increased number of protons (i.e. greater positive charge of nucleus)

→ harder to remove electron!

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

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

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V		
Mn		
Mn^{2+}		
Ti^{2+}		
Cu		
Cu^{2+}		
Cu^+		
Te^{2-}		

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn		
Mn^{2+}		
Ti^{2+}		
Cu		
Cu^{2+}		
Cu^+		
Te^{2-}		

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}		
Ti^{2+}		
Cu		
Cu^{2+}		
Cu^+		
Te^{2-}		

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}		
Cu		
Cu^{2+}		
Cu^+		
Te^{2-}		

Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$
Cu		
Cu^{2+}		
Cu^+		
Te^{2-}		

Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$
Cu	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]4s^1 3d^{10}$
Cu^{2+}		
Cu^+		
Te^{2-}		

Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$
Cu	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]4s^1 3d^{10}$
Cu^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$	$[Ar]3d^9$
Cu^+		
Te^{2-}		

Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$
Cu	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]4s^1 3d^{10}$
Cu^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$	$[Ar]3d^9$
Cu^+	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$	$[Ar]3d^{10}$
Te^{2-}		

Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

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

Atom/Ion	Full configuration	Condensed configuration
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$
Cu	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]4s^1 3d^{10}$
Cu^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$	$[Ar]3d^9$
Cu^+	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$	$[Ar]3d^{10}$
Te^{2-}	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$	$[Kr]5s^2 4d^{10} 5p^6$

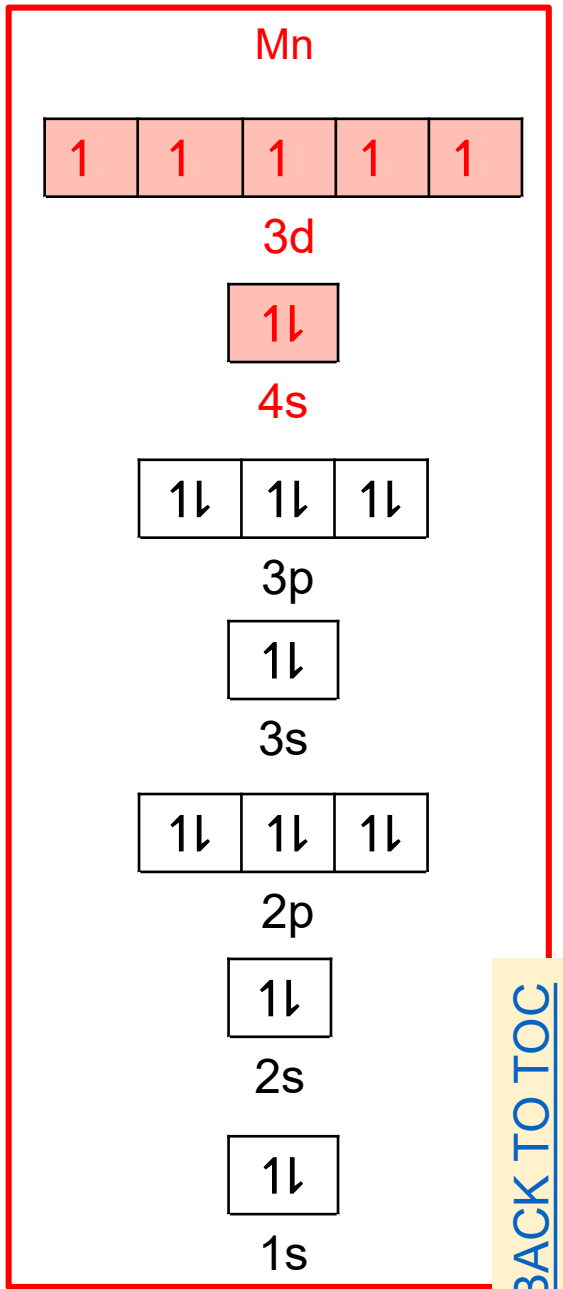
Special Notes:
1. Cu is an exception and fills only half an s orbital.
2. For transition metal cations, remove electrons from s orbital first.

BACK TO TOC

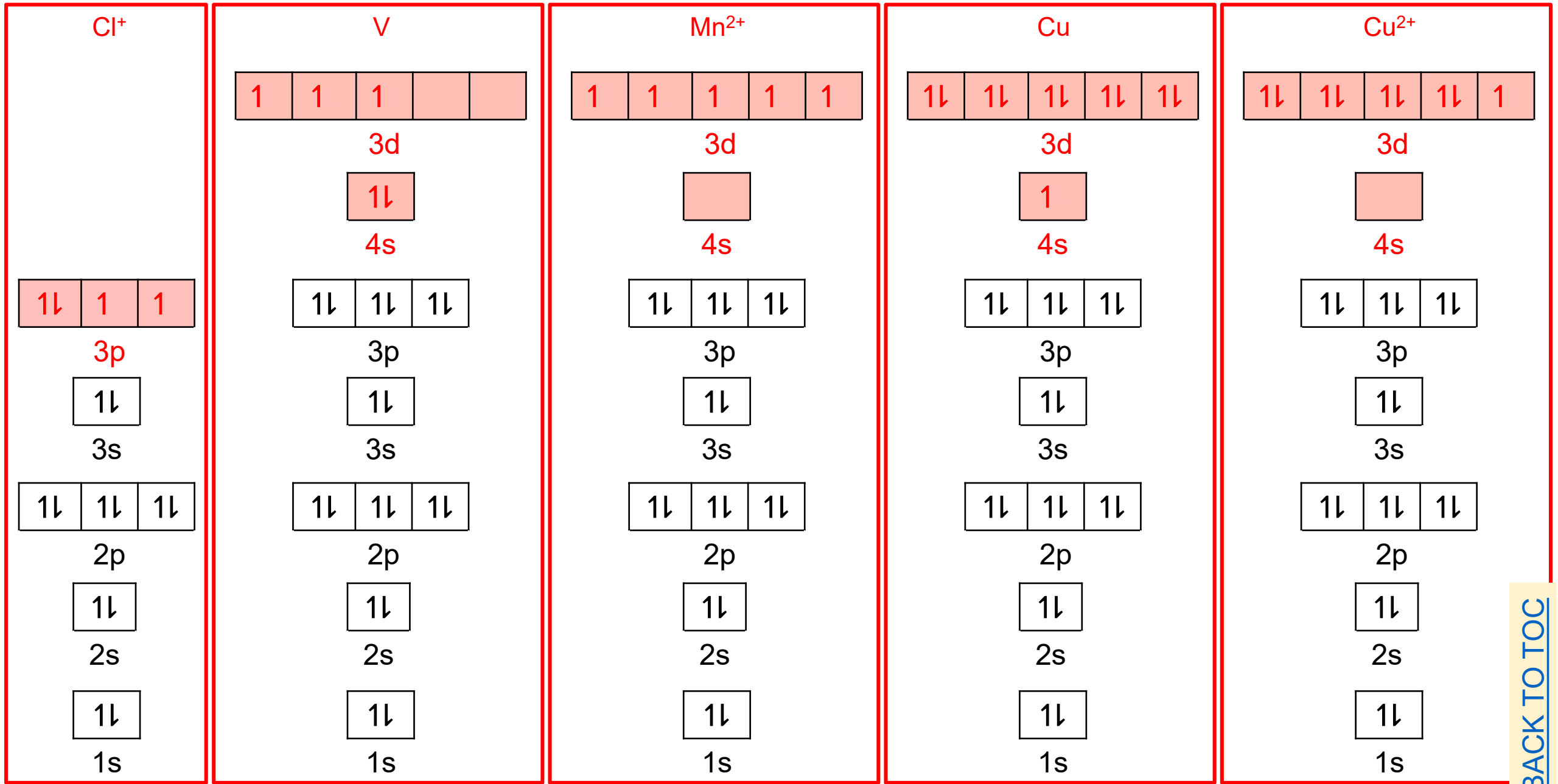
For each of the following atoms or ions, determine the number of unpaired electrons.

Atom/Ion	Full configuration	Condensed configuration	Unpaired electrons
Cl^+	$1s^2 2s^2 2p^6 3s^2 3p^4$	$[Ne]3s^2 3p^4$	2 unpaired electrons
V	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$	$[Ar]4s^2 3d^3$	3 unpaired electrons
Mn	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$	$[Ar]4s^2 3d^5$	5 unpaired electrons
Mn^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$	$[Ar]3d^5$	5 unpaired electrons
Ti^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$	$[Ar]3d^2$	2 unpaired electrons
Cu	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$	$[Ar]4s^1 3d^{10}$	1 unpaired electrons
Cu^{2+}	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$	$[Ar]3d^9$	1 unpaired electrons
Cu^+	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$	$[Ar]3d^{10}$	0 unpaired electrons
Te^{2-}	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6$	$[Kr]5s^2 4d^{10} 5p^6$	0 unpaired electrons

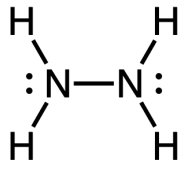
For most of these, the orbital diagram is as shown on the right (Mn, 25 electrons). The general principles are to: (**1**) determine how many electrons the atom/ion has, (**2**) fill from the lowest-energy orbitals first, and (**3**) fill across orbital before pairing electrons to maximize unpaired electrons.



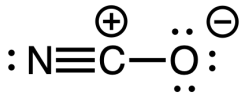
BACK TO TOC


Cl+
1↓ 1 1
3p
1↓
3s
1↓ 1↓ 1↓
2p
1↓
2s
1↓
1s
V
1 1 1
3d
1↓
4s
1↓ 1↓ 1↓
3p
1↓
3s
1↓ 1↓ 1↓
2p
1↓
2s
1↓
1s
Mn2+
1 1 1 1 1
3d
4s
1↓ 1↓ 1↓
3p
1↓
3s
1↓ 1↓ 1↓
2p
1↓
2s
1↓
1s
Cu
1↓ 1↓ 1↓ 1↓ 1↓
3d
1
4s
1↓ 1↓ 1↓
3p
1↓
3s
1↓ 1↓ 1↓
2p
1↓
2s
1↓
1s
Cu2+
1↓ 1↓ 1↓ 1↓ 1
3d
4s
1↓ 1↓ 1↓
3p
1↓
3s
1↓ 1↓ 1↓
2p
1↓
2s
1↓
1s

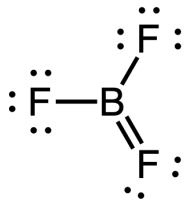
BACK TO TOC



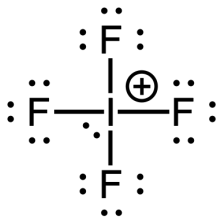
I



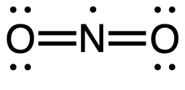
II



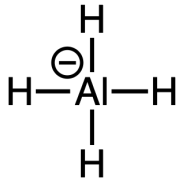
III



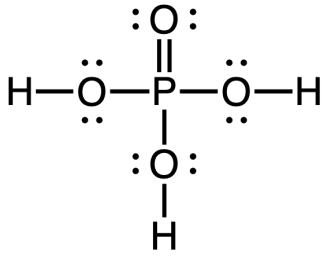
IV



V



VI



VII

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

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

Structure IV → Iodine has 10 electrons

Structure V → Nitrogen has 9 electrons

Structure VII → Phosphorus has 10 electrons

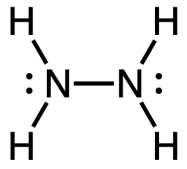
B. Which structures have an incorrect formal charge assignment?

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

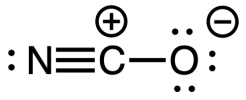
D. Given that the electronegativities of H and B are equal, which structure has the most polar bond?

