Chemistry 122 | Winter 2008 | Oregon State University
Exam 1 | January 31, 2008 | Dr. Richard Nafshun

Instructions: You should have with you several number two pencils, an eraser, your 3" x 5" note card, a calculator, and your University ID Card. If you have notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT or place the notes directly on the table at the front of the room.

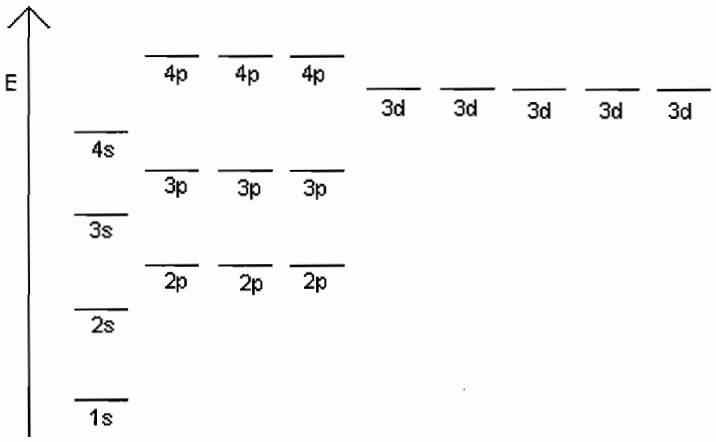
Fill in the front page of the Scantron answer sheet with your last name, first name, middle initial, and student identification number. **Leave the class section number and the test form number blank.**

This exam consists of 25 multiple-choice questions. Each question has four points associated with it. Select the best multiple-choice answer by filling in the corresponding circle on the rear page of the answer sheet. If you have any questions before the exam, please ask. If you have any questions during the exam, please ask the proctor. Open and start this exam when instructed. When finished, place your Scantron form in the appropriate stack and present your University ID Card to the proctor. You may keep the exam packet, so please show your work and mark the answers you selected on it.

IA		IIIB	IVB	VB	VIB	VIIB	VII			1B	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984	10 Ne Neon 20.179
11 Na Sodium 22.98977	12 Mg Magnesium 24.305											13 Al Aluminum 26.9815	14 Si Silicon 28.0855	15 P Phosphorus 30.97376	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.08	21 Sc Scandium 44.9559	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.996	25 Mn Manganese 54.9380	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.70	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.9216	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.9059	40 Zr Zirconium 91.22	41 Nb Niobium 92.9064	42 Mo Molybdenum 95.94	43 Tc Technetium 98.906	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.4	47 Ag Silver 107.868	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.9045	54 Xe Xenon 131.30
55 Cs Cesium 132.9054	56 Ba Barium 137.33	57–71 *Rare earths	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.9804	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium 226.0254	89–103 †Actinides	104 Rf Rutherfordium (261)	105 Ha Hahnium (262)	106 Sg Seaborgium (263)	107 Ns Neilsbohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 ‡ (269)	111 ‡			114				

→ Stable region?

57 La Lanthanium 138.9055	58 Ce Cerium 140.12	59 Pr Praseodymium 140.9077	60 Nd Neodymium 144.24	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.9254	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9304	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.029	93 Np Neptunium 237.0482	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (254)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium 259	103 Lr Lawrencium 262


