



Western Australian Certificate of Education Examination, 2012

Question/Answer Booklet

CHEMISTRY

Stage 2

Please place your student identification label in this box

Student Number: In figures

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In words

Time allowed for this paper

Reading time before commencing work: ten minutes

Working time for paper: three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet

Multiple-choice Answer Sheet

Chemistry Data Sheet

Number of additional
answer booklets used
(if applicable):

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener,
correction tape/fluid, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in the WACE examinations

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of total exam
Section One: Multiple-choice	25	25	45	25	25
Section Two: Short answer	12	12	70	105	40
Section Three: Extended answer	4	4	65	50	35
Total					100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2012*. Sitting this examination implies that you agree to abide by these rules.
2. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

3. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.
4. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.
5. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
 - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
 - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.
6. The Chemistry Data Sheet is **not** handed in with your Question/Answer Booklet.

See next page

Section One: Multiple-choice

25% (25 Marks)

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 45 minutes.

- Approximately how many electrons would be required to have the same total mass as one proton?
 - 0.5
 - 1
 - 200
 - 2000
- A covalent bond would be expected to form between atoms which have the electron configurations
 - 2,7 and 2,6.
 - 2,8,8 and 2.
 - 2,8,1 and 2,8,7.
 - 2,8,5 and 2,8,8,1.
- What is the conjugate acid of HCO_3^- ?
 - H_2CO_3
 - CO_3^{2-}
 - H_3O^+
 - H_2O
- What would be the chemical formula of the compound formed between magnesium and nitrogen?
 - Mg_2N_3
 - Mg_3N_2
 - Mg_2N
 - MgN
- Which of the following chemicals are **least** likely to be found in a typical Western Australian household?
 - bicarbonate of soda (NaHCO_3) and methane (CH_4)
 - ethanol ($\text{CH}_3\text{CH}_2\text{OH}$) and copper (Cu)
 - chloroform (CHCl_3) and sodium (Na)
 - sodium chloride (NaCl) and acetic acid (CH_3COOH)

See next page

6. Which one of the following descriptions relates correctly to an ionic solid?
- (a) an ordered lattice arrangement of cations and free valence electrons
 - (b) a crystalline form that is hard and has lustre
 - (c) a high melting point due to strong intermolecular bonding
 - (d) valence electrons are free to conduct charge
7. Which one of the following 0.100 mol L^{-1} aqueous solution combinations will form at least one precipitate?
- (a) sodium chloride, barium nitrate, potassium hydroxide
 - (b) tin(II) nitrate, caesium nitrate, sodium sulfate
 - (c) copper(II) sulfate, sodium ethanoate, hydrochloric acid
 - (d) barium hydroxide, sodium chloride, iron(II) sulfate
8. Which of the following substances would be the **best** to add to a household swimming pool to raise its pH?
- (a) sodium carbonate
 - (b) ammonia
 - (c) ammonium nitrate
 - (d) hydrochloric acid
9. The oxidation numbers of nitrogen in the series, N_2 , N_2O , NO_3^- and NH_3 respectively are
- (a) 0, 0, +5, -3.
 - (b) 0, -1, -1, +3.
 - (c) 0, +1, +5, -3.
 - (d) +2, +2, +1, +1.
10. In a 2.00 mol L^{-1} H_3PO_4 solution, which species, excluding H_2O , would have the greatest concentration?
- (a) H^+
 - (b) PO_4^{3-}
 - (c) H_3PO_4
 - (d) H_2PO_4^-
11. Which of the following lists contain **only** strong electrolytes?
- (i) BaSO_4 , AgCl , HCl
 - (ii) glucose, ethanol, tartaric acid
 - (iii) HCl , CH_3COOH , HNO_3
 - (iv) NH_3 , NaCl , KNO_3
- (a) (i) only
 - (b) (ii) and (iii) only
 - (c) (i), (iii) and (iv)
 - (d) (iv) only

See next page

12. Which one of the following reactions is **not** a redox reaction?

- (a) $\text{K(s)} + \text{O}_2(\text{g}) \longrightarrow \text{K}_2\text{O(s)}$
- (b) $2 \text{Na(s)} + 2 \text{H}_2\text{O}(\ell) \longrightarrow 2 \text{NaOH(aq)} + \text{H}_2(\text{g})$
- (c) $\text{Li}_2\text{O(s)} + \text{H}_2\text{O}(\ell) \longrightarrow 2 \text{LiOH(aq)}$
- (d) $2 \text{Na(s)} + \text{H}_2(\ell) \longrightarrow 2 \text{NaH(s)}$

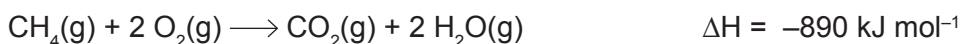
13. A normal adult has about 5.5 litres of blood which has a pH of 7.4. When a patient is injected with a drug, care must be taken to ensure that the drug does not change the pH of the blood. A small amount of a drug of pH 3 is injected into a patient.

