Singleton High School

2016
Higher School Certificate
Trial Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black pen
- Draw diagrams using pencil
- A data sheet and Periodic Table are provided
- Write your student number and/or name at the top of every page

Total marks - 100

Section I - Pages 1 - 23
75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
- Attempt Question 1 – 20
- Allow about 35 minutes for this part

Part B – 55 marks
- Attempt Questions 21 – 32
- Allow about 1 hour and 40 minutes for this part

Section II - Pages 24 - 37
25 marks

- Attempt **ONE** question from Questions 33 – 37
- Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME .....

1 What is the main reason ethylene can be transformed into so many useful products?

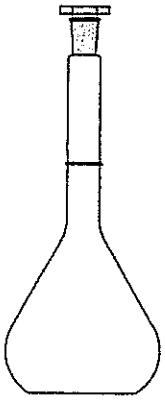
(A) It has a highly reactive double bond.

(B) It has a relatively high molecular mass.

(C) It can easily undergo condensation polymerisation.

(D) It can be easily obtained from biomass.

2 How would the piece of equipment shown below best be described?



(A) Qualitative glassware, designed to contain a set volume of a solution

(B) Quantitative glassware, designed to contain a set volume of solution

(C) Qualitative glassware, designed to deliver a set volume of solution

(D) Quantitative glassware, designed to deliver a set volume of solution

3 The data in the table below relates to information about the sources and amounts of atmospheric sulfur dioxide produced by the USA in 2011.

Source	*Sulfur dioxide (tonnes)*
Fuel combustion	5 424 306
Industrial processes	667 150
Wildfires	195 494
Miscellaneous	16 893
Solvent	483
Dust	22
Agriculture	8

From this information, in what area would sulfur dioxide pollution be the greatest problem?

(A) Forests

(B) Farmland

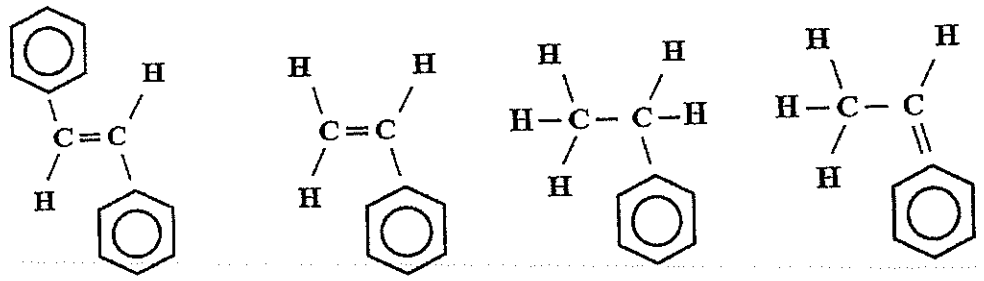
(C) Cities

(D) Deserts

4 Polystyrene is a commercially important polymer.

Which of the following structural formulae correctly represents the monomer in polystyrene?

(A) (B) (C) (D)



5 Which of the following is the final rinsing step in preparing a burette for use?

(A) Rinse with dilute hydrochloric acid.

(B) Rinse with distilled water.

(C) Rinse with the solution to be titrated.

(D) Rinse with the solution to be delivered.

6 Which of the following is a common use of ammonia?

(A) As a weak acid

(B) As a food flavouring

(C) In the manufacture of fertiliser

(D) To test for water hardness

7 A variety of chemicals is used to treat local water supplies to make the water suitable for drinking.

Which alternative below best describes the main purpose for the use of the listed chemicals?

	Chlorine	*Fluoride*	Fe^{3+} *or* Al^{3+}
(A)	Kill microorganisms	Dental care	Adjust pH
(B)	Dental care	Prevent eutrophication	Prevent eutrophication
(C)	Kill microorganisms	Dental care	Promote sedimentation
(D)	Dental care	Prevent sedimentation	Adjust pH

JL

8 Which of the following is the main polymer found in biomass?

(A) Protein

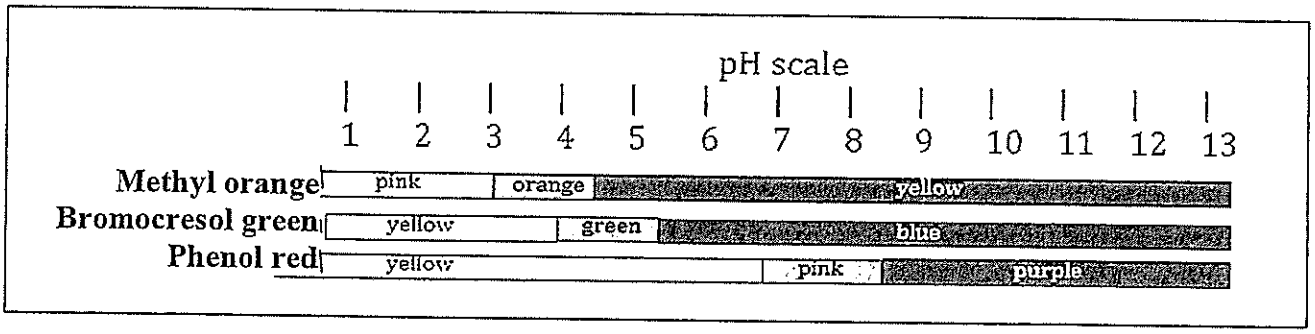
(B) Cellulose

(C) Glucose

(D) Glycogen

Refer to the pH chart below to answer Questions 9 and 10.

The colour changes of three acid-base indicators are recorded in the chart below.



9 A solution is yellow for *phenol red* and orange for *methyl orange*.

What colour could *bromocresol green* show in this solution?

(A) Yellow

(B) Pink

(C) Purple

(D) Red

10 The hydrogen ion concentration in another solution is 8.75×10^{-5} moles per litre.

What colour would methyl orange show in this solution?

