**2013**

#### VCE

**Chemistry**

**Trial Examination**

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| **Kilbaha Multimedia Publishing****PO Box 2227** **Kew Vic 3101** **Australia** | **Tel: (03) 9018 5376** **Fax: (03) 9817 4334** **kilbaha@gmail.com**[**http://kilbaha.com.au**](http://kilbaha.com.au) |

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|  | **VICTORIAN CERTIFICATE OF EDUCATION****Year 2013** |
| STUDENT NUMBER Letter  |
| Figures |  |  |  |  |  |  |  |  |  |  |  |
| Words |  |  |  |  |  |  |  |  |  |  |  |

###### CHEMISTRY

**Trial Written Examination**

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

**QUESTION AND ANSWER BOOK**

## Structure of book

|  |  |  |  |
| --- | --- | --- | --- |
| *Section* | *Number of* *questions* | *Number of questions* *to be answered* | *Number of* *marks* |
| A | 30 | 30 | 30 |
| B | 12 | 12 | 95 |
|  |  |  |  Total 125 |

* Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers,

 sharpeners, rulers and one scientific calculator.

* Students are NOT permitted to bring into the examination room: blank sheets of paper and/or

 white out liquid/tape.

**Materials supplied**

* Question and answer book of 35 pages.
* A data book
* Answer sheet for multiple-choice questions.

**Instructions**

* Write your **student number** in the space provided above on this page.
* Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
* All written responses must be in English.

**At the end of the examination**

* Place the answer sheet for multiple-choice questions inside the front cover of this book.
* You may keep the data book

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices**

**into the examination room.**

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|  | **VCE CHEMISTRY 2013****Trial Written Examination**  |

MULTIPLE-CHOICE ANSWER SHEET

# Student Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Student Number \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

If your name or number on this sheet is incorrect, notify the Supervisor.

Use a **PENCIL** for **ALL** entries. For each question, shade the box that indicates your answer.

All answers must be completed like **THIS** example.

|  |  |  |  |
| --- | --- | --- | --- |
| **A** | **B** | **C** | **D** |

Marks will **NOT** be deducted for incorrect answers.

**NO MARK** will be given if more than **ONE** answer is completed for any question.

If you make a mistake, **ERASE** the incorrect answer. **DO NOT** cross it out.

|  |  |
| --- | --- |
| **ONE ANSWER PER LINE** | **ONE ANSWER PER LINE** |
| 1. | A | B | C | D | 16. | A | B | C | D |
| 2. | A | B | C | D | 17. | A | B | C | D |
| 3. | A | B | C | D | 18. | A | B | C | D |
| 4. | A | B | C | D | 19. | A | B | C | D |
| 5. | A | B | C | D | 20. | A | B | C | D |
| 6. | A | B | C | D | 21. | A | B | C | D |
| 7. | A | B | C | D | 22. | A | B | C | D |
| 8. | A | B | C | D | 23. | A | B | C | D |
| 9. | A | B | C | D | 24. | A | B | C | D |
| 10. | A | B | C | D | 25. | A | B | C | D |
| 11. | A | B | C | D | 26. | A | B | C | D |
| 12. | A | B | C | D | 27. | A | B | C | D |
| 13. | A | B | C | D | 28. | A | B | C | D |
| 14. | A | B | C | D | 29. | A | B | C | D |
| 15. | A | B | C | D | 30. | A | B | C | D |

**SECTION A – Multiple-choice questions**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

**Question 1**

Which one of the following analytical techniques involves the motion of ions of different mass in a magnetic field?

**A.** Gas chromatography (GC)

**B.** Thin layer chromatography (TLC)

**C.** Mass spectroscopy

**D.** Atomic absorption spectroscopy (AAS)

**Question 2**

In colour printing, the ink colours cyan, magenta and yellow are used. When these colours are mixed, black is formed. The best way to show that black ink is made up of cyan, magenta and yellow would be to use

**A.** mass spectroscopy.

**B.** atomic absorption spectroscopy (AAS).

**C.** UV-visible spectroscopy.

**D.** thin layer chromatography (TLC).

**Question 3**

Nitrogen gas and hydrogen gas react to form ammonia gas according to the balanced equation shown below. A powdered iron catalyst is used in the industrial production of ammonia.