Which one of the following is the resulting pH of this patient's blood?

- (a) more than 7.4
 - (b) a little less than 7.4
 - (c) approximately 5.2
 - (d) approximately 3.0
14. Which combination of anode, cathode and electrolyte could be used to silver-plate a nickel knife?

	Anode	Cathode	Electrolyte
(a)	knife	Ag(s)	AgNO ₃ (aq)
(b)	knife	Ag(s)	Ni(NO ₃) ₂ (aq)
(c)	Ag(s)	knife	AgNO ₃ (aq)
(d)	Ag(s)	knife	Ni(NO ₃) ₂ (aq)

15. The combustion of natural gas (mainly methane) can be represented by:

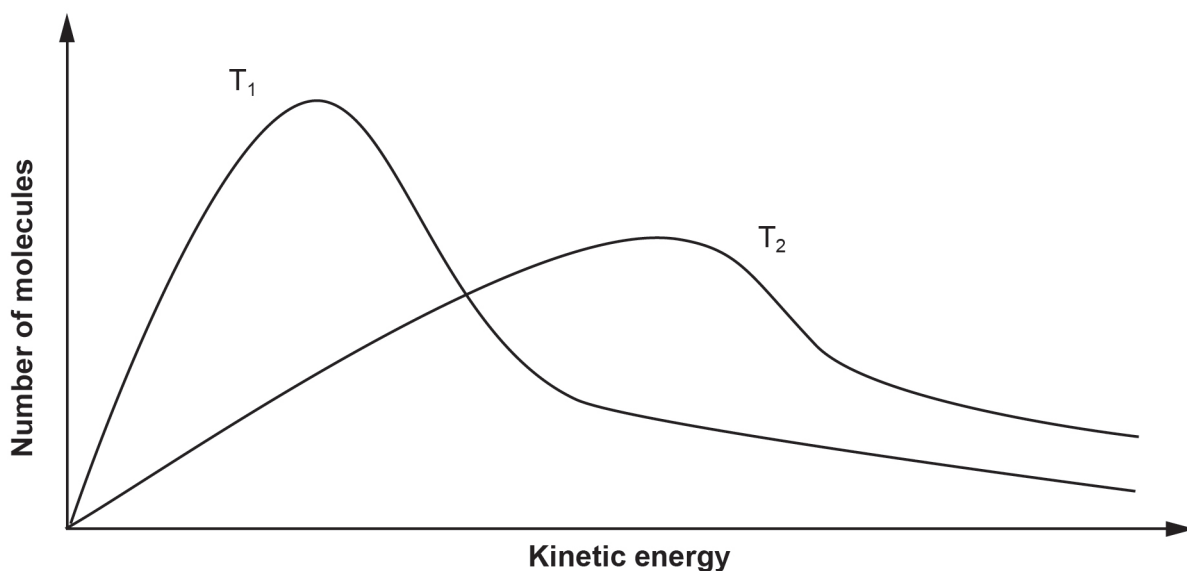


Which one of the following would decrease the rate of the reaction?

- (a) increasing the volume at constant temperature
 - (b) increasing the temperature at constant volume
 - (c) passing the gases over the surface of a catalyst
 - (d) increasing the concentration of reactants at constant temperature
16. What change(s) occur(s) while a liquid is boiling?
- (i) The average kinetic energy of the particles increases.
 - (ii) The attractive forces between the particles become stronger.
 - (iii) The spacing between the particles increases.
- (a) (i) only
 - (b) (ii) and (iii) only
 - (c) (iii) only
 - (d) (i) and (iii) only

