

See announcements on Blackboard next week for office hour announcement.

DO NOT OPEN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

In the meantime, read this...

- On your Scantron card, please record the following:

Name: (your name)	Test no.: Final
Subject: Chem 105	Period: (your section–day, eve or online)
Date: 12/10/16	
- You may not leave the room before the Instructor announcement at 8:30. After that time, you may leave, but you must turn in your Scantron form before leaving the room. You will not be permitted to return to the exam room (unless you have previously made arrangements with the Instructor).
- At the end of the exam, or when you finish, turn in **only your Scantron form**. All answers will be recorded on the Scantron form. If you record your answers in the test booklet, you will be able to check them against the posted key this weekend. Since you're keeping the test booklet, you can take it apart and use any parts of it as scratch paper.
- You may use your calculator and a pencil. **Scantron only reads pencil** reliably. Use of other writing implements on the Scantron form may cause delays or errors in scoring. Foreign substances on your Scantron form will cause it to be unreadable by our machine and may result in a score of 0. Deliberate attempts to affect accurate scoring will result in a 0 for the exam, a failing grade for the course, and action under the terms of the Academic Dishonesty policies of the University as described in the Redbook.
- No papers or objects other than your exam paper, calculator, and pencils are permitted.** All other papers and objects must be stowed out of sight. Put all notes, books, etc away and out of sight. Turn off audible and vibrate signals on all electronic devices, and put all devices other than your calculator away and out of sight. **Communications devices must be put away. Use of calculator functions on communication devices is not permitted. Sharing calculators is not permitted.**
- If you need more scratch paper, you may get it from the proctors. **You may not use your own paper.**
- Strategy hint: take a quick look over the whole exam before you start. If you see something that looks easy for you, go for it! It's good to get a few points in the bag right away.
- Strategy hints for multiple choice:
 - ▶ when you have determined that an option is not correct, mark it off so you don't have to check it again!
 - ▶ even if you think you have found the right answer, look at the remaining answers to see if any of them are a better match.

Wandering eyes will not be tolerated. Students who appear to have trouble keeping their eyes on their own paper will be moved to a more appropriate location.

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Periodic Table of the Elements

1A		2A												3A		4A		5A		6A		7A		8A	
1																					1	2			
H																					H	He			
1.008																					1.008	4.003			
3	4											5	6	7	8					9	10				
Li	Be										B	C	N	O					F	Ne					
6.941	9.012										10.81	12.01	14.01	16.00					19.00	20.18					
11	12										13	14	15	16					17	18					
Na	Mg										Al	Si	P	S					Cl	Ar					
22.99	24.31										26.98	28.09	30.97	32.06					35.45	39.95					
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	47.87	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.41	69.72	72.64	74.92	78.96	79.90	83.80								
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								
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]								
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116										
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg															
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[281]	[272]	[285]	[284]	[289]	[288]	[292]										

	58	59	60	61	62	63	64	65	66	67	68	69	70	71
Lanthanides	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]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]	[262]

Potentially useful information:

$$[\text{H}^+] \times [\text{OH}^-] = 1.0 \times 10^{-14}$$

$$\text{pH} = -\log[\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$

$$1 \text{ mol} = 6.022 \times 10^{23}$$

Strong acids: HCl HNO₃ H₂SO₄

$$1\% \text{ w/v} = 1\text{g}/100 \text{ mL} = 1 \text{ g/dL}$$

$$1 \text{ ppm} = 1 \mu\text{g/mL}$$

$$1 \text{ ppb} = 1 \text{ ng/mL}$$

$$\text{Dilution: } C_1 \times V_1 = C_2 \times V_2$$

$$\text{equivalents} = \text{moles} \times \text{charge}$$

Part I. True/False and Multiple Choice, 1 point each. Record your answer on the Scantron card.

A. Decide whether each statement is (A) TRUE or (B) FALSE.

(A) TRUE or (B) FALSE

- 1 Most transition elements can have more than one possible charge on their ions.
- 2 One milliliter is equal to 1000 liters.
- 3 Holding your breath and retaining more CO_2 can cause your blood pH to drop.
- 4 Ethanol has two carbon atoms, so it is a gas at room temperature.
- 5 Compounds that can form hydrogen bonds with water are always highly soluble.
- 6 Hydrogen bonds are stronger than covalent bonds.
- 7 A solution that contains both H_3PO_4 and H_2PO_4^- will be a buffer solution.
- 8 A molecular substance can have dispersion forces or hydrogen bonding between its molecules, but not both.
- 9 Soluble ionic compounds are strong electrolytes.
- 10 A silver atom has a mass of 107.9 g.
- 11 Elements in the same Group of the periodic table typically have similar chemical properties.
- 12 An element with five valence electrons will typically form five covalent bonds in compounds.
- 13 CH_3OH dissociates into CH_3^+ and OH^- when it dissolves in water.
- 14 The solubility of a gas in water increases as the temperature of the solution decreases.
- 15 Elements are homogeneous mixtures, while compounds are heterogeneous mixtures.

