

**Chemistry 121 Summer 2008 Oregon State University
Midterm Exam 2 July 3rd, 2008 10 am**

DO NOT OPEN THIS EXAM UNTIL INSTRUCTED.

CALCULATORS ARE NOT TO BE SHARED.

Instructions :

You should have with you several number two pencils, an eraser, your 3" x 5" notecard, and your University ID Card. You may use an approved calculator if you wish. If you have other notes with you, place them in a sealed backpack and place the backpack OUT OF SIGHT. Or place the notes directly on the table at the front of the room.

Fill in the front page of the Scantron answer sheet with your last name, first name, middle initial, and student identification number. Leave the class section number and the test form number blank.

This exam consists of 20 multiple-choice questions, each worth 5 points. Select the best answer by filling in the corresponding circle on the rear page of the answer sheet.

If you have any questions before the exam, please ask. If you have any questions during the exam, please raise your hand to attract the attention of a proctor. The proctor will come to you.

Present your ID card when submitting the exam. Place your open-ended portion of this exam in the appropriate stack. You may keep the question paper, but the instructor will retain the Scantron sheets, so please mark the answers you selected on the question sheet for later reference.

Scoring :

20 multiple-choice questions @ 5 pts each = 100 pts

Information not already provided in the questions

1 L = 1000 cm³ $N_A = 6.022 \times 10^{23}$ particles/mol $T(K) = T(C^\circ) + 273.15$ $T(C^\circ) = T(K) - 273.15$

A periodic table, a list of polyatomic ions, solubility rules and a list of strong acids and bases, and oxidation number rules are provided on the next four sheets. Check to see that you have them.

Also check to see that your exam does have 20 questions on it.

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18									
	1A	2A	3B	4B	5B	6B	7B		8B		1B	2B	3A	4A	5A	6A	7A	8A									
1	1 H 1.00794		KEY Atomic number → 1 Symbol → H Atomic mass → 1.0079																	2 He 4.00260							
2	3 Li 6.941	4 Be 9.01218																				5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
3	11 Na 22.9898	12 Mg 24.3050																				13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80									
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30									
6	55 Cs 132.905	56 Ba 137.327	57-71 * Rare Earths	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.09	79 Au 196.9665	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)									
7	87 Fr (223)	88 Ra 226.025	89-103 † Actinides	104 Rf (261)	105 Ha (262)	106 Sg (263)	107 Ns (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)																

*Lanthanide Series	57 La 138.906	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm 145	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
†Actinide Series	89 Ac 227.028	90 Th 232.0381	91 Pa 231.0359	92 U 238.029	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No 259	103 Lr 262

Table 3.1 Formulas and Names of Some Common Polyatomic Ions

Formula	Name	Formula	Name
CATION: Positive Ion			
NH_4^+	ammonium ion		
ANIONS: Negative Ions			
Based on a Group 4A element		Based on a Group 7A element	
CN^-	cyanide ion	ClO^-	hypochlorite ion
CH_3CO_2^-	acetate ion	ClO_2^-	chlorite ion
CO_3^{2-}	carbonate ion	ClO_3^-	chlorate ion
HCO_3^-	hydrogen carbonate ion (or bicarbonate ion)	ClO_4^-	perchlorate ion
Based on a Group 5A element		Based on a transition metal	
NO_2^-	nitrite ion	CrO_4^{2-}	chromate ion
NO_3^-	nitrate ion	$\text{Cr}_2\text{O}_7^{2-}$	dichromate ion
PO_4^{3-}	phosphate ion	MnO_4^-	permanganate ion
HPO_4^{2-}	hydrogen phosphate ion		
H_2PO_4^-	dihydrogen phosphate ion		
Based on a Group 6A element			
OH^-	hydroxide ion		
SO_3^{2-}	sulfite ion		
SO_4^{2-}	sulfate ion		
HSO_4^-	hydrogen sulfate ion (or bisulfate ion)		

SOLUBLE COMPOUNDS

Almost all salts of Na^+ , K^+ , NH_4^+

Salts of nitrate, NO_3^-
 chlorate, ClO_3^-
 perchlorate, ClO_4^-
 acetate, CH_3CO_2^-

EXCEPTIONS

Almost all salts of Cl^- , Br^- , I^-

Halides of Ag^+ , Hg_2^{2+} , Pb^{2+}

Compounds containing F^-

Fluorides of Mg^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+}

Salts of sulfate, SO_4^{2-}

Sulfates of Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+}

INSOLUBLE COMPOUNDS

Most salts of carbonate, CO_3^{2-}
 phosphate, PO_4^{3-}
 oxalate, $\text{C}_2\text{O}_4^{2-}$
 chromate, CrO_4^{2-}

EXCEPTIONS

Salts of NH_4^+ and the alkali metal cations

Most metal sulfides, S^{2-}

Most metal hydroxides and oxides

$\text{Ba}(\text{OH})_2$ is soluble

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<i>Strong Acids</i>	<i>Strong Bases</i>
HCl, HBr, HI	LiOH, NaOH, KOH
HNO_3	$\text{Ca}(\text{OH})_2$ (slightly soluble)
HClO_4	$\text{Ba}(\text{OH})_2$
H_2SO_4	$\text{Sr}(\text{OH})_2$

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OXIDATION NUMBER RULES

- **The oxidation number of a free element is always 0.**
- **The oxidation number of a monatomic ion equals the charge of the ion.**
- **The oxidation number of fluorine in compounds is -1.**
- **The oxidation number of hydrogen in compounds is +1.**

Exception: the oxidation number of hydrogen is -1 in metal hydrides, like CaH_2 .