Structure III Structure VI Structure VII

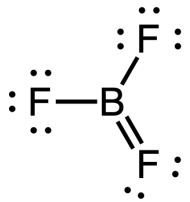
BACK TO TOC



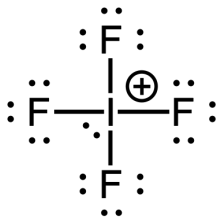
I



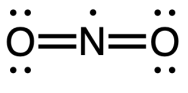
II



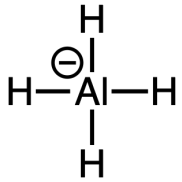
III



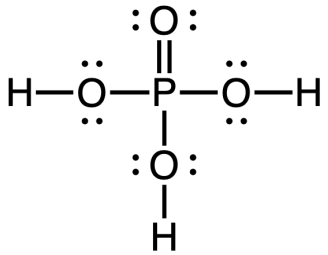
IV



V



VI



VII

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

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

Structure IV → Iodine has 10 electrons

Structure V → Nitrogen has 9 electrons

Structure VII → Phosphorus has 10 electrons

B. Which structures have an incorrect formal charge assignment?

Structure II → Carbon should be “0”

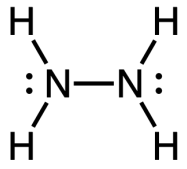
Structure III → Boron should be “+1” and F (in B=F) should be “–1”

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

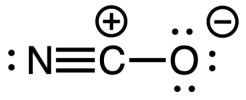
D. Given that the electronegativities of H and B are equal, which structure has the most polar bond?

Structure III Structure VI Structure VII

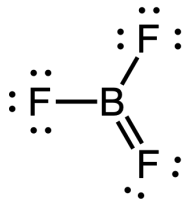
BACK TO TOC



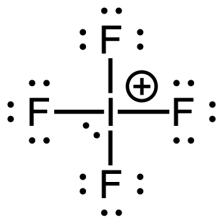
I



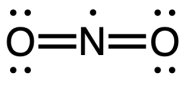
II



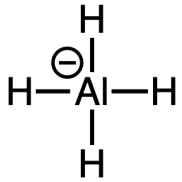
III



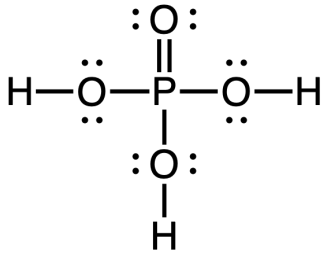
IV



V



VI



VII

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

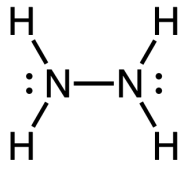
A. Which structures have an atom that breaks the octet rule?
   - Structure IV → Iodine has 10 electrons
   - Structure V → Nitrogen has 9 electrons
   - Structure VII → Phosphorus has 10 electrons

B. Which structures have an incorrect formal charge assignment?
   - Structure II → Carbon should be “0”
   - Structure III → Boron should be “+1” and F (in B=F) should be “–1”

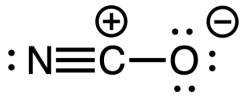
C. Which structures could have another reasonable resonance structure that obeys the octet rule?
   Structures II and III

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

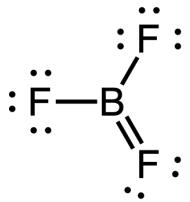
BACK TO TOC



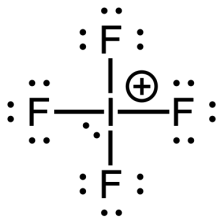
I



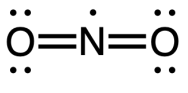
II



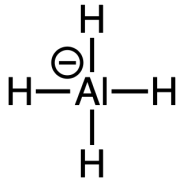
III



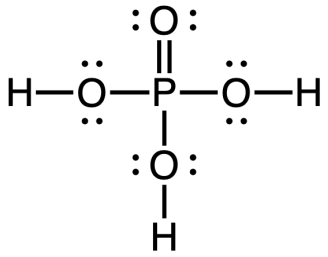
IV



V



VI



VII

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

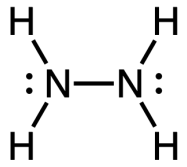
A. Which structures have an atom that breaks the octet rule?
   - Structure IV → Iodine has 10 electrons
   - Structure V → Nitrogen has 9 electrons
   - Structure VII → Phosphorus has 10 electrons

B. Which structures have an incorrect formal charge assignment?
   - Structure II → Carbon should be “0”
   - Structure III → Boron should be “+1” and F (in B=F) should be “–1”

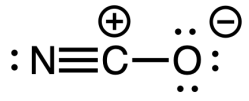
C. Which structures could have another reasonable resonance structure that obeys the octet rule?
   Structures II and III

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

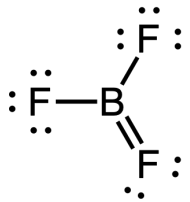
BACK TO TOC



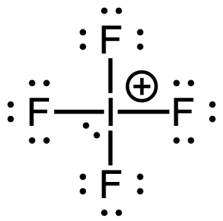
I



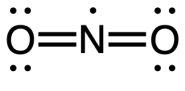
II



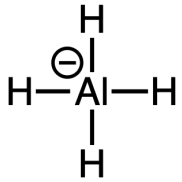
III



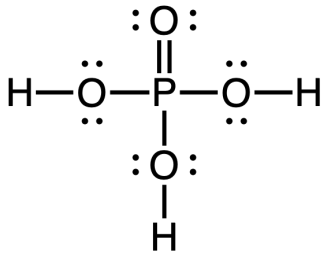
IV



V



VI



VII

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

A. Which structures have only <u>one</u> π bond?
Structures III and VII

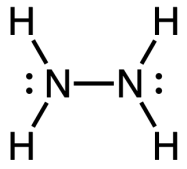
B. Which structures would be paramagnetic?

C. Which structures contain an sp-hybridized atom?

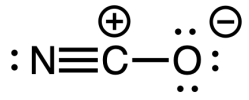
D. Which structures contain an sp^2-hybridized atom?

E. Which structures have a bond angle that is 180°?

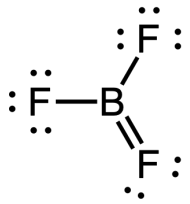
BACK TO TOC



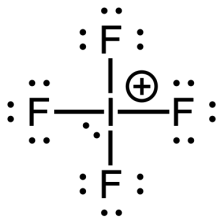
I



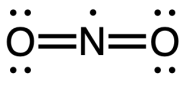
II



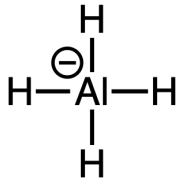
III



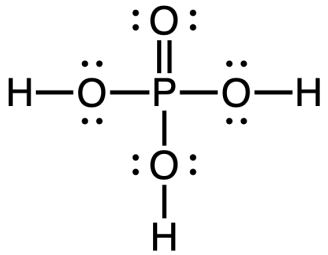
IV



V



VI



VII

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

A. Which structures have only <u>one</u> π bond?
Structures III and VII

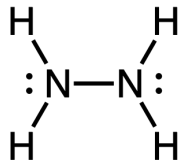
B. Which structures would be paramagnetic?
Structure V → Nitrogen has one unpaired electron (radical)

C. Which structures contain an sp-hybridized atom?

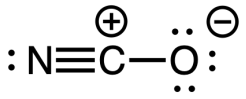
D. Which structures contain an sp^2-hybridized atom?

E. Which structures have a bond angle that is 180°?

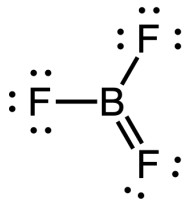
BACK TO TOC



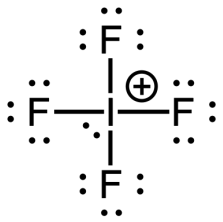
I



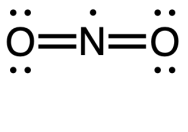
II



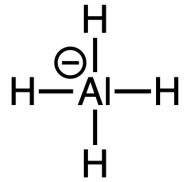
III



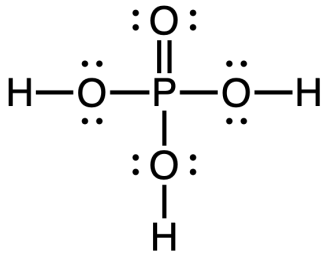
IV



V



VI



VII

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

A. Which structures have only <u>one</u> π bond?
Structures III and VII

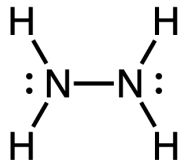
B. Which structures would be paramagnetic?
Structure V → Nitrogen has one unpaired electron (radical)

C. Which structures contain an sp-hybridized atom?
Structure II → Both C and N are sp-hybridized

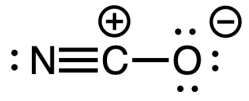
D. Which structures contain an sp^2-hybridized atom?

E. Which structures have a bond angle that is 180°?

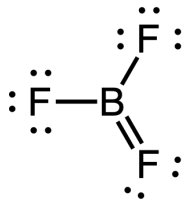
BACK TO TOC



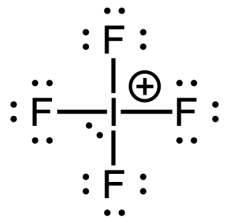
I



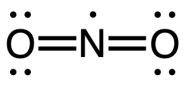
II



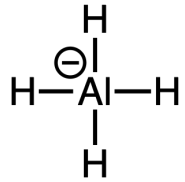
III



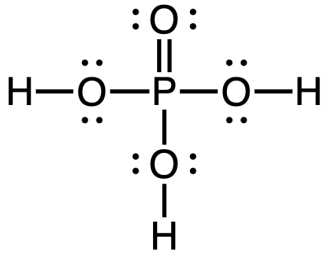
IV



V



VI



VII

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

A. Which structures have only <u>one</u> π bond?
Structures III and VII

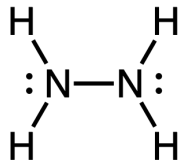
B. Which structures would be paramagnetic?
Structure V → Nitrogen has one unpaired electron (radical)

C. Which structures contain an sp-hybridized atom?
Structure II → Both C and N are sp-hybridized

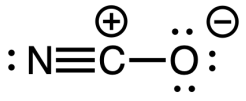
D. Which structures contain an sp^2-hybridized atom?
Structure III → B and the F in B=F are sp^2-hybridized
Structure V → All atoms are sp^2-hybridized
Structure VI → The O atom in (P=O) is sp^2-hybridized

E. Which structures have a bond angle that is 180°?

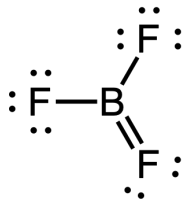
BACK TO TOC



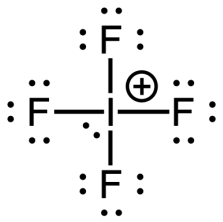
I



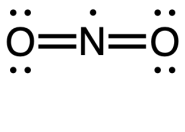
II



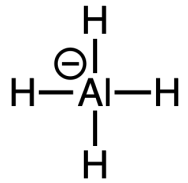
III



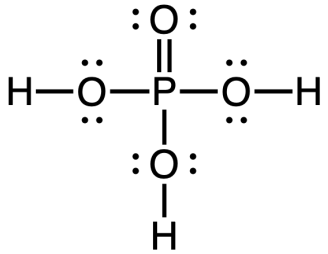
IV



V



VI



VII

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

A. Which structures have only <u>one</u> π bond?
Structures III and VII

B. Which structures would be paramagnetic?
Structure V → Nitrogen has one unpaired electron (radical)

C. Which structures contain an sp-hybridized atom?
Structure II → Both C and N are sp-hybridized

D. Which structures contain an sp^2-hybridized atom?
Structure III → B and the F in B=F are sp^2-hybridized
Structure V → All atoms are sp^2-hybridized
Structure VI → The O atom in (P=O) is sp^2-hybridized

E. Which structures have a bond angle that is 180°?
Structure II → Linear geometry
Structure IV → See-saw geometry; one of the F-I-F bond angles is 180°

BACK TO TOC

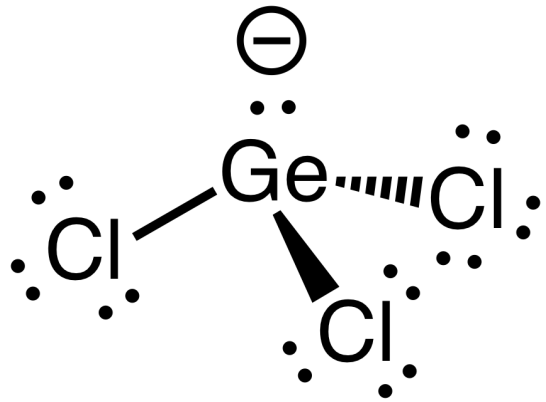
Consider the molecular ion: $[GeCl_3]^-$

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.



