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Year 11 Units 1 & 2 Examination, 2017

Question/Answer Booklet

CHEMISTRY

Student Name: _____

Teacher Name: _____

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

To be provided by the candidate

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

Special items: up to three non-programmable calculators approved for use in the ATAR 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 examination
Section One: Multiple-choice	25	25	50	25	25
Section Two: Short answer	8	8	60	70	35
Section Three: Extended answer	5	5	70	80	40
				Total	100

Instructions to candidates

1. 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, do not erase or use correction fluid, and shade your new answer. 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 answers in this Question/Answer Booklet.

3. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of 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 that you are continuing to answer at the top of the 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, do not erase or use correction fluid, and shade your new answer. 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: 50 minutes.

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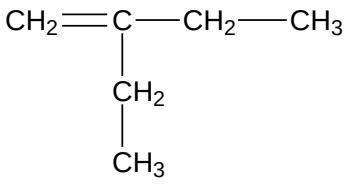
1. Which one of the following occurs as the atomic number increases for the Group 17 elements?

   (a) atomic radii decrease
   (b) melting points decrease
   (c) the tendency to gain electrons decreases
   (d) the elements become more reactive

2. The electron configuration for calcium is:

   (a) $1s^2\ 2s^8\ 3s^8\ 4s^2$
   (b) $1s^2\ 2s^2\ 2p^8\ 3s^2\ 3p^6$
   (c) $1s^2\ 2s^4\ 2p^6\ 3s^8$
   (d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

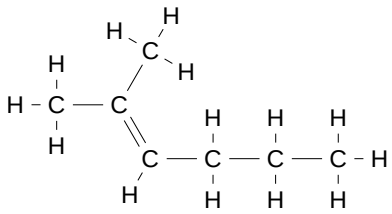
3. Which one of the following is the correct name for the compound shown below?



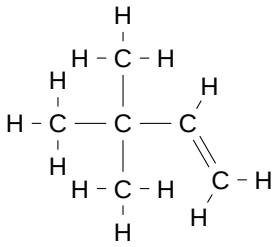
   (a) 3-ethylbut-1-ene
   (b) 3-methylpent-3-ene
   (c) 2-ethylbut-1-ene
   (d) hex-3-ene

4. Which one of the below is the structural formula for 2,2-dimethylhex-3-ene?

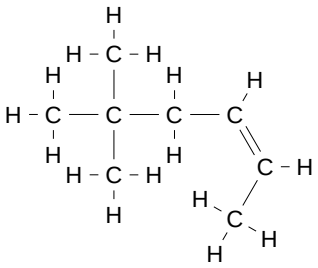
(a)



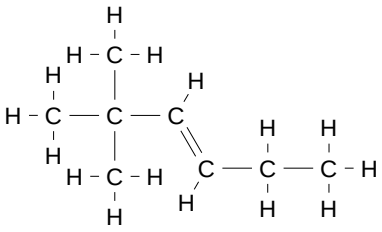
(c)



(b)



(d)



5. The coefficients required to balance the equation shown are respectively:

$$\_C_3H_8 + \_O_2 \rightarrow \_CO_2 + \_H_2O$$

(a)	1	5	3	4
(b)	1	2	1	4
(c)	2	5	6	8
(d)	2	5	6	4

6. Which one of these is the correct formula for barium phosphate?

(a) Ba_2PO_4
(b) $Ba_3(PO_4)_2$
(c) $Ba_2(PO_4)_3$
(d) $Ba_2(PO_3)_4$

7. Which one of these elements in Period 2 has the largest atomic radius?

(a) fluorine
(b) lithium
(c) carbon
(d) boron

8. When a gas is cooled in a sealed, rigid container, the

(a) pressure increases.
(b) volume and pressure decrease.
(c) pressure decreases.
(d) pressure might increase or decrease depending on the size of the gas particles.

9. Which one of the following elements will have the lowest electronegativity?

(a) Na
(b) Aℓ
(c) Si
(d) F

10. Which one of the following statements about elements in Groups 1 and 2 on the Periodic Table is **correct**?

(a) They can only become positively charged and form strong covalent molecules.
(b) They form negative ions because they have few valence electrons.
(c) They can either lose or share electrons to form positive ions or a strong metallic lattice.
(d) They can form positive ions because they have loosely held valence electrons.

