Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Teacher's Use	
Section	Mark
Task	
Section A	
Section B	
TOTAL ISA Mark	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Chemistry CHM3T/Q10/test

Unit 3T AS Investigative Skills Assignment

Written Test

For submission by 15 May 2010

For this paper you must have:
- the Periodic Table/Data Sheet, provided at the end of this paper
- the task sheet and your Candidate Results Sheet
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour

Instructions
- 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.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 30.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use accurate scientific terminology.

Signature of Teacher marking the ISA .... Date ....

Section A

These questions are about the task, an investigation of halide ions.

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

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

1 Use your knowledge of the chemistry of the halides and your results to identify the halide ion in each of the solutions **P**, **Q** and **R**.

Halide ion in **P** ....

Halide ion in **Q** ....

Halide ion in **R** ....

(2 marks)

2 Using your results for solution **A** and your answers from Question **1**, identify the **two** halide ions in **A**.

....

(1 mark)

3 Give an ionic equation, including state symbols, for the reaction occurring in **Test 1** between the halide ion in **P** and silver nitrate.

....

(1 mark)

4 In **Test 4** state the type of reaction occurring between dilute nitric acid and ammonia.

....

(1 mark)

5 In **Test 4** for **Q** identify the final halide-containing product.

....

(1 mark)

6 State the observation you would have made in **Test 1** if silver nitrate solution had been added to a solution of fluoride ions.

....

(1 mark)

7 Give **one** reason why these tests are designed to use a small amount of silver nitrate.

....

....

(1 mark)

8

Turn over for the next question

Section B

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

Introduction

Desalination is a technique for making drinking water by the removal of salts from sea water. It is used in parts of the world where fresh water is in short supply. A problem with this technique is the increase in the concentration of salts, particularly of sodium chloride, in the effluent (the solution returned to the sea).

Desalination uses a process called reverse osmosis. In this process, sea water under high pressure is passed over a special membrane which allows only pure water to pass through it.

The owners of a desalination plant have asked for the effluent to be analysed at different operating pressures. This is needed to find an **approximate** value for the maximum operating pressure that gives an effluent that has a minimum harmful effect on the environment.

A chemist sampled the effluent at different pressures. For each pressure, a 250 cm^3 sample of effluent was taken in a measuring cylinder and poured into a weighed beaker. The water was evaporated by heating and the beaker reweighed. The following results were obtained.

Experiment	**1**	**2**	**3**	**4**	**5**	**6**
Pressure / MPa	0.1	0.5	1.0	2.5	4.0	8.0
Beaker mass before heating / g	55.3	55.5	55.0	55.1	55.3	56.3
Beaker mass after heating / g	62.5	64.9	65.3	66.6	67.5	69.4
Mass of solid in beaker / g						

8 Complete the table above to determine the mass of solid that remains in the beaker at each pressure.

Plot a graph of mass of solid (*y*-axis) against pressure on the graph paper on page 5.

Draw a smooth curve through the points.

(4 marks)

Do not write outside the box

Turn over ▶

Do not write outside the box

9 To minimise harmful effects on the environment, the concentration of sodium chloride in the effluent should not exceed 44.0 g dm^{-3}. Use your graph to find a value for the pressure, in MPa, that the chemist should advise to be the maximum operating pressure.

Assume that all the solid left in the beaker is sodium chloride.

....

....

(1 mark)

10 In Experiment **1** the 250 cm^3 sample of the effluent contained the same amount of sodium chloride as the original sea water. Calculate the concentration, in mol dm^{-3}, of sodium chloride in sea water.

Assume that all the solid left in the beaker is sodium chloride.
Show your working.

....

....

....

(2 marks)

11 For the measuring cylinder and the balance, the maximum total errors are shown below. These errors take into account multiple measurements.

250 cm^3 measuring cylinder	±1.0 cm^3
balance	±0.1 g

Estimate the maximum percentage error in using these pieces of apparatus, and hence estimate their combined error.

