

Chemistry 121 Summer 2008 Oregon State University

Final Exam - July 11th, 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 4" x 6" 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.

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.

Open and start this exam when instructed. Present your ID card when submitting the exam. You may keep the question paper, so please mark the answers you selected on it.

Scoring :

28 multiple-choice questions @ 5 pts each = 140 pts

Information not already provided in the questions

$$1 \text{ L} = 1000 \text{ cm}^3 \quad N_A = 6.022 \times 10^{23} \text{ particles/mol} \quad T(\text{K}) = T(\text{C}^\circ) + 273.15 \quad T(\text{C}^\circ) = T(\text{K}) - 273.15$$

$$h = 6.626 \times 10^{-34} \text{ J s} \quad c = 3.00 \times 10^8 \text{ m / s}$$

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

Some possibly useful formulas:

$$\Delta E = q + w \quad \lambda = c / \nu \quad \Delta E = h \nu \quad \lambda = h / m \nu$$

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

CH121 Summer 2008 Final

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)		

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.

CH121 Summer 2008 Final

1. Which statement is **TRUE**?

- a. The precision of a set of measurements is a reflection of the scatter in the results.
- b. The metal gallium has a melting point of 303 K. It should therefore not melt in your hand (37 °C).
- c. $1 \text{ pm} = 10^{-9} \text{ m}$.
- d. The density of liquid water is 1 g/L.
- e. Melting ice to water is a chemical change.

2. A attoliter (aL) is defined as $1 \times 10^{-18} \text{ L}$. What is the length in cm of the side of a cubic box that is 1 aL in volume?

- a. 10^{-15} cm .
- b. 10^{-7} cm .
- c. 10^{-6} cm .
- d. 10^{-5} cm .
- e. 10^{-2} cm .

3. What is the answer to the following computation to the correct number of significant figures?

$$(2.789 \times 0.164) / (10.101)$$

- a. 4.53×10^{-3}
- b. 0.0453
- c. 4.52×10^{-2}
- d. 0.045282
- e. 0.045

4. A piece of aluminum ($d = 2.70 \text{ g/mL}$) is dropped into 5.00 mL of water and the volume increases to 6.50 mL. What is the mass of the piece of Al?

- a. 0.56 g
- b. 1.80 g
- c. 2.70 g
- d. 13.5 g
- e. 4.05 g

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5. Which statement is **TRUE**?

- a. An electron has nearly the same mass as a proton.
- b. The ^{14}C isotope has 7 neutrons.
- c. An electron has a charge about $1/2000^{\text{th}}$ that of a proton.
- d. The neutron has the same mass and charge as a proton.
- e. The ^3H isotope has one proton.

6. Which symbol is correct for the element copper (Cu) with 35 neutrons?

- a. $^{64}_{29}\text{Cu}$
- b. $^{35}_{29}\text{Cu}$
- c. $^{64}_{35}\text{Cu}$
- d. $^{29}_{35}\text{Cu}$
- e. $^{29}_{64}\text{Cu}$

7. Which statement is **TRUE**?

- a. 1 mol of C contains 12.01×10^{23} atoms.
- b. The atomic mass of natural carbon is 12.00 u.
- c. The number of ^{12}C atoms in 1 mol of ^{12}C is 6.02×10^{23} .
- d. The number of C-12 atoms in 1 mol of natural carbon is 6.02×10^{23} .
- e. The atomic weight of C is Avogadro's number expressed in grams.

8. How many atoms are there in 0.750 mol Ti?

- a. 6.02×10^{23}
- b. 1.73×10^{25}
- c. 1.57×10^{-2}
- d. 4.52×10^{23}
- e. 7.56×10^{21}

9. Which of the following is an *ionic compound* ?

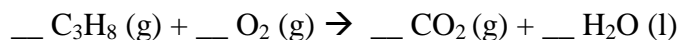
- a. CH_4 (g)
- b. RbI (s)
- c. N_2O (g)
- d. CO_3
- e. HCl (g)

CH121 Summer 2008 Final

10. What is correct formula for the compound dichlorine heptoxide?

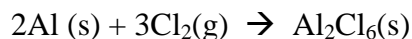
- a. Cl_2O_6
- b. Cl_2O_7
- c. Cr_2O_7
- d. C_2O_7
- e. ClO_5

11. When the following equation is correctly balanced what is the ratio of moles of water produced to moles of oxygen (O_2) that are consumed?