- **The oxidation number of oxygen in compounds is -2.**

Exception: the oxidation number of oxygen is -1 in peroxides, like BaO_2 .

- **The oxidation number of Cl, Br, I in compounds is -1.**

Exception: when combined with O or F, the preceding rules apply.

The oxidation numbers of all other elements in a compound adjust such that:

- **The sum of the oxidation numbers of all of the atoms in a neutral compound is 0.**
- **The sum of the oxidation numbers in a polyatomic ion is equal to the charge of the ion.**

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- Pick the correct combination of name and formula for the molecular compound that contains 10 oxygen and 4 phosphorus atoms.
 - Phosphorus oxide - PO
 - Decaoxygen tetraphosphide - $O_{10}P_4$
 - Dioxygen decaphosphide - P_4O_{10}
 - Tetraphosphorus decaoxide - P_4O_{10}
 - Phosphorus oxide - P_4O_{10}
- Which pair of elements is more likely to form an ionic compound?
 - P and I
 - O and Mg
 - N and O
 - Ni and Al
 - Al and Rb
- Which is the correct name for the compound Rh_2O_3 ?
 - rhodium (III) oxide
 - dirhodium dioxide
 - rhodium (VI) oxide
 - chromium oxide
 - rhodium (II) oxide
- Which of the following statements is INCORRECT?
 - The molar mass of a compound is the molecular mass expressed in grams.
 - The molar mass of the nitrogen gas in the air is about 28 g/mol.
 - One mole of $Mg(NO_3)_2$ contains three moles of O atoms.
 - The number of oxygen atoms in one mole of carbon dioxide is 1.204×10^{24} .
 - The amount of substance expressed in moles always is a smaller number than the amount expressed in grams.
- What is the molar mass of aluminum sulfate, $Al_2(SO_4)_3$?
 - 150.0 g/mol
 - 123.0 g/mol
 - 315.2 g/mol
 - 288.2 g/mol
 - 342.2 g/mol

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6. Which of the following expressions is correct to determine the number of atoms of H in 50.0 g of water ?

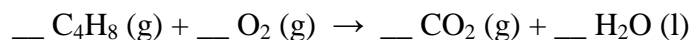
- a. $50.0 \text{ g} \times (1 \text{ mol} / 18.02 \text{ g}) \times (N_A \text{ atoms} / \text{mol})$
- b. $50.0 \text{ g} \times (18.02 \text{ g} / 1 \text{ mol}) \times (2 N_A \text{ atoms} / \text{mol})$
- c. $50.0 \text{ g} \times (1 \text{ mol} / 18.02 \text{ g}) \times (2 N_A \text{ atoms} / \text{mol})$
- d. $(50.0 \text{ g} \times (18.02 \text{ g/mol})) / (2 N_A \text{ atoms} / \text{mol})$
- e. $(50.0 \text{ g} \times (1 \text{ mol} / 18.02 \text{ g})) / (N_A \text{ atoms} / \text{mol})$

7. CuO reacts with ammonia as follows :



When correctly balanced, the relative stoichiometric coefficients of the ammonia and CuO are:

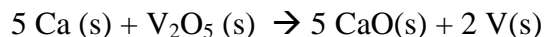
- a. 3, 2
 - b. 2, 1
 - c. 2, 4
 - d. 4, 2
 - e. 2, 3
8. Choose the correct set of coefficients that balance the following equation :



- a. 1, 5, 4, 2
 - b. 2, 7, 4, 6
 - c. 1, 6, 4, 4
 - d. 1, 2, 1, 2
 - e. 2, 4, 2, 6
9. Which of the following statements correctly describes the Law of Conservation of Mass?
- a. The volume of reactants is equal to the volume of products.
 - b. In a chemical reaction, matter can be converted to heat and light, but not into electricity.
 - c. The mass of all the products of a chemical reaction never changes, regardless of the amount of reactants used.
 - d. The mass of the reactants in a chemical reaction is always less than the amount of products produced.

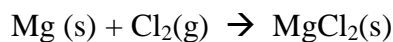
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- e. The total mass of substances taking part in a chemical reaction is the same before and after reaction.
10. Calcium metal is used to make vanadium using the reaction :



If I start with 0.5 moles of Ca how many moles of vanadium will I make when the Ca has completely reacted?