17. Which one of the following obeys the IUPAC system of naming organic compounds?
- (a) 1-methylpropane
 - (b) 2,2-diethylbutane
 - (c) cis-1,1-dichloroethane
 - (d) cis-2,3-dibromobut-2-ene
18. Two identical flasks are both at 25°C and 100 kPa pressure. One flask contains carbon dioxide gas and the other flask contains nitrogen gas. Which one of the following statements about the gases in the two flasks is true?
- (a) The same number of atoms is contained in each flask.
 - (b) The average velocity of the particles in the two flasks is the same.
 - (c) The flasks contain the same mass of gas.
 - (d) The average kinetic energy of the particles in the two flasks is the same.
19. Which one of the following number of moles is equivalent to the greatest mass of substance?
- (a) 0.50 mol of chloride ions
 - (b) 0.20 mol of mercury atoms
 - (c) 0.25 mol of oxygen molecules
 - (d) 2.00 mol of water molecules
20. When 4.59 g of zinc acetate, $\text{Zn}(\text{CH}_3\text{COO})_2$, is dissolved in enough water to make 1.00 L of solution, the concentrations of zinc and acetate ions are, respectively,
- (a) 0.0250 mol L⁻¹ and 0.0250 mol L⁻¹.
 - (b) 0.0250 mol L⁻¹ and 0.0500 mol L⁻¹.
 - (c) 0.0369 mol L⁻¹ and 0.0738 mol L⁻¹.
 - (d) 0.0250 mol L⁻¹ and 0.0125 mol L⁻¹.
21. Which equation below **best** represents the H_2PO_4^- ion acting as a Brønsted-Lowry acid?
- (a) $\text{H}_2\text{PO}_4^-(\text{aq}) \longrightarrow 2 \text{H}^+(\text{aq}) + \text{PO}_4^{3-}(\text{aq})$
 - (b) $\text{H}_2\text{PO}_4^-(\text{aq}) + \text{OH}^-(\text{aq}) \longrightarrow \text{H}_3\text{PO}_4(\text{aq}) + \text{H}_2\text{O}(\ell)$
 - (c) $\text{H}_2\text{PO}_4^-(\text{aq}) + \text{H}_2\text{O}(\ell) \longrightarrow \text{H}_3\text{PO}_4(\text{aq}) + \text{OH}^-(\text{aq})$
 - (d) $\text{H}_2\text{PO}_4^-(\text{aq}) + \text{H}_2\text{O}(\ell) \longrightarrow \text{HPO}_4^{2-}(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$
22. Which one of the following compounds contains only ionic bonds?
- (a) CH_3OH
 - (b) HCl
 - (c) NaH
 - (d) NaNO_3

23. Which one of the following statements **best** describes a covalent bond?
- (a) The atoms have a noble gas configuration.
 - (b) The atoms have formed an infinite network.
 - (c) One of the atoms involved in the bond is a metal and the other is a non-metal.
 - (d) There is simultaneous attraction of both nuclei to a shared electron pair.
24. Which one of the following characteristics does **not** apply to solutions?
- (a) They are homogeneous mixtures.
 - (b) They contain two or more substances.
 - (c) They have uniform composition.
 - (d) They always contain a solid that has dissolved in a liquid.
25. The diagram below illustrates the kinetic energy distribution curves for a gas system at two different temperatures, T_1 and T_2 , where T_2 is greater than T_1 .



Given that all other conditions are the same for the gas system at the two temperatures, consider the following statements.

- (i) The molecules at T_1 have a higher average velocity than the molecules at T_2 .
- (ii) At T_2 more molecules have a higher kinetic energy than T_1 .
- (iii) Those molecules with higher kinetic energy collide more frequently.
- (iv) Fewer molecules at T_1 will have the required activation energy (E_a) for a chemical change than at T_2 .

The correct statements are:

- (a) (ii), (iii) and (iv) only.
- (b) (i), (ii) and (iii) only.
- (c) (ii) and (iii) only.
- (d) (i), (ii), (iii) and (iv).

End of Section One

See next page

Section Two: Short answer

40% (105 Marks)

This section has 12 questions. Answer **all** questions. Write your answers in the space provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

Do not use abbreviations, such as 'nr' for 'no reaction', without first defining them.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

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Suggested working time: 70 minutes.

Question 26**(8 marks)**

- (a) Chemists use letters and numbers to provide information about chemical species. Even their positions provide information. In each case below, state what information is indicated by the figure within the circle. (3 marks)







- (b) Complete the table below for the ion ${}_{19}^{40} \text{K}^+$. (4 marks)

Number of protons	Number of neutrons	Number of electrons	Electron configuration

- (c) Name the element whose atomic form has the same electron configuration as ${}_{19}^{40} \text{K}^+$. (1 mark)

Question 27

(6 marks)

(a) Complete the table below by writing the formula of each of the compounds listed.

(3 marks)

Name of compound	Formula of compound
ammonia	
sodium oxide	
tin(II) phosphate	

(b) Complete the table below by writing the name of each of the compounds listed. (3 marks)

Formula of compound	Name of compound
$\text{Fe}_2(\text{SO}_4)_3$	
P_2S_5	
C_2H_4	

Question 28

(4 marks)

For the species listed in the table below, draw electron dot diagrams.