- a. 4 / 5
- b. 2 / 1
- c. 2 / 5
- d. 3 / 5
- e. 4 / 3

12. Aluminum metal reacts with chlorine gas (Cl_2)



If I start with 107 g of chlorine gas, how much aluminum metal will I need to completely react?

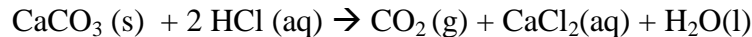
- a. 54.3 g
- b. 81.5 g
- c. 27.2 g
- d. 13.5 g
- e. 40.7 g

13. How many moles of solid sodium sulfate (Na_2SO_4) would I need to dissolve in water to make 0.200 L of solution that has $[\text{Na}^+] = 1.00 \text{ M}$?

- a. 0.100 mol
- b. 0.200 mol
- c. 0.250 mol
- d. 0.400 mol
- e. 0.500 mol

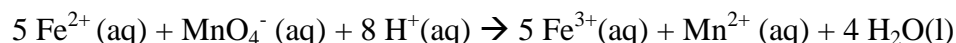
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14. What is the net ionic reaction for the following:



- a. $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- b. $2 \text{HCl}(\text{aq}) \rightarrow 2 \text{H}^+(\text{aq}) + 2 \text{Cl}^-(\text{aq})$
- c. $2 \text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- d. $\text{CO}_3^{2-}(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{CaCl}_2(\text{aq})$
- e. $\text{CaCO}_3(\text{s}) + 2 \text{H}^+(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

15. Which of the statements below about the reaction below is **CORRECT**?



- a. The oxidation number of Fe atoms decreases, therefore Fe^{2+} is oxidized.
- b. Mn atoms are reduced because their oxidation number has increased.
- c. H atoms are oxidized while O atoms are reduced.
- d. The oxidation number of Fe atoms increases, therefore Fe^{2+} are the reducing agents.
- e. There are no oxidizing or reducing agents in this reaction.

16. If a gas expands during a constant pressure chemical process during which heat flows out of the system, which of the following is statements is **CORRECT** ?

- a. q is positive and w is negative
- b. q is negative and w is positive
- c. q is positive and w is zero
- d. q is zero and w is positive
- e. q is negative and w is negative

17. What mass of water can I heat from 10.0°C to 20.0°C if I have 41,840 J of heat available? (specific heat of water = $4.184 \text{ J} / \text{g}^\circ\text{C}$)

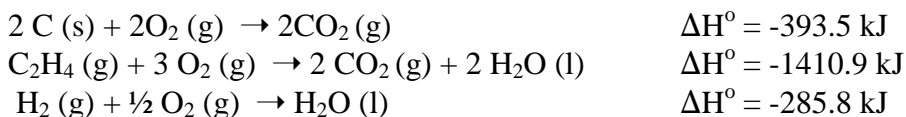
- a. 1.00 g
- b. 4.814 g
- c. 100. g
- d. 1.00 kg
- e. 41,840 g

CH121 Summer 2008 Final

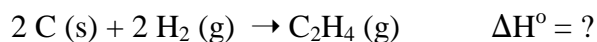
18. Which of the following statements is **CORRECT** ?

- a. An exothermic process is one in which heat passes from the surroundings to the system.
- b. In an endothermic process the sign of the heat transfer is negative.
- c. The change in ΔE is equal to the heat transfer at constant volume.
- d. The change in ΔH is equal to the work done under constant pressure conditions.
- e. P-V work (w) always has a negative sign.

19. Given the following reactions and enthalpy changes under standard conditions

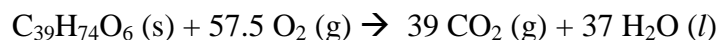


Use Hess's Law to calculate the enthalpy changes under standard conditions associated with the reaction.



