

Name _____

If you do NOT want your graded exam placed in the cardboard box outside my office, then please mark a cross here _____

(1-10) are True / False

- 1) Chemistry is the science that deals with transformations on the atomic and molecular levels.
- 2) There are 3 different p atomic orbitals within the 2nd quantum shell of an atom.
- 3) Ions that are present but play no role in a reaction are called uncertainty ions.
- 4) Krypton has a larger atomic radius than Argon.
- 5) When one mole of Na₂SO₄ (Sodium sulfate) is dissolved in water, a total of four moles of ions are produced.
- 6) The wavelength of a wave is the distance between identical points on successive waves.
- 7) This is an example of a disproportionation reaction:
$$\text{CCl}_4 + 4 \text{HF} \rightarrow \text{CF}_4 + 4 \text{HCl}$$
- 8) 103.25 has five significant figures.
- 9) The molecule P₂O₅ is named Phosphine Oxide.
- 10) No two electrons in the same atom can have the same four quantum number values.

11) Name one type of electromagnetic radiation (or region in the electromagnetic spectrum) with lower *energy* than visible light.

12) What does a concentration of 10 M (ten molar) mean?

13-16) On the following schematic of a period table, indicate where the following elements are located:

- Main group elements likely to form cations of charge +2.
- The most electronegative halogen.
- The smallest element of the 3rd row.
- The most metallic member of Group I (1A).

17-18) Label the following orbitals (e.g. 1s) in the following orbital diagram, and then use them to illustrate the ground state electron configuration of Sulfur.

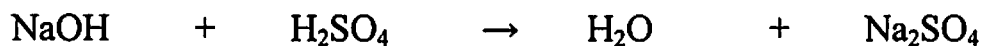


19) Which element would produce a 1+ cation with the electron configuration of $[\text{Ar}] 4s^1$?

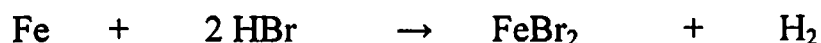
20-21) For an ideal gas, $P V = n R T$, name these four inter-related physical properties.

22-23) A bottle of 12.0 M hydrochloric acid has only 71.4 mL left in it. What will the new HCl concentration be if the solution is diluted to 250.0 mL?

24-25) For the following equation, balance it, and then provide the net ionic equation.

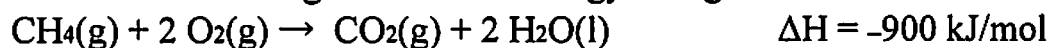


26) For the following reaction, indicate which species is being reduced.

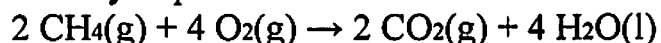


27) What is one of the assumptions we make for an “ideal gas”?

28) Based on the following reaction and energy change:



What would you predict for the ΔH of this reaction?



29-30) Draw a Lewis structure for the ammonia molecule NH_3 , and show why the Nitrogen atom satisfies the Octet Rule.

(31-40) are multiple choice

31) Substances that are able to ionize in aqueous solutions to form hydroxide ions are called:

- a) Elements
- b) Acids
- c) Isotopes
- d) Bases
- e) Titrations

32) Under the same conditions, which gas molecules would have the larger velocity (diffuse and effuse faster)?

- a) Kr
- b) N₂
- c) Cl₂
- d) F₂
- e) All would have the same speed

33) Which atomic orbital is described by quantum numbers $n = 2$, $l = 0$, $m_l = 0$?

- a) 1s
- b) 2s
- c) 2p
- d) 3s
- e) 2p_x

34) The hydronium ion (H₃O⁺) involves the interaction of how many total valence electrons?

- a) 7
- b) 8
- c) 9
- d) 10
- e) Insufficient data provided to determine.

35) Which sequence of numbers is the correct listing of the oxidation states of Hydrogen in H₂, NaH and HCl?

