Candidate Name: .....

St Swithun's
WINCHESTER

Chemistry

Sixth Form Academic Assessment

Sample paper

Time allowed : 1 hour

Instructions to Candidates

Candidates should answer <u>all</u> questions
Some of the questions involve material you will NOT have studied. You should use the information in the question, and your own logical reasoning to answer them.

<u>Further Information</u>

You may use a calculator

You may detach the periodic table from the back of the paper for ease of use if you wish

Marking allocation

For examiner use only

	score	total
1		5
2		5
3		6
4		9
5		9
6		10
7		13
8		8
total		65

1. Give the formulae for the following chemical compounds: (5)

   a) Silicon dioxide ……

   b) Aluminium Carbonate ……

   c) Copper (I) Oxide ……

   d) Sodium Hydrogen carbonate ……

   e) Silver Nitrate ……..

2. Balance the following equations.

a) ……CH_4 + ……O_2 → ……..C + ……H_2O (1)

b) ……I_2 + ……$Na_2S_2O_3$ → ……..NaI + ……$Na_2S_4O_6$ (2)

c) …….Fe_2O_3 + ……..HCl → …….. $FeCl_3$ + …….. H_2O (2)

3. Ammonium dichromate is an explosive compound that decomposes exothermically to produce chromium oxide, nitrogen gas and steam.
A wick made of a wooden splint soaked in ethanol is position in the centre of a small heap of ammonium dichromate. The wick is ignited to start the reaction.

a) Given that the equation below is correctly balanced, deduce the formula of the chromium oxide that forms.

$$(NH_4)_2Cr_2O_{7\,(s)} \rightarrow \ldots\ldots\ldots\ldots\ldots + N_{2(g)} + 4H_2O_{(g)} \qquad (1)$$

b) Explain why this reaction is **not** regarded as combustion, despite the reaction being started by igniting the ethanol splint wick.

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(1)

c) Describe a test, and the expected result that could be carried out to demonstrate the presence of water vapour in the gases produced from this reaction.

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(2)

d) The reaction is faster when the ammonium dichromate is used as a fine powder. Suggest why it would be dangerous to grind the ammonium dichromate powder to produce a fine powder.

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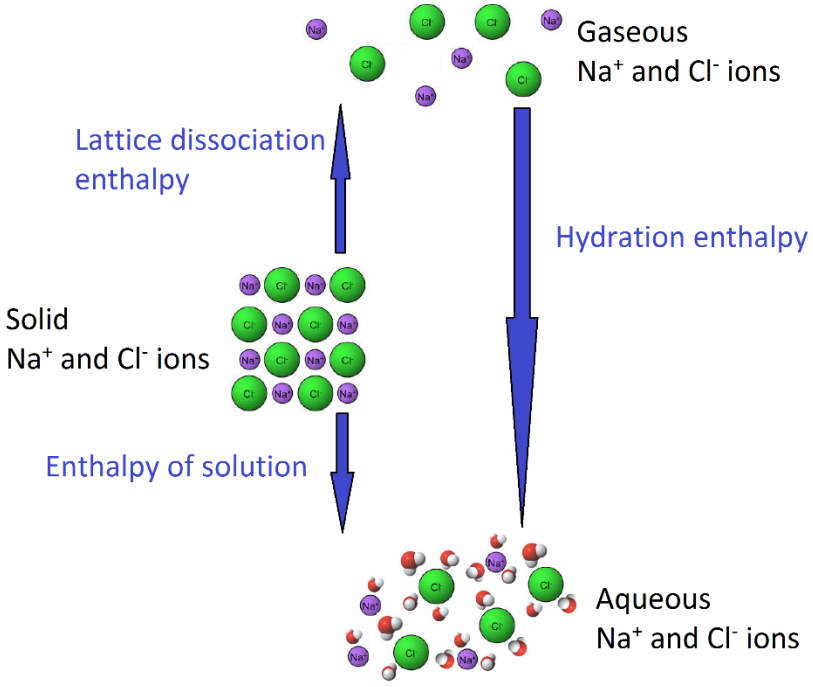
(2)

4. The diagrams show the arrangement of ions in sodium chloride when it is in solid form, gaseous and dissolved.

   The arrows are labelled to show the energy changes involved in converting between these forms.



a) The table gives data for two of the energy changes shown above.