B. For each of the following pure substances at room temperature, state whether it will be (A) solid, (B) liquid or (C) gas. (*In each case, think about the kind of substance and what the factors are that decide its state at room temperature. Drawing structures or writing formulas may help.*)

A SOLID

B LIQUID

C GAS

- | | |
|-------------------------------------|--------------------|
| 16 A substance that melts at 61 °C. | 19 Dipropyl ether. |
| 17 Propyne. | 20 Propanol. |
| 18 Magnesium nitrate. | 21 Hexane. |

C. Determine whether each of the following names refers to a molecule that (A) cannot exist, cannot be drawn using the instructions provided in the name, or violates the rules of bonding; (B) does not violate the rules of bonding but is named incorrectly; or (C) is a reasonable molecule with the correct name.

A Not possible

B Reasonable structure, but wrong name

C Reasonable structure and correctly named

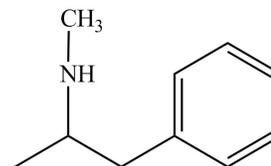
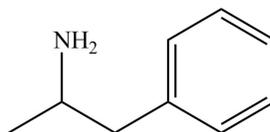
- | | | |
|--------------------|-------------|---------------|
| 22 1-methylpropane | 23 2-ethene | 24 2-pentanol |
|--------------------|-------------|---------------|

Part I continued (1 point each).

D. For each of the following pairs of substances, choose the option (A or B) that is **more soluble in water**. (In each case, think about the kind of substance and what factors go into making it soluble or insoluble. Drawing structures or writing formulas may help.)

25 A amphetamine

B methamphetamine



26 A ethanol

B 1-hexanol

A amphetamine

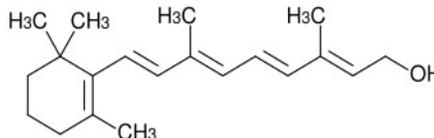
B methamphetamine

27 A sodium bromide

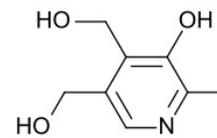
B silver(I) bromide

28 A Vitamin A

B Vitamin B6



A Vitamin A



B Vitamin B6

E. The following items refer to the molecule shown below. For each functional group, **mark (A) if the functional group is present, (B) if it is not**. (Hint: circle and label the functional groups in the structure first, then answer for each of the functional groups listed.)

29 alcohol

36 carboxylic acid

30 aldehyde

37 carboxylate ion

31 alkene

38 ester

32 alkyne

39 ether

33 amine

40 ketone

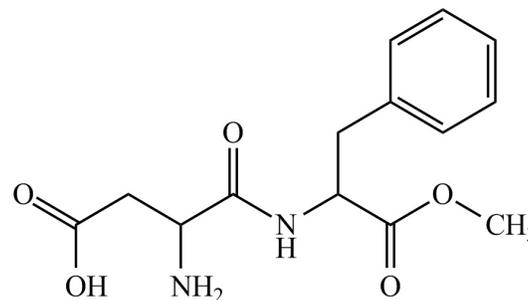
34 amide

41 phenol

35 aromatic group

42 thiol

A PRESENT B NOT PRESENT



F. Assign each of the following aqueous solutions as (A) acidic, (B) basic or (C) neutral. (In each case, think about the kind of substance and what factors go into making it act as an acid, a base, or neither.)

A ACIDIC

B BASIC

C NEUTRAL

43 A solution with pH 0

47 A solution of 0.1 M CH₃OH44 A solution with [H⁺] = 1.0 × 10⁻⁸ M48 A solution of 0.1 M CH₃CO₂H

45 A solution of 0.1 M NaOH

49 A solution with pH 10

46 A solution of ammonia

50 A solution of CO₂

Part II. Hydrogen Bonding Sketch (3 points). Write your answer in the green space on the back of your Scantron card. (*Alternate: as always, you can earn up to four points for a sketch of the hydrogen bonding interaction between two water molecules.*)

Draw a simple sketch of the hydrogen-bonding interaction between a molecule of 2-butanol and a molecule of water.

