Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Teacher's Use	
Section	Mark
PSA	
Task	
Section A	
Section B	
TOTAL (max 50)	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Chemistry CHM3T/P14/test

Unit 3T AS Investigative Skills Assignment

Written Test

For submission by 15 May 2014

For this paper you must have:	**Time allowed**
• the Periodic Table/Data Sheet provided at the end of this paper • your Task Sheet and your Candidate Results Sheet • a ruler with millimetre measurements • a calculator.	• 1 hour
Instructions	**Information**
• Use black ink or black ball-point pen. • Fill in the boxes at the top of this page. • Answer **all** questions. • You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages. • Do all rough work in this book. Cross through any work you do not want to be marked.	• The marks for questions are shown in brackets. • The maximum mark for this paper is 30. • You are expected to use a calculator, where appropriate. • You will be marked on your ability to: – organise information clearly – use scientific terminology accurately.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:
I confirm that the candidate's work was conducted under the conditions laid out by the specification. I have authenticated the candidate's work and am satisfied that to the best of my knowledge the work produced is solely that of the candidate.

Signature of teacher ..... Date .....

Section A

These questions are about the task, the determination of the composition of a mixture.

You should use your Task Sheet and your Candidate Results Sheet to answer these questions.

Answer **all** questions in the spaces provided.

1 Record the average titre from your Candidate Results Sheet.

[1 mark]

.....

2 The concentration of the hydrochloric acid used was 0.0985 mol dm^{-3}.

Calculate the amount, in moles, of HCl in 25.0 cm^3 of this hydrochloric acid.

[1 mark]

.....

.....

3 Use your answers from Questions **1** and **2** to calculate the concentration, in mol dm^{-3}, of sodium hydroxide in solution **A**. Show your working.
Give your answer to the appropriate precision.

[2 marks]

.....

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.....

4 Use your answer from Question **3** to calculate the concentration, in g dm^{-3}, of sodium hydroxide in solution **A**.

(If you were unable to complete the calculation in Question **3**, you may assume that the concentration of the sodium hydroxide is 0.135 mol dm^{-3}. This is **not** the correct value.)

[1 mark]

.....

.....

5 Complete evaporation of 25.0 cm^3 of solution **A** left 0.395 g of solid residue. This solid residue contained only sodium chloride and sodium hydroxide.

Use your answer from Question **4** to calculate the percentage by mass of **sodium chloride** in the residue. Show your working.

[2 marks]

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6 State why the presence of sodium chloride in solution **A** does **not** give an incorrect result in the titration.

[1 mark]

.....

.....

7 The maximum total errors for the pipette and the burette are

pipette ±0.05 cm^3
burette ±0.15 cm^3

These errors take into account multiple measurements.

Estimate the combined maximum percentage error in using both of these pieces of apparatus. (You should use your average titre from Question **1** to calculate the percentage error in using the burette.)

[1 mark]

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8 The correct technique can improve the accuracy of a titration.

8 (a) State why it is important to fill the space below the tap in the burette with solution **A** before beginning an accurate titration.

[1 mark]

.....

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8 (b) Suggest **one** reason why a 250 cm^3 conical flask is preferred to a 250 cm^3 beaker for a titration.

[1 mark]

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.....

8 (c) During a titration, a chemist rinsed the inside of the conical flask with deionised water. The water used for rinsing remained in the conical flask.

8 (c) (i) Give **one** reason why this rinsing can improve the accuracy of the end-point.

[1 mark]

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.....

.....

8 (c) (ii) Explain why the water used for rinsing has **no** effect on the accuracy of the titre.

[1 mark]

.....

.....

8 (d) Suggest **one** reason why repeating a titration makes the value of the average titre more reliable.

[1 mark]

.....

.....

9 **Table 1** shows some information about three hydrochloric acid solutions used to clean bricks and concrete.

Table 1

Cleaner	Acid content by mass / %	Price per 25 dm^3 / £
Plattern Concrete Acid	24.0	14.39
Dub-Lit Brick Cleaner	28.9	16.99
Conpat Brick Acid	35.9	24.99

Use the data in **Table 1** to determine the cleaner that offers the best value for money, based on acid content. Show your working.

[1 mark]

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10 Sodium hydroxide is often sold as a concentrated solution containing 12.0 mol dm^{-3} of sodium hydroxide.

Calculate the volume of water that should be added to 10.0 cm^3 of a 12.0 mol dm^{-3} solution of sodium hydroxide to make a 0.250 mol dm^{-3} solution. Show your working.

[2 marks]

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17

Turn over ▶

Section B

Answer **all** questions in the spaces provided.

11 Sodium hydroxide can be obtained as a monohydrate ($NaOH.H_2O$). When heated, the water of crystallisation is lost, leaving anhydrous sodium hydroxide (NaOH).

A chemist weighed a clean, dry crucible. The chemist transferred 1.10 g of $NaOH.H_2O$ to the crucible. The crucible and its contents were heated until a constant mass had been reached. The chemist recorded this mass.

The experiment was repeated using different masses of the monohydrate.