11. What volume (in mL) of $O_2(g)$ is required to react with 25.0 mL of $H_2(g)$ at S.T.P. in the reaction shown below?

$$2\ H_2(g)\ +\ O_2(g)\ \rightarrow\ \ 2\ H_2O(\ell)$$

(a) 12.5
(b) 50.0
(c) 25.0
(d) 22.7

12. Silicon dioxide does not conduct electricity. Which of the following best explains this observation?

(a) It has delocalised valence electrons.
(b) It consists only of non-metal atoms.
(c) All of the valence electrons are involved in covalent bonds.
(d) It is a covalent network substance.

13. Which one of these has bonds that consist of pairs of electrons attracted to adjacent nuclei?

(a) sodium fluoride
(b) magnesium fluoride
(c) aluminium fluoride
(d) silicon tetrafluoride

14. Which one of these electron configurations represents a stable element?

(a) 2, 8, 1
(b) 2, 8, 7
(c) 2, 8, 8
(d) 2, 8, 8, 2

15. Which one of the following substances contains **only** covalent bonds?

(a) Fe_2O_3
(b) NH_4NO_3
(c) $NaC\ell$
(d) SiO_2

16. According to the following equation:

$$K_2SO_3 + 2\ HC\ell \rightarrow SO_2 + 2\ KC\ell + H_2O$$

what is the greatest number of moles of potassium chloride ($KC\ell$) that could be produced when 5 moles of potassium sulfite (K_2SO_3) are mixed with hydrochloric acid ($HC\ell$)?

(a) 2 moles
(b) 2.5 moles
(c) 5 moles
(d) 10 moles

17. Which one of the following aqueous solutions will form a white precipitate when a solution of potassium phosphate is added?

(a) sodium nitrate
(b) nickel (II) nitrate
(c) copper (II) nitrate
(d) aluminium nitrate

18. The chemical properties of an element are influenced mainly by the number of

(a) protons in the nucleus of its atoms.
(b) valence electrons of its atoms.
(c) occupied electron shells of its atoms.
(d) protons and neutrons in the nucleus of its atoms.

19. If salt crystals dissolve when added to a salt solution, it can be concluded correctly that the original solution was

(a) unsaturated
(b) saturated
(c) supersaturated
(d) either saturated or supersaturated

20. How many moles of carbonate ions are there in 4 moles of iron (III) carbonate?

(a) 4
(b) 6
(c) 8
(d) 12

21. Which of the following processes is endothermic?

(a) burning methane
(b) distilling ethanol
(c) condensing steam
(d) freezing water

22. What effect does changing the pH of a solution from 3 to 5 have on the hydrogen ion concentration?

(a) increases by a factor of four
(b) decreases by halving
(c) increases by a factor of 10
(d) decreases by a factor of 100

23. Which one of these correctly shows the products of a reaction between sulfuric acid and magnesium hydrogen carbonate?

(a) magnesium sulfate and water
(b) magnesium sulfate, hydrogen and carbon dioxide
(c) magnesium sulfate, water and sulfur dioxide
(d) magnesium sulfate, water and carbon dioxide

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

$$CH_4\,(g) + 2\,O_2\,(g) \rightarrow CO_2\,(g) + 2\,H_2O\,(g) \qquad \Delta H = -890\ kJ\ mol^{-1}$$

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

25. Which one of the following observations can be explained in terms of hydrogen bonding?

(a) The boiling point of H_2S is greater than that of PH_3.
(b) The melting point of CH_4 is less than that of PH_3.
(c) The boiling point of H_2O is greater than that of H_2S.
(d) The melting point of HI is greater than that of NH_3.

End of Section One

Section Two: Short answer **35% (70 Marks)**

This section has **8** questions. Answer **all** questions. Write your answers in the spaces provided.

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Suggested working time: 60 minutes.

Question 26 **(14 marks)**

(a) Complete the table below by writing the name of the molecule and the name of the main intermolecular force between the molecules. (6)

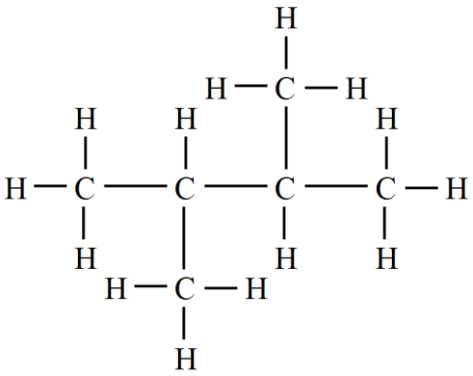
Formula	Name	Main type of intermolecular force
CO		
C_2H_6		
SO_2		

(b) Draw electron dot diagrams (Lewis structures), state the shape and polarity for each of the molecules below. (8)

Formula	Lewis structure	Shape	Is it polar?
PH_3			
CF_4			

Question 27 **(8 marks)**

Consider the structure below.