Steric Number at Ge = 4 (3 atoms + 1 lone pair)

Molecular Geometry at Ge = Trigonal Pyramid

Hybridization at Ge = sp^3

Polar? = Polar

BACK TO TOC

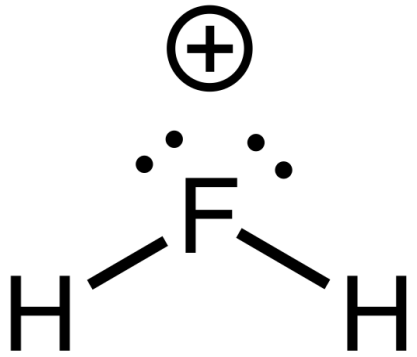
Consider the molecular ion: $[FH_2]^+$

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.



Steric Number at F = 4 (2 atoms + 2 lone pair)

Molecular Geometry at F = Bent (or angular)

Hybridization at F = sp^3

Polar? = Polar

BACK TO TOC

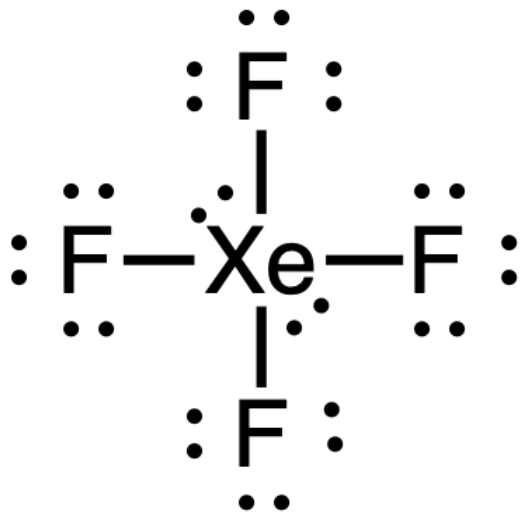
Consider the molecule: XeF_4

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.



Steric Number at Xe = 6 (4 atoms + 2 lone pair)

Molecular Geometry at Xe = Square Planar

Hybridization at Xe = sp^3d^2

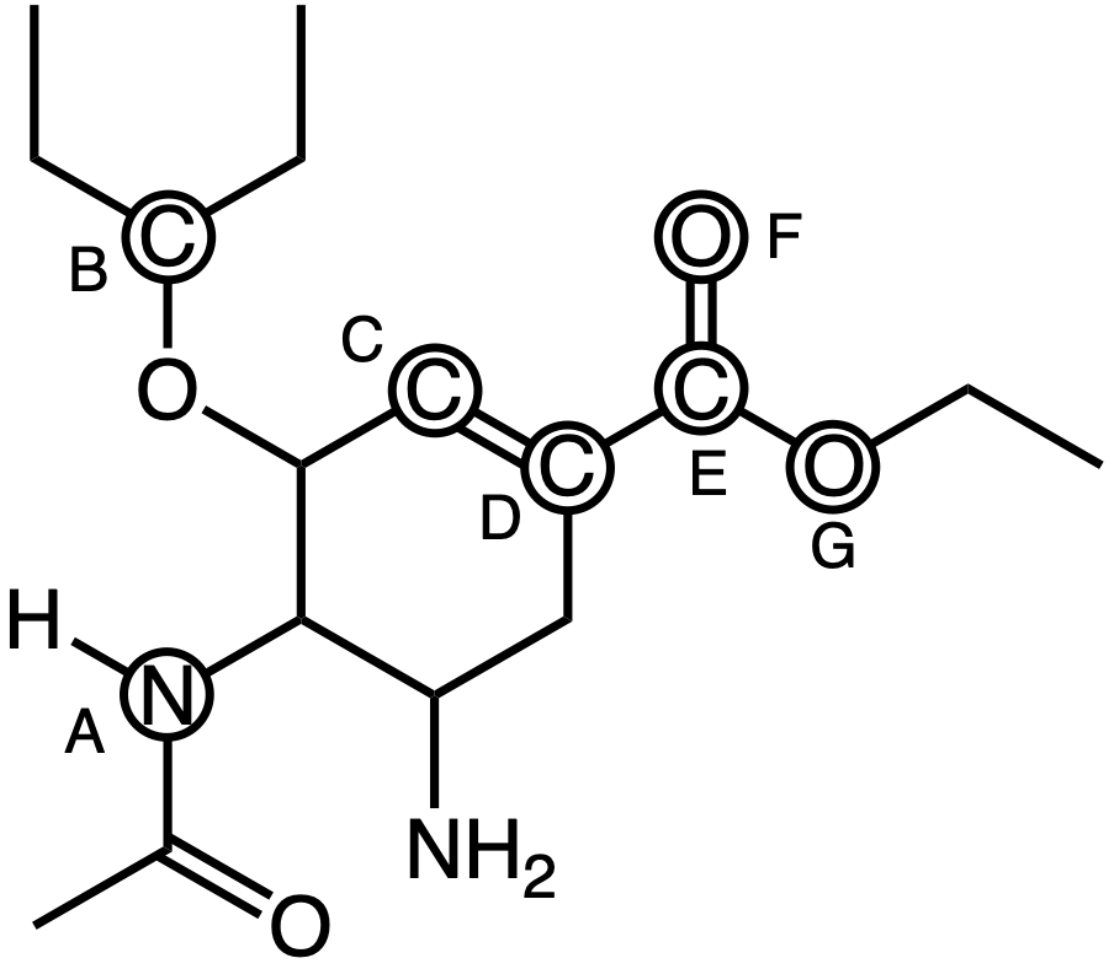
Polar? = Nonpolar

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A. Trigonal pyramidal sp^3

B.

C.

D.

E.

F. N/A

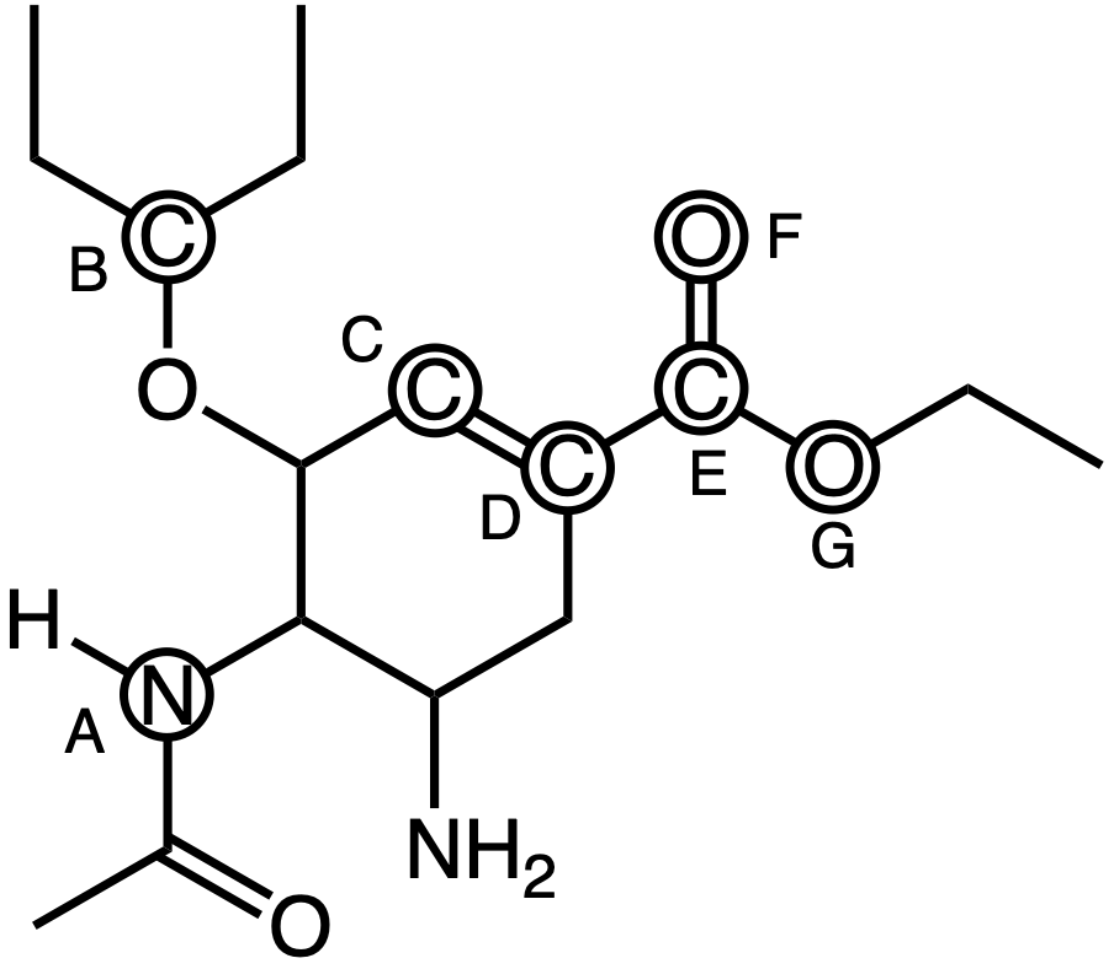
G.

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A. Trigonal pyramidal sp^3

B. Tetrahedral sp^3

C.

D.

E.

F. N/A

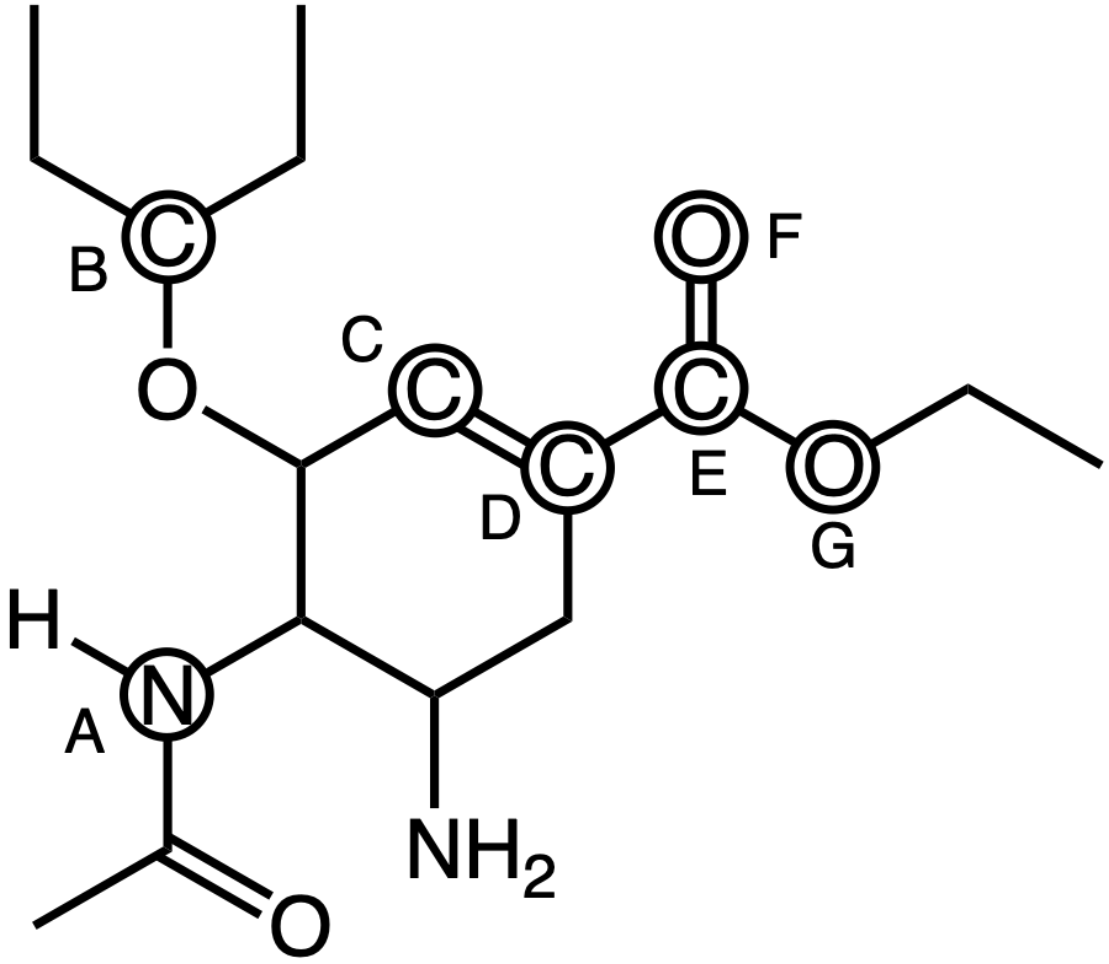
G.