E
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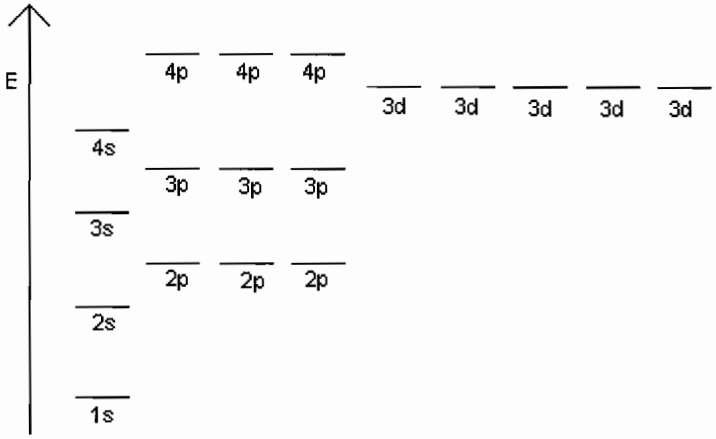
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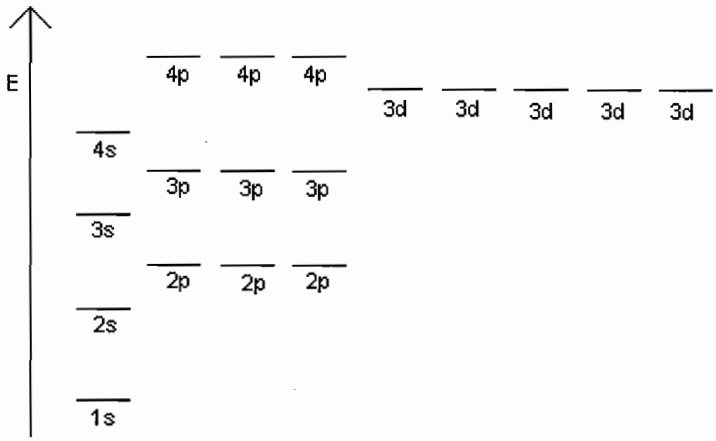
E
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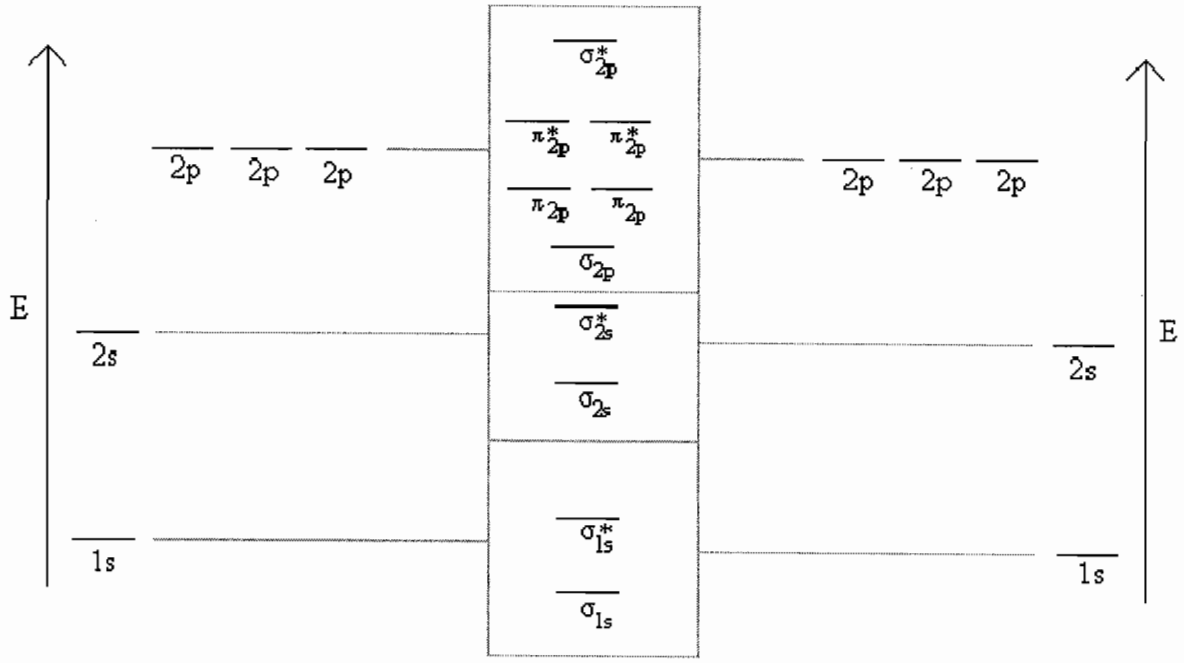
E
2p
2p
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2s
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σ^*_{2p}
π^*_{2p}
π^*_{2p}
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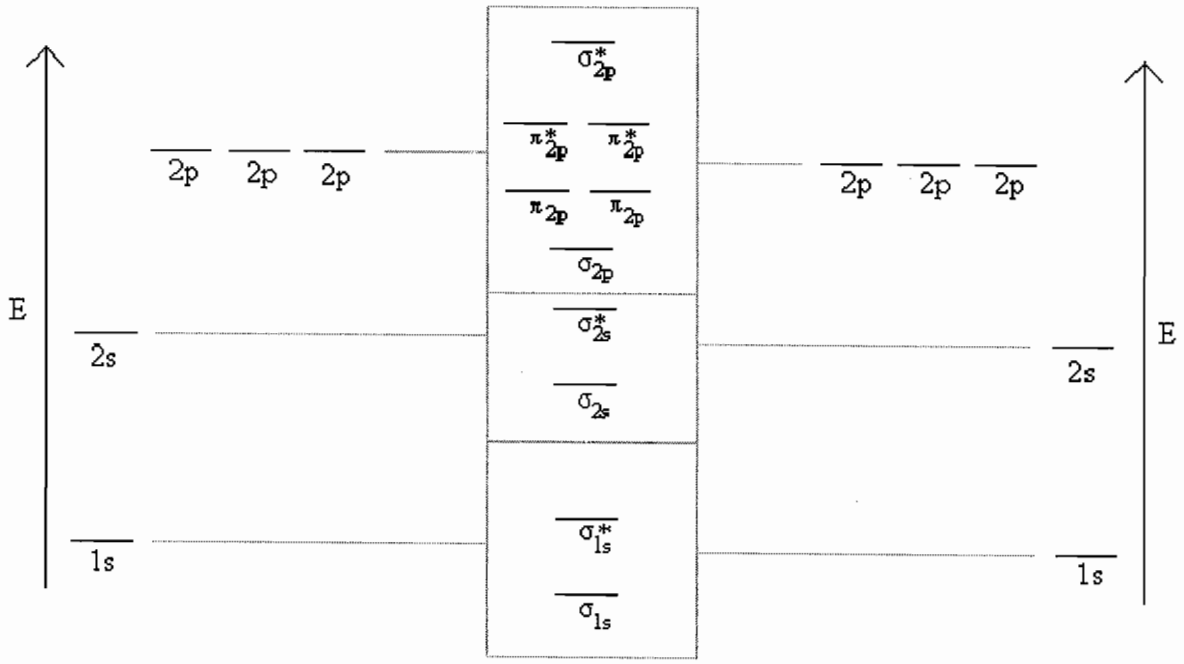
E


