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 Examiner's Use Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
Section C	
TOTAL EMPA MARK	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Chemistry   CHM3X

Unit 3X   AS Externally Marked Practical Assignment

Written Test

For submission by 15 May 2014

For this paper you must have:
- the Periodic Table/Data Sheet provided as an insert (enclosed)
- your Task Sheets 1 and 2, including your own Candidate Results Sheets
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 20 minutes

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 36.
- 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 has met the requirements of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

Practical Skills Verification	**Yes**	☐

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

CHM3X

Section A

These questions are about the investigations into some additives used in foods.

You should use Task Sheets 1 and 2, including your own Candidate Results Sheets, to answer these questions.

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

1   Record the average titre from your Candidate Results Sheet for Task 1.

[1 mark]

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2   The concentration of sodium hydroxide solution used in Task 1 was 0.100 mol dm^{-3}.

Calculate the amount, in moles, of NaOH used in your titration.

[1 mark]

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3   The formula of succinic acid can be represented as $HOOC(CH_2)_nCOOH$, where n is an integer in the range 0 to 10

3 (a)   Succinic acid reacts with sodium hydroxide as shown by the following equation.

$$HOOC(CH_2)_nCOOH + 2NaOH \longrightarrow NaOOC(CH_2)_nCOONa + 2H_2O$$
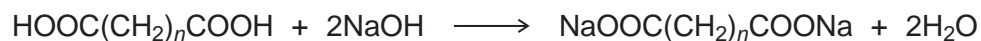
Use your answer from Question **2** and this equation to calculate the amount, in moles, of succinic acid in the sample that you weighed out in Task 1. Give your answer to 3 significant figures. Show your working.

[3 marks]

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3 (b) Use your answer to Question **3 (a)** and the mass of succinic acid from your Candidate Results Sheet for Task 1 to calculate the M_r of succinic acid.
Hence calculate the value of *n* to the nearest whole number. Show your working.

(If you were unable to complete the calculation in Question **3 (a)**, you should assume that the amount of acid was 0.0114 mol. This is **not** the correct amount.)

[3 marks]

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4 The maximum total error for the balance is ±0.01 g.

Use the mass of succinic acid from your Candidate Results Sheet for Task 1 to estimate the maximum percentage error in using this piece of apparatus.

[1 mark]

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5 Succinic acid is toxic and corrosive but is used in the food industry as a sweetener.

Explain why this use of succinic acid is acceptable.

[1 mark]

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Turn over ▶

6 Succinic acid can be produced by the fermentation of glucose.

Suggest and explain the main environmental impact of fermentation reactions.

[2 marks]

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7 Solution **P** contains a Group 2 metal compound.

7 (a) State and explain **one** observation from your Candidate Results Sheet for Task 2 which shows that solution **P** could contain magnesium ions.

[1 mark]

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7 (b) State and explain **one** observation from your Candidate Results Sheet for Task 2 which confirms that solution **P** does **not** contain barium ions.

[1 mark]

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7 (c) Use your observations from your Candidate Results Sheet for Task 2 to identify the negative ion in solution **P**.
Explain your answer.

[2 marks]

Identity...

Explanation ....

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16

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Turn over ▶

Section B

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

8 The alcohol 2-methylpropan-2-ol, $(CH_3)_3COH$, reacts to form esters that are used as flavourings by the food industry. The alcohol can be oxidised to produce carbon dioxide and water.

A student carried out an experiment on a pure sample of 2-methylpropan-2-ol to determine its enthalpy of combustion. A sample of the alcohol was placed into a spirit burner and positioned under a beaker containing 50 cm^3 of water. The spirit burner was ignited and allowed to burn for several minutes before it was extinguished.

The results for the experiment are shown in **Table 1**.

Table 1

Initial temperature of the water / ⁰C	18.1
Final temperature of the water / ⁰C	45.4
Initial mass of spirit burner and alcohol / g	208.80
Final mass of spirit burner and alcohol / g	208.58

8 (a) Use the results from **Table 1** to calculate a value for the heat energy released from the combustion of this sample of 2-methylpropan-2-ol.
The specific heat capacity of water is 4.18 J K^{-1} g^{-1}.
Show your working.

[2 marks]

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8 (b) Calculate the amount, in moles, of 2-methylpropan-2-ol burned in the experiment. Hence calculate a value, in kJ mol^{-1}, for the enthalpy of combustion of 2-methylpropan-2-ol.
Show your working.

(If you were unable to calculate an answer to Question **8 (a)**, you should assume that the heat energy released was 5580 J. This is **not** the correct value.)

[3 marks]

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8 (c) An equation for the combustion of 2-methylpropan-2-ol is

$$(CH_3)_3COH(l) + 6O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(l)$$
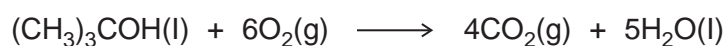
Table 2 contains some standard enthalpy of formation data.

Table 2

	$(CH_3)_3COH(l)$	$O_2(g)$	$CO_2(g)$	$H_2O(l)$
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	−360	0	−393	−286

Use the data from **Table 2** to calculate a value for the standard enthalpy of combustion of 2-methylpropan-2-ol. Show your working.

[3 marks]

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Question 8 continues on the next page

Turn over ▶

8 (d) An accurate value for the enthalpy of combustion of 2-methylpropan-2-ol in which water is formed as a gas is –2422 kJ mol^{-1}.

Use this value and your answer from Question **8 (b)** to calculate the overall percentage error in the student's experimental value for the enthalpy of combustion of 2-methylpropan-2-ol.

[1 mark]

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8 (e) Suggest **one** improvement that would reduce errors due to heat loss in the student's experiment.

[1 mark]

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8 (f) Suggest **one** other source of error in the student's experiment. Do **not** include heat loss, apparatus error or student error.

[1 mark]

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9 A sample of 2-methylpropan-2-ol was contaminated with butan-2-ol. The student separated the two alcohols using chromatography.

Identify a reagent or combination of reagents that the student could use to distinguish between these alcohols. State what would be observed for each alcohol.

[3 marks]

Reagent(s) ....

Observation with 2-methylpropan-2-ol ....

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....

Observation with butan-2-ol ....

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14

**Turn over for the next question**

Section C

These questions test your understanding of the skills and techniques you have acquired during your AS course.

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

10   A student investigated how the initial rate of reaction between sulfuric acid and magnesium at 20 ºC is affected by the concentration of the acid.

The equation for the reaction is

$$H_2SO_4(aq) + Mg(s) \longrightarrow MgSO_4(aq) + H_2(g)$$
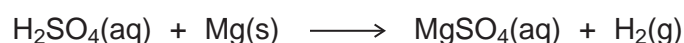
10 (a)   The student made measurements every 20 seconds for 5 minutes. The student then repeated the experiment using double the concentration of sulfuric acid.

State a measurement that the student should make every 20 seconds. Identify the apparatus that the student could use to make this measurement.

[2 marks]

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10 (b)   State **one** condition, other than temperature and pressure, that would need to be kept constant in this investigation.

[1 mark]

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10 (c) When the student had finished the investigation, an excess of sodium hydroxide solution was added to the reaction mixture. This was to neutralise any unreacted sulfuric acid. The student found that a further reaction took place, producing magnesium hydroxide.

10 (c) (i) Draw a diagram to show how the student could separate the magnesium hydroxide from the reaction mixture.

[2 marks]

10 (c) (ii) Suggest **one** method the student could use for removing soluble impurities from the sample of magnesium hydroxide that has been separated.

[1 mark]

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6

END OF QUESTIONS

WMP/Jun14/CHM3X

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