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A. Trigonal pyramidal sp^3

B. Tetrahedral sp^3

C. Trigonal planar sp^2

D.

E.

F. N/A

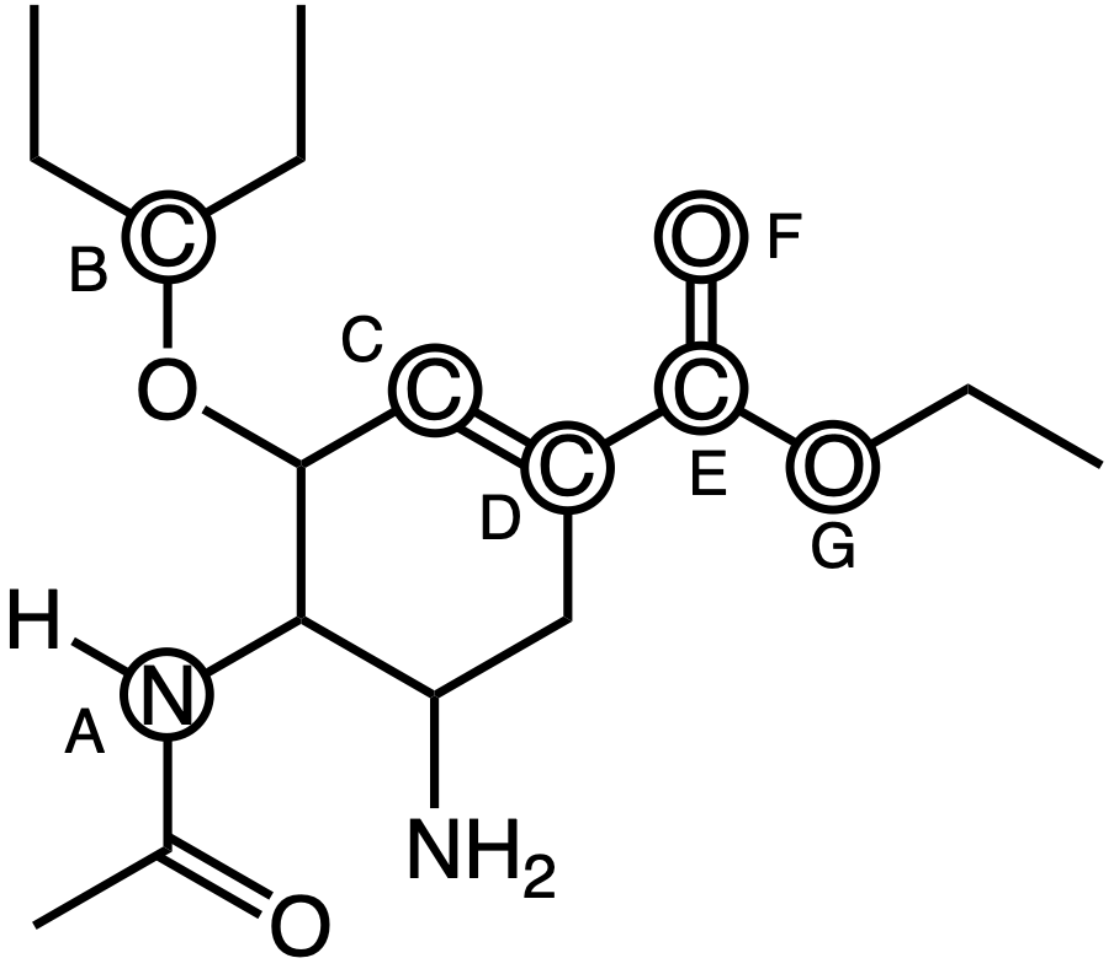
G.

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A. Trigonal pyramidal sp^3

B. Tetrahedral sp^3

C. Trigonal planar sp^2

D. Trigonal planar sp^2

E.

F. N/A

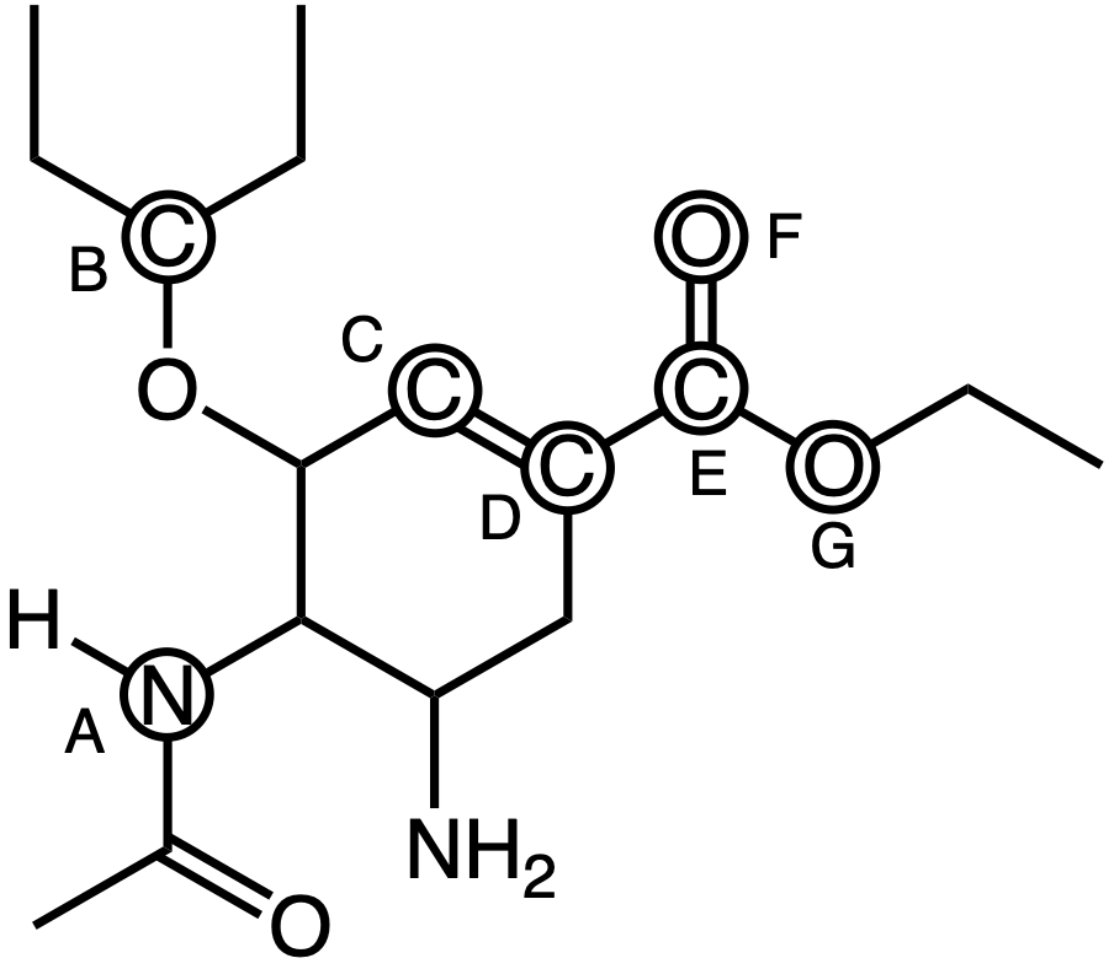
G.

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A. Trigonal pyramidal sp^3

B. Tetrahedral sp^3

C. Trigonal planar sp^2

D. Trigonal planar sp^2

E. Trigonal planar sp^2

F. N/A

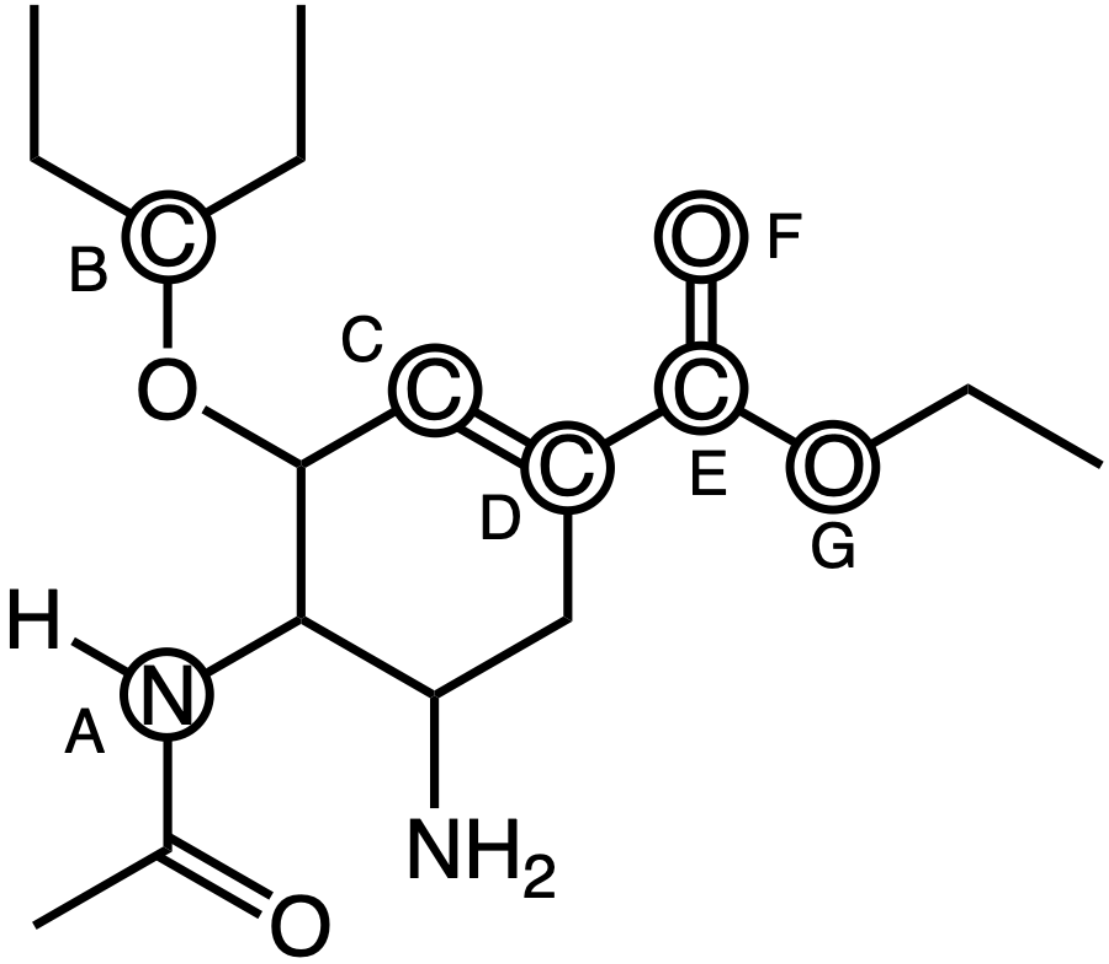
G.