(A) Pink

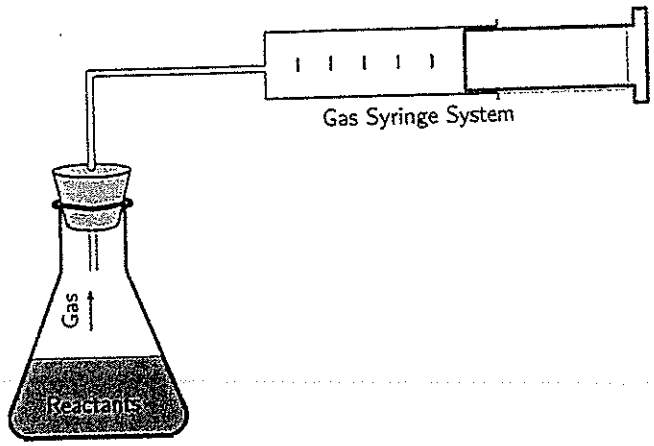
(B) Orange

(C) Yellow

(D) Green

11 The equipment shown below was used to measure the volume of gas produced by a fixed amount of chemical reactants.

How could the reliability of the results be addressed?



(A) By repeating the test several times under the same conditions

(B) By repeating the test using more of each of the reactants

(C) By varying the temperature using a water bath.

(D) By using a clean syringe for the test

12 In nature, many processes require the pH of an aquatic system to be carefully maintained.

What is a common ion which stabilises the pH in waterways?

(A) Na^+

(B) Cl^-

(C) SO_4^{2-}

(D) HCO_3^-

13 A student is to design a method to measure the total dissolved solids in a water sample from a local creek.

A valid method should include which of the following processes?

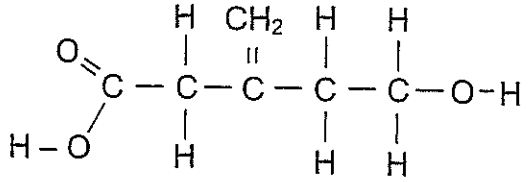
(A) Evaporation only

(B) Filtration followed by evaporation

(C) Evaporation followed by precipitation

(D) Precipitation followed by filtration

14 The molecule below can form either an addition polymer, or a condensation polymer.



If a section from each of these two different types of polymers was isolated so that each of the two sections contained exactly 60 carbon atoms, which of the following inferences would be correct?

(A) The addition polymer would have a higher molecular weight and would contain C=C bonds.

(B) The addition polymer would have a lower molecular weight and would contain C=C bonds.

(C) The condensation polymer would have a higher molecular weight and would contain C=C bonds.

(D) The condensation polymer would have a lower molecular weight and would contain C=C bonds.

15 The following is a quote from an historical scientific journal relating to the concept of an acid.

> *It is suggested that an acid is a substance that has hydrogen that may be replaced by a metal to form a metal salt.*

Which definition of an acid is closest to the above quote?

(A) Arrhenius

(B) Bronsted-Lowry

(C) Davy

(D) Lavoisier

16 Motor cars require the correct amount of oxygen from the air to mix with fuel vapour.

Assuming petrol to be pure octane, which of the following oxygen/petrol vapour volume ratios would be more desirable in a car engine?

(A) 25:2

(B) 8:1

(C) 1:1

(D) 1:12.5

17 A fertiliser contains 18.80% sulfate. A 2.990 g sample of the fertiliser is treated and the sulfate is precipitated as barium sulfate.

What mass of barium sulfate precipitate would be obtained?

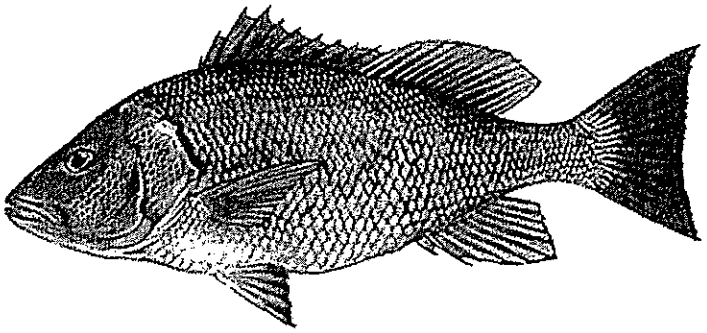
(A) 0.1590 g

(B) 0.5621 g

(C) 1.365 g

(D) 1.927 g

18 Tissue samples from a red snapper fish were analysed for mercury content using atomic absorption spectroscopy.



The average concentration was determined to be 0.190 ppm.

What mass of mercury, in micrograms, would be ingested if a 150 gram portion of this fish was eaten?

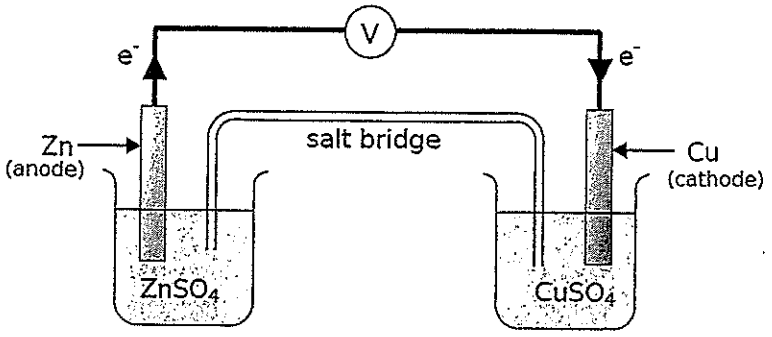
(A) 1.27

(B) 7.45

(C) 21.4

(D) 28.5

19 A student set up the following galvanic cell. Both electrodes were weighed before beginning the experiment and each beaker contained 200 mL of a suitable electrolyte at 0.100 mol L^{-1} concentration.



After a short period of time, the student weighed the copper electrode and found that it had increased in mass by 0.435 g.

Based on this information, what was the final concentration of zinc ions in the zinc sulfate electrolyte?

(A) 0.034 mol L^{-1}

(B) 0.100 mol L^{-1}

(C) 0.127 mol L^{-1}

(D) 0.134 mol L^{-1}

20 A dilute solution of acetic acid is found to have a pH of 2.8.
A small amount of solid sodium acetate is dissolved in the solution.

Which best states the pH of the resulting solution?

(A) pH < 2.8

(B) pH = 2.8

(C) pH > 2.8

(D) pH = 7.0

Section I (continued)

Part B – 55 marks
Attempt Questions 21–32
Allow about 1 hour 40 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 21 (4 marks)

During your HSC Chemistry course you performed a first-hand investigation where you produced ethanol by fermentation and monitored mass changes.

Construct a flow diagram of the steps you followed in this investigation. 4

STUDENT NUMBER/NAME: .....