Lattice dissociation enthalpy of NaCl (kJmol^{-1})	Hydration enthalpy of NaCl (kJmol^{-1})
780	-784

Use the data to show that the enthalpy of solution for sodium chloride is -4 kJmol^{-1}.

(1)

b) Would you expect the temperature of water to increase or decrease when sodium chloride is added to it? Give a reason for your answer

Temperature would ……..

Reason ……

…….. (1)

c) Derive a formula to calculate enthalpy of solution (ΔH_{sol}) from lattice dissociation enthalpy (ΔH_{diss}) and Hydration enthalpy (ΔH_{hyd}).

(1)

d) The enthalpy data for some other ionic compounds is given in the table.
Use the data, and the formula you derived in part (c) to calculate the missing values in the table.

Compound	ΔH_{diss} ($kJmol^{-1}$)	ΔH_{hyd} ($kJmol^{-1}$)	ΔH_{sol} ($kJmol^{-1}$)
$MgCl_2$	2526	-2682	
$CaCl_2$	2258	-2335	
AgCl	905		+54
KCl	711		+13

(4)

e) Which of the compounds above dissolves most exothermically?

…… (1)

f) Use the data to suggest why AgCl is insoluble

……

…… (1)

5. Diamond and Silicon dioxide have similar structures. Both have very high melting points.
The diagram shows their structures.

Diamond

Silicon dioxide

a) Explain, with reference to the structure and bonding in diamond and silicon dioxide, why they both have high melting points.

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(3)

b) Silicon dioxide is a solid at room temperature. It has the formula SiO_2.
Carbon dioxide is a gas at room temperature. It has the formula CO_2.
Explain, with reference to structure and bonding of Carbon dioxide, why it is a gas at room temperature.

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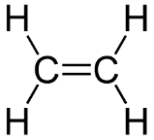
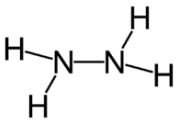
(3)

c) Draw a dot and cross diagram to show the electron arrangement in CO_2.
Show outer shells only.

(2)

d) Ethene and hydrazine have similar molar masses. They are both gases at room temperature.

Some information about Ethene and hydrazine is given in the table below.

Gas	**Molar mass (g)**	**Structure**
Ethene	28	
Hydrazine	32	

Suggest which molecule would have the higher boiling point. Give a reason for your answer.

Molecule with higher boiling point ……

Reason ……

…… (1)

6. Magnesium sulfate is used to draw infection out from wounds. It absorbs moisture from the skin around the wound, causing the skin to shrivel back, exposing the infection.

   The magnesium sulfate works most effectively in this way when it is used as an anhydrous salt.

a) Describe how to safely prepare crystals of hydrated magnesium sulfate from magnesium carbonate and sulfuric acid.

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……(5)

b) A student wanted to find the formula of hydrated magnesium sulfate.
She took a sample of hydrated magnesium sulfate and heated it to constant mass

   The equation for the reaction that occurred is given below:

$$MgSO_4 \bullet nH_2O \rightarrow MgSO_4 + nH_2O$$

   The formula $MgSO_4 \bullet nH_2O$ represents magnesium sulfate and its water of crystallisation.

The data she collected is given in the table below

Mass of hydrated magnesium sulfate and crucible	8.87 g
Final mass of anhydrous magnesium sulfate and crucible	8.15 g
Mass of empty crucible	5.75 g

i. Why was it important to keep heating the magnesium sulfate to constant mass?

……..

