

Name _____ Rec. TA/time _____

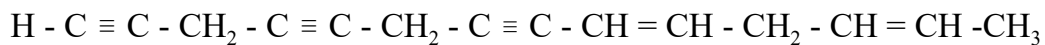
Show **ALL** your work or **EXPLAIN** to receive full credit.

1. (3 pts) For $\text{CH}_3\text{CH}_2\text{PH}_2$ what are the molecular shapes around the C and P atoms, in the order given in the molecule, left to right?
 - a) tetrahedral, tetrahedral, tetrahedral
 - b) tetrahedral, tetrahedral, trigonal pyramidal
 - c) tetrahedral, tetrahedral, bent
 - d) trigonal pyramidal, bent, trigonal pyramidal
 - e) tetrahedral, linear, trigonal pyramidal

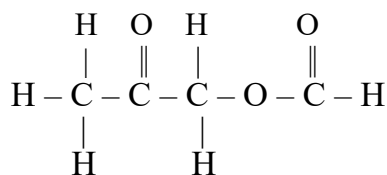
2. (3 pts) Which hybrid orbitals lead to a **bent** shape with bond angles of about 105° ?
 - a) sp
 - b) sp^2
 - c) sp^3
 - d) sp^3d
 - e) sp^3d^2

3. (3 pts) Describe what a sigma, σ , bond is and what a pi, π , bond is in terms of their electron density. Sketch what a pi bond between two atoms looks like (use two large dots to represent the nucleus of each atom).

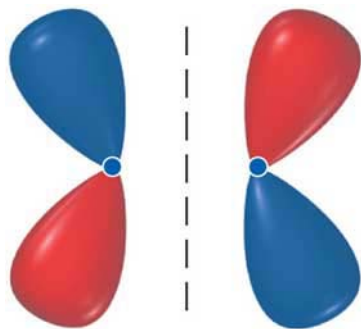
4. (3 pts) How many **sp** hybridized carbon atoms are contained in the following compound?



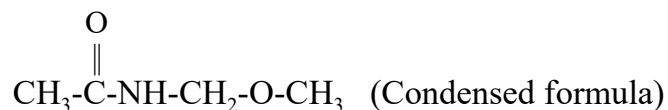
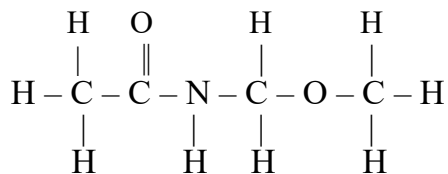
5. (7 pts) For the following molecule (draw in any lone-pair electrons not shown), what are the total number of σ and π bonds in the molecule? **Explain your answers.**



6. (2 pts) Consider the following figure. Is this a (sigma or pi), (bonding or antibonding) molecular orbital.



7. (6 pts) For the following molecule (draw in any lone-pair electrons not shown) answer the questions below. **Explain your answers.**



a) What are the hybridizations of all the central atoms left to right?

CH₃ carbon atom on the far left:

C = O carbon atom:

C – N – C nitrogen atom:

N – C – O carbon atom:

C – O – C oxygen atom:

CH₃ carbon atom on the far right:

b) What are the bond angles around all the central atoms from left to right?

H – C – C (1st C atom on the left)

C – C – N (2nd C atom from left)

C – N – C (the N atom)

N – C – O (C atom between N and O atoms)

C – O – C (O atom between the two C atoms on the right)

O – C – H (C atom on the far right)

8. (8 pts) Using the appropriate **MO diagram**, for each of the following, give the **bond order** and whether it is paramagnetic **or** diamagnetic (and how you know this).