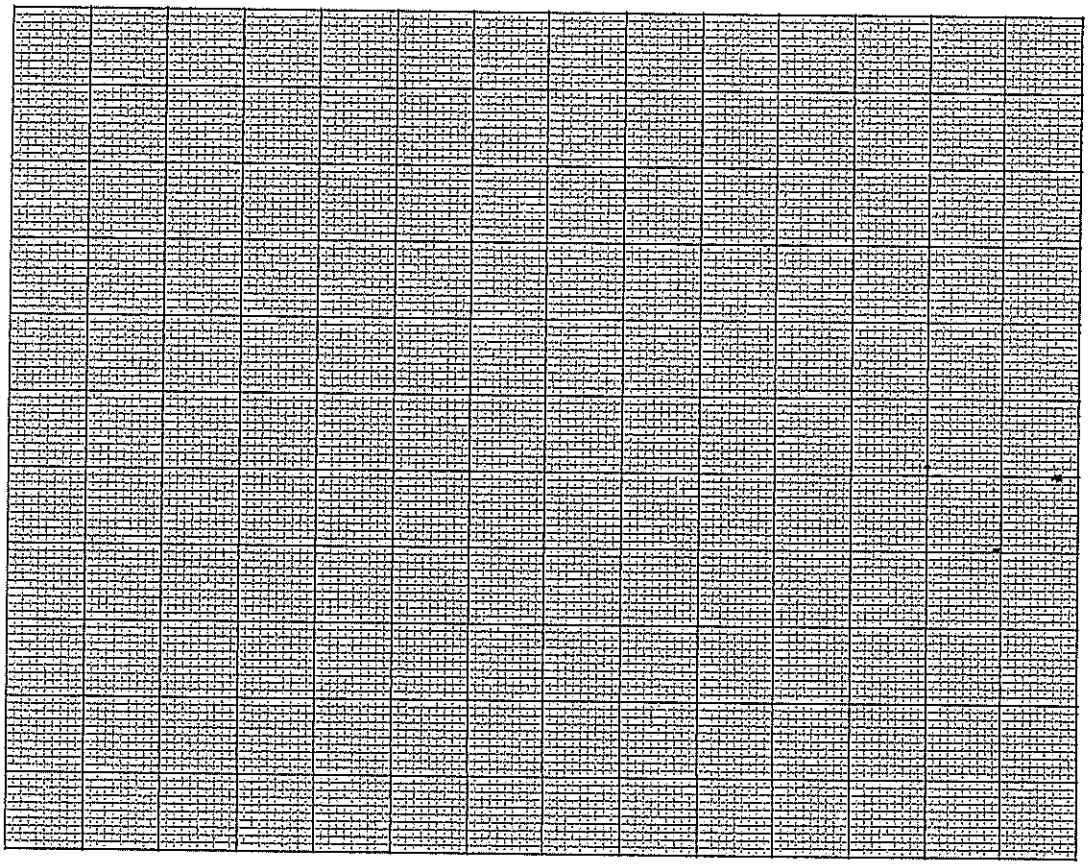
Question 22 (4 marks)

Marks

A sample of water was analysed for lead using Atomic Absorption Spectroscopy. Standard lead solutions were prepared first and the results are as shown in the table below.

$[Pb^{2+}]$ mg L^{-1}	0	2.5	5.0	7.5	10
Absorbance	0.000	0.167	0.331	0.500	0.667

(a) Construct a graph of the data in the above table. **2**



Question 22 continues on the next page

Question 22 (continued)

Marks

(b) The water sample was analysed and the absorbance measured as 0.786.

Estimate $[Pb^{2+}]$ in this solution and describe a way of increasing the accuracy of this estimate. **2**

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End of Question 22

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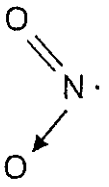
Question 23 (2 marks) **Marks**

Nitrogen dioxide is a brown, poisonous gas. A possible electronic structure, with one unpaired electron (·), is shown below.



(a) Write a balanced chemical equation for the equilibrium between nitrogen dioxide and dinitrogen tetroxide gas ($N_2O_4(g)$). **1**

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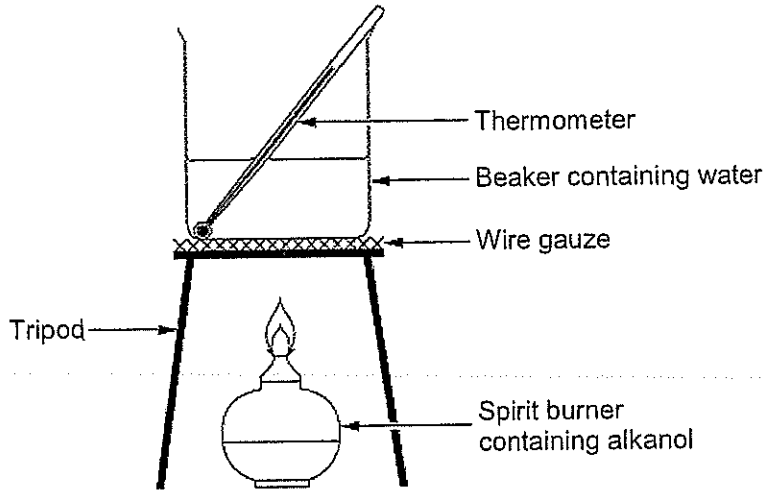
(b) Draw a possible electronic structure of dinitrogen tetroxide. **1**

STUDENT NUMBER/NAME: .....

Question 24 (4 marks) **Marks**

A student performed a first-hand investigation to determine the quantitative relationship between heat of combustion and molar mass of alkanols. The student did this by burning different alkanols to heat water using the equipment shown in the diagram below.



The student collected the data in the following table.

Alcohol (or fuel)	*Molar mass (g)*	*Measured* ΔH_c $(kJ\ mol^{-1})$
Methanol	32	460
Ethanol	46	722
1-Propanol	60	982
1-Butanol	74	1248
1-Pentanol	88	1729

(a) Identify the independent variable in this investigation. 1

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(b) Describe the relationship between heat of combustion and molar mass of alkanols. 1

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Question 24 continues on the next page

Question 24 (continued) **Marks**

(c) Assess the appropriateness of the equipment for this investigation. **2**

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End of Question 24

STUDENT NUMBER/NAME: .....

Question 25 (6 marks) **Marks**

During a practical exercise a student set up four different galvanic cells using zinc as a common electrode and a saturated sodium nitrate salt bridge for each cell. The highest voltage reached by each cell was measured. The student's incomplete results are shown in the table below.