(a) Give the IUPAC **name** of this compound. (1)

(b) **Draw** a full structural formula and give the IUPAC **name** for an isomer of the compound. (3)

(c) Write balanced equations for the reactions of the compound shown in part (a), C_6H_{14}, with the following substances: (4)

(i) Excess oxygen.

_____

_____

(ii) Limited amount of chlorine, in the presence of UV light.

_____

_____

Question 28 **(6 marks)**

Complete the following table describing some isotopes.

Name of Species	Symbol	Number of protons	Number of neutrons	Number of electrons	Atomic number	Mass number
	^{197}Au					
Carbon-13				6		
	N^{3-}				7	14

Question 29 **(9 marks)**

The solubility of copper (II) chloride ($CuC\ell_2.H_2O$) is approximately 75.7 g/100 mL at 25 ^oC.

(a) Determine the concentration in mol L^{-1} of a solution made by completely dissolving 45.0 g of $CuC\ell_2.H_2O(s)$ in 120 mL of water at 25 ^oC. (assume no volume change) (2)

(b) Is this solution saturated, unsaturated or supersaturated? Explain your answer. (2)

(c) Describe the appearance of this solution. (2)

(d) Describe all the types of bonding present between particles in the solution of copper (II) chloride. (3)

Question 30 **(7 marks)**

20.0 mL of 5.00 x 10^{-2} mol L^{-1} lead (II) nitrate solution is added to an excess of sodium iodide solution.

(a) Write a balanced ionic equation, with state symbols, for the reaction that occurs when they are mixed. (2)

(b) Describe in full what you would observe in the reaction, including any:

- Colours
- Odours
- Precipitates (give the colour)
- Gases evolved (give the colour or describe as colourless) (2)

(c) Calculate the mass of solid product. (3)

Question 31 **(8 marks)**

Calculate the pH of the following solutions:

(a) 1.45×10^{-3} mol L^{-1} nitric acid (1)

(b) 0.0672 mol L^{-1} potassium hydroxide solution (2)

(c) A solution made by mixing 15.0 mL of 2.25×10^{-3} mol L^{-1} sulfuric acid and 45.0 mL of 1.75×10^{-3} mol L^{-1} barium hydroxide solution, giving your answer to the appropriate number of significant figures. (5)

Question 32 **(7 marks)**

Potassium is a highly reactive metal, which was first isolated from potash, the ashes of plants, from which its name derives. It is always found in nature as part of an ionic salt, such as potassium chloride, which is found in sea water. Potassium chloride is also produced by the violently exothermic reaction of potassium metal with chlorine gas.

$$2\ K\ (s) + C\ell_2\ (g) \rightarrow 2\ KC\ell\ (s)$$

(a) Using a labelled diagram, describe the bonding present in solid potassium. (3)

(b) Using a labelled diagram, describe the bonding present in solid potassium chloride. (2)

(c) Explain why solid potassium can conduct electricity, whereas solid potassium chloride cannot. (2)

Question 33 **(11 marks)**

A group of students decided to carry out experiments to investigate the following reaction:

$$NiCO_3(s) + 2\,HC\ell(aq) \rightarrow NiC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

(a) Describe in full what they would observe in the reaction, including any:

- Colours
- Odours
- Precipitates (give the colour)
- Gases evolved (give the colour or describe as colourless) (3)

(b) In the first experiment, Annie measured out exactly 15.0 g of nickel (II) carbonate. Calculate the volume of 2.00 mol L^{-1} $HC\ell$ solution that will react completely with 15.0 g of $NiCO_3(s)$. (3)

(c) In the second experiment, Sid started with 10.0 mL of 2.00 mol L^{-1} hydrochloric acid. Calculate the concentration of $NiC\ell_2$ (aq) in mol L^{-1} produced when excess solid $NiCO_3$ reacts with 10.0 mL of 2.00 mol L^{-1} $HC\ell$ (aq). (assume no change in volume) (3)