All valence shell electron pairs should be represented either as : or as —

(for example, water $\text{H} \cdot \ddot{\text{O}} \cdot \text{H}$ or $\text{H} - \ddot{\text{O}} - \text{H}$ or $\text{H} - \overline{\text{O}} - \text{H}$).

Species	Electron dot diagram
CaCl_2	
PCl_3	

Question 29

(12 marks)

- (a) When solid potassium carbonate is dropped into a container of dilute sulfuric acid, it reacts and bubbles of a colourless gas are given off.

Write the balanced chemical equation for this reaction. Show only those species that take part in the reaction and use the appropriate state symbols. (3 marks)

- (b) When 4.22 g of solid zinc metal is mixed with excess hydrochloric acid, a gas is produced according to the following equation.



- (i) How many moles of hydrogen gas will be produced? (3 marks)

- (ii) What volume will this hydrogen gas occupy at S.T.P.? (2 marks)

Question 29 (continued)

- (c) If the same mass of magnesium instead of zinc was reacted with the hydrochloric acid, would more, less or the same amount of gas be produced under the same conditions?
(4 marks)

Circle your answer. more less the same

Explain by reason or calculation why this is so.

Question 30**(9 marks)**

Pure anhydrous copper(II) sulfate is white. When water molecules form part of the ionic lattice, the blue coloured hydrous copper(II) sulfate is produced. In simple terms, 'hydrous' or 'hydrated' means 'with water' while 'anhydrous' means 'without water'. Water can be removed from a substance by heating it. This is called dehydrating the substance.

A 29.95 g sample of the hydrated copper(II) sulfate was heated in a crucible over a Bunsen burner to drive off the water from its crystal lattice. The sample was subjected to repeated heating and weighing until there was no further change in mass as indicated by the table below.

Initial sample	1st weighing	2nd weighing	3rd weighing	4th weighing	5th weighing	6th weighing
29.95 g	24.33 g	22.46 g	19.72 g	19.15 g	19.15 g	19.15 g

- (a) What was the mass of water driven off from the hydrated form of copper(II) sulfate?
(1 mark)

- (b) Calculate the percentage by mass of copper(II) sulfate in hydrated copper(II) sulfate. (2 marks)

Hydrates are inorganic salts that contain a specific number of water molecules loosely attached. Examples include magnesium sulfate heptahydrate (Epsom salts) and sodium carbonate decahydrate (washing soda). The formulas for these substances are $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$.

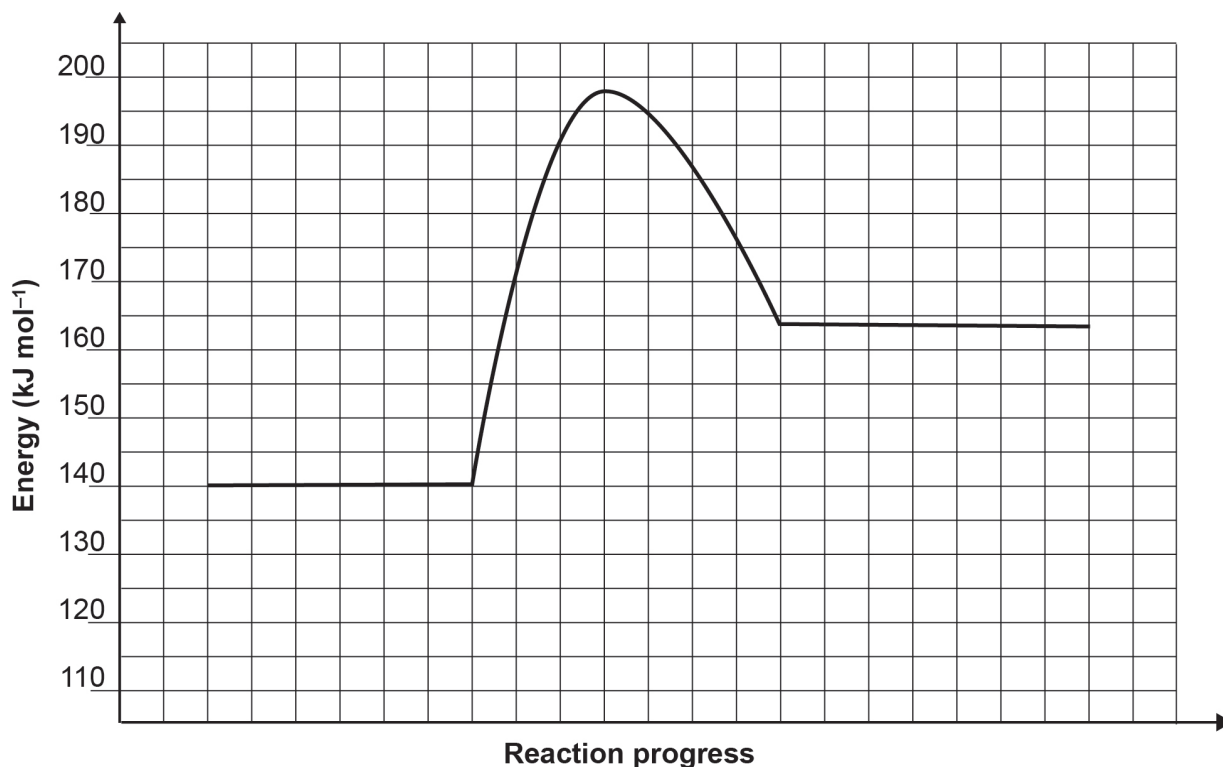
- (c) Using your answers from Parts (a) and (b), show that the formula of hydrated copper(II) sulfate is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. (5 marks)

