Name: _____   Student number: _____

Chemistry 1E03   **Term Test**   **Sept. 30, 2016**

McMaster University   *VERSION 1*

Instructors: Drs. P. Britz-McKibbin, R.S. Dumont, P. Kruse & L. Davis

Duration: 90 minutes

This test contains 14 numbered pages printed on both sides. There are **20** multiple-choice questions appearing on pages numbered 3 to 10. Pages 11 and 12 provide extra space for rough work. Page 13 includes some useful data and equations, and there is a periodic table on page 14. You may tear off the last pages 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** additional penalty for incorrect answers.

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

<u>ANSWER ALL QUESTIONS</u> ON THE ANSWER SHEET, IN PENCIL.
Instructions for entering multiple-choice answers are given on page 2.
SELECT <u>ONE AND ONLY ONE</u> 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 FX 991 electronic calculators may be used; but they must NOT be transferred between students. Use of periodic tables or 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 EXAMINIATION 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, **exam version number** in the space provided and fill in the corresponding bubble numbers underneath.

3. 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.

4. Pay particular attention to the Marking+ Directions on the form.

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

1. Which of the following statements are **TRUE**?

(i)   1 mole of KNO_3 has a larger mass than 1 mole of $NaNO_3$.

(ii)   10 L of N_2 has lower mass than 9 L of F_2, if both gases are at 300 K and 1 bar pressure.

(iii)   10 g of gold has more atoms than 10 g of lead.

A)   i, ii, iii
B)   i, iii
C)   i
D)   ii
E)   ii, iii

2. How many **moles of ions** – both cations and anions – are present in solution when 0.75 mol of calcium chloride is dissolved in 0.25 L of distilled water?

A)   0.75
B)   3.00
C)   1.50
D)   0.80
E)   2.25

3. What is the **correct chemical formula** for potassium hydrogen sulfite?

A) $KHSO_4$
B) $KHSO_3$
C) K_2SO_3
D) K_2HSO_4
E) $PHSO_4$

4. One of the most potent carcinogens (found in air particulate, cigarette smoke and grilled food) is benzo[a]pyrene (molar mass = 252.30 g/mol). Combustion analysis finds that it is 95.21 mass % C and 4.79 mass % H. Which is the **correct molecular formula**?

A) $C_{19}H_{18}$
B) $C_{22}H_{16}$
C) $C_{20}H_{14}$
D) $C_{18}H_{12}$
E) $C_{20}H_{12}$

5. The anion $^{33}S^-$ contains

A)   17 neutrons, 16 protons, 17 electrons
B)   16 neutrons, 17 protons, 18 electrons
C)   17 neutrons, 17 protons, 16 electrons
D)   33 neutrons, 16 protons, 17 electrons
E)   33 neutrons, 17 protons, 18 electrons

6. A sample weighing 0.6760 g that contains an unknown amount of Ba^{2+} ions was completely dissolved in water and treated with an excess of sodium sulfate, Na_2SO_4. A precipitate of $BaSO_4$ formed which was dried and weighed, yielding 0.4105 g. What is the **mass percentage** of barium in the original sample?

A)   58.83
B)   24.15
C)   35.73
D)   69.78
E)   39.77

7. What is the correct **ordering** of the following elements, according to **increasing atomic radius**?   Rb, Ne, Sr, Si, Ge, N

A)   Ne < N < Si < Ge < Sr < Rb
B)   Ne < N < Ge < Si < Sr < Rb
C)   Ne < Sr < Si < Rb < N < Ge
D)   N < Ne < Si < Ge < Rb < Sr
E)   N < Ne < Ge < Si < Rb < Sr

8. Which of the following orderings are **CORRECT**, according to **increasing ionic** or **atomic radius**?

(i) $Rb^+ < Sr^{2+} < Se^{2-} < Br^-$

(ii) $N^- < N^{2-} < N^{3-}$

(iii)   Cl < As < Se < In

A)   ii, iii
B)   i, iii
C)   i, ii
D)   i, ii, iii
E)   ii

9. Which of the following statements are **TRUE**?

(i)   The first ionization energy of nitrogen is higher than that of oxygen.

(ii)   The first ionization energy of oxygen is higher than that of fluorine.

(iii) $Be(g) + e^- \rightarrow Be^-(g)$ has a positive change in energy.

(iv) $O(g) + e^- \rightarrow O^-(g)$ has a positive change in energy.

A)   i, iii
B)   i, ii
C)   ii, iii, iv
D)   i, ii, iv
E)   ii, iv

10. Which of the following orderings is/are **CORRECT**, according to **increasing magnitude of electron affinity**?

(i)   Si < S < Cl

(ii)   Ge < As < Br

(iii)   Ca < K < Ge

A)   ii, iii
B)   i, ii
C)   ii
D)   i, ii, iii
E)   i, iii

11. Which of the following statements are **TRUE**?

(i) CO_2 is a more acidic oxide than N_2O_5 .

