

Time: 100 min.

Chemistry 101  
Final Examination

February 2, 1999

Name:

Student Number:

Signature:

Circle one: Sects. 1, 2, 3, 7 Prof. Kortz  
Sects. 4, 5, 6, 8 Prof. Sultan

**Instructions:**

- There are 50 multiple-choice type questions and only ONE of the proposed answers is correct. Circle the letter corresponding to the right answer. No penalty for wrong answers.
- Tables of atomic numbers and molar masses of the elements provided
- Pencil and red pen will not be graded
- Do not detach any pages

**Constants:**

Gas constant,  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$

Planck's constant,  $h = 6.626 \times 10^{-34} \text{ J s}$

Speed of light,  $c = 2.998 \times 10^8 \text{ m s}^{-1}$

Rydberg constant,  $R_H = 109678 \text{ cm}^{-1} = 2.18 \times 10^{-18} \text{ J}$

Electron mass,  $m_e = 9.11 \times 10^{-31} \text{ kg}$

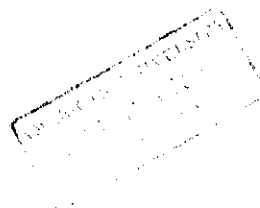
Electron charge,  $e = 1.60 \times 10^{-19} \text{ C}$

1 atm = 760 mmHg

Avogadro's number,  $N_A = 6.022 \times 10^{23} \text{ molec mol}^{-1}$

Activity series:

Li  
K  
Ba  
Ca  
Na  
Mg  
Al  
Zn  
Cr  
Fe  
Cd  
Co  
Ni  
Sn  
Pb  
H  
Cu  
Hg  
Ag  
Pt  
Au



- The Lewis structure for the chlorate ion ( $\text{ClO}_3^-$ ) should show \_\_\_\_\_ single bond(s), \_\_\_\_\_ double bond(s) and \_\_\_\_\_ lone pairs.
  - a. 2, 1, 9
  - b. 3, 0, 10
  - c. 2, 1, 8
  - d. 1, 2, 8
  - e. 0, 3, 7
  
- Avogadro's Law relates the number of molecules of a gas to its
  - a. pressure
  - b. temperature
  - c. molar mass
  - d. volume
  
- The electron dot formula for  $\text{O}_2$  shows:
  - a. a single covalent bond
  - b. a double covalent bond
  - c. an ionic bond
  - d. a total of 16 electron dots
  - e. a total of 32 electron dots
  
- Which of the following covalent bonds is the least polar?
  - a. C-Cl
  - b. C-C
  - c. C-H
  - d. O-C
  - e. N-C
  
- The interaction between Ba and Cl in  $\text{BaCl}_2$  is through a(n) \_\_\_\_\_ bond.
  - a. single, nonpolar covalent
  - b. ionic
  - c. double, polar covalent
  - d. single, polar covalent
  - e. double, nonpolar covalent
  
- Which answer does not belong? The atomic number of an element
  - a. corresponds to the number of protons in the element
  - b. identifies the order in which the element was discovered
  - c. is always an integer
  - d. corresponds to the number of electrons in the element
  - e. plus the number of neutrons gives the mass number of the element
  
- The peroxide ion ( $\text{O}_2^{2-}$ ) has
  - a. a double bond
  - b. a triple bond
  - c. six lone pairs
  - d. two resonance structures
  - e. a polar covalent bond

- Which molecule has a Lewis structure that does not obey the octet rule?
  - a.  $\text{N}_2\text{O}$
  - b.  $\text{CS}_2$
  - c.  $\text{PH}_3$
  - d.  $\text{CCl}_4$
  - e.  $\text{NO}_2$
  
- Which one of the following molecules has an atom with an incomplete octet?
  - a.  $\text{NF}_3$
  - b.  $\text{H}_2\text{O}$
  - c.  $\text{AsCl}_3$
  - d.  $\text{GeF}_4$
  - e.  $\text{BF}_3$
  
- Which one of the following molecules has an atom with an expanded octet?
  - a.  $\text{HCl}$
  - b.  $\text{AsCl}_5$
  - c.  $\text{ICl}$
  - d.  $\text{NCl}_3$
  - e.  $\text{Cl}_2$
  
