Concordia University CHEM 205

Winter 2016, Dr. C. Rogers, Section 03, Tues/Thurs

LAST NAME:

FIRST NAME:

STUDENT ID:

Chem 205 - GENERAL CHEMISTRY I

MIDTERM EXAMINATION

PLEASE READ THIS BOX WHILE WAITING TO START

INSTRUCTIONS:

- Calculators are permitted; cell phones and other electronic devices are not allowed.
- This test paper includes 9 pages; please read over the whole test before starting.
- A periodic table (incomplete) is included and may be detached (not graded).
- Fill in your name & ID # on scansheet, in pencil (fill circles completely).
- Please write clearly and organize your work logically.
- Read the instructions to each section carefully.
- **Duration: 70 minutes. GOOD LUCK!**

Professor use - Grades:

Pages 2-4:	/ 40
Page 5:	/ 11
TOTAL:	/ 50 (MAX. 51)
PERCENT:	%

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PART A: MULTIPLE-CHOICE QUESTIONS – 2 marks each

Colour in final answer on scansheet, in pencil. Circle answer here too, as a backup.

 # 1. Which is the best description of the change involved when sodium chloride (NaCl) dissolves in water?

a) It is a chemical change, because the ions change their charges when they dissolve.
b) It is a physical change, because the ions dissociate but do not change charges.
c) It is a chemical change, because heat is needed for the process to occur.
d) It is a physical change, because the solid NaCl melts to become liquid.

 # 2. Which one of the important historical experiments listed below did <u>not</u> give the results described?

a) The Curies' experiments with radioactivity proved that atoms are made up of smaller particles.
b) Thomson's experiments showed that atoms contain negatively charged particles (electrons).
c) Rutherford's experiments proved that Thomson's plum-pudding model of the atom is correct.
d) Millikan's oil-drop experiment showed that the charge on any particle is a whole-number multiple of the electron charge.

 # 3. How many protons, neutrons, and electrons are in a $^{58}Fe^{3+}$ cation?

a) 26 p^+, 32 n^0, 26 e^-
b) 32 p^+, 26 n^0, 32 e^-
c) 26 p^+, 32 n^0, 23 e^-
d) 32 p^+, 26 n^0, 29 e^-

 # 4. An element (E) has several isotopes, with these abundances: 54.5% ^{72}E, 15.6% ^{73}E, 29.9% ^{74}E. What is the most reasonable atomic weight for this element?

a) 72.1 g/mol
b) 72.8 g/mol
c) 73.4 g/mol
d) 73.8 g/mol

 # 5. Which one of the following statements about ionic compounds is <u>incorrect</u>?

a) Ionic compounds form extended 3-dimensional networks called crystal lattices.
b) Positive and negative ions are attracted to each other by electrostatic forces.
c) As the ion charges increase, the attraction between the ions decreases.
d) Ionic crystals tend to be rigid, and they cleave along planes.

 # 6. What is the balanced chemical equation when BF_3 and H_2O react to produce B_2O_3 and HF?

a) $BF_3(g) + H_2O(g) \rightarrow B_2O_3(s) + HF(g)$
b) $2\ BF_3(g) + 3\ H_2O(g) \rightarrow B_2O_3(s) + 3\ HF(g)$
c) $BF_3(g) + 3\ H_2O(g) \rightarrow B_2O_3(s) + 3\ HF(g)$
d) $2\ BF_3(g) + 3\ H_2O(g) \rightarrow B_2O_3(s) + 6\ HF(g)$

 # 7. An analysis was performed to find the concentration of a NaOH solution, with the following results:

Trial	**Concentration (M)**
1	0.69 ± 0.02
2	0.76 ± 0.02
3	0.61 ± 0.02

If the actual concentration of NaOH was 0.70 M, which choice best describes the analysis data?

a) precise – the average deviation of the concentrations from trials 1-3 is < 5%
b) accurate – the relative error of the concentrations from trials 1-3 is < 5%
c) neither (a) nor (b)
d) both (a) and (b)

 # 8. In which set of compounds below are all the compounds insoluble in water?

a) Na_2CO_3, $CaCO_3$, $(NH_4)_2CO_3$
b) $(NH_4)_2S$, FeS, Na_2SO_4
c) NH_4Cl, KNO_3, NaOH
d) NaCl, AgCl, $ZnCl_2$
e) ZnS, NiS, $CaCO_3$

 # 9. When water is boiling, bubbles rise to the surface. What do the bubbles contain?

a) air (mostly N_2 and O_2 gases)
b) nothing (a vacuum)
c) H_2 and O_2 gases
d) H^+ and OH^- ions
e) H_2O vapour

 # 10. Which one of the following statements is not true?

a) When two soluble salts are mixed together, an insoluble salt may form and precipitate.
b) When a molecular compound is dissolved in water, covalent bonds are broken.
c) When two metals mix together, a solid solution called an alloy is formed.
d) When a metal reacts with a nonmetal, an ionic compound is formed.
e) When two nonmetals react, a covalent compound is formed.