For each experiment, the chemist recorded the original mass of $NaOH.H_2O$ and the mass of NaOH left after heating. The chemist's results are shown in **Table 2**.

Table 2

Mass of $NaOH.H_2O$ / g	**Mass of NaOH / g**
0.50	0.48
1.10	0.79
2.05	1.41
2.95	2.06
3.50	2.28
4.20	2.93
4.90	3.41

11 (a) Plot a graph of **mass of $NaOH.H_2O$** (*y*-axis) against **mass of NaOH** on the grid on page 7.
Draw a straight line of best fit on the graph.

[3 marks]

11 (b) Use your graph to determine the mass of $NaOH.H_2O$ needed to form 1.00 g of NaOH

[1 mark]

..... g

Question 11 continues on the next page

11 (c) Use your answer from Question **11 (b)** to confirm that the formula of sodium hydroxide monohydrate is $NaOH.H_2O$

[2 marks]

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12 Sodium hydroxide is used to remove grease from metal components.
Sodium hydroxide cannot be used to clean components made of aluminium because it reacts with this metal.

12 (a) Balance the equation for the reaction of aqueous sodium hydroxide with aluminium.

[1 mark]

..... $NaOH$ + ... Al + ... H_2O $\longrightarrow$ ..... $NaAl(OH)_4$ + $3H_2$

12 (b) In 1986, a sealed aluminium tank exploded while being used by mistake for transporting concentrated sodium hydroxide solution.

Suggest **one** reason why the tank exploded.

[1 mark]

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13 A strong alkali such as potassium hydroxide is used as the electrolyte in some alkaline batteries for household use. The electrolyte will escape if the battery casing is broken.

Suggest **one** reason why a leak of this electrolyte is hazardous.

[1 mark]

.....

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14 Sodium phosphate and ammonia are formed when ammonium phosphate is heated with sodium hydroxide solution in a conical flask. There is **one** other product in this reaction.

14 (a) Complete and balance the equation for the reaction of ammonium phosphate with sodium hydroxide.

[2 marks]

$(NH_4)_3PO_4$ + ... NaOH $\longrightarrow$ Na_3PO_4 + ... NH_3 + ...

14 (b) Ammonia is an alkaline gas. Describe how you would use a named indicator to show that ammonia gas is released from the flask in this reaction. State the colour change that you would observe.

[2 marks]

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13

END OF QUESTIONS

GCE Chemistry Data Sheet

Table A

Infrared absorption data

Bond	Wavenumber /cm^{-1}
N — H (amines)	3300 – 3500
O — H (alcohols)	3230 – 3550
C — H	2850 – 3300
O — H (acids)	2500 – 3000
C ≡ N	2220 – 2260
C = O	1680 – 1750
C = C	1620 – 1680
C — O	1000 – 1300
C — C	750 – 1100

Table B

^{1}H n.m.r. chemical shift data

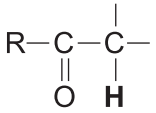
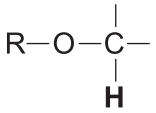
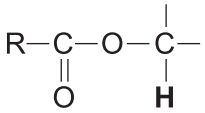
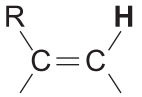
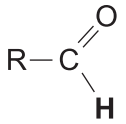
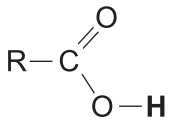
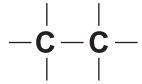
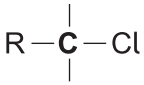
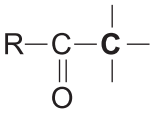
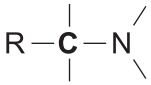
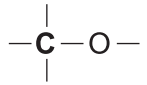
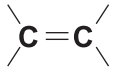
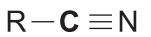
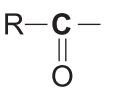
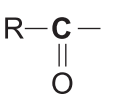
Type of proton	δ/ppm
ROH	0.5 – 5.0
RCH_3	0.7 – 1.2
RNH_2	1.0 – 4.5
R_2CH_2	1.2 – 1.4
R_3CH	1.4 – 1.6
	2.1 – 2.6
	3.1 – 3.9
RCH_2Cl or Br	3.1 – 4.2
	3.7 – 4.1
	4.5 – 6.0
	9.0 – 10.0
	10.0 – 12.0

Table C

^{13}C n.m.r. chemical shift data

Type of carbon	δ/ppm
	5 – 40
 Cl or Br	10 – 70
	20 – 50
	25 – 60
 alcohols, ethers or esters	50 – 90
	90 – 150
	110 – 125
	110 – 160
 esters or acids	160 – 185
 aldehydes or ketones	190 – 220

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
(1)	*(2)*											*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
			Key				1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4		relative atomic mass **symbol** name atomic (proton) number									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	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(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	[98] **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	[268] **Db** dubnium 105	[271] **Sg** seaborgium 106	[272] **Bh** bohrium 107	[270] **Hs** hassium 108	[276] **Mt** meitnerium 109	[281] **Ds** darmstadtium 110	[280] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

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	173.1 **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