APPENDIX I: THE STOICHIOMETRY TEST INSTRUMENT

Only the first tier of each test items is presented in this Appendix. The second and third tiers for each item were identical to that shown in Figure 1. A periodic Table was provided as an attachment to the test.

Question 1

Given the equation $3A + B \rightarrow C + D$, if 4 moles of A reacted with 2 moles of B, which of the following is true?

a. The limiting reactant is the one with the higher molar mass.

b. A is the limiting reactant because you need 6 moles of A to react with 2 moles of B.

c. B is the limiting reactant because three A molecules react with every one B molecule.

d. B is the limiting reactant because there are only 2 moles of B available.

e. Neither reactant is limiting.

Question 2

A mole ratio is:

a. A fraction. b. A ratio. c. A conversion factor. d. All of the above.

e. Both a ratio and a conversion factor

Question 3

Given the following balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$, which of these is an **INCORRECT** mole ratio?

a. $\frac{3 \text{ moles } H_2}{1 \text{ mole } N_2}$

b. $\frac{2 \text{ moles } NH_3}{3 \text{ moles } H_2}$

c. $\frac{6 \text{ moles } NH_3}{3 \text{ moles } N_2}$

d. $\frac{1 \text{ mole } N_2}{3 \text{ moles } NH_3}$

Question 4

Balancing a chemical equation is achieved by:

a. setting the coefficients equal to one and adjusting subscripts in the formulas

b. adjusting the coefficients to the smallest possible whole number ratio

c. adjusting the number of elements produced

d. adjusting the formula of a compound.

e. writing in appropriate coefficients to ensure mass balance then adjusting the coefficients to the smallest possible whole number ratio.

Question 5

When the equation: $Cu_2O + CH_4 \rightarrow H_2O + Cu + CO_2$ is correctly balanced the coefficient in front of the formula for copper(I) oxide (Cu_2O) is:

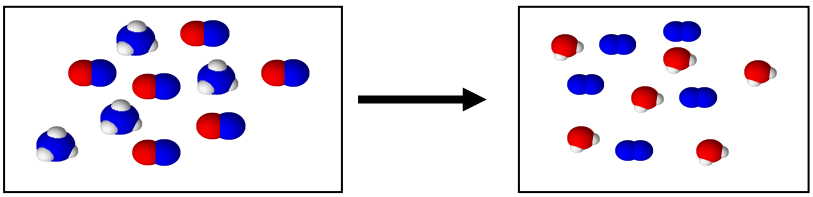
a. 1 b. 2 c. 3 d. 4 e. none of the above.

Question 6

Ammonia ( ) reacts with nitrogen monoxide ( ) to form nitrogen gas ( ) and water ( ).

Consider the mixture of ammonia and nitrogen monoxide in a closed container before (A) and after (B) the reaction has occurred. All reactants were used up during the reaction.

How many moles of each reactant were there if 13.7 moles of $N_2(g)$ is produced?



A B

a. 10.96 moles $NH_3(g)$ and 16.44 moles NO(g)

b. 2.74 moles $NH_3(g)$ and 16.44 moles NO(g)

c. 3.43 moles $NH_3(g)$ and 5.15 moles NO(g)

d. 54.8 moles $NH_3(g)$ and 82.2 moles NO(g)

Question 7

How many moles of methane (CH_4) are required to produce one mol of copper (Cu) by the reaction given in **question 5**?

a. 0.5 moles b. 1.0 moles c. 1.5 moles d. 0.25 moles e. 0.125 moles f. none of the above.

Question 8

Joseph Priestley discovered oxygen in the eighteenth century by using heat to decompose mercury(II) oxide:

$$2\ HgO(s) + heat \rightarrow 2\ Hg(s) + O_2(g)$$

What mass of mercury(II) oxide would be required to produce 100 g of O_2.

a. 100 g b. 200 g c. 627 g d. 677 g e. 1354 g f. 2700 g

Question 9

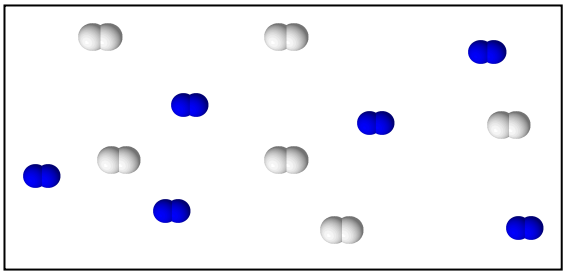
What mass of calcium carbonate ($CaCO_3$) is needed to react completely with 50.00 mL of 0.383 M sulfuric acid (H_2SO_4) according to the following balanced chemical equation?