Cell number	*Galvanic cell notation*	*Half-equations*	*Voltage measured (V)*	*Theoretical voltage (from reduction table)(V)*
1	$Zn\|Zn^{2+} \parallel Cu^{2+}\|Cu$	$Zn \rightarrow Zn^{2+} + 2e$ $Cu^{2+} + 2e \rightarrow Cu$	0.91	1.10
2	$Zn\|Zn^{2+} \parallel Fe^{2+}\|Fe$	$Zn \rightarrow Zn^{2+} + 2e$ $Fe^{2+} + 2e \rightarrow Fe$	0.27	0.32
3	$Zn\|Zn^{2+} \parallel Pb^{2+}\|Pb$	$Zn \rightarrow Zn^{2+} + 2e$ $Pb^{2+} + 2e \rightarrow Pb$	0.55	0.63
4	$Mg\|Mg^{2+} \parallel Zn^{2+}\|Zn$		0.91	1.60

(a) Suggest an aim for this experiment. **1**

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(b) Identify ONE reason why the measured voltage is less than the theoretical voltage in each cell. **1**

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(c) Identify the following for the $Zn|Zn^{2+} \parallel Cu^{2+}|Cu$ cell:

(i) Oxidant. **1**

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(ii) Reductant. **1**

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Question 25 continues on the next page

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Question 25 (continued) **Marks**

(d) Identify the reduction and oxidation half-equations for cell number 4 and explain why the order of elements is reversed in the Galvanic cell notation. **2**

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End of Question 25

STUDENT NUMBER/NAME: .....

Question 26 (5 marks) **Marks**

Experiments using radioisotopes of the metal cadmium have shown that freshwater prawns accumulate metals from their diet rather than directly from the water in which they live. The metal accumulates in their body. The data from experiments such as these can be used to monitor metal-pollution from activities like mining.

(a) Calculate the neutron : proton ratio (N/P) for the isotope Cadmium – 115. 1

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(b) Write an equation which represents the beta decay of the isotope Cadmium – 115. 1

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(c) Name an instrument that could measure the radiation emitted by prawns that were given a meal containing this radioisotope. 1

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(d) Outline an impact this research could have on the understanding of the health of aquatic ecosystems. 2

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Question 27 (4 marks) **Marks**

When carbon dioxide gas dissolves in water, heat energy is released.

(a) Write a balanced equation for this reaction (include states). **1**

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(b) Identify TWO ways in which the solubility of carbon dioxide gas may be increased and explain these in terms of Le Chatelier's Principle. **3**

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STUDENT NUMBER/NAME: .....

Question 28 (5 marks) **Marks**

In a school laboratory, a student prepares a primary standard solution by dissolving 1.33 grams of anhydrous sodium carbonate in distilled water, transferring the solution to a volumetric flask and making up the total volume to 250.0 mL.

(a) Calculate the concentration of the carbonate ion in this standard solution. **2**

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(b) 25.0 mL amounts of the sodium carbonate solution were placed into 4 separate conical flasks and 2 drops of methyl orange indicator were added to each. Each solution was titrated with an unknown concentration of sulfuric acid solution, with the following results:

Titration	*Volume of acid needed to reach the end point (mL)*
1	24.55
2	22.05
3	22.15
4	22.10

Use this data to calculate the concentration of the sulfuric acid solution. **3**

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STUDENT NUMBER/NAME: .....

Question 29 (6 marks) **Marks**

The following extract was taken from a student's journal concerning the production of an ester.

The ester, ethyl butanoate, was prepared by refluxing a mixture of ethanol and butanoic acid. A few drops of concentrated sulfuric acid was added to the mixture and the refluxing continued for forty-five minutes. The product mixture was then cooled and poured into 100 mL of cold distilled water.

(a) Identify a safety procedure that should be used when refluxing. **1**

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(b) Write a balanced chemical equation for this reaction. **1**

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(c) Explain what happens when the product is placed into distilled water. **2**

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(d) Describe TWO roles for concentrated sulfuric acid in the reaction system. **2**

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STUDENT NUMBER/NAME: .....

Question 30 (6 marks) **Marks**

The presence of ozone, O_3, in the upper atmosphere is vital to life on Earth, however it is considered a pollutant gas when formed in the lower atmosphere.

(a) Describe a way in which ozone is produced in the lower atmosphere. 1

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(b) Using ozone as an example, describe the formation of a coordinate covalent bond. 2

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(c) Identify fluorocarbons that can replace CFCs and evaluate their effectiveness. 3

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STUDENT NUMBER/NAME: .....

Question 31 (5 marks) **Marks**

Discuss the need to monitor reaction vessels, using the Haber process as an example.

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Question 32 (4 marks)

Describe factors that can affect the amount of dissolved oxygen in a body of water and explain why the biochemical oxygen demand is considered a better indicator of water quality, than dissolved oxygen. 4

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Section II – Pages 24 - 37

25 marks
Attempt ONE question from Questions 33–37
Allow about 45 minutes for this section

Answer parts (a)–(d) of the question in Section II Answer Booklet 1.
Extra writing booklets are available.

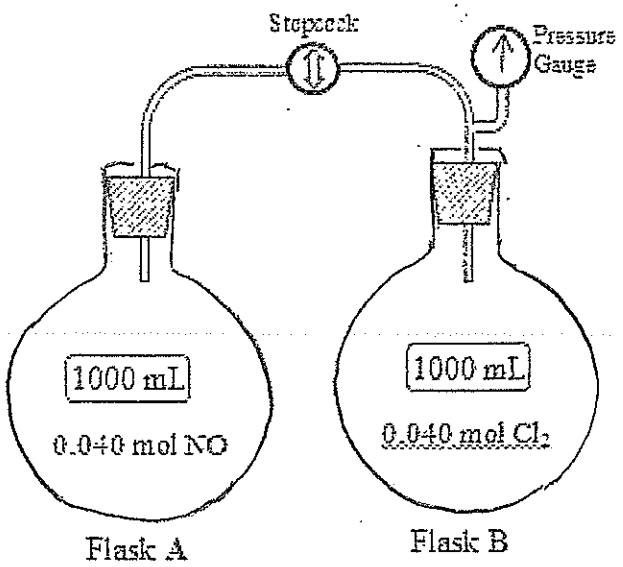
Show all relevant working in questions involving calculations.

STUDENT NUMBER/NAME: .....