Don't put your answer here. Put it in the green space on the back of your Scantron card.

Part III. Multiple choice (3 points each). Record your answers on the back of the Scantron card.

51 Which of the following is a reasonable measurement for a UofL student ID card?

- A thickness = 1 μm B length = 8.5 cm C mass = 120 g D volume = 15 μL

52 Which of these is a reasonable mass for 1 mole of an element?

- A 0.0020 amu B 20 amu C 0.0020 g D 20 g
E more than one of these

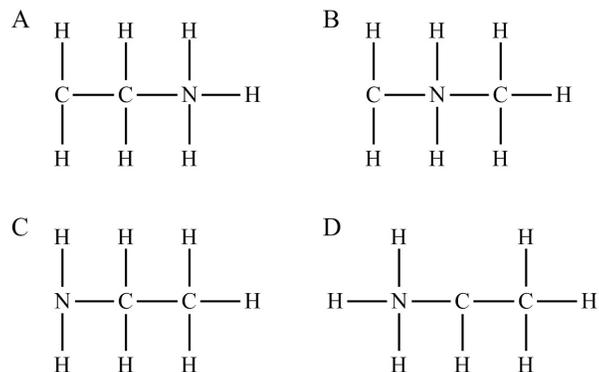
53 How many **protons** are there in the ion $^{56}\text{Fe}^{3+}$?

- A 3 B 23 C 26 D 29 E 30

54 Which of the following does NOT correctly pair the name and formula of a compound (that is, either the name or the formula is **incorrect**, or the name and formula do not match)?

- A sulfur tetrachloride, SCl_4 B iron(III) sulfate, $\text{Fe}_2(\text{SO}_4)_3$
C aluminum nitride, $\text{Al}(\text{NO}_3)_3$ D calcium carbonate, CaCO_3
E ammonium phosphide, $(\text{NH}_4)_3\text{P}$

55 Which of the structures at right is most likely to be correct for the compound $\text{C}_2\text{H}_7\text{N}$, based on the normal bonding requirements of the atoms involved?

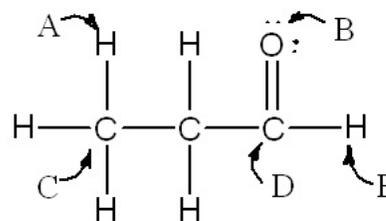


- E more than one of these

56 Which ionic compound below is **insoluble** in water?

- A iron(III) hydroxide
- B sodium phosphate
- C potassium permanganate
- D copper(II) chloride
- E lead(II) nitrate

57 In the molecule at right, one of the marked atoms carries a strong positive charge because of the electronegativities of the atoms around it. Which atom is it? (Use the letters marking each arrow.)



Questions 57-59

58 In the molecule shown at right, one of the marked atoms can participate in hydrogen bonding with an atom of water. Which atom is it?

59 The molecule shown above is best described as:

- A acidic
- B basic
- C neutral
- D amphiprotic
- E polyprotic

60 Blood plasma has a total solute concentration of about 0.28 M. What will happen to a blood cell that is placed in a 0.14 M solution of sodium sulfate? (*Hint: write the correct formula for sodium sulfate.*)

- A crenation (the cell will shrivel)
- B hemolysis (the cell will swell and burst)
- C the cell will become more basic
- D the cell will become more acidic
- E nothing; the solution is isotonic

61 A floor cleaning solution concentrate contains dye at a concentration of 0.2 mg/L. If 50 mL of this solution is diluted to a volume of 1 L, what is the concentration of the dye in the final solution?

- A 0.01 mg/L
- B 0.1 mg/L
- C 10 mg/L
- D 200 mg/L
- E 10,000 mg/L

62 Which of the following species is **triprotic**?

- A H_3PO_4
- B H_2PO_4^-
- C PO_4^{3-}
- D OH^-
- E P^{3-}

63 Which species is the **conjugate base of HPO_4^{2-}** ?

- A H_3PO_4
- B H_2PO_4^-
- C PO_4^{3-}
- D OH^-
- E P^{3-}

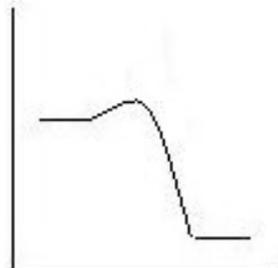
64 Which species is **amphiprotic**?