……(1)

ii. Calculate the mass of water of crystallisation lost from the crystals

Mass of water of crystallization = ……..g
(1)

iii. Use the data to calculate the formula of hydrated magnesium sulfate.
[M_r $MgSO_4$ = 120, M_r H_2O = 18]

(3)

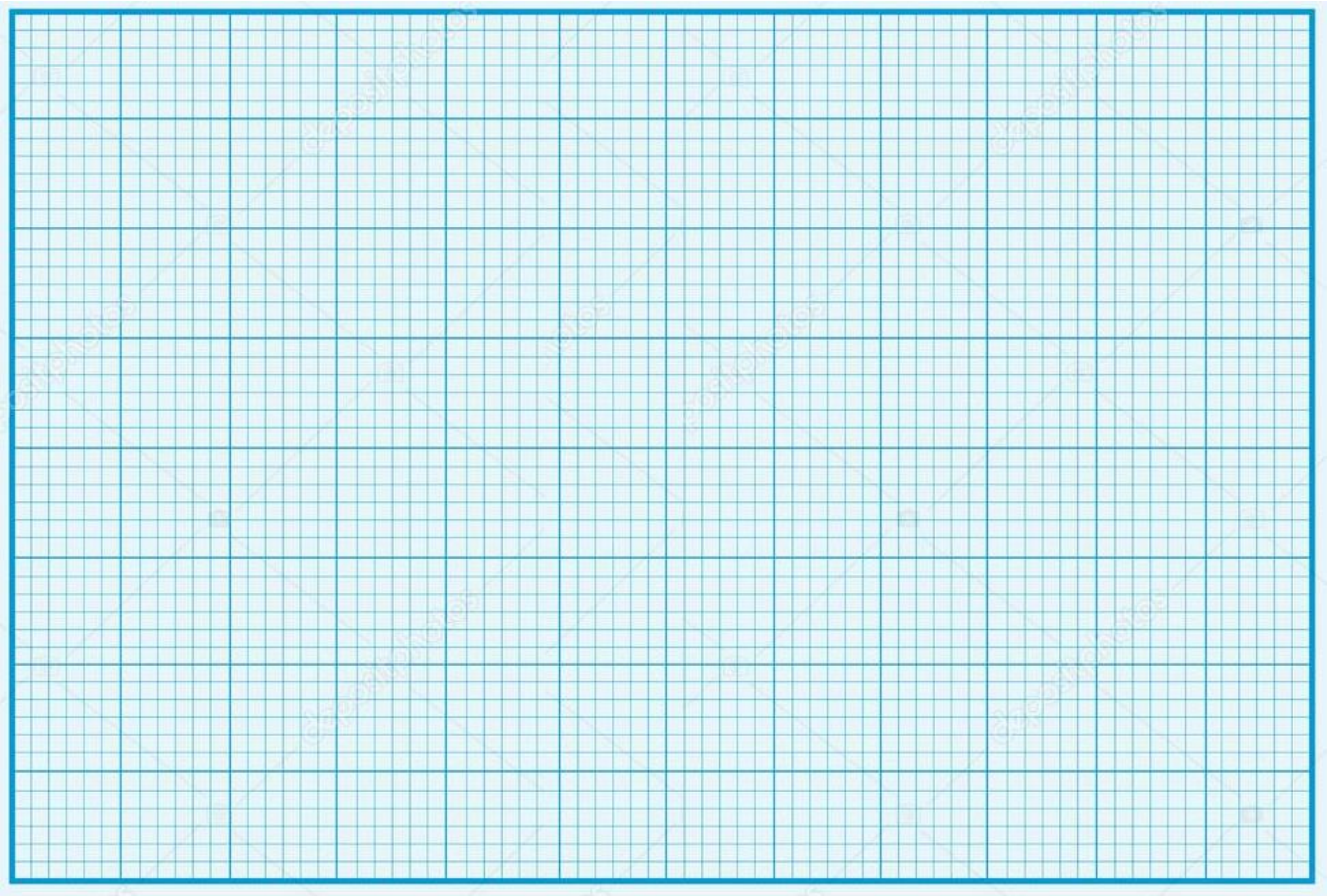
7. Metals and solutions can undertake displacement reactions.
There is a temperature change while the reaction occurs.

A student measured 25cm^3 of copper sulfate solution using a measuring cylinder and carried out a series of reactions.
In each reaction, she added a known mass of zinc powder to a fresh portion of the copper sulfate in a beaker.
She stirred the mixture and recorded the maximum temperature change.

The table below shows the data she collected.

Mass of Zn powder added (g)	0.50	1.00	1.50	2.00	2.50	3.00
Temperature rise (^{o}C)	15.0	28.5	44.0	46.0	46.5	46.0

a) Use the grid below to plot the data. Choose sensible scales for the axes.