N2(g) + 3H2(g)  2NH3(g) H = -91 kJ mol-1

Which one of the following best describes the effect of adding a powdered iron catalyst to a mixture of nitrogen gas and hydrogen gas at constant temperature?

**A.** An increase in the equilibrium yield and an increase in the rate of reaching equilibrium.

**B.** No change in the equilibrium yield but an increase in the rate of reaching equilibrium.

**C.** No change in the equilibrium yield and no change in the rate of reaching equilibrium.

**D.** An increase in the equilibrium yield but no change in the rate of reaching equilibrium.

**Question 4**

Sodium hydroxide (NaOH) cannot be used as a primary standard in volumetric analysis. When a solution of NaOH is exposed to the air, its pH decreases slowly. This is because

**A.** NaOH reacts with the carbon dioxide in the air.

**B.** NaOH reacts with the nitrogen in the air.

**C**. some of the water evaporates.

**D.** NaOH reacts with the oxygen in the air.

**Question 5**

An acid-base indicator (HY) is itself a weak acid that reacts according to the balanced equation:

HY(aq) + H2O(l)  Y‑(aq) + H3O+(aq)

The acidity constant, *Ka* , for this equation at a fixed temperature is 10-6 M.

The pH, at which the concentrations of Y-(aq) and HY(aq) are equal, is

**A.** 3

**B.** 6

**C.** 9

**D.** 12

**Question 6**

Thin layer chromatography can be used to identify amino acids. In one such experiment, the first amino acid **G** has an *Rf* value of 0.3. The second amino acid **H** has an *Rf* value of 0.6.

A sample of each of the amino acids is placed at the same time on a chromatographic plate.

Which one of the following statements is true?

**A.** Amino acid **H** will move 0.9 as far on the plate as amino acid **G**.

**B.** Amino acid **H** will move 0.6 as far on the plate as amino acid **G**.

**C.** Amino acid **H** will move twice as far on the plate as amino acid **G**.

**D.** Amino acid **H** will move half as far on the plate as amino acid **G**.

**Question 7**

The sodium ion content of a sports drink was analysed using atomic absorption spectroscopy (AAS). A series of standard sodium ion solutions were used to produce the calibration curve shown below.

A certain sports drink is found to have an absorbance of 72%. What mass of sodium chloride (NaCl) is present in 1 L of the sports drink?

**A.** 0.58 g

**B.** 0.89 g

**C.** 1.46 g

**D.** 1.76 g

**Question 8**

Seawater contains approximately 0.0009 mol L-1 of bromide ions (Br-). If all the Br- could be extracted as Br2 from 1 m3 of seawater, the mass produced would be closest to

**A.** 0.0009 × 79.9 g.

**B.** 0.0009 × 79.9 × 103 g.

**C.** 2 × 0.0009 × 79.9 g.

**D.**  × 0.0009 × 79.9 × 103 g.

**Question 9**

Hydrocarbons will burn in oxygen to form carbon dioxide and water. When one mole of a particular hydrocarbon was reacted with excess pure oxygen, equal numbers of mole of CO2 and H2O were formed. The hydrocarbon could have been

**A.** CH4

**B.** C2H6

**C.** C3H6

**D.** C4H6

**Question 10**

Hydrogen peroxide decomposes to form water and oxygen according to the following equation:

 2H2O2(aq) → 2H2O(l) + O2(g)

In this reaction, hydrogen peroxide is acting as

**A.** an oxidant only.

**B.** a reductant only.

**C.** neither an oxidant nor a reductant.

**D.** both an oxidant and a reductant.

**Question 11**

Methanoic acid behaves in water as a weak acid according to the equation:

HCOOH(aq) + H2O(l)  H3O+(aq) + HCOO-(aq) ; *K*a = 1.8 × 10-4 M at 25oC

A strong acid is added to a solution of methanoic acid so as to increase [H+].