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$$

a. 19.2 g b. 0.958 g c. 1.92 g d. 9.58 g e. 767 g f. 13.1 g

Question 10

Nitrogen (N_2) and hydrogen (H_2) react to form ammonia (NH_3). Consider the mixture of N_2 ( ) and H_2 ( ) in a closed container as illustrated below:



In your opinion, the chemical reaction **stops** when:

a. all the nitrogen is used up.

b. all the nitrogen and all the hydrogen are both totally used up.

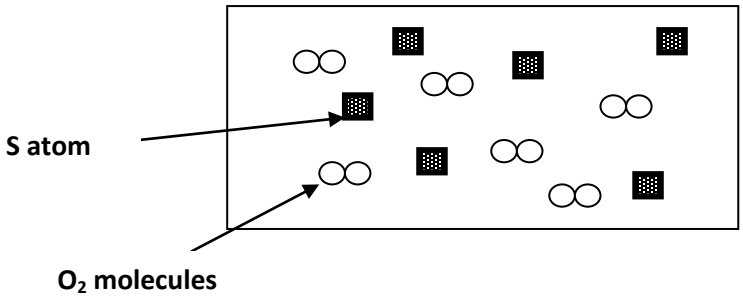
c. all the hydrogen is used up.

d. all the nitrogen or all the hydrogen is used up.

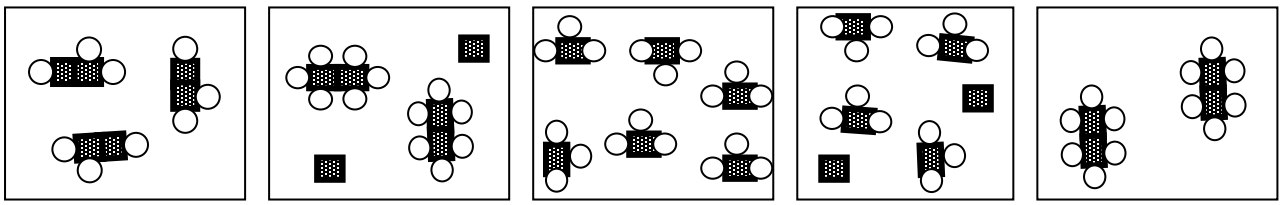
e. I do not know.

Question 11

The diagram represents a mixture of S atoms and O_2 molecules in a closed container.



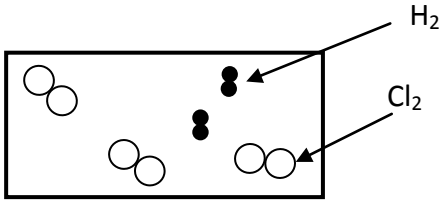
Which diagram shows the results after the mixture reacts as completely as possible according to the equation $2S + 3O_2 \rightarrow 2SO_3$. ?



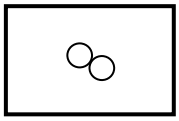
a. b. c. d. e.

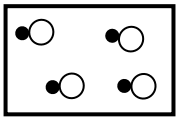
Question 12

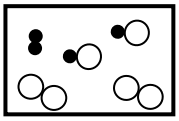
Here is a picture of a container with three Cl_2 molecules and two H_2 molecules. A chemical reaction occurs until the maximum amount of HCl has been produced. The reaction is $H_2 + Cl_2 \rightarrow 2\ HCl$

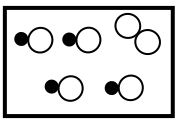


The picture of the container after the reaction looks like:

a. 

b. 

c. 

d. 

e. none of these

Question 13

Consider the following generic chemical reaction: $3A + 2B \rightarrow 4C$

How many moles of B would you need to react completely with 5 moles of A?

a. 1.2 b. 1.5 c. 2 d. 3.3 e. none of the above

Question 14

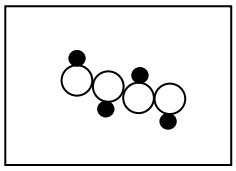
Hydrogen peroxide will decompose to form water and oxygen gas according to the following equation.

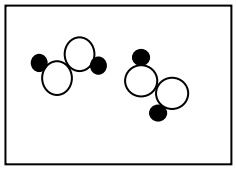
$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Hydrogen peroxide water oxygen

Use the following key for the diagrams: Oxygen ○ Hydrogen ●

Which diagram is the best representation of the hydrogen peroxide before it decomposes?


a.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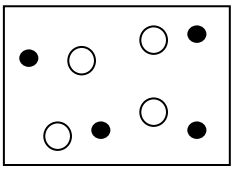
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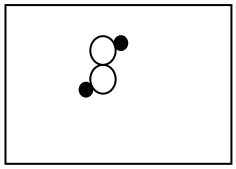
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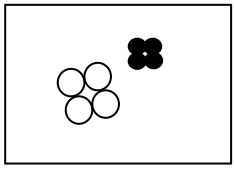

e.