E
2p
2p
2p
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1s
σ^*_{2p}
π^*_{2p}
π^*_{2p}
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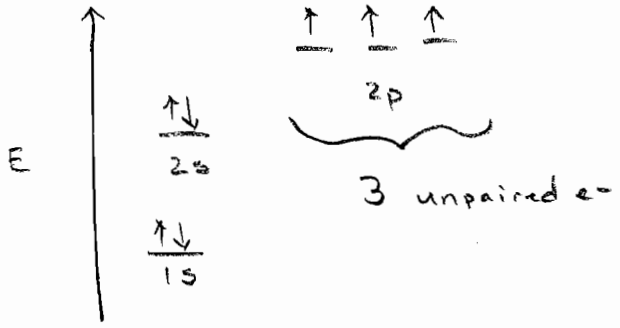
σ_{2p}
σ^*_{2s}
σ_{2s}
σ^*_{1s}
σ_{1s}
2p
2p
2p
2s
1s
E

Please read each exam question carefully. Terms such as *correct, false, unpaired, pairs, H-C-F bond angle, H-C-H angle, greatest, and smallest are* used.

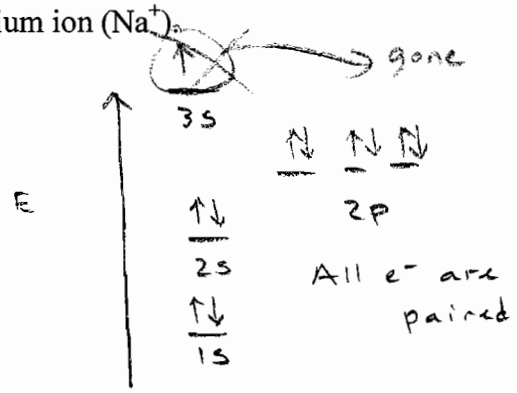
1. There are ___ **unpaired** electrons in a ground-state nitrogen atom.

