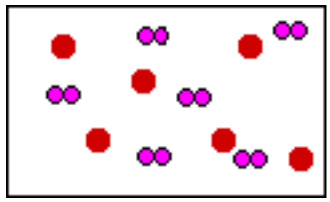
Stoichiometry Part I

Name Section

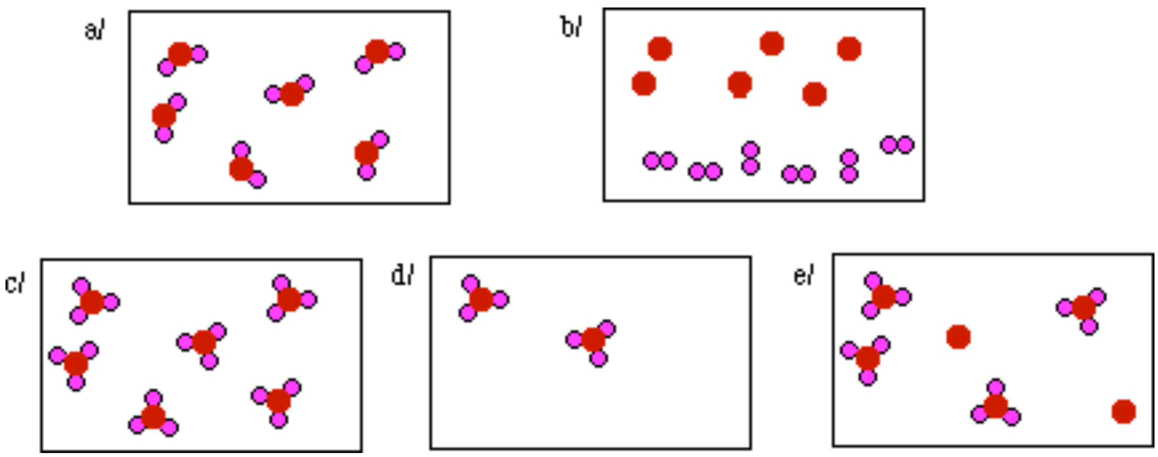
DCI10.2.The equation for the reaction is

$$2S(g) + 3O_2(g) \text{ ---> } 2SO_3(g)$$

Consider a mixture of sulfur atoms and dioxygen molecules in a closed container below:



Which of the following is the best representation of the mixture after the reaction described above occurs. For each of the following explain why the representation is correct or incorrect.

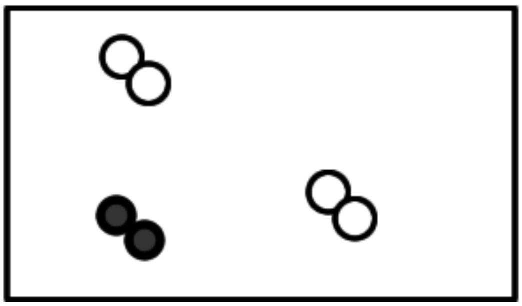


The best choice is diagram e. Since the product is SO_3 diagrams 'a' and 'b' are eliminated. Neither diagram 'a' or 'b' contain any SO_3 molecules. Diagrams 'c' and 'd' do not conform to the number of sulfur and oxygen atoms that were originally in the container. Only diagram 'e' has the same number of sulfur atoms and oxygen atoms as we started with. It looks like there is some excess sulfur atoms when the reaction s complete.

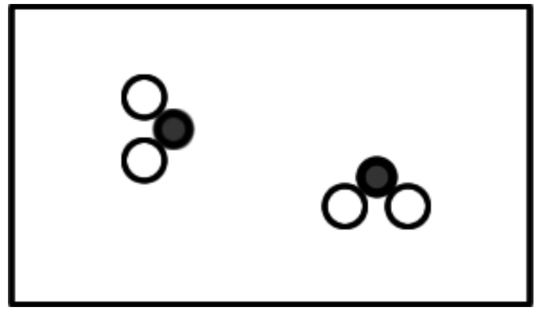
DCI10.1.The reaction between hydrogen and oxygen to form water is shown below

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

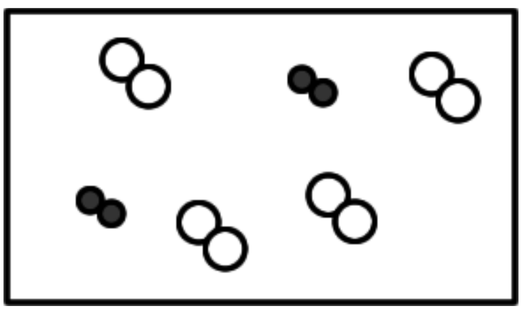
a) In the container below draw a mixture of the reactants before any reaction has occurred.