(3)

b) Draw a line of best fit through the first 3 points, and a second line of best fit through the remaining 3 points.
Make sure both lines are extrapolated, so that the lines cross.
(1)

c) Explain why the temperature rise reaches a maximum, and then does not increase, despite more zinc being added.

…….

…… (1)

d) Use your graph to determine the precise minimum mass of zinc powder to produce the maximum temperature rise.

Minimum mass of zinc powder …… g (1)

e) The copper sulfate solution used in the reaction was prepared by dissolving 31.90g $CuSO_4$ in 200 cm^3 of water.

i. Determine the concentration in g/cm^3 of copper sulfate in the solution that was prepared.

……g/cm^3 (1)

ii. Determine the mass of copper sulfate present in the 25cm^3 of solution used.

Mass of $CuSO_4$ = ……..g (1)

iii. Determine the volume of this copper sulfate solution that would be need to react with precisely 1.00g of Zinc powder

Volume of $CuSO_4$ solution = ……..cm^3 (1)

f) The energy produced in this reaction can be calculated using the formula

$Q = mc\triangle T$

where Q is the energy change in J
m is the total mass of solution the thermometer is in
c is the specific heat capacity of water, which is 4.2 J g^{-1} $^{o}C^{-1}$
$\triangle T$ is the maximum temperature change in ^{o}C

Calculate the maximum energy produced in this reaction
(Assume the mass of solution is the mass of water in the solution only, do not include the mass of solvent)

Energy change = ……..J (2)

g) The literature value for the energy change for this reaction is 5425 J.

Suggest **two** changes the student could make to her experiment to improve the accuracy of her data.

1. ……

2. …… (2)

8. You are given samples of 4 chemicals. They are all soluble white powders.

The chemicals are : Potassium bromide
Potassium sulfate
Sodium sulfate
Sodium carbonate.

The jars are labelled A, B, C and D. You do know which chemical is which.

You are required to describe some tests and the expected results that would enable you to find the identities of A, B, C and D.

The following tests may be useful:

Flame test			**Sulfate test**	
Potassium compounds	Produce a lilac flame when held in a blue Bunsen flame		Sulfate compounds	Produce a white precipitate when $BaCl_{2(aq)}$ is added to a solution of a sulfate
Sodium compounds	Produce a golden yellow flame when held in a blue Bunsen flame		Other compounds	Remain a colourless solution when $BaCl_{2(aq)}$ is added
Halide test			**Carbonate test**	
Bromide compounds	Produce a cream precipitate when $AgNO_{3(aq)}$ is added to a solution containing a bromide		Carbonate compounds	Fizz when dilute HCl is added to the solid. Gas produced turns limewater cloudy
Other non halide compounds	Remain a colourless solution when $AgNO_{3(aq)}$ is added		Other compounds	Do not fizz when dilute HCl is added

a) Which gas is produced when carbonate react with dilute HCl?

……(1)

b) Deduce the identity of the white precipitate formed when $BaCl_{2(aq)}$ is added to solutions containing sulfate compounds.

……(1)

c) Use the information in the table to describe how to carry out a series of tests to determine the identity of A, B, C and D.
Make sure you say what the expected results would be that would enable you to deduce the identity of a compound.

