ك 103 شعبة 13

Chapter 3 (exercises)

Q1. Sample exercise 3.7 page 90

Without using calculator, arrange the following samples in order to increasing number of carbon atoms:

12 g ^{12}C , 1 mol C_2H_2 , 9 x 10^{23} molecules of CO_2

Answer:

12 g of ^{12}C = 1 mole of C = 6.03 x 10^{23} number of carbons

1 mole of C_2H_2 = 2 x 6.03 x 10^{23} = 12.06 x 10^{23} carbon atoms (because we have 2 atoms in C_2H_2)

CO_2 contain 9 x 10^{23} carbon

The order of increasing carbon atoms is $C_2H_2 > CO_2 > {}^{12}C$

Q2. Practice exercise page 90

Without using calculator, arrange the following samples in order of increasing number of oxygen atoms:

1 mole of H_2O, 1 mole of CO_2 , 3 x 10^{23} molecules O_3 .

Answer:

1 mole H_2O contain 1 mole oxygen = 6.03 x 10^{23} number of oxygen atoms in H_2O

1 mole of CO_2 contain 2 moles of oxygen = 2 x 6.03 x 10^{23} number of oxygen atoms in CO_2

O_3 molecule contain 3 x 3 x 10^{23} oxygen atoms = 9.0 x 10^{23}

The order is: $H_2O < O_3 < CO_2$

Q3. Sample exercise 3.8 page 90

Calculate the number of H atoms in o.350 mole of $C_6H_{12}O_6$

Answer:

1 mole of $C_6H_{12}O_6$ contain 6.03 x 10^{23} molecules of $C_6H_{12}O_6$

0.250 mole of $C_6H_{12}O_6$ contain (0.250 mole) (6.03 x 10^{23}) /(1 mole) = 2.11 x 10^{23} atom s of $C_6H_{12}O_6$

Each molecule of $C_6H_{12}O_6$ contain 12 H atoms

2.11×10^{23} atoms of $C_6H_{12}O_6$ contain (12 H atoms) x (2.11×10^{23}) / 1 = 2.53×10^{24} H atoms

Q4. Practice exercise page 91

How many oxygen atoms are in a) 0.25 mole of $Ca(NO_3)_2$, b) 1.50 Na_2CO_3

Answer:

a) Number of molecules of $Ca(NO_3)_2$ = (0.25 mole of $Ca(NO_3)_2$) x (6.03×10^{23}) / (1 mole of $Ca(NO_3)_2$

= 1.51×10^{23} number of $Ca(NO_3)_2$ molecule

Each 1 molecule of $Ca(NO_3)_2$ contain 6 oxygen atoms

Number of oxygen atoms = (1.51×10^{23})x(6)/ (1) = 9.06×10^{23}

b)number of molecules of $Na(CO_3)_2$ = (1.50 mole of Na_2CO_3)x(6.03×10^{23})/(1 mole of Na_2CO_3)

= 9.05×10^{23}

Each 1 molecule of Na_2CO_3 contain 3 atoms of oxygen

Numner of oxygen atoms = (9.05×10^{23})x (3) / 1 = 27.1×10^{23}

Q5. Sample exercise 3.9 page 92

What is the mass in grams of 1.000 mole glucose ($C_6H_{12}O_6$)?

Answer:

We are given a chemical formula $C_6H_{12}O_6$ and asked for the determination its molar mass.

6 C atoms = 6(12.0 amu) = 72.0 amu

12 H atoms = 12(1.0 amu) = 12 amu

6 O atoms = 6(16.0 amu) 96.0 amu

Total = 180.0 amu

Glucose has a formula weight = 180.0 amu

Glucose has a mass of = 180.0 g

Glucose has a molar mass of = 180.0 mol/g

Q6. Practice exercise page 92

Calculate the molar mass of $Ca(NO_3)_2$.

1 Ca atom = 1(40 amu) = 40 amu

2 N atoms = 2 (14 amu) = 28 amu

6 O atoms = 6(16 amu) = 96 amu

Molar mass of $Ca(NO_3)_2$ = 164 amu

Q.7 Sample exercise 3.10 page 93

Calculate the number of molar mass of glucose in 5.380 g of $C_6H_{12}O_6$.

Answer:

Molar mass of $C_6H_{12}O_6$ = 180 g / mol

1 mol of glucose = 180 g

Number of moles = mass / molar mass = (5.380 g)/(180 g/mol) = 0.02989 mol

Q.8 Practice exercise page 93

How many moles of $NaHCO_3$ are in 508 g of $NaHCO_3$.