- (d) Why is the sample re-heated and re-weighed several times? (1 mark)

Question 31

(11 marks)

The energy profile diagram for a particular chemical reaction is given below. Use it to answer the following questions. Use the appropriate units if relevant.



- (a) Complete the table with the symbol, value and unit for the chemical reaction's heat of reaction and activation energy. (4 marks)

	Symbol	Value	Unit
Activation energy	E_a		kJ mol^{-1}
Heat of reaction			

- (b) On the energy profile diagram above, sketch what the graph would look like if a catalyst was used. (2 marks)

- (c) By circling the correct answer below, indicate whether the reaction represented in the energy profile diagram is exothermic, endothermic or neither. (1 mark)

exothermic

endothermic

neither

- (d) By circling the correct answer below, indicate the change in temperature that would be observed if a thermometer was placed into the reacting vessel during the reaction. (1 mark)

increase

decrease

no change

- (e) By circling the correct answer below, indicate whether the energy stored in the bonds of the reactants of an **exothermic** reaction has a higher, lower or equivalent value than that of the energy stored in the bonds of the products. (1 mark)

higher

lower

equivalent

- (f) It is not possible to observe a chemical reaction on an atomic level but macroscopic changes can be observed and measured. In general terms, what change could be measured to determine if a substance added to a reaction actually increased the rate of the chemical reaction? (2 marks)

Question 32

(9 marks)

- (a) For each of these two substances, state the type of bonding, a use and the property of each substance that allows it to be used as suggested. (6 marks)

Substance	Type of bonding	Use	Property
graphite			
copper			

- (b) Describe how the theory of bonding in copper can explain the property stated in Part (a). (3 marks)

