CHEM 1225
Exam I
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February 4, 1999

Name ______**KEY**__________

TA's Name ______________________

Lab Section ______

Please sign your name below to give permission to post your course scores on homework, laboratories and exams. If you do not sign no scores will be posted. All scores will be posted by a random number which will be assigned to you by Dr. Gelder.

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(signature)

INSTRUCTIONS:

1. This examination consists of a total of 8 different pages. The last page includes a periodic table, a solubility table and some useful information. All work should be done in this booklet.
2. PRINT your name, TA's name and your lab section number <u>now</u> in the space at the top of this sheet. <u>DO NOT SEPARATE THESE PAGES</u>. You will receive 2 points for knowing your TA’s name AND laboratory section number in which you are officially enrolled.
3. Answer all questions that you can and whenever called for show your work clearly. Your method of solving problems should pattern the approach used in lecture. You do not have to show your work for the multiple choice (if any) or short answer questions.
4. No credit will be awarded if your work is not shown in problems 8, 9 and 10.
5. Point values are shown next to the problem number.
6. Budget your time for each of the questions. Some problems may have a low point value yet be very challenging. If you do not recognize the solution to a question quickly, skip it, and return to the question after completing the easier problems.
7. Look through the exam before beginning; plan your work; then begin.
8. Relax and do well.

	Page 2	Page 3	Page 4	Page 5	Page 6	TOTAL
SCORES	____ (17)	____ (18)	____ (35)	____ (15)	____ (13)	____ (100)

(9) 1. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous.

a) $AgNO_3$*(aq)* + HCl*(aq)* → **HNO_3*(aq)*** + **AgCl*(s)***

b) $Fe(NO_3)_3$*(aq)* + **3**KSCN*(aq)* → **$3KNO_3$*(aq)*** + **$FeSCN^{2+}$*(aq)*** + **$2SCN^-$*(aq)***

c) **2**Na_3PO_4*(aq)* + **3**$Ba(NO_3)_2$*(aq)* → **$Ba_3(PO_4)_2$*(s)*** + **$6NaNO_3$*(aq)***

(8) 2. Write the balanced ionic and balanced net ionic chemical equations for any two of the reactions in Problem 1. (Remember to include the correct charges on all ions and the phase of each species.)

1a, 1b or 1c)

Ionic equation:

$$Ag^+(aq) + NO_3^-(aq) + Cl^-(aq) + H^+(aq) \rightarrow H^+(aq) + NO_3^-(aq) + AgCl(s)$$

Net Ionic equation:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

1a, 1b or 1c)

Ionic equation:

$$Fe^{3+}(aq) + 3NO_3^-(aq) + 3SCN^-(aq) + 3K^+(aq) \rightarrow 3K^+(aq) + 3NO_3^-(aq) + FeSCN^{2+}(aq) + 2SCN^-(aq)$$

Net Ionic equation:

$$Fe^{3+}(aq) + SCN^-(aq) \rightarrow FeSCN^{2+}(aq) +$$

1a, 1b or 1c)

Ionic equation:

$$6Na^+(aq) + 2PO_4^{3-}(aq) + 6NO_3^-(aq) + 3Ba^{2+}(aq) \rightarrow 6Na^+(aq) + 6NO_3^-(aq) + Ba_3(PO_4)_2(s)$$

Net Ionic equation:

$$2PO_4^{3-}(aq) + 3Ba^{2+}(aq) \rightarrow Ba_3(PO_4)_2(s)$$

(18) 3a. Give an example of the formula of an ionic compound.

NaCl

b) Based on the elements in the chemical formula for a compound, state the general rule we use to identify whether a substance is an ionic compound.

Ionic compounds are characterized as containing a metallic element and one or more nonmetallic elements. (Note: there are a few exceptions to this rule, which you should be aware of.)

c) Give an example of the formula of a covalent compound.

CO_2

d) Based on the elements in the chemical formula for a compound, state the general rule we use to identify whether a substance is a covalent compound.

Covalent compounds are characterized as containing only nonmetallic elements. (Note: there are exceptions to this rule, but for our purposes this rule works.)

e) A bond is described as a force that holds two atoms together. Describe the nature of the bond in an ionic compound.

An ionic bond results from the attractive force between opposite charges. An ionic compound is composed of ions, a positively charged cation and a negatively charged anion. The ionic bond results from the electrostatic attraction between the opposite charges.

f) A bond is described as a force that holds two atoms together. Describe the nature of the bond in a covalent compound.

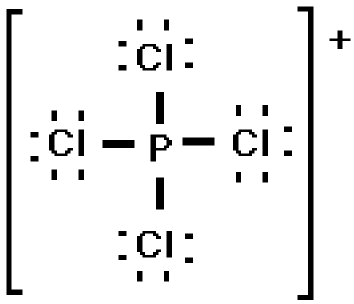
A covalent bond occurs when the atomic orbitals in two nonmetallic atoms occupy the same or very nearly the same region of space. When the atomic orbitals of adjacent atoms occupy the same region it is called orbital overlap. For our purposes we identified an electron from each atom contributing to the bond. We use the term sharing of electrons for this covalent bond.

g) List a chemical or physical property, which distinguishes ionic compounds from covalent compounds.

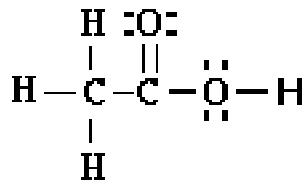
In general ionic compounds are solids at room temperatrue, while covalent compounds can be gas, liquid or solid phase at room temperature. Ionic compounds form ions when added to water, while many covalent compounds do not form ions when added to water.

(15) 4. Draw a possible Lewis electron-dot structure for each of the species below. Include all resonance structures if they are needed to adequately represent the bonding.