Answer:

Number of moles of $NaHCO_3$ = mass / molar mass = (508 g)/(84 g/mol) = 6.05 mol

Q9. Practice exercise page 93

What is the mass, in gram , a) 6.33 mol of $NaHCO_3$ and b) 3.0×10^{-5} mole of sulfuric acid

Answer:

a)mole of $NaHCO_3$ = mass/ molar mass

6.33 mole = mass / (84 g/mol) = 532 g

b) mole of H_2SO_4 = mass / molar mass

3.0×10^{-5} mole = mass / (98 g/mol) mass = 2.9×10^{-3} g

Q10. Practice exercise page 93

a)How many nitric acid molecules are in 4.20 g HNO_3 ? b) How many O_2 atoms are in the sample?

Answer:

a) Mole of HNO_3 = (4.20 g)/(63 g/mol) = 0.067

1 mole of HNO_3 contain 6.03×10^{23} molecules

0.067 mole of HNO_3 = (0.067 mol)(6.03×10^{23} molecules)/(1 mol) = 0.402×10^{23} molecules

b) 1 molecule HNO_3 contain 3 O atom

Oxygen in sample contain = (0.402×10^{23}) (3) / (1) = 1.2×10^{23} molecules.

Q11. Sample exercise 3.16 page 100

How many grams of water are produced in the oxidation of 1.00 g glucose ($C_6H_{12}O_6$)?

$C_6H_{12}O_{6\,(g)} + 6O_{2\,(g)} \rightarrow 6CO_{2\,(g)} + 6H_2O_{\,(l)}$

Answer:

Mole of $C_6H_{12}O_6$ = (1g)/ (180.1 g/mol) = 0.00556

1 mole of glucose forms 6 mole CO_2

Mole of H_2O = (0.00556 mol glucose) (6 mol of CO_2) / 1 mol of glucose

= 0.033

Grams of H_2O = 0.033 mole x (18 g/mol) = 0.6 g

Q12. Practice exercise page 101

The decomposition of $KClO_3$ to form oxygen $2KClO_3 \rightarrow 2Cl + 3O_{2\,(g)}$. How many grams of O_2 can

Be prepared from 4.50 g $KClO_3$?

Answer:

Mole of $KClO_3$ = (4.50 g)/ (122.5) = 0.037

Mole of O_2 = (0.037 mole $KClO_3$) (3 mol O_2) / (2 mole $KClO_3$) = 0.0551

Grams og O_2 = (0.0551 mole O_2) x 16 = 0.88

Q13. Sample exercise 3.17 page 101

The lithium hydroxide reacts with CO_2 to form solid lithium carbonate and liquid water. How many

Grams of CO_2 can be absorbed by 1 g of LiOH?

Answer:

Moles of LiOH = (1 g) / (23.95 g/mol) = 0.042

2 mole LiOH form 1 mole CO_2

0.042 mole of LiOH form = (0.042 mol LiOH) x (1 mol CO_2) / (2 mol LiOH)

= 0.021 mole CO_2

Grams of CO_2 = (0.021 mole) x (44.01 g/mol) = 0.919 g

Q14. Practice exercise page 102

Propane C_3H_3 , is a common fuel used for cooking heating. What mass of O_2 is consumed in the combustion of 1.0 g of propane?

Answer:

$C_3H_{8\,(g)}$ + $5O_{2\,(g)}$ → $3\,CO_{2\,(g)}$ + $4\,H_2O_{(l)}$

Mole of C_3H_8 = (1 g) / (39 g/mol) = 0.023

1 mole of C_3H_8 needs 5 mole of O_2

Moles of O_2 = (0.023 mole C_3H_8)x(5 mol mol O_2) / (1 mol C_3H_8) = 0.0115

Mass of O_2 = (0.0115 mole of CO_3) x (32 g/mol) = 3.68

Q 15. Sample exercise 3.18 page 104

The important commercial process for converting N_2 from the air into nitrogen containing compounds is based on the reaction of N_2 and H_2 to form NH_3 .

$N_{2\,(g)}$ + $H_{2\,(g)}$ → $NH_{3\,(g)}$

How many moles of NH_3 can be formed from 3.0 mole N_2 and 6.0 mole H_2 ?

