Neap

Trial Examination 2020

VCE Chemistry Units 1&2

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	11	11	90
			Total 120

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

Question and answer booklet of 25 pages

Data booklet

Answer sheet for multiple-choice questions

Instructions

Write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

You may keep the data booklet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

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

Choose the response that is **correct** or that **best answers** the question.

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

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

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

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1

Alkanes

A. are a series of related compounds with the general formula C_nH_{2n}.

B. have the same empirical formula as alkenes and alkynes.

C. can be polymerised to make a wide variety of polymer materials.

D. differ by a $-CH_2$ grouping between consecutive members of the series.

Use the following information to answer Questions 2 and 3.

Samples of solid KCl, molten KCl and an aqueous solution of KCl were tested for electrical conductivity.

Question 2

Which of the samples are likely to conduct electricity?

A. molten KCl and an aqueous solution of KCl only

B. solid KCl and molten KCl only

C. solid KCl and an aqueous solution of KCl only

D. all of the samples of KCl

Question 3

Which one of the following statements correctly explains the results of the electrical conductivity experiment?

A. The metal potassium is a component of KCl and all metals conduct electricity.

B. Only the samples of KCl with delocalised electrons will conduct electricity.

C. Any sample that did not conduct electricity must not contain any ions.

D. Charged particles must be able to move freely in order to conduct electricity.

Question 4

Crude oil

A. consists of one type of compound that has a single molecular formula.

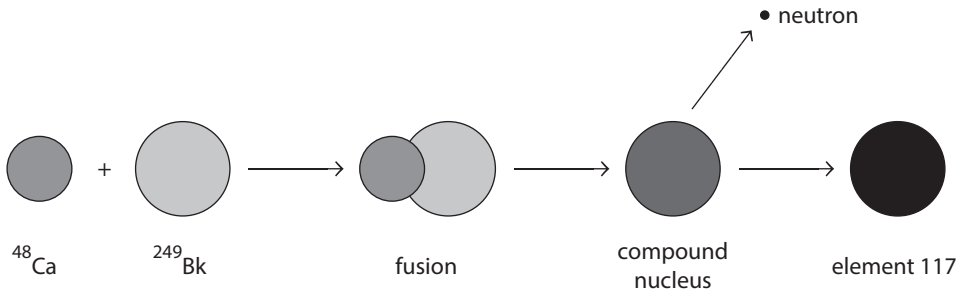
B. is mostly made from the elements carbon, hydrogen and oxygen.

C. is formed from the remains of aquatic organisms over many millions of years.

D. is used directly after extraction from underground to provide a fuel source.

Use the following information to answer Questions 5–7.

Scientists have synthesised element 117 by firing ^{48}Ca nuclei at high speed at ^{249}Bk atoms. The process is shown in the simplified diagram below.



Question 5

The following statements refer to the process shown above:

I There are fewer nuclear particles in element 117 than in a ^{48}Ca nucleus and a ^{249}Bk atom combined.

II Element 117 is likely to have 117 protons and 117 neutrons in each atom.

III Element 117 would have a smaller atomic radius than any element in the same group of the periodic table.

Which of these statements are **incorrect**?

A. I and II only
B. II and III only
C. I and III only
D. I, II and III

Question 6

Calcium has numerous isotopes, with ^{48}Ca being the isotope of lowest naturally occurring mass number.

Using the information provided in the Data Booklet, what prediction can be made about the percentage abundance of the ^{48}Ca isotope in a sample of calcium?

A. very low abundance
B. very high abundance
C. equal to the abundance of all the other isotopes
D. no prediction can be made without knowing the abundance of all other isotopes

Question 7

Calcium atoms are able to form ions with a double-positive charge.

Which of the following is correct for is correct for an ion of ^{48}Ca with a double-positive charge?

	Protons	Neutrons	Electrons
A.	20	28	22
B.	28	20	18
C.	28	20	22
D.	20	28	18

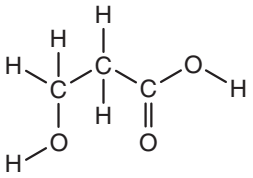
Question 8

Which of the following gives the correct names for the shapes of the molecules listed?

	Pyramidal	V-shaped
A.	NF_3	C_2H_2
B.	BF_3	H_2O
C.	PH_3	OF_2
D.	SO_3	CS_2

Use the following information to answer Questions 9 and 10.

The structural formula of a particular compound is shown below.



Question 9

How many moles of atoms are present in 6.59 g of the compound?

A. 0.073
B. 0.879
C. 9.10
D. 79.1

Question 10

A student was asked which bond within the compound (C–O, O–H, C–C or C–H) would be expected to be the most polar.

In order to answer this question, which of the following sets of data would be most useful for the student?

A. bond lengths for the four bonds listed
B. bond strengths for the four bonds listed
C. electronegativity values for the three elements involved in the bonds listed
D. atomic radii for the three elements involved in the bonds listed

Question 11

Ice floats on liquid water because

A. covalent bonds are stronger in solid water than in liquid water.
B. ice crystals have water molecules in a more open arrangement than in liquid water.
C. hydrogen bonding has no effect at very low temperatures.
D. solids always have a higher density than liquids of the same substance.

