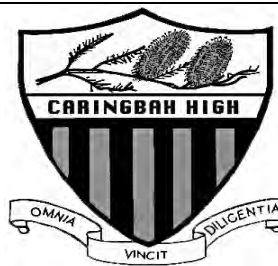Student Number:

_____

2012

Trial HSC Examination

HSC Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your student number at the top of each page where relevant
- A data sheet and Periodic Table are provided at the back of this exam paper

Total marks – 100

This examination has TWO SECTIONS, Section I and Section II

SECTION I – Total marks 83
This section has two parts **Part A and Part B**

Part A – 20 marks- Multiple Choice
Attempt Questions 1–20

- Allow <u>about</u> 35 minutes for this part

Part B – 63 marks
Longer Answer Questions

- Attempt Questions 21– 31
- Allow <u>about</u> 2 hours for this part

SECTION II – Total marks 17
Option Question
- Allow <u>about</u> 25 minutes for this part
- USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS

Section 1 (63 marks)
**Part A - Multiple Choice questions (20 marks)**

Use the multiple choice answer sheet provided for questions 1-20
_____

1   The conversion of ethanol to ethylene is an example of

(A)   Addition polymerisation and requires a peroxide catalyst

(B)   Esterification and requires concentrated sulfuric acid as a catalyst

(C)   A substitution reaction which occurs in the presence of UV light

(D)   Dehydration and requires concentrated sulfuric acid as a catalyst

2   Polyethene (polyethylene) is an extremely important polymer, available in two general forms - high density polyethene (HDPE) and low density polyethene (LDPE). Which of the following statements about polyethene is correct?

(A)   HDPE is branched and has a lower melting point than LDPE.

(B)   HDPE unbranched and has a lower melting point than LDPE.

(C)   LDPE is branched and has a lower melting point than HDPE.

(D)   LDPE is unbranched and has a higher melting point than HDPE.

3   The production of polyethylene involves an addition reaction. The sequence of events that best describe the process is

(A)   high pressures of 100-300 MPa → propagation → initiation → termination

(B)   initiation→ propagation → termination → high pressures of 100-300 MPa

(C)   high pressure of 100-300 MPa→ initiation → propagation → termination

(D)   propagation→ high pressures of 100-300 MPa→ termination→ initiation

4   Phosphorus-30 is produced by bombarding aluminium-27 with alpha particles. Which of the following nuclear equations correctly represents this?

(A) $^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n$

(B) $^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{31}_{15}P$

(C) $^{13}_{27}Al + ^{2}_{4}He \rightarrow ^{15}_{30}P + ^{0}_{1}n$

(D) $^{27}_{13}Al + ^{3}_{2}He \rightarrow ^{30}_{15}P$

5 Which of the following identifies the main advantage of ethanol as a source of energy, compared with fossil fuels?

(A) Ethanol has higher energy content.

(B) Ethanol does not release carbon dioxide as a combustion product.

(C) Ethanol is a renewable resource.

(D) Ethanol is cheaper.

6 Metallic copper can be produced from copper (II) oxide by reacting it with hydrogen gas, as shown in the following equation:

$$CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}$$
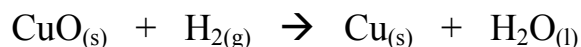
Which of the following statements regarding this reaction is correct?

(A). Hydrogen gas is acting as an oxidant

(B) Copper undergoes an increase in oxidation state

(C) Hydrogen atoms accept electrons from CuO

(D) The oxidation state of oxygen remains unchanged.

7 Which of the following reactions represents combustion in the presence of an **<u>inadequate</u>** oxygen supply?

(A) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$

(B) $C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$

(C) $C_6H_{12}O_{6(aq)} \rightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$

(D) $CH_{4(g)} + O_{2(g)} \rightarrow C_{(s)} + 2H_2O_{(l)}$

8 Ethanol is a good solvent for a range of chemicals. It can dissolve in water but is also blended with petrol as a fuel. It exhibits these properties because of the range of intermolecular forces it can exert on other molecules.
Which of the following lists all the intermolecular forces which ethanol can exert on other molecules?

