Name: _____   Student number: _____

Chemistry 1A03   **Test 1**   **Sept 28, 2018**

McMaster University   **VERSION 1**

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Duration: 90 minutes

This test contains 16 numbered pages printed on both sides. There are 20 multiple-choice questions appearing on pages numbered 3 to 12. Pages 13 and 14 are extra space for rough work. Page 15 includes some useful data and equations, and there is a periodic table on page 16. You may tear off the last page to view the periodic table and the data provided.

You must enter your name and student number on this question sheet, as well as on the answer sheet. Your invigilator will be checking your student card for identification.

You are responsible for ensuring that your copy of the question paper is complete. Bring any discrepancy to the attention of your invigilator.

All questions are worth 1 mark - the total marks available are 20. There is no penalty for incorrect answers.

BE SURE TO ENTER THE CORRECT VERSION OF YOUR TEST (shown near the top of page 1), IN THE SPACE PROVIDED ON THE ANSWER SHEET.

ANSWER ALL QUESTIONS ON THE ANSWER SHEET, IN PENCIL.

Instructions for entering multiple-choice answers are given on page 2.

SELECT ONE AND ONLY ONE ANSWER FOR EACH QUESTION from the answers **(A)** through **(E). No work written on the question sheets will be marked**. The question sheets may be collected and reviewed in cases of suspected academic dishonesty.

Academic dishonesty may include, among other actions, communication of any kind (verbal, visual, *etc*.) between students, sharing of materials between students, copying or looking at other students' work. If you have a problem please ask the invigilator to deal with it for you. Do not make contact with other students directly. Try to keep your eyes on your own paper – looking around the room may be interpreted as an attempt to copy.

Only **Casio FX991-MS or FX991-MS**+ electronic calculators may be used. They must NOT be transferred between students. Use of any aids other than those provided, is not allowed.

Name: _____   Student number: _____

OMR EXAMINATION – STUDENT INSTRUCTIONS

NOTE: IT IS YOUR RESPONSIBILITY TO ENSURE THAT THE ANSWER SHEET IS PROPERLY COMPLETED: YOUT EXAMINATION RESULT DEPENDS UPON PROPER ATTENTION TO THESE INSTRUCTIONS.

The scanner, which reads the sheets, senses the bubble shaded areas by their non-reflection of light. A heavy mark must be made, completely filling the circular bubble, with an HB pencil. Marks made with a pen will **NOT** be sensed. Erasures must be thorough, or the scanner will still sense a mark. Do **NOT** use correction fluid on the sheets. Do **NOT** put any unnecessary marks or writing on the sheet.

1. On SIDE 1 (**red side**) of the form, in the top box, *in pen*, print your student number, name, course name, and the date in the spaces provided. Then you **MUST** write your signature, in the space marked SIGNATURE.

2. In the second box, *with a pencil*, mark your **student number** in the space provided. If your student number does **NOT** begin with a 4, put "00" before your student number. Then fill in the corresponding bubble numbers underneath.

3. Do NOT put in a leading zero when bubbling in your **exam version number**.

4. Answers: mark only **ONE** choice from the alternatives (A,B,C,D,E) provided for each question. The question number is to the left of the bubbles. Make sure that the number of the question on the scan sheet is the same as the number on the test paper.

5. Pay particular attention to the marking directions on the form.

6. Begin answering the question using the first set of bubbles, marked "1".

Page 2 of 16   **Version # 1**   Continued on next page

1. Which statement about $^{37}_{17}X^+$ is **false**?

   A) The element is chlorine.
   B) There are 17 protons.
   C) There are 20 neutrons.
   D) There are 18 electrons.

2. A 10.0 g sample of propane (C_3H_8) (g) was combusted in a 25.0 L rigid vessel containing pure O_2 (g) at $P_{O2} = 1.500$ bar and an initial temperature of 25.0 °C. At the end of the reaction <u>the temperature of the vessel is 250. °C</u>. At the end of the reaction, what is the **mole fraction of $CO_2(g)$** in the vessel?

   A) 0.263
   B) 0.421
   C) 0.346
   D) 0.538

3. Lithium has two stable isotopes with natural abundances of 92.41% (^{7}Li) and 7.59% (^{6}Li). **How many atoms of ^{6}Li** are there in a 1.54 g sample of **lithium oxide**?

    A) 1.87×10^{20}
    B) 3.00×10^{20}
    C) 7.32×10^{21}
    D) 4.71×10^{21}

4. Select the ONE species from the following selections that has **sulfur** in a **different oxidation state** than the other three selections.

    A) HSO_3^-
    B) SO_3^{2-}
    C) HSO_4F
    D) $SOCl_2$

5. Aluminum (1.15 g) reacts with oxygen gas (0.971 L) at 25 °C and 1.05 bar to produce aluminum oxide. What is the **% yield** of the reaction if 1.78 g of aluminum oxide is obtained?