Question 12

Consider the following alcohol compounds and their boiling points:

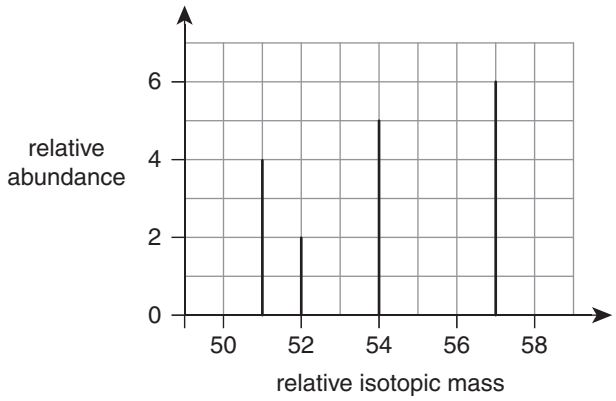
Compound	CH_3OH	C_2H_5OH	C_3H_7OH	C_4H_9OH
Boiling point (°C)	65	78	97	118

The major type of bonding responsible for the increasing boiling points of the four alcohols is

A. dispersion forces.
B. hydrogen bonding.
C. covalent bonding.
D. dipole-dipole bonding.

Use the following information to answer Questions 13 and 14.

The mass spectrum of an imaginary element Z is shown below.



Question 13

What is the percentage abundance of the heaviest isotope?

A. 6
B. 23
C. 35
D. 57

Question 14

What is the relative atomic mass of the element Z?

A. 53.5
B. 54.1
C. 54.7
D. 55.9

Question 15

Which one of the following conversions **cannot** be achieved?

A. a concentrated weak acid to a dilute weak acid
B. a dilute strong acid to a concentrated strong acid
C. a concentrated strong acid to a dilute weak acid
D. a concentrated weak base to a dilute weak base

Question 16

Using certain chemical reactions, all of the metal was isolated from a sample of a metal chloride compound.

The following data were recorded:

Mass of beaker	32.39 g
Mass of beaker and metal chloride sample	43.71 g
Mass of metal isolated	8.27 g

Using the same process, 2.73 g of the metal was isolated from a second sample of the metal chloride.

How many grams of chlorine are present in this second sample?

A. 0.32
B. 1.01
C. 1.72
D. 3.05

Question 17

In a redox reaction, an oxidising agent causes

A. oxidation and in the process is reduced.
B. reduction and in the process is oxidised.
C. oxidation and in the process is oxidised.
D. reduction and in the process is reduced.

Question 18

Spectator ions

A. are always present in a redox reaction.
B. gain electrons in a chemical reaction.
C. lose a proton in an acid–base reaction.
D. are unchanged in a chemical reaction.

Question 19

In an experiment, 10 g each of water and cooking oil were heated separately from 20°C to 40°C.

Which one of the following statements is correct?

A. The water and cooking oil required equal amounts of heat to reach 40°C.
B. Water required a greater amount of heat to reach 40°C because it has a higher specific heat capacity.
C. Water required a greater amount of heat to reach 40°C because it has a lower specific heat capacity.
D. From the information given, it is not possible to conclude the comparative amounts of heat required to heat the substances to 40°C.

Question 20

20.0 mL of a 0.10 M solution of the weak base ammonia, NH_3, is titrated with a 0.10 M solution of hydrochloric acid, HCl, using methyl red as an indicator.

It would be expected that the endpoint would occur with a colour change of

A. yellow to red, and a titre of 20.0 mL.
B. yellow to red, and a titre of less than 20.0 mL.
C. red to yellow, and a titre of 20.0 mL.
D. red to yellow, and a titre of more than 20.0 mL.

Question 21

The specific heat capacity of water is 4.18 J g^{-1} $°C^{-1}$. Heat was added to 8.0 g of water to raise its temperature from 25°C to 60°C.

If the same amount of heat was added to 40 g of lead, which has a specific heat capacity of 0.13 J g^{-1} $°C^{-1}$, the expected temperature change in the metal would be closest to

A. 35°C

B. 175°C

C. 225°C

D. 2250°C

Use the following information to answer Questions 22 and 23.

Sodium reacts with chlorine gas according to the following equation:

$$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$$

Question 22

The reduction half-equation for this reaction is

A. $Na(s) \rightarrow Na^+(s) + e^-$

B. $Na(s) + e^- \rightarrow Na^+(s)$

C. $Cl_2(g) + 2e^- \rightarrow 2Cl^-(s)$

D. $Cl_2(g) \rightarrow 2Cl^-(s) + 2e^-$

Question 23

If 55 g of sodium is reacted with 80 g of chlorine gas in a closed vessel, what chemicals will remain in the vessel after reaction is complete?

