ATOMS & IONS 1

1) Complete the following table about some atoms and ions. The first row has been done for you.

Particle	Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electron structure
$^{23}_{11}Na^+$	ion	11	23	11	12	10	2,8
$^{31}_{15}P$							
		13	27			10	
	atom	2	4				
				12	12		2,8

2) a) Complete the table to show the electron structure of the following ions.

Ion	F^-	Na^+	Al^{3+}	K^+	S^{2-}	H^+
Electron structure						

Ion	O^{2-}	Ca^{2+}	Li^+	Mg^{2+}	Cl^-	Be^{2+}
Electron structure						

b) i) Complete the table below to show the electronic structure of some Group 0 elements (noble gases).

ii) Place the ions from part (a) into the correct row of the table.

Element	Electron structure	Ions from part (a) with the same electronic structure
He		
Ne		
Ar		

c) What is the link between the electronic structure of ions and Group 0 elements (noble gases)?

……

……

d) i) Complete the table with the ions from part 2a (except H^+). Ions for Group 1 have been done for you.

Group	1	2	3	4	5	6	7	0
Ions	Li^+ Na^+ K^+							
Charge	+1							

ii) Predict the charge that the following ions would have using the Periodic Table and your table.

strontium ions …… iodide ions …… rubidium ions ……

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Give electron structure of atoms			Link between ions and PT group		
Good SPG			Give electron structure of ions			Can predict ion charges		
Can work with PNE numbers			Link between ions and Group 0					

ATOMS & IONS 1

1) Complete the following table about some atoms and ions. The first row has been done for you.

Particle	Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electron structure
$^{23}_{11}Na^+$	ion	11	23	11	12	10	2,8
$^{31}_{15}P$	**atom**	**15**	**31**	**15**	**16**	**15**	**2,8,5**
$^{27}_{13}Al^{3+}$	**ion**	13	27	**13**	**14**	10	**2,8,3**
$^{4}_{2}He$	atom	2	4	**2**	**2**	**2**	**2**
$^{24}_{12}Mg^{2+}$	**ion**	**12**	**24**	12	12	**10**	2,8

2) a) Complete the table to show the electron structure of the following ions.

Ion	F^-	Na^+	Al^{3+}	K^+	S^{2-}	H^+
Electron structure	**2,8**	**2,8**	**2,8**	**2,8,8**	**2,8,8**	**0**

Ion	O^{2-}	Ca^{2+}	Li^+	Mg^{2+}	Cl^-	Be^{2+}
Electron structure	**2,8**	**2,8,8**	**2**	**2,8**	**2,8,8**	**2**

b) i) Complete the table below to show the electronic structure of some Group 0 elements (noble gases).

ii) Place the ions from part (a) into the correct row of the table.

Element	Electron structure	Ions from part (a) with the same electronic structure
He	**2**	**Li^+ Be^{2+}**
Ne	**2,8**	**F^- O^{2-} Na^+ Mg^{2+} Al^{3+}**
Ar	**2,8,8**	**S^{2-} Cl^- K^+ Ca^{2+}**

c) What is the link between the electronic structure of ions and Group 0 elements (noble gases)?

Ions have the same electron structure as the noble gases

d) i) Complete the table with the ions from part 2a (except H^+). Ions for Group 1 have been done for you.

Group	1	2	3	4	5	6	7	0
Ions	Li^+ Na^+ K^+	**Be^{2+} Mg^{2+} Ca^{2+}**	**Al^{3+}**			**O^{2-} S^{2-}**	**Cl^-**	
Charge	**+1**	**+2**	**+3**			**–2**	**–1**	

ii) Predict the charge that the following ions would have using the Periodic Table and your table.

strontium ions **+2** iodide ions **–1** rubidium ions **+1**

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Give electron structure of atoms			Link between ions and PT group		
Good SPG			Give electron structure of ions			Can predict ion charges		
Can work with PNE numbers			Link between ions and Group 0					

NAMING SUBSTANCES 2

Name the following substances.