Question 33 – Industrial Chemistry (25 marks) **Marks**

(a) Nitrosyl chloride (NOCl) is a yellow-orange gas which can be formed by the reaction of colourless nitric oxide (NO) and pale green chlorine gas.

$$2NO(g) + Cl_2(g) \rightleftarrows 2NOCl(g)$$



Flask A initially contains 0.040 mol of NO gas, while flask B contains 0.040 mol of chlorine. The entire assembly is heated to 120°C. The stopcock between the flasks is then opened allowing the gases to mix and establish equilibrium.

(i) Describe the changes observed at the pressure gauge as equilibrium is approached. 1

(ii) At equilibrium it is determined that the concentration of NOCl is 0.012 mol L^{-1} Determine the concentration of each of the other gases and hence calculate the equilibrium constant for this reaction at 120°C. 3

Question 33 continues on the next page

Question 33 (a) (continued) **Marks**

(iii) If the gas mixture is heated to 200° C, its colour becomes less orange and more green. What is the effect of the increase in temperature on the equilibrium position and the equilibrium constant? **2**

(b) The *contact process* is so named because oxygen and sulfur dioxide are brought into contact with a catalyst.

(i) Discuss the relationship between the rate of reaction and the temperature and pressure conditions that produce a maximum yield from the contact process include an equation in your answer. **3**

(ii) Outline the steps by which the product of the contact process is used to make sulphuric acid. **2**

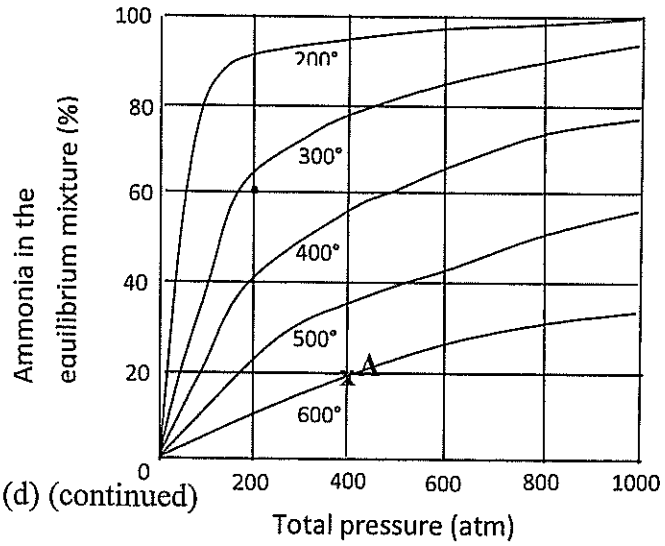
(iii) Describe the procedure to dilute 18 molL-1 concentrated sulphuric acid to obtain a 2 mol-1 solution of sulphuric acid. 2

(c) The world's population is increasing at an exponential rate and this growing population needs enough natural resources to exist.

Evaluate progress that has been made to solve this issue, for a natural resource that is NOT a *fossil fuel.* **5**

(d)

(i) The graphs below show the molar fraction (%) of ammonia present at equilibrium when ammonia gas is placed in a pressure vessel with a catalyst.



Question 33 (d) (continued)

(i) Explain why a 90% yield of ammonia is not practicable in the Haber process. **2**

(ii) 1.0 L of a gas mixture, at a pressure of 400 atm and temperature of 600°C, contains a total of 5.56 moles of gas molecules. Calculate the equilibrium constant for the production of ammonia, at point A on the graph, and describe the effect of temperature on the equilibrium constant. **3**

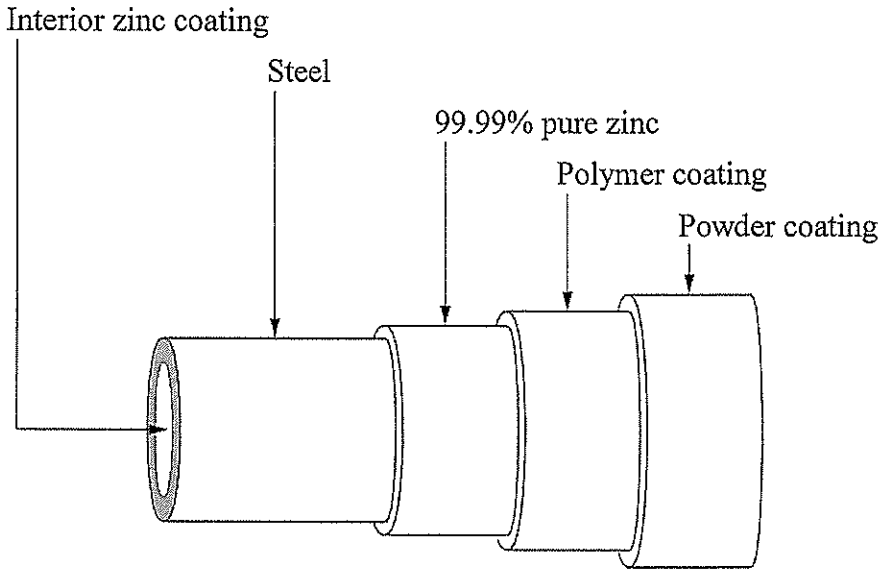
(iii) When the pressure on a gas mixture is doubled, the concentration of all gases present in the mixture is doubled. With reference to the equilibrium constant expression, explain why doubling the pressure on the equilibrium system referred to in the graph results in an increased percentage of ammonia. **2**

End of question 33

Question 34 — Shipwrecks, Corrosion and Conservation (25 marks)

Answer parts (a)–(e) in Section II Answer Booklet

(a) This diagram shows the various layers of a pipe. **3**



Outline TWO reasons why this pipe would be resistant to corrosion.

(b) Iron corrodes differently under acidic and neutral conditions.