A. NaCl(s) only

B. Na(s) and NaCl(s) only

C. $Cl_2(g)$ and NaCl(s) only

D. $Cl_2(g)$, Na(s) and NaCl(s)

Question 24

The concentration of an aqueous solution of ethanol (C_2H_5OH) was expressed using a number of different units.

Which one of the following is **not** equivalent to the other stated concentrations of ethanol?

A. 0.246 mol L^{-1}

B. 11.3 g L^{-1}

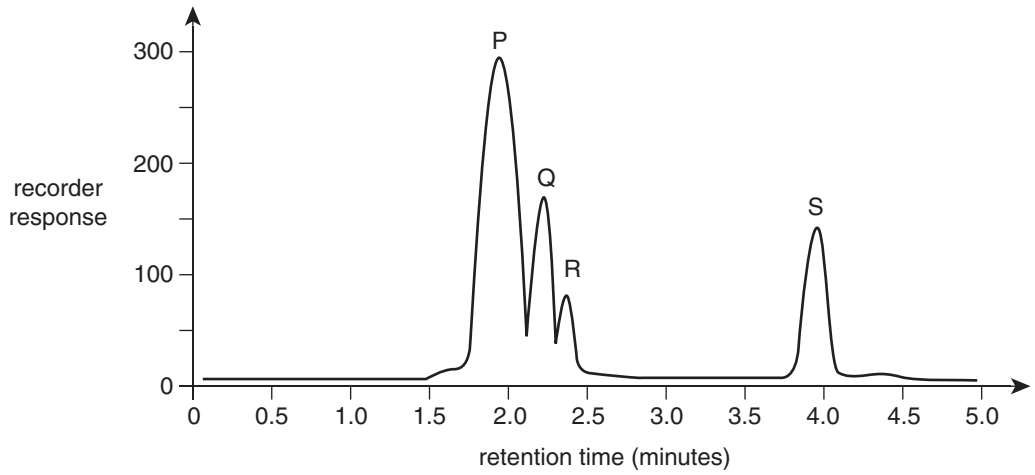
C. 1.13% m/v

D. 1.13×10^3 ppm

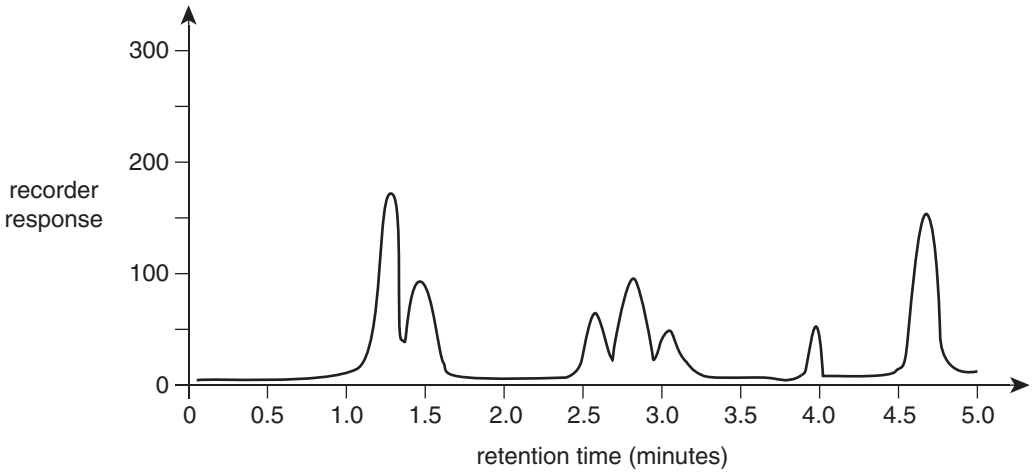
Use the following information to answer Questions 25 and 26.

Water samples taken from two different rivers were analysed by high-performance liquid chromatography (HPLC) using the same column under identical conditions. The recorded output is shown below. The peaks in one water sample are marked with the letters P, Q, R and S, representing the components of the sample that produce each peak.

Water sample 1



Water sample 2



Question 25

Which one of the following statements about water sample 1 is correct?

A. Component S has the strongest attraction to the mobile phase.

B. Component P will be removed from the column last.

C. Component P is twice the concentration of component S.

D. Component R has the lowest concentration of any component.

Question 26

Which of the components present in water sample 1 are **not** likely to be present in water sample 2?

A. P and Q only

B. R and S only

C. P, Q and R only

D. Q, R and S only

Question 27

At 25°C, the pH of solution X is 3 and the pH of solution Y is 6.

Which one of the following statements about these solutions is correct?

A. Solution X has more than twice the hydrogen ion concentration of solution Y.

B. The hydroxide ion concentration in solution Y is lower than that in solution X.

C. Solution X is acidic and so has no hydroxide ions present.

D. Solution X must be a strong acid and solution Y must be a weak acid.

Question 28

The reactivity series for metals M, N, O and P is as follows:

$$M < N < O < P$$

Which one of the following statements is a valid conclusion that can be drawn from this information?