- Within each of the following species all bonds are equivalent. Which one requires two resonance structures?
  - a.  $\text{CO}_2$
  - b.  $\text{ClNO}_2$
  - c.  $\text{H}_2\text{O}$
  - d.  $\text{CH}_4$
  - e.  $\text{H}_2\text{S}$
  
- What is the formal charge on the oxygen atom in  $\text{N}_2\text{O}$ , which has two double bonds?
  - a. 0
  - b. +1
  - c. -1
  - d. -2
  - e. +2
  
- Which of the following is a useful guideline for neutral covalent molecules:
  - a. Lewis structures with large formal charges are preferred
  - b. the preferred Lewis structure is one in which positive formal charges are on the most electronegative atoms
  - c. a Lewis structure in which there are no formal charges is preferred
  - d. the preferred Lewis structure is one in which negative formal charges are on the least electronegative atoms

• The bond angle in the molecule  $\text{Cl}_2\text{O}$  is expected to be closest to

- a.  $90^\circ$
- b.  $109^\circ$
- c.  $120^\circ$
- d.  $145^\circ$
- e.  $180^\circ$

• Which of the following molecules is nonpolar?

- a.  $\text{NH}_3$
- b.  $\text{OF}_2$
- c.  $\text{CH}_3\text{Cl}$
- d.  $\text{H}_2\text{O}$
- e.  $\text{BeCl}_2$

• "No two electrons in an atom can have the same four quantum numbers" is a statement called

- a. the Pauli exclusion principle
- b. Bohr's equation
- c. Hund's rule
- d. DeBroglie's relation
- e. Dalton's atomic theory

• Calculate the frequency of the light absorbed by a hydrogen atom during a transition of its electron from the  $n=3$  to the  $n=6$  principal energy level.

- a.  $1.64 \times 10^{15} \text{ s}^{-1}$
- b.  $9.13 \times 10^{13} \text{ s}^{-1}$
- c.  $3.65 \times 10^{14} \text{ s}^{-1}$
- d.  $1.82 \times 10^{19} \text{ s}^{-1}$
- e.  $2.70 \times 10^{14} \text{ s}^{-1}$

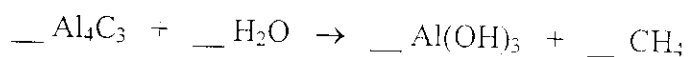
- A 5.0 liter tank was filled with 46 liters of  $O_2$  (g) and 12 liters of He (g), both measured at 25 °C and 1.0 atm pressure. Calculate the total pressure in the tank at 25 °C.
  - 2.39 atm
  - 9.39 atm
  - 11.6 atm
  - 22.4 atm
  - 23.4 atm
  
- When methane ( $CH_4$ ) is burned in oxygen, water vapor and carbon dioxide are formed. If the final pressure of the gaseous products is 6 mm Hg, what is the partial pressure of water vapor?
  - 1 mm Hg
  - 2 mm Hg
  - 3 mm Hg
  - 4 mm Hg
  - 6 mm Hg
  
- The correct formula for stannous iodide is
  - $SbI_2$
  - $SrI_4$
  - $SnI_2$
  - $SbI_4$
  - $SnI_4$
  
- The correct name for  $MgCl_2$  is
  - manganese(II) chloride
  - magnesium dichloride
  - magnesium(II) chloride
  - magnesium chloride
  - manganous chloride
  
- Real gases do not always obey the ideal gas law because real gas molecules
  - are attracted to one another
  - are in constant motion
  - are widely separated
  - have elastic collisions
  - have negligible intermolecular interactions
  
- Beta ( $\beta$ ) rays
  - are positively charged particles
  - are electrons
  - are high-energy rays with no charge
  - are equivalent to microwaves
  - are deflected by a positively charged plate

- For the reaction  $\text{CO}_{(g)} + 3\text{H}_{2(g)} \rightarrow \text{CH}_{4(g)} + \text{H}_2\text{O}_{(g)}$  carried out at constant pressure and temperature in a container sealed with a piston, which of the following would remain constant?
  - a. mass of the sample
  - b. volume of the sample
  - c. total number of molecules in the sample
  - d. density of the sample
  - e. none of the above
  
- Ions and atoms that are isoelectronic have the same
  - a. chemical properties
  - b. electron affinity
  - c. first ionization energy
  - d. electron configuration
  - e. atomic number
  
