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Name and Index Number: ( )	Class:

SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