(A) covalent bonds, dispersion forces

(B) dipole-dipole interactions, dispersion forces

(C) covalent bonds, hydrogen bonds, dispersion forces

(D) dispersion forces, dipole-dipole interactions, hydrogen bonds

9   The table below shows the pH and colour ranges of some common acid-base indicators.

Indicator	low pH colour	pH range	high pH colour
bromothymol blue	Yellow	6.0-7.6	blue
phenolphthalein	Colourless	8.3-10	pink

A student carries out the following procedure:

1.   Add a few drops of phenolphthalein to 50 mL of 0.1M NH_3 solution.
2.   Add 50mL of 0.1M HNO_3 (aq) to the NH_3 solution.
3.   Add a few drops of a bromothymol blue to the mixture formed from steps 1 and 2.

Which of the following is the best prediction of the colour of the mixture at the end of each step of the procedure?

	Step 1	Step 2	Step 3
A	colourless	pink	yellow
B	colourless	pink	green
C	pink	colourless	yellow
D	pink	colourless	blue

10   The pH of a sulfuric acid solution is measured at 2.0 by a pH meter.

Which of the following alternatives shows the correct concentrations of hydrogen and sulfate ions in this solution?

	Concentration of hydrogen ions in solution (M)	Concentration of sulfate ions in solution (M)
A	1.0×10^{-1}	2.0×10^{-1}
B	1.0×10^{-2}	2.0×10^{-2}
C	1.0×10^{-1}	5.0×10^{-2}
D	1.0×10^{-2}	5.0×10^{-3}

11 Which of following may lead to increased levels of both sulfur dioxide and nitrogen dioxide in the atmosphere?

(A)   Production of photochemical smog

(B)   Lightning strikes during thunderstorms

(C)   Production of radioisotopes at a nuclear reactor

(D)   Production of electricity at a coal-fired power station

12 Which of the following sets of chemical species could have their concentration measured using atomic absorption spectroscopy?

(A) SO_2, SO_3, CO_2, O_3

(B) NH_4^+, Al^{3+}, Cu^{2+}, Sr^{2+}

(C) Cu^{2+}, Hg^+, Pb^{2+}, Pb^{4+}

(D) SO_4^{2-}, CO_3^{2-}, Cl^-, NO_3^-

13 The graph below shows a titration curve of an aqueous alkali with an aqueous acid of similar concentration.

Volume of aqueous alkali added
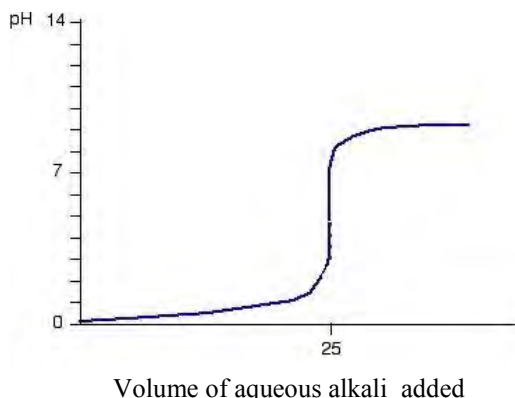
Which of the following could be the acid and alkali in this titration?

	Acid	Alkali
(A)	HCl	NH_3
(B)	CH_3COOH	NH_3
(C)	HCl	NaOH
(D)	CH_3COOH	NaOH

14   The Haber process is an important industrial process used to produce ammonia gas, NH_3, according to the equation

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$
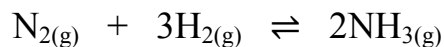
What volume of hydrogen gas measured at 100 kPa and 25°C, would have reacted to produce 51.10 g of ammonia?