(i) Write an equation to represent the process of rusting under neutral conditions. **2**

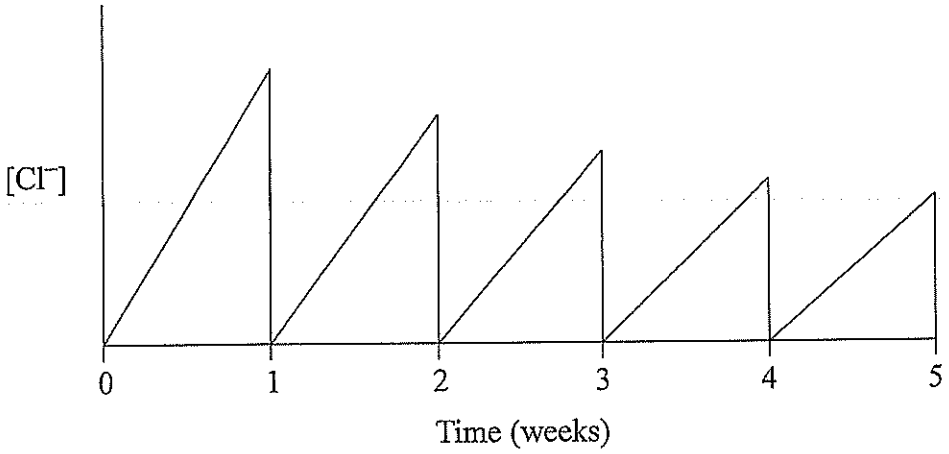
(ii) Explain why iron will corrode faster under acidic conditions than under neutral conditions. **3**

Question 34 continues on page 29

Question 34 (continued)

(c) A wooden artefact was recovered from a shipwreck. After it was removed from the ocean, it was placed in a tank of distilled water. The water was changed weekly and the chloride ion concentration was monitored. After 10 weeks, the artefact was dried slowly in a controlled environment.

The graph shows the chloride ion concentration in the tank in the first five weeks.



(i) Account for the shape of this graph. **2**

(ii) Explain the possible effect on the artefact if it had been simply left to dry instead of undergoing the procedure described above. **3**

(d) An investigation is to be set up in a school laboratory to determine the rate of corrosion of iron in different oxygen concentrations.

(i) Identify the variables that need to be kept constant in this investigation. **2**

(ii) Describe TWO limitations in making qualitative and/or quantitative observations in this investigation. **3**

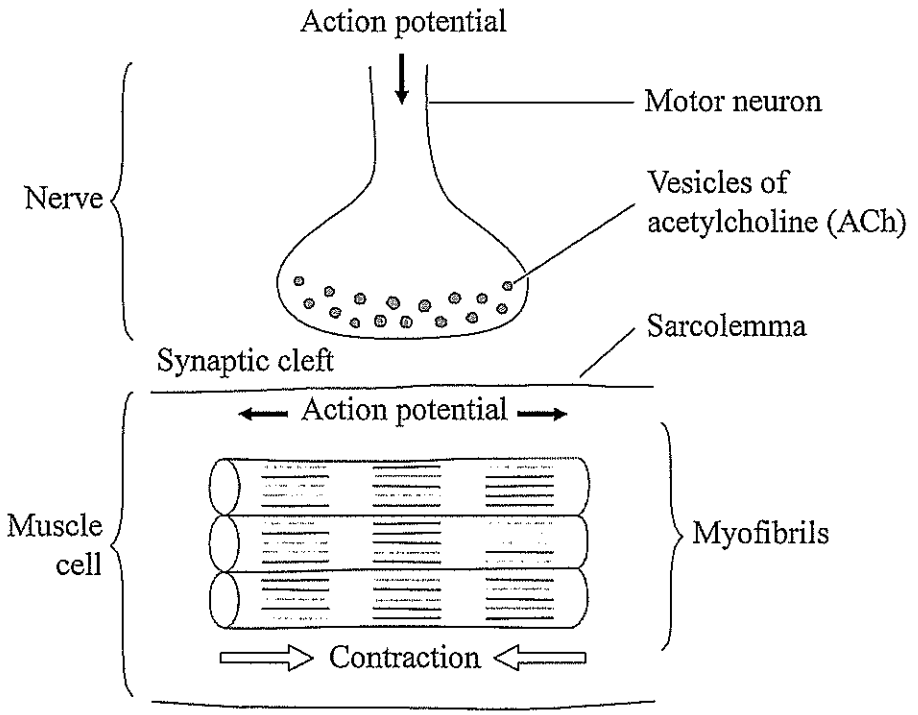
(e) Explain why a range of factors should be considered when using electrolysis to clean and stabilise a metal artefact. **7**

End of Question 34

Question 35 — The Biochemistry of Movement (25 marks)

Answer parts (a)–(e) in Section II Answer Booklet 1.

(a) The diagram represents the junction between a nerve and a muscle cell. An action potential in the nerve causes contraction in the muscle cell. **3**



In your answer booklet, write steps 5 and 6 to show how this contraction occurs.

Step 1	Action potential travels down nerve to endplate
Step 2	ACh (chemical neurotransmitter) is released into synaptic cleft
Step 3	ACh initiates action potential on the muscle cell membrane (sarcolemma)
Step 4	Action potential travels along sarcolemma, through T tubules to sarcoplasmic reticulum
Step 5	
Step 6	
Step 7	Enzyme (myosin ATP-ase) allows breakdown of ATP to release energy
Step 8	Actin and myosin slide over each other
Step 9	Muscle shortens (contracts)

Question 35 continues on page 31

Question 35 (continued)

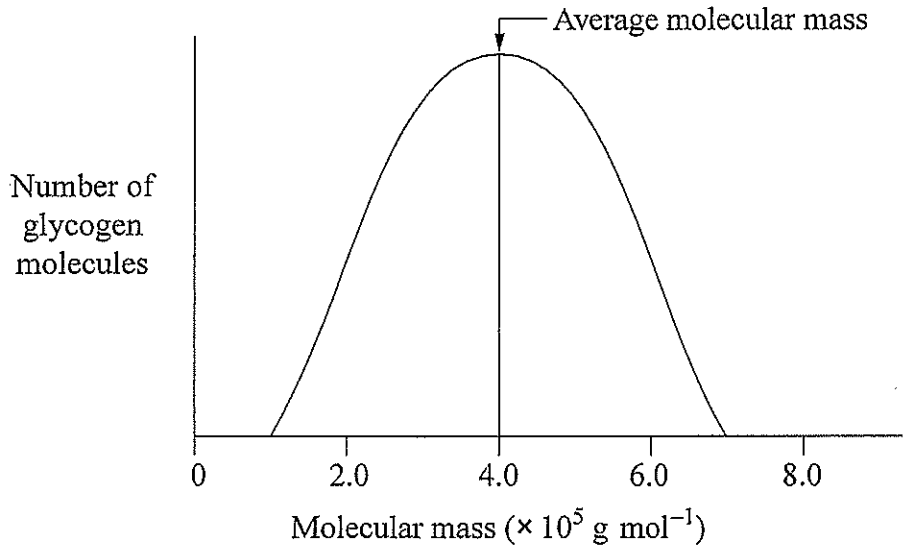
(b) (i) Name an enzyme and outline its function. **2**

(ii) Explain how a change in pH might change the shape and structure of an enzyme. **3**

(c) Glucose is a carbohydrate monomer which forms the extensively branched polymer, glycogen.