A. P would displace any of the metals from a solution of their ions.

B. M would displace O from a solution of O^{2+} ions.

C. N would react readily with a solution of P^{2+} ions.

D. N^{2+} ions would react with M^{2+} ions to produce metal N.

Use the following information to answer Questions 29 and 30.

The ionic product (K_w) of pure water varies with temperature as shown in the table below.

Temperature (°C)	15	35	55
K_w **(M^2)**	4.51×10^{-15}	2.09×10^{-14}	7.29×10^{-14}

Question 29

The pH of pure water at 35°C is

A. 6.57

B. 6.83

C. 7.00

D. 7.17

Question 30

Which one of the following statements about pure water at different temperatures is correct?

A. As the temperature of pure water increases, the pH increases.

B. For pure water at 15°C, $[OH^-]$ is greater than $[H_3O^+]$.

C. The hydrogen ion concentration of pure water is greater at 0°C than at 25°C.

D. Regardless of the temperature, pure water is always neutral.

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, NaCl(s).

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1 (11 marks)

The condensed (semi-structural) formulas of four different isomers of the alcohol C_4H_9OH are shown in the table below.

Compound	Condensed formula
A	$CH_3CH_2CH_2CH_2OH$
B	$CH_3CH_2CH(OH)CH_3$
C	$CH_3C(CH_3)(OH)CH_3$
D	$CH_3CH(CH_3)CH_2OH$

a. Using the information from the table above, define the term 'isomer'. 1 mark

_____

_____

_____

b. Draw the structural formula of **compound B**, showing all bonds. 1 mark

c. Give the systematic name of **compound C**. 1 mark

_____

d. Place a tick in the right-hand column for any feature listed in the table below that would be different for the isomers of C_4H_9OH shown. 1 mark

number of covalent bonds in each molecule	
empirical formula	
ability to conduct electricity	
boiling point	
percentage by mass of carbon	

e. An ester was produced in the following chemical reaction using **compound A**:

$$CH_3CH_2CH_2CH_2OH + \text{carboxylic acid Q} \rightarrow C_7H_{14}O_2 + H_2O$$

i. State a major use of esters in the manufacture of consumer products. 1 mark

_____

ii. Write the name of carboxylic acid Q. 1 mark

_____

f. An alcohol in the same family of compounds as C_4H_9OH has the following composition by mass: 37.5% carbon, 12.5% hydrogen and 50.0% oxygen.

i. Showing all necessary calculations, determine the empirical formula of this alcohol. 2 marks

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ii. In 0.195 g of the alcohol there are 3.67×10^{21} molecules of the compound. Determine the molecular formula of the alcohol. 3 marks

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Question 2 (7 marks)

Various properties of four metals are shown in the table below.

Metal	Melting point (°C)	Boiling point (°C)	Density (g cm^{-3})	Reactivity with oxygen	Reactivity with dilute acid
potassium	63	759	0.89	rapid reaction	violent reaction
lead	328	1749	11.3	no reaction	no reaction
iron	1538	2862	7.9	very slow reaction	slow reaction
magnesium	650	1091	1.74	slow reaction	rapid reaction

a. **i.** State a common property of the four metals that is **not** shown in the table above. 1 mark

_____

ii. Explain the property stated in **part a.i.** using the metallic bonding model. 2 marks

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_____

b. The information in the table above highlights differences in physical properties between main-group metals and transition-group metals.

State **one** difference. 1 mark

_____

_____

c. Using their elemental symbols, write the four metals in order of decreasing reactivity. 1 mark

_____

d. Some of the ways that iron is modified before being used for particular applications are shown in the table below.

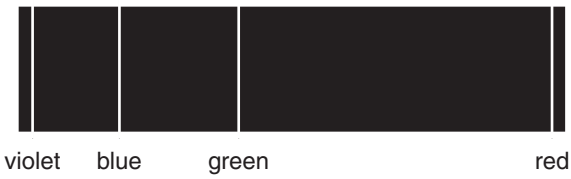
Explain the purpose of **one** of these modifications by writing in the appropriate space in the table. 2 marks

Modification	Purpose of this modification (fill only one row)
coating iron with zinc to make galvanised iron sheets	
annealing by heating iron to red-hot and then cooling slowly	
mixing molten iron with carbon and other molten metals to make stainless steel	

Question 3 (8 marks)

The current model of atomic structure has been developed over many years using the results of experimental work and analysis by scientists.

a. To develop the model of atomic structure, scientist Niels Bohr analysed the emission spectrum of hydrogen atoms, which showed four different coloured lines on a black background as shown below.