(A)   16.53 L

(B)   24.79 L

(C)   102.2 L

(D)   111.6 L

15   Which of the following lists contains substances which are in order of __increasing__ boiling points?

(A)   ethanol, ethene, ethane

(B)   methanol, ethane, propanol

(C)   propanol, ethanol, methanol

(D)   methane, methanol, methanoic acid

16   The heat of combustion of propan-2-ol (2-propanol) is 33.5 kJ/g. The enthalpy change for the combustion reaction is:

(A) -1.54×10^3 kJ/mol

(B) $+2.01 \times 10^3$ kJ/mol

(C) -2.01×10^3 kJ/mol

(D) $+1.54 \times 10^3$ kJ/mol

17   In an art restoration project, a conservator prepares a copper-plate etching solution by diluting concentrated nitric acid, HNO_3, to a concentration of 0.30 M. The pH of this new solution is:

(A)   0.30

(B)   13.48

(C)   0.52

(D)   0.15

18   The flow diagram below shows 3 steps that can be used to identify carbonate, chloride and sulfate ions present in a sample.

$$\boxed{\text{Sample}}$$

Step 1   Add excess $HNO_{3(aq)}$

$$\boxed{\text{Bubbles observed}}$$

Step 2   Add excess $Ba(NO_3)_{2(aq)}$

$$\boxed{\text{White precipitate forms}}$$

Step 3   Filter off precipitate.

Add $AgNO_{3(aq)}$ to the filtrate

$$\boxed{\text{White precipitate forms}}$$
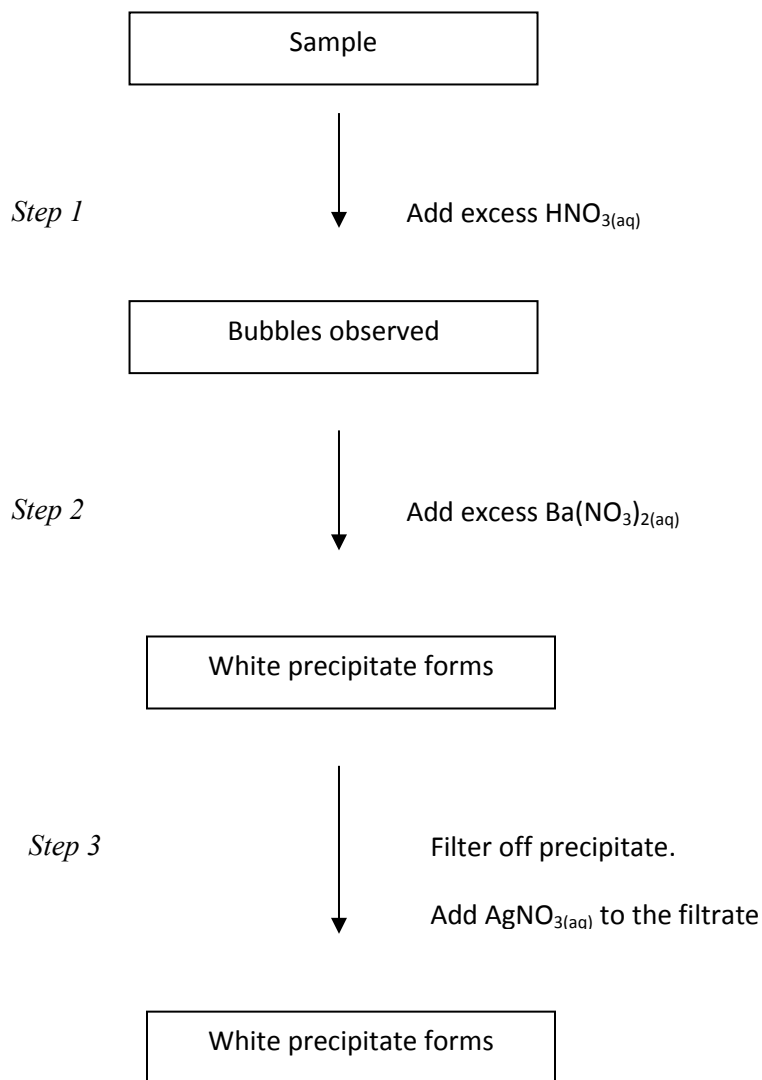
The products formed in the 3 steps, <u>in order</u> are:

