Name……. Date…….

Test on Stoichiometry

1 A compound, X, contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass.

The relative molecular mass, Mr, of X is 60.

What is the molecular formula of X?

A CH_2O **B** CH_4O **C** C_2H_4O **D** $C_2H_4O_2$

2 What is the percentage, by mass, of **nitrogen** in the fertiliser **$(NH_4)_3PO_4$?**

[Ar: H, 1; N, 14; O, 16; P, 31]

A 9.4% **B** 18.8% **C** 28.2% **D** 37.6%

3 A 25 cm^3 sample of dilute sulphuric acid contains 0.025 moles of the acid.

What is the concentration of the acid in the solution?

A 0.25 mol /dm^3 **B** 0.50 mol /dm^3 **C** 1.00 mol /dm^3 **D** 2.00 mol /dm^3

4 The empirical formula of a liquid compound is C_2H_4O.

To find the empirical formula, it is necessary to know the

A density of the compound.

B percentage composition of the compound.

C relative molecular mass of the compound.

D volume occupied by 1 mole of the compound.

5 The equation represents the action of dilute nitric acid on copper.

$$xCu + yHNO_3 \rightarrow xCu(NO_3)_2 + 4H_2O + 2NO$$

What are the values of x and y?

A x = 1, y = 4 **B** x = 1, y = 8 **C** x = 3, y = 4 **D** x = 3, y = 8

6.(a) Complete the table below

Compound	Formula	RFM	Mass	Number of moles	Volume of solution	Concentration
Iron(iii) sulfate	$Fe_2(SO_4)_3$		6.4g		$20cm^3$	
	$NaNO_3$		3.4g			$0.2mol/dm^3$
Silver nitrate	$AgNO_3$				$80cm^3$	$0.08mol/dm^3$
Oxygen gas	O_2		9.6g			XXXXXXXX
Propane gas	C_3H_8				$14.2dm^3$	XXXXXXXX

(1 mole of gas occupies $24dm^3$)

(b) Complete the following word equations.

(i) magnesium hydroxide + dilute nitric acid

..... [1]

(ii) zinc + dilute sulfuric acid

..... [1]

(iii) copper carbonate + dilute sulfuric acid

..... [1]

(c) Complete the following equations for reactions of these two acids.

(i) sodium hydroxide + phosphoric acid → ..... + ... **[1]**

(ii) $CuO + H_2SO_4 \rightarrow$ ..... + ... **[1]**

(iii) Mg + …. HCl → ..... + ... **[1]**

(iv) $K_2CO_3 + H_2SO_4 \rightarrow$ ..... + ... + ... **[1]**

7. (a) Sodium nitrate is a white crystalline solid. When heated it melts and the following reaction occurs.

$$\mathbf{2NaNO_3(l) \rightarrow 2NaNO_2(l) + O_2(g)}$$

A 3.40 g sample of sodium nitrate is heated.

Calculate the

• number of moles of $NaNO_3$ used,

..... mol

• number of moles of O_2 formed,

..... mol

• volume of O_2 formed, in dm^3 (measured at r.t.p.).

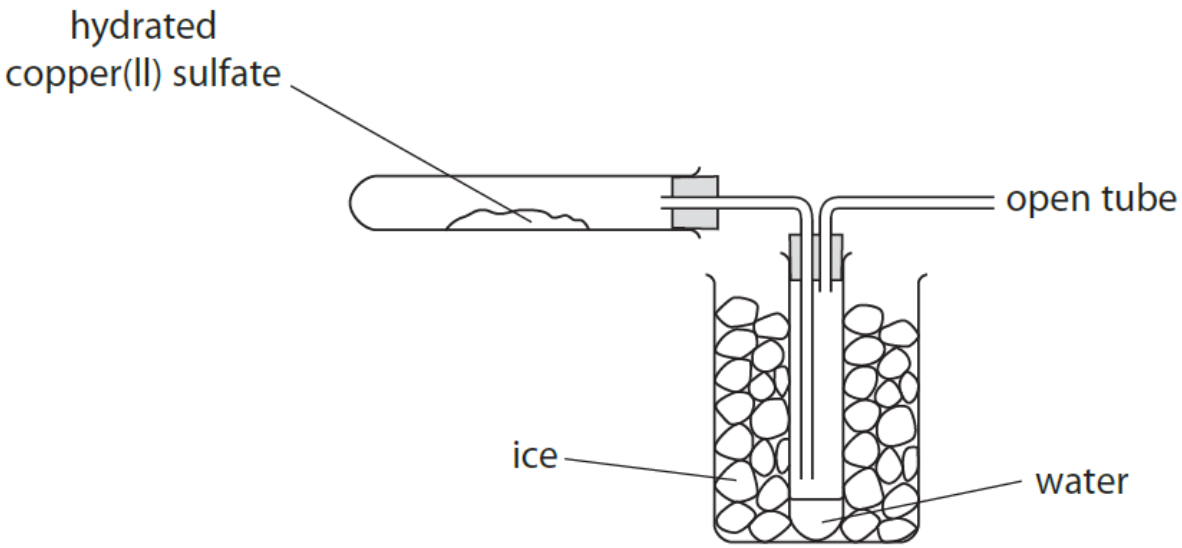
..... dm^3

[3]