(d) In the third experiment, Phil worked out the mass of 3.00 moles of nickel (II) carbonate. Calculate the volume of CO_2 (g) produced at S.T.P. when 3.00 moles of $NiCO_3$ (s) completely reacts in an excess of $HC\ell$ (aq). (2)

End of Section Two

Section Three: Extended answer **40% (80 Marks)**

This section contains **5** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

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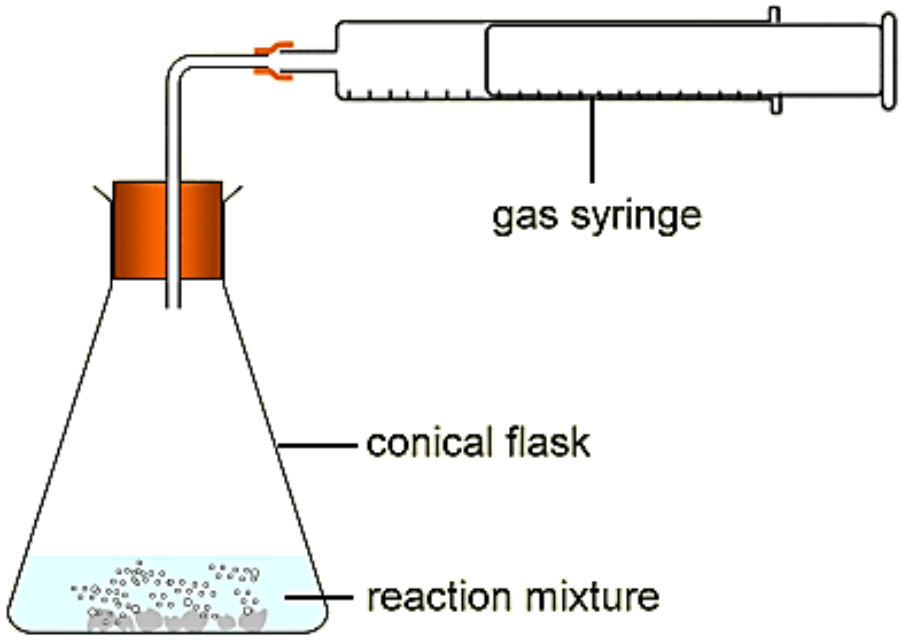
Suggested working time: 70 minutes.

Question 34 **(20 marks)**

A class of students was asked to investigate factors affecting the rate of the reaction between acids and magnesium. The reaction equipment is shown below.



Some students carried out an investigation into the effect of concentration of nitric acid on the rate of this reaction, by combining 20.0 mL of dilute nitric acid of various concentrations, with 0.10 g of magnesium ribbon.

(a) Write a balanced equation for this reaction, with state symbols, and give observations for the reaction, including any:

- Colours
- Odours
- Precipitates (give the colour)
- Gases evolved (give the colour or describe as colourless) (3)

The group chose to measure the total volume of gas produced and the time it took to be produced. Their results are shown in the table on the next page.

(b) Explain why each of the trials produced about the same volume of gas. (3)

The group's experimental results are shown below.

Trial	Concentration of HNO_3 used (mol L^{-1})	Volume of HNO_3 used (mL)	Volume of gas produced (mL)	Time taken (s)	1 / time (s^{-1})
1	0.25	100	30.5	33.4	
2	0.20	100	27.3	40.1	
3	0.15	100	28.4	47.4	
4	0.10	100	29.7	60.5	
5	0.05	100	28.1	75.8	

(c) In the table above, complete the column for the values of 1 / time taken, giving your answers to **three** significant figures. (1)

(d) On the grid below, draw a graph of 1 / time against concentration of nitric acid. (5)

There is a spare grid at the end of the paper if required.

(e) Use collision theory to explain the effect of increasing the concentration of nitric acid on the rate of this reaction. (4)

Another group of students in the same class carried out their investigation using the same concentrations of ethanoic acid, CH_3COOH, instead of nitric acid.

