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Chemistry 14A - Fall 2019: Test 2

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Write in Pen. Check your significant figures and units. Good Luck.

All work must be shown to get credit. Box your final answer.

Total points: 50 Total time: 50 minutes

Planck's constant, h = 6.62608 x 10^{-34} J.s

Avogadro's constant, N_A = 6.02214 x 10^{23} mol^{-1}

Rydberg constant, R = 3.28984 x 10^{15} Hz

Boltzmann's constant, k = 1.38 x 10^{-23} $J \cdot K^{-1}$

Faraday's constant, F = 96,485 $C \cdot mol^{-1}$

Gas constant, R = 8.314 $J \cdot K^{-1} \cdot mol^{-1}$ = 8.206 x 10^{-2} $L \cdot atm \cdot K^{-1} \cdot mol^{-1}$

= 8.314 x 10^{-2} $L \cdot bar \cdot K^{-1} \cdot mol^{-1}$ = 62.364 $L \cdot Torr \cdot K^{-1} \cdot mol^{-1}$

Mass of electron, m_e = 9.1095 x 10^{-31} kg Charge of an electron = 1.602 × 10^{-19} coulombs

Mass of proton, m_p = 1.6726 x 10^{-27} kg Mass of neutron, m_n = 1.6749 × 10^{-27} kg

1 eV = 1.602 × 10^{-19} J Speed of light, c = 2.99792 x 10^{8} $m.s^{-1}$

C_2 = Second radiation constant = 0.0144 K·m 1 J = 1 $kg.m^2.s^{-2}$

0°C = 273.15 K 1L = 1 dm^3 1 atm = 101.325 kPa π = 3.14

Water Density = 1 $g.ml^{-1}$ $\ln(X) = 2.303 \log_{10}(X)$ 1 kcal = 4.18 kJ 1 W = 1 $J.s^{-1}$

1mW = 1 x 10^{-3} W 1 kg = 1000 g PV = nRT $pH = -\log[H^+]$

1 nm = 10^{-9} m 1 Å = 10^{-10} m 1 pm = 10^{-12} m

$c = \lambda \nu$ $E = h \nu$ $E = pc$ $p = mv$ E_n = -

λ = $E_k = mv^2$ $T \lambda_{MAX} = C_2$ $\Delta p \Delta x \geq \pi$ E_n =

$E_{TOTAL}\, \psi(x) = E_K\, \psi(x) + V(x)\, \psi(x) = - \pi \psi + V(x)\, \psi(x)$

1. Methane (CH_4) and fluoroform (CHF_3) are both strong greenhouse gas. What types of intermolecular forces are present in a sample of methane? What types of intermolecular forces are present in a sample of fluoroform? Predict which sample would have a higher boiling point. (8 pts)

① Methane has London dispersion force as its type of intermolecular force.

② Fluoroform's types of intermolecular forces are London dispersion forces and dipole-dipole forces.

③ Fluoroform would have the higher boiling point.

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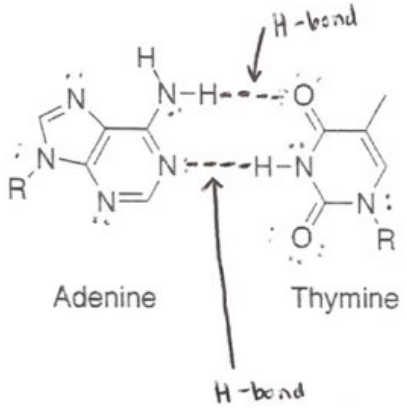
2. a) Hydrogen bonding is important for nucleic acids. Draw how two separate nucleic acids below (adenine and thymine, structures shown below) will interact via H-Bonding to form a AT pair. (3pts)



H-bonds are between H and N, O, or F

3

2 ☆ b) There are two different base pairs in a DNA molecule, an AT pair as described in (a) and a guanine-cytosine pair (GC). Which pair has a higher melting point in a DNA molecule: An AT pair, or a GC pair? Why? (4 pts)

what's the difference between a AT pair and GC pair

what does guanine-cytosine look like?

The AT pair has a higher melting point because it has 2 points of Hydrogen bonding in regards to the intermolecular forces between the adenine and thymine. ×

higher melting point correlates w more surface area and stronger intermolecular forces

+2

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3. Enzymes are biological catalysts that drive a specific chemical reaction forward. A newly discovered enzyme, Enzyme-Z, was found to be able to catalyze the breakdown of certain molecules based on their molecular shape.