- A H_3PO_4
- B H_2PO_4^-
- C PO_4^{3-}
- D OH^-
- E P^{3-}

- 65 Which of the following statements is TRUE for a solution that has pH = 9.0?
- A $[H^+] = 9.0 \text{ M}$ B $[H^+] = 1 \times 10^{-9} \text{ M}$ C $[H^+] = [OH^-]$
D $[H^+] = 0.10 \text{ M}$ E $[OH^-] = 9.0 \text{ M}$
- 66 What is the pH of a solution that has $[H^+] = 0.005 \text{ M}$?
- A pH = 2×10^{-12} B pH = 0.005 C pH = 2.3
D pH = 5 E pH = 11.70
- 67 Calculate the molar mass of carbon disulfide. (*Hint: first write the formula of carbon disulfide.*)
- A 40.10 g B 44.07 g C 56.08 g D 68.19 g E 76.13 g
- 68 Which of the following pairs of compounds are NOT isomers of each other?
- A 1-hexene and 2-hexene B 1-hexene and 1-hexyne
C hexanal and 2-hexanone D hexane and 2-methylpentane
E 2-hexene and cyclohexane
- 69 Write the balanced equation for the combustion of propene. **How many molecules of oxygen are required for the combustion of four molecules of propene?**
- A 5 B 9 C 12 D 18 E 24
- 70 Which compound is a **secondary alcohol**?
- A 1-butanol B 2-butanol C cyclohexanol D ethanol
E more than one of these
- 71 What product results from the **condensation** of two molecules of CH_3CH_2OH ?
- A $CH_3CH_2OCH_2CH_3$ B ethene C ethanal
D $CH_3CH_2O^-$ E $CH_3CH_2^+ + OH^-$
- 72 What product results from the **oxidation of the alcohol** of CH_3CH_2OH ?
- A $CH_3CH_2OCH_2CH_3$ B ethene C ethanal
D $CH_3CH_2O^-$ E $CH_3CH_2^+ + OH^-$

- 73 Which of the following changes is likely to **decrease** the rate of a reaction that happens in aqueous solution?
- A increasing the temperature of the solution B adding an appropriate catalyst
C adding more water to the solution D stirring the mixture
E increasing the concentration of the reactants in solution

- 74 The graphic at right represents the energy changes taking place in a reaction. Which statement is TRUE for the reaction represented?



- A The forward and reverse reactions have the same activation energy.
B The forward and reverse reactions have the same ΔH value.
C The forward reaction is exothermic.
D The reverse reaction is exothermic.
E The reaction probably only involves breaking bonds, not forming them.

- 75 Which element is a **noble gas**?

A sodium B oxygen C magnesium D helium E fluorine

- 76 Which of the following elements appears in its stable state as **diatomic, gas-phase molecules**?

A He B O C Na D S E I

- 77 Which substance has the weakest dispersion forces?

A CH_4 B CH_3OH C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

- 78 Which substance has the greatest solubility in water?

A CH_4 B CH_3OH C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

Use the structures **A-D** at the side of the page to answer the next few questions.

In all cases, you may use the letter corresponding to the correct structure, or you may answer **E** for "more than one of these, or none of these." You may use each option once, more than once, or not at all.

79 Which substance contains an **alkene** group?

80 Which molecule could undergo **reduction of a carbonyl**?

81 Which compound acts as a **base**?

82 Which molecule contains a **phenol** functional group?

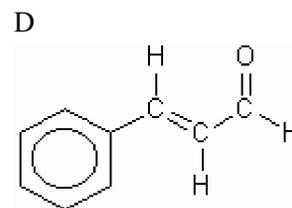
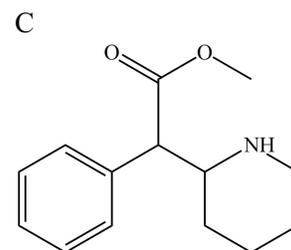
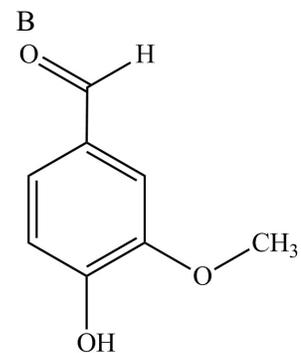
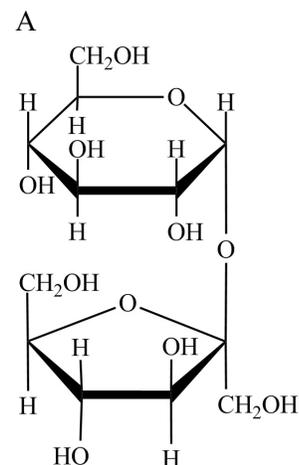
83 Which example is **not** capable of hydrogen bonding **as a pure substance**?