Answer:

1 mole of N_2 needs 3.0 mole of H_2

Mole of H_2 = (3.0 mol) x (3.0 mol H_2) / (1 mol N_2) = 9.0 mole

Mole of NH_3 = (6 mol H_2)x (2 mol NH_3 / 3 mol H_2) = 4.0 mol NH_3

	N_2	+ $3H_3$	→ $2NH_3$
Initial quantities	3.0 mole	6.0 mole	0 mole
Change (reaction)	- 2 mole	-6.0 mole	+ 4.0 mole
Final quantities	1.0 mole	0 mole	4.0 mole

Q16. Practice exercise page 104

Consider the reaction $2Al_{(s)} + 3Cl_{2\,(g)} \rightarrow 2AlCl_{3\,(s)}$. A mixture of 1.5 mole of Al and 3.0 mole of Cl_2 to react.

a) Which is the limiting reaction?

b) How many moles of the $AlCl_3$ are formed?

c) How many moles of the excess reactant at the end of reaction?

Answer:

2 moles of Al needs 3 moles of Cl_2

1.5 mole of Al needs Cl_2 = (1.5 mol Al) x (3 mol Cl_2) / (2 mol Al) = 2.25 mol of Cl_2

Al is a limiting reaction or limiting reagent.

Cl_2 is the excess reaction or excess reagent.

Moles of $AlCl_3$ formed = (2.25 mol Cl_2)x (2 mol $AlCl_3$)/ (3 mol Cl_2) = 1.5 mol $AlCl_3$

	2Al	+ $3Cl_2$	→ $2AlCl_3$
Initial quantities	1.5 mole	3.0 mole	0 mole
Change (reaction0	- 1.5 mole	- 2.25 mole	+ 1.5 mole
Final quantities	0 mole	0.75 mole	1.5 mole

Q17. Sample exercise 3.19 page 104

Consider the following reaction that occur in the fuel cell $2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O$

Suppose a fuel cell is set with 150 g of H_2 gas and 1500 g of O_2 gas. How many grams of water can be formed?

Answer:

2 mole of H_2 = 1 mole of O_2 = 2 mole of H_2O

Mole H_2 = (150 g H_2) x (1 mol H_2 / 2.0 g) = 75 mol H_2

Mole O_2 = (1500 g)/(32 g/mol) = 47 mol O_2

Mole of O_2 = (75 mol H_2) x (1 mol O_2) / (2 mol H_2) = 37.5 mol O_2 needs for reaction

H_2 is the limiting reagent

Mole of H_2O = (75 mol H_2)x (2 mol H_2O) / (2 mol H_2) = 75 mol H_2O

Mass of H_2O = (75 mol) x (18 g/mol) = 1400 g of water

Q18. Practice exercise page 105

A strip of zinc metal with mass 2.00 g is placed in an aqueous solution containing 2.50 g of $AgNO_3$,

the reaction is $Zn_{(s)}$ + 2 $AgNO_{3\,(s)}$ → 2 $Ag_{(s)}$ + $Zn(NO)_{2\,(aq)}$.

a) Which of the reaction is limiting?

b) How many grams of Ag will form?

c) How many grams of $Zn(NO)_2$ will form?

d) How many grams of excess reagent will be left at the end of reaction?

Answer:

a)1 mol Zn = 2 mol $AgNO_3$ = 2 mol Ag = 1 mol $Zn(NO)_2$

mole of Zn = (2.00 g) / (65.39 g/mol) = 0.031

mole of $AgNO_3$ = (2.50 g) / (169.89 g/mol) = 0.015

$AgNO_3$ is the limiting reagent

b) 2 mol $AgNO_3$ = 2 mol Ag

mole of Ag = (0.015 mol $AgNO_3$)x (2 mol Ag)/ (2 mol $AgNO_3$) = 0.015 mole

gram of Ag = (0.015 mole) x (107.89 g/mol) = 1.62 g

c)2 mol of Ag = 1 mole $Zn(NO_3)_2$

mole of $Zn(NO)_2$ = (0.015 mol Ag)x (1 mol $Zn(NO)_2$) /(2 mol Ag) = 0.0075 gram of $Zn(NO)_2$ = (0.0075 mole) x (189.39 g/mol) = 1.4 g

d)excess of reagent Zn = 0.031 – (0.015/2) = 0.0235 mol

gram of Zn = 0.0235 x 65.39 = 1.53 g

Q 19. Practice page 107

Imagine that you working on ways to improve the process by which iron ore containing Fe_2O_3 is converted into Fe. The reaction is $Fe_2O_{3\,(s)} + 3CO_{(g)} \rightarrow 2Fe_{(s)} + 3CO_{2\,)g)}$.

a)If you start with 150 g of Fe_2O_3 as the limiting reagent, what is the theoretical yield of Fe?

b)If the actual yield of Fe in your test was 87.9 g, what was the percentage yield?