(A)   Hydrogen gas, barium chloride, silver sulfate

(B)   Carbon dioxide gas, barium sulfate, silver chloride

(C)   Hydrogen gas, barium sulfate, silver chloride

(D)   Carbon dioxide gas, barium chloride, silver sulfate

19 The diagram below represents a simple galvanic cell in which two metals are placed in a liquid. The metals are connected by a voltmeter. Which of the following combinations would give the highest voltmeter reading?
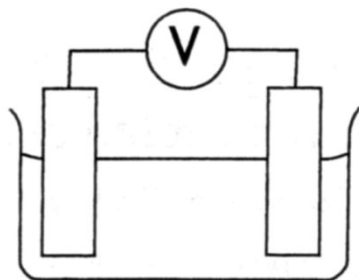
	METALS	LIQUID
(A)	Silver and copper	Water
(B)	Magnesium and lead	Ethanol
(C)	Zinc and tin	Hydrochloric acid
(D)	Both Iron	Copper Sulfate (aq)

20 Consider the equilibrium reaction represented by the equation below:

$$2NO_{2\,(g)} \quad \rightleftharpoons \quad N_2O_{4\,(g)} \qquad \triangle H = -60kJ$$
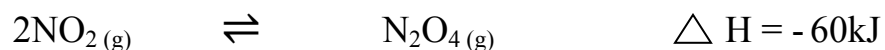
If the temperature is decreased and the volume kept constant, which of the following correctly describes the effect on the concentration of $N_2O_{4\,(g)}$.

(A)   Concentration of $N_2O_{4\,(g)}$ increases because the reaction is exothermic

(B)   Concentration of $N_2O_{4\,(g)}$ decreases because the reaction is exothermic

(C)   Concentration of $N_2O_{4\,(g)}$ remains the same because of the mole ratios

(D)   Concentration of $N_2O_{4\,(g)}$ decreases because the pressure increases

2012 Trial HSC Examination
Chemistry

Student Number: _____

OUTCOME	MARK
Knowledge and Understanding	**/75**
Planning & Conducting Investigations **Q22, 30a**	**/12**
Problem Solving **Q25c, 26c, 31a, 32a**	**/13**
TOTAL	**/100**

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST alternative.

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

Section I continued

Part B- 63 marks
Attempt Questions 21-31
Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 21 (marks)

The diagram below shows a short section of polyester, which is an important polymer in our everyday world.

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\end{array}
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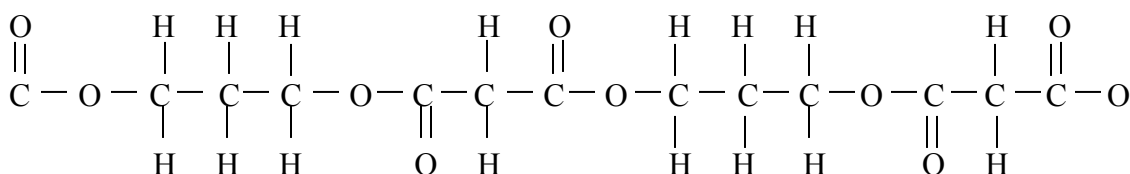
a. Use this information to draw the structures of the two (2) monomers that make up this chain.   **2**

Monomer 1   Monomer 2

b. Identify the type of polymerisation process that is used to make this polyester.   **1**

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c. Identify the molecule that is eliminated at each step of the polymerisation.   **1**

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d. Polystyrene is another important polymer in our everyday world. Explain ONE use of this
    polymer with reference to its properties.   **2**

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Question 22

During your Chemistry course you have studied a dry cell OR a lead acid cell. You have also compared this cell with one other type of galvanic cell.