- a) 0, 1, 1
- b) 2, 81, 24
- c) 0, -1, +1
- d) 0, +1, -1
- e) +1, +1, +1

36) Using the best Lewis structure of methane (CH_4), what is the formal charge on the Carbon atom?

- a) -2
- b) -1
- c) 0
- d) +1
- e) +2

37) Oxidation is best described as:

- a) Formation of protons
- b) Gain of electrons
- c) Loss of electrons
- d) Formation of hydroxide ions
- e) None of the above

38) The kinetic molecular theory of gases explains gas behavior in terms of:

- a) wavefunctions
- b) the wavelength of the molecules
- c) the frequency and energy of molecular collisions within a container
- d) orbital energies
- e) oxidation states

39) A molecule of type AB_4E_2 would have what type of molecular geometry?

- a) Octahedral
- b) Planar triangular
- c) Tetrahedral
- d) Trigonal bipyramidal
- e) Square planar

40) The molecule PCl_5 would have what type of molecular shape?

- a) Octahedral
- b) Planar triangular
- c) Tetrahedral
- d) Trigonal bipyramidal
- e) Square planar

41-42) For an electron (mass = 9.11×10^{-31} kg) moving with a velocity of 3.00×10^5 m/s, calculate the de Broglie wavelength.

$$\lambda = \frac{h}{mv} \quad \text{Planck's Constant} = 6.626 \times 10^{-34} \text{ J s} \quad \text{J} = \frac{\text{kg m}^2}{\text{s}^2}$$

43) What does your numerical answer above mean in the context of trying to experimentally measure or detect the associated wavelength of an electron?

44-45) A 49.62 gram sample of a compound containing only carbon, oxygen, and chlorine is experimentally determined to contain 6.02 g C, 8.00 g O, and 35.62 g Cl. What is this compound's percent composition by mass of C, O and Cl?

46-47) How many moles of Ammonium Chromate, $(\text{NH}_4)_2\text{CrO}_4$, are contained in 300.0 grams?

48-50) A molecule with the formula $\text{C}_6\text{H}_8\text{O}_6$ has two acidic Hydrogens (meaning a diprotic acid). A sample of this molecule was analyzed by titration using 0.125 M $\text{NaOH}(\text{aq})$, and it required 29.5 mL of the base to neutralize the acidic sample. How many grams of the $\text{C}_6\text{H}_8\text{O}_6$ molecule were in the sample?

*****Bonus Questions for +1 points each (up to 3 total)*****

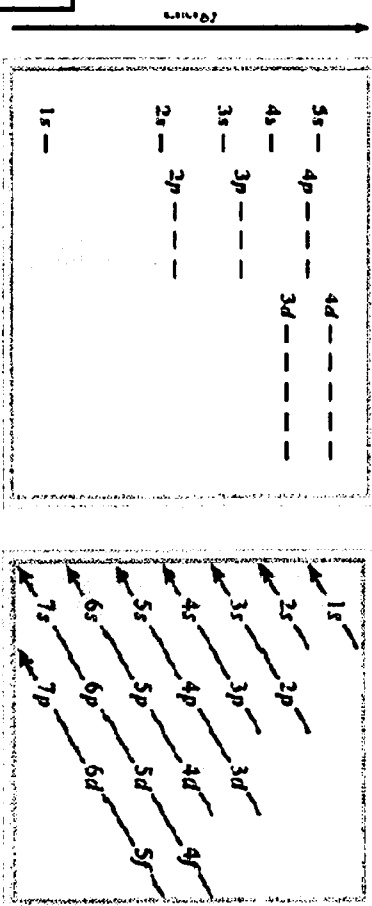
What were the 3 “names” I used for the online answers to your Exams this semester?