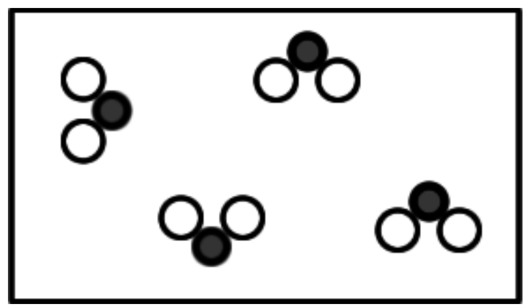


b) In the container below draw the mixture after the reaction has occurred as described by the equation above.



Another possibly;

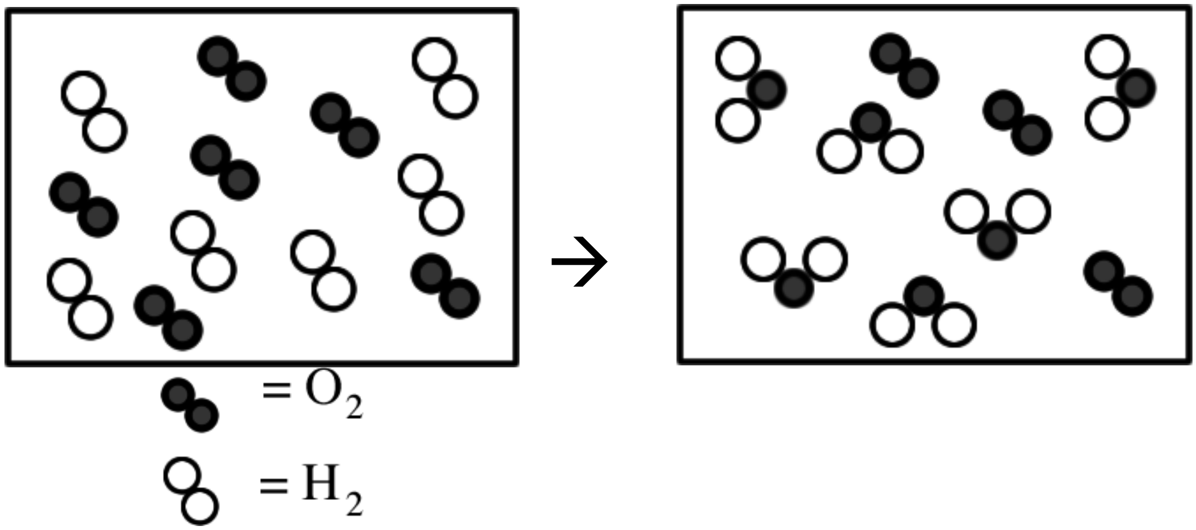




Important note: The number of dihydrogen and dioxygen molecules in the drawing on the left is not critical. The balanced chemical equation says that the ratio that dihydrogen REACTS with dioxygen is a two to one ratio. The coefficients in the balanced chemical equation say nothing about how many dihydrogen and dioxygen molecules are present initially.

The number of dihydrogen and dioxygen molecules in the drawing on the right is critical. The balanced chemical equation says the reactants combine in a two (dihyrogen) to one (dioxygen) ratio. In the second drawing set four dihydrogen molecules would require two dioxygen molecules to produce four water molecules. SO the ratio as defined by the balanced chemical equation is followed.

c) In the left most container below is a mixture of H_2 and O_2 molecules. In the container on the right, below, draw what the contents of the container would be after the reaction takes place.



= O_2
= H_2

DCI10.3. In the combustion reaction

$$2C_6H_{14}(l) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(g)$$

Calculate the number of moles of CO_2 formed when

a) 2.0 moles of C_6H_{14} react with excess O_2

Setup an ICE table,

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**2.0 mol**	**excess**	**0**	**0**
Change				
Final				

Since C_6H_{14} is the limiting reagent, we can calculate the moles of O_2 that react,

$$2.0 \text{ mol } C_6H_{14}\left(\frac{19 \text{ mol } O_2}{2 \text{ mol } C_6H_{14}}\right) = 19.0 \text{ mol } O_2$$