BACK TO TOC

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

i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



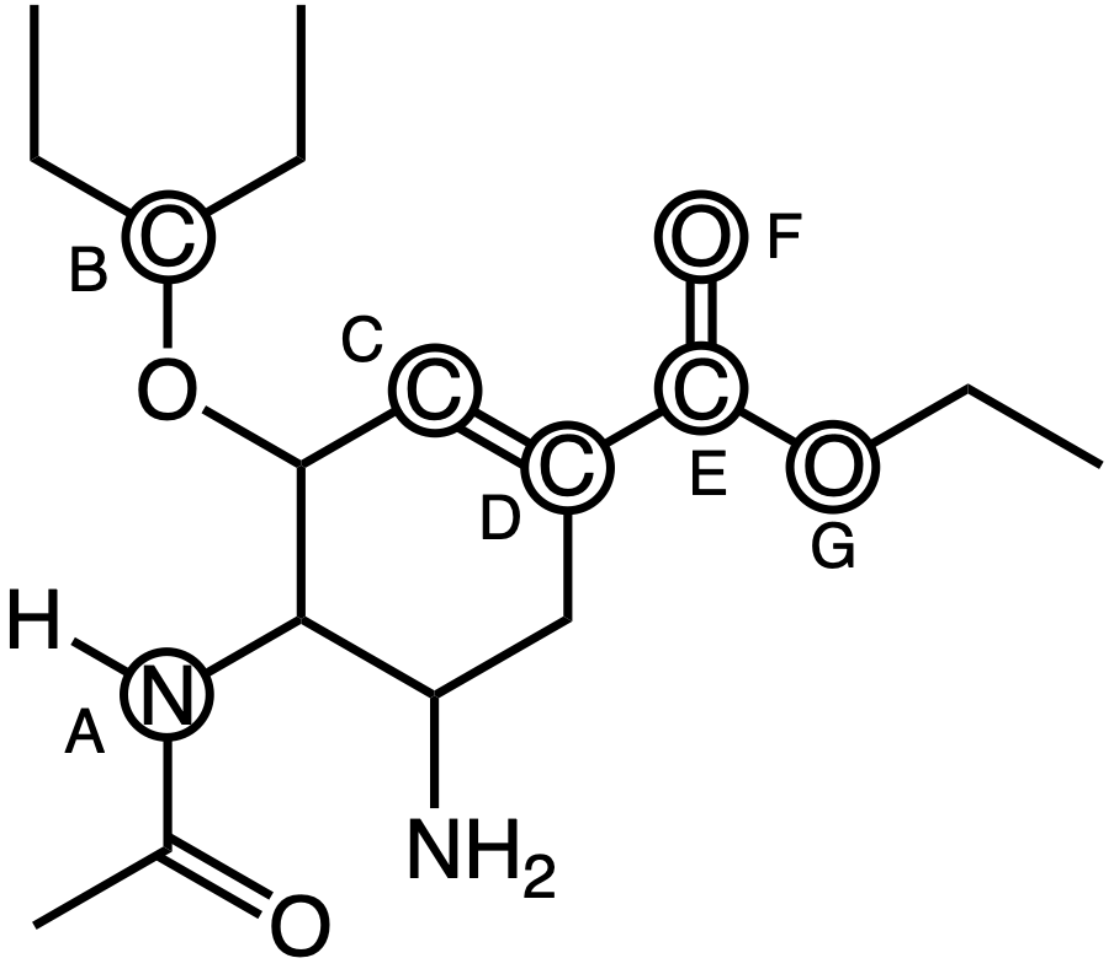
A.	Trigonal pyramidal	sp^3
B.	Tetrahedral	sp^3
C.	Trigonal planar	sp^2
D.	Trigonal planar	sp^2
E.	Trigonal planar	sp^2
F.	N/A	sp^2
G.		

BACK TO TOC

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

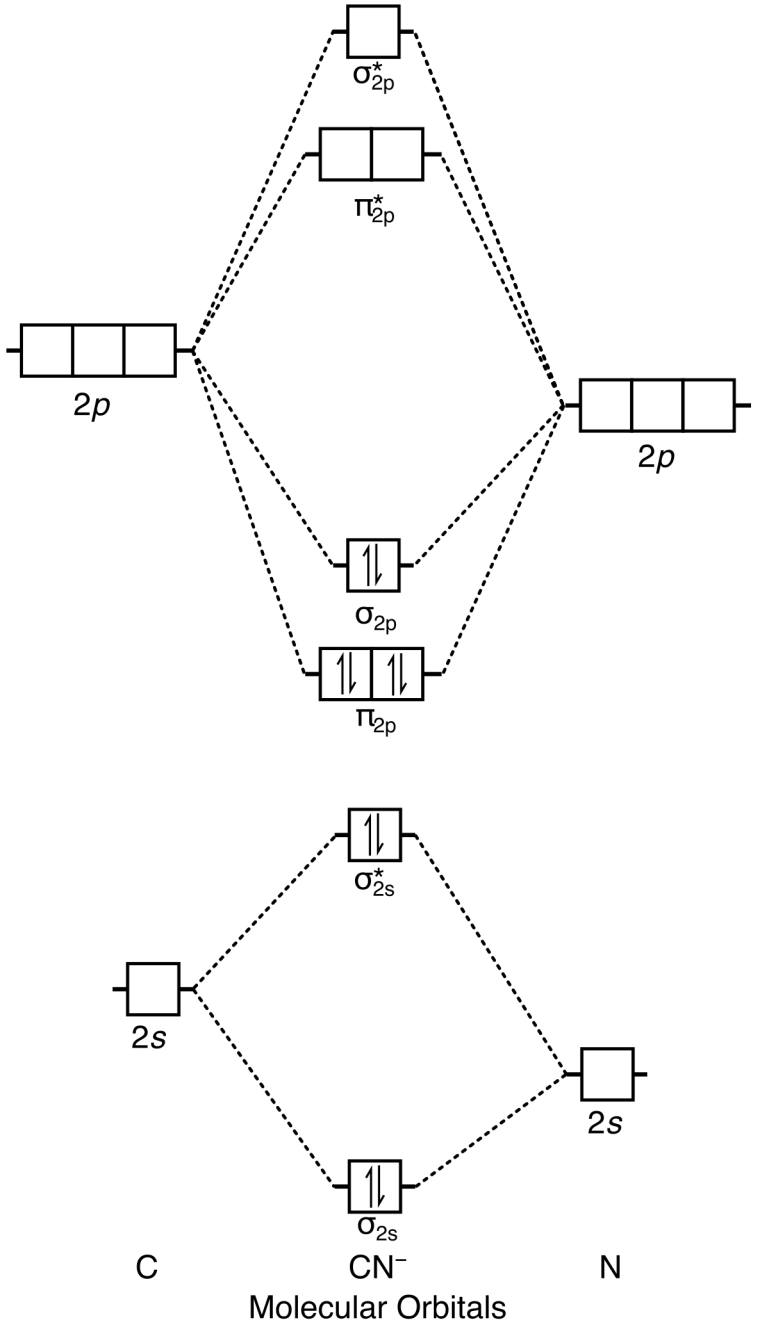
i. Give the molecular geometry at the central atom.

ii. State the hybridization at the central atom.



A.	Trigonal pyramidal	sp^3
B.	Tetrahedral	sp^3
C.	Trigonal planar	sp^2
D.	Trigonal planar	sp^2
E.	Trigonal planar	sp^2
F.	N/A	sp^2
G.	Bent (or angular)	sp^3

BACK TO TOC



Consider the cyanate ion, 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 CN^-.
You do not need to fill in the electrons for the atomic orbitals.

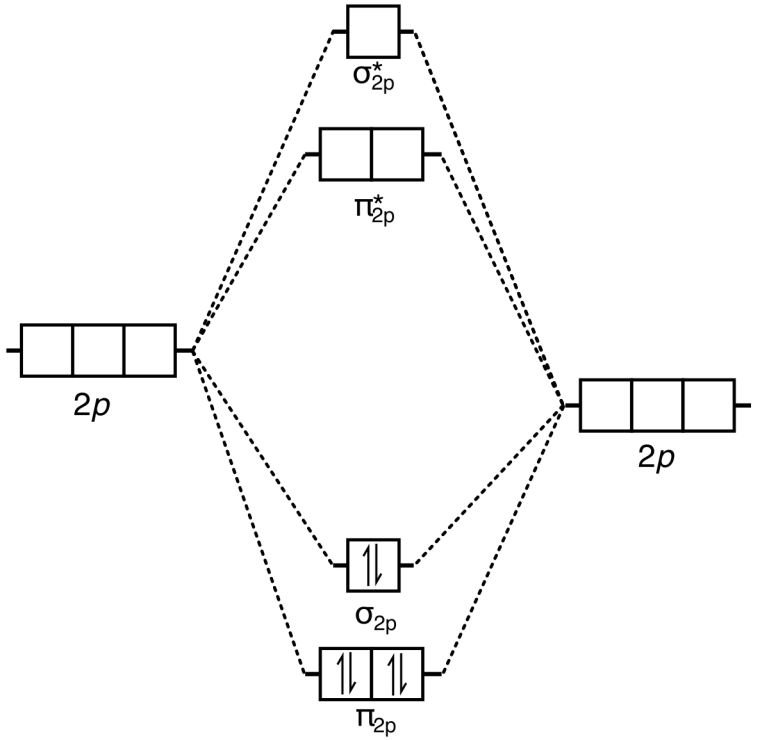
B. Determine the bond order for CN^- based on your diagram.

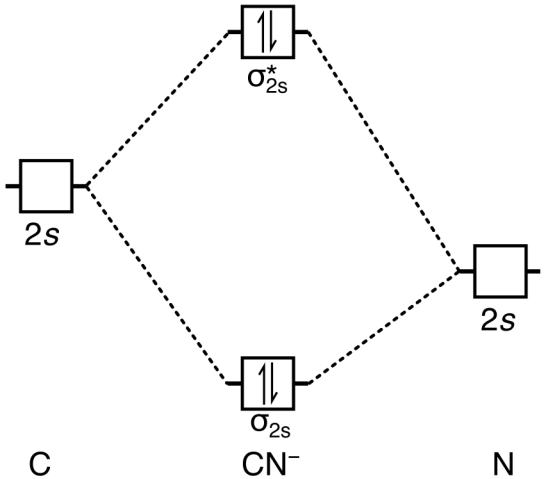
C. Do you expect CN^- to be paramagnetic or diamagnetic?

D. Do you expect neutral CN to be paramagnetic or diamagnetic?

E. Do you expect CN^{3-} to be paramagnetic or diamagnetic?

BACK TO TOC





Consider the cyanate ion, 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 CN^-.
You do not need to fill in the electrons for the atomic orbitals.

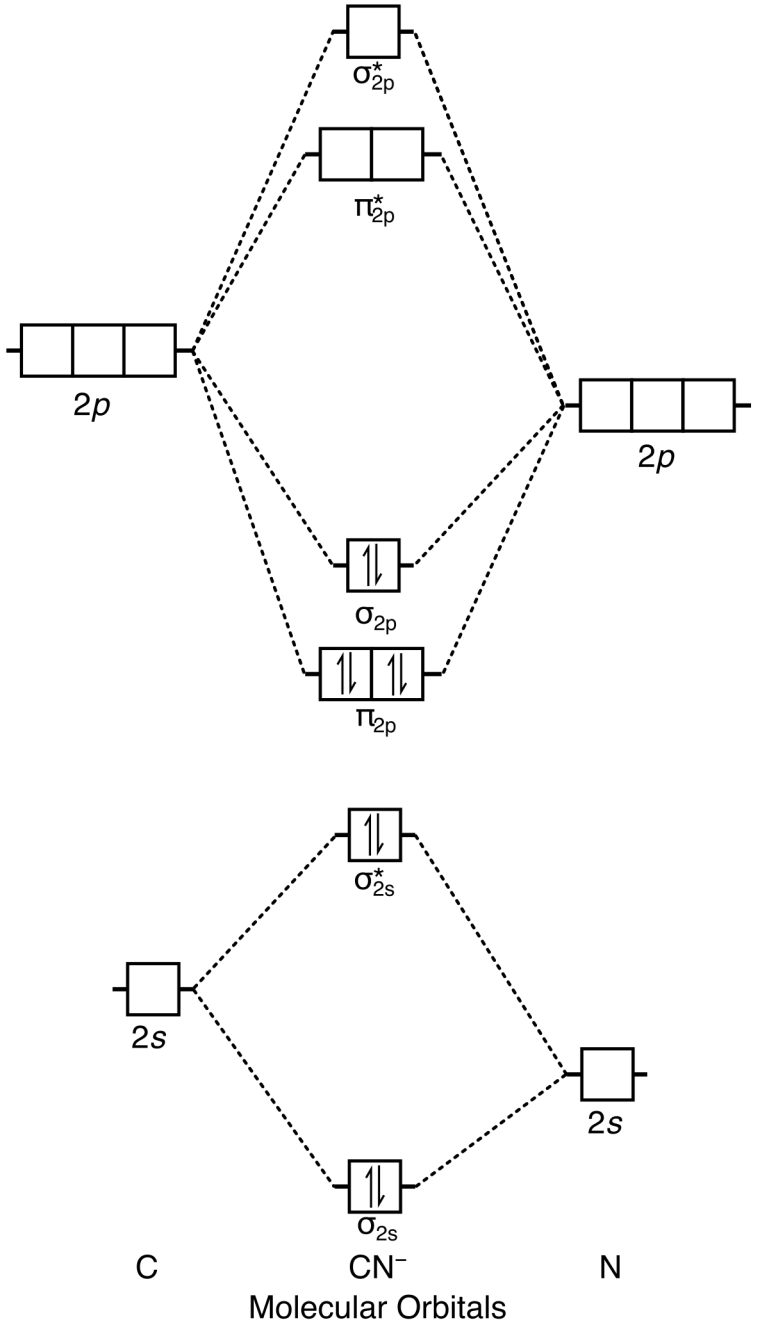
B. Determine the bond order for CN^- based on your diagram.
BO = ½ [bonding – antibonding] = ½ [8 – 2] = 3 (triple bond)

C. Do you expect CN^- to be paramagnetic or diamagnetic?

D. Do you expect neutral CN to be paramagnetic or diamagnetic?

E. Do you expect CN^{3-} to be paramagnetic or diamagnetic?

BACK TO TOC



Consider the cyanate ion, 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 CN^-.
You do not need to fill in the electrons for the atomic orbitals.