84 Which molecule does *not* contain an aromatic group?

85 Which molecule contains exactly 9 C atoms in its formula?

86 Which substance is most soluble in water?

87 Which substance has the smallest molar mass?

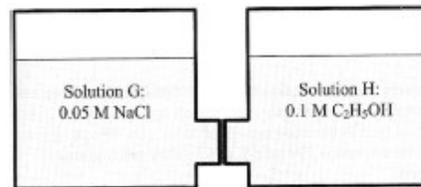


Remember that in each question on this page, "**E. More than one of these, or none of these**" is also an option.

88 Electrical current is measured in amps (named after the scientist André-Marie Ampère). The output of the power converter for the Surface Pro is about 2.6 amps. What is this value in **milliamps**?

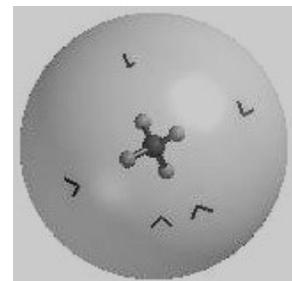
- A 0.0026 B 2.6 C 260 D 2,600 E 2.6×10^6

89 In the osmosis apparatus shown, Solution G contains 0.05 M NaCl and solution H contains 0.1 M C₂H₅OH. The two solutions are separated by a membrane that permits water and both solutes to pass. Which statement about this experiment is FALSE?



- A At the beginning of the experiment, there is no net flow of water through the membrane.
 B At the beginning of the experiment, Solution G conducts electricity but Solution H does not.
 C Sodium chloride dialyzes from Solution G to Solution H.
 D Ethanol dialyzes from Solution H to Solution G.
 E Over time, the surface of Solution H will rise and the surface of Solution G will fall.

90 The picture at right represents an ion in aqueous solution; the small v-shaped structures surrounding the central ion represent water molecules. Which of these is a possible identity for the ion?



- A chloride ion B phosphate ion C ammonium ion
 D sodium ion E hydroxide ion

91 Which of the solutions below will act as a buffer solution?

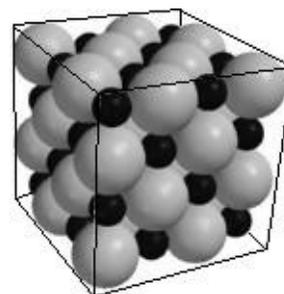
- A 0.1 M HCl + 0.1 M Cl⁻ B 0.1 M HCl + 0.1 M HF
 C 0.1 M HCl + 0.1 M OH⁻ D 0.1 M HF + 0.1 M F⁻
 E 0.1 M NaF + 0.1 M F⁻

92 To what **class of matter** does the sample represented at right belong?

- A atom B element C compound D mixture

93 What is the **state** or **phase** of the sample represented in the picture?

- A solid B liquid C aqueous D gas



Questions 92-94

94 Which formula is a reasonable identity for the substances represented in the picture?

- A Na B H₂ C CO₂ D KCl E CH₄

95 Which of the following measurements is a value for **density**?

A NH_3 : 17.03 g/mol

B SiO_2 : 2.6 g/mL

C HCl: 0.15 mol/L

D Sodium in blood: 135 mEq/L

E Amoxicillin: 40 mg/kg

96 What is the main attraction between N and H atoms in a single ammonia molecule?

A ionic bonds

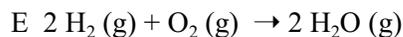
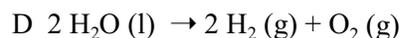
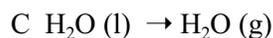
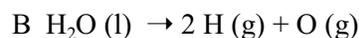
B covalent bonds

C hydrogen bonds

D dispersion forces

E both hydrogen bonds and dispersion forces

For the remaining questions, consider the processes represented by these equations:



97 Which equation represents the auto-ionization (self-ionization) of water?

98 Which equation represents a physical process and not a chemical reaction?

99 Which equation best represents what happens when water is boiled?

100 Which equation represents a process in which bonds are only broken, not formed?

101 Have a terrific break! **Before you go**–

- Did you do the hydrogen-bonding sketch in Part II (before Question 51)?
- Did you fill out the information on your Scantron card as instructed on the Cover Sheet?
- Check to make sure that you have recorded exactly one answer for every question, 1-100.