When equilibrium is re-established at 25oC,

**A.** the pH will have increased.

**B.** more HCOO- ions will have been produced from HCOOH.

**C.** the value of the fraction will have increased.

**D.** the value of the fraction will not have changed.

**Question 12**

The equilibrium between NO(g), O2(g) and NO2(g) is described by the equation:

2NO(g) + O2(g)  2NO2(g) ∆H = -114 kJ mol-1

At a temperature of 500 K, the equilibrium constant is 6.6 × 105.

When the temperature of this equilibrium mixture is decreased at constant volume, the number of mole of NO2(g) in the equilibrium mixture will

**A.** increase.

**B.** remain the same.

**C.** decrease.

**D.** be unknown since more information is required to find the answer.

**Question 13**

A 0.1 M benzoic acid solution and a 0.1 M hydrochloric acid solution at 25oC

**A.** have different values of pH.

**B.** have the same value of pH.

**C.** both produce OH-(aq) ions.

**D.** are both strong acids.

**Question 14**

The pH of a 0.1 M solution of ethanoic acid is closest to

**A.** 1

**B.** 3

**C.** 5

**D.** 7

**Question 15**

Poly(methyl methacrylate) (PMMA) is a transparent thermoplastic, often used as a lightweight or shatter-resistant alternative to glass. It is made from the monomer methyl methacrylate.

The structure of methyl methacrylate is shown below.



When poly(methyl methacrylate) is formed from this monomer, the **repeating unit** in the polymer chain will have

**A.** 0 double bonds.

**B.** 1 double bond.

**C.** 2 double bonds.

**D.** 3 double bonds.

**Question 16**

The correct semi-structural formula for the ester ethyl butanoate is

**A.** CH3CH2CH2COOCH2CH3

**B.** CH3COOCH2CH2CH2CH3

**C.** CH3CH2CH2CH2COOCH2CH3

**D.** CH3CH2CH2COOCH2CH2CH3

**Question 17**

A neutralisation reaction and the energy change that occurs, can be represented by the equation:

OH-(aq) + H+(aq)  H2O(l) H = 

When 4 mol of H­Cl(aq) is added to 2 mol of NaOH(aq),

**A.** 112 kJ of energy will be released.

**B.** 112 kJ of energy will be absorbed.

**C.** 224 kJ of energy will be released.

**D.** 224 kJ of energy will be absorbed.

**Question 18**

A galvanic cell is made from the half-cells Fe3+(aq) / Fe2+(aq) (graphite electrode) and

Zn2+(aq) / Zn(s) (zinc metal electrode). The reaction occurring at the positive electrode is

**A.** Zn(s) → Zn2+(aq) + 2e-

**B.** Zn2+(aq) + 2e- → Zn(s)

**C.** Fe2+(aq) → Fe3+(aq) + e-

**D.** Fe3+(aq) + e- → Fe2+(aq)

**Question 19**

Hydrogen gas will react explosively with oxygen gas to produce water and thermal energy.

A galvanic cell is constructed to use this chemical reaction to produce electrical energy.

The anode and cathode reactions in this galvanic cell are respectively:

|  |  |  |
| --- | --- | --- |
|  | **Anode reaction** | **Cathode reaction** |
| **A.** | H2(g) + 2OH-(aq)→ 2H2O(l) + 2e-  | O2(g) + 2H2O(l) + 4e-→ 4OH-(aq) |
| **B.** | O2(g) + 2H2O(l) + 4e-→ 4OH-(aq) | H2(g) + 2OH-(aq)→ 2H2O(l) + 2e-   |
| **C.** | 4OH-(aq)→ O2(g) + 2H2O(l) + 4e- | 2H2O(l) + 2e- → H2(g) + 2OH-(aq)   |
| **D.** | 2H2O(l) + 2e- → H2(g) + 2OH-(aq)   | 4OH-(aq)→ O2(g) + 2H2O(l) + 4e- |

**Question 20**

Sodium metal **cannot** be produced by electrolysis of an aqueous sodium chloride solution because