8 The apparatus in the diagram is used to heat a sample of hydrated copper(II) sulfate crystals, $CuSO_4.5H_2O$

The equation for the reaction that takes place is

$$CuSO_4.5H_2O(s) \rightarrow CuSO_4(s) + 5H_2O(l)$$



(a) Draw an arrow on the diagram to show where heat is applied.

(1)

(b) What is the purpose of the ice?

(1)

.....

(c) Calculate the maximum mass of water that could be collected when a sample of hydrated copper(II) sulfate of mass 2.50 g is heated.

[*M*r of $CuSO_4.5H_2O$ is 250]

(3)

mass of water = ... g

9 Titanium is a metal that can be extracted from its ore in a three-stage process.

stage 1	titanium ore is converted into titanium dioxide, TiO_2
stage 2	titanium dioxide is then converted into titanium chloride, $TiCl_4$
stage 3	titanium chloride is converted into titanium, Ti

(a) A titanium ore contains the composition by mass

Fe = 36.8% Ti = 31.6% O = 31.6%

Show by calculation that the empirical formula of this ore is $FeTiO_3$

(3)

10 Potassium hydrogencarbonate ($KHCO_3$) decomposes on heating.

Three possible equations for the decomposition are

equation 1 $2KHCO_3(s) \rightarrow K_2O(s) + 2CO_2(g) + H_2O(g)$

equation 2 $KHCO_3(s) \rightarrow KOH(s) + CO_2(g)$

equation 3 $2KHCO_3(s) \rightarrow K_2CO_3(s) + CO_2(g) + H_2O(g)$

When 8.00 g of potassium hydrogencarbonate is heated until it is fully decomposed, 5.52 g of solid is formed.

(a) Complete the table by calculating the amount, in moles, of each solid.

(2)

Solid	M_r of solid	Mass of solid in g	Amount of solid in mol
$KHCO_3$	100	8.00	
K_2O	94	5.52	
KOH	56	5.52	
K_2CO_3	138	5.52	

(b) Use the information in the table to explain which equation, 1, 2 or 3, represents the decomposition of potassium hydrogencarbonate.

(2)

.....

.....

.....

.....

.....

11(a) One of the compounds in the table reacts with bromine to form G, a compound with the composition by mass C = 22.2%, H = 3.7%, Br = 74.1%.

(i) Show, by calculation, that the empirical formula of G is C_2H_4Br

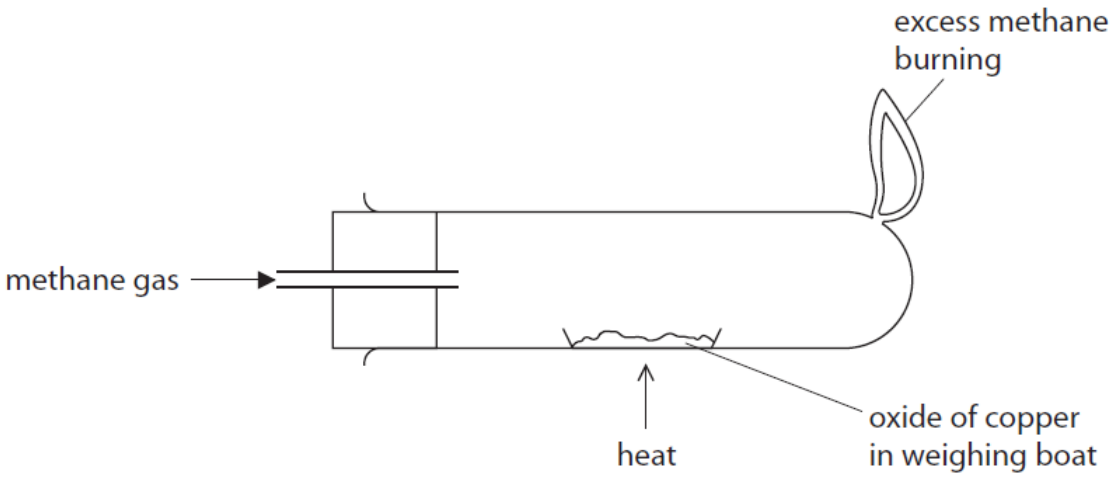
(3)

(ii) The relative formula mass of G is 216

Deduce the molecular formula of G.