- The ionization energy with the lowest value is
  - a. the first ionization energy of Rb
  - b. the second ionization energy of Rb
  - c. the first ionization energy of Ca
  - d. the second ionization energy of Ca
  - e. the third ionization energy of Ca
  
- The effective nuclear charge is the
  - a. arrangement of electrons around the nucleus of an atom or ion
  - b. measure of an atom's tendency to gain an electron
  - c. charge actually felt by the electrons
  - d. amount of energy needed to remove the most loosely bound electron from a mole of gaseous atoms
  
- With respect to the size of the species, which of the following relationships is correct?
  - a.  $\text{K} < \text{K}^+$
  - b.  $\text{Cl} < \text{Cl}^-$
  - c.  $\text{S}^{2-} < \text{Cl}^-$
  - d.  $\text{Cr}^{2+} < \text{Cr}^{3+}$
  - e.  $\text{O} > \text{N}$
  
- Which of the following molecules do not follow the octet rule?
 

(1)  $\text{H}_2\text{S}$     (2)  $\text{BCl}_3$     (3)  $\text{PH}_3$     (4)  $\text{SF}_4$

  - a. 1, 4
  - b. 2, 3
  - c. 1, 2
  - d. 3, 4
  - e. 2, 4

- What is the coefficient of  $\text{H}_2\text{O}$  when the following equation is properly balanced with smallest set of whole numbers?



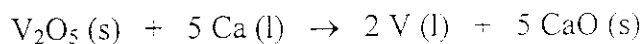
- a. 3
  - b. 4
  - c. 6
  - d. 12
  - e. 24
- 
- Which of the following is a nonelectrolyte
  - a. NaOH
  - b.  $\text{HNO}_3$
  - c.  $\text{CH}_3\text{COOH}$  (acetic acid)
  - d. KF
  - e.  $\text{C}_2\text{H}_6\text{O}$  (ethanol)
- 
- According to the solubility rules, which one of the following is soluble in water?
  - a.  $\text{Hg}_2\text{Cl}_2$
  - b.  $\text{Na}_2\text{S}$
  - c.  $\text{Ag}_2\text{CO}_3$
  - d.  $\text{Ag}_2\text{S}$
  - e.  $\text{BaSO}_4$
- 
- The oxidation number of Cl in  $\text{ClO}_4^-$  is
  - a. -1
  - b. +1
  - c. +3
  - d. +5
  - e. +7
- 
- Which of the following equations does not represent an oxidation-reduction reaction?
  - a.  $3 \text{Al} + 6 \text{HCl} \rightarrow 3 \text{H}_2 + 2 \text{AlCl}_3$
  - b.  $2 \text{H}_2\text{O} \rightarrow 2 \text{H}_2 + \text{O}_2$
  - c.  $2 \text{NaCl} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{PbCl}_2 + 2 \text{NaNO}_3$
  - d.  $2 \text{NaI} + \text{Br}_2 \rightarrow 2 \text{NaBr} + \text{I}_2$
  - e. None of these

- How many grams of  $\text{Cl}_2$  can be prepared from the reaction of 15.0 g of  $\text{MnO}_2$  and 30.0 g of  $\text{HCl}$  according to the following equation?



- a. 0.82 g
- b. 5.8 g
- c. 12.2 g
- d. 14.6 g
- e. 58.4 g

- What is the theoretical yield of vanadium that can be produced by the reaction of 40.0 g of  $\text{V}_2\text{O}_5$  with 40.0 g of calcium according to the following equation?



- a. 11.2 g
- b. 20.3 g
- c. 22.4 g
- d. 40.0 g
- e. 5.6 g

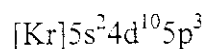
- One mole of iron
  - a. is heavier than one mole of lead (Pb)
  - b. is 77.0 g of iron
  - c. is 26.0 g of iron
  - d. weighs the same as one mole of lead
  - e. none of these

- Which of the following contains the greatest number of atoms?
  - a. 100 g of Pb
  - b. 2.0 mole of Ar
  - c. 0.1 mole of Fe
  - d. 5 g of He
  - e. 20 million  $\text{O}_2$  molecules

- How many atoms are in 6.0 g of  $\text{Na}_3\text{N}$ ?
  - a.  $3.6 \times 10^{24}$  atoms
  - b.  $4.6 \times 10^{22}$  atoms
  - c.  $1.3 \times 10^{23}$  atoms
  - d. 0.217 atoms
  - e. 0.072 atoms



- Which element has the following electron configuration?