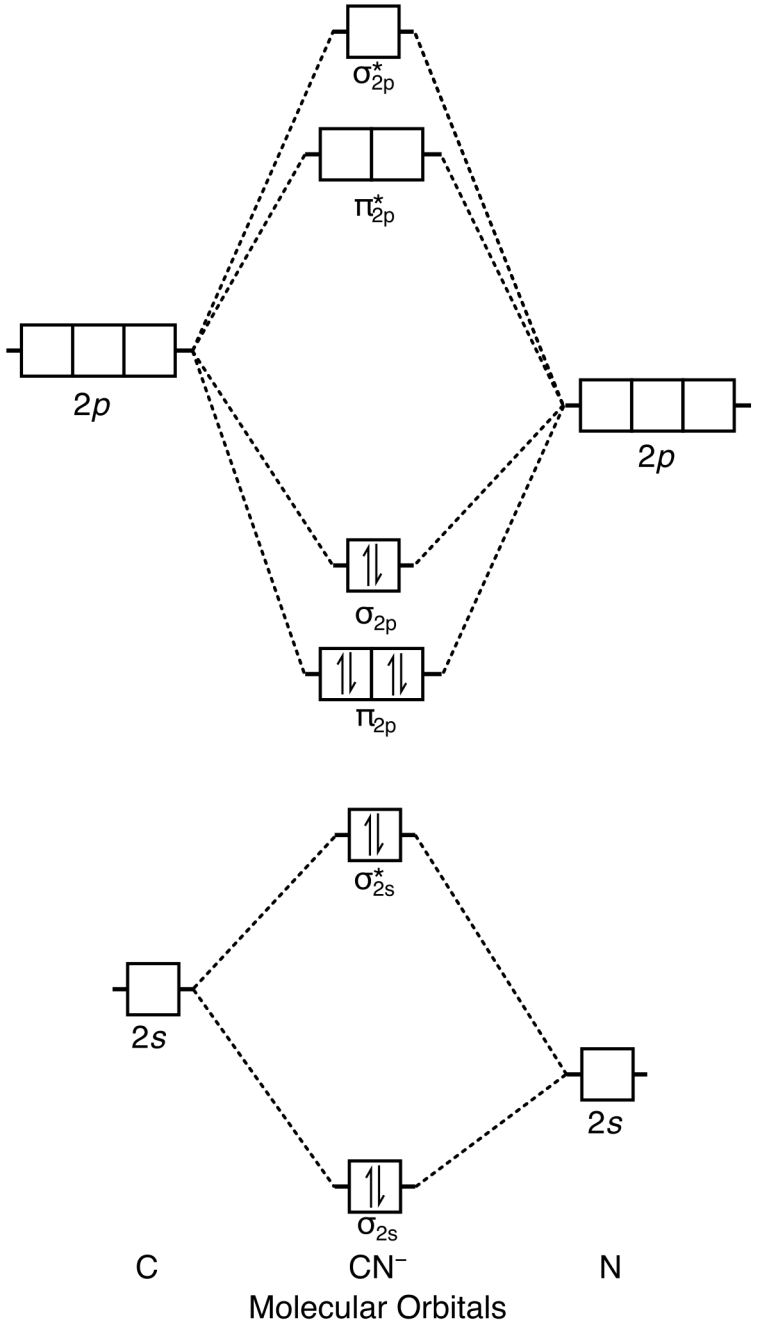
B. Determine the bond order for CN^- based on your diagram.
BO = ½ [bonding – antibonding] = ½ [8 – 2] = 3 (triple bond)

C. Do you expect CN^- to be paramagnetic or diamagnetic?
Diamagnetic: all electrons paired

D. Do you expect neutral CN to be paramagnetic or diamagnetic?

E. Do you expect CN^{3-} to be paramagnetic or diamagnetic?

BACK TO TOC



Consider the cyanate ion, 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 CN^-.
You do not need to fill in the electrons for the atomic orbitals.

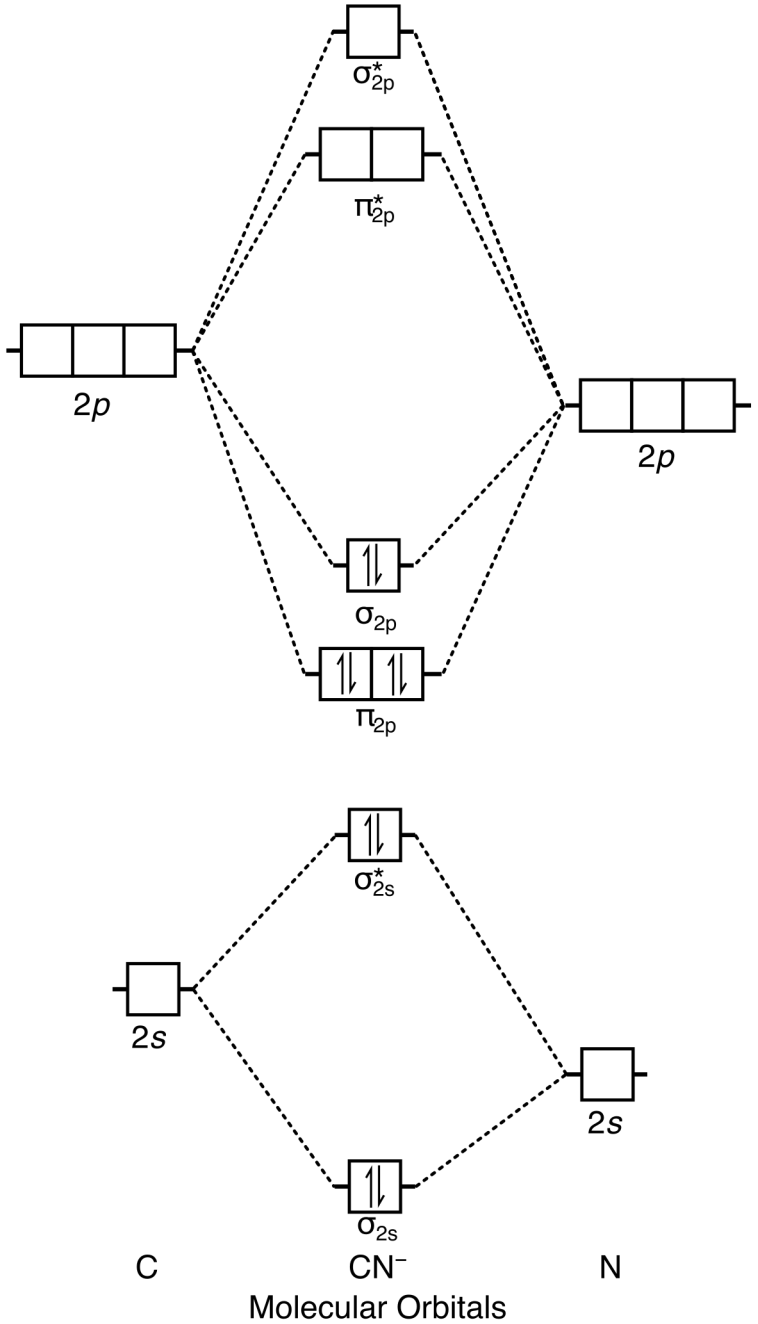
B. Determine the bond order for CN^- based on your diagram.
BO = ½ [bonding – antibonding] = ½ [8 – 2] = 3 (triple bond)

C. Do you expect CN^- to be paramagnetic or diamagnetic?
Diamagnetic: all electrons paired

D. Do you expect neutral CN to be paramagnetic or diamagnetic?
Paramagnetic: one unpaired electron in σ_{2p} orbital

E. Do you expect CN^{3-} to be paramagnetic or diamagnetic?

BACK TO TOC



Consider the cyanate ion, 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 CN^-.
You do not need to fill in the electrons for the atomic orbitals.

B. Determine the bond order for CN^- based on your diagram.
BO = ½ [bonding – antibonding] = ½ [8 – 2] = 3 (triple bond)

C. Do you expect CN^- to be paramagnetic or diamagnetic?
Diamagnetic: all electrons paired

D. Do you expect neutral CN to be paramagnetic or diamagnetic?
Paramagnetic: one unpaired electron in σ_{2p} orbital

E. Do you expect CN^{3-} to be paramagnetic or diamagnetic?
Paramagnetic: two unpaired electrons in two π^*_{2p} orbitals

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ (C,D,F) (D,F) (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2, CuCl, Br_2, CH_3OH	Solubility in water	
$BaCl_2$, H_2, CO, Kr, HF	Boiling point	
CH_3OH, Cl_2, N_2, CH_3Cl	Melting point	
N_2, KBr, O_2, HCN	Boiling point	
FeO, NaCl, CF_4, CH_3OH	Melting point	
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) Ion-Dipole (B)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Hydrogen Bonding (C)

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

Dipole-Dipole (D) Dipole-Induced Dipole (E)

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

Dispersion Forces (F)

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH (C,D,F), CH_3OCH_3 (D,F), $CH_3CH_2CH_3$ (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2 (E,F), CuCl (solid), Br_2 (E,F), CH_3OH (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$, H_2, CO, Kr, HF	Boiling point	
CH_3OH, Cl_2, N_2, CH_3Cl	Melting point	
N_2, KBr, O_2, HCN	Boiling point	
FeO, NaCl, CF_4, CH_3OH	Melting point	
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) / Ion-Dipole (B): If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Hydrogen Bonding (C): Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

Dipole-Dipole (D) / Dipole-Induced Dipole (E): If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

Dispersion Forces (F): If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ (C,D,F) (D,F) (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2, CuCl, Br_2, CH_3OH (E,F) (solid) (E,F) (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$, H_2, CO, Kr, HF (A) (F) (D,F) (F) (C,D,F)	Boiling point	$H_2 < Kr < CO < HF < BaCl_2$
CH_3OH, Cl_2, N_2, CH_3Cl	Melting point	
N_2, KBr, O_2, HCN	Boiling point	
FeO, NaCl, CF_4, CH_3OH	Melting point	
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) | Ion-Dipole (B) | Hydrogen Bonding (C) | Dipole-Dipole (D) | Dipole-Induced Dipole (E) | Dispersion Forces (F)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH (C,D,F), CH_3OCH_3 (D,F), $CH_3CH_2CH_3$ (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2 (E,F), CuCl (solid), Br_2 (E,F), CH_3OH (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$ (A), H_2 (F), CO (D,F), Kr (F), HF (C,D,F)	Boiling point	$H_2 < Kr < CO < HF < BaCl_2$
CH_3OH (C,D,F), Cl_2 (F), N_2 (F), CH_3Cl (D,F)	Melting point	$N_2 < Cl_2 < CH_3Cl < CH_3OH$
N_2, KBr, O_2, HCN	Boiling point	
FeO, NaCl, CF_4, CH_3OH	Melting point	
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) | Ion-Dipole (B) | Hydrogen Bonding (C) | Dipole-Dipole (D) | Dipole-Induced Dipole (E) | Dispersion Forces (F)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ (C,D,F) (D,F) (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2, CuCl, Br_2, CH_3OH (E,F) (solid) (E,F) (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$, H_2, CO, Kr, HF (A) (F) (D,F) (F) (C,D,F)	Boiling point	$H_2 < Kr < CO < HF < BaCl_2$
CH_3OH, Cl_2, N_2, CH_3Cl (C,D,F) (F) (F) (D,F)	Melting point	$N_2 < Cl_2 < CH_3Cl < CH_3OH$
N_2, KBr, O_2, HCN (F) (A) (F) (D,F)	Boiling point	$N_2 < O_2 < HCN < KBr$
FeO, NaCl, CF_4, CH_3OH	Melting point	
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) | Ion-Dipole (B) | Hydrogen Bonding (C) | Dipole-Dipole (D) | Dipole-Induced Dipole (E) | Dispersion Forces (F)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ (C,D,F) (D,F) (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2, CuCl, Br_2, CH_3OH (E,F) (solid) (E,F) (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$, H_2, CO, Kr, HF (A) (F) (D,F) (F) (C,D,F)	Boiling point	$H_2 < Kr < CO < HF < BaCl_2$
CH_3OH, Cl_2, N_2, CH_3Cl (C,D,F) (F) (F) (D,F)	Melting point	$N_2 < Cl_2 < CH_3Cl < CH_3OH$
N_2, KBr, O_2, HCN (F) (A) (F) (D,F)	Boiling point	$N_2 < O_2 < HCN < KBr$
FeO, NaCl, CF_4, CH_3OH (A) (A) (F) (C,D,F)	Melting point	$CF_4 < CH_3OH < NaCl < FeO$
CH_3OH, CH_3CH_3, H_2CO	Surface Tension	

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) | Ion-Dipole (B) | Hydrogen Bonding (C) | Dipole-Dipole (D) | Dipole-Induced Dipole (E) | Dispersion Forces (F)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

A & B = N, O, or F

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

BACK TO TOC

Arrange the following sets of compounds in order of increasing _____.