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**2.0 mol**	**excess**	**0**	**0**
Change	**-2.0 mol**	**-19.0 mol**		
Final				

Since C_6H_{14} is the limiting reagent, we can calculate the moles of CO_2 and H_2O that form,

$$2.0 \text{ mol } C_6H_{14}\left(\frac{12 \text{ mol } CO_2}{2 \text{ mol } C_6H_{14}}\right) = 12.0 \text{ mol } CO_2$$

$$2.0 \text{ mol } C_6H_{14}\left(\frac{14 \text{ mol } H_2O}{2 \text{ mol } C_6H_{14}}\right) = 14.0 \text{ mol } H_2O$$

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**2.0 mol**	**excess**	**0**	**0**
Change	**-2.0 mol**	**-19.0 mol**	**12.0 mol**	**14.0 mol**
Final				

We can now finish the ICE table by adding the Initial and the Change entries for each reactant and product.

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**2.0 mol**	**excess**	**0**	**0**
Change	**-2.0 mol**	**-19.0 mol**	**12.0 mol**	**14.0 mol**
Final	**0**	**excess**	**12.0 mol**	**14.0 mol**

b) 6.0 moles of O_2 react with excess C_6H_{14}

Setup an ICE table,

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**excess**	**6.0 mol**	**0**	**0**
Change				
Final				

Since O_2 is the limiting reagent, we can calculate the moles of C_6H_{14} that react, (remember the ratio of the reactants in the Change row must be the same as the ratio of the reactant in the balanced chemical equation,

$$6.0 \text{ mol } O_2\left(\frac{2 \text{ mol } C_6H_{14}}{19 \text{ mol } O_2}\right) = 0.632 \text{ mol } C_6H_{14}$$

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**excess**	**6.0 mol**	**0**	**0**
Change	**-0.632 mol**	**-6.0 mol**		
Final				

Since O_2 is the limiting reagent, we can calculate the moles of CO_2 and H_2O that form,

$$6.0 \text{ mol } O_2\left(\frac{12 \text{ mol } CO_2}{19 \text{ mol } O_2}\right) = 3.79 \text{ mol } CO_2$$

$$6.0 \text{ mol } O_2\left(\frac{14 \text{ mol } H_2O}{19 \text{ mol } O_2}\right) = 4.42 \text{ mol } H_2O$$

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**excess**	**6.0 mol**	**0**	**0**
Change	**-0.632 mol**	**-6.0 mol**	**3.79 mol**	**4.42 mol**
Final				

We can now finish the ICE table by adding the Initial and the Change entries for each reactant and product.

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	**excess**	**6.0 mol**	**0**	**0**
Change	**-0.632 mol**	**-6.0 mol**	**3.79 mol**	**4.42 mol**
Final	**excess**	**0**	**3.79 mol**	**4.42 mol**

c) 38.0 g of H_2O is formed

Setup an ICE table,

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	?	?	0	0
Change				
Final				38.0 mol

We will assume there is no $CO_2(g)$ or $H_2O(g)$ present initially. So the 38.0 mol that need to be produced will appear in the Final row for H_2O. Since there was no H_2O present initially the change must be 38.0 mol.

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	?	?	0	0
Change				38.0 mol
Final				38.0 mol

We can now calculate the mole of $CO_2(g)$ that are formed and the moles of $2C_6H_{14}(l)$ and $19O_2$ that must have reacted.

$$38.0 \text{ mol } H_2O \left(\frac{12 \text{ mol } CO_2}{14 \text{ mol } H_2O}\right) = 32.6 \text{ mol } CO_2$$

$$38.0 \text{ mol } H_2O \left(\frac{19 \text{ mol } O_2}{14 \text{ mol } H_2O}\right) = 51.6 \text{ mol } CO_2$$

$$38.0 \text{ mol } H_2O \left(\frac{2 \text{ mol } C_6H_{14}}{14 \text{ mol } H_2O}\right) = 5.43 \text{ mol } C_6H_{14}$$

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	?	?	0	0
Change	-5.43 mol	-51.6 mol	32.6 mol	38.0 mol
Final				38.0 mol

and then complete the table,

	$2C_6H_{14}(l)$ +	$19O_2(g)$ →	$12CO_2(g)$ +	$14H_2O(g)$
Initial	5.43 mol	51.6 mol	0	0
Change	-5.43 mol	-51.6 mol	32.6 mol	38.0 mol
Final	0 mol	0 mol	32.6 mol	38.0 mol