Formula	Name
O_2	
CuO	
Cu	
$CuSO_4$	
CuS	
$CuCO_3$	
$FeSO_4$	
$Fe(NO_3)_2$	
N_2	
H_2SO_4	
CO	
CO_2	
NO_2	
HCl	
$KHCO_3$	
K_2CO_3	
Mg	
AgF	
$Ca(OH)_2$	
$CaCO_3$	

Name	Formula
Al_2O_3	
Na	
$Al_2(SO_4)_3$	
HNO_3	
I_2	
Ni	
Al	
Na_2O	
NaOH	
NaBr	
Na_2CO_3	
He	
CH_4	
NH_3	
NH_4Br	
H_2Te	
$SnCl_4$	
WO_3	
HgO	
TiC	

NAMING SUBSTANCES 2

Name the following substances.

Formula	Name
O_2	**Oxygen**
CuO	**Copper oxide**
Cu	**Copper**
$CuSO_4$	**Copper sulfate**
CuS	**Copper sulfide**
$CuCO_3$	**Copper carbonate**
$FeSO_4$	**Iron sulfate**
$Fe(NO_3)_2$	**Iron nitrate**
N_2	**nitrogen**
H_2SO_4	**Sulfuric acid**
CO	**Carbon monoxide**
CO_2	**Carbon dioxide**
NO_2	**Nitrogen dioxide (nitrogen oxide)**
HCl	**Hydrochloric acid**
$KHCO_3$	**Potassium hydrogencarbonate**
K_2CO_3	**Potassium carbonate**
Mg	**Magnesium**
AgF	**Silver fluoride**
$Ca(OH)_2$	**Calcium hydroxide**
$CaCO_3$	**Calcium carbonate**

Name	Formula
Al_2O_3	**Aluminium oxide**
Na	**Sodium**
$Al_2(SO_4)_3$	**Aluminium sulfate**
HNO_3	**Nitric acid**
I_2	**Iodine**
Ni	**Nickel**
Al	**Aluminium**
Na_2O	**Sodium oxide**
NaOH	**Sodium hydroxide**
NaBr	**Sodium bromide**
Na_2CO_3	**Sodium carbonate**
He	**Helium**
CH_4	**methane**
NH_3	**Ammonia**
NH_4Br	**Ammonium bromide**
H_2Te	**Hydrogen telluride**
$SnCl_4$	**Tin chloride**
WO_3	**Tungsten oxide**
HgO	**Mercury oxide**
TiC	**Titanium carbide**