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4



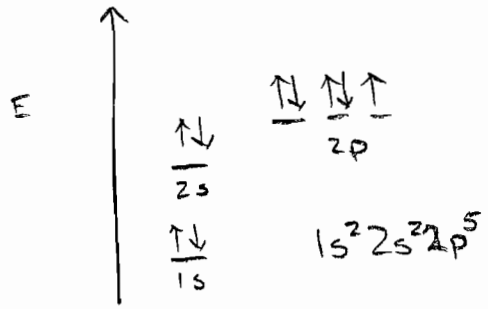
2. There are ___ **unpaired** electrons in a ground-state sodium ion (Na^+).

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4



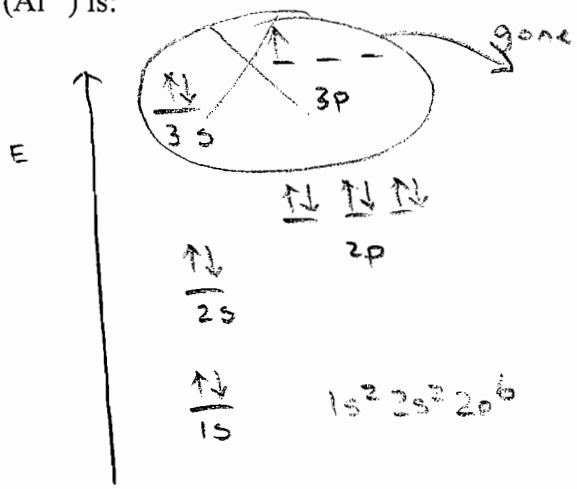
3. The ground-state electron configuration of a fluorine atom is:

(A) $1s^2 2s^2 3s^2 3p^1$
(B) $1s^2 2s^2 3s^1$
(C) $1s^2 2s^2 2p^5$
(D) $1s^2 2s^2 2p^3$
(E) $1s^2 2s^2 3s^3$



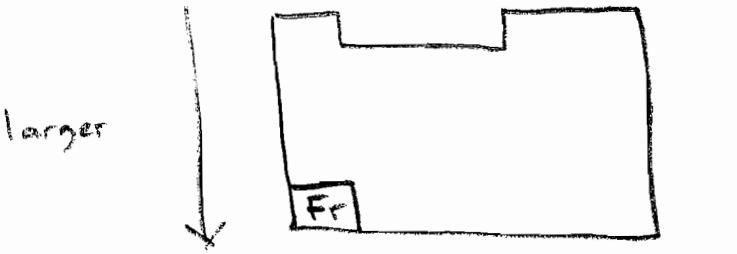
4. The ground-state electron configuration of an aluminum ion (Al^{3+}) is:

(A) $1s^2 2s^2 3s^2 3p^2$
(B) $1s^2 2s^2 3s^1$
(C) $1s^2 2s^2 2p^6$
(D) $1s^2 2s^2 2p^6 3s^2 3p^2$
(E) $1s^2 2s^2 2p^4$



5. Consider O, P, Ge, Ba, and Fr. The atom with the **largest** atomic size is:

(A) O
(B) P
(C) Ge
(D) Ba
(E) Fr



6. Consider Br and Br^-. Consider Na, and Na^+. Which of the following statements is correct?

(A) Br is smaller than Br^-.
(B) Na is smaller than Na^+.
(C) This question is ambiguous and cannot be answered without a data table.

Same number of protons

Br Br^-

larger — one more e⁻ than Br

Same number of protons

Na Na^+

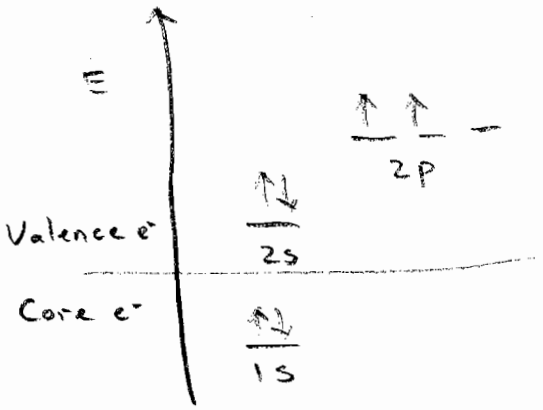
Smaller — one less e⁻ than Na

7. Ionization energy is:

(A) the energy required to separate protons from neutrons
(B) the energy required to remove an electron
(C) the energy required to pull on a pair of electrons
(D) the energy required to push two electrons together
(E) the energy required to form a Noble Gas from a Group 7 element

8. Consider a carbon atom in the ground-state. Which of the following statements is **false**?

(A) The carbon atom has 6 electrons; 2 are core electrons and 4 are valence electrons.
(B) The valence electrons in the carbon atom are all located in 2p orbitals. and the 2s
(C) The core electrons in the carbon atom are all located in the 1s orbital.
(D) There are two unpaired electrons in the carbon atom.
(E) The carbon atom is paramagnetic.

