Practice Test A3 Composition of Substances

Name_____Per_____

- ***Remember, this is practice - Do NOT cheat yourself of finding out what you are capable of doing. Be sure you follow the testing conditions outlined below.***
- ***DO NOT USE A CALCULATOR. AP Chem does NOT allow the use of a calculator for the MC part of the exam, so it is time to start practicing without one. You may use ONLY a periodic table.***
- ***While you should practice working as fast as possible, it is more important at this point in the course, that you practice without a calculator, even if it slows you down. Look for the "easy math" − common factors and rough estimation − do NOT do "long division" to try to get exact values. Remember it is a MC test, use the answers to help.***
- ***Mark which questions you would like to "go over." Send me an email with the prob #'s***

1. The simplest formula for a hydrocarbon that is 20.0 percent hydrogen by mass is
   a. CH
   b. CH_2
   c. CH_3
   d. C_2H_2
   e. C_2H_3

2. Which of the following represents the correct method for converting 11.0 g of copper metal to the equivalent number of copper atoms?
   a. $11\left(\frac{1}{63.55}\right)\left(\frac{6.02\times10^{23}}{1}\right)$
   b. $11\left(\frac{1}{63.55}\right)$
   c. $11\left(\frac{1}{63.55}\right)\left(\frac{63.55}{6.02\times10^{23}}\right)$
   d. $11\left(\frac{63.55}{1}\right)\left(\frac{6.02\times10^{23}}{1}\right)$
   e. $11\left(\frac{1}{63.55}\right)\left(\frac{1}{6.02\times10^{23}}\right)$

3. The mass of element X found in 1.00 mole of each of four different compounds is 28.0 g, 42.0 g, 56.0 g, and 70 g, respectively. The possible atomic weight of X is
   a. 8.00
   b. 14.0
   c. 28.0
   d. 38.0
   e. 42.0

4. In which of the following compounds is the mass ratio of element X to oxygen closest to 2.5 to 1? (The molar mass of X is 40.0 g/mol.)
   a. X_5O_2
   b. X_3O_2
   c. X_2O
   d. XO_2
   e. XO

5. Which of the following statements is false about $CaCO_3$?
   a. The molar mass of $CaCO_3$ is 100.1 g mol^{-1}.
   b. 50 g of $CaCO_3$ contains 9×10^{23} oxygen atoms.
   c. A 200 g sample of $CaCO_3$ contains 80 g of calcium.
   d. 25 g of $CaCO_3$ contains 0.25 mole of carbon atoms
   e. Oxygen makes up nearly 60% of the mass of this compound.

6. If 63 g of $H_2C_2O_4 \cdot 2H_2O$ were heated to drive off the water of hydration, how much anhydrous $H_2C_2O_4$ would remain?
   a. 18 g
   b. 27 g
   c. 36 g
   d. 45 g
   e. 61 g

7. How many H atoms are present in 1.8 g of $C_6H_{12}O_6$?
   a. 6.0×10^{23}
   b. 6.0×10^{21}
   c. 7.2×10^{21}
   d. 7.2×10^{22}
   e. 7.2×10^{23}

8. Determine the empirical formula when 1.04 g of chrome was burned in oxygen to produce 1.52 g of oxide product.
   a. CrO
   b. CrO_2
   c. Cr_2O_3
   d. Cr_2O
   e. Cr_3O_2

9. What is the approximate percentage of nitrogen by mass in ammonium phosphide?
   a. 3%
   b. 30%
   c. 50%
   d. 70%
   e. 85%

10. The number of moles of NH_3 molecules in 34.0 g of NH_3
    a. 1
    b. 2
    c. 3
    d. 5

11. The number of moles in 3.01×10^{24} atoms of carbon atoms
    a. 2
    b. 3
    c. 5
    d. 8

12. The number of moles of S atoms in 6.02×10^{23} molecules of S_8
    a. 1
    b. 2
    c. 5
    d. 8

13. Which of the following contain approximately 3.01×10^{23} particles
    a. 32.0 g of oxygen molecules
    b. 16.0 g of oxygen molecules
    c. 4.0 g of helium atoms
    d. 23 g of sodium atoms

14. Which of the following contain(s) the same number of atoms as 48.6 g of magnesium
    a. 56 g of nitrogen molecules
    b. 48.6 g of calcium atoms
    c. 4 moles of magnesium atoms
    d. 1.2×10^{24} atoms of carbon

15. All of the following quantities have a mass of 79.9 g EXCEPT
    a. 1 mole of bromine atoms
    b. 6.02×10^{23} bromine atoms
    c. 3.01×10^{23} Br_2 molecules
    d. 0.5 mole of bromine atoms

16. Which of the following choices contains 0.5 mole of sodium ions?
    a. 106 g sodium carbonate
    b. 53 g of sodium carbonate
    c. 26.5 g of sodium carbonate
    d. 3.0×10^{23} mole of sodium carbonate

17. If 1.5×10^{23} atoms of an unknown element have a mass of 12 g, what is the molar mass of the element closest to?
    a. 3.0 g mol^{-1}
    b. 12 g mol^{-1}
    c. 24 g mol^{-1}
    d. 48 g mol^{-1}