You should use the mass of the solid in the beaker in Experiment **1** to estimate the percentage error in using the balance.
Show your working.

....

....

....

....

(2 marks)

Do not write outside the box

12 Consider your graph.

12 (a) Is the curve good enough to use with confidence to predict the intermediate values? Explain your answer.

....

....

....

(1 mark)

12 (b) Identify the anomalous results, if any.

....

....

(1 mark)

13 Give **one** reason why the owners of the plant were satisfied with the maximum operating pressure determined in Question **9** despite the combined errors you have calculated in Question **11**.

....

....

....

(1 mark)

14 (a) Suggest **one** harmful effect that effluent with a high concentration of sodium chloride might have if it is returned to the sea.

....

....

(1 mark)

14 (b) Suggest **one** low cost method of treating the effluent so that this harmful effect could be reduced.

....

....

(1 mark)

15 Bromine can be obtained by reacting the bromide ions in the concentrated sea water using chlorine gas in a displacement reaction. Write an equation for this reaction.

....

....

(1 mark)

Turn over ▶

16 The solid obtained by the chemist after heating the effluent to dryness was treated with concentrated sulfuric acid. A vigorous reaction resulted, including the formation of a purple vapour of iodine. Give **one** reason why this procedure could **not** be adapted to be an economic method for producing iodine from sea water on an industrial scale.

....

....

(1 mark)

17 Sea water contains some organic material. After removing all the water, by heating the effluent samples strongly, it was noticed that the solid formed contained black particles. These particles are insoluble in water.

On heating very strongly in air these particles burned to give a colourless gas.

17 (a) Identify these black particles.

....

(1 mark)

17 (b) Suggest how these black particles are formed by heating the effluent strongly.

....

....

(1 mark)

17 (c) Suggest how a sample of the black particles could be separated from the solid formed.

....

....

....

(2 marks)

18 The water produced by some desalination plants is acidic due to the presence of hydrochloric acid. Lime, $Ca(OH)_2$, is added to neutralise this acid. Write an equation for this reaction.

....

(1 mark)

19 Lime is used because it is relatively inexpensive and available in large quantities. Identify **one** other large-scale use of lime.

....

(1 mark)

END OF QUESTIONS

22

GCE Chemistry Data Sheet

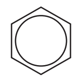
Table 1
Infrared absorption data

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 2
^{1}H n.m.r. chemical shift data

Type of proton	δ/ppm
RO**H**	0.5 – 5.0
RC**H**$_3$	0.7 – 1.2
RN**H**$_2$	1.0 – 4.5
R_2C**H**$_2$	1.2 – 1.4
R_3C**H**	1.4 – 1.6
R–C(=O)–C(**H**)–	2.1 – 2.6
R–O–C(**H**)–	3.1 – 3.9
RC**H**$_2$Cl or Br	3.1 – 4.2
R–C(=O)–O–C(**H**)–	3.7 – 4.1
R(C=C)**H** (R–C=C–**H**)	4.5 – 6.0
R–C(=O)–**H**	9.0 – 10.0
R–C(=O)–O–**H**	10.0 – 12.0

Table 3
^{13}C n.m.r. chemical shift data

Type of carbon	δ/ppm
–**C**–**C**–	5 – 40
R–**C**–Cl or Br	10 – 70
R–C(=O)–**C**–	20 – 50
R–**C**–N<	25 – 60
–**C**–O– alcohols, ethers or esters	50 – 90
>**C**=**C**<	90 – 150
R–**C**≡N	110 – 125
	110 – 160
R–**C**(=O)– esters or acids	160 – 185
R–**C**(=O)– aldehydes or ketones	190 – 220

The Periodic Table of the Elements

Key

relative atomic mass **symbol** name atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (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	[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						

*** 58 – 71** Lanthanides	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
† 90 – 103 Actinides	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