Question 33

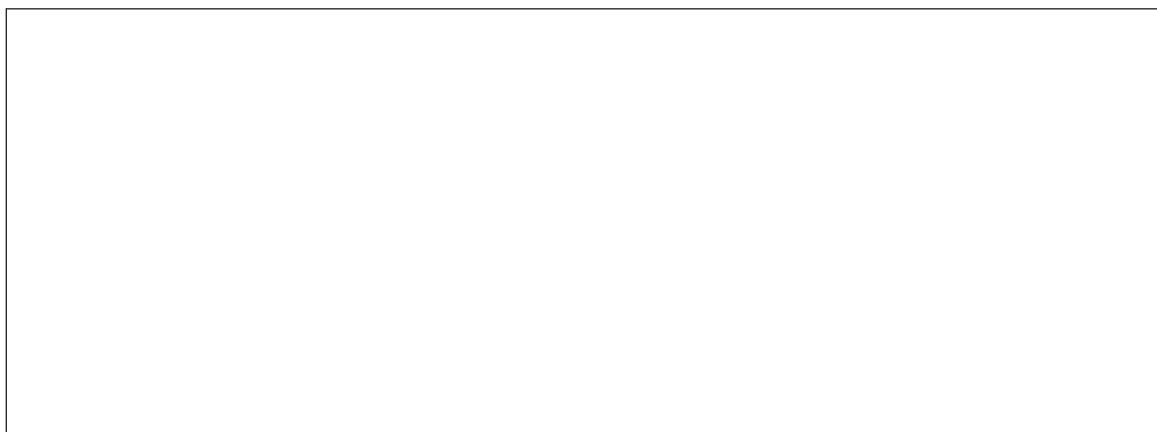
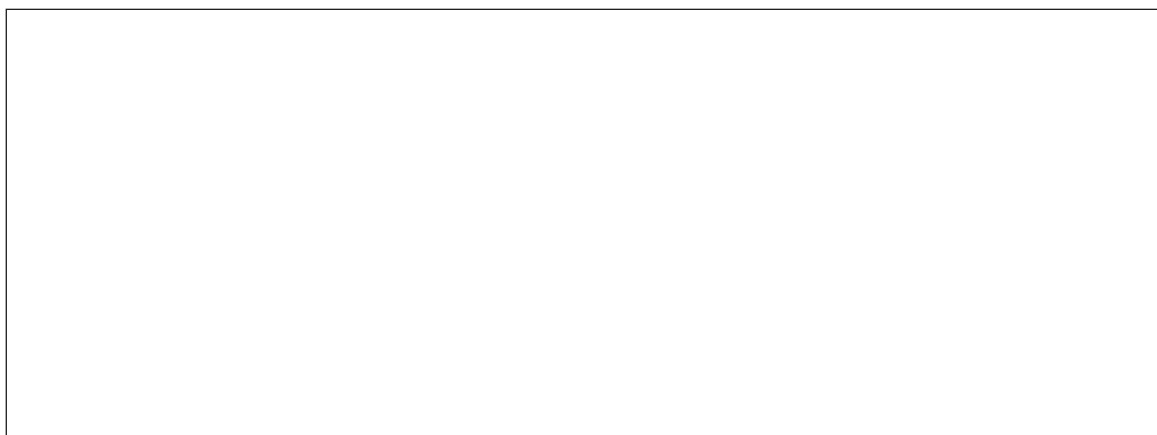
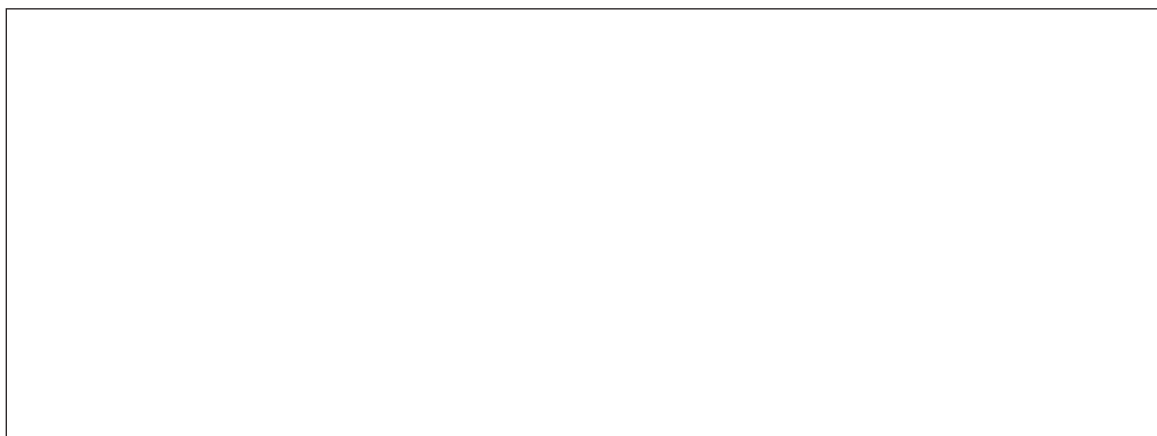
(11 marks)

- (a) Carbon can form many different compounds. State two aspects of carbon's bonding capacity that explain this phenomenon. (2 marks)

One: _____

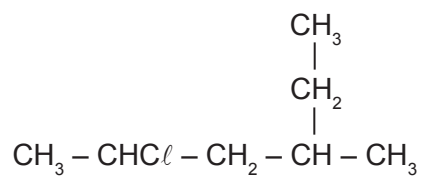
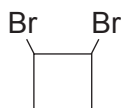
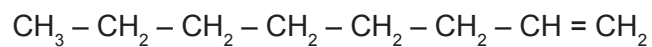
Two: _____

- (b) Draw three structural isomers of pentane, C_5H_{12} . (3 marks)



Question 33 (continued)

- (c) State the IUPAC name for each of the following organic compounds. (4 marks)



- (d) Write the balanced equation for the combustion of benzene in excess oxygen gas. (2 marks)

Question 34

(10 marks)

- (a) Write the balanced chemical equation for the reaction, if any, that occurs when the following substances are mixed as described. Only include those species that take part in the reaction. If no reaction occurs write, 'no reaction'. (4 marks)

Iron(III) sulfate solution is mixed with sodium carbonate solution.