Exam1:

Exam2:

Exam3:

1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIIIB	10 VIII	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.01	2 He 4.00	3 Li 6.94	4 Be 9.01	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 39.1	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	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 65.39	31 Ga 69.72	32 Ge 72.61	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 127.6	53 I 126.9	54 Xe 131.29
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac^ (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (266)	110 Ds (271)	111 Rg (272)							



58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa (231)	92 U 238.0	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 (260)

Name _____

Fluorine Indium Aluminum

If you do NOT want your graded exam placed in the cardboard box outside my office, then please mark a cross here _____

(1-10) are True / False

1) Chemistry is the science that deals with transformations on the atomic and molecular levels. *True*

2) There are 3 different p atomic orbitals within the 2nd quantum shell of an atom. *True*

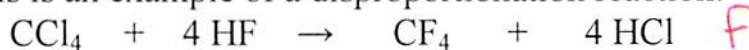
3) Ions that are present but play no role in a reaction are called uncertainty ions. *F*

4) Krypton has a larger atomic radius than Argon. *True*

5) When one mole of Na₂SO₄ (Sodium sulfate) is dissolved in water, a total of four moles of ions are produced. *F*

6) The wavelength of a wave is the distance between identical points on successive waves. *True*

7) This is an example of a disproportionation reaction:



8) 103.25 has five significant figures. *True*

9) The molecule P₂O₅ is named Phosphine Oxide. *F*

10) No two electrons in the same atom can have the same four quantum number values. *True*

11) Name one type of electromagnetic radiation (or region in the electromagnetic spectrum) with lower *energy* than visible light.

Infrared, microwave, radiowaves

12) What does a concentration of 10 M (ten molar) mean?

10M means 10 moles per liter.

13-16) On the following schematic of a period table, indicate where the following elements are located:

A schematic periodic table with 7 rows and 18 columns. The first two columns are on the left, and the last two columns are on the right, with a gap in the middle. Red annotations include: a vertical rectangle around the first two columns of the first three rows; a red arrow pointing to the first cell of the first row; a red arrow pointing to the first cell of the second row; a red arrow pointing to the first cell of the third row; a red arrow pointing to the first cell of the fourth row; a red arrow pointing to the first cell of the fifth row; a red arrow pointing to the first cell of the sixth row; a red arrow pointing to the first cell of the seventh row; a red arrow pointing to the first cell of the eighth row; a red arrow pointing to the first cell of the ninth row; a red arrow pointing to the first cell of the tenth row; a red arrow pointing to the first cell of the eleventh row; a red arrow pointing to the first cell of the twelfth row; a red arrow pointing to the first cell of the thirteenth row; a red arrow pointing to the first cell of the fourteenth row; a red arrow pointing to the first cell of the fifteenth row; a red arrow pointing to the first cell of the sixteenth row; a red arrow pointing to the first cell of the seventeenth row; a red arrow pointing to the first cell of the eighteenth row; a red arrow pointing to the first cell of the nineteenth row; a red arrow pointing to the first cell of the twentieth row; a red arrow pointing to the first cell of the twenty-first row; a red arrow pointing to the first cell of the twenty-second row; a red arrow pointing to the first cell of the twenty-third row; a red arrow pointing to the first cell of the twenty-fourth row; a red arrow pointing to the first cell of the twenty-fifth row; a red arrow pointing to the first cell of the twenty-sixth row; a red arrow pointing to the first cell of the twenty-seventh row; a red arrow pointing to the first cell of the twenty-eighth row; a red arrow pointing to the first cell of the twenty-ninth row; a red arrow pointing to the first cell of the thirtieth row; a red arrow pointing to the first cell of the thirty-first row; a red arrow pointing to the first cell of the thirty-second row; a red arrow pointing to the first cell of the thirty-third row; a red arrow pointing to the first cell of the thirty-fourth row; a red arrow pointing to the first cell of the thirty-fifth row; a red arrow pointing to the first cell of the thirty-sixth row; a red arrow pointing to the first cell of the thirty-seventh row; a red arrow pointing to the first cell of the thirty-eighth row; a red arrow pointing to the first cell of the thirty-ninth row; a red arrow pointing to the first cell of the fortieth row.

