version: 367

Exam 3 - F22 - McCord - ch301n

last name ______ first name ______ uteid ______ signature ______

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (267)	105 Db (268)	106 Sg (269)	107 Bh (270)	108 Hs (270)	109 Mt (278)	110 Ds (281)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (290)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (266)

constants

$R = 0.08206$ L atm/mol K

$R = 8.314$ J/mol K

$N_A = 6.022 \times 10^{23}$ /mol

$h = 6.626 \times 10^{-34}$ J·s

$c = 3.00 \times 10^{8}$ m/s

$F = 96485$ C/mol e^-

$e = 1.602 \times 10^{-19}$ C

$m_e = 9.11 \times 10^{-31}$ kg

Rydberg Constants

$\mathcal{R} = 2.18 \times 10^{-18}$ J

$\mathcal{R} = 3.29 \times 10^{15}$ s^{-1}

$\mathcal{R} = 1.097 \times 10^{7}$ m^{-1}

conversions

1 atm = 760 torr

1 atm = 101325 Pa

1 atm = 1.01325 bar

1 atm = 14.7 psi

1 bar = 10^5 Pa

1 in = 2.54 cm

1 mi = 5280 ft

1 Å= 10^{-10} m

1 lb = 453.6 g

1 ton = 2000 lbs

1 tonne = 1000 kg

1 gal = 3.785 L

1 gal = 231 in^3

1 fl oz = 29.57 mL

conversions

1 cal = 4.184 J

1 eV = 1.602×10^{-19} J

1 kWh = 3600 J

water data

$C_{s,ice} = 2.09$ J/g °C

$C_{s,water} = 4.184$ J/g °C

$C_{s,steam} = 2.03$ J/g °C

$\rho_{water} = 1.00$ g/mL

$\rho_{ice} = 0.9167$ g/mL

$\rho_{seawater} = 1.024$ g/mL

$\Delta H_{fus} = 334$ J/g

$\Delta H_{vap} = 2260$ J/g

$K_w = 1.0 \times 10^{-14}$

This exam should have exactly 25 questions. Each question is equally weighted at 4 points each. You will enter your answer choices on the virtual bubblehseet after you have finished. Your score is based on what you submit on the virtual bubblesheet and not what is circled on the exam.

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1. Carbon dioxide has a carbon-oxygen double bond. Carbon monoxide has a carbon-oxygen triple bond. Which of the following statements is true?

a. the bonds in carbon monoxide are weaker and longer than the bonds in carbon dioxide

b. the bonds in carbon monoxide are stronger and longer than the bonds in carbon dioxide

c. the bonds in carbon monoxide are stronger and shorter than the bonds in carbon dioxide

d. the bonds in carbon monoxide are weaker and shorter than the bonds in carbon dioxide

Explanation: A triple bond is stronger and shorter than a double bond.

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2. Which of the following is a reason why greenhouse gases are important to our ecosystems?

a. Without greenhouse gases, global temperatures would average around -15° C.

b. Greenhouse gases account for the majority of our atmosphere.

c. Greenhouse gases absorb about 99% of the total radiation from the sun.

d. The planet would be much warmer without greenhouse gases.

Explanation: Greenhouse gases make up a minuscule fraction of our atmosphere, but without them, global temperatures would be much colder.

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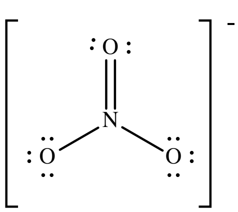
3. What is the formal charge on nitrogen for the nitrate resonance structure shown below?



a. +5

b. -1

c. 0

d. +3

e. +1

Explanation: FC = valence electrons - (bonds + lone pair electrons)

+1 = 5 - 4

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4. Catalysts have a whole set of properties. Which of the following is the MAIN thing that catalysts do for chemical reactions?

a. speed them up

b. stop them

c. make them emit radiation

d. make more limiting reactants

e. make them reverse in direction

Explanation: All catalysts speed up reactions.

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5. $SeCl_4$ has four bonds and one lone pair. What are the electronic and molecular geometries, respectively?

a. trigonal bipyramidal, seesaw

b. trigonal planar, tetrahedral

c. seesaw, square pyramidal

d. seesaw, trigonal bipyramidal

e. square pyramidal, seesaw

Explanation: A molecule with five total areas of electron density assumes a trigonal bipyramidal electronic geometry. If only one area is a lone pair, you have AX_4E which leaves 4 bonded atoms in a see-saw molecular geometry. The 1 lone pair occupies an equatorial position (allowing maximal bond angles between the lone pair and the adjacent areas of electron density)

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6. Which of the following is not capable of hydrogen bonding?

a. $CH_3CH_2NH_2$

b. CH_3CH_2F

c. HF

d. $CH_3CH_2CH_2OH$

e. H_2O

Explanation: CH_3CH_2F is the only option which does not have a hydrogen bound to one of the 3 most electronegative elements: N, O, F. An H bound to one of these atoms is necessary to hydrogen bond.