**A.** Cl-(aq) is a stronger oxidant than Na+(aq).

**B.** H2(g) is a stronger reductant than Na(s).

**C.** H2O(l) is a stronger oxidant than Na+(aq).

**D.** Cl-(aq) is a stronger reductant than Na(s).

**Question 21**

The reaction between glucose and fructose to form the disaccharide sucrose is best described as a

**A.** condensation reaction with the formation of an ether linkage.

**B.** hydrolysis reaction with the formation of an ether linkage.

**C.** condensation reaction with the formation of an ester linkage.

**D.** hydrolysis reaction with the formation of an ester linkage.

**Question 22**

When glycerol reacts with a carboxylic acid, the number of ester linkages in the fat produced is

**A.** 1

**B.** 2

**C.** 3

**D.** 4

**Question 23**

The balanced chemical equation for the hydrolysis of starch or glycogen to produce glucose is best shown as

**A.** (C6H12O6)*n*(aq) + *n*H2O(l)  *n*C6H10O5(aq)

**B.** (C6H12O6)*n*(aq) + *n*H2O(l)  *n*C6H12O6(aq)

**C.** (C6H10O5)*n*(aq) + *n*H2O(l)  *n*C6H10O5(aq)

**D.** (C6H10O5)*n*(aq) + *n*H2O(l)  *n*C6H12O6(aq)

**Question 24**

The chemical structure of phenylalanine, is shown below.



The functional groups in phenylalanine are

**A.** C6H5 and OH.

**B.** CH2 and NH2.

**C.** NH2 and C6H5.

**D.** NH2 and COOH.

**Question 25**

Which one of the following would be predicted to react spontaneously with hydrogen gas but **not** with oxygen gas?

**A.** Pb(s)

**B.** Cu2+(aq)

**C.** Ag(s)

**D.** Al3+(aq)

**Question 26**

A graphite rod is to be copper plated in an electrolytic cell. The graphite rod forms one electrode and a copper rod the other electrode. The electrolyte provides a source of Cu2+(aq).

When the cell is correctly connected, electrons will flow to the

**A.** copper rod from the external power supply.

**B.** copper rod through the electrolyte.

**C.** graphite rod through the electrolyte.

**D.** graphite rod from the external power supply.

**Question 27**

The total number of double covalent bonds in **linolenic acid** is

**A.** 3

**B.** 4

**C.** 5

**D.** 6

**Question 28**

Use this code.

**N** = Nitrogen Bases (Adenine, Thymine, Guanine, Cytosine)

**S** = Sugar Units

**P** = Phosphate Units

Which one of the following best represents a section of DNA?

|  |  |
| --- | --- |
| **A.** |  **N** **S** **N** **S** | | | |-----**P**-----**P**-----**P**-----**P**----- |
| **B.**  |  **P** **P** | |  -----**N**-----**S**-----**N**-----**S**----- |
| **C.**  |  **S** **P** **S** **P** | | | |-----**N**-----**N**-----**N**-----**N**----- |
| **D.**  |  **N** **N** | |-----**S**-----**P**-----**S**-----**P**----- |

**Question 29**



The systematic name for the compound shown above, is

**A.** 2-methylbutan-3-ol

**B.** 2,2-dimethylpropan-2-ol

**C.** 3-methylbutan-2-ol

**D.** pentan-2-ol

**Question 30**



% Transmission

Wavenumber cm-1

Which one of the following compounds is most likely to have the infrared absorption spectrum shown above?

**A.** butan-2-ol

**B.** butanoic acid

**C.** butene

**D.** 2-chlorobutane

END OF SECTION A

Instructions for Section B

Answer all questions in the spaces provided.

To obtain full marks for your responses you should

* give simplified answers with an appropriate number of significant figures for all numerical

 questions; unsimplified answers will not be given full marks.

* show all working in your answers to numerical questions. No credit will be given for an

 incorrect answer unless it is accompanied by details of the working.

* make sure all chemical equations are balanced and that the formulas for individual substances

 include an indication of state; for example, H2(g); NaCl(s)

**Question 1 (10 marks)**

**a.** Briefly explain why copper metal glows with a green flame when heated. You may also use a diagram to help with your explanation.