   A) 67.2
   B) 81.9
   C) 71.2
   D) 98.1

6. Boron and hydrogen form various compounds with formula B_xH_y. When 0.161 g of a particular B_xH_y compound was burned in **excess** $O_2(g)$ it produced 0.420 g of $B_2O_3(s)$ according to the following **unbalanced** reaction equation:

   $$B_xH_y \text{ (s)} + O_2(g) \rightarrow B_2O_3 \text{ (s)} + H_2O \text{ (l)}$$
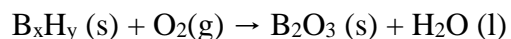
   Which of the following could be the **molecular formula** for B_xH_y?

   A) B_5H_9
   B) B_2H_6
   C) B_6H_{10}
   D) B_4H_{10}

7. Which one of the following is **NOT an allowed set** of quantum numbers (n, ℓ, m_ℓ, m_s) for an <u>excited electron</u> in a sodium atom?

    A) 3, 2, 0, –½
    B) 3, 1, 0, ½
    C) 2, 1, 1, –½
    D) 4, 0, 0, ½

8. In a photoelectric effect experiment, light is shone on a sample of tantalum (threshold energy 6.89×10^{-19} J), and photoelectrons are released with a speed of 1.40×10^6 m/s. **How many** of these statements are **true**?
    I.   The frequency of incident light required is 2.39×10^{15} s^{-1}.
    II.   The kinetic energy of the ejected photoelectrons is 8.93×10^{-19} J.
    III.   The wavelength of the emitted photoelectrons is 0.520 nm.

    A) 3
    B) 2
    C) 0
    D) 1

9.   A valence electron in a nitrogen atom is excited to $n = 4$. Which electron configuration could **NOT** represent the excited state nitrogen atom?

   A) $1s^2\ 2s^2\ 2p^3\ 4s^1$
   B) $1s^2\ 2s^1\ 2p^3\ 4s^1$
   C) $1s^2\ 2s^2\ 2p^2\ 4p^1$
   D) $1s^2\ 2s^1\ 2p^3\ 4d^1$

10.   The change in energy for a particular electronic transition in a hydrogen atom is **negative**. What can you conclude?

   A)   Energy was emitted as a result of the transition.
   B)   The hydrogen atom was ionized.
   C)   The transition is not possible due to the specific radii of hydrogen's energy levels.
   D)   The electron transitioned from a lower energy level to a higher one.

11. A scientist runs an experiment to recreate the photoelectric effect using red and blue light with two different metals. Red and blue light both eject electrons from Metal 1. However, only blue light ejects electrons from Metal 2.

Which statement is **false**?

A) Increasing the intensity of red light will cause electrons to eject from Metal 2.
B) Decreasing the intensity of blue light will decrease the number of electrons ejected from Metal 1.
C) For Metal 1, the electrons ejected using blue light have greater speed than the electrons ejected using red light.
D) Metal 2 has a greater threshold energy than Metal 1.

12. What **wavelength of light (in nm)** is emitted when an electron transitions from a *3d* orbital to a *2p* orbital in a **hydrogen atom**?

A) 486.2 nm
B) 656.3 nm
C) 364.6 nm
D) 205.7 nm

13. Which statement is **false**?

    A) Orbitals describe regions of high probability of finding an electron.
    B) For objects moving at a given speed, the larger the mass of an object, the shorter its wavelength.
    C) Results from experiments on the photoelectric effect indicate that electrons have wave properties.
    D) For an electron in an atom, the larger the value of n, the larger the average distance from the nucleus.

14. **How many** of these statements are **true**?
    I.   Metal oxides generate acidic solutions when dissolved in water.
    II.   Metallic character of atoms increases moving to the right on the periodic table.
    III.   Amphoteric oxides can react with both acids and bases.

    A) 1
    B) 2
    C) 3
    D) 0

15. Which of the following represents the **second ionization energy** of zinc?

    A) $Zn \rightarrow Zn^{2+} + 2e^-$
    B) $Zn^{2+} + 2e^- \rightarrow Zn$
    C) $Zn^+ + e^- \rightarrow Zn^{2+}$
    D) $Zn^+ \rightarrow Zn^{2+} + e^-$

16. Given the ionization values below, **predict the identities of elements X and Y**:

Ionization Energy	Element X (kJ mol^{-1})	Element Y (kJ mol^{-1})
1st	590	738
2nd	1145	1451
3rd	4912	7733
4th	8153	10542
5th	10496	13630

    A)   Element X is Calcium, Element Y is Magnesium
    B)   Element X is Potassium, Element Y is Calcium
    C)   Element X is Magnesium, Element Y is Calcium
    D)   Element X is Calcium, Element Y is Potassium

17. **How many** of these statements are **true**?
>   I.   When comparing Si, N, C, and O, the magnitude of electron affinity is smallest for N.
>   II. When comparing Al, Si, Na, and Cl, the value of Z_{eff} for a valence electron is smallest for Na.
>   III. When comparing Li, F, Cs, and At, the atomic radius is largest for At.