Outline the structure of the atom proposed by Bohr and state how it is consistent with the spectral evidence that he observed. 3 marks

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b. The current model of the atom is known as the 'quantum mechanical model' and is a complex mathematical model developed by Erwin Schrödinger to refine Bohr's ideas.

i. Complete the table below showing features of the **third shell** of an atom, using the quantum mechanical model. 4 marks

number of subshells	
total number of orbitals	
maximum number of electrons	
number of p-type orbitals	

ii. Write the electron configuration (using subshell notation) of an atom of atomic number 32. 1 mark

_____

Question 4 (13 marks)

The naturally occurring elements of group 14 in the periodic table range from the non-metal carbon, C, to the metallic element lead, Pb.

a. Moving down the group from C to Pb, state the trend in the following properties:

i. electronegativity 1 mark

_____

ii. first ionisation energy 1 mark

_____

b. Element 114 in group 14 was made synthetically by scientists.

Without completing any experiments, how can the physical and chemical properties of element 114 be predicted? 2 marks

_____

_____

_____

_____

_____

_____

c. The various structural forms of carbon, the first element in group 14, include diamond, graphite and fullerenes.

Identify which of these forms of carbon, if any, will conduct electricity. Explain the conductivity, or lack of conductivity, for each form. 3 marks

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_____

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_____

_____

d. Like all of the group 14 elements, carbon and silicon react with oxygen to produce oxide compounds. CO_2 is a gas at room temperature whereas SiO_2 is a hard, brittle solid with the very high melting temperature of 1700°C.

i. Even though these compounds, CO_2 and SiO_2, have similar formulas, explain how it can be concluded that SiO_2 does **not** consist of individual or discrete molecules. 2 marks

_____

_____

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_____

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ii. The carbon to oxygen bonds in CO_2 are polar but the molecule has no overall polarity.

Draw the structural formula of CO_2 and use it to explain why the molecule is non-polar. 2 marks

_____

_____

_____

_____

iii. Name all of the bond types and interactive forces present in a sample of solid carbon dioxide (dry ice). 2 marks

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_____

_____

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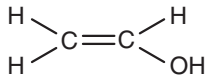
Question 5 (4 marks)

The polymer polyvinyl alcohol (PVA) has many uses in the production of consumer items. The monomer involved in the polymerisation is vinyl alcohol or ethenol, shown below.



a. Draw a section of polyvinyl alcohol that contains at least six carbon atoms. 1 mark

b. Polyvinyl alcohol is a thermoplastic polymer.

Outline how this polymer is different to a thermosetting polymer with reference to structure, bonding and properties. 3 marks

Question 6 (11 marks)

Sulfuric acid, H_2SO_4, is a strong acid and is one of the most widely manufactured chemicals in the world.

a. Sulfuric acid reacts with water in two stages. The first stage is represented by the following equation:

$$H_2SO_4(l) + H_2O(l) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$$

i. Write the equation for the second stage. 1 mark

_____

ii. Why is sulfuric acid classed as a strong acid? 1 mark

_____

_____

b. When manufactured, sulfuric acid is a viscous liquid with a concentration of approximately 18 M.

What volume of 18 M sulfuric acid would be diluted to make 125 L of 1.5 M sulfuric acid? 2 marks

_____

_____

_____

c. Sulfuric acid can be used to prepare the volatile hydrochloric acid, HCl. The reaction is shown by the following equation:

$$H_2SO_4(l) + NaCl(s) \rightarrow HCl(g) + NaHSO_4(s)$$

The pH of 1.0 M hydrochloric acid is 0, whereas the pH of 1.0 M sulfuric acid is less than 0.

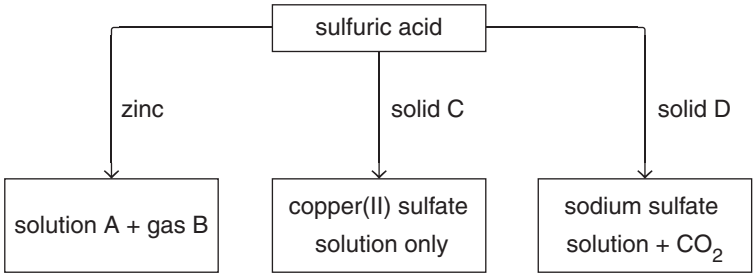
Explain why the two acids have different pH values. 2 marks

_____

_____

_____

d. A number of chemical reactions involving dilute sulfuric acid are shown in the diagram below.



i. Name each of the substances shown in the table below. 3 marks

Solution A	Gas B	Solid D

ii. Write a balanced equation for a possible chemical reaction of sulfuric acid with solid C. 2 marks

_____

Question 7 (7 marks)

The preparation of insoluble salts by precipitation is a standard laboratory procedure. To prepare a sample of the insoluble compound lead(II) sulfate, the steps below were followed.