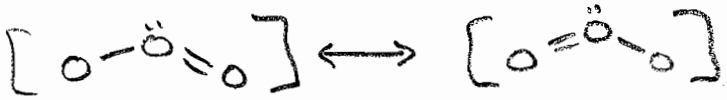


9. The Lewis Dot Structure of water depicts:

(A) There are no lone **pairs** of electrons.
(B) There is one lone **pair** of electrons.
(C) There are two lone **pairs** of electrons.
(D) There are three lone **pairs** of electrons.
(E) There are four lone **pairs** of electrons.

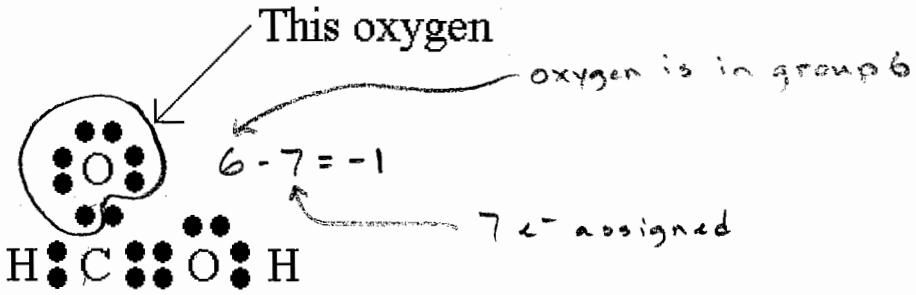
10. Consider one oxygen-oxygen bond in ozone (O_3). The oxygen-oxygen bond order in ozone is:

(A) 1.00
(B) 1.33
(C) 1.50
(D) 2.00
(E) 2.66



Bond Order = $\frac{3}{2}$ or 1.5 or $1\frac{1}{2}$

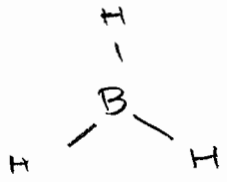
11. A student () proposes the Lewis Dot Structure below for HCOOH. Determine the formal charges on the top oxygen atom in this structure.



(A) The top oxygen has a formal charge of -2
(B) The top oxygen has a formal charge of -1
(C) The top oxygen has a formal charge of 0
(D) The top oxygen has a formal charge of +1
(E) The top oxygen has a formal charge of +2

12. The H-B-H bond angle in boron trihydride (BH_3) is:

(A) 90°
(B) 120°
(C) 109.5°
(D) A little greater than 109.5°
(E) A little less than 109.5°



trigonal planar

13. The molecular geometry of water is:

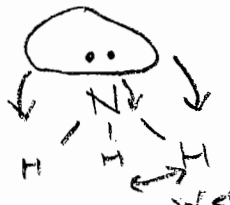
(A) bent
(B) trigonal planar
(C) trigonal pyramidal
(D) tetrahedral
(E) octahedral

14. The molecular geometry of NF_3 is:

(A) bent
(B) trigonal planar
(C) trigonal pyramidal
(D) linear
(E) octahedral

15. The H-N-H bond angle in ammonia (NH_3) is:

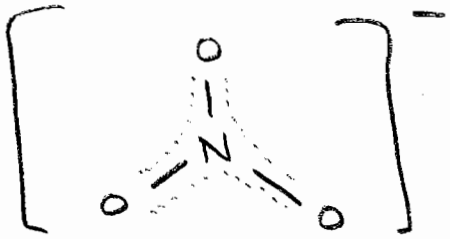
(A) 90°
(B) 120°
(C) 109.5°
(D) A little greater than 109.5°
(E) A little less than 109.5°



109.5°
107°
a little less than 109.5° because the lone pair of e⁻ occupies a greater volume than the bonding e⁻