(f) Describe how their results would be different, and explain why this is the case. (4)

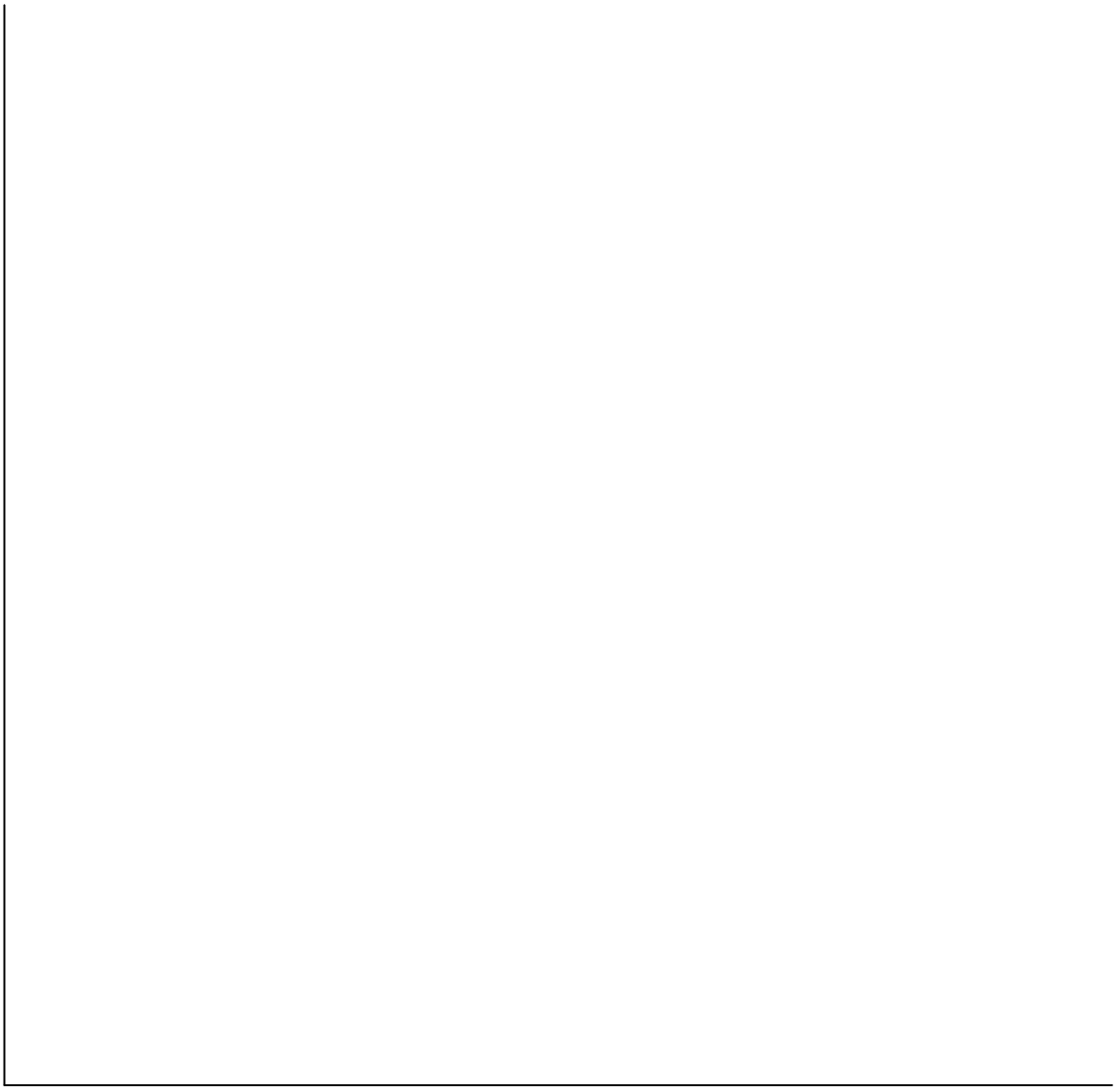
Question 35 **(15 marks)**

Photosynthesis is the process by which plants, some algae and some bacteria use energy from sunlight to produce glucose from carbon dioxide and water. This glucose can be used for cellular respiration, and oxygen is formed in the reaction.

$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2 \qquad \Delta H = +2803\ kJ\ mol^{-1}$$

The green pigment chlorophyll absorbs blue and red light, and is present in high quantities in cells that do photosynthesis. Plants can photosynthesise across a wide temperature range, providing they have visible light of the right wavelengths and sufficient intensity.