Answer:

a)1 mol Fe_2O_3 = 3 mol CO = 2 mol Fe = 3 mol CO_2

mole of Fe_2O_3 = (150 g) / (159.694 g/mol) = 0.94 mol

mole of Fe = (0.94 mol Fe_2O_3) x(2 mol Fe) / (1 mol /g) = 1.88

gram of Fe = (1.88 mol) x (55.847 g/mol) = 105 g

b) Theoretical yield = (87.9 g / 105 g) x 100 = 83%

Exercise page 109

3.33

Calculate the following quantities

a) Mass in gram of 0.105 moles sucrose $C_{12}H_{22}O_{11}$.
b) Mole of $Zn(NO)_3$ in 143.50 g of this substance.
c) Number of molecules in 1.0×10^{-6} mole of CH_3CH_2OH.
d) Number of N atoms in 0.41 mole NH_3 .

Answer:

a) molar mass of $C_{12}H_{22}O_{11}$ = 12 x 12 + 22 x 1 + 11 x 16 = 342

grams of sucrose = 0.105 mole x 342 = 35.91 g

b) molar mass of $Zn(NO)_2$ = 65.39 + 2 x 14 + 2 x 16 = 125.39

Mole of $Zn(NO)_2$ = (143.509 g) / (125.39 g/mol) = 1.145

c)1.0 x 10^{-6} moles contain CH_3CH_2OH molecules = (6.03 x 10^{23} molecules)(1.0 x 10^{-6})/(1 mole)

= 6.03 x 10^{17} molecules of CH_3CH_2OH.

d)molecules on NH_3 in 0.410 = (6.03 x 10^{23})(0.410 mol NH_3) / (1 mol NH_3)

= 2.4723 x 10^{23} molecules of NH_3

1 molecule of NH_3 = 1 atom of N

2.4723 x 10^{23} molecules of NH_3 x (1 N / 1 NH_3) = 2.4723 x 10^{23} number of atoms of N

3.39

A sample of glucose contains 1.250 x 10^{21} carbon atom.

a)How many atoms of hydrogen does in contain?

b)How many molecules of glucose does it contain?

c)How many moles of glucose does it contain?

d)What is the mass of this sample in grams?

Answer:

a)6 mol of C = 12 mol of H_2

hydrogen atoms = (1.25 x 10^{21} C atoms) x (12 mol H_2)/(6 mol H_2 atoms)

= 2.50 x 10^{21} H_2 atoms

b)1 mol $C_6H_{12}H_6$ = (1.25 C atoms) x (1 mol $C_6H_{12}O_6$)/(6 mol C) = 0.21 x 10^{21}

c)1 mol $C_6H_{12}O_6$ = (0.21 x 10^{21} atoma) (1 mol $C_6H_{12}O_6$) /(6.03 x 10^{23}) = 3.5 mol

d)mass of glucose = 3.5 mol x 180 g/mol = 6.21

3.7

Sodium hydroxide reacts with CO_2 as follows 2NaOH $_{(s)}$ + $CO_{2\,(g)}$ → $Na_2CO_{3\,(s)}$ + $H_2H_{\,(l)}$

Which reagent is the limiting when 1.85 mole NaOH and 1.00 mole CO_2 are allowed to react? How many moles of $Na_2\,CO_3$ can be produced? How many moles of the excess reactant remain after the completion of the reaction?

Answer:

2 mol NaOH = 1 mol CO_2 = 1 mol $Na_2\,CO_3$ 1 mol $H_2\,O$

Mole of CO_2 = (1.85 mol NaOH)x (1 mol CO_2) / (2 mol NaOH) = 0.925 mol CO_2

The limiting reagent is NaOH

1.00 – 0.025 = 0.075 mole of CO_2 (excess reagent)

Mole of $Na_2\,CO_3$ = (1 mol $Na_2\,CO_3$)x(1.85 mol NaOH) / (2 mol NaOH) = 0.925 mole