

CH301 Fall 2013
 Vanden Bout/LaBrake
 Unit 3 Exam (25 POINTS)

Name: _____ **KEY** _____
 UT EID: _____
 VERSION #: _____

Questions on front and back. Show work for partial credit. Your work and answers must fit in the boxes provided for each question. Responses outside the boxes will not be graded.

1. (8 points)

a. Fill in the Molecular Orbital (MO) diagram for N_2^{2+} .

+3 pts for correct diagram

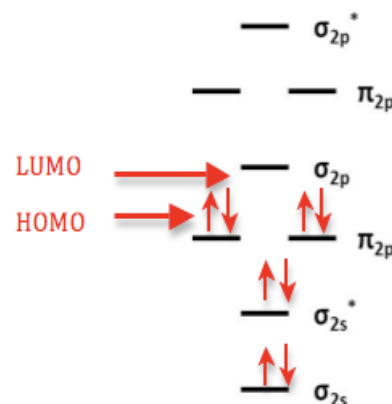
b. Identify on the MO diagram the location of the HOMO and the LUMO.

+2 pts (+1 for HOMO, +1 for LUMO) for correct analysis based on the filled out MO

c. State the bond order.

B.O. = $0.5(\# \text{bonding electrons} - \text{antibonding electrons})$
 B.O. = $0.5(6-2) = 0.5(4) = 2$

 B.O. = 2
 +2 pts for correct analysis based on the filled out MO



d. Is N_2^{2+} expected to be paramagnetic or diamagnetic?

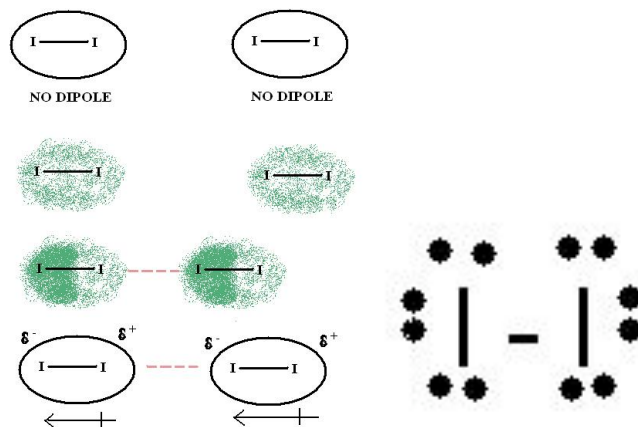
Diamagnetic
 +1 pts for correct analysis based on the filled out MO

2. (8 points)

Iodine exists as a solid up to 114 °C at 1 atm pressure. Brass, an alloy of copper and zinc, has a melting point of 900 °C at 1 atm pressure. Fully describe each solid. Identify the type of solid and report on their physical properties (macroscopic view). Provide a microscopic description for each solid; include a picture and description of the forces that hold the substance together in the solid phase.

+1 for each correct microscopic picture (+2 pts total)
 +1 for type of solid (+2 pts total)
 +1 for correct IMFs/microscopic view of the solid (+2 pts total)
 +1 for correct macroscopic property given (+2 pts total)

 Iodine:



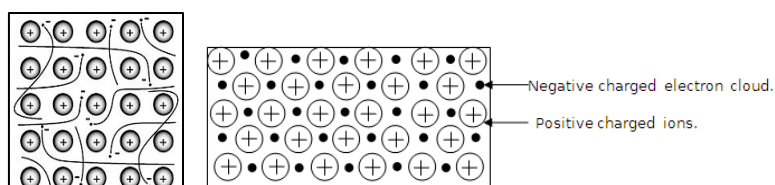
Some possible pictures:

Type of solid: Molecular solid

Types of IMFs/microscopic view: Dispersion Forces only

Macroscopic properties (must include at least one): Brittle, hard, not a conductor, low BP

Brass:



Some possible pictures:

Type of solid: Metallic solid

Types of IMFs/microscopic view: Metallic bonds with a “sea of electrons” (delocalized)

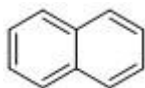
Macroscopic properties (must include at least one): Malleable, ductile, good conductor, shiny

3. (9 points)

A. On your first day in the laboratory, your boss provides you with four unmarked vials. She was able to evaluate the melting and boiling points of each compound, but needs your help identifying the molecule in each vial. The four possible chemicals are benzene, naphthalene, acenaphthene, and pyracene. Please identify the compound in each vial as well as its phase (solid, liquid or gas) at room temperature.



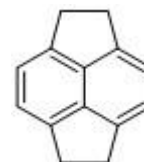
Benzene



Naphthalene



Acenaphthene



Pyracene

Vial Number	Compound Identity	Melting Point [°C]	Boiling Point [°C]	Phase at Room Temperature
Vial 1	Naphthalene	80	218	Solid
Vial 2	Pyrene	214	363	Solid
Vial 3	Benzene	5.5	176	Liquid
Vial 4	Acenaphthene	93	279	Solid

+2 pts for compounds (+1 if only half correct)

+2 pts for correct phases (+1 if only half correct)

B. What is the dominant intermolecular force for the compounds listed in part A?

The dominant force is dispersion (aka London dispersion forces, induced dipoles, van der waals forces).

+2 pts for correct IMF

C. Of the four compounds, which has the strongest intermolecular forces? Why?

Pyrene has the strongest IMFs because it is the largest and therefore the most polarizable.
+3 pts total (+1 for correct compound, +2 for correct explanation of polarizable)