

CHEM 1314 3:30 pm Theory
Exam II
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Name _____
TA's Name _____
Lab Section _____

INSTRUCTIONS:

1. This examination consists of a total of 6 different pages. The last page include a periodic table and some useful equations. All work should be done in this booklet.
2. PRINT your name, TA's name and your lab section number now in the space at the top of this sheet. DO NOT SEPARATE THESE PAGES.
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.
4. No credit will be awarded if your work is not shown in problems 2, 4 and 7a.
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 2	Page 3	Page 4	Page 5	TOTAL
SCORES	_____	_____	_____	_____	_____	_____
	(1)	(30)	(24)	(29)	(16)	(100)

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

- a) $3\text{Mg}(s) + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s)$
- b) $\text{S}_8(g) + 8\text{O}_2(g) \rightarrow 8\text{SO}_2(g)$
- c) $2\text{C}_6\text{H}_{14}(l) + 19\text{O}_2(g) \rightarrow 12\text{CO}_2(g) + 14\text{H}_2\text{O}(g)$
- d) $2\text{K}(s) + \text{Cl}_2(g) \rightarrow 2\text{KCl}(s)$

Grading: 3 points for the correct products, balance and phases. If the products are all correct, -1 for balance and -1 for phases

(18) 2. Perform the following conversions. Be sure your answer has the correct number of significant figures.

- a) 400. cm³ to liters

$$400 \text{ cm}^3 \times \frac{1 \text{ L}}{1000 \text{ cm}^3} = 0.400 \text{ L}$$

- b) the volume of a ball is 2.00 ft³. Convert to km³. (use at least 3 conversions factors.)

$$2.00 \text{ ft}^3 \times \left(\frac{12 \text{ in}}{1 \text{ foot}} \right)^3 \times \left(\frac{2.54 \text{ cm}}{1 \text{ inch}} \right)^3 \times \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^3 \times \left(\frac{1 \text{ km}}{1000 \text{ m}} \right)^3 = 5.66 \times 10^{-11} \text{ km}^3$$

- c) What is 10.0 Kelvin on the Fahrenheit scale?

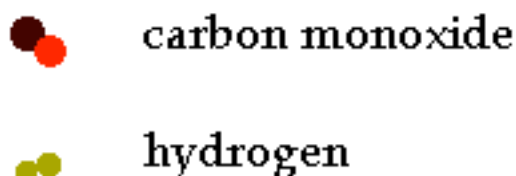
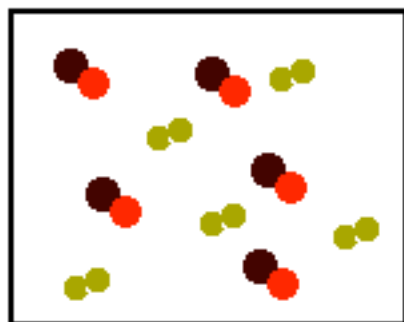
$$\text{K} = ^\circ\text{C} + 273.15$$

$$^\circ\text{C} = \text{K} - 273.15 = 10.0 - 273.15 = -263.2 ^\circ\text{C}$$

$$^\circ\text{F} = \frac{9}{5}(^\circ\text{C}) + 32 = \frac{9}{5}(-263.2) + 32 = -441.8$$

Grading: each part is worth 6 points. Deduct 1 point for sig fig, 1 point for units, 1 point for math error. Deduct 3 points for a 'simple' conversion error. If more than 1 conversion error deduct all points.

- (6) 3. Diagram the following system as viewed at the atomic level in the space provided. Be sure to clearly label each of the substances in your diagram.



A homogeneous mixture of carbon monoxide and hydrogen at room temperature.