(i) Explain an advantage of the extensive branching of the chains of a glycogen molecule. **2**

(ii) The graph shows the distribution of molecular mass of a large number of glycogen molecules. **3**



Calculate the number of glucose monomers in an average glycogen molecule.

Question 35 continues on page 32

(d) An investigation is to be set up to represent the structure of fatty acids.

(i) Identify the essential features of fatty acid molecules that should be included in this representation. **2**

(ii) Describe TWO limitations of using models or diagrams to represent fatty acid molecules. **3**

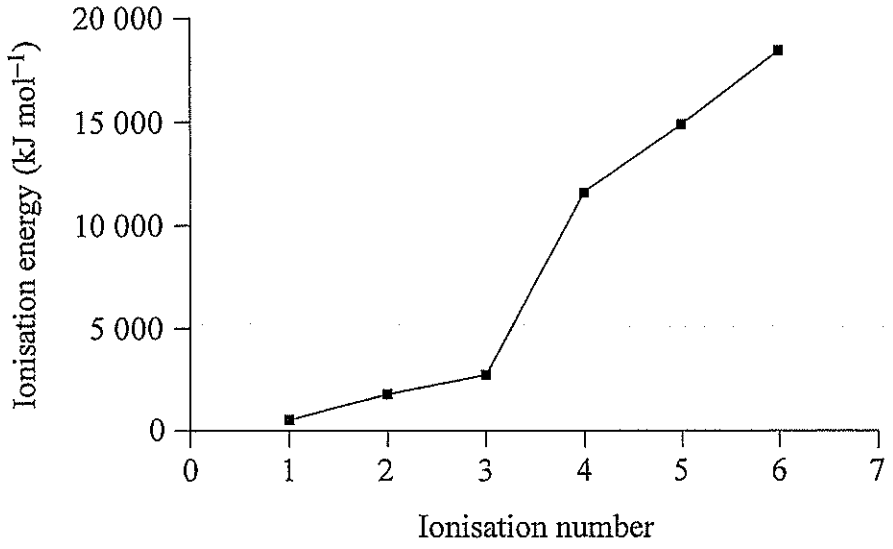
(e) Explain how damage to mitochondria affects ATP production and energy output of cells. **7**

End of Question 35

Question 36 — The Chemistry of Art (25 marks)

Answer parts (a)–(e) in Section II Answer Booklet 1.

(a) The successive ionisation energies of aluminium are presented below. **3**



Explain the trend in ionisation energy.

(b) Pigments play a significant role in the creation of cave paintings by Aboriginal people.

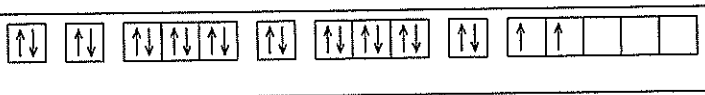
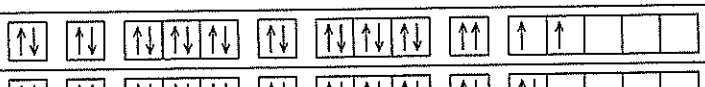
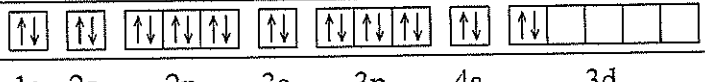
(i) Outline the process used to prepare and attach pigments to cave walls. **2**

(ii) Describe THREE pigments used by Aboriginal people in traditional art, with reference to their chemical composition and colour. **3**

Question 36 continues on page 34

Question 36 (continued)

(c) Three electron configurations are presented in the table. For elemental titanium, the ground state is represented by I, while II and III are both invalid ground state electron configurations.

		Electron Configurations
I	Ground state	
II	Invalid	
III	Invalid	
		1s 2s 2p 3s 3p 4s 3d

(i) Write a valid electron configuration for Ti^{3+}. **2**

(ii) Explain why II and III do not represent the ground state configuration for elemental titanium. **3**

(d) An investigation is to be conducted to study the changes in oxidation state of a transition metal.

(i) Outline a valid procedure that could be used to carry out the investigation. **2**

(ii) Describe TWO limitations of the procedure outlined in part (i). **3**

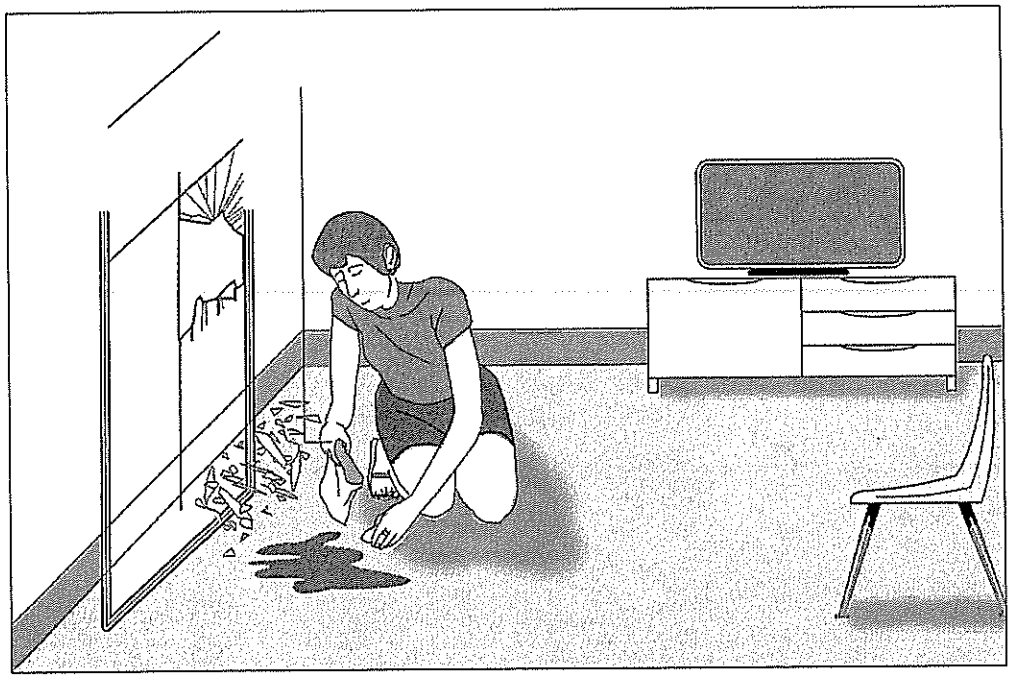
(e) Explain the role of electrons in determining colour. **7**

End of Question 36

Question 37 — Forensic Chemistry (25 marks)

Answer parts (a)–(e) in Section II Answer Booklet 1.