- a. Sn
- b. Sb
- c. Pb
- d. Bi
- e. Te

- An atom of iron has \_\_\_ unpaired electrons and is \_\_\_\_\_.

- a. 0, diamagnetic
- b. 6, diamagnetic
- c. 3, paramagnetic
- d. 5, paramagnetic
- e. 4, paramagnetic

- A molecule of the type  $\text{AB}_4\text{E}_2$  has the geometry:

- a. tetrahedral
- b. distorted tetrahedron
- c. octahedral
- d. square planar
- e. square pyramidal

- The geometry of the  $\text{ClF}_3$  molecule is best described as:

- a. distorted tetrahedron
- b. trigonal planar
- c. tetrahedral
- d. T-shaped
- e. trigonal pyramidal

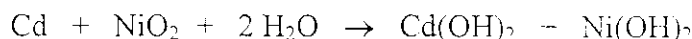
- According to the VSEPR theory, the geometry of the atoms in the carbonate ion,  $\text{CO}_3^{2-}$  is

- a. square planar
- b. tetrahedral
- c. trigonal planar
- d. pyramidal
- e. octahedral

- According to the VSEPR theory, which of the following species is linear?

- a.  $\text{H}_2\text{S}$
- b.  $\text{HCN}$
- c.  $\text{BF}_3$
- d.  $\text{H}_2\text{CO}$
- e.  $\text{SO}_2$

- Identify the reducing agent in the following equation.



- Cd
- NiO<sub>2</sub>
- H<sub>2</sub>O
- Cd(OH)<sub>2</sub>
- Ni(OH)<sub>2</sub>

- Which of the following is a disproportionation reaction?

- 2C<sub>2</sub>H<sub>6</sub>(g) + 7 O<sub>2</sub>(g) → 4 CO<sub>2</sub>(g) + 6 H<sub>2</sub>O
- 2 KBr(aq) + Cl<sub>2</sub>(g) → 2 KCl(aq) + Br<sub>2</sub>(l)
- 2 H<sub>2</sub>O<sub>2</sub>(aq) → 2 H<sub>2</sub>O(l) + O<sub>2</sub>(g)
- CaBr<sub>2</sub>(aq) + H<sub>2</sub>SO<sub>4</sub>(aq) → CaSO<sub>4</sub>(s) + 2 HBr(g)
- 2 Al(s) + 3 H<sub>2</sub>SO<sub>4</sub>(aq) → Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>(aq) + 3 H<sub>2</sub>(g)

- Complete this sentence: Atoms emit visible and ultraviolet light

- as electrons jump from lower energy levels to higher levels.
- as the atoms condense from a gas to a liquid.
- as electrons jump from higher energy levels to lower levels.
- as they are heated and the solid melts to form a liquid.
- as the electrons move about the atom within an orbit.

- Calculate the wavelength associated with a <sup>20</sup>Ne<sup>+</sup> ion moving at a velocity of 2.0 × 10<sup>5</sup> m/s. The atomic mass of Ne-20 is 19.992 amu.

- 1.0 × 10<sup>-14</sup> m
- 1.0 × 10<sup>-16</sup> m
- 1.0 × 10<sup>-18</sup> m
- 9.7 × 10<sup>12</sup> m
- 2.0 × 10<sup>-13</sup> cm

- A possible set of quantum numbers for the last electron added to complete an atom of gallium Ga in its ground state is

	n	l	m <sub>l</sub>	m <sub>s</sub>
a.	4	0	0	-1/2
b.	3	1	0	-1/2
c.	4	1	0	+1/2
d.	3	1	1	+1/2
e.	4	2	1	+1/2