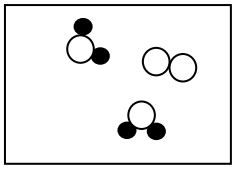
Question 15

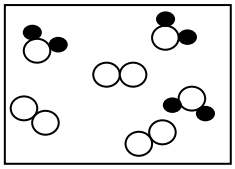
Hydrogen peroxide will decompose to form water and oxygen gas according to the following equation.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$
Hydrogen peroxide water oxygen

Use the following key for the diagrams: Oxygen ○ Hydrogen ●

Which diagram is the best representation of the products after hydrogen peroxide decomposes?


a.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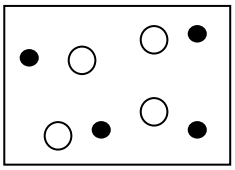
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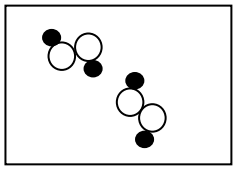
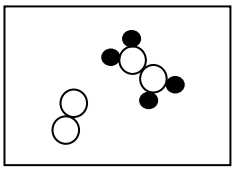

d.


e.

Question 16

Your body reacts sugar with oxygen to form carbon dioxide and water according to the following chemical equation.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$
Sugar oxygen carbon dioxide water

How many million oxygen atoms would be needed to react completely with one million sugar molecules?
a. 3 b. 6 c. 9 d. 12 e. none of the above

Question 17

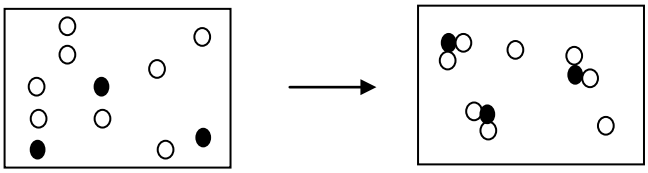
Butane is combusted completely with excess oxygen to form water and carbon dioxide.

$$2C_4H_{10} + 13O_2 \rightarrow 10H_2O + 8CO_2$$
Butane oxygen water carbon dioxide

The reaction yielded 1 mole of water. How many moles of carbon dioxide were produced?
a. 0.8 b. 1.25 c. 4 d. 8 e. none of the above

Question 18

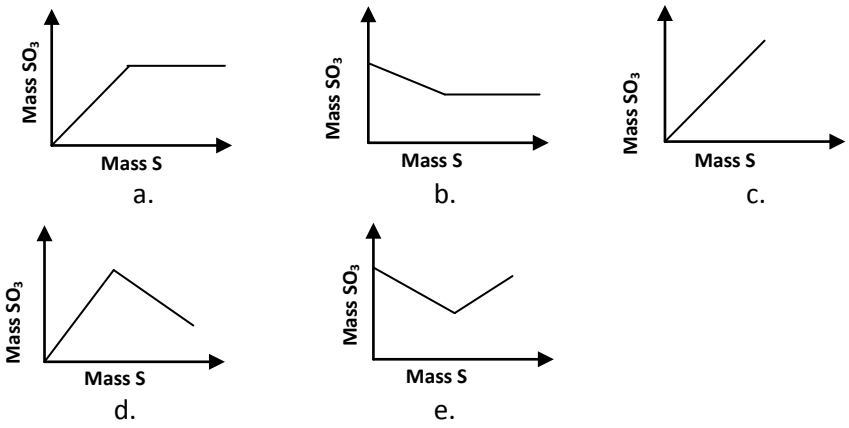
The reaction of element X (●) with element Y (○) is represented in the following diagram.



Which equation describes this reaction?
a. $3X + 8Y \rightarrow X_3Y_8$ b. $3X + 6Y \rightarrow X_3Y_6$ c. $X + 2Y \rightarrow XY_2$ d. $3X + 8Y \rightarrow 3XY_2 + 2Y$
e. $X + 4Y \rightarrow XY_2$

Question 19

For the chemical reaction: $2S + 3O_2 \rightarrow 2SO_3$, which of the following graphs best represents the formation of SO_3, if S is added indefinitely (or in excess) to a fixed amount of O_2?



Question 20

Use the following equation:

$CaCO_3$	+	$2HCl$	→	CO_2	+	$CaCl_2$	+	H_2O
Calcium carbonate		hydrochloric acid		Carbon dioxide		calcium chloride		water

If 14g of calcium carbonate react with 0.2 moles of hydrochloric acid, which reactant(s) determines the mass of carbon dioxide produced? (the molecular weight of calcium carbonate is 100 g/mole)

a. $CaCO_3$ b. HCl c. Any of the two reactants d. None of the two reactants e. Both $CaCO_3$ and HCl