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)	

General Certificate of Education
Advanced Level Examination
June 2011

Chemistry CHM6T/P11/test

Unit 6T A2 Investigative Skills Assignment

For submission by 15 May 2011

For this paper you must have:	**Time allowed**
• 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.	• 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 space 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 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, Determination of an equilibrium constant.

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

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

1 Record the average titre from your Candidate Results Sheet.

.....

(1 mark)

2 The concentration of sodium hydroxide solution was 0.100 mol dm^{-3}.

Use your answer from Question **1** to calculate the amount, in moles, of sodium hydroxide required to neutralise all of the acid in 25.0 cm^3 of the diluted equilibrium mixture.

.....

.....

(1 mark)

3 Use your answer to Question **2** to calculate the total amount, in moles, of H^+ ions in the whole sample of undiluted equilibrium mixture (250 cm^3 of diluted equilibrium mixture).

.....

.....

(1 mark)

4 The mixture you prepared and allowed to reach equilibrium contained 2.00 cm^3 of 1.00 mol dm^{-3} sulfuric acid as a catalyst.

4 (a) Calculate the amount, in moles, of H^+ ions in the sulfuric acid. Assume that the sulfuric acid is completely dissociated.

.....

.....

.....

(1 mark)

4 (b) Use your answers to Question **3** and Question **4 (a)** to calculate the amount, in moles, of propanoic acid in the whole sample of undiluted equilibrium mixture.

.....

(1 mark)

5 The equation for the reaction occurring in the mixture is given below.

$$CH_3CH_2COOH(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3CH_2COOCH_2CH_3(l) + H_2O(l)$$

5 (a) The original 7.00 cm^3 sample of propanoic acid used to prepare the equilibrium mixture contained 0.0940 mol of CH_3CH_2COOH

Use your answer to Question **4 (b)**, to calculate the amount, in moles, of propanoic acid that has reacted at equilibrium.
(If you were unable to complete the calculation in Question **4 (b)** assume that the amount of propanoic acid in the whole sample of undiluted equilibrium mixture was 0.0258 mol. This is **not** the correct answer.)

.....

(1 mark)

5 (b) The original 7.00 cm^3 sample of ethanol used to prepare the equilibrium mixture contained 0.102 mol of CH_3CH_2OH

Use this information and your answer to Question **5 (a)** to calculate the amount, in moles, of ethanol remaining at equilibrium.

.....

.....

(1 mark)

5 (c) Use your answer to Question **5 (a)** to deduce the amount, in moles, of $CH_3CH_2COOCH_2CH_3$ and the amount, in moles, of H_2O formed at equilibrium.

$CH_3CH_2COOCH_2CH_3$ .....

.....

.....

H_2O .....

.....

.....

(2 marks)

6 Suggest the main reason why the actual amount of water in the equilibrium mixture is greater than that deduced in Question **5 (c)**.

.....

.....

(1 mark)

Turn over ▶

7 In another experiment, at a fixed temperature, a different equilibrium mixture contained the following amounts, in moles, of each component.

CH_3CH_2COOH	CH_3CH_2OH	$CH_3CH_2COOCH_2CH_3$	H_2O
0.0424	0.0525	0.0745	0.0813

7 (a) Write an expression for the equilibrium constant, K_c, for the reaction given in Question **5**.

.....

.....

.....

(1 mark)

7 (b) Use the data in the table above to calculate a value for the equilibrium constant, K_c, at this fixed temperature.
Record your answer to the appropriate precision.

.....

.....

.....

(2 marks)

8 If the mixture is uncovered during the time it is left to reach equilibrium, some of the ester formed will evaporate.
Explain why a smaller volume of sodium hydroxide would then be required in the titration compared with the volume for the covered mixture.

.....

.....

.....

(2 marks)

15

Section B

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

9 Propanoic acid can be made from propan-1-ol by oxidation using acidified potassium dichromate(VI). Propanal is formed as an intermediate during this oxidation.

9 (a) State the colour of the chromium species after the potassium dichromate(VI) has reacted.

.....

(1 mark)

9 (b) Describe the experimental conditions and the practical method used to ensure that the acid is obtained in a high yield. Draw a diagram of the assembled apparatus you would use.

Conditions .....

.....

Apparatus

(4 marks)

9 (c) Describe the different experimental conditions necessary to produce propanal in high yield rather than propanoic acid.

.....

.....

(2 marks)

Turn over ▶

10 Propan-1-ol is a volatile, flammable liquid.
Give **one** safety precaution that should be used during the reaction to minimise this hazard.

.....

(1 mark)

11 A student followed the progress of the oxidation of propan-1-ol to propanoic acid by extracting the organic compounds from one sample of reaction mixture.

11 (a) Give a chemical reagent which would enable the student to confirm the presence of propanal in the extracted compounds.
State what you would observe when propanal reacts with this reagent.

Reagent .....

Observation .....

.....

(2 marks)

11 (b) Give a chemical reagent that would enable the student to confirm the presence of propanoic acid in the extracted compounds.
State what you would observe when propanoic acid reacts with this reagent.

Reagent .....

Observation .....

.....

(2 marks)

12 Predict which **one** of the compounds, propan-1-ol, propanal and propanoic acid will have the highest boiling point. Explain your answer.

Prediction .....

Explanation .....

.....

.....

.....

.....

(3 marks)

END OF QUESTIONS

15

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

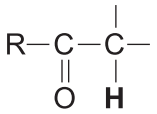
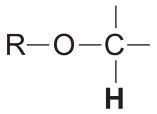
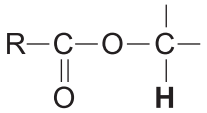
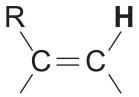
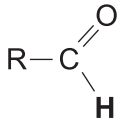
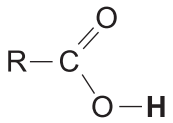
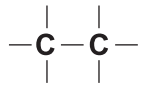
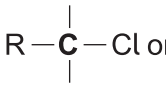
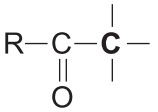
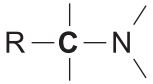
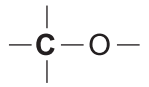
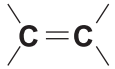
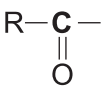
Type of proton	δ/ppm
ROH	0.5 – 5.0
RCH$_3$	0.7 – 1.2
RNH$_2$	1.0 – 4.5
R$_2$CH$_2$	1.2 – 1.4
R$_3$CH	1.4 – 1.6
	2.1 – 2.6
	3.1 – 3.9
RCH$_2$Cl or Br	3.1 – 4.2
	3.7 – 4.1
	4.5 – 6.0
	9.0 – 10.0
	10.0 – 12.0

Table 3

^{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

Turn over ▶

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
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