



THOMPSON RIVERS  
UNIVERSITY  
KAMLOOPS, BC

# UCC Chemistry Contest

## Chemistry 11

May 21, 2003 Time: 60 minutes

Please follow the instructions below. We will send your teacher a report on your performance. Top performers are eligible for prizes.

The contest consists of 25 multiple choice questions. You have 60 minutes to complete the test. All questions are of equal value, there is no particular order to the questions and there is no penalty for incorrect answers.

Please answer on the Scantron Answer Sheet. In the **top right hand corner** of the answer sheet, please print the following information:

**Your name (last name, first name),  
your school,  
your teacher**

Indicate your answer on the Scantron answer sheet by marking one choice beside the question number. Mark only one answer for each question with a firm pencil mark, just filling the selected answer box. If you change your answer, be sure to erase completely your previous answer.

**Additional material:** The last page of the test contains a Periodic Table. The value of Avagadro's number is  $6.022 \times 10^{23}$ . Any other useful information is included in the question. You will require a calculator.

1. Hydrogen has three isotopes ( $^1\text{H}$ ,  $^2\text{H}$ ,  $^3\text{H}$ ) and chlorine has two isotopes ( $^{35}\text{Cl}$ ,  $^{37}\text{Cl}$ ). How many isotopic combinations of hydrogen chloride molecules are there?
- (a) one  
(b) three  
(c) five  
→ (d) **six**
2. What is the final concentration in a solution prepared by mixing 500.0 mL of a 0.600 M glucose solution with 300.0 mL of a 0.400 M glucose solution. Assume that the volumes of the two solutions are additive.
- (a) **0.525 M**  
(b) 0.225 M  
(c) 0.840 M  
(d) 0.375 M
3. A 43.20 mL sample of 0.3260M sodium hydroxide (NaOH) is required to react completely with 36.70 mL of a phosphoric acid ( $\text{H}_3\text{PO}_4$ ) solution. What is the molarity of the phosphoric acid solution?
- (a) 0.3836 M  
→ (b) **0.1279 M**  
(c) 0.09231 M  
(d) 0.1918 M
4. A garden fertilizer is labeled with the code 10 11 14. This code describes the chemical composition and represents the **mass ratio** of the elements N, P and K in the fertilizer. If a chemist gardener wishes to know the composition as a **mole ratio** of N, P and K, this could be represented as:
- (a) 14 11 10  
(b) 8 19 11  
(c) 14 28 10  
→ (d) **20 10 10**

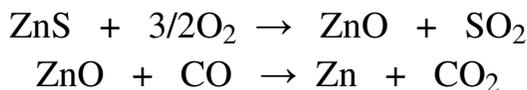
5. Cryolite ( $\text{Na}_3\text{AlF}_6$ ) is used in the production of aluminum from its ores and is made by the reaction



The coefficients for NaOH and cryolite, respectively, in the balanced equation are:

- (a) **6, 2**  
(b) 1, 2  
(c) 2, 1  
(d) 9, 12

6. The sulfide ore of zinc ( $\text{ZnS}$ ) is converted to elemental zinc by “roasting” it (heating it in air) and then heating the  $\text{ZnO}$  produced with carbon monoxide. The two reactions may be written as:



The amount of product actually formed in a reaction divided by the amount theoretically possible and multiplied by 100 is known as the reaction’s percent yield. If we began with 5.32 g of  $\text{ZnS}$  and produced 3.30 g of pure  $\text{Zn}$ , what is the percent yield for the overall process?

[Molar Mass  $\text{ZnS} = 97.46 \text{ g mol}^{-1}$ ]

- (a) 108%  
(b) **92.4%**  
(c) 46.2%  
(d) 61.6%

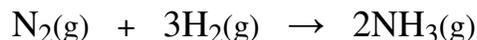
7. Which of the following describes a chemical property?