Ammonia gas is bubbled through a dilute solution of nitric acid.

- (b) Describe the predicted observations for the reactions, if any, when each of the following substances is mixed as described. If no reaction occurs write, 'no observable change'. (6 marks)

Bromine water, $\text{Br}_2(\text{aq})$, is added to potassium iodide solution, $\text{KI}(\text{aq})$.

Silver nitrate solution, $\text{AgNO}_3(\text{aq})$, is added to sodium sulfide solution, $\text{Na}_2\text{S}(\text{aq})$.

Magnesium ribbon, $\text{Mg}(\text{s})$, is ignited and placed in a gas jar full of oxygen gas, $\text{O}_2(\text{g})$.

Question 35

(3 marks)

Given a $0.0111 \text{ mol L}^{-1} \text{ Mg(NO}_3)_2$ solution, calculate the concentration in g L^{-1} for each ion present.

Question 36

(12 marks)

- (a) Write the structural formula for any products when propane ($\text{CH}_3 - \text{CH}_2 - \text{CH}_3$) is mixed with iodine (I_2) in the presence of UV light and a catalyst. (2 marks)

- (b) Write the structural formula for any products when propene ($\text{CH}_2 = \text{CH} - \text{CH}_3$) is mixed with iodine (I_2). (2 marks)

- (c) Write the structural formula for any products when cyclopentene is mixed with iodine (I_2).
(2 marks)

- (d) Write the structural formula for any products when benzene is mixed with iodine (I_2) in the presence of UV light and a catalyst.
(2 marks)

- (e) Draw and name the geometric isomers of but-2-ene.
(4 marks)

Name: _____

Name: _____

Question 37

(10 marks)

In a chemical laboratory, the labels have fallen off four identical reagent bottles. Each bottle contained white crystals.

The labels read: zinc carbonate, aluminium sulfate, aluminium nitrate and zinc chloride.

By completing the table below, describe briefly a sequence of tests that can be used to identify which label belongs with which bottle. Any reagent may be used in your tests. No equations are required.

At each step describe the test used, describe the identifying observations and write the name or correct formula of the substance identified by that test.

Test description	Observations	Name of the identified substance

End of Section Two

See next page

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Section Three: Extended answer

35% (50 Marks)

This section contains **four (4)** questions. You must answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to three significant figures and include appropriate units where applicable.

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Suggested working time: 65 minutes.

Question 38

(11 marks)

Vinegar is a common household substance that for years has been used in a variety of ways in and around the home.

- (a) List three distinctly different uses for vinegar in and around the home. (3 marks)

One: _____

Two: _____

Three: _____



There is a wide range of different types of vinegar, including white, malt, red wine, balsamic and rice vinegar. The common ingredients of vinegar are water and acetic acid, $\text{CH}_3\text{COOH}(\text{aq})$. Most household vinegars do not normally exceed 5% in concentration. Solutions of above 10% require careful handling.

- (b) Why might solutions above 10% require careful handling? (2 marks)

See next page

Vinegar is effectively a dilute solution of a weak acid.

- (c) Vinegar is characterised as a dilute solution. What does 'dilute' mean in this case?
(3 marks)

- (d) Acetic acid is characterised as a weak acid. What does 'weak' mean in this case?
(3 marks)

Question 39

(12 marks)

An interesting thing you can do with household vinegar is to soften the shell of a boiled egg by leaving it to soak in vinegar overnight.

- (a) The ingredient in eggshells that makes them hard is calcium carbonate, $\text{CaCO}_3(\text{s})$. Write the equation for the reaction that occurs when vinegar, $\text{CH}_3\text{COOH}(\text{aq})$, and eggshells come in contact with each other. (2 marks)

- (b) If each eggshell contains on average 4.00 g of calcium carbonate, what is the maximum number of eggs that can be softened by having all their calcium carbonate dissolved if they are immersed in one 2.00 L bottle of vinegar containing 5.00% acetic acid? Assume that 2.00 L of vinegar has a mass of 2.00 kg. (5 marks)

- (c) The label on a 1.25 L bottle of vinegar states that it contains 25.0 g of acetic acid, $\text{CH}_3\text{COOH}(\text{aq})$.
- (i) Calculate the number of moles of acetic acid present in the full bottle of vinegar. (2 marks)

- (ii) Determine the concentration of acetic acid in mol L⁻¹. (1 mark)

- (iii) Determine the concentration of acetic acid in g L⁻¹. (1 mark)

- (iv) 2.0 L of this vinegar will soften fewer eggs than the vinegar in Part (b). Explain why. (1 mark)

Question 40

(15 marks)

Although we are witnessing technological advances in motor vehicle engineering, most cars today are still powered by the internal combustion engine. This is an engine in which a fuel such as petrol is mixed with oxygen in the air and burns. Heat and gases are generated.