1. Prepare 50 mL of 0.100 M K_2SO_4 solution and 50 mL of 0.100 M $Pb(NO_3)_2$ solution by dissolving the solids separately in water.
2. Mix the prepared aqueous solutions in a beaker.
3. Filter the contents of the beaker and, after washing the beaker with a small amount of water, pour the washings onto the filter paper.
4. Pour a small amount of cold distilled water onto the solid trapped on the filter paper.
5. Dry the filter paper and determine the mass of the solid.

a. Calculate the mass of solid potassium sulfate required to make the K_2SO_4 solution in step 1. 2 marks

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_____

_____

_____

b. Write a balanced ionic equation for the reaction in step 2. 1 mark

_____

c. What was the purpose of filtering the washings in step 3? 1 mark

_____

_____

d. In step 3, the filtrate is the material that passed through the filter paper.
List the ions present in the filtrate. 1 mark

_____

e. One aim of the preparation of an insoluble salt is to maximise the yield of the salt.

i. If the yield was 100%, 1.52 g of lead(II) sulfate would have been produced in this preparation. The actual mass produced was 1.38 g.
Calculate the percentage yield for this preparation of lead(II) sulfate. 1 mark

_____

_____

ii. Suggest **one** reason why the yield was not 100%. 1 mark

_____

_____

Question 8 (9 marks)

There is wide variation in the solubility of substances in water.

a. The solubility of solid sodium sulfate, Na_2SO_4, in water (in grams of solute per 100 g of water) at various temperatures is shown in the table below.

Solubility (g per 100 g)	58	56	52	50	47	45
Temperature (°C)	10	20	30	40	50	60

i. What is unusual about the trend in the solubility of the solid shown in the table? 1 mark

_____

_____

ii. Describe how 50 mL of pure water at 30°C could be used to make a **saturated** solution of sodium sulfate. 2 marks

_____

_____

_____

_____

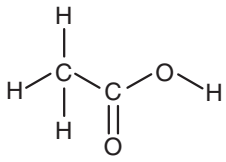
iii. How could it be easily shown that the solution described in **part a.ii.** is saturated? 1 mark

_____

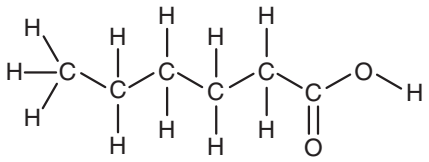
_____

b. The solubility of two liquids, compound A and compound B, at 20°C is shown below.

Compound A



Compound B



Compound A is soluble in all proportions in water, while the solubility of compound B is 1.0 g per 100 g of water.

i. With the aid of an appropriate drawing of the molecular interactions and labelling of relevant bond types, explain the solubility of compound A in water. 3 marks

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_____

_____

_____

ii. Why is the solubility of compound B so low in comparison to compound A? 2 marks

_____

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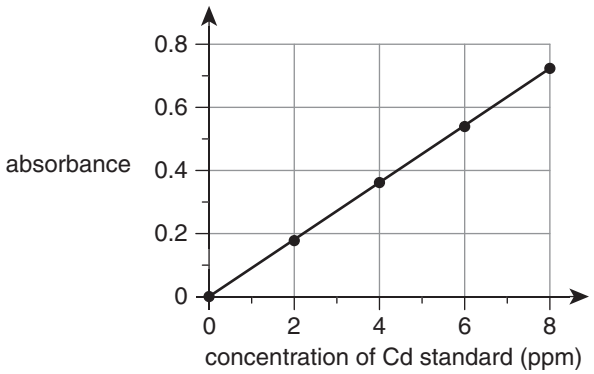
_____

Question 9 (7 marks)

Samples from the wastewater storage on an industrial site were taken and analysed by atomic absorption spectroscopy (AAS) to find the cadmium, Cd, concentration.

a. A set of standard solutions was prepared and the absorbance of each solution was measured using an appropriately set atomic absorption spectrophotometer. The calibration graph shown below was generated.



The samples of wastewater were diluted by a factor of five before the absorbance of each could be determined.

i. Suggest why the dilution was necessary. 1 mark

_____

_____

ii. The absorbance of one diluted sample was 0.45.
Determine the concentration, in ppm, of the **undiluted** sample. 2 marks

_____

_____

iii. Calculate the mass of cadmium (in kg) in 5000 litres of the wastewater. 2 marks

_____

_____

_____

b. The concentration of cadmium in the wastewater could have also been determined using gravimetric analysis.

i. Outline **one** advantage of using gravimetric analysis instead of AAS. 1 mark

_____

_____

ii. Outline **one** advantage of using AAS instead of gravimetric analysis. 1 mark

_____

_____

Question 10 (8 marks)

A large quantity of water that had been used in the extraction of minerals in mining was stored so that it could be treated before being released into the environment. One treatment involved the low pH of the water being returned to neutral. Samples of the water were taken and titrated with standardised sodium hydroxide, NaOH, solution. The following results were obtained:

Volume of water samples analysed:	20.00 mL
Concentration of NaOH solution:	0.127 M
Average titre of NaOH solution required to reach endpoint:	22.35 mL
Stoichiometric ratio between H^+ ions and OH^- ions:	1 : 1

a. **i.** Calculate the average number of moles of NaOH used in each titration. 1 mark

_____

_____

ii. Determine the number of moles of H^+ ions in each 20.00 mL sample of the water. 1 mark

_____

iii. Calculate the concentration of H^+ ions, in mol L^{-1}, in the stored water. 1 mark

_____

_____

iv. Calculate the pH of the stored water. 1 mark

_____

b. Explain **one** reason why it is necessary to return the stored water to a close to neutral pH before it is released into local waterways or rivers. 2 marks

_____

_____

_____

_____

_____

c. A standard solution of NaOH cannot be prepared by weighing a mass of solid NaOH and dissolving it in a set volume of water.