- (a) the density of gold is  $19.3 \text{ g mL}^{-1}$   
(b) a particular type of steel is very hard and consists of 95% iron, 4% carbon and 1% miscellaneous other elements  
(c) the helium inside a balloon tends to leak out after several hours  
→ (d) **refrigeration slows the rate at which fruit ripens**

8. “Kamloopsium”, a previously unknown element recently discovered by researchers at UCC, has been found to contain two isotopes,  $^{79}\text{Ka}$  and  $^{81}\text{Ka}$ , in 30.54% and 69.46% natural abundance, respectively. The masses of the two isotopes are  $78.92\text{ g mol}^{-1}$  and  $80.92\text{ g mol}^{-1}$ , respectively. The molar mass of a naturally occurring sample of “Kamloopsium” is:
- (a)  $80.00\text{ g mol}^{-1}$
  - (b)  $79.92\text{ g mol}^{-1}$
  - (c)  $79.53\text{ g mol}^{-1}$
  - (d)  **$80.31\text{ g mol}^{-1}$**
9. Which of the following statements contain **no** errors or ambiguities?
- (a) the molar mass of  $\text{H}_2\text{O}$  is 18.01
  - (b) a mole of water contains  $6.022 \times 10^{23}$  atoms
  - (c) **the mass of a mole of  $^{12}\text{C}$  atoms is exactly 12.0000 g**
  - (d)  $\text{CH}_4$  is a polyatomic ion
10. How many grams of chromium are contained in 35.8 g of  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ ?
- [Molar Mass  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 = 252.0\text{ g mol}^{-1}$ ]
- (a) 35.8 g
  - (b) **14.8 g**
  - (c) 7.39 g
  - (d) 3.70 g
11. Caproic acid is the compound responsible for the aroma of dirty gym socks and running shoes. A combustion analysis led to the empirical formula  $\text{C}_3\text{H}_6\text{O}$ . In a separate experiment, a 2.32 g sample of caproic acid was found to contain 0.0200 moles. What is the molecular formula of caproic acid?
- (a)  $\text{C}_3\text{H}_6\text{O}$
  - (b)  **$\text{C}_6\text{H}_{12}\text{O}_2$**
  - (c)  $\text{C}_9\text{H}_{18}\text{O}_3$
  - (d)  $\text{C}_{12}\text{H}_{24}\text{O}_4$

12. An empty sample vial weighs 55.32 g. When filled with mercury ( $d = 13.53 \text{ g mL}^{-1}$ ), the vial weighs 185.56 g. How much would the vial weigh if it was filled with water ( $d = 0.997 \text{ g mL}^{-1}$ )?
- (a) **64.92 g**  
(b) 9.60 g  
(c) 130.24 g  
(d) 59.66 g
13. A 230.0 mL sample of a 0.275M aqueous  $\text{CaCl}_2$  solution is left on a bench overnight; 57.5 mL of water evaporates overnight. What is the molarity of the  $\text{CaCl}_2$  solution the next morning?
- (a) 0.220 M  
(b) 1.10 M  
→ (c) **0.367 M**  
(d) 0.275 M
14. A chemist determined in a set of four experiments that the density of magnesium metal was:  $1.68 \text{ g mL}^{-1}$ ,  $1.67 \text{ g mL}^{-1}$ ,  $1.69 \text{ g mL}^{-1}$  and  $1.69 \text{ g mL}^{-1}$ . The accepted value for its density is  $1.84 \text{ g mL}^{-1}$ . Which of the following best describes the chemist's data?
- (a) good accuracy and good precision  
(b) good accuracy and poor precision  
(c) poor accuracy and poor precision  
→ (d) **poor accuracy and good precision**
15. Which of the following solutions will have the **lowest** concentration of bromide ions?
- (a) 0.20M  $\text{AlBr}_3$   
(b) 0.20M  $\text{CaBr}_2$   
→ (c) **0.35M NaBr**  
(d) all solutions have the same bromide ion concentration

16. Ammonia (NH<sub>3</sub>) is synthesized industrially by the following reaction:



Assuming complete reaction, if you have 1.39 mol N<sub>2</sub> and 3.44 mol H<sub>2</sub>, how many moles of which reactant will be left over?