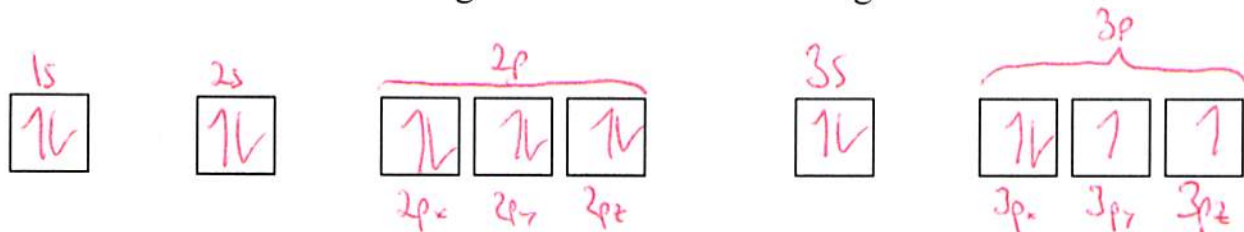
- Main group elements likely to form cations of charge +2.

- The most electronegative halogen.

- The smallest element of the 3rd row.

- The most metallic member of Group I (1A).

17-18) Label the following orbitals (e.g. 1s) in the following orbital diagram, and then use them to illustrate the ground state electron configuration of Sulfur.



19) Which element would produce a 1+ cation with the electron configuration of [Ar] 4s¹?

Calcium

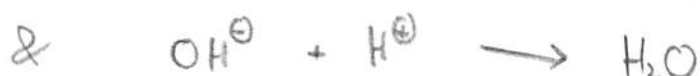
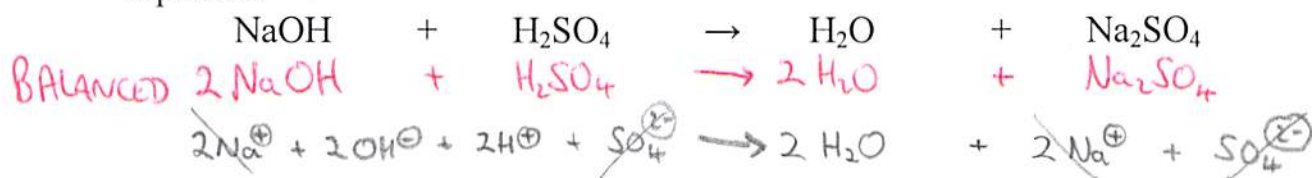
20-21) For an ideal gas, $P V = n R T$, name these four inter-related physical properties.

Pressure Amount (number of moles)
Volume Temperature

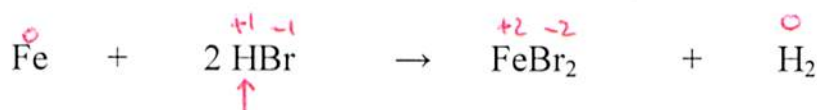
22-23) A bottle of 12.0 M hydrochloric acid has only 71.4 mL left in it. What will the new HCl concentration be if the solution is diluted to 250.0 mL?

$$\begin{aligned}
 M_1 V_1 &= M_2 V_2 \Rightarrow M_2 = \frac{M_1 V_1}{V_2} = \frac{12.0 \times 71.4}{250.0} \\
 &= 3.4272 \\
 &= \underline{\underline{3.43 \text{ M}}} \quad (3 \text{ sig. figs.})
 \end{aligned}$$

24-25) For the following equation, balance it, and then provide the net ionic equation.



26) For the following reaction, indicate which species is being reduced.

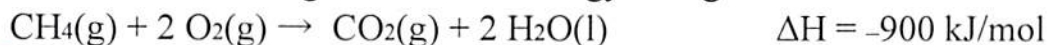


The Hydrogen in H-Br is being reduced

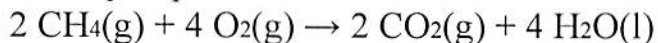
27) What is one of the assumptions we make for an "ideal gas"?