BALANCING EQUATIONS 3

1) $Ca + H_2O \rightarrow Ca(OH)_2 + H_2$

2) $NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

3) $FeCl_3 + NaOH \rightarrow Fe(OH)_3 + NaCl$

4) $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$

5) $MgO + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$

6) $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O$

7) $Ca(OH)_2 + HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$

8) $PCl_3 + H_2O \rightarrow P(OH)_3 + HCl$

9) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + H_2O + NO_2$

10) $Pb_3O_4 + HNO_3 \rightarrow Pb(NO_3)_2 + PbO_2 + H_2O$

BALANCING EQUATIONS 3

1) $Ca + 2\ H_2O \rightarrow Ca(OH)_2 + H_2$

2) $2\ NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

3) $FeCl_3 + 3\ NaOH \rightarrow Fe(OH)_3 + 3\ NaCl$

4) $2\ Al + 3\ H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3\ H_2$

5) $MgO + 2\ HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$

6) $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2\ H_2O$

7) $Ca(OH)_2 + 2\ HNO_3 \rightarrow Ca(NO_3)_2 + 2\ H_2O$

8) $PCl_3 + 3\ H_2O \rightarrow P(OH)_3 + 3\ HCl$

9) $Cu + 4\ HNO_3 \rightarrow Cu(NO_3)_2 + 2\ H_2O + 2\ NO_2$

10) $Pb_3O_4 + 4\ HNO_3 \rightarrow 2\ Pb(NO_3)_2 + PbO_2 + 2\ H_2O$

BALANCING EQUATIONS 4

1) $Na + H_2O \rightarrow NaOH + H_2$

2) $KOH + H_2SO_4 \rightarrow K_2SO_4 + H_2O$

3) $Mg(NO_3)_2 + NaOH \rightarrow Mg(OH)_2 + NaNO_3$

4) $NO + H_2O + O_2 \rightarrow HNO_3$

5) $C_5H_{12} + O_2 \rightarrow CO_2 + H_2O$

6) $Br_2 + NaI \rightarrow NaBr + I_2$

7) $K_2CO_3 + HNO_3 \rightarrow KNO_3 + CO_2 + H_2O$

8) $NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

9) $ZnCO_3 \rightarrow ZnO + CO_2$

10) $H_3PO_4 + NaOH \rightarrow Na_3PO_4 + H_2O$

BALANCING EQUATIONS 4

1) $2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$

2) $2\ KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$

3) $Mg(NO_3)_2 + 2\ NaOH \rightarrow Mg(OH)_2 + 2\ NaNO_3$

4) $4\ NO + 2\ H_2O + 3\ O_2 \rightarrow 4\ HNO_3$

5) $C_5H_{12} + 8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

6) $Br_2 + 2\ NaI \rightarrow 2\ NaBr + I_2$

7) $K_2CO_3 + 2\ HNO_3 \rightarrow 2\ KNO_3 + CO_2 + H_2O$

8) $2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

9) $ZnCO_3 \rightarrow ZnO + CO_2$

10) $H_3PO_4 + 3\ NaOH \rightarrow Na_3PO_4 + 3\ H_2O$

MOLES (A)

1 Calculate the relative formula mass (M_r) of each of the following substances.

a CO_2 .....

b Mg .....

c sodium oxide .....

d calcium nitrate .....

2 Calculate the mass in grams of one atom of ^{19}F. Give your answer in standard form to 3 significant figures.
(the Avogadro constant = 6.022×10^{23} mol^{-1})

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3 One molecule of water has a mass of 2.99×10^{-23} g. Use this to calculate the mass in grams of two moles of water molecules.
(the Avogadro constant = 6.022×10^{23} mol^{-1})

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MOLES (F)

1 5.2 g of chromium (Cr) reacts with 4.8 g of oxygen (O_2) to form chromium oxide. Find the molar reacting ratio between chromium and oxygen.

2 0.48 g of hydrazine (N_2H_4) decomposes to form 0.14 g of nitrogen (N_2) and 0.34 g of ammonia (NH_3). Find the molar ratios and use this to give the equation for the reaction.

1 5.2 g of chromium (Cr) reacts with 4.8 g of oxygen (O_2) to form chromium oxide. Find the molar reacting ratio between chromium and oxygen.

moles Cr = $\frac{mass}{M_r}$ = $\frac{5.2}{52}$ = 0.1 mol

moles O_2 = $\frac{mass}{M_r}$ = $\frac{4.8}{32}$ = 0.15 mol

reacting ratio Cr : O_2 = 0.10 : 0.15 = $\frac{0.10}{0.10}$: $\frac{0.15}{0.10}$ = 1 : 1.5 = 2 : 3

∴ $2Cr + 3O_2 \rightarrow$

2 0.48 g of hydrazine (N_2H_4) decomposes to form 0.14 g of nitrogen (N_2) and 0.34 g of ammonia (NH_3). Find the molar ratios and use this to give the equation for the reaction.

