



THOMPSON RIVERS
UNIVERSITY
KAMLOOPS, BC

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TRU Chemistry Contest

Chemistry 11 Answers

May 16, 2007 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 **clearly 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, to fill the selected answer box. If you change your answer, be sure to completely erase your previous answer.

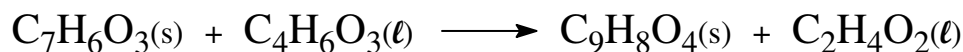
Additional material: The last page of the test contains a Periodic Table and the value of Avogadro's number. Any other useful information is included in the question.

Programmable calculators are not permitted

1. What volume of a 12.0 M stock solution of HCl(aq) is required to prepare 250.0 mL of a 0.500 M HCl(aq) solution?

- (a) 2.44 mL
- (b) **10.4 mL**
- (c) 8.02 mL
- (d) 11.5 mL

2. Aspirin, C₉H₈O₄ (Molar Mass 180.2 g/mol), a drug used to relieve minor aches and pains, is prepared by the following reaction:



If you need to prepare 45.0 g of aspirin, and the yield for the reaction is 85.0%, how many grams of salicylic acid, C₇H₆O₃ (Molar Mass 138.1 g/mol) must you use?

- (a) 44.9 g
- (b) **40.6 g**
- (c) 36.4 g
- (d) 32.2 g

3. The electronic configuration 1s² 2s² 2p⁶ 3s² 3p⁶ represents the arrangement of the electrons in the:

- (a) **potassium cation**
- (b) chlorine atom
- (c) fluoride anion
- (d) potassium anion

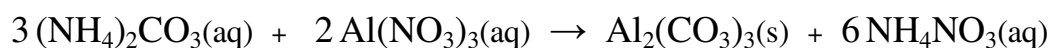
4. Which of the following describes a chemical change?

- (a) the evaporation of water from the Thompson rivers
- (b) the expansion of a helium balloon when heated
- (c) the melting of butter on mashed potatoes
- (d) **the rusting of iron**

5. If 25.0 mL of a 0.150 M standard sulfuric acid solution is required to completely neutralize a 10.0 mL solution of lithium hydroxide, what is the molarity of the basic solution?

- (a) 0.650 M
- (b) 0.375 M
- (c) 0.975 M
- (d) **0.750 M**

6. In the following reaction



what mass of aluminum carbonate (Molar Mass 204 g/mol) would precipitate if 2.50 g of ammonium carbonate (Molar Mass 86.1 g/mol) reacts completely?

- (a) 17.8 g
- (b) 5.92 g
- (c) **1.97 g**
- (d) 2.50 g

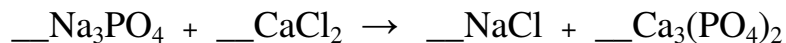
7. A chemistry student has taken a series of measurements for the mass of a block of metal. The separate measurements are: 100.3 g, 100.2 g, and 100.1 g. What is the precision of the measurement?

- (a) good to 1/10000
- (b) **good to 1/1000**
- (c) good to 1/100
- (d) good to 1/10

8. Aluminum oxide is an ionic compound. Calculate the number of aluminum ions (Al^{3+}) and oxide ions (O^{2-}) that are in a 51 g sample of aluminum oxide?

- (a) **6.0×10^{23} Al^{3+} ions and 9.0×10^{23} O^{2-} ions**
- (b) 3.0×10^{23} Al^{3+} ions and 2.0×10^{23} O^{2-} ions
- (c) 9.0×10^{23} Al^{3+} ions and 6.0×10^{23} O^{2-} ions
- (d) 3.0×10^{23} Al^{3+} ions and 4.0×10^{23} O^{2-} ions

9. Calcium phosphate, $\text{Ca}_3(\text{PO}_4)_2$, occurs naturally and can be made by the following reaction:



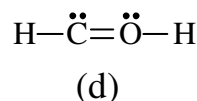
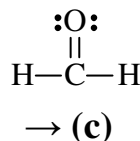
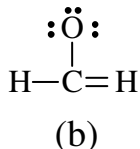
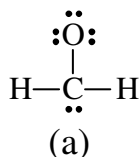
The coefficients for Na_3PO_4 and $\text{Ca}_3(\text{PO}_4)_2$, respectively, in the balanced equation, are:

- (a) 6, 3
(b) 1, 2
(c) 3, 6
→ **(d) 2, 1**
10. Dimethylhydrazine, the fuel used in rocket propulsion systems, is made of carbon, hydrogen and nitrogen atoms. A 2.859 g sample of the compound is burned in excess air, and it produces 4.190 g of carbon dioxide and 3.428 g of water. What is the empirical formula? (Molar Masses: $\text{CO}_2 = 44.01 \text{ g/mol}$; $\text{H}_2\text{O} = 18.02 \text{ g/mol}$)
- (a) $\text{C}_2\text{H}_4\text{N}$
(b) CH_4N_2
(c) $\text{C}_4\text{H}_2\text{N}_2$
→ **(d) CH_4N**
11. How many single covalent bonds must a silicon atom form in order to have a complete octet in its valence shell?
- **(a) 4**
(b) 3
(c) 2
(d) 1
12. A 15% by mass solution has a density of 1.2 g/mL. What is the mass per liter concentration of this solution?
- **(a) 180 g/L**
(b) 150 g/L
(c) 125 g/L
(d) cannot be determined from this information

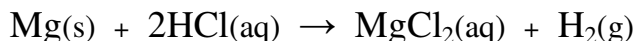
13. Naturally occurring copper (Cu) consists of two isotopes and has an atomic mass of 63.56 g/mol. One of the isotopes has a mass of 62.93 g mol⁻¹ and an abundance of 69.09%. What is the atomic mass of the other isotope?