(2)

(b) A teacher uses this apparatus to demonstrate the reaction between a different oxide of copper and methane.



(i) The teacher heats the oxide of copper until the reaction is complete.

The table shows the teacher's results.

	Mass in g
empty weighing boat	15.05
weighing boat + oxide of copper	18.63
weighing boat + copper	18.23

Use the teacher's results to show that the empirical formula of this oxide of copper is Cu_2O

(4)

(ii) When hydrated copper(II) sulfate crystals are heated, anhydrous copper(II) sulfate forms.

A mass of 12.5 g of hydrated copper(II) sulfate crystals is heated in a crucible until all the water of crystallisation is removed.

A mass of 8.0 g of anhydrous copper(II) sulfate forms.

Show by calculation that the formula of hydrated copper(II) sulfate is $CuSO_4.5H_2O$

[*M*r of $CuSO_4$ = 159.5 *M*r of H_2O = 18]

(4)

12 Lithium hydroxide (LiOH) and lithium peroxide (Li_2O_2) have been used in spacecraft to remove the carbon dioxide astronauts breathe out.

The equations for the reactions with carbon dioxide are

$$2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$$

$$2Li_2O_2 + 2CO_2 \rightarrow 2Li_2CO_3 + O_2$$

(b) (i) Calculate the mass of lithium hydroxide needed to react with 100 g of carbon dioxide.

[*M*r of LiOH = 24]

(3)

mass of lithium hydroxide = ... g

(ii) Calculate the volume of carbon dioxide, at room temperature and pressure, removed by 100 g of lithium peroxide.

[*M*r of Li_2O_2 = 46]

Assume that one mole of gas has a volume of 24 000 cm^3 at rtp.

(3)

volume of carbon dioxide = ... cm^3

(c) After drying the crystals, the student weighs them and then heats them until they reach a constant mass.

This equation represents the change that occurs during heating.

$$MgSO_4.xH_2O \rightarrow MgSO_4 + xH_2O$$

These are the student's results.

mass of dry crystals before heating = 17.2 g

mass of crystals after heating to a constant mass = 8.3 g

Use these results to find the value of x in the formula of $MgSO4.xH_2O$

[*M*r values: $MgSO_4$ = 120, H_2O = 18]

(4)

(d) Potassium sulfate can be prepared by reacting aqueous potassium hydroxide with dilute sulfuric acid.

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

In an experiment, 20.0 cm^3 of 0.650 mol / dm^3 sulfuric acid is just neutralised by aqueous potassium hydroxide.

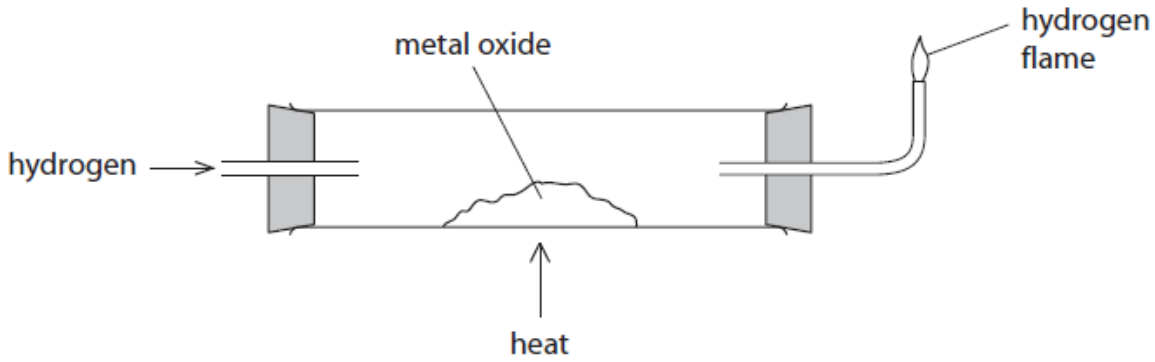
(i) Calculate the maximum mass of potassium sulfate, K_2SO_4, that could be prepared.

maximum mass of potassium sulfate = ... g [3]

(ii) After crystallisation, 1.72 g of dry potassium sulfate was obtained. Calculate the percentage yield of potassium sulfate.

percentage yield of potassium sulfate = ... % [1]

13. This apparatus can be used to investigate the reduction of metal oxides.



In an experiment using a different metal oxide, a mass of 2.8 g of metal is obtained from 3.6 g of the metal oxide.

The formula of the metal oxide is MO, where M is the symbol of the metal.

Deduce the amount, in moles, of M in the sample of the metal oxide hence calculate the relative atomic mass of M?

(5)

relative atomic mass of M = ...

Metal M is ……

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).