moles N_2H_4 = $\frac{mass}{M_r}$ = $\frac{0.48}{32}$ = 0.015 mol

moles N_2 = $\frac{mass}{M_r}$ = $\frac{0.14}{28}$ = 0.005 mol

moles NH_3 = $\frac{mass}{M_r}$ = $\frac{0.34}{17}$ = 0.020 mol

reacting ratio N_2H_4 : N_2 : NH_3 = 0.015 : 0.005 : 0.020 = $\frac{0.015}{0.005}$: $\frac{0.005}{0.005}$: $\frac{0.020}{0.005}$ = 3 : 1 : 4

∴ $3N_2H_4 \rightarrow N_2 + 4NH_3$

MOLES (G)

The volume of one mole of any gas at room temperature and pressure is 24 dm^3

1 What is the volume of 0.50 moles of hydrogen gas (H_2) at room temperature and pressure?

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2 How many moles in 1.8 dm^3 of helium gas (He) at room temperature and pressure?

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3 What is the volume of 7.0 g of nitrogen gas (N_2) at room temperature and pressure?

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4 What volume of oxygen gas reacts with 100 cm^3 of butane gas, with both gases measured at the same temperature and pressure?

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

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5 What volume of hydrogen gas, measured at room temperature and pressure, is formed when 6.9 g of sodium reacts with water?

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

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The volume of one mole of any gas at room temperature and pressure is 24 dm^3

1 What is the volume of 0.50 moles of hydrogen gas (H_2) at room temperature and pressure?

volume of H_2 = 24 x moles = 24 x 0.50 = 12 dm^3

2 How many moles in 1.8 dm^3 of helium gas (He) at room temperature and pressure?

moles of He = $\frac{volume}{24}$ = $\frac{1.8}{24}$ = 0.075 mol

3 What is the volume of 7.0 g of nitrogen gas (N_2) at room temperature and pressure?

moles of N_2 = $\frac{mass}{M_r}$ = $\frac{7.0}{28}$ = 0.25 mol

volume of N_2 = 24 x moles = 24 x 0.25 = 6 dm^3

4 What volume of oxygen gas reacts with 100 cm^3 of butane gas, with both gases measured at the same temperature and pressure?

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

volume of O_2 = $\frac{13}{2}$ x moles C_4H_{10} = $\frac{13}{2}$ x 100 = 650 cm^3

5 What volume of hydrogen gas, measured at room temperature and pressure, is formed when 6.9 g of sodium reacts with water?

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

moles of Na = $\frac{mass}{M_r}$ = $\frac{6.9}{23}$ = 0.30 mol

moles of H_2 = = $\frac{1}{2}$ x 0.30 = 0.15 mol

volume of H_2 = 24 x moles = 24 x 0.15 = 3.6 dm^3

1 In a titration, 25.0 cm^3 of 0.200 mol/dm^3 sodium hydroxide solution reacted with 28.5 cm^3 of sulfuric acid. Find the concentration of the sulfuric acid in mol/dm^3.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

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2 In a titration, 25.0 cm^3 of 0.040 mol/dm^3 barium hydroxide solution reacted with 21.6 cm^3 of hydrochloric acid. Find the concentration of the hydrochloric acid in mol/dm^3 and g/dm^3.

$$Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

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1 In a titration, 25.0 cm^3 of 0.200 mol/dm^3 sodium hydroxide solution reacted with 28.5 cm^3 of sulfuric acid. Find the concentration of the sulfuric acid in mol/dm^3.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

25.0 cm^3 28.5 cm^3
0.200 mol/dm^3

moles NaOH = conc x volume (dm^3) = 0.200 x $\frac{25.0}{1000}$ = 0.0050 mol

moles H_2SO_4 = $\frac{\text{moles NaOH}}{2}$ = $\frac{0.0050}{2}$ = 0.0025 mol

concentration H_2SO_4 = $\frac{\text{moles NaOH}}{\text{volume } (dm^3)}$ = $\frac{0.0025}{\frac{28.5}{1000}}$ = 0.0877 mol/dm^3