The next 3 questions refer to the following series of answer choices. They may be used once, more than once, or not at all.

a. CH_2
b. C_5H_{12}
c. CH_4
d. C_2H_6

18. Which represents the empirical formula for butene, which has the molecular formula C_4H_8?

19. Which represents the formula of a hydrocarbon which is 80% C by mass?

20. Which represents the formula in which there is 25% H by mass?

21. The mass percent of calcium chloride is closest to?
    a. 25% Ca and 75% Cl
    b. 40% Ca and 71% Cl
    c. 36% Ca and 64% Cl
    d. 66% Ca and 33% Cl

22. When iron is heated in the presence of fluorine gas, the product of the reaction was found to contain nearly 50% by mass of each element. What is the empirical formula of this compound?
    a. Fe_2F
    b. FeF_2
    c. FeF_3
    d. Fe_3F

23. In which of the following compounds is the mass ratio of molybdenum ($_{42}$Mo) to sulfur ($_{16}$S) closest to 1 to 1?
    a. Mo_2S
    b. MoS_2
    c. MoS_3
    d. Mo_2S_3

24. In which of the following compounds is the mass ratio of copper to oxygen closest to 2 to 1?
    a. CuO_2
    b. Cu_2O
    c. Cu_2O_3
    d. CuO_3

25. The mass of element X found in 1.00 mole of each of four different compounds is 24.0 g, 48.0 g, 60.0 g, and 72.0 g. A possible atomic weight of X is
    a. 72.0
    b. 48.0
    c. 24.0
    d. 12.0

26. When a hydrate of X_2CO_3 is heated until all the water is removed, it loses 46 percent of its mass.

    MM of anhydrate, X_2CO_3, is 106 g/mol

    The formula of the hydrate is
    a. $X_2CO_3 \cdot 10H_2O$
    b. $X_2CO_3 \cdot 7H_2O$
    c. $X_2CO_3 \cdot 5H_2O$
    d. $X_2CO_3 \cdot 3H_2O$

27. How many moles of hydrogen atoms are in 5.0 moles of aluminum acetate, $Al(C_2H_3O_2)_3$
    a. 9.0
    b. 15
    c. 30
    d. 45

28. If 1.5×10^{23} atoms of an unknown element have a mass of 12 g, what is the molar mass of the element closest to?
    a. 3.0 g mol^{-1}
    b. 12 g mol^{-1}
    c. 24 g mol^{-1}
    d. 48 g mol^{-1}

Practice Test A3 **Composition of Substances** ***ANSWERS***

1. c Again, it is important to know that a hydrocarbon is any compound made of just hydrogen and carbon. Probably the easiest way to work this problem would be to use the answers and calculate the mass ratio for the mass of H to the total mass of compound: CH is 1/13, CH_2 is 3/14, CH_3 is 3/15, C_2H_2 is 2/26, and C_2H_3 is 3/27.
The CH_3 compound: 3/15 should pop out as ⅕ which is of course 20%.

2. a Putting in the correct units, allows you to see the dimensional analysis will work.
$11g\left(\frac{1mol}{63.55g}\right)\left(\frac{6.02\times10^{23}atoms}{1mol}\right)=Cu\ atoms$, the actual value would be approximately 1×10^{23}, but the actual value is unimportant for this question.

3. b In any compound that contains some element X, the number of atoms of X will always be whole numbers 1, 2, 3, etc (since you can't have half an atom). Thus you must look for a factor that is common to each of the masses of X provided.

4. e Remember you can NOT use your calculator. Whether you like it or not, you've got to get used to it. Perhaps you need to practice your times tables?
In this problem, if the mass ratio is to be 2.5 X to 1 Oxygen, since the mass of oxygen is 16 calculate the mass for X that is 2.5 times greater than 16. This would be 40, which is the molar mass of X, thus the formula must be XO.

5. e (a) The molar mass is ~100: 40 + 12 + 2(16). (b) 50 g is 0.5 mol of $CaCO_3$ which is 3×10^{23} $CaCO_3$ units × 3 oxygen atoms per unit thus 9×10^{23} oxygen atoms. (c) 100 g of contains 40 g of Ca (see the molar mass calculation) thus 200 g must contain double the mass of calcium, 80 g. (d) 25 g is 0.25 mole, and there is only 1 carbon atom per $CaCO_3$, thus 0.25 mole of carbon atoms. (e) The oxygen in the compound is 48 g per molar mass which is much closer to 50% than 60%

6. d It would be best to add up the molar mass of this hydrate and find that the molar mass is 126 g/mol, thus 63 g is ½ mole. Thus when the water is removed, a ½ mole of the anhydrate will remain. Add the molar mass of $H_2C_2O_4$ to find out its molar mass is 90, thus a half mole or 45 g will remain.