(a) Draw an enthalpy profile diagram for this chemical reaction, and label important features. (5)



(b) Is this reaction endothermic or exothermic? How do you know? What does this tell you about the relative bond energies of the reactants and products in the reaction? (5)

(c) The rate of photosynthesis varies significantly with the light and weather conditions. With reference to activation energy,

- explain why plants cannot photosynthesise at night.
- predict how the rate of photosynthesis during the day would be affected by temperature conditions.
- explain why changing the temperature affects the rate of photosynthesis. (5)

Question 36 **(8 marks)**

Hydrogen halides are gaseous molecular compounds that can act as acids when dissolved in water, with varying strength. They can also be used to make halogenated organic compounds, which are precursors to many useful organic products, such as medicines and polymers.

The boiling points of the hydrogen halides are given below. Use the information in the table, and your understanding of intermolecular forces, to answer the questions that follow.

Hydrogen halide	Boiling point (K)
HF	292
HCℓ	188
HBr	206
HI	238

(a) Explain why hydrogen fluoride's boiling point is significantly higher than the boiling points of the other hydrogen halides. (3)

(b) Explain the trend observed in the boiling points of hydrogen chloride, hydrogen bromide and hydrogen iodide (exclude hydrogen fluoride). Refer to all types of intermolecular bonds present in your answer. (5)

Question 37 **(19 marks)**

Western Australia has deposits of a wide range of metal ores, and the mining industry is one of the largest commodity sectors in Australia. Mining and extraction of metals involves large volumes of water, which can be contaminated with heavy metal salts. These ions must be removed before the mine water can be reused or released to the environment.

Mine water may contain valuable amounts of gold and other precious metals, so it is often economically viable to extract these substances from the solution. There are a variety of methods of removing dissolved salts from water; including precipitation then filtration, and distillation.

(a) Describe the purification of mine water by distillation. Include the physical properties of the components that allow this method to work. (3)

(b) Does distillation allow dissolved gases to remain in the water? Explain your answer. (2)

(c) Explain why distillation would not be suitable as a method to purify mine water on a industrial scale. (1)

(d) Explain why laboratory filtration is not able to separate the dissolved ions from mine water. (2)

Water from gold mining operations can contain measurable quantities of gold (III) chloride in solution. The Au^{3+} ions can be tested for by a precipitation reaction with sodium carbonate solution.

(e) Write a balanced equation with state symbols for this precipitation reaction. (2)

(f) Determine the gold (III) chloride concentration, in mol L^{-1}, if 2.50×10^{2} mL of mine water produced 4.18×10^{-3} g of precipitate. (3)

(g) Express the concentration of gold (III) ions in parts per million by mass. You can assume that 2.50×10^2 mL of solution has a mass of 2.50×10^2 g. (3)

Gold has one stable isotope, ^{197}Au, and 18 radioactive isotopes. The relative proportion of isotopes present can be used to identify the source of a sample of gold.

Gold produced by the Granny Smith mine in Kalgoorlie was analysed by a mass spectrometer. Three isotopes of gold were present, in the proportions below.

Isotope	**Percentage abundance**
^{195}Au	2.564 %
^{196}Au	1.136 %
^{197}Au	96.30 %

(h) Calculate the relative atomic mass of this sample of gold, expressing your answer to **four** significant figures. (3)

Question 38 **(18 marks)**

Both *cis*-1,2-dichloroethene and *trans*-1,2-dichloroethene, and sometimes even a mixture of the compounds, are used as solvents in the production of waxes, resins and polymers, and also as refrigerants. Unfortunately, they are toxic substances, and so should not be released into the environment.

(a) Draw the full structural formula of *trans*-1,2-dichloroethene. Use your diagram to help you explain the difference between the structural and geometric isomers of this compound. (4)

(b) The manufacture of the isomers of 1,2-dichloroethene begins with one hydrocarbon, that is analysed to be 85.6 % carbon by mass. Calculate the empirical formula of the hydrocarbon. (4)

(c) A sample of the gaseous hydrocarbon has a volume of 1.182 L at S.T.P and a mass of 1.460 g. Work out the molecular formula of the hydrocarbon. (4)

During the manufacture of the isomers of 1,2-dichloroethene, samples of the reactants and products are frequently tested, to ensure that the reaction is giving the desired products. One of the tests carried out on the hydrocarbon reactant and the range of products is a test for unsaturation.

(d) Explain the difference between a saturated and an unsaturated hydrocarbon.

Suggest a test that could be used to establish whether the substances are saturated or unsaturated, and give expected observations that would confirm saturation and unsaturation.

Write a balanced equation for the reaction that would take place in the test, for one of the compounds discussed in this question. (6)

End of questions

Additional Working Space

Spare grid for Question 34

Additional Working Space