- a. 0.4 mol
 - b. 5.0 mol
 - c. 0.5 mol
 - d. 0.2 mol
 - e. 2.0 mol
11. Magnesium metal reacts with chlorine gas (Cl_2)



If I start with 35.5 g of chlorine gas, how much magnesium metal will I need to completely react?

- a. 24.3 g
 - b. 97.2 g
 - c. 12.2 g
 - d. 48.6 g
 - e. 71.0 g
12. Which of the answers correctly best describes the following list of compounds?

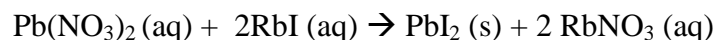
Ethanol, HCl, NH_3 , CH_3COOH , NaCl

- a. Strong electrolyte, strong acid, strong base, strong acid, weak electrolyte
- b. Non-electrolyte, strong acid, weak base, weak acid, strong electrolyte
- c. Weak electrolyte, weak acid, weak base, weak acid, strong electrolyte
- d. Non-electrolyte, strong acid, strong base, weak acid, strong electrolyte
- e. Non-electrolyte, weak acid, weak base, strong acid, strong electrolyte

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13. Which of the following will result in an insoluble precipitate when mixed with an aqueous $\text{Ba}(\text{NO}_3)_2$ solution?
- HNO_3 (aq)
 - NH_4Cl (aq)
 - N_2 (g)
 - K_2SO_4 (aq)
 - LiOH (aq)

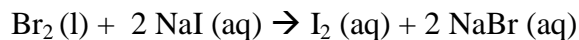
14. Which are the spectator ions in the following reaction?



- I^- and NO_3^-
 - Pb^{2+} and NO_3^-
 - Pb^{2+} and I^-
 - Rb^+ and I^-
 - Rb^+ and NO_3^-
15. What are the products when nitric acid (HNO_3) reacts with calcium carbonate (CaCO_3)?
- NO_2 (g), H_2O and $\text{Ca}(\text{OH})_2$ (aq).
 - $\text{Ca}(\text{NO}_3)_2$ (aq), H_2O (l) and CO_2 (g).
 - HCaCO_2 and $\text{Ca}(\text{NO}_3)_2$ (aq).
 - H_2 (g) and $\text{Ca}(\text{NO}_3)_2$ (aq).
 - $\text{Ca}(\text{OH})_2$ (aq), NH_3 (g) and CO_2 (g).
16. Assign oxidation numbers to all the elements in NaH_2PO_4 .
- Na = +1, H = -1, P = +5, O = -2
 - Na = +1, H = +1, P = +5, O = -2
 - Na = +1, H = +1, P = +1, O = -1
 - Na = -1, H = -1, P = -5, O = +2
 - Na = +1, H = -1, P = +9, O = -2

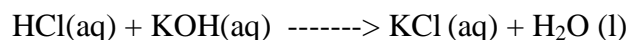
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17. Elemental bromine displaces elemental iodine from sodium iodide solution



Which of the statements below about this reaction is CORRECT?

- a. Br in Br_2 is oxidized and I is acting as an oxidizing agent.
 - b. Na^+ is oxidized and is acting as a reducing agent.
 - c. Br_2 is reduced, Na^+ is reduced and I is oxidized.
 - d. Br in Br_2 is reduced and I is acting as a reducing agent.
 - e. This is not a redox reaction.
18. The concentration of ions in a 2.0 M solution of $\text{K}_3(\text{PO}_4)_2$ are
- a. $[\text{K}^+] = 2.0 \text{ M}$; $[\text{PO}_4^{3-}] = 2.0 \text{ M}$
 - b. $[\text{K}^+] = 4.0 \text{ M}$; $[\text{PO}_4^{3-}] = 6.0 \text{ M}$
 - c. $[\text{K}^+] = 6.0 \text{ M}$; $[\text{PO}_4^{3-}] = 4.0 \text{ M}$
 - d. $[\text{K}^+] = 4.0 \text{ M}$; $[\text{PO}_4^{3-}] = 4.0 \text{ M}$
 - e. $[\text{K}^+] = 6.0 \text{ M}$; $[\text{PO}_4^{3-}] = 6.0 \text{ M}$
19. I wish to make 60.0 mL of a 0.500 M NaCl solution from a 1.50 M NaCl solution. How many mL of the concentrated solution should I take to make up to the final volume?
- a. 180.0 mL
 - b. 120.0 mL
 - c. 60.0 mL
 - d. 45.0 mL
 - e. 20.0 mL
20. I perform the following acid/base neutralization titration.



A 50.0 mL volume of the HCl required 75.0 mL of a 0.160 M KOH solution to be neutralized. What is the concentration of the acid?

- a. 0.240 M
- b. 0.107 M
- c. 0.160 M
- d. 0.500 M
- e. 9.38 M