Suggest **one** reason why this is the case. 2 marks

_____

_____

_____

_____

_____

Question 11 (5 marks)

A number of contaminants may be found in water from wells. These include arsenic, As, a highly toxic species, and hydrogen sulfide gas, H_2S, known as 'rotten egg gas'. Various water treatment processes involving both acid–base and redox reactions are employed to remove these contaminants to produce drinkable water.

a. Arsenic may be removed by adsorption to solid iron compounds to create particles large enough to be filtered from the water. The following reaction occurs when iron(III) chloride solution is added to well water:

$$3H_2O(l) + FeCl_3(aq) \rightarrow Fe(OH)_3(s) + 3HCl(aq)$$

The $Fe(OH)_3(s)$ strongly adsorbs arsenic species, providing the pH is low.

i. Circle **one** of the terms below to identify how water is acting during the reaction between water and iron(III) chloride. 1 mark

acid base oxidising agent reducing agent

ii. How does the reaction between water and iron(III) chloride ensure that the pH is low? 1 mark

_____

_____

b. A second water treatment removes hydrogen sulfide gas by reaction with manganese dioxide, MnO_2, which is coated on to the surface of a filtering medium made from naturally occurring glauconite greensand. The hydrogen sulfide is oxidised to solid sulfur, which can be filtered from the water. The manganese dioxide is reduced to $Mn^{2+}(aq)$.

i. Write a balanced half-equation for the oxidation of hydrogen sulfide to sulfur. 1 mark

_____

ii. Write a balanced half-equation for the reduction of $MnO_2(s)$ to $Mn^{2+}(aq)$. 1 mark

_____

iii. In various situations MnO_2 is able to act as an oxidising agent and a reducing agent. Give the chemical symbol or formula for another species that can act as both an oxidising agent and a reducing agent. 1 mark

_____

END OF QUESTION AND ANSWER BOOKLET

Neap

Trial Examination 2020

VCE Chemistry Units 1&2

Written Examination

Data Booklet

Instructions

This data booklet is provided for your reference.

A question and answer booklet is provided with this data booklet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

1. Periodic table of the elements

Key: 79 (atomic number) / **Au** (symbol of element) / 197.0 (relative atomic mass) / gold (name of element)

1 **H** 1.0 hydrogen																	2 **He** 4.0 helium
3 **Li** 6.9 lithium	4 **Be** 9.0 beryllium											5 **B** 10.8 boron	6 **C** 12.0 carbon	7 **N** 14.0 nitrogen	8 **O** 16.0 oxygen	9 **F** 19.0 fluorine	10 **Ne** 20.2 neon
11 **Na** 23.0 sodium	12 **Mg** 24.3 magnesium											13 **Al** 27.0 aluminium	14 **Si** 28.1 silicon	15 **P** 31.0 phosphorus	16 **S** 32.1 sulfur	17 **Cl** 35.5 chlorine	18 **Ar** 39.9 argon
19 **K** 39.1 potassium	20 **Ca** 40.1 calcium	21 **Sc** 45.0 scandium	22 **Ti** 47.9 titanium	23 **V** 50.9 vanadium	24 **Cr** 52.0 chromium	25 **Mn** 54.9 manganese	26 **Fe** 55.8 iron	27 **Co** 58.9 cobalt	28 **Ni** 58.7 nickel	29 **Cu** 63.5 copper	30 **Zn** 65.4 zinc	31 **Ga** 69.7 gallium	32 **Ge** 72.6 germanium	33 **As** 74.9 arsenic	34 **Se** 79.0 selenium	35 **Br** 79.9 bromine	36 **Kr** 83.8 krypton
37 **Rb** 85.5 rubidium	38 **Sr** 87.6 strontium	39 **Y** 88.9 yttrium	40 **Zr** 91.2 zirconium	41 **Nb** 92.9 niobium	42 **Mo** 96.0 molybdenum	43 **Tc** (98) 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** 183.8 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** (210) polonium	85 **At** (210) astatine	86 **Rn** (222) radon
87 **Fr** (223) francium	88 **Ra** (226) radium	**89–103** actinoids	104 **Rf** (261) rutherfordium	105 **Db** (262) dubnium	106 **Sg** (266) seaborgium	107 **Bh** (264) bohrium	108 **Hs** (267) hassium	109 **Mt** (268) meitnerium	110 **Ds** (271) darmstadtium	111 **Rg** (272) roentgenium	112 **Cn** (285) copernicium	113 **Nh** (280) nihonium	114 **Fl** (289) flerovium	115 **Mc** (289) moscovium	116 **Lv** (292) livermorium	117 **Ts** (294) tennessine	118 **Og** (294) oganesson

57 **La** 138.9 lanthanum	58 **Ce** 140.1 cerium	59 **Pr** 140.9 praseodymium	60 **Nd** 144.2 neodymium	61 **Pm** (145) 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
89 **Ac** (227) actinium	90 **Th** 232.0 thorium	91 **Pa** 231.0 protactinium	92 **U** 238.0 uranium	93 **Np** (237) neptunium	94 **Pu** (244) plutonium	95 **Am** (243) americium	96 **Cm** (247) curium	97 **Bk** (247) berkelium	98 **Cf** (251) californium	99 **Es** (252) einsteinium	100 **Fm** (257) fermium	101 **Md** (258) mendelevium	102 **No** (259) nobelium	103 **Lr** (262) lawrencium

The value in brackets indicates the mass number of the longest-lived isotope.