Grading: 2 points each for the correct diatomic for hydrogen and carbon monoxide. 1 point for gas phase and 1 point for homogeneous mixture

- (18) 4. A particular homogeneous mixture of ethanol ($\text{C}_2\text{H}_6\text{O}$) and water has a density of $0.945 \text{ g} \cdot \text{mL}^{-1}$. This ethanol solution is also 36.0% (by mass) ethanol. The density of pure ethanol is $0.789 \text{ g} \cdot \text{mL}^{-1}$.

- a) A sample of this ethanol solution has a mass of 250. g, calculate the volume of the solution.

$$250. \text{ g ethanol solution} \times \frac{1 \text{ mL ethanol solution}}{0.945 \text{ g ethanol solution}} = 265 \text{ mL of ethanol solution}$$

- b) How many grams of water and ethanol are in the sample in a)?

$$250. \text{ g ethanol solution} \times \frac{36.0 \text{ g pure ethanol}}{100 \text{ g ethanol solution}} = 90.0 \text{ g of pure ethanol}$$

$$250. \text{ grams} - 90.0 \text{ grams} = 160. \text{ grams of water}$$

- c) Calculate the volumes of pure ethanol and water that must be mixed to prepare the solution in part a)?

$$90.0 \text{ g pure ethanol} \times \frac{1 \text{ mL pure ethanol}}{0.789 \text{ g pure ethanol}} = 114 \text{ mL of pure ethanol}$$

$$160.0 \text{ g pure water} \times \frac{1 \text{ mL pure water}}{1.00 \text{ g pure water}} = 160 \text{ mL of pure water}$$

- d) What is interesting about the answer in part a) and the answer(s) in part c)?

To prepare the solution of ethanol and water we would mix 114 mLs ethanol with 160 mLs of water. What is interesting is the volume of the mixture is smaller than the volume of the pure liquids added together. So upon mixing there is a contraction of the total volume. Why this happens is discussed in CHEM 1515.

Grading: Parts a, b and c are worth 5 points each. Pretty much R/W. 1 point for the correct units in part a). Part d) is worth 3 points. It was relatively easy to get 1 point (assuming parts a and c were correct), a little harder to get two points and 3 points were pretty difficult.

- (6) 5. Predict a reasonable formula for the compound formed from each of the following combinations of elements or polyatomic ions.

- a) sodium and sulfate **Na₂SO₄**
- b) iron and bromide **FeBr₂ or FeBr₃**
- c) carbon and fluorine **CF₄**

Grading: R/W 2 points each

- (11) 6. Complete the following table;

Name of the compound	Formula of the compound	Ionic or Covalent Compound
sodium sulfide	Na₂S	ionic
Phosphorus pentachloride	PCl₅	covalent
Nickel (II) phosphate	Ni ₃ (PO ₄) ₂	ionic
Potassium peroxide		ionic
Nitric acid	H ₂ SO _{4(aq)}	
octane	C ₈ H ₁₈	covalent

Grading: R/W 1 point each. Spelling and symbols had to be perfect for the point.

- (12) 7. The relative weighted average atomic mass of gallium is 69.723 u. Gallium has two naturally occurring isotopes. One of those isotopes has a mass of 70.9247 u and a percent abundance of 39.89%.

- a) Calculate the mass of the other isotope of gallium.

The relative average atomic mass of gallium from the periodic table is 69.723 u. The fractional abundance of the unknown Ga isotope must be 1 - 0.3989 = 0.6011, because only two isotopes of Ga exist.

Average atomic mass = \sum (mass_{isotope} · fractional abundance_{isotope})

$$69.723 \text{ u} = (70.9247 \text{ u})(0.3989) + x(0.6011)$$

$$69.723 \text{ u} = 28.292 + x(0.6011)$$

$$41.431 \text{ u} = x(0.6011)$$

$$x = 68.93 \text{ u}$$

- b) How many neutrons, protons and electrons are in each of the isotopes of gallium?