3 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 1 (continued)**

**b.** Naturally occurring copper metal has a relative atomic mass of 63.5 and consists of two stable isotopes with relative isotopic masses 63 and 65. On the graph below, sketch the **approximate output** when a mass spectrometer is used to analyse a sample of copper.

You must put appropriate labels and numbers on each axis.

3 marks

**c.** Copper and 7M nitric acid react according to the equation:

3Cu(s) + 8HNO3(aq)  3Cu(NO3)2(aq) + 2NO(g) + 4H2O(l)

In a particular experiment, 0.6 mol of copper reacted and nitrogen (I) oxide (NO) was the only oxide of nitrogen produced.

 Calculate the number of mole of nitrogen (I) oxide produced. 2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 1 (continued)**

**d.** The nitrogen (I) gas was purified and then contained in a vessel of volume 3.00 L at 31oC.

Calculate the gas pressure in the vessel. 2 marks

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**Question 2** **(4 marks)**

High performance liquid chromatography (HPLC) is the most sensitive chromatographic technique.

The components of HPLC are shown in the diagram below.

Carrier Gas

Glass column that contains the liquid stationery phase.

Sample injection point

Detector

oven

Chart recorder

**a.** Describe the function of the stationary phase in HPLC. 2 marks

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**b.** Explain why this technique is very sensitive. 2 marks

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**Question 3 (9 marks)**

When coal is burned in a power station, one of the unwanted byproducts is sulfur dioxide gas, SO2(g). The SO2 content of an air sample can be determined by passing a known volume of air through a solution containing excess H2O2, where the following reaction takes place:

SO2(g) + H2O2(aq) → H2SO4(aq)

The amount of unreacted H2O2 is then determined by titration with standardised potassium permanganate solution according to the equation:

2MnO4-(aq) + 5H2O2(aq) + 6H+(aq) → 2Mn2+(aq) + 5O2(g) + 8H2O(l)

In a particular analysis, 20.0 m3 of air was passed through 200 cm3 of 0.15 M H2O2 solution.

The H2O2 that did not react with SO2 required for its oxidation 25.00 cm3 of 0.01 M KMnO4 solution.

**a.** Calculate the number of mole of H2O2 in the initial solution. 1 mark

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**b.** Calculate the number of mole of H2O2 that did **not** react with SO2. 2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**c.** Calculate the number of mole of H2O2 that had reacted with SO2. 2 marks

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**Question 3** (continued)

**d.** Calculate the mass of SO2 (in grams) that reacted with H2O2. 2 marks

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**e.** Calculate the SO2 content of the air in g m-3. 2 marks

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**Question 4 (10 marks)**

The following reaction sequence uses the important hydrocarbons ethane and ethene.

Ethane is a **saturated** hydrocarbon and ethene is an **unsaturated** hydrocarbon.

ethane

**B**

**A**

ethanol

chloroethane

Cr2O72-(aq)/H+(aq)

**E**

**F, G**

**C**

ethene

**D**

propan-1-ol

**a.** Explain the meaning of the term **unsaturated**. 1 mark

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**b.** Give the name and chemical formula for each of the reagents below. 5 marks

|  |  |  |
| --- | --- | --- |
| Reagent  | Name | Chemical Formula |
| **A** |  |  |
| **B** |  |  |
| **E** |  |  |
| **F** |  |  |
| **G** |  |  |

**Question 4 (continued)**

**c.** Give the systematic name and structural formula for each of the compounds below.

4 marks

|  |  |  |
| --- | --- | --- |
| Compound | Systematic Name | Structural Formula |
| **C** |  |  |
| **D** |  |  |

**Question 5 (9 marks)**

When concentrated sulfuric acid is added to water, a strongly exothermic reaction occurs.

 H2O(l)

To determine *H* for the reaction: H2SO4(l)   H2SO4(aq), a student first calibrated a calorimeter in the following way.