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The Periodic Table

$^{1}H_{1}$ Hydrogen																	$^{4}He_{2}$ Helium
$^{7}Li_{3}$ Lithium	$^{9}Be_{4}$ Beryllium											$^{11}B_{5}$ Boron	$^{12}C_{6}$ Carbon	$^{14}N_{7}$ Nitrogen	$^{16}O_{8}$ Oxygen	$^{19}F_{9}$ Fluorine	$^{20}Ne_{10}$ Neon
$^{23}Na_{11}$ Sodium	$^{24}Mg_{12}$ Magnesium											$^{27}Al_{13}$ Aluminium	$^{28}Si_{14}$ Silicon	$^{31}P_{15}$ Phosphorous	$^{32}S_{16}$ Sulphur	$^{35.5}Cl_{17}$ Chlorine	$^{40}Ar_{18}$ Argon
$^{39}K_{19}$ Potassium	$^{40}Ca_{20}$ Calcium	$^{45}Sc_{21}$ Scandium	$^{48}Ti_{22}$ Titanium	$^{51}V_{23}$ Vanadium	$^{52}Cr_{24}$ Chromium	$^{55}Mn_{25}$ Manganese	$^{56}Fe_{26}$ Iron	$^{59}Co_{27}$ Cobalt	$^{59}Ni_{28}$ Nickel	$^{64}Cu_{29}$ Copper	$^{65}Zn_{30}$ Zinc	$^{70}Ga_{31}$ Gallium	$^{73}Ge_{32}$ Germanium	$^{75}As_{33}$ Arsenic	$^{79}Se_{34}$ Selenium	$^{80}Br_{35}$ Bromine	$^{84}Kr_{36}$ Krypton
$^{85}Rb_{37}$ Rubidium	$^{88}Sr_{38}$ Strontium	$^{89}Y_{39}$ Yttrium	$^{91}Zr_{40}$ Zirconium	$^{93}Nb_{41}$ Niobium	$^{96}Mo_{42}$ Molybdenum	$^{98}Tc_{43}$ Technecium	$^{101}Ru_{44}$ Ruthenium	$^{103}Rh_{45}$ Rhodium	$^{106}Pd_{46}$ Palladium	$^{108}Ag_{47}$ Silver	$^{112}Cd_{48}$ Cadmium	$^{115}In_{49}$ Indium	$^{119}Sn_{50}$ Tin	$^{122}Sb_{51}$ Antimony	$^{128}Te_{52}$ Tellurium	$^{127}I_{53}$ Iodine	$^{131}Xe_{54}$ Xenon
$^{133}Cs_{55}$ Caesium	$^{137}Ba_{56}$ Barium	Lanthanides	$^{178}Hf_{72}$ Hafnium	$^{181}Ta_{73}$ Tantalum	$^{184}W_{74}$ Tungsten	$^{186}Re_{75}$ Rhenium	$^{190}Os_{76}$ Osmium	$^{192}Ir_{77}$ Iridium	$^{195}Pt_{78}$ Platinum	$^{197}Au_{79}$ Gold	$^{201}Hg_{80}$ Mercury	$^{204}Tl_{81}$ Thallium	$^{207}Pb_{82}$ Lead	$^{209}Bi_{83}$ Bismuth	$^{209}Po_{84}$ Polonium	$^{210}At_{85}$ Astatine	$^{222}Rn_{86}$ Radon
$^{223}Fr_{87}$ Francium	$^{226}Ra_{88}$ Radium	Actinides	$^{261}Rf_{104}$ Rutherfordium														

Lanthanides	$^{139}La_{57}$ Lanthanium	$^{140}Ce_{58}$ Cerium	$^{141}Pr_{59}$ Praseodinium	$^{144}Nd_{60}$ Neodynium	$^{145}Pm_{61}$ Promethium	$^{150}Sm_{62}$ Samarium	$^{152}Eu_{63}$ Europium	$^{157}Gd_{64}$ Gadolinium	$^{159}Tb_{65}$ Terbium	$^{163}Dy_{66}$ Dysprosium	$^{165}Ho_{67}$ Holmium	$^{167}Er_{68}$ Erbium	$^{169}Tm_{69}$ Thallium	$^{173}Yb_{70}$ Ytterbium	$^{175}Lu_{71}$ Lutetium
Actinides	$^{227}Ac_{89}$ Actinium	$^{232}Th_{90}$ Thorium	$^{231}Pa_{91}$ Protactinium	$^{238}U_{92}$ Uranium	$^{237}Np_{93}$ Neptunium	$^{244}Pu_{94}$ Plutonium	$^{243}Am_{95}$ Americium	$^{247}Cm_{96}$ Curium	$^{247}Bk_{97}$ Berkelium	$^{251}Cf_{98}$ Californium	$^{252}Es_{99}$ Einsteinium	$^{257}Fm_{100}$ Fermium	$^{258}Md_{101}$ Mendeleevium	$^{259}No_{102}$ Nobelium	$^{260}Lr_{103}$ Lawrencium

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