 # 11. Which ionic compound in the list below is not possible?

a) $(NH_4)_3PO_4$
b) $Fe(ClO_4)_2$
c) $LiHCO_3$
d) $CaSO_4$
e) K_2NO_3

 # 12. Fill in the blank: The statement "the total mass of materials is not affected by a chemical change in those materials" is called a(n) _____.

a) experiment
b) observation
c) natural law
d) hypothesis
e) theory

 # 13. A piece metal with a mass of 33.2 g is submerged in 10.0 mL of water in a graduated cylinder and the volume rose to 22.3 mL. What is the identity of the metal?

a) magnesium, 1.74 g/cm^3
b) aluminum, 2.70 g/cm^3
c) copper, 8.96 g/cm^3
d) silver, 10.5 g/cm^3
e) iron, 7.87 g/cm^3

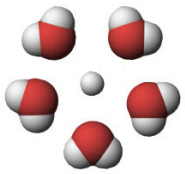
 # 14. Which one of the following compounds is named <u>incorrectly</u>?

a) P_2O_5, phosphorus oxide
b) $FeSO_4$, iron (II) sulfate
c) CO, carbon monoxide
d) Li_2S, lithium sulfide
e) NH_3, ammonia

 # 15. The melting point of indium metal is 156.2°C. At 434.8 K, what is the physical state of indium?

a) a mixture of solid, liquid and gas
b) a mixture of solid and liquid
c) liquid
d) solid
e) gas

 # 16. Which statement about this dissolved ion surrounded by water molecules is <u>correct</u>?



a) The water molecules direct their O atoms towards the ion because the water molecules pack together more efficiently that way.
b) Based on the orientation of the water molecules, we know that the ion has positive charge.
c) Based on the orientation of the water molecules, we know that the ion has negative charge.
d) More than one of the above statements are true.
e) All of the above statements are wrong.

 # 17. Which element below is too reactive with air and water to be found in nature in its elemental form?

a) potassium
b) nitrogen
c) helium
d) sulfur
e) gold

 # 18. Which of the following descriptions of elements (in their elemental forms) is incorrect?

a) Oxygen is a diatomic gas that causes metals to corrode and organic materials to burn.
b) Sodium is a soft silvery metal made of atoms packed together to form a solid.
c) Carbon has 3 allotropes: diamond, graphite and Buckminsterfullerene (C_{60}).
d) Hydrogen is a highly flammable gas that is made of free atoms.
e) Mercury is the only metal that is liquid at room temperature.

 # 19. A particular hydrocarbon has the empirical formula CH_2. If its molar mass is 140.3 g/mol, what is its molecular formula?

a) CH_2
b) C_3H_6
c) C_5H_{10}
d) C_8H_{16}
e) $C_{10}H_{20}$

 # 20. Which statement correctly describes a strong electrolyte?

a) a substance that dissociates partially in water to yield a small concentration of ions
b) a substance that dissociates fully in water to yield a high concentration of ions
c) a substance that dissolves fully in water to yield hydrated neutral molecules
d) a substance that does not dissolve in water but conducts electricity
e) a substance that generates its own electric current when melted

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PART B: SHOW COMPLETE WORK TO GET FULL CREDIT (answer on exam)

 # 21. (5 marks) Epsom salts is a hydrated ionic compound with the formula: $MgSO_4 \bullet xH_2O$. A 4.93 g sample of Epsom salt was heated to drive off the water of hydration, and the mass of the sample after complete dehydration was 2.41 g. Find the number of waters of hydration (x) in Epsom salt. Show full calculations and explanatory key words for <u>each step</u>.

 # 22. One way to soften "hard" water (which contains dissolved Ca^{2+} and Mg^{2+} ions, like Montreal's water) is to add a soluble phosphate salt to precipitate out the calcium and magnesium ions. Imagine you add 125 mL of 0.50 M Na_3PO_4 to hard water that contains dissolved $CaCl_2$ (ignore Mg^{2+} here for simplicity).

a) **(2 marks)** Write the net ionic equation for the reaction when aqueous Na_3PO_4 and $CaCl_2$ are mixed.

b) **(1 mark)** What is the name of the insoluble product that forms?

c) **(3 marks)** Calculate the concentration of Na^+ ions in (i) the original 125 mL of Na_3PO_4 solution, and (ii) the supernatant solution after the reaction if the final volume is 1.0 L. Show your work.

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EXTRA SPACE / ROUGH WORK

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POTENTIALLY USEFUL INFORMATION

Atomic mass unit: 1 amu = 1.66054×10^{-27} kg Avogadro's number: N = 6.022×10^{23} mol^{-1}

PERIODIC TABLE OF THE ELEMENTS – missing 1st 20 elements

(this will not be graded)

1.008																	4.00
6.941	9.012											10.81	12.01	14.007	15.999	18.998	20.18
22.99	24.31											26.98	28.09	30.97	32.07	35.45	39.95
39.10	40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (97.91)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	**La-Lu**	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** 208.98	85 **At** 209.99	86 **Rn** 222.02
87 **Fr** 223	88 **Ra** 226.03	**Ac-Lr**	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)									

57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.35	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
89 **Ac** 227.03	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (245)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)