2 In a titration, 25.0 cm^3 of 0.040 mol/dm^3 barium hydroxide solution reacted with 21.6 cm^3 of hydrochloric acid. Find the concentration of the hydrochloric acid in mol/dm^3 and g/dm^3.

$$Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

25.0 cm^3 21.6 cm^3
0.050 mol/dm^3

moles $Ba(OH)_2$ = conc x volume (dm^3) = 0.040 x $\frac{25.0}{1000}$ = 0.00100 mol

moles HCl = 2 x moles $Ba(OH)_2$ = 2 x 0.00100 mol = 0.00200 mol

concentration HCl in mol/dm^3 = $\frac{\text{moles NaOH}}{\text{volume } (dm^3)}$ = $\frac{0.00200}{\frac{21.6}{1000}}$ = 0.0926 mol/dm^3

concentration HCl in g/dm^3 = M_r x concentration HCl in mol/dm^3 = 0.0926 x 36.5 = 3.38 g/dm^3

1 In a titration, 25.0 cm^3 of 0.200 mol/dm^3 sodium hydroxide solution reacted with 28.5 cm^3 of sulfuric acid. Find the concentration of the sulfuric acid in mol/dm^3.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

25.0 cm^3 28.5 cm^3
0.200 mol/dm^3

moles NaOH = conc x volume (dm^3) = 0.200 x $\frac{25.0}{1000}$ = 0.0050 mol

moles H_2SO_4 = $\frac{\text{moles NaOH}}{2}$ = $\frac{0.0050}{2}$ = 0.0025 mol

concentration H_2SO_4 = $\frac{\text{moles NaOH}}{\text{volume } (dm^3)}$ = $\frac{0.0025}{\frac{28.5}{1000}}$ = 0.0877 mol/dm^3

2 In a titration, 25.0 cm^3 of 0.040 mol/dm^3 barium hydroxide solution reacted with 21.6 cm^3 of hydrochloric acid. Find the concentration of the hydrochloric acid in mol/dm^3 and g/dm^3.

$$Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

25.0 cm^3 21.6 cm^3
0.050 mol/dm^3

moles $Ba(OH)_2$ = conc x volume (dm^3) = 0.040 x $\frac{25.0}{1000}$ = 0.00100 mol

moles HCl = 2 x moles $Ba(OH)_2$ = 2 x 0.00100 mol = 0.00200 mol

concentration HCl in mol/dm^3 = $\frac{\text{moles NaOH}}{\text{volume } (dm^3)}$ = $\frac{0.00200}{\frac{21.6}{1000}}$ = 0.0926 mol/dm^3

concentration HCl in g/dm^3 = M_r x concentration HCl in mol/dm^3 = 0.0926 x 36.5 = 3.38 g/dm^3

A student carried out a titration to find the concentration of a solution of calcium hydroxide. In each titration, the student used 25.0 cm^3 of the calcium hydroxide solution and titrated it against 0.0100 mol/dm^3 hydrochloric acid solution.

$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

The student's results are shown in the table.

titration	1	2	3
start reading / cm^3	0.00	23.15	0.10
end reading / cm^3	23.15	47.05	23.90
volume added / cm^3			

a Find the mean titre to the appropriate number of significant figures and give the uncertainty in this measurement.

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b Find the concentration of the calcium hydroxide in mol/dm^3 and g/dm^3. Give your answers to 3 significant figures.

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c Outline the key steps in carrying out this titration.