Set	Property	Ordered Set
CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ (C,D,F) (D,F) (F)	Vapor pressure at 298 K	$CH_3CH_2OH < CH_3OCH_3 < CH_3CH_2CH_3$
O_2, CuCl, Br_2, CH_3OH (E,F) (solid) (E,F) (C,D,F)	Solubility in water	CuCl (*s*); $O_2 < Br_2 < CH_3OH$
$BaCl_2$, H_2, CO, Kr, HF (A) (F) (D,F) (F) (C,D,F)	Boiling point	$H_2 < Kr < CO < HF < BaCl_2$
CH_3OH, Cl_2, N_2, CH_3Cl (C,D,F) (F) (F) (D,F)	Melting point	$N_2 < Cl_2 < CH_3Cl < CH_3OH$
N_2, KBr, O_2, HCN (F) (A) (F) (D,F)	Boiling point	$N_2 < O_2 < HCN < KBr$
FeO, NaCl, CF_4, CH_3OH (A) (A) (F) (C,D,F)	Melting point	$CF_4 < CH_3OH < NaCl < FeO$
CH_3OH, CH_3CH_3, H_2CO (C,D,F) (F) (D,F)	Surface Tension	$CH_3CH_3 < H_2CO < CH_3OH$

Strong IMFs lead to:

- Higher boiling points
- Higher melting points
- Smaller vapor pressure
- Greater surface tension

Below each of the compounds, I have listed the IMFs present for pure solutions of that compound (or with water for solubility). The legend is as follows:

Ion-Ion (A) | Ion-Dipole (B) | Hydrogen Bonding (C) | Dipole-Dipole (D) | Dipole-Induced Dipole (E) | Dispersion Forces (F)

If two compounds both have ion-ion interactions, the interactions are stronger for higher charges(q) and smaller ions (d) via:

$$E \propto \frac{q_1 q_2}{d}$$

Can only occur for this specific arrangement:

Ⓐ:·····H—Ⓑ

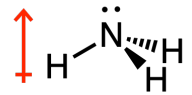
A & B = N, O, or F

If two compounds both have dipole-dipole interactions, interactions are stronger for larger dipoles (greater EN differences).

If two compounds both have dispersion, interactions are stronger for more massive (heavier) and more spread out molecules.

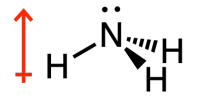
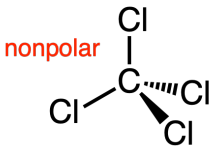
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4				
C_6H_5OH				
$CH_3CH_2OCH_2CH_3$				
Kr				
CO_2				
$(CH_3)_2NH$				

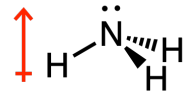
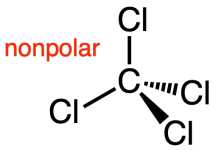
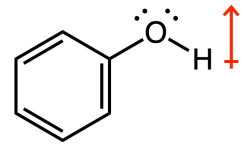
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	
C_6H_5OH				
$CH_3CH_2OCH_2CH_3$				
Kr				
CO_2				
$(CH_3)_2NH$				

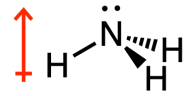
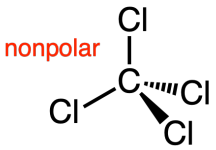
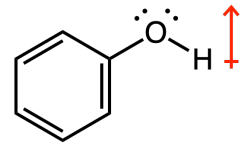
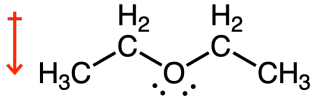
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	
C_6H_5OH	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
$CH_3CH_2OCH_2CH_3$				
Kr				
CO_2				
$(CH_3)_2NH$				

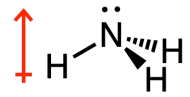
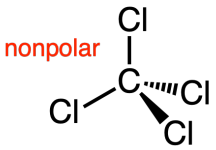
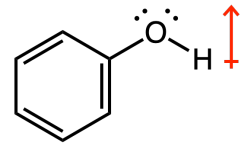
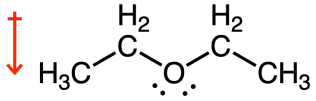
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	
C_6H_5OH	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
$CH_3CH_2OCH_2CH_3$	Dipole-Dipole	Hydrogen Bonding	Dipole-Induced Dipole	
Kr				
CO_2				
$(CH_3)_2NH$				

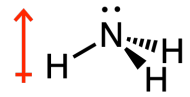
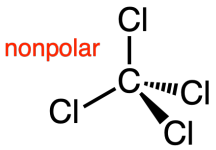
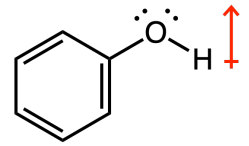
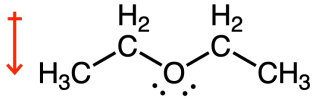
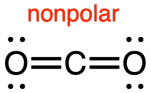
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	
C_6H_5OH	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
$CH_3CH_2OCH_2CH_3$	Dipole-Dipole	Hydrogen Bonding	Dipole-Induced Dipole	
Kr	Dispersion	Dipole-Induced Dipole	Dispersion	Kr nonpolar
CO_2				
$(CH_3)_2NH$				

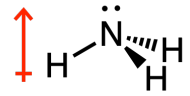
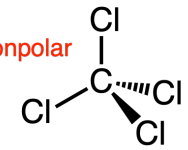
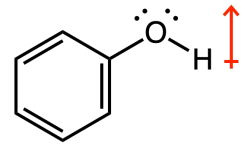
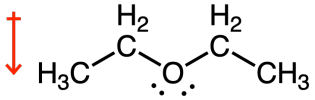
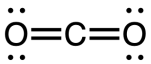
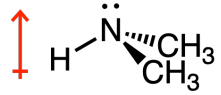
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	
C_6H_5OH	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
$CH_3CH_2OCH_2CH_3$	Dipole-Dipole	Hydrogen Bonding	Dipole-Induced Dipole	
Kr	Dispersion	Dipole-Induced Dipole	Dispersion	Kr nonpolar
CO_2	Dispersion	Dipole-Induced Dipole	Dispersion	
$(CH_3)_2NH$				

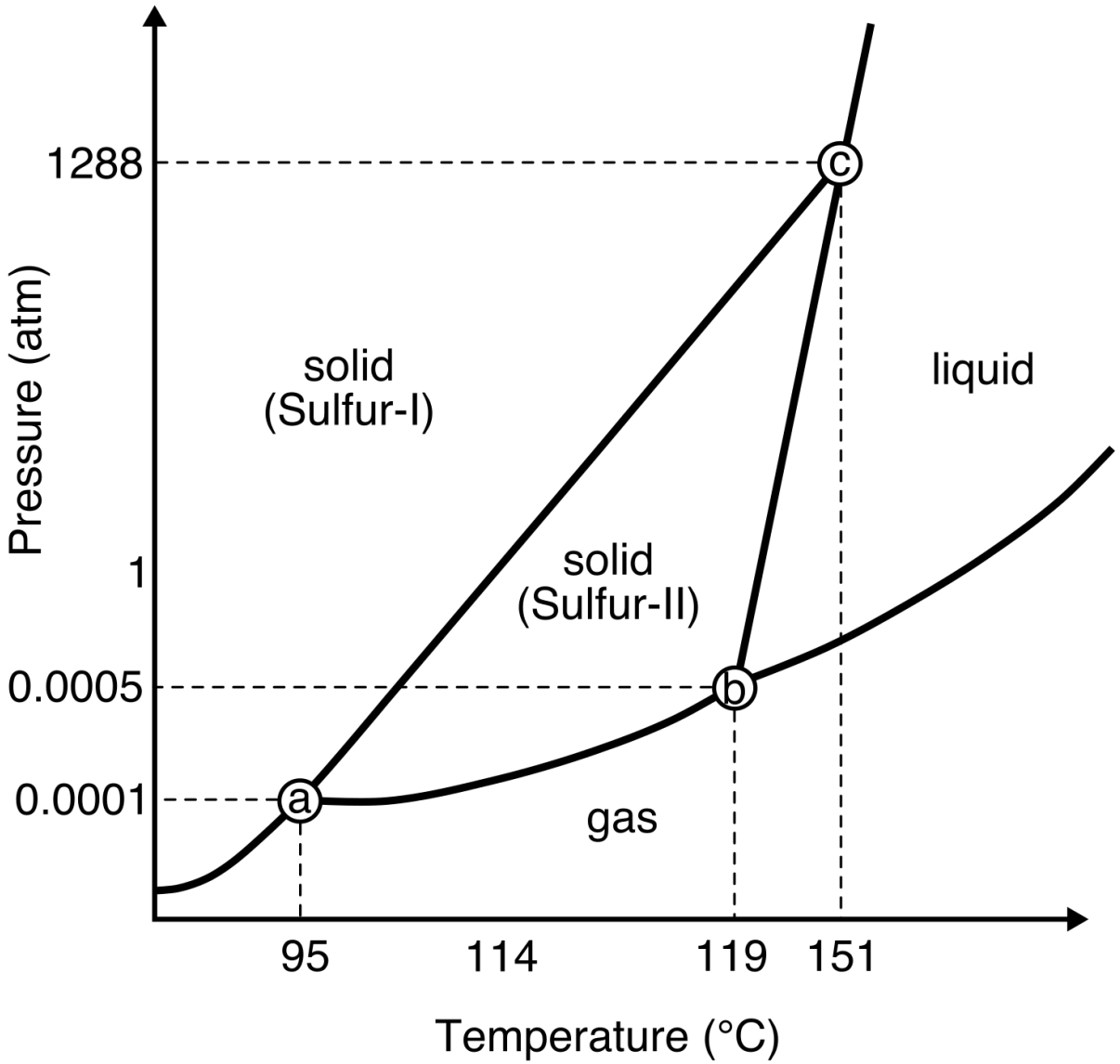
BACK TO TOC

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

Molecule	Intermolecular interactions with **itself**	Intermolecular interactions with **water (H_2O)**	Intermolecular interactions with **methane (CH_4)**	**Lewis Structure (Dipole drawn if polar)**
NH_3	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
CCl_4	Dispersion	Dipole-Induced Dipole	Dispersion	nonpolar 
C_6H_5OH	Hydrogen Bonding	Hydrogen Bonding	Dipole-Induced Dipole	
$CH_3CH_2OCH_2CH_3$	Dipole-Dipole	Hydrogen Bonding	Dipole-Induced Dipole	
Kr	Dispersion	Dipole-Induced Dipole	Dispersion	Kr nonpolar
CO_2	Dispersion	Dipole-Induced Dipole	Dispersion	nonpolar 
$(CH_3)_2NH$	Dipole-Dipole	Dipole-Dipole	Dipole-Induced Dipole	

BACK TO TOC

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): Sulfur-I, Sulfur-II, Gas
   (b): Sulfur-II, Gas, Liquid
   (c): Sulfur-I, Sulfur-II, Liquid