- (a) 2.05 mol of N<sub>2</sub>
- (b) 2.05 mol of H<sub>2</sub>
- (c) **0.24 mol of N<sub>2</sub>**
- (d) 1.15 mol of H<sub>2</sub>

17. The total number of valence electrons present in the tetrafluoroborate anion, BF<sub>4</sub><sup>-</sup>, is:

- (a) **32**
- (b) 31
- (c) 26
- (d) 24

18. You take a breath and inhale  $1.16 \times 10^{22}$  molecules of air, a mixture of several substances. Assume that the effective molar mass of air is 29.0 g mol<sup>-1</sup>. What is the mass of air that you inhaled?

- (a) 151 g
- (b) 5.59 g
- (c) **0.560 g**
- (d) 2.46 g

19. Ascorbic acid is an essential vitamin and is composed of (by mass) 40.92% C, 4.58% H and the remainder is oxygen. What is the empirical formula of Vitamin C?

- (a) **C<sub>3</sub>H<sub>4</sub>O<sub>3</sub>**
- (b) C<sub>2</sub>H<sub>4</sub>O<sub>3</sub>
- (c) C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>
- (d) C<sub>6</sub>H<sub>8</sub>O<sub>6</sub>

20. The following table lists the names and corresponding formulae of a number of compounds. Some lines in the table contain errors.

i	cobalt(II) chloride	$\text{Co}_2\text{Cl}$
ii	dinitrogen tetroxide	$\text{N}_2\text{O}_4$
iii	dipotassium permanganate	$\text{K}_2\text{MnO}_4$
iv	chromium(III) carbonate	$\text{Cr}_2(\text{CO}_3)_3$
v	sodium chlorate	$\text{NaClO}_3$
vi	hydrobromic acid	$\text{HBr}(\text{aq})$

The lines which are **completely correct** are:

- (a) i, iii, iv, vi
- (b) ii, iii, v, vi
- (c) i, iii, v, vi
- (d) **ii, iv, v, vi**

21. The condensed electronic configuration  $[\text{He}] 2s^2 2p^3$  represents the arrangement of electrons in the:

- (a) fluoride anion
- (b) oxide anion
- (c) carbon atom
- (d) **nitrogen atom**

22. Which of the following describes a heterogeneous mixture?

- (a) two substances present, one phase present
- (b) one substance present, two phases present
- (c) one substance present, one phase present
- (d) **two substances present, two phases present**

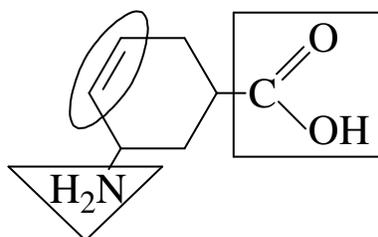
23. The elements N and P are located in Group 5A (15) of the Periodic Table because:

- (a) they both form acidic oxides
- (b) they both form hydrides with the formula  $\text{EH}_3$
- (c) **they both have five valence electrons**
- (d) they are both non-metals

24. Halons are compounds containing carbon, fluorine, chlorine and bromine that were once used in some fire extinguishers. The percent fluorine by mass of the halon  $\text{CF}_2\text{ClBr}$  is:

- (a) **22.98%**  
(b) 11.49%  
(c) 12.98%  
(d) 36.44%

25. The selected functional groups in the following molecule are:



- (a) alkyne, ketone, amine  
→ (b) **amine, alkene, carboxylic acid**  
(c) alkene, amine, ester  
(d) aldehyde, alkene, amine

