

WINTER 2004
2nd MIDTERM

(Total number of pages = 7)

(Total points = 50)

(Total time = 50 mins)

****Carefully remove last page which is your Periodic Table.****

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WRITE IN PEN (Show all your work on this paper.)

Constants and Formulas

Planck constant, $h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$

Avogadro constant, $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

Rydberg constant, $R = 3.29 \times 10^{15} \text{ Hz}$

Gas constant, $R = 8.314 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$

Mass of electron, $m_e = 9.1 \times 10^{-31} \text{ kg}$

Speed of light, $c = 3.0 \times 10^8 \text{ m} \cdot \text{s}^{-1}$

$0^\circ\text{C} = 273.15 \text{ K}$

$1\text{L} = 1 \text{ dm}^3$

$1 \text{ atm} = 101.325 \text{ kPa}$

$\pi = 3.14$

$E = h \nu$

$E = pc$

$E_n = \frac{h^2 n^2}{8 m L^2}$

$p = mv$

$E_n = - \frac{h R}{n^2}$

$\lambda = \frac{h}{p}$

$c = \lambda \nu$

$\text{pH} = \text{p}K_A + \text{LOG} \frac{[\text{A}^-]_{\text{INITIAL SALT}}}{[\text{AH}]_{\text{INITIAL ACID}}}$

$E = \frac{1}{2} m v^2$

$\Delta p \times \Delta x \geq \frac{h}{4\pi}$

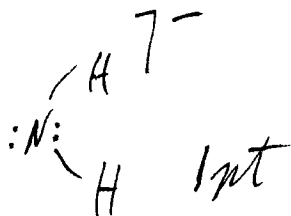
Solution to $AX^2 + BX + C = 0$

is $X = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

Q1A. Predict the electron arrangement in NH_2^- .

(3pt)

tetrahedral 3pt

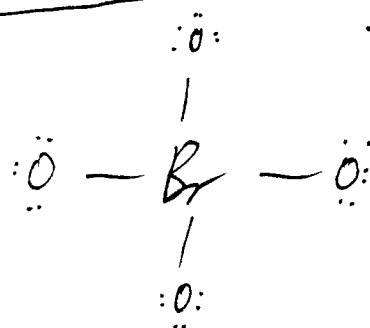


$$\begin{array}{r} \text{N } 5e^- \\ 2 \times \text{H } 2 \times 1e^- = 2e^- \\ \hline 7e^- \end{array}$$

B. What is the shape of BrO_4^- ?

(3pt)

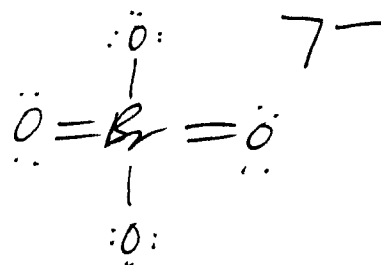
tetrahedral 3pt



$$\begin{array}{r} \text{Br } 7e^- \\ 4 \times \text{O } 4 \times 6e^- = 24e^- \\ \hline 31e^- \end{array}$$

1pt

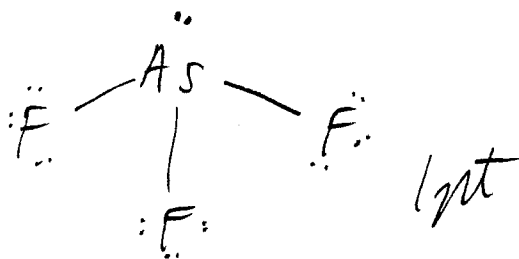
or



C. What is the shape of AsF_3 ?

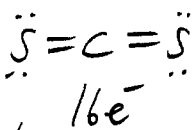
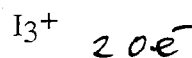
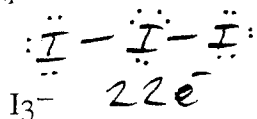
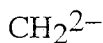
(4pt)

trigonal pyramidal 4pt

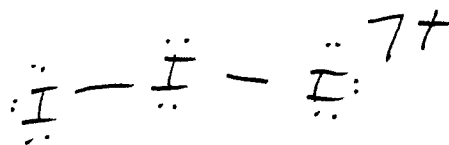


$$\begin{array}{r} \text{As } 5e^- \\ 3 \times \text{F } 3 \times 7 = 21e^- \\ \hline 26e^- \end{array}$$

Q2A. All of the following have a linear shape except (3pt)
(Circle your answer.)



$3 \times 7 = 21e^- - 1e^- = 20e^-$

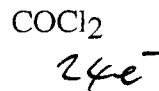
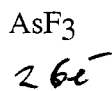
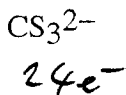
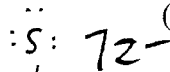


I_3^+ 3pt

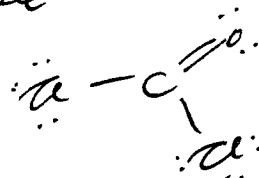
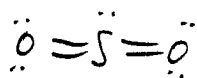
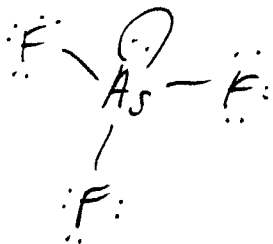
and/or

CH_2^{2-} $8e^-$ 3pt
tetrahedral

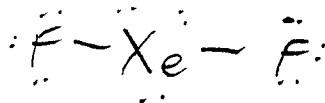
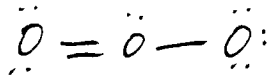
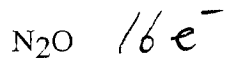
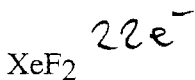
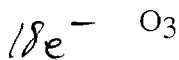
B. Which of the following has bond angles slightly less than 109° ? (4pt)
(Circle your answer.)