* 100 mL of de-ionised water was added to the insulated calorimeter.
* A 4.0 amp current was passed through the water for 40 seconds at a voltage of 4.0 volts.
* The change in temperature during this time was 2.0 oC.

**a.** Calculate the calibration factor for the calorimeter and its contents. 3 marks

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**Question 5 (continued)**

**b.** Describe the next experimental steps **and** the calculations required to determine

the *H* value for the reaction: 4 marks

 H2O(l)

 H2SO4(l)   H2SO4(aq)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**c.** Give two possible sources of error in this experiment. 2 marks

Error 1 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Error 2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 6 (6 marks)**

**a.** An alternative to burning coal for electrical energy production is the use of natural gas.

A particular sample of natural gas contains 90% methane and 10% ethane. The complete combustion with oxygen of this natural gas is shown in the equations below:

 CH4(g) + 2O2 (g)  CO2 (g) + 2H2O(g) *H* = - 890 kJ mol-1

 2C2H6 (g) + 7O2 (g)  4CO2 (g) + 6H2O(g) *H* = - 1560 kJ mol-1

Calculate the energy, in kJ, released when 5000 kg of this natural gas reacts with oxygen.

4 marks

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**b. “**Coal is best described as a non-renewable energy source while natural gas can be described as **both** a non-renewable and a renewable energy source.” Explain.

2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Question 7 (5 marks)**

**a.** Sodium dichromate, Na2Cr2O7(aq) is formed when acid is added to Na2CrO4(aq) according to the equation:

2CrO4 2- (aq) + 2H+(aq)  Cr2O7 2-(aq) + H2O(l)

Is this reaction a redox reaction? Give a reason for your answer. 2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**b.** Zinc metal can be used as a reductant with Na2Cr2O7(aq) to produce Cr3+(aq).

Write a balanced overall equation for this reduction reaction. 2 marks

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**c.** Write a balanced chemical equation for the combination of 2 molecules of glycine to form a dipeptide.

1 mark

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### Question 8 (7 marks)

100 mL of 1.0M AgNO3(aq) and 100 mL of 1.0M Cu(NO3)2(aq) are mixed in a beaker and connected to a power supply through platinum electrodes as shown in the diagram below.

The cell is operated for a long time and a number of different reactions are observed at the electrodes.

**A**

**B**

+

\_

power supply

**a.** The cathode is electrode \_\_\_\_\_\_\_\_\_\_\_\_ (select either A or B) 1 mark

**b.** The equation for the first reaction to occur at the cathode is 1 mark

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**c.** The equation for the second reaction to occur at the cathode is 1 mark

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**d.** The equation for the last reaction to occur at the cathode is 1 mark

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**e.** While the cell is operating, 0.003 mol of oxygen gas is produced in 5 minutes. Assuming that this is the only reaction occurring at the anode, calculate the average current flowing during this time.

3 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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### Question 9 (9 marks)

Complete the following tables by giving the name, semi-structural formula and structural formula of the alkanol and alkanoic acid that will react to produce the ester **pentyl butanoate**.

**a.**

|  |  |
| --- | --- |
| Name of alkanol | 1 mark |
| Semi-structural formula of alkanol | 1 mark |
| Structural formula of alkanol | 1 mark |

**b.**

|  |  |
| --- | --- |
| Name of alkanoic acid | 1 mark |
| Semi-structural formula of alkanoic acid | 1 mark |
| Structural formulaof alkanoic acid | 1 mark |

### Question 9 (continued)

**c.** Draw the structure of **pentyl butanoate**.

Your structure must show all chemical bonds. 2 marks

**d.** In your structure above, draw a circle around the ester functional group. 1 mark

### Question 10 (6 marks)

Draw a diagram to illustrate each of the following.

**a.** A peptide link between two alpha amino acids. 2 marks

List the elements that make up the peptide link.

**b.** The link between the two ring structures in sucrose. 2 marks

Give the name of the linkage.

**c.** A disulfide link in a protein molecule. 2 marks

Describe the function of the disulfide link in the protein molecule.