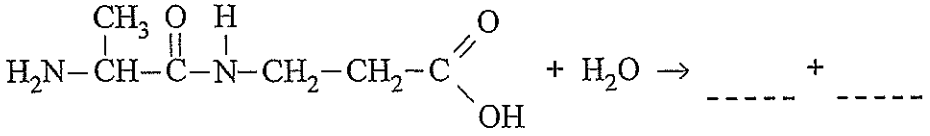
(a) This picture shows a forensic scientist collecting a blood sample from a crime scene. **3**



Explain TWO errors that this scientist is making while collecting the blood sample.

(b) Hydrolysis can be used to break down proteins into amino acids.

(i) This equation represents the hydrolysis of a dipeptide. **2**

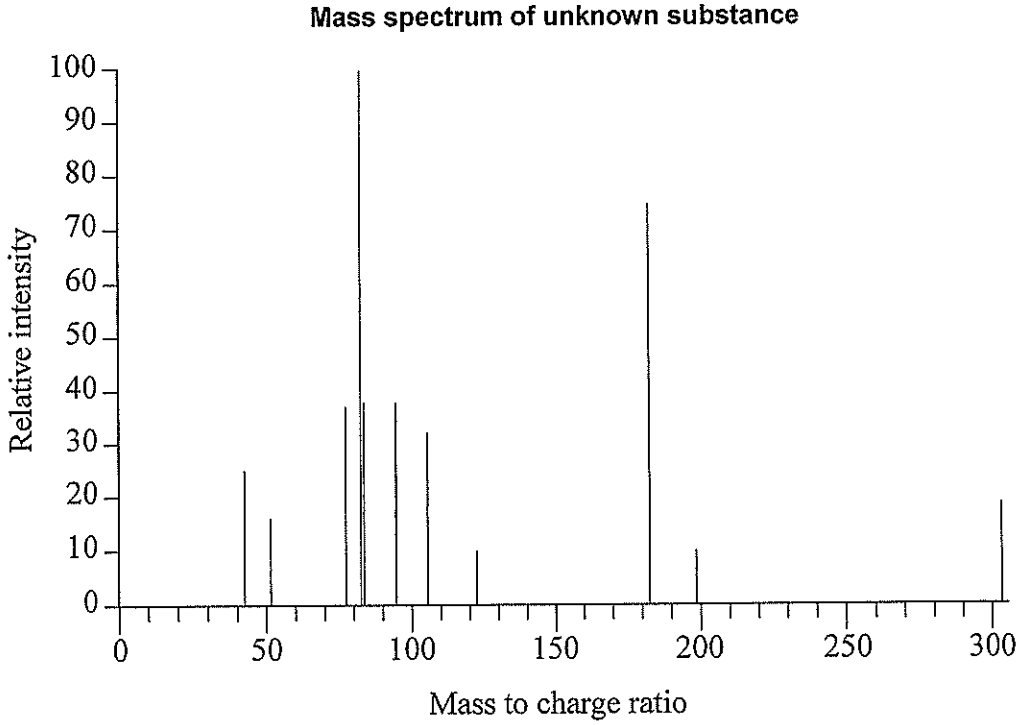


In your answer booklet, draw the TWO products of the hydrolysis of the dipeptide.

(ii) Describe how protein hydrolysis is used in forensic analysis. **3**

Question 37 continues on page 36

(c) (i) An unknown substance was collected. It was analysed and its mass spectrum collected. **2**



This table shows the mass to charge ratio of a selection of fragments in the mass spectrum for three compounds of interest in forensic investigations.

Compound name	*Significant fragments (mass to charge ratio)*
Caffeine	67 109 194
Cocaine	82 94 182
Paracetamol	43 109 151

Using the information in the table, identify the unknown substance and justify your choice.

(ii) Describe how mass spectrometry can be useful for analysing forensic evidence. **3**

Question 37 continues on page 37

(d) An investigation is to be conducted in a school laboratory to separate organic compounds using chromatography.

(i) Outline a valid procedure that could be used in a school laboratory to carry out the investigation. **2**

(ii) Describe TWO limitations of carrying out the procedure outlined in part (i). **3**

(e) Explain why DNA evidence may be challenged when used in court cases. **7**

End of paper

JL

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Uut Ununtrium	114 Fl Flerovium	115 Uup Ununpentium	116 Lv Livermorium	117 Uus Ununseptium	118 Uuo Ununoctium

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (January 2016 version).

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.

Chemistry

DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$\text{pH} = -\log_{10}[\text{H}^+] \qquad \Delta H = -mC\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

STUDENT NUMBER/NAME: .....

Singleton High School

Chemistry

Section I Part A - Multiple Choice

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

correct

A ● B ● C ○ D ○

Start Here →

1	A ○	B ○	C ○	D ○	**11**	A ○	B ○	C ○	D ○
2	A ○	B ○	C ○	D ○	**12**	A ○	B ○	C ○	D ○
3	A ○	B ○	C ○	D ○	**13**	A ○	B ○	C ○	D ○
4	A ○	B ○	C ○	D ○	**14**	A ○	B ○	C ○	D ○
5	A ○	B ○	C ○	D ○	**15**	A ○	B ○	C ○	D ○
6	A ○	B ○	C ○	D ○	**16**	A ○	B ○	C ○	D ○
7	A ○	B ○	C ○	D ○	**17**	A ○	B ○	C ○	D ○
8	A ○	B ○	C ○	D ○	**18**	A ○	B ○	C ○	D ○
9	A ○	B ○	C ○	D ○	**19**	A ○	B ○	C ○	D ○
10	A ○	B ○	C ○	D ○	**20**	A ○	B ○	C ○	D ○