When the gases produced in the reaction expand they apply a force to parts of the engine. This force moves the car's components over a distance, transforming chemical energy into useful mechanical energy and driving its axle and wheels, moving the car.

- (a) Use the kinetic theory of matter to explain what happens to the volume of the gases produced as the temperature of the combustion chamber increases. Include at least one diagram. (3 marks)

Only about 10mg of fuel is needed during each combustion cycle. To mix the fuel and air in a small engine, a device called a carburettor may be used. The correct mixture of fuel and air is needed to ensure that the engine runs properly. The carburettor is designed to get the mixture just right by spraying a small amount of fuel into the combustion chamber of the engine.

- (b) By referring to the collision theory, explain why the fuel-air mixture is sprayed as a fine mist rather than poured into the combustion chamber for burning. (3 marks)

- (c) Other than by experimentation, how could a chemist predict the best fuel to oxygen ratio? (1 mark)

Question 40 (continued)

The following questions involve determining the identity of a particular fuel. The fuel is a hydrocarbon.

- (d) To avoid any changing density problems, masses rather than volumes were used in the first part of the investigation. 1.00 kg of this fuel was burned in excess oxygen. The gases were collected and examined. It was found that 3.10 kg of carbon dioxide and 1.26 kg of water were produced.

Calculate the empirical formula of the fuel that was used. Show all your workings.

(5 marks)

Working

Answer: Empirical formula

- (e) Further investigation occurred and it was found that at 0°C and 100 kPa, 50.0 g of this fuel produced 11.5 L of gas. What is the molecular formula of the fuel that was used? (3 marks)

Working

Answer: Molecular formula

Question 41

(12 marks)

A traditional technique for cleaning the tarnish, $\text{Ag}_2\text{S}(\text{s})$, off silverware without using an abrasive cleaner (which wears away the precious metal) involves setting up a simple electrolytic cell.

The piece of silver to be cleaned can be placed on the bottom of a glass or enamel pan and covered with aluminum foil. A solution of baking soda, $\text{NaHCO}_3(\text{aq})$ and table salt, $\text{NaCl}(\text{aq})$, can be added and brought to the boil to the pan. The piece of silver must be in contact with the aluminium foil. The process takes some time but at the end the silverware is sparkling clean.

This process works because tarnish on silver, $\text{Ag}_2\text{S}(\text{s})$, is caused by sulfide ions. The salt and baking soda solution make an ion-carrying solution that transfers the sulfide ions from the silver to the aluminum foil.

- (a) Write the half-equation where the silver sulfide, $\text{Ag}_2\text{S}(\text{s})$, is converted to pure silver, $\text{Ag}(\text{s})$. (2 marks)

- (b) Write the half-equation where aluminium forms aluminium ions. (2 marks)

- (c) Combine the two reaction half-equations to produce a balanced overall redox equation for the process. (2 marks)

- (d) Explain the purpose of the salt and baking soda solution. (1 mark)

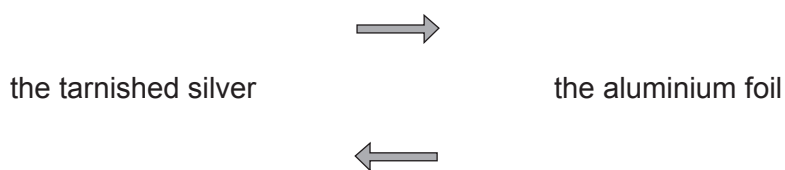
- (e) Circle the substance that is acting as the cathode. (1 mark)

the tarnished silver or the aluminium foil

- (f) Circle the substance at which reduction is occurring. (1 mark)

the tarnished silver or the aluminium foil

- (g) Circle the arrow showing the correct direction in which electrons will flow during this process. (1 mark)



- (h) State the oxidation number of silver: (2 marks)

in the Ag_2S tarnish. _____

when it has been converted to the silver metal. _____

End of questions

ACKNOWLEDGEMENTS

Section Three

Question 38(a) *A bottle of white vinegar* [Image] by courtesy of the examining panel.

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