Isotope	Protons	Neutrons	Electrons
⁷¹ ₃₁ Ga	31	40	31
⁶⁹ ₃₁ Ga	31	38	31

(6) 8. Complete each calculation and report the answer to the correct number of significant figures.

a) $\frac{3.05 \times 10^{20}}{8.340 \times 10^{24}} = 3.66 \times 10^{-5}$

b) $\frac{15}{65} + \frac{8}{1234} = 0.1538 + 0.00081037 = 0.016$

c) $(8.34 \cdot 0.450) - \frac{1.001}{0.83} = 3.753 - 2.411 = 1.3$

grading: R/W 2 points each

(10) 9. Complete the following table

Formula	M , Molar Mass $\frac{\text{g}}{\text{mol}}$	m , mass of sample (gms)	n , moles of sample (mol)	N , number of atoms, molecules, or formula units
P_2O_5	142	284	2.00	1.20×10^{24} f.u.
X	95.94	8.478	8.84×10^{-2}	5.32×10^{22} atoms
NaBrO_3	151	0.484	3.21×10^{-3}	1.93×10^{21} f.u.

P_2O_5 : $284 \text{ g} \frac{1 \text{ mol}}{142 \text{ g}} = 2.00 \text{ mol}$ $2.00 \text{ mol} \frac{6.02 \times 10^{23} \text{ f.u.}}{1 \text{ mol}} = 1.20 \times 10^{24} \text{ f.u.}$

X: $5.32 \times 10^{22} \text{ atoms} \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} = 8.84 \times 10^{-2} \text{ mol}$

$\frac{8.478 \text{ g}}{8.84 \times 10^{-2} \text{ mol}} = 95.94 \frac{\text{g}}{\text{mol}}$ X is Mo (molybdenum)

NaBrO_3 : $3.21 \times 10^{-3} \text{ mol} \frac{151 \text{ g}}{1 \text{ mol}} = 0.484 \text{ g}$

$3.21 \times 10^{-3} \text{ mol} \frac{6.02 \times 10^{23} \text{ f.u.}}{1 \text{ mol}} = 1.93 \times 10^{21} \text{ f.u.}$

What is the symbol for the unknown element, X? **Mo**

Periodic Table of the Elements																					
IA												VIII									
1	1	2																			
	H	He																			
	1.008	4.00																			
2	3	10																			
	Li	Be	B														C	N	O	F	Ne
	6.94	9.01	10.81														12.01	14.01	16.00	19.00	20.18
3	11	18																			
	Na	Mg	Al														Si	P	S	Cl	Ar
	22.99	24.30	26.98														28.09	30.97	32.06	35.45	39.95
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36			
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr			
	39.10	40.08	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.38	69.72	72.59	74.92	78.96	79.90	83.80			
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54			
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe			
	85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3			
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86			
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn			
	132.9	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(209)	(210)	(222)			
7	87	88	89	104	105	106	107	108	109	110	111	112		114		116					
	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt												
	(223)	226.0	227.0	(261)	(262)	(266)	(264)	(269)	(268)	(271)	(272)	(277)	(285)		(289)						
Lanthanides					58	59	60	61	62	63	64	65	66	67	68	69	70	71			
					Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu			
					140.1	140.9	144.2	(145)	150.4	152.0	157.2	158.9	162.5	164.9	167.3	168.9	173.0	175.0			
Actinides					90	91	92	93	94	95	96	97	98	99	100	101	102	103			
					Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr			
					232.0	231.0	238.0	237.0	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)			

Useful Information

1 pound (lb) = 453.59237 gram (gm)

1 liter (L) = 1.056718 quart (qt)

1 inch (in) = 2.54 centimeters (cm)

$$^{\circ}\text{C} = \frac{5}{9}(^{\circ}\text{F} - 32)$$

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

$$\text{relative weighted average atomic mass} = \sum (\text{isotopic mass} \cdot \text{fractional abundance})$$

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

$$\text{density of water} = 1.00 \frac{\text{g}}{\text{mL}}$$