(ii)   As is more electronegative than Ge.

(iii)   BaO is a basic oxide.

A)   i, ii, iii
B)   i, ii
C)   ii
D)   ii, iii
E)   i, iii

12. Which of the following statements are **TRUE**?

(i)   Second ionization energy (I_2) is greater than first ionization energy (I_1), for all elements.

(ii)   Lithium (Li) has a higher second ionization energy than berylium (Be).

(iii)   All ionization energies are positive.

A)   i, ii
B)   i, ii, iii
C)   ii
D)   ii, iii
E)   i, iii

13. Which one of the following statements is **FALSE**?

A)   The ground state electron configuration of an oxygen atom has two unpaired
         electrons.
B) O^{2-} is larger than F^-.
C)   Be has a larger ionization energy than Li.
D)   Al has a larger ionization energy than B.
E)   Be is smaller than Li.

14. A sample of hydrogen atoms have their electrons excited to various energy levels; this is followed by emission of light. Which one of the following emission transitions produces a photon with the **shortest wavelength**?

A) $n = 2 \rightarrow n = 1$
B) $n = 3 \rightarrow n = 2$
C) $n = 7 \rightarrow n = 6$
D) $n = 5 \rightarrow n = 2$
E) $n = 7 \rightarrow n = 1$

15. Which one of the following represents the electron configuration of an **excited oxygen atom**?

A) $1s^2\, 2s^2\, 2p^3\, 3s^1$
B) $1s^2\, 2s^2\, 2p^5$
C) $1s^2\, 2s^2\, 2p^4$
D) $1s^2\, 2s^1\, 2p^3\, 3s^1$
E) $1s^2\, 2s^0\, 2p^3\, 3s^2$

16. A detector receives a signal consisting of green light, with a wavelength of 540 nm. The total energy of the signal is 2.50×10^{-14} J. **How many photons** were in the signal?

A) 1.48×10^4
B) 6.80×10^7
C) 6.80×10^4
D) 2.10×10^{-5}
E) 1.48×10^7

17. Identify the **FALSE** statement(s):
    (i) (3, 2 , −1, −1/2) is an allowed set of (n, ℓ, $m_ℓ$, m_s) quantum numbers for a **3p** electron.
    (ii) The ground-state electron configuration of the sulfide anion (S^{2-}) has two **unpaired** electrons.
    (iii) On average, a 3p electron is **further away** from the nucleus than a 3s electron.
    (iv) The ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$) electron configuration represents the ground state of the **Si⁺ cation**.
    (v) An iron atom in its ground state is **paramagnetic** – i.e., it has unpaired electrons.

                                              _____

A)   i, iv
B)   i, ii
C)   ii, iii
D)   iv, v
E)   v

18. It takes 492 kJ of energy to remove one mole of electrons from the atoms on the surface of solid gold. What is the **maximum wavelength (in nm)** of light capable of doing this?

A)   123
B)   243
C)   404
D)   743
E)   817

19. What is the **maximum number of electrons** that can be associated with the set of quantum numbers n = 3, ℓ = 2, m_ℓ = −2?

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

20. From the Cl-Cl bond energy (243 kJ mol^{-1}), calculate the **minimum frequency** of light (in Hz or s^{-1}) which will dissociate a Cl_2 molecule into Cl atoms.

A) 3.67×10^{38}
B) 7.63×10^{-38}
C) 9.06×10^{15}
D) -5.62×10^{-19}
E) 6.09×10^{14}

Name: _____   Student number: _____

Extra space for rough work:

Name: _____   Student number: _____

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.**

R = 8.3145 J K^{-1} mol^{-1} = 0.08206 L atm K^{-1} mol^{-1}

N_A = 6.022×10^{23} mol^{-1}

c = 2.9979×10^8 m s^{-1}

h = 6.6256×10^{-34} Js

m_e = 9.10×10^{-31} kg

1 bar = 100.0 kPa

$0°C$ = 273.15 K

1 J = 1 kg m^2 s^{-2} = 1 kPa L = 1 Pa m^3

1 m = 10^9 nm = 10^{10} Å

1 cm^3 = 1 mL

1 g = 10^3 mg

1 Hz = 1 cycle/s

De Broglie wavelength:

$\lambda = h / mv = h / p$

Hydrogen atom energy levels:

$E_n = -R_H / n^2 = -2.178 \times 10^{-18}$ J $/ n^2$

PERIODIC TABLE OF THE ELEMENTS