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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, $C_9H_8O_4$ (Molar Mass 180.2 g/mol), a drug used to relieve minor aches and pains, is prepared by the following reaction:

$$C_7H_6O_{3(s)} + C_4H_6O_{3(\ell)} \longrightarrow C_9H_8O_{4(s)} + C_2H_4O_{2(\ell)}$$
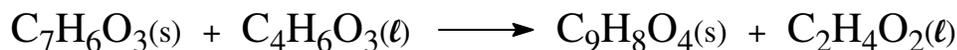
If you need to prepare 45.0 g of aspirin, and the yield for the reaction is 85.0%, how many grams of salicylic acid, $C_7H_6O_3$ (Molar Mass 138.1 g/mol) must you use?

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

3. The electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ 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

    $$3\,(NH_4)_2CO_3(aq) \;+\; 2\,Al(NO_3)_3(aq) \;\rightarrow\; Al_2(CO_3)_3(s) \;+\; 6\,NH_4NO_3(aq)$$
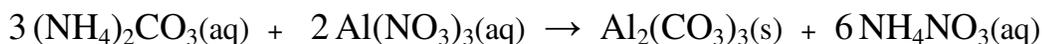
    what mass of aluminum carbonate (Molar Mass 204 g/mol) would precipitate if 2.50 g of ammonium carbonate (Molar Mass 86.1 g/mol) reacts completely?

    (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, $Ca_3(PO_4)_2$, occurs naturally and can made by the following reaction:

$$\_\_Na_3PO_4 \ + \ \_\_CaCl_2 \ \rightarrow \ \_\_NaCl \ + \ \_\_Ca_3(PO_4)_2$$
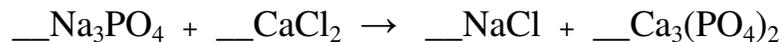
The coefficients for Na_3PO_4 and $Ca_3(PO_4)_2$, respectively, in the balanced equation, are:

(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: CO_2 = 44.01 g/mol; H_2O = 18.02 g/mol)

(a) C_2H_4N
(b) CH_4N_2
(c) $C_4H_2N_2$
→ **(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, H_2CO, 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?

$$\ddot{\text{O}}\colon \quad\quad :\ddot{\text{O}}: \quad\quad :\text{O}: \quad\quad$$

        :Ö: :Ö: :O:
        | || ||
H—C—H   H—C=H   H—C—H   H—C̈=Ö—H
    (a)   (b)   → **(c)**   (d)
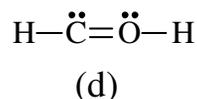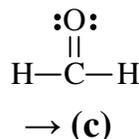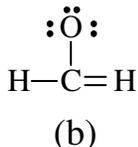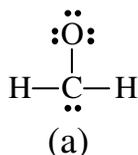
15. A chemist reacts 3.012 g of Mg metal with 50.0 mL of 3.00 M $HCl_{(aq)}$ to produce hydrogen gas. Assuming the reaction goes to completion, how many moles of which reactant will be left over?

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_2{(aq)} + H_2{(g)}$$
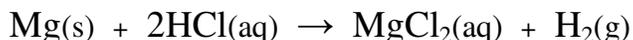
    (a) 0.049 mol of HCl
→ **(b) 0.049 mol of Mg**
    (c) 0.0026 mol of Mg
    (d) 0.0026 mol of HCl

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_3S_2
iii	beryllium chlorate	$Be(ClO_3)_2$
iv	diphosphorous trioxide	P_2O_3
v	barium hydroxide octahydrate	$Ba(OH) \cdot 8H_2O$
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) $C_6H_6Cl_2O$
(b) $C_5H_{11}Cl_2O$
→ **(c) $C_4H_6Cl_2O_2$**
(d) $C_4H_{12}ClO_4$

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:

$$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$$
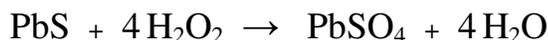
If a painting had originally been covered with 9.6 g of PbS and you had 3.0 g of H_2O_2, what percentage of the PbS could be removed from the painting?

→ **(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) O_2
→ **(b) $MgCl_2$**
   (c) Al
   (d) C_3H_8

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 $C_2H_2F_4$. 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 $S_4O_6^{2-}$ ion is:

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

24. The selected functional groups in the following molecule are:
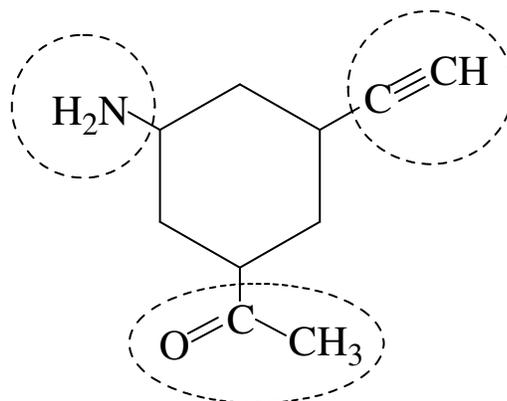
   (a) ketone, alkyne, amide
   (b) amine, alkene, ketone
   (c) alkyne, amide, ester
→ **(d) alkyne, ketone, amine**

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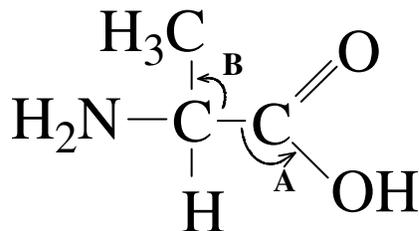
   are:

   (a) A = 90° and B = 180°
→ **(b) A = 120° and B = 109°**
   (c) A = 109° and B = 109°
   (d) A = 120° and B = 180°

The End

8

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)