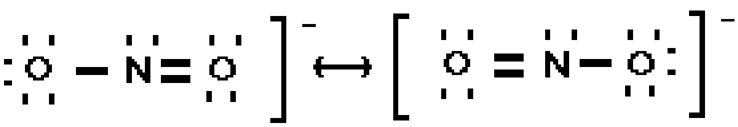
a) PCl_4^+



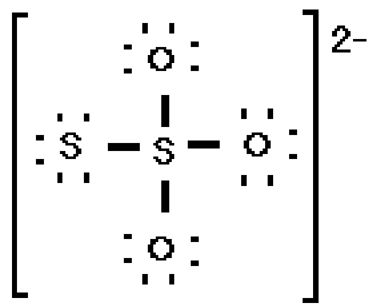
b) CH_3COOH



c) NO_2^-



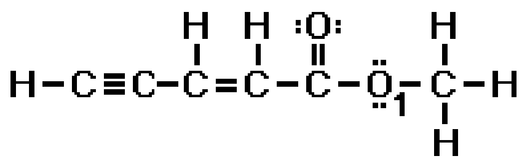
d) $S_2O_3^{2-}$



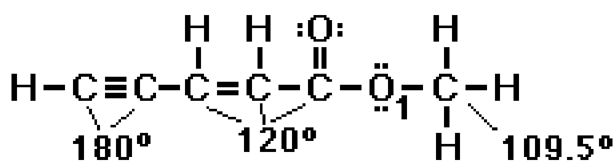
(21) 5. Complete the following table

Compound	Number of bonding groups on central atom	Number of non-bonding pairs on central atom	Name of the molecular geometry	Bond Angle(s)	Polarity (polar or nonpolar
SCl_2	**2**	**2**	**Bent**	**<109.5°**	**polar**
NF_3	**3**	**1**	**Pyramidal**	**<109.5°**	**polar**
NO_2^+	**2**	**0**	**Linear**	**180°**	
SO_2	**2**	**1**	**bent**	**<120°**	**polar**
NH_2^-	**2**	**2**	**Bent**	**<109.5°**	

(7) 6. Consider the Lewis structure for the compound



(a) What are the approximate bond angles about each of the carbon atoms? (Be careful to clearly indicate which carbon atom you associate with each bond angle.)



(b) What is the approximate bond angle around the oxygen atom labeled O_1?

109.5˚ around O_1

(8) 7. What is the electron-pair geometry in H_2O? What is its molecular geometry? Explain why the H-O-H bond angle is not 109.5˚

There are four groups of electrons around the central oxygen in water so the electron-pair geometry is tetrahedral. The molecular geometry is bent. The reason they are different is because the molecular geometry looks at the number of bonding and nonbonding groups of electrons around the central atom. The electron-pair geometry only looks at the number of groups of electrons around the central atom and does not differentiate between bonding and nonbonding groups.

(4) 8. The other day the measured atmospheric pressure was 30.07 inches of mercury. Convert this pressure to units of mm Hg and atmospheres.

$$30.07 \text{ in Hg} \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)\left(\frac{10 \text{ mm}}{1 \text{ cm}}\right) = 7.64 \times 10^2 \text{ mm Hg}$$

$$30.07 \text{ in Hg} \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)\left(\frac{10 \text{ mm}}{1 \text{ cm}}\right)\left(\frac{1 \text{ atm}}{760 \text{ mm Hg}}\right) = 1.005 \text{ atm}$$

(6) 9. A fixed quantity of an ideal gas at constant pressure occupies a volume of 6.75 L at –10.5 ˚C. Calculate the temperature the sample will have to be heated to for the volume to be 14.8 L.

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V_2 = \frac{V_1 \cdot T_2}{T_1} = \frac{14.8 \text{ L} \cdot 262.65 \text{ K}}{6.75 \text{ L}} = 576 \text{ K}$$

(3) 10. A fixed quantity of an ideal gas at a constant temperature exhibits a pressure of 715 torr and occupies a volume of 12.3 L. Calculate the volume the gas will occupy at 1.40 atm.

$$1.40 \text{ atm} \left(\frac{760 \text{ torr Hg}}{1 \text{ atm}}\right) = 1064 \text{ torr}$$

$$P_1V_1 = P_2V_2$$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{715 \text{ torr} \cdot 12.3 \text{ L}}{1064 \text{ torr}} = 8.27 \text{ L}$$

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1 **H** 1.008																	2 **He** 4.00
2	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
3	11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	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** 65.38	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	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** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
6	55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	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** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** 226.0	89 **Ac** 227.0	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)									

Lanthanides	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** 157.2	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
Actinides	90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.0	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)

Useful Information

$P \cdot V = k$ (at constant T and mol)

$V = k \cdot T$ (at constant P and mol)

$V = k \cdot n$ (at constant P and T)

1 atm = 760 mm Hg = 760 torr = 101,325 pascals (Pa)

$K = {}^{\circ}C + 273.15$

Solubility Table

Ion	Solubility	Exceptions
NO_3^{-}	soluble	none
ClO_4^{-}	soluble	none
Cl^{-}	soluble	except Ag^{+}, Hg_2^{2+}, *Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, Ag^{+}
CO_3^{2-}	insoluble	except Group IA and NH_4^{+}
PO_4^{3-}	insoluble	except Group IA and NH_4^{+}
CrO_4^{2-}	insoluble	except Group IA, IIA and NH_4^{+}
^{-}OH	insoluble	except Group IA, *Ca^{2+}, Ba^{2+}, Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^{+}
Na^{+}	soluble	none
NH_4^{+}	soluble	none
K^{+}	soluble	none

*slightly soluble