USEFUL INFORMATION

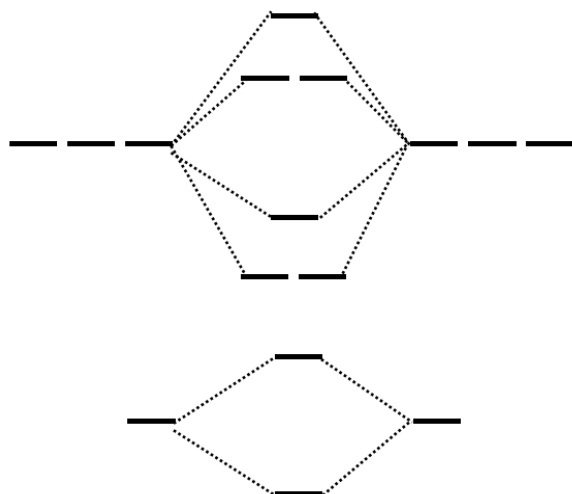
$$R = 0.08206 \text{ L-atm/mol-K} = 8.3145 \text{ J/mol-K}$$

$$\text{Avogadro's number} = 6.02 \times 10^{23} \text{ particles/mole}$$

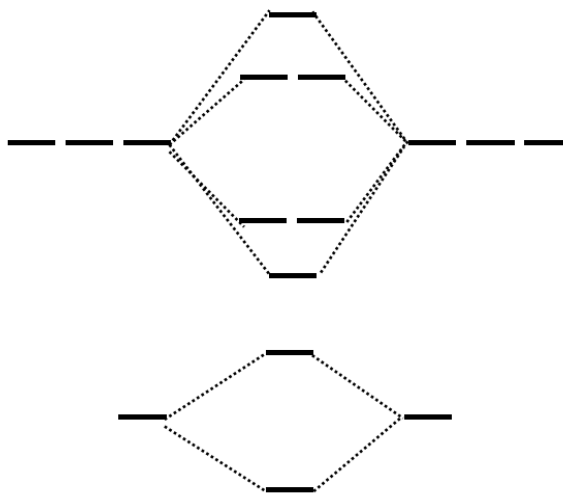
$$1 \text{ \AA} = 1 \times 10^{-10} \text{ m} = 1 \times 10^{-8} \text{ cm}$$

$$\text{molar volume at STP} = 22.41 \text{ L}$$

B₂, C₂, N₂ and their ions:



O₂, F₂, Ne₂ and their ions:



	IA	IIA	IIIB	IVB	VB	VIB	VII	VIII	IX	X	XIB	XIIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 H 1																	4.003 He 2
2	6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.179 Ne 10
3	22.990 Na 11	24.305 Mg 12											26.98 Al 13	28.09 Si 14	30.974 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
4	39.098 K 19	40.08 Ca 20	44.96 Sc 21	47.88 Ti 22	50.94 V 23	52.00 Cr 24	54.94 Mn 25	55.85 Fe 26	58.93 Co 27	58.69 Ni 28	63.546 Cu 29	65.38 Zn 30	69.72 Ga 31	72.59 Ge 32	74.92 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
5	85.47 Rb 37	87.62 Sr 38	88.91 Y 39	91.22 Zr 40	92.91 Nb 41	95.94 Mo 42	98 Tc 43	101.07 Ru 44	102.91 Rh 45	106.42 Pd 46	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.69 Sn 50	121.75 Sb 51	127.60 Te 52	126.90 I 53	131.39 Xe 54
6	132.91 Cs 55	137.33 Ba 56	138.91 La 57	178.39 Hf 72	180.95 Ta 73	183.85 W 74	186.21 Re 75	190.23 Os 76	192.22 Ir 77	195.08 Pt 78	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.2 Pb 82	208.98 Bi 83	209 Po 84	210 At 85	222 Rn 86
7	223 Fr 87	226.03 Ra 88	227.03 Ac 89	261 Rf 104	262 Ha 105	263 Sg 106	262 Ns 107	265 Hs 108	266 Mt 109	269 110	272 111	277 112						

Lanthanide Series	140.12 Ce 58	140.91 Pr 59	144.24 Nd 60	145 Pm 61	150.36 Sm 62	151.96 Eu 63	157.25 Gd 64	158.93 Tb 65	162.50 Dy 66	164.93 Ho 67	167.26 Er 68	168.93 Tm 69	173.04 Yb 70	173.04 Lu 71
Actinide Series	232.04 Th 90	231.04 Pa 91	238.03 U 92	237.05 Np 93	Pu 94	Am 95	Cm 96	Bk 97	Cf 98	Es 99	Fm 100	Md 101	No 102	Lr 103

A PERIODIC CHART OF THE ELEMENTS
(Based on ¹²C)