AsF_3
4pt



C. Which of the following is polar? (3pt)
(Circle your answer.)



linear

O_3 3pt

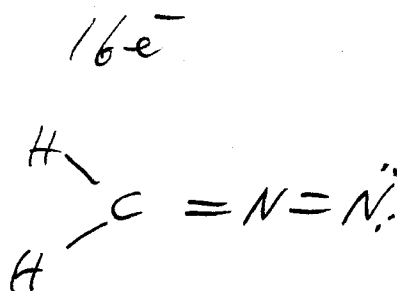
linear, dipole cancel

Q3A. How many σ - and π -bonds are present in diazomethane, CH_2NN ?

(2pt)

4 sigma and 2 pi

1pt 1pt



B. Which of the following has the longest bond?

(5pt)

(Circle your answer.)

N_2

NO^-

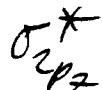
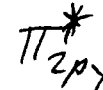
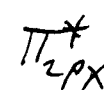
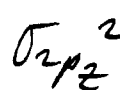
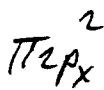
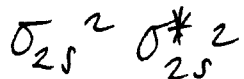
N_2^{2+}

N_2^{2-}

O_2^{2-}

5pt

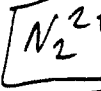
$$B.O = \frac{1}{2}(8-4) = 3$$



$$B.O = \frac{1}{2}(8-4) = 2$$



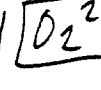
$$B.O = \frac{1}{2}(6-2) = 2$$



$$B.O = \frac{1}{2}(8-4) = 2$$



$$B.O = \frac{1}{2}(8-6) = 1$$



C. All of the following are paramagnetic except

(Circle your answer.)

O_2^+

O_2^-

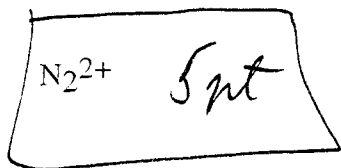
N_2^{2+}

N_2^{2-}

O_2

(5pt)

Use (B) to determine which has paired e^- .



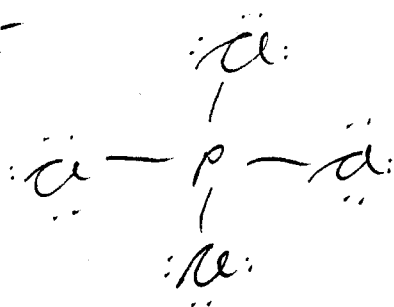
Q4. Identify the hybrid orbitals used by the phosphorus atoms in the following species:

A. PCl_4^+

$32e^-$

$7+$

(2pt)



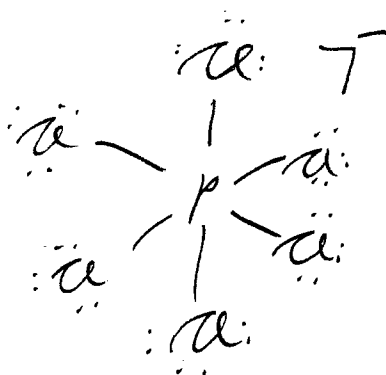
sp^3 2pt

B. PCl_6^-

P $5e^-$

$$6 \times 2 + 6 \times 7e^- = 42e^-$$

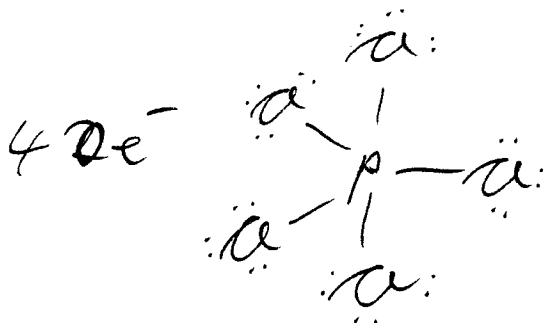
$$\frac{1e^-}{48e^-}$$



(2pt)

sp^3d^2 2pt

C. PCl_5

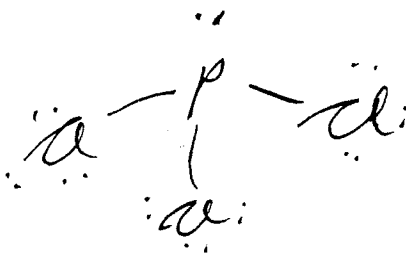


(2pt)

sp^3d 2pt

D. PCl_3

$26e^-$



(2pt)

sp^3 2pt

Q5A. In the complex ion $[\text{Ni}(\text{OH}_2)_6]^{2+}$,
(Circle your answer.)

(2pt)

OH_2 is a Lewis acid.

OH_2 has a charge of -1 in the complex.

Ni has an oxidation number of 0.

Ni is a Lewis base and OH_2 is a Lewis acid.

Ni is a Lewis acid and OH_2 is a Lewis base.

Ni is a Lewis acid and OH_2 is a Lewis base.

B. What is the oxidation number of iron in $\text{K}_4[\text{Fe}(\text{CN})_6]$?

(2pt)

+2

C. What is the name of the complex $\text{Na}[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$?

(4pt)

sodium triamminetrichlorocobaltate(II)
1pt 1pt 1pt 1pt

D. What is the coordination number of the complex $\text{Na}[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$?

(2pt)

6