- No interactions between the gaseous atoms/molecules.
- The atoms/molecules are of negligible volume relative to the container.

28) Based on the following reaction and energy change:

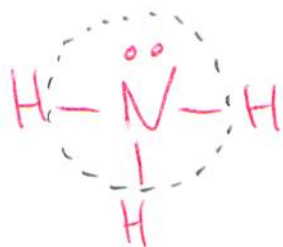


What would you predict for the ΔH of this reaction?



Double the amount = double energy change = -1800 kJ/mol

29-30) Draw a Lewis structure for the ammonia molecule NH_3 , and show why the Nitrogen atom satisfies the Octet Rule.



1 bond = $2e^-$

So 3 bonds + 1 lone pair = 8 electrons around N

$$\downarrow$$

$$5+3=8e^-$$

(31-40) are multiple choice

31) Substances that are able to ionize in aqueous solutions to form hydroxide ions are called:

- a) Elements
- b) Acids
- c) Isotopes
- d) Bases
- e) Titrations

32) Under the same conditions, which gas molecules would have the larger velocity (diffuse and effuse faster)?

- a) Kr = 84
- b) N₂ = 28
- c) Cl₂ = 71
- d) F₂ = 38
- e) All would have the same speed

33) Which atomic orbital is described by quantum numbers $n = 2, l = 0, m_l = 0$?

- a) 1s
- b) 2s
- c) 2p
- d) 3s
- e) 2p_x

\downarrow
2 \downarrow
s \downarrow
1 type

34) The hydronium ion (H₃O⁺) involves the interaction of how many total valence electrons?

- a) 7
- b) 8
- c) 9
- d) 10
- e) Insufficient data provided to determine.

$\rightarrow 3 + 6 - 1 = 8$

35) Which sequence of numbers is the correct listing of the oxidation states of Hydrogen in H₂, NaH and HCl?

- a) 0, 1, 1 -1 +1
- b) 2, 81, 24
- c) 0, -1, +1
- d) 0, +1, -1
- e) +1, +1, +1

36) Using the best Lewis structure of methane (CH_4), what is the formal charge on the Carbon atom?

- a) -2
- b) -1
- c) 0
- d) +1
- e) +2



37) Oxidation is best described as:

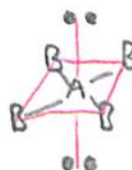
- a) Formation of protons
- b) Gain of electrons
- c) Loss of electrons
- d) Formation of hydroxide ions
- e) None of the above

38) The kinetic molecular theory of gases explains gas behavior in terms of

- a) wavefunctions
- b) the wavelength of the molecules
- c) the frequency and energy of molecular collisions within a container
- d) orbital energies
- e) oxidation states

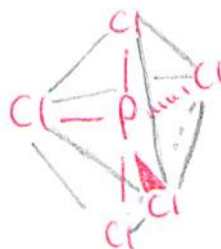
39) A molecule of type AB_4E_2 would have what type of molecular geometry?

- a) Octahedral
- b) Planar triangular
- c) Tetrahedral
- d) Trigonal bipyramidal
- e) Square planar



40) The molecule PCl_5 would have what type of molecular shape?

- a) Octahedral
- b) Planar triangular
- c) Tetrahedral
- d) Trigonal bipyramidal
- e) Square planar



41-42) For an electron (mass = 9.11×10^{-31} kg) moving with a velocity of 3.00×10^5 m/s, calculate the de Broglie wavelength.

$$\lambda = \frac{h}{mv} \quad \text{Planck's Constant} = 6.626 \times 10^{-34} \text{ J s} \quad \text{J} = \frac{\text{kg m}^2}{\text{s}^2}$$

$$\lambda = \frac{6.626 \times 10^{-34}}{9.11 \times 10^{-31} \times 3.00 \times 10^5} \quad \frac{\cancel{\text{kg}} \cdot \text{m}^2}{\cancel{\text{s}^2}} \cdot \cancel{\text{s}} \cdot \frac{\cancel{\text{s}}}{\cancel{\text{kg}} \cdot \cancel{\text{m}}}$$

$$= 2.42444 \times 10^{-9}$$

$$= 2.42 \times 10^{-9} \text{ Metres}$$

43) What does your numerical answer above mean in the context of trying to experimentally measure or detect the associated wavelength of an electron?