The End

**Periodic Table**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A
1 <b>H</b> 1.008																	2 <b>He</b> 4.003
3 <b>Li</b> 6.941	4 <b>Be</b> 9.012											5 <b>B</b> 10.81	6 <b>C</b> 12.011	7 <b>N</b> 14.007	8 <b>O</b> 15.999	9 <b>F</b> 18.998	10 <b>Ne</b> 20.179
11 <b>Na</b> 22.99	12 <b>Mg</b> 24.305											13 <b>Al</b> 26.982	14 <b>Si</b> 28.086	15 <b>P</b> 30.974	16 <b>S</b> 32.066	17 <b>Cl</b> 35.453	18 <b>Ar</b> 39.948
19 <b>K</b> 39.098	20 <b>Ca</b> 40.078	21 <b>Sc</b> 44.956	22 <b>Ti</b> 47.88	23 <b>V</b> 50.942	24 <b>Cr</b> 51.996	25 <b>Mn</b> 54.938	26 <b>Fe</b> 55.847	27 <b>Co</b> 58.93	28 <b>Ni</b> 58.69	29 <b>Cu</b> 63.546	30 <b>Zn</b> 65.39	31 <b>Ga</b> 69.72	32 <b>Ge</b> 72.61	33 <b>As</b> 74.9216	34 <b>Se</b> 78.96	35 <b>Br</b> 79.904	36 <b>Kr</b> 83.80
37 <b>Rb</b> 85.468	38 <b>Sr</b> 87.62	39 <b>Y</b> 88.906	40 <b>Zr</b> 91.224	41 <b>Nb</b> 92.906	42 <b>Mo</b> 95.94	43 <b>Tc</b> (98)	44 <b>Ru</b> 101.07	45 <b>Rh</b> 102.9	46 <b>Pd</b> 106.42	47 <b>Ag</b> 107.87	48 <b>Cd</b> 112.41	49 <b>In</b> 114.82	50 <b>Sn</b> 118.71	51 <b>Sb</b> 121.76	52 <b>Te</b> 127.60	53 <b>I</b> 126.90	54 <b>Xe</b> 131.29
55 <b>Cs</b> 132.91	56 <b>Ba</b> 137.33	57 <b>La*</b> 138.91	72 <b>Hf</b> 178.49	73 <b>Ta</b> 180.95	74 <b>W</b> 183.85	75 <b>Re</b> 186.21	76 <b>Os</b> 190.2	77 <b>Ir</b> 192.2	78 <b>Pt</b> 195.08	79 <b>Au</b> 196.97	80 <b>Hg</b> 200.59	81 <b>Tl</b> 204.38	82 <b>Pb</b> 207.2	83 <b>Bi</b> 208.98	84 <b>Po</b> (209)	85 <b>At</b> (210)	86 <b>Rn</b> (222)
87 <b>Fr</b> (223)	88 <b>Ra</b> 226.03	89 <b>Ac**</b> 227.03	104 <b>Rf</b> (261)	105 <b>Db</b> (262)	106 <b>Sg</b> (263)	107 <b>Bh</b> (262)	108 <b>Hs</b> (265)	109 <b>Mt</b> (266)									
		*	58 <b>Ce</b> 140.12	59 <b>Pr</b> 140.91	60 <b>Nd</b> 144.24	61 <b>Pm</b> (145)	62 <b>Sm</b> 150.36	63 <b>Eu</b> 151.96	64 <b>Gd</b> 157.25	65 <b>Tb</b> 158.93	66 <b>Dy</b> 162.50	67 <b>Ho</b> 164.93	68 <b>Er</b> 167.26	69 <b>Tm</b> 168.93	70 <b>Yb</b> 173.04	71 <b>Lu</b> 174.97	
		**	90 <b>Th</b> 232.04	91 <b>Pa</b> 231.04	92 <b>U</b> 238.03	93 <b>Np</b> 237.05	94 <b>Pu</b> (244)	95 <b>Am</b> (243)	96 <b>Cm</b> (247)	97 <b>Bk</b> (247)	98 <b>Cf</b> (251)	99 <b>Es</b> (252)	100 <b>Fm</b> (257)	101 <b>Md</b> (258)	102 <b>No</b> (259)	103 <b>Lr</b> (260)	