# AMERICAN UNIVERSITY OF BEIRUT

## DEPARTMENT OF CHEMISTRY

### TABLE OF ATOMIC NUMBERS AND WEIGHTS 1955

ELEMENT	SYMBOL	ATOMIC NUMBER	ATOMIC WEIGHT*	ELEMENT	SYMBOL	ATOMIC NUMBER	ATOMIC WEIGHT*
Actinium	Ac	89	227	Molybdenum	Mo	42	95.95
Aluminum	Al	13	26.98	Neodymium	Nd	60	144.27
Americium	Am	95	(243)	Neon	Ne	10	20.183
Antimony	Sb	51	121.76	Neptunium	Np	93	(237)
Argon	Ar	18	39.944	Nickel	Ni	28	58.71
Arsenic	As	33	74.91	Niobium	Nb	41	92.91
Astatine	At	85	(210)	Nitrogen	N	7	14.008
Barium	Ba	56	137.36	Osmium	Os	76	190.2
Berkelium	Bk	97	(249)	Oxygen	O	8	16 (PKR)
Beryllium	Be	4	9.013	Palladium	Pd	46	106.4
Bismuth	Bi	83	209.00	Phosphorus	P	15	30.975
Boron	B	5	10.82	Platinum	Pt	78	195.09
Bromine	Br	35	79.916	Plutonium	Pu	94	(242)
Cadmium	Cd	48	112.41	Polonium	Po	84	210
Caesium	Cs	55	132.91	Potassium	K	19	39.10
Calcium	Ca	20	40.08	Praseodymium	Pr	59	140.92
Californium	Cf	98	(249)	Promethium	Pm	61	(145)
Carbon	C	6	12.011	Protactinium	Pa	91	231
Cerium	Ce	58	140.13	Radium	Ra	88	226.05
Cesium	Cs	55	132.91	Radon	Rn	86	222
Chlorine	Cl	17	35.457	Rhenium	Re	75	186.22
Chromium	Cr	24	52.01	Rhodium	Rh	45	102.91
Chromium	Cr	24	52.01	Rubidium	Rb	37	85.48
Cobalt	Co	27	58.94	Ruthenium	Ru	44	101.1
Copper	Cu	29	63.54	Samarium	Sm	62	150.35
Curium	Cm	96	(248)	Scandium	Sc	21	44.96
Dysprosium	Dy	66	162.51	Selenium	Se	34	78.96
Erbium	Er	68	167.27	Silicon	Si	14	28.09
Europlutonium	Eu	63	152.0	Silver	Ag	47	107.880
Fluorine	F	9	19.00	Sodium	Na	11	22.991
Francium	Fr	87	(223)	Strontium	Sr	38	87.63
Gadolinium	Gd	64	156.9	Sulphur	S	16	32.066
Gallium	Ga	31	69.72	Tantalum	Ta	73	180.95
Germanium	Ge	32	72.60	Tellurium	Te	52	127.61
Gold	Au	79	197.0	Terbium	Tb	65	158.93
Hafnium	Hf	72	178.50	Thallium	Tl	81	204.39
Helium	He	2	4.003	Thorium	Th	90	232.05
Holmium	Ho	67	164.94	Thulium	Tm	69	168.94
Hydrogen	H	1	1.0080	Tin	Sn	50	118.70
Iodine	I	53	126.91	Titanium	Ti	22	47.90
Iridium	Ir	77	192.2	Tungsten	W	74	183.86
Iron	Fe	26	55.85	Uranium	U	92	238.07
Krypton	Kr	36	83.80	Vanadium	V	23	50.95
Lanthanum	La	57	138.92	Xenon	Xe	54	131.30
Lead	Pb	82	207.21	Ytterbium	Yb	70	173.04
Lithium	Li	3	6.940	Yttrium	Y	39	88.92
Lutetium	Lu	71	174.99	Zinc	Zn	30	65.38
Magnesium	Mg	12	24.32	Zirconium	Zr	40	91.22
Manganese	Mn	25	54.94				
Mendelevium	Mv	101	(256)				
Mercury	Hg	80	200.61				

### PERIODIC TABLE OF THE ELEMENTS

I A		II A		III B										IV B										V B										VI B										VII B										VIII										IX										X										XI										XII																																																																																																													
1	H	2	He	3	Li	4	Be	5	B	6	C	7	N	8	O	9	F	10	Ne	11	Na	12	Mg	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar	19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr	37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe	55	Cs	56	Ba	57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn	87	Fr	88	Ra	89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	99	Es	100	Fm	101	Md	102	No