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$$Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$$

The student's results are shown in the table.

titration	1	2	3
start reading / cm^3	0.00	23.15	0.10
end reading / cm^3	23.15	47.05	23.90
volume added / cm^3	**23.15**	**23.90**	**23.80**

a Find the mean titre to the appropriate number of significant figures and give the uncertainty in this measurement.

mean = $\frac{23.90 + 23.80}{2}$ = 23.85 ± 0.05 cm^3

b Find the concentration of the calcium hydroxide in mol/dm^3 and g/dm^3. Give your answers to 3 significant figures.

moles HCl = conc x volume (dm^3) = 0.0100 x $\frac{23.85}{1000}$ = 0.0002385 mol

moles $Ca(OH)_2$ = $\frac{\text{moles HCl}}{2}$ = $\frac{0.0002385}{2}$ = 0.00011925 mol

concentration $Ca(OH)_2$ in mol/dm^3 = $\frac{\text{moles } Ca(OH)_2}{\text{volume } (dm^3)}$ = $\frac{0.00011925}{\frac{25.0}{1000}}$ = 0.00477 mol/dm^3

concentration $Ca(OH)_2$ in g/dm^3 = M_r x concentration $Ca(OH)_2$ in mol/dm^3

= 0.00477 x 74 = 0.353 g/dm^3

c Outline the key steps in carrying out this titration.

- **using a pipette**
- **place 25.0 cm^3 of calcium hydroxide in a conical flask**
- **add an indicator**
- **put acid in a burette**
- **add acid to flask until indicator changes colour**
- **add drop by drop near the end**
- **record results**
- **repeat**

1 Calculate the relative formula mass (M_r) of each of the following substances.

a CO_2 **12 + 2(16) = 44**

b Mg **24**

c sodium oxide **Na_2O 2(23) + 16 = 62**

d calcium nitrate **$Ca(NO_3)_2$ 40 + 2(14) + 6(16) = 164**

2 Calculate the mass in grams of one atom of ^{19}F. Give your answer in standard form to 3 significant figures. (the Avogadro constant = 6.022×10^{23} mol^{-1})

mass of one atom $= \frac{19}{6.022 \times 10^{23}} = 3.16 \times 10^{-23}$ **g**

3 One molecule of water has a mass of 2.99×10^{-23} g. Use this to calculate the mass in grams of two moles of water molecules.

mass of two moles $= 2 \times 6.022 \times 10^{23} \times 2.99 \times 10^{-23} = 36$ **g**

MOLES (B)

1 What is the mass of one mole of CO_2?

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2 How many moles are there in 99 g of H_2O?

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3 What is the mass of 0.250 moles of N_2?

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4 How many moles are there in 1.2 kg of Mg?

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5 Calculate the relative formula mass (M_r) of each of the following substances.

a $Mg(NO_3)_2$ .....

b oxygen .....

c potassium sulfate .....

6 Calculate the mass in grams of one atom of ^{31}P. Give your answer in standard form to 3 significant figures. (the Avogadro constant = 6.022×10^{23} mol^{-1})

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MOLES (B)

1 What is the mass of one mole of CO_2?

M_r = 12 + 2(16) = 44

mass of 1 mole of CO_2 = 44 g

2 How many moles are there in 99 g of H_2O?

M_r = 2(1) + 16 = 18

moles = $\frac{\text{mass}}{M_r}$ = $\frac{99}{18}$ = 5.5 moles

3 What is the mass of 0.250 moles of N_2?

M_r = 2(14) = 28

mass = M_r x moles = 28 x 0.250 = 7.0 g

4 How many moles are there in 1.2 kg of Mg?

M_r = 24

moles = $\frac{\text{mass}}{M_r}$ = $\frac{1200}{24}$ = 50 moles

5 Calculate the relative formula mass (M_r) of each of the following substances.

a $Mg(NO_3)_2$ **M_r = 24 + 2(14) + 6(16) = 148**

b oxygen **O_2** **M_r = 2(16) = 32**

c potassium sulfate **K_2SO_4** **M_r = 2(39) + 32 + 4(16) = 174**

6 Calculate the mass in grams of one atom of ^{31}P. Give your answer in standard form to 3 significant figures. (the Avogadro constant = 6.022×10^{23} mol^{-1})

mass of one atom = $\frac{31}{6.022 \times 10^{23}}$ = 5.15×10^{-23} g

MOLES (C)

1 What mass of iron is formed when 240 g of iron(III) oxide reacts with carbon monoxide?

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

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2 What mass of oxygen reacts with 9.2 g of sodium?

$$4Na + O_2 \rightarrow 2Na_2O$$

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3 How many moles in each of the following?

a 12 mg of magnesium .....