Compare the dry cell OR lead acid cell with *one other* type of galvanic cell, in terms of the chemistry involved, its impact on society and its impact on the environment. **7**

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Question 23

Consider the following reactions involving water:

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$$

$$CO_3^{2-}{}_{(aq)} + H_2O_{(l)} \rightarrow HCO^{3-}{}_{(aq)} + OH^-{}_{(aq)}$$

$$2Cu(NO_3)_{2(s)} + 2H_2O_{(l)} \rightarrow 2Cu_{(s)} + O_{2(g)} + 4HNO_{3(aq)}$$
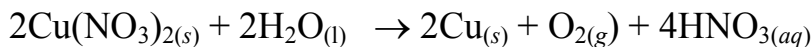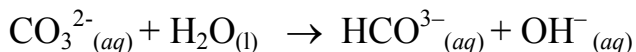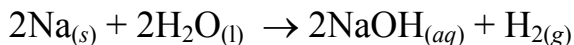
a. Identify, giving reasons, a reaction above in which water is neither the oxidising agent nor the reducing agent. **2**

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b. Identify, giving reasons, a reaction above in which water is acting as an oxidizing agent. **2**

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Question 24

The daily recommended intake for Vitamin C (ascorbic acid) is 60 mg.

The label on a brand of orange juice claims the juice contains over half the daily requirement of Vitamin C (ascorbic acid) in every 100 mL of the juice. The concentration of ascorbic acid in juice can be determined by titration method. A sample of juice is titrated against a standard solution of iodine using starch as an indicator.

The following redox reaction takes place as the iodine is added to the juice sample:

$$C_6H_8O_{6(aq)} + I_{2(aq)} \rightarrow 2I^-{}_{(aq)} + C_6H_6O_{6(aq)} + 2H^+{}_{(aq)}$$
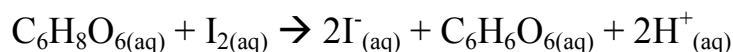
The starch remains colourless as the iodine is added until all of the ascorbic acid present has reacted with the iodine. As soon as any excess iodine is present, a blue-black colour is observed, as the starch reacts with the iodine. This is the end-point of the titration.

In an experiment to determine the vitamin C content in the above juice, a 25.0 mL sample of juice was added to a conical flask, along with 5 drops of starch solution. This sample was titrated with 5.00×10^{-3} mol/L iodine solution. An average of 9.15 mL of iodine was needed to reach the end-point.

a. Calculate the mass (in mg) of ascorbic acid present in the 25 mL sample of orange juice.
   Show your working. **3**

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b. Determine if the claim made on the label of the orange juice is valid. **<u>Show your working.</u>**　　　　**1**

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Question 25
The condensed structural formula of an organic compound (X) is shown in the following diagram.
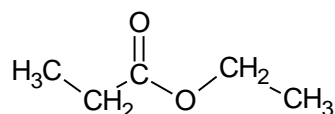
a.　Identify the family of organic compounds to which the above chemical belongs.　　　　**1**

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b.　Draw the structural formula and give the IUPAC systematic name for one isomer of this compound.　**3**

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c.　In an experiment to produce a sample of the organic compound X, a chemist refluxed a suitable reaction mixture for 1 hour. At this point, 5.00×10^{-3} moles of H^+ ions remained in the reaction flask along with compound X. The chemist added excess sodium carbonate solution to remove the unwanted H^+ ions.

Calculate the volume of carbon dioxide gas which would theoretically be produced from the addition of the sodium carbonate at 25°C and 100 kPa pressure. **<u>Show all working</u>**.　　　　**3**

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Question 26

The following reaction takes place in an electrochemical cell:

$$Zn_{(s)} + 2Ag^+_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Ag_{(s)}$$
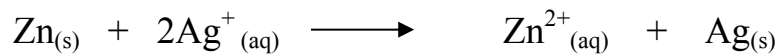
a. Draw a labelled diagram of the cells for this reaction. **5**

b. Analyse the reaction and write the redox half equations associated with this cell. **2**

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c. Calculate the E^0 value for the reaction. **3**

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Question 27

In the Haber process, ammonia is produced from nitrogen and hydrogen according to the equation:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \qquad \Delta H = -92 \text{ kJ mol}^{-1}$$

Discuss the conditions that will favour the industrial production of $NH_{3(g)}$. Include the effects of the following:
• temperature
• pressure
• the relative amounts of reactants
• catalyst   **8**

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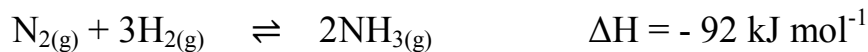..