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7. What is the product of the ozone-depleting mechanism that allows one chlorine atom to destroy around 100,000 ozone molecules in the stratosphere?

a. ozone

●b. a chlorine radical

c. oxygen gas

d. chlorine gas

Explanation: The chlorine radical is a catalyst for the depletion of ozone. It is both a reactant and a product of the ozone-depleting mechanism.

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8. Chlorofluorocarbons (CFC) use as refrigerants has impacted the environment because they...

a. inadvertently caused an increase in carbon monoxide which is a toxic pollutant.

b. depleted ozone at ground level via direct reaction.

●c. provided the source of the catalyst that causes ozone depletion.

d. were toxic when inhaled in small quantities.

e. rapidly cooled down the air due to their thermal properties.

Explanation: CFC use has impacted the environment because they produce chlorine atoms which act as catalysts in ozone depletion.

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9. A molecule has three bonds and three lone pairs. What is the molecular geometry?

●a. T-shape

b. octahedral

c. see-saw

d. trigonal planar

e. trigonal pyramid

Explanation: This will be a T-shaped molecular geometry because it is AX_3E_3 which is octahedral electronic geometry with 3 positions removed (lone pairs).

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10. Which of the following best describes the bonds in the hybrid resonance structure for nitrite, NO_2^-?

a. a single N-O bond and a double O-O bond resonating back and forth

b. a single N-O bond and a double N-O bond resonating back and forth

●c. two N-O 1.5 bonds

d. two N-O single bonds

Explanation: NO_2^- is a resonant structure consisting of N-O bonds that have an average 1.5 bond order.

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11. Which of the following molecules can readily absorb IR radiation?

I. Ar

II. O_2

III. CO_2

IV. CH_2F_2

●a. III and IV

b. I, II, III, and IV

c. I and III

d. I and IV

e. I, II, and IV

Explanation: Carbon dioxide and HFCs are greenhouse gases capable of absorbing IR radiation.

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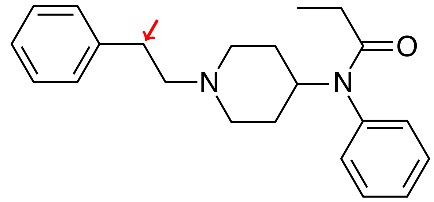
12. (Part 1 of 4) How many carbon atoms are in this structure?



a. 19

b. 21

●c. 22

d. 18

e. 20

Explanation: There are 22 carbons.

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13. (Part 2 of 4) That was so much fun, lets now count the hydrogens. How many hydrogens are in this structure.?

a. 24

●b. 28

c. 27

d. 30

e. 25

f. 26

Explanation: There are 28 hydrogens.

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14. (Part 3 of 4) There is a marked bond angle. What is the value of that bond angle?

a. 120°

●b. 109.5°

c. 117°

d. 90°

e. 180°

Explanation: That is a C with 2 bonds to other C's and 2 more bonds to implied H's. That is 4 regions which means it is tetrahedral with a bond angle of 109.5°.

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15. (Part 4 of 4) The structure doesn't explicitly show any lone pairs, although there are some lone pairs. How many lone pairs are on this molecule?

●a. 4

b. 2

c. 5

d. 6

e. 3

Explanation: Each of the two N's have 1 LP each. The O has two lone pairs. That is a total of 4 lone pairs.

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16. Which substance listed is a polar covalent compound?

●a. CH_3OH

b. H_2

c. KBr

d. MgI_2

e. F_2

Explanation: The only polar covalent molecule listed here is CH_3OH. The KBr and the MgI_2 are both ionic compounds.

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17. What is the molecular geometry for NBr_3?

a. trigonal planar

b. T-shape

c. octahedral

d. tetrahedral

●e. trigonal pyramid

Explanation: The nitrogen will have three bonds and one lone pair. This will be a trigonal pyramidal molecular geometry.

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18. One of the best properties of refrigerants (freons) used in the previous century seemed "good". Later, we found that property to actually be somewhat "bad". What is that property?

a. highly polar

b. great heat exchangers

c. adsorbers of CO_2

●d. relative inertness

Explanation: Inertness. They stayed in the atmosphere for years and years. This allowed them to easily reach the ozone layer and begin to react and initiate ozone depletion.