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b 8.0 kg of oxygen .....

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4 What is the mass of each of the following?

a 0.100 moles of calcium hydroxide .....

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b 0.025 moles of aluminium sulfate .....

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MOLES (B)

1 What is the mass of one mole of CO_2?

M_r = 12 + 2(16) = 44

mass of 1 mole of CO_2 = 44 g

2 How many moles are there in 99 g of H_2O?

M_r = 2(1) + 16 = 18

moles = $\frac{\text{mass}}{M_r}$ = $\frac{99}{18}$ = 5.5 moles

3 What is the mass of 0.250 moles of N_2?

M_r = 2(14) = 28

mass = M_r x moles = 28 x 0.250 = 7.0 g

4 How many moles are there in 1.2 kg of Mg?

M_r = 24

moles = $\frac{\text{mass}}{M_r}$ = $\frac{1200}{24}$ = 50 moles

5 Calculate the relative formula mass (M_r) of each of the following substances.

a $Mg(NO_3)_2$ **M_r = 24 + 2(14) + 6(16) = 148**

b oxygen **O_2** **M_r = 2(16) = 32**

c potassium sulfate **K_2SO_4** **M_r = 2(39) + 32 + 4(16) = 174**

6 Calculate the mass in grams of one atom of ^{31}P. Give your answer in standard form to 3 significant figures. (the Avogadro constant = 6.022×10^{23} mol^{-1})

mass of one atom = $\frac{31}{6.022 \times 10^{23}}$ = 5.15×10^{-23} g

1 What mass of iron is formed when 240 g of iron(III) oxide reacts with carbon monoxide?

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

moles Fe_2O_3 = $\frac{mass}{M_r}$ = $\frac{240}{160}$ = 1.5 moles

moles Fe = 2 x 1.5 = 3.0 moles

mass Fe = M_r x moles = 56 x 3.0 = 168 g

2 What mass of oxygen reacts with 9.2 g of sodium?

$$4Na + O_2 \rightarrow 2Na_2O$$

moles Na = $\frac{mass}{M_r}$ = $\frac{9.2}{23}$ = 0.4 moles

moles O_2 = $\frac{0.4}{4}$ = 0.1 moles

mass O_2 = M_r x moles = 32 x 0.1 = 3.2 g

3 How many moles in each of the following?

a 12 mg of magnesium — **moles Mg = $\frac{mass}{M_r}$ = $\frac{0.012}{24}$ = 0.0005 moles**

b 8.0 kg of oxygen — **moles O_2 = $\frac{mass}{M_r}$ = $\frac{8000}{32}$ = 250 moles**

4 What is the mass of each of the following?

a 0.100 moles of calcium hydroxide — **mass $Ca(OH)_2$ = M_r x moles = 74 x 0.100 = 7.4 g**

b 0.025 moles of aluminium sulfate — **mass $Al_2(SO_4)_3$ = M_r x moles = 342 x 0.025 = 8.55 g**

1 a What is the maximum mass of potassium fluoride that can be formed when 1.56 g of potassium reacts with fluorine?

$$2K + F_2 \rightarrow 2KF$$

moles K = $\frac{\text{mass}}{M_r}$ = $\frac{1.56}{39}$ = 0.04 moles

moles KF = 0.04 moles

mass KF = M_r x moles = 58 x 0.4 = 2.32 g

b In an experiment, a student reacted 1.56 g of potassium with fluorine and made 1.48 g of potassium fluoride. Calculate the percentage yield.