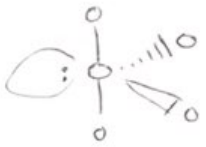
a) Enzyme-Z was found to catalyze the breakdown of SF_4. Draw the Lewis structure of SF_4 and determine its shape. (6 pts)

SF_4
34 ve⁻

Lewis:

AX_4E

Shape: see-saw ✓



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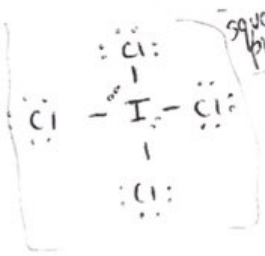
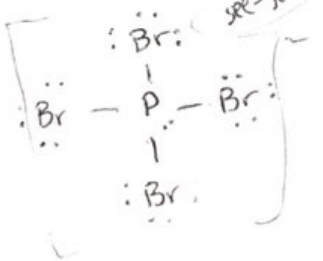
b) If Enzyme-Z breaks down molecules only based on their shape, which of the following would it also be able to breakdown: ICl_4^-, PBr_4^-, NH_4^+? (4 pts)

what has see saw

ICl_4^-
36 ve⁻

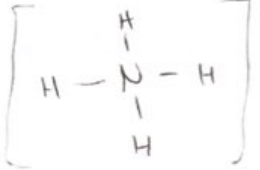


PBr_4^-
34 ve⁻



NH_4^+
8 ve⁻

tetrahedral



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Enzyme Z could also breakdown PBr_4^-

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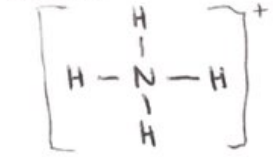
4. Draw the Lewis structure of NH_4^+, and determine the molecular shape and the bond angle(s). (6 pt)

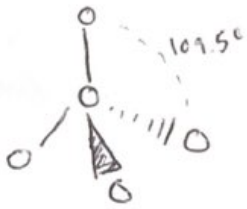
NH_4^+
8 ve⁻ total

Shape: tetrahedral

bond angles: 109.5°

Lewis:





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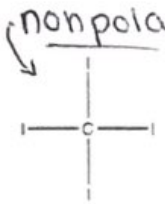
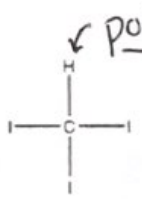
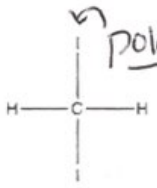
5. Suggest, giving reasons, which substance of the following pair is likely to have a higher normal boiling point? NH_3 or PH_3 (4 pts)

PH_3 should have the higher boiling point because although it shares the same shape with NH_3, P is larger than N making the molecular weight and surface area of PH_3 larger than NH_3.

6. Identify whether the molecule as a whole is polar or nonpolar based off the net dipole moment (Hint: Consider the VSEPR shapes of these molecules) (6 pts)







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CH_2I_2 VSEPR

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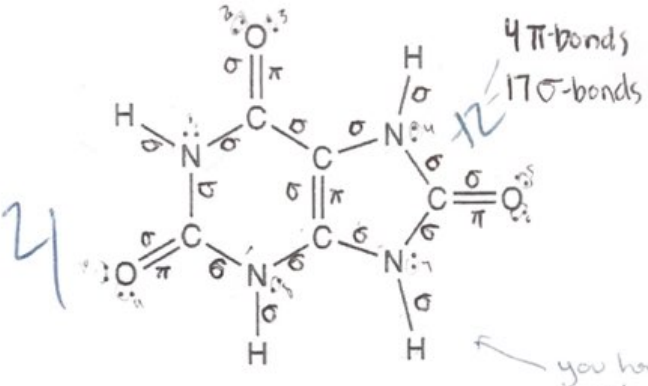
→ look for lone pairs — intermolecular force

7. a) Uric acid (shown below) is a product of the metabolic breakdown of nucleotides and a normal component of urine. Label all sigma and pi bonds and give the total number of hydrogen bonding sites. (6 pts)

H connects to N, O, F in H-bonding ✓



4 π-bonds
17 σ-bonds
12

4

you have all N-H circled +2

~~hydrogen bonding sites~~

10 hydrogen bonding sites

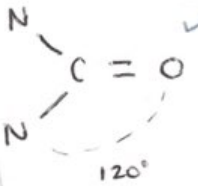
X

14 H-bonding sites

b) Pick ~~three~~ different bond angles in Uric acid and give the approximate value of those bond angles. (3 pts)

3

~~1~~

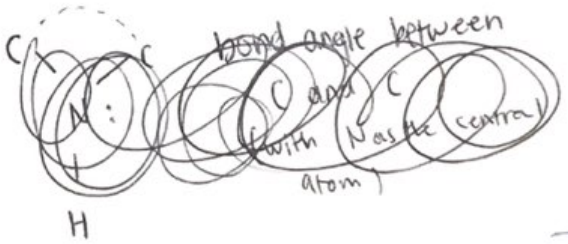


bond angle between O and N (with C being the central atom) is 120° ✓

bond angle between C and N (with C as the central atom) is 120° ✓

trigonal pyramidal

bond angle between C and H (with N being the central atom) is slightly less than 109.5° ~~as~~ (≈ 107°) ✓



bond angle between C and C (with N as the central atom)

H

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