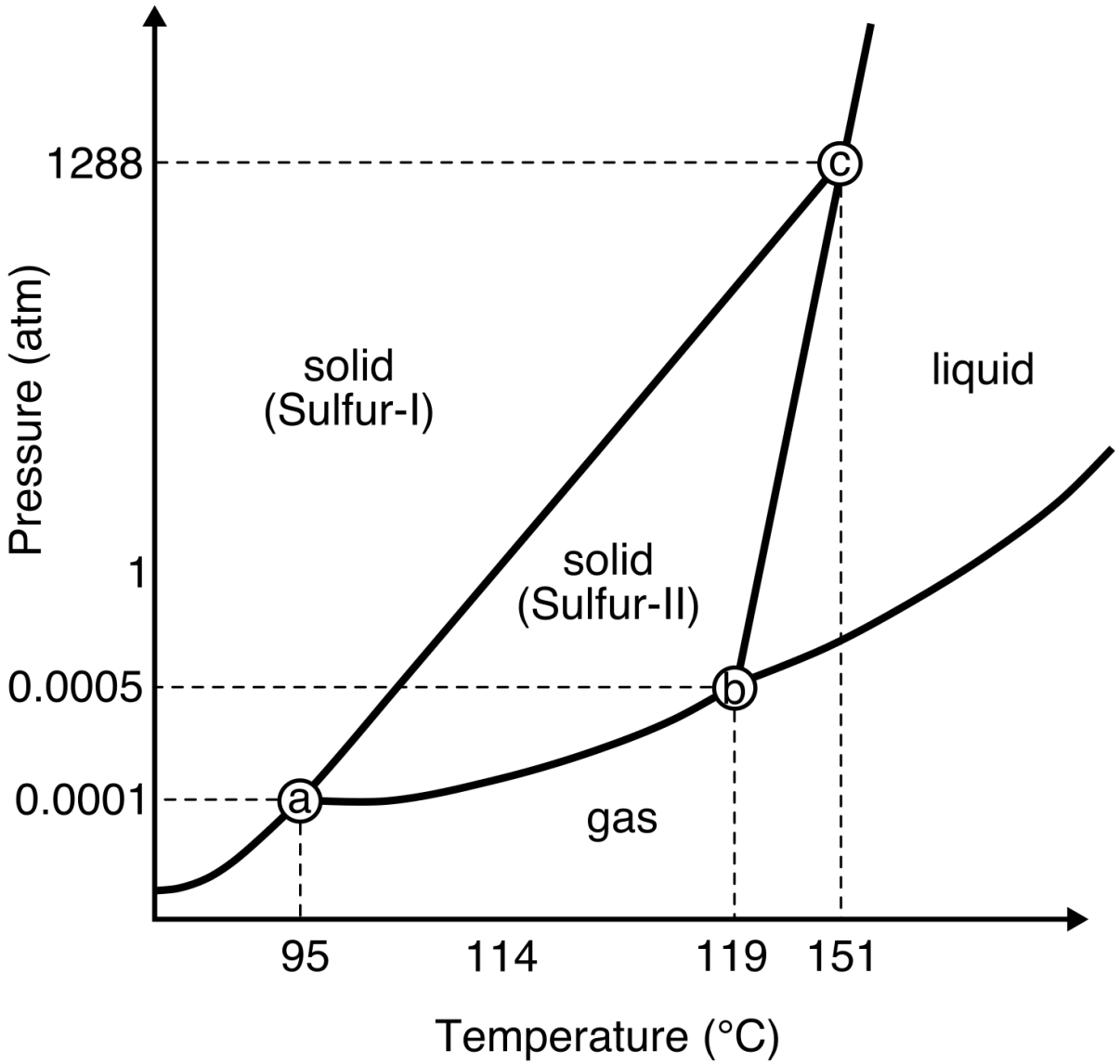
B. At which triple point will solid Sulfur-II float on top of liquid sulfur?

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?

BACK TO TOC

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): Sulfur-I, Sulfur-II, Gas
   (b): Sulfur-II, Gas, Liquid
   (c): Sulfur-I, Sulfur-II, Liquid

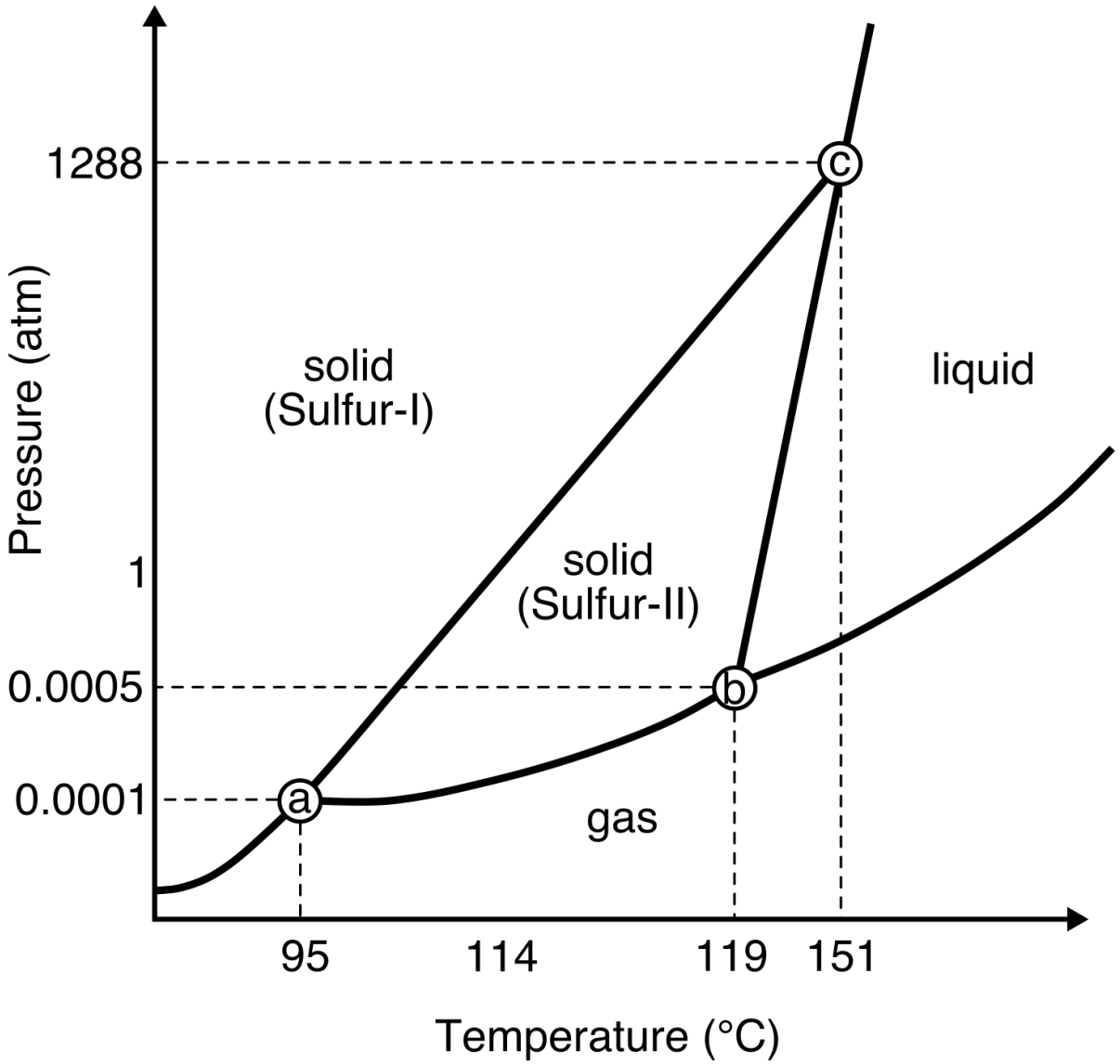
B. At which triple point will solid Sulfur-II float on top of liquid sulfur?
   None

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?

BACK TO TOC

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): Sulfur-I, Sulfur-II, Gas
   (b): Sulfur-II, Gas, Liquid
   (c): Sulfur-I, Sulfur-II, Liquid

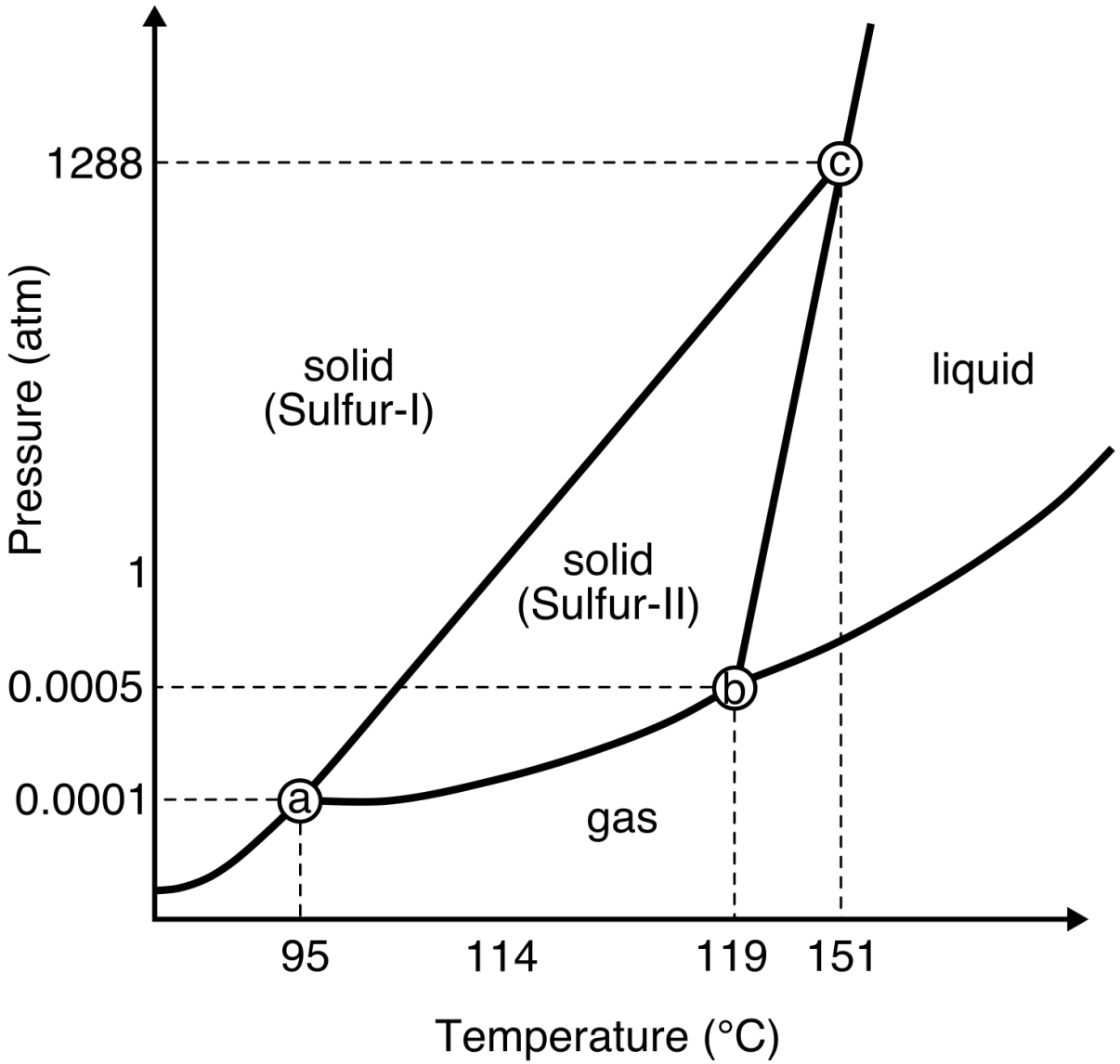
B. At which triple point will solid Sulfur-II float on top of liquid sulfur?
   None

C. Which of the two solid phases, Sulfur-I or Sulfur-II, is less dense?
   Sulfur-II

D. Can either of the two solid states sublime at atmospheric pressure? Which?

BACK TO TOC

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): Sulfur-I, Sulfur-II, Gas
   (b): Sulfur-II, Gas, Liquid
   (c): Sulfur-I, Sulfur-II, Liquid

B. At which triple point will solid Sulfur-II float on top of liquid sulfur?
   None

C. Which of the two solid phases, Sulfur-I or Sulfur-II, is less dense?
   Sulfur-II

D. Can either of the two solid states sublime at atmospheric pressure? Which?
   No, Sulfur-II can sublime at <0.0005 atm.
   Sulfur-I sublimes at <0.0001 atm.

BACK TO TOC