% yield = $100 \times \frac{\text{mass formed}}{\text{maximum mass possible}}$ = $100 \times \frac{1.48}{2.32}$ = 63.8%

c Give two reasons why the percentage yield is less than 100%.

incomplete reaction

some products escape / left on apparatus

reaction may be reversible

2 Calculate the percentage yield in a reaction where 1.0 kg of iron is made from 1.6 kg of iron(III) oxide.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

moles Fe_2O_3 = $\frac{\text{mass}}{M_r}$ = $\frac{1600}{160}$ = 10 moles

moles Fe = 20 moles

mass Fe = M_r x moles = 56 x 20 = 1120 g

% yield = $100 \times \frac{\text{mass formed}}{\text{maximum mass possible}}$ = $100 \times \frac{1000}{1120}$ = 89.3%

MOLES (E)

1 a How many moles of magnesium bromide are formed when 3.0 moles of magnesium reacts with 2.0 moles of bromine?

$Mg + Br_2 \rightarrow MgBr_2$

.....

b How many moles of ammonia are formed when 4.0 moles of nitrogen reacts with 9.0 moles of hydrogen?

$N_2 + 3H_2 \rightarrow 2NH_3$

.....

c How many moles of iron oxide are formed when 12.0 moles of iron reacts with 6.0 moles of oxygen?

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

.....

2 4.8 g of magnesium is reacted with 4.5 g of steam. Work out which is the limiting reagent and then calculate the mass of magnesium oxide formed.

$$Mg + H_2O \rightarrow MgO + H_2$$

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3 2.0 g of calcium is reacted with 0.32 g of oxygen. Work out which is the limiting reagent and then calculate the mass of calcium oxide formed.

$$2Ca + O_2 \rightarrow 2CaO$$

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1 a How many moles of magnesium bromide are formed when 3.0 moles of magnesium reacts with 2.0 moles of bromine?

$Mg + Br_2 \rightarrow MgBr_2$

2.0 moles of $MgBr_2$

b How many moles of ammonia are formed when 4.0 moles of nitrogen reacts with 9.0 moles of hydrogen?

$N_2 + 3H_2 \rightarrow 2NH_3$

6.0 moles of NH_3

c How many moles of iron oxide are formed when 12.0 moles of iron reacts with 6.0 moles of oxygen?

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

4.0 moles of Fe_2O_3

2 4.8 g of magnesium is reacted with 4.5 g of steam. Work out which is the limiting reagent and then calculate the mass of magnesium oxide formed.

$$Mg + H_2O \rightarrow MgO + H_2$$

moles Mg = $\frac{mass}{M_r}$ = $\frac{4.8}{24}$ = 0.2 mol

moles H_2O = $\frac{mass}{M_r}$ = $\frac{4.5}{18}$ = 0.25 mol

0.2 moles of Mg needs 0.2 moles of H_2O for all the Mg to react,

there is more than enough H_2O and so the H_2O is in excess, therefore Mg is the limiting reagent

therefore 0.2 moles of Mg reacts with the 0.2 moles of H_2O, and forms 0.2 moles of MgO

mass MgO = M_r x moles = 40 x 0.2 = 8 g

3 2.0 g of calcium is reacted with 0.32 g of oxygen. Work out which is the limiting reagent and then calculate the mass of calcium oxide formed.

$$2Ca + O_2 \rightarrow 2CaO$$

moles Ca = $\frac{mass}{M_r}$ = $\frac{2.0}{40}$ = 0.05 mol

moles O_2 = $\frac{mass}{M_r}$ = $\frac{0.32}{32}$ = 0.01 mol

0.05 moles of Ca needs 0.025 moles of O_2 for all the Ca to react, but we don't have this much O_2

therefore O_2 is the limiting reagent (so the Ca is in excess and does not all react)

therefore only 0.02 moles of Ca reacts with the 0.01 moles of O_2, and forms 0.02 moles of CaO

mass CaO = M_r x moles = 56 x 0.02 = 1.12 g