Can be detected / measured / observed.

44-45) A 49.62 gram sample of a compound containing only carbon, oxygen, and chlorine is experimentally determined to contain 6.02 g C, 8.00 g O, and 35.62 g Cl. What is this compound's percent composition by mass of C, O and Cl?

$$\% \text{ C by mass} = \frac{6.02}{49.62} \times 100\% = 12.1\% \quad (3 \text{ sig-figs})$$

$$\% \text{ O by mass} = \frac{8.00}{49.62} \times 100\% = 16.1\%$$

$$\% \text{ Cl by mass} = \frac{35.62}{49.62} \times 100\% = 71.8\%$$

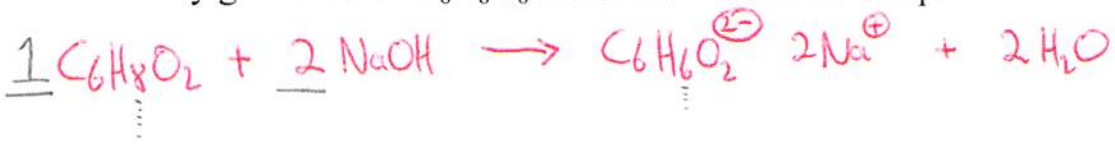
46-47) How many moles of Ammonium Chromate, $(\text{NH}_4)_2\text{CrO}_4$, are contained in 300.0 grams?

$$\begin{array}{l}
 2\text{N} = 2 \times 14.01 = 28.02 \\
 8\text{H} = 8 \times 1.01 = 8.08 \\
 1\text{Cr} = 1 \times 52.00 = 52.00 \\
 4\text{O} = 4 \times 16.00 = 64.00
 \end{array}
 \left. \vphantom{\begin{array}{l} 2\text{N} \\ 8\text{H} \\ 1\text{Cr} \\ 4\text{O} \end{array}} \right\} 152.10 = \text{FW of } (\text{NH}_4)_2\text{CrO}_4.$$

So Molar Mass = $152.10 \frac{\text{g}}{\text{mol}}$.

300.0g has $\frac{300.0}{152.10} \frac{\text{g. mol}}{\text{g}} = 1.97 \text{ moles}$ (1 used, 3 sig fig)

48-50) A molecule with the formula $\text{C}_6\text{H}_8\text{O}_6$ has two acidic Hydrogens (meaning a diprotic acid). A sample of this molecule was analyzed by titration using 0.125 M $\text{NaOH}(\text{aq})$, and it required 29.5 mL of the base to neutralize the acidic sample. How many grams of the $\text{C}_6\text{H}_8\text{O}_6$ molecule were in the sample?



Moles of $\text{NaOH} = \frac{29.5}{1000} \times 0.125 = 0.0036875$ moles of base

Moles of acid = $\frac{1}{2}$ the amount of base
 $= 0.00184375$ moles.

Molar Mass of $\text{C}_6\text{H}_8\text{O}_6 = (6 \times 12.01) + (8 \times 1.01) + (6 \times 16.00) = 176.14 \frac{\text{g}}{\text{mol}}$

So grams = $0.00184375 \times 176.14 = \underline{0.325 \text{ g}}$ (3 sig figs)

*****Bonus Questions for +1 points each (up to 3 total)*****

What were the 3 "names" I used for the online answers to your Exams this semester?

Exam1: Untrustworthy Atoms

Exam2: CATION because it's PAWSitively Charged.

Exam3: Yo Dawg, I heard you like iron, so here's an iron
with an ion of iron.