2. Electrochemical series

Reaction	Standard electrode potential (E^0) in volts at 25°C
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightleftharpoons Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+1.23
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(aq)$	+0.68
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	–0.25
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	–0.28
$Cd^{2+}(aq) + 2e^- \rightleftharpoons Cd(s)$	–0.40
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$	–1.18
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	–1.66
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	–2.37
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	–2.71
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	–2.87
$K^+(aq) + e^- \rightleftharpoons K(s)$	–2.93
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	–3.04

3.Chemical relationships

Name	Formula
number of moles of a substance	$n = \frac{m}{M}; \quad n = cV$

4. Physical constants and standard values

Name	Symbol	Value
Avogadro constant	N_A or L	6.02×10^{23} mol^{-1}
specific heat capacity of water	c	4.18 kJ kg^{-1} K^{-1} or 4.18 J g^{-1} K^{-1}
density of water at 25°C	d	997 kg m^{-3} or 0.997 g mL^{-1}
ionic product for water	K_W	1.00×10^{-14} mol^2 L^{-2} at 298 K (self-ionisation constant)

5. Unit conversions

Measured value	Conversion
1 litre (L)	1 dm^3 or 1×10^{-3} m^3 or 1×10^3 cm^3 or 1×10^3 mL

6. Metric (including SI) prefixes

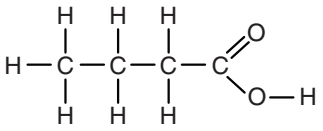
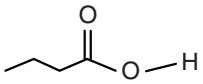
Metric (including SI) prefixes	Scientific notation	Multiplying factor
giga (G)	10^9	1 000 000 000
mega (M)	10^6	1 000 000
kilo (k)	10^3	1000
deci (d)	10^{-1}	0.1
centi (c)	10^{-2}	0.01
milli (m)	10^{-3}	0.001
micro (μ)	10^{-6}	0.000001
nano (n)	10^{-9}	0.000000001
pico (p)	10^{-12}	0.000000000001

7. Acid–base indicators

Name	pH range	Colour change from lower pH to higher pH in range
thymol blue (1st change)	1.2–2.8	red → yellow
methyl orange	3.1–4.4	red → yellow
bromophenol blue	3.0–4.6	yellow → blue
methyl red	4.4–6.2	red → yellow
bromothymol blue	6.0–7.6	yellow → blue
phenol red	6.8–8.4	yellow → red
thymol blue (2nd change)	8.0–9.6	yellow → blue
phenolphthalein	8.3–10.0	colourless → pink

8. Representations of organic molecules

The following table shows different representations of organic molecules, using butanoic acid as an example.

Formula	Representation
molecular formula	$C_4H_8O_2$
structural formula	
semi-structural (condensed) formula	$CH_3CH_2CH_2COOH$ or $CH_3(CH_2)_2COOH$
skeletal structure	

9. A solubility table

High solubility	Low solubility
Compounds containing the following ions are soluble in water. • Na^+, K^+, NH_4^+, NO_3^-, CH_3COO^- • Cl^-, Br^-, I^- (unless combined with Ag^+ or Pb^{2+}) • SO_4^{2-} (however $PbSO_4$ and $BaSO_4$ are not soluble, Ag_2SO_4 and $CaSO_4$ are slightly soluble)	Compounds containing the following ions are generally insoluble, unless combined with Na^+, K^+ or NH_4^+. • CO_3^{2-}, PO_4^{3-}, S^{2-} • OH^- ($Ba(OH)_2$ and $Sr(OH)_2$ are soluble; $Ca(OH)_2$ is slightly soluble)

END OF DATA BOOKLET

Neap

Trial Examination 2020

VCE Chemistry Units 1&2

Written Examination

Multiple-choice Answer Sheet

Student's Name: _____

Teacher's Name: _____

Instructions

Use a **pencil** for **all** entries. If you make a mistake, **erase** the incorrect answer – **do not** cross it out. Marks will **not** be deducted for incorrect answers.
No mark will be given if more than **one** answer is completed for any question.

All answers must be completed like **this** example: [A] [B] [C] [D]

Use pencil only

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D
26	A	B	C	D
27	A	B	C	D
28	A	B	C	D
29	A	B	C	D
30	A	B	C	D