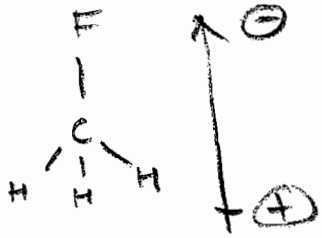
16. The O-N-O bond angle in the nitrate ion (NO_3^-) is:

(A) 90°
(B) 120°
(C) 109.5°
(D) A little greater than 109.5°
(E) A little less than 109.5°



17. Consider C_2H_6, CF_4, CH_3F, CH_4, and CO_2. Which of the following statements is **correct**?

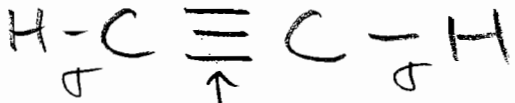
(A) C_2H_6 is a **polar molecule**
(B) CF_4 is a **polar molecule**
(C) CH_3F is a **polar molecule**
(D) CH_4 is a **polar molecule**
(E) CO_2 is a **polar molecule**



Not symmetrical

18. Consider ethene, C_2H_2. Ethene contains:

(A) no π-bonds
(B) one π-bond
(C) two π-bonds
(D) three π-bonds
(E) four π-bonds

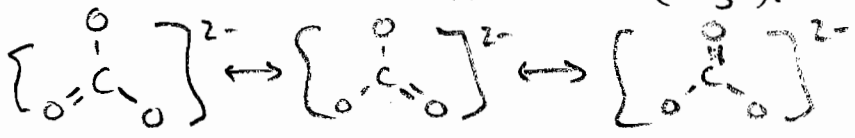


1 σ
2 π

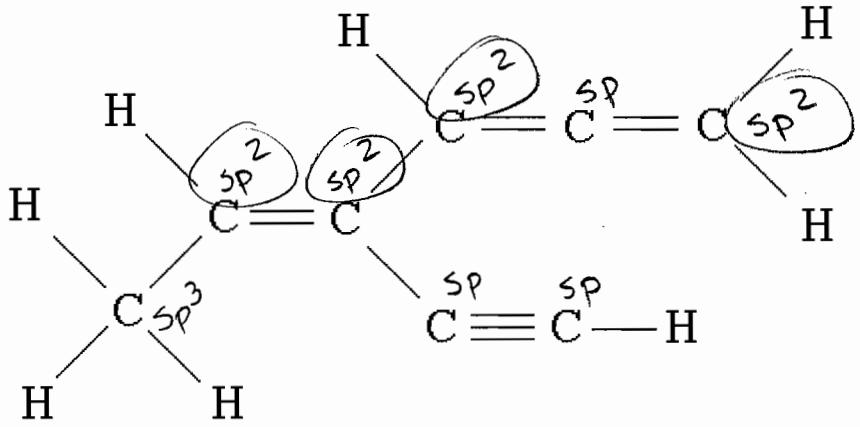
(A "triple" is one σ and two π)

19. There are _____ resonance forms for the ~~[illegible]~~ carbonate ion (CO_3^{2-}).

(A) 0
(B) 1
(C) 2
(D) 3
(E) 4



20. Consider the molecule below and identify the **correct** statement.



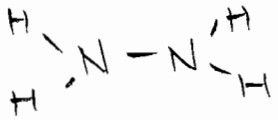
(A) There are 2 carbons that have sp^2 hybridization schemes
(B) There are 3 carbons that have sp^2 hybridization schemes
(C) There are 4 carbons that have sp^2 hybridization schemes
(D) There are 5 carbons that have sp^2 hybridization schemes
(E) There are 6 carbons that have sp^2 hybridization schemes