A)   1
B)   0
C)   2
D)   3

18. Arrange the following ions in order of **increasing ionic radius** (smallest to largest):

$$S^{2-}, K^+, Cl^-, Na^+$$
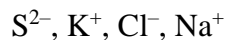
A) $Na^+ < K^+ < S^{2-} < Cl^-$
B) $Cl^- < S^{2-} < Na^+ < K^+$
C) $S^{2-} < Cl^- < Na^+ < K^+$
D) $Na^+ < K^+ < Cl^- < S^{2-}$

19. Which of the following **reactions** takes place when calcium oxide is added to water at room temperature?

   A) $CaO + H_2O \rightarrow Ca(OH)_2$
   B) $CaO + H_2O \rightarrow Ca + O_2 + 2H^+$
   C)   No reaction.
   D) $CaO + H_2O \rightarrow Ca + H_2O_2$

20. The ground state of elements A and B have the following electron configurations:

$$A = [He]2s^2 2p^4 \quad B = [He]2s^2 2p^3$$
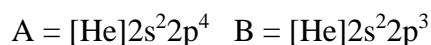
Which of the following statements about ionization energy (IE) is **true**?

   A)   IE (B) > IE (A) because losing an electron from A results in a half-filled shell.
   B)   IE (A) > IE (B) because losing an electron from A results in a half-filled shell.
   C)   IE (A) > IE (B) because A is further to the right in the periodic table.
   D)   IE (B) > IE (A) because A is further to the right in the periodic table.

Extra space for rough work

Extra space for rough work

Name: _____   Student number: _____

Some general data are provided on this page.

A periodic table with atomic weights is provided on the next page.

STP = 273.15 K, 1 atm F = 96485 C/mol
N_A = 6.022 × 10^{23} mol^{-1} c = 2.9979 × 10^8 m/s
h = 6.6256 × 10^{-34} Js m_e = 9.109 × 10^{-31} kg
density(H_2O, l) = 1.00g/mL $\Delta H°_{vap}[H_2O]$ = 44.0 kJ mol^{-1}
Specific heat of water = 4.184 J / g·°C
R = 8.3145 J K^{-1} mol^{-1} = 0.08206 L atm K^{-1} mol^{-1} = 0.083145 L bar K^{-1} mol^{-1}

1 bar = 100.00 kPa = 750.06 mm Hg = 0.98692 atm   0°C = 273.15 K
1 J = 1 kg m^2 s^{-2} = 1 kPa L = 1 Pa m^3 1 m = 10^6 μm = 10^9 nm = 10^{10} Å
1 cm^3 = 1 mL   1 g = 10^3 mg
1 Hz = 1 cycle/s

De Broglie wavelength: Hydrogen atom energy levels:
$\lambda = h / mu = h / p$ $E_n = -R_H / n^2 = -2.179 \times 10^{-18}$ J / n^2
                                                         $KE = \frac{1}{2}mu^2$

Nernst Equation:

$$E = E° - \frac{RT}{zF}\ln Q \quad = E° - \frac{0.0257 \text{ V}}{z}\ln Q \quad = E° - \frac{0.0592 \text{ V}}{z}\log_{10} Q$$

Entropy change: $\Delta S = \dfrac{q_{rev}}{T}$

Solubility Guidelines for Common Ionic Solids

Follow the lower-numbered guideline when two guidelines are in conflict. This leads to the correct prediction in most cases.

1. Salts of group 1 cations and the NH_4^+ cation are soluble . Except LiF and Li_2CO_3 which are insoluble.
2. Nitrates, acetates, bicarbonates, and perchlorates are soluble.
3. Salts of silver, lead and mercury (I) are insoluble. Except AgF which is soluble.
4. Fluorides, chlorides, bromides, and iodides are soluble. Except Group 2 fluorides which are insoluble
5. Carbonates, phosphates, chromates, sulfides, oxides, and hydroxides are insoluble. Except Group 2 sulfides and hydroxides of Ca^{2+}, Sr^{2+}, and Ba^{2+} which are soluble.).
6. Sulfates are soluble except for those of calcium, strontium, and barium.

PERIODIC TABLE OF THE ELEMENTS

Atomic weights are based on $^{12}C = 12$ and conform to the 1987 IUPAC report values rounded to 5 significant digits. Numbers in [ ] indicate the most stable isotope.

— Transition Metals —

* Lanthanides

** Actinides