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Question 28

In a first-hand investigation in her Chemistry class, Jasmine performed a set of titration reactions in which a 10.00 mL sample of H_2SO_4 was titrated with 0.50 M KOH in three separate trials. She obtained the results as shown below.

Trial   Volume of 0.50M KOH titrated
  1   20.30 mL
  2   19.10 mL
  3   18.90 mL

a. Write a balanced symbol equation for the reaction.   **1**

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b. Calculate the concentration of the H_2SO_4. **3**

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Question 29
Given the equilibrium:

$$HCO_3{}^-{}_{(aq)} + NH_4{}^+{}_{(aq)} \rightleftharpoons H_2CO_{3(aq)} + NH_{3(g)}$$
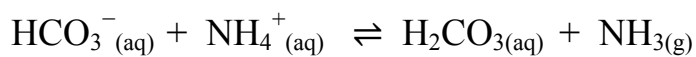
a. Identify an acid – conjugate base pair **1**

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b. Identify a base – conjugate acid pair **1**

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Question 30
a. During your chemistry course you performed a first-hand investigation to determine the percentage of carbon dioxide in a soft drink sample. Outline the method that you used. **5**

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b. Explain the conditions that affect the solubility of carbon dioxide in carbonated beverages. Include at least one balanced equation in your answer. **2**

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Question 31

A student carried out various water quality tests on samples of water from five different locations, labelled A - E. Their results are summarised in the table below.

	A	**B**	**C**	**D**	**E**
Turbidity (NTU)	0.9	15.5	2.1	10.4	50.2
pH	7.4	8.6	7.0	7.2	6.9
DO (ppm)	9.2	6.0	6.8	6.5	6.8
Phosphate (ppm)	0.03	0.30	0.03	0.01	0.05
Ca^{2+} (ppm)	32	21	87	20	18

a.   Identify the site (A to E) which may have been located next to farmland. <u>Justify</u> your answer.   **2**

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b.   Identify which sample would be classified as the "hardest" water and explain one impact that this would have on people using this water.   **2**

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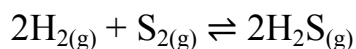
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EXAM CONTINUES ON NEXT PAGE

Section II
Question 32 - Industrial Chemistry (17 marks)
Answer this question in a separate writing booklet.

a.   Consider the following equilibrium:

$$2H_{2(g)} + S_{2(g)} \rightleftharpoons 2H_2S_{(g)}$$

Initially, 9.0×10^{-4} mol S_2 and 1.1×10^{-2} mol H_2S are placed in a 1.0L container. At equilibrium, there is 8.6×10^{-3} mol H_2S present.

    i.   Determine the equilibrium concentrations of H_2 and S_2.   **2**

    ii.   Write the equilibrium constant expression for this reaction.   **1**

    iii.   Calculate the equilibrium constant, K.   **2**

b.   Nitrogen dioxide is an intensely red-brown gas, which is manufactured from colourless nitric oxide in the following equilibrium:

$$2NO_{(g)} \quad + \quad O_{2(g)} \quad\quad \rightleftharpoons \quad\quad 2NO_{2(g)}$$
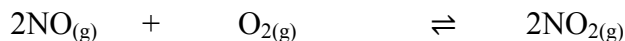
The following table gives equilibrium constants at different temperatures for the above reaction.

Temperature (K)	750	1500	2000
Equilibrium constant, K	110	0.03	6×10^{-4}

Use this information to explain the impact of temperature changes on the system.   **2**

c.   Outline the steps and reaction conditions for the industrial production of sulfuric acid. Include appropriate chemical reactions.   **4**

d.   Identify and describe an industrial use for sulfuric acid.   **2**

e.   Identify 2 precautions that must be taken when using or storing sulfuric acid and describe what relevant protection measures can be taken.   **4**

END OF EXAM