7. d First this problem, it is important to add the molar mass of the glucose, $C_6H_{12}O_6$ to get 180 g/mol. Thus 1.8 g is 0.01 mole, which would be 6.0×10^{23} molecules, but we must go a step further and realize that there are 12 H atoms in each molecule, thus 12 × 6 is 72, giving us 7.2×10^{22} H atoms. All of this should be done WITHOUT a calculator. Formally the dimensional analysis would look like this: $1.8g\times\frac{1mol}{180g}\times\frac{6.0\times10^{23}molecules}{1mol}\times\frac{12H's}{1molecule}=7.2\times10^{22}H\ atoms$

8. c First it would be best to realize that 1.04 g of chromium which forms 1.25 g of chrome oxide, means that 0.48 g of oxygen have reacted. Since the molar mass of oxygen is 16, you should realize that this is 0.03 mol of oxygen, The molar mass of chromium is 52, thus 1.04 g is 0.02 mol of chromium, this means the mole ratio of Cr:O is 2:3, thus Cr_2O_3
Again, all of this should be done WITHOUT a calculator. If you are struggling to "see" the easy math, you may need help with your times tables. This is why I suggested on page one of the summer homework packet that you work with some online times tables games to get good at multiplication and division without a calculator.

9. c The first most important piece to this problem is your ability to write a correct chemical formula for ammonium phosphide, $(NH_4)_3P$. Then you should add the molar mass: 3(14) + 12(1) + 31 = 85. Then it should be obvious that the nitrogen is 42/85 which is approximately 50%

10. b The molar mass of NH_3 is 17 g mol^{-1}, thus 34 g is 2 moles of molecules.

11. c $3.01\times10^{24}\left(\frac{1mol}{6.02\times10^{23}atoms}\right)=0.5\times10^{1}mol=5mol$ Perhaps you need help with computations involving scientific notation?

12. d $6.02\times10^{23}S_8\times\frac{1mol}{6.02\times10^{23}molecules}\left(\frac{8Satoms}{1S_8molecules}\right)=8Satoms$

13. b In this problem should quickly recognize the the number of particles you are given is ½ mole. Since the molar mass of oxygen molecule, O_2 is 32 g mol^{-1}, 16 g would be 0.5 mole

14. d $48.6g\left(\frac{1mol}{24.3g}\right)=2mol$, thus we are looking for 2 moles of atoms. $1.2\times10^{24}\left(\frac{1mol}{6.02\times10^{23}atoms}\right)=2mol$. Perhaps you selected (a), but it is incorrect because while the molar mass of N_2 is 28 g, 56 g would be 2 mol of molecules, since it is a diatomic molecule, this would be 4 moles of atoms.

15. d Remember you are looking for the FALSE item. Br has a molar mass of 79.9, thus a half mol would be ~40 g making (d) false.

16. c It is important that you write the correct formula for sodium carbonate, Na_2CO_3 with a molar mass of 106 g mol^{-1}, thus for (c) the calculation below applies $26.5g\left(\frac{1mol}{106g}\right)=\sim\frac{1}{4}mol\times\frac{2Na}{1Na_2CO_3}=\frac{1}{2}$ mol Na atoms

17. d It is important to remember that molar mass is simply the mass divided by moles. $1.5\times10^{23}\left(\frac{1mol}{6.02\times10^{23}atoms}\right)=0.25mol$ and $\left(\frac{12g}{0.25mol}\right)=48g\bullet mol^{-1}$

18. a Empirical formula is the lowest whole number ratio.

19. d the carbon in C_2H_6 is $\left(\frac{24g}{30g}\right)=\frac{8}{10}=80\%$

20. c the H in CH_4 is $\left(\frac{4g}{16g}\right)=\frac{1}{4}=25\%$

21. c Learn to estimate without access to a calculator. $CaCl_2$, with a molar mass of 111, thus Ca is $\frac{40}{111}$ which is less than 40%, but certainly not as low as 25%

22. c Fe = ~56 g mol^{-1} and F = 19 g mol^{-1} thus 50% by mass would need to be 1 Fe (56) and 3 F (3×19 = 57)

23. c Mo = 96 g mol^{-1} S = 32 g mol^{-1} thus 3 sulfur for each Mo

24. a Cu = 64 g mol^{-1} O = 16 g mol^{-1} thus 2 O's to each Cu

25. d The molar mass must be a factor of all of the masses given, thus 12 is the only choice, if 6, 4, or 3 had been choices, they would work also, but they were not options.

26. c In this problem, you are looking for the water to be just under half of the total mass of the hydrate. Some quick calculations should lead you to this: $\left(\frac{5\times18}{(5\times18)+106}\right)=\left(\frac{90}{196}\right)=\ \sim50\%$

27. d $5molAl(C_2H_3O_2)_3\times\left(\frac{9H's}{1Al(C_2H_3O_2)}\right)=45H$

28. d Perhaps you have never seen the label g mol^{-1} ? Don't panic, this means g/mol or $\frac{g}{mol}$

It is important to remember that molar mass is simply the mass divided by moles. $1.5\times10^{23}\left(\frac{1mol}{6.02\times10^{23}atoms}\right)=0.25mol$ and $\left(\frac{12g}{0.25mol}\right)=48g\ mol^{-1}$