- (a) 63.56 g/mol
- (b) 66.93 g/mo
- (c) 62.12 g/mol
- (d) **64.96 g/mol**

14. Formaldehyde, H₂CO, is a gas with a pungent smell and is used to preserve biological specimens. Which of the following structures represents the correct Lewis structure for formaldehyde?



15. A chemist reacts 3.012 g of Mg metal with 50.0 mL of 3.00 M HCl(aq) to produce hydrogen gas. Assuming the reaction goes to completion, how many moles of which reactant will be left over?



- (a) 0.049 mol of HCl
- (b) **0.049 mol of Mg**
- (c) 0.0026 mol of Mg
- (d) 0.0026 mol of HCl

16. Identify the type of bonding you would expect in the following:

(i) Ni(s), (ii) MgO(s), (iii) HCl(g)

- (a) (i) metallic, (ii) covalent, (iii) ionic
- (b) (i) ionic, (ii) covalent, (iii) metallic
- (c) (i) covalent, (ii) metallic, (iii) ionic
- (d) **(i) metallic, (ii) ionic, (iii) covalent**

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

i	lead(II) carbonate	PbCO ₃
ii	nickel(III) sulfide	Ni ₃ S ₂
iii	beryllium chlorate	Be(ClO ₃) ₂
iv	diphosphorous trioxide	P ₂ O ₃
v	barium hydroxide octahydrate	Ba(OH)·8H ₂ O
vi	gold(I) hypochlorite	AuClO

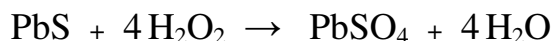
The lines which are **completely correct** are:

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

18. A compound is found to have the following percentage composition by mass: 30.57% carbon, 3.83 % hydrogen, 45.22% chlorine, 20.38% oxygen. Based on a molar mass of 157.0 g, what is the molecular formula of this compound?

- (a) C₆H₆Cl₂O
(b) C₅H₁₁Cl₂O
→ (c) **C₄H₆Cl₂O₂**
(d) C₄H₁₂ClO₄

19. The following reaction between lead sulfide and hydrogen peroxide is used to carefully clean oil paintings that have blackened due to the reaction of the lead-based paints with atmospheric hydrogen sulfide:



If a painting had originally been covered with 9.6 g of PbS and you had 3.0 g of H₂O₂, what percentage of the PbS could be removed from the painting?

- (a) **55 %**
(b) 100 %
(c) 84 %
(d) 45 %

20. What is the molar concentration of ethanol in a 5.0 % by volume mixture of ethanol in water? The density of pure ethanol is 0.78 g/mL and its molar mass is 46.08 g/mol.

- (a) **0.85 M**
(b) 0.94 M
(c) 0.77 M
(d) 0.71 M

21. Which of the following will have the highest solubility in water?

- (a) O₂
→ (b) **MgCl₂**
(c) Al
(d) C₃H₈

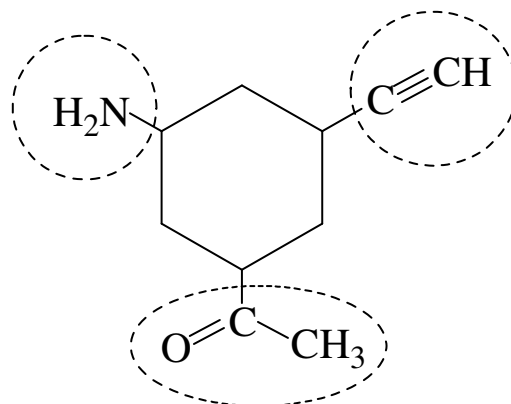
22. The Montreal Protocol effectively reduced the use of chlorofluorocarbons (CFCs) and manufacturers have developed hydrofluorocarbons (HFCs) as an alternative. HFC-134a is a popular one, with the formula C₂H₂F₄. The percent fluorine by mass in HFC-134a is:

- (a) 18.62 %
(b) 37.24 %
(c) 55.86 %
→ (d) **74.48 %**

23. The total number of valence electrons in one S₄O₆²⁻ ion is:

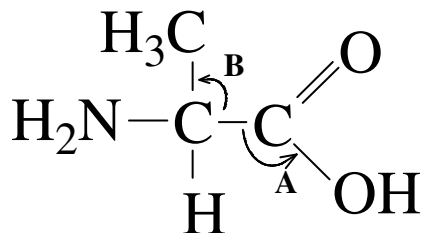
- (a) **62**
(b) 112
(c) 60
(d) 114

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



- (a) ketone, alkyne, amide
- (b) amine, alkene, ketone
- (c) alkyne, amide, ester
- (d) **alkyne, ketone, amine**

25. The approximate bond angles indicated by the labels **A** and **B** in the structure of the amino acid alanine



are:

- (a) $\text{A} = 90^\circ$ and $\text{B} = 180^\circ$
- (b) **$\text{A} = 120^\circ$ and $\text{B} = 109^\circ$**
- (c) $\text{A} = 109^\circ$ and $\text{B} = 109^\circ$
- (d) $\text{A} = 120^\circ$ and $\text{B} = 180^\circ$

The End

Data Page

Avogadro's Number = 6.022×10^{23} /mol

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3A	4A	5A	6A	7A	8A			1B	2B	3B	4B	5B	6B	7B	8B
1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.99	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.066	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	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	57 La* 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	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 (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac** 227.03	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									
		*	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	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	
		**	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	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)	