### Question 11 (8 marks)

Methanoic acid is a weak acid which ionises slightly in aqueous solution according to the equation:

HCOOH(aq) + H2O(l)  H3O+(aq) + HCOO-(aq)

**a.** Calculate the pH of an aqueous solution of methanoic acid at 25oC if the equilibrium concentration of HCOOH is 0.01M. 2 marks

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**b.** Sodium methanoate is added to this equilibrium mixture at 25oC.

Will the pH of the solution increase or decrease? Explain your answer. 2 marks

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### Question 11 (continued)

**c.** The forward reaction for HCOOH(aq) + H2O(l)  H3O+(aq) + HCOO-(aq) is exothermic.

On the graph below, plot the concentrations of HCOOH(aq) , H3O+(aq) and HCOO-(aq) when the following changes are carried out sequentially on a system initially at equilibrium at 25oC.

The initial equilibrium concentration of HCOOH is 0.01M.

1. A few drops of 0.01M HCl(aq) are added to the equilibrium system at constant temperature and the system is allowed to reach a new equilibrium position. 2 marks
2. The temperature is increased to 45oC and the system is allowed to reach a new equilibrium position. 2 marks

Clearly label your graph.

Describe the changes shown on your graph **including** any changes in the value of *Ka*

for methanoic acid.

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### Question 12 (12 marks)

##### A student has three unknown compounds (X, Y and Z) each with the molecular formula C4H10O.

##### 1H NMR is available as an analytical tool to help to identify these three compounds.

The 1H NMR spectrum of compound **X** is shown below.

|  |  |
| --- | --- |
| Compound | 1H NMR spectrum (simplified) |
| **X** | 4 5 3 2 0 ppm1  |

**a.** How many different hydrogen environments are in compound **X**?

Give a reason for your answer. 2 marks

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**b.** There is a triplet at the largest chemical shift (approximately 3.3).

How many hydrogen atoms are on the neighbouring carbon atom? 1 mark

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**c.** Draw the structural formula of compound **X** and give its systematic name. 2 marks

|  |  |
| --- | --- |
| **Structural Formula** | **Name****\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |

### Question 12 (continued)

##### A student has three unknown compounds (X, Y and Z) each with the molecular formula C4H10O.

##### 1H NMR is available as an analytical tool to help to identify these three compounds.

The 1H NMR spectrum of compound **Y** is shown below.

|  |  |
| --- | --- |
| Compound | 1H NMR spectrum (simplified) |
| **Y** | 4 5 3 2 0 ppm1  |

**d.** How many different hydrogen environments are in compound **Y**?

Give a reason for your answer. 2 marks

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**e.** There is a sextet at the largest chemical shift (approximately 3.6).

How many hydrogen atoms are on the neighbouring carbon atom? 1 mark

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**f.** Draw the structural formula of compound **Y** and give its systematic name. 2 marks

|  |  |
| --- | --- |
| **Structural Formula** | **Name****\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |

### Question 12 (continued)

##### A student has three unknown compounds (X, Y and Z) each with the molecular formula C4H10O.

##### 1H NMR is available as an analytical tool to help to identify these three compounds.

The 1H NMR spectrum of compound **Z** is shown below.

|  |  |
| --- | --- |
| Compound | 1H NMR spectrum (simplified) |
| **Z** | 4 5 3 2 0 ppm1  |

**g.** Draw the structural formula of compound **Z**. 1 mark

|  |
| --- |
| **Structural Formula** |

### Question 12 (continued)

##### h. Carbon-13 NMR can be used to determine the number of equivalent carbon environments in a compound. Use the structure you have drawn to complete the following table to show the number of different carbon environments in compound Z. 1 mark

|  |  |  |
| --- | --- | --- |
| Compound | Number of carbon atoms | Number of different carbon environments |
|  Z |  |  |

##### End of questions for the 2013 Kilbaha VCE Chemistry Trial Examination

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| **Kilbaha Multimedia Publishing****PO Box 2227** **Kew Vic 3101** **Australia** | **Tel: (03) 9018 5376** **Fax: (03) 9817 4334** **kilbaha@gmail.com**[**http://kilbaha.com.au**](http://kilbaha.com.au) |