BOLTON
SCHOOL
BOYS' DIVISION

Transition from GCSE to AS level

Part 9 - Percentage Yield and Atom Economy

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Percentage yield

Most reactions do not produce 100% yield

The reaction

- may not go to completion or
- by-products may be formed

Yield is often expressed as percentage yield, i.e.

The actual yield is given as a percentage of the maximum yield expected if the reaction worked perfectly.

$$\text{Percentage yield} = \frac{\text{actual yield}}{\text{maximum expected yield}} \times 100$$

Example 4

a) What mass of magnesium chloride is formed when 6.80 g magnesium react with excess hydrochloric acid ? (Mg = 24.3 Cl = 35.5)

b) If the actual mass of $MgCl_2$ obtained is 19.5g, calculate the percentage yield.

a) $Mg + 2HCl \rightarrow MgCl_2 + H_2$

M_r values Mg = 24.3 $MgCl_2 = 24.3 + (35.5 \times 2)$

$= 24.3 + 71.0 = 95.3$

Step 1

$$\text{mol of Mg} = \frac{\text{mass given}}{\text{mass of one mole}} = \frac{6.80}{24.3} = 0.280$$

Step 2

From the equation, 0.280 mol Mg forms 0.280 mol of $MgCl_2$

Step 3

mass of $MgCl_2$ formed = no of moles × mass of one mole

$= 0.280 \times 95.3$

∴ Expected yield of $MgCl_2$ = **26.7g** (3 sig figs)

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∴ Expected yield of $MgCl_2$ = **26.7g** (3 sig figs)

b) $$\text{Percentage yield} = \frac{\text{actual yield}}{\text{expected yield}} \times 100 = \frac{19.5}{26.7} \times 100$$

= **73.1%** (3 sig figs)

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[97] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac** † actinium 89	[267] **Rf** rutherfordium 104	[270] **Db** dubnium 105	[269] **Sg** seaborgium 106	[270] **Bh** bohrium 107	[270] **Hs** hassium 108	[278] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[281] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

Key

relative atomic mass
symbol
name
atomic (proton) number

140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.0 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

* **58 – 71** Lanthanides

† **90 – 103** Actinides

Use this for the task on the next page

Percentage Yield

1. 2.0 g of calcium is added to excess dilute hydrochloric acid.
   3.33 g of calcium chloride is produced.
   Calculate the percentage yield.

2. 4.6 g of sodium is added to excess water.
   3.0 g of sodium hydroxide is produced.
   Calculate the percentage yield.

3. 7.8 g of potassium is burnt in excess oxygen.
   3.2 g of potassium oxide is produced.
   Calculate the percentage yield.

4. 1.28 g of methane is burnt in excess oxygen.
   1.2 g of water is produced.
   Calculate the percentage yield.

Pause this presentation while you complete the exercise on the previous page.

When complete move to the next page where you can check your answers.

Percentage Yield Answers

1. 60%

2. 37.5 %

3. 34.0 %

4. 41.7 %

Having checked your work you will have either:

1. Completed the task correctly - well done :)

2. Made some mistakes - which you now understand (having seen the correct answer) - that's OK as you have 'learned from your mistakes'

3. Do not understand the answer - if this is the case you **must** seek assistance from your teacher (if you do not then you will ***never*** understand this and this may be a building block for later work!)

When you’re confident with this topic move onto part 10:

Atom economy