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19. Why are HFCs, the newest refrigerants in use, considered unsustainable?

●a. HFCs are extremely potent greenhouse gases.

b. HFCs are rapidly depleting the ozone layer.

c. HFCs emit harmful UV radiation.

d. HFCs are cooling down the ozone layer.

Explanation: The current concern with HFCs is that they are potent greenhouse gases, even though they do not negatively impact the ozone layer like HCFCs and CFCs.

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20. The overall energy exchange of our earth with the surrounding universe is and example of ______ .

a. electric potential

●b. dynamic equilibrium

c. the Chapman Cycle

d. static equilibrium

Explanation: The earth has equal amounts of energy IN and OUT. But the energy is in constant flux which means there is a dynamic equilibrium constantly in play. (see notes from 10/20).

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21. Draw ozone and then determine which of the following statements is/are true.

I. ozone has a trigonal planar electronic geometry

II. the bond angles in ozone are approximately 109.5°

III. the bonds in ozone are weaker than the bond angles in diatomic oxygen

IV. ozone has a bent molecular geometry

a. I, II, III, and IV

b. I and III

c. I and IV

●d. I, III, and IV

e. I, II, and IV

Explanation: The ozone molecule is a resonant structure with a bond order equal to about 1.5, which will result in weaker bonds than oxygen. The structure has a trigonal planar electronic geometry and a bent molecular geometry. The bond angles are slightly less than 120°.

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22. What is the molecular geometry of BrF_5? (Hint: it has one lone pair)

a. tetrahedral

b. octahedral

c. square planar

d. trigonal bipyramid

●e. square pyramid

Explanation: BrF_5 has 5 bonds and one lone pair. This points to square pyramid geometry.

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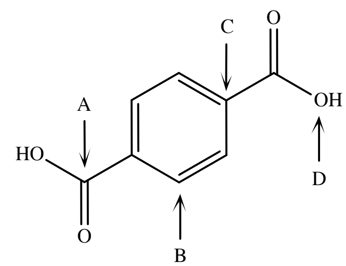
23. Which arrow(s) is/are pointing to a central atom with a trigonal planar molecular geometry?



●a. A, B, and C only

b. A, B, C, and D

c. B and C only

d. A and B only

e. A and C only

Explanation: When you account for implied hydrogens where necessary, you will see that arrows A, B, and C point to trigonal planar geometries.

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24. When comparing N_2 and Cl_2, does N_2 have a longer or shorter bond length, a stronger or weaker bond, and is it more or less stable than Cl_2?

a. longer, weaker, less stable

b. longer, weaker, more stable

●c. shorter, stronger, more stable

d. shorter, stronger, less stable

e. longer, stronger, more stable

f. shorter, weaker, less stable

Explanation: N_2 has a bond order of 3, while Cl_2 only has a bond order of 1. Higher bond order corresponds to shorter bonds, stronger bonds, and more stable bonds.

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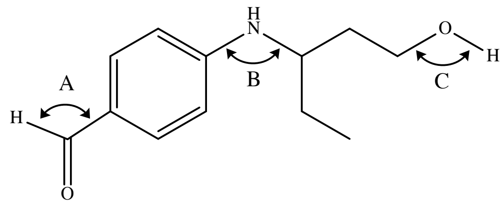
25. What are the bond angles at positions labeled A, B, and C (in that order)?



a. 107°, 109.5°, 90°

b. 120°, 109.5°, 109.5°

●c. 120°, 107°, 104.5°

d. 120°, 120°, 120°

e. 109.5°, 120°, 178°

Explanation: The aldehyde at position A has 3 areas of electron density and no lone pairs, creating a trigonal planar shape with bond angles of 120. The amine at position B has a core tetrahedral electronic geometry around the nitrogen, with 3 bonds and 1 (implied) lone pair. The lone pair squeezes the remaining bond angles to slightly less than 109.5 - meaning we tweak the angle down to 107. Last, the oxygen at position C has two lone pairs as well as the bonds to the carbon and hydrogen atoms. The core tetrahedral geometry is tweaked by the two lone pairs so that the final bent configuration of the C-O-H bond is a double tweak resulting in 104.5.

After you are finished and have all your answers circled, go to the front of the room and then use the QR code there to pull up the virtual answer page. Enter the appropriate info plus all your answers - click the SUBMIT button. Make sure you get the confirmation screen and show it to the TA or proctor. After that, turn in your exam and scratch paper. You're free to leave after that.

https://mccord.cm.utexas.edu/helium

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