- a. -731.6 kJ
- b. + 445.8 kJ
- c. +1232.8 kJ
- d. +731.6 kJ
- e. - 445.8 kJ

20. What is the $\Delta H^\circ_{\text{rxn}}$ for the reaction of the fat glyceryl trilaurate ($\text{C}_{39}\text{H}_{74}\text{O}_6$)



given the following enthalpies of formation :

$$\Delta H^\circ_f \text{ (kJ/mol)} \quad \text{C}_{39}\text{H}_{74}\text{O}_6 \text{ (s)} = -2.02 \times 10^3 \quad \text{CO}_2 \text{ (g)} = -393.5 \quad \text{H}_2\text{O (l)} = -285.8$$

(HINT : why is the value for $\text{O}_2(\text{g})$ missing?)

- a. -2.79×10^4 kJ
- b. -2.39×10^4 kJ
- c. $+2.79 \times 10^4$ kJ
- d. $+2.39 \times 10^4$ kJ
- e. -2.59×10^4 kJ

CH121 Summer 2008 Final

21. It took 11.0 minutes for commands to travel from Earth to the Pathfinder vehicle that landed on Mars in 1997. How many km did the messages travel? ($c = 3.00 \times 10^8$ m/s) [HINT: You don't need to use any of the formulas from the front page!]

- a. 3.00×10^8 km
- b. 1.98×10^8 km
- c. 3.30×10^9 km
- d. 3.30×10^6 km
- e. 1.98×10^{11} km

22. What is the energy contained in one photon from a Star Wars laser-blaster that has a wavelength of 450. nm? ($h = 6.626 \times 10^{-34}$ Js)

- a. 2.98×10^{-40} J
- b. 4.42×10^{-19} kJ
- c. 4.42×10^{-19} J
- d. 2.26×10^{-18} J
- e. 450 J

23. Arrange the following segments of the electromagnetic spectrum in order of increasing wavelength.

1. AM radio 2. X-rays 3. Infra-red 4. Ultra-violet
- a. 1, 2, 3, 4
 - b. 4, 3, 2, 1
 - c. 1, 3, 4, 2
 - d. 3, 2, 1, 4
 - e. 2, 4, 3, 1

24. If the de Broglie wavelength associated with a particle of mass $m = 9.109 \times 10^{-28}$ kg is 6.07×10^{-15} m, at what fraction of the speed of light is it traveling? ($h = 6.626 \times 10^{-34}$ Js, $c = 3.00 \times 10^8$ m/s)

- a. 10 % of the speed of light
- b. 20 % of the speed of light
- c. 80 % of the speed of light
- d. 40 % of the speed of light
- e. 120 % of the speed of light

CH121 Summer 2008 Final

25. Which of the following statements is **INCORRECT** ?

- a. A line spectrum occurs only at specific frequencies.
- b. Hot solids emit a continuous spectrum of radiation.
- c. The atomic emission spectrum of the H atom results from the electron moving to a higher energy level.
- d. The solutions to the Schrodinger equation are called wavefunctions.
- e. You cannot measure, at the same time with precision, the location and energy of an electron.

26. Which of the following statements is **INCORRECT** ?

- a. A d -subshell has 3 orbitals.
- b. The $n = 3$ shell contains 9 orbitals.
- c. There is no such thing as a $1p$ orbital.
- d. The magnetic quantum number (m_l) determines the orientation of an atomic orbital.
- e. The angular momentum quantum number (l) determines the shape of an atomic orbital.

27. Which of the following represents an allowable set of quantum numbers?

- a. $n = 2, l = -2, m_l = 2$
- b. $n = 2, l = 1, m_l = -1$
- c. $n = 1, l = 0, m_l = -1$
- d. $n = 3, l = 3, m_l = -3$
- e. $n = 0, l = 0, m_l = 0$

28. Select the correct orbital names (s , p_x , d_{xy} etc) for the following:



- a. s, p_z, d_{xy}, p_y
- b. $s, p_z, d_{x^2-y^2}, p_z$
- c. s, d_{z^2}, d_{xy}, p_x
- d. s, d_{z^2}, d_{yz}, p_x
- e. s, p_z, d_{xy}, p_z

CH121 Summer 2008 Final