21. Consider N_2, N_2H_2, and N_2H_4. Which of these has the strongest nitrogen-nitrogen bond?

(A) N_2
(B) N_2H_2
(C) N_2H_4

$N \equiv N$ triple bond - strongest

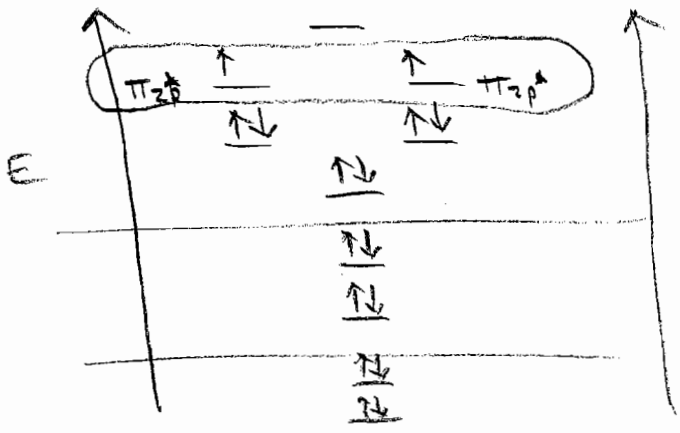
$H-N=N-H$



single bond - weakest

22. Consider MO (Molecular Orbital Theory). For the O_2 molecule, there are _____ electrons in the π_{2p^*} anti-bonding orbitals?

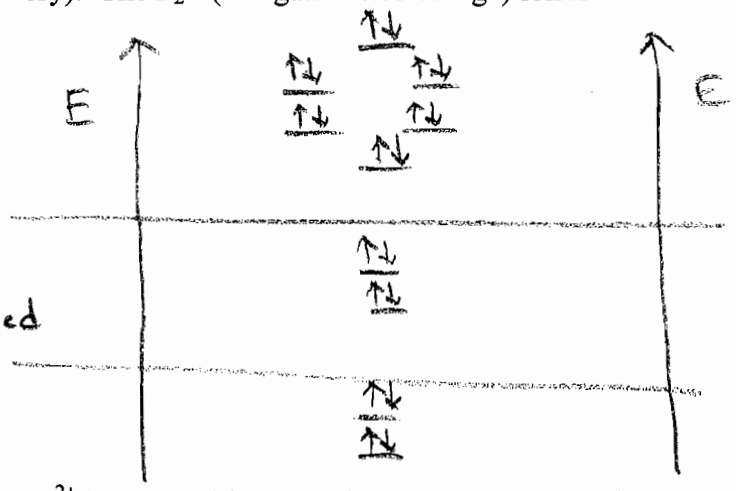
(A) 0
(B) 1
(C) 2
(D) 3
(E) 4



23. Consider MO (Molecular Orbital Theory). The F_2^{2-} (a negative two charge) ion is:

(A) paramagnetic
(B) diamagnetic
(C) tetramagnetic
(D) McCain-magnetic
(E) Obama-magnetic

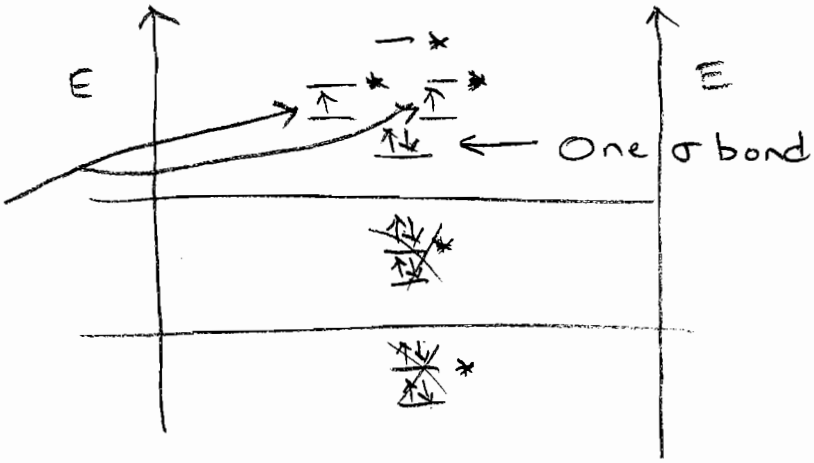
All e⁻ are paired



24. Molecular orbital theory predicts the N_2^{2+} ion (a positive two charge) has a bond order of:

(A) 0.0
(B) 1.0
(C) 1.5
(D) 2.0
(E) 3.0

½ π bond + ½ π bond



25. Because of Chemistry 122...

(A) My new favorite movie character is Bond, James Bond
(B) I have attained a magnetic personality
(C) I realize that success in soccer is due to tremendous "team chemistry"
(D) I may purchase a hybrid vehicle
(E) Oh, I'm out of here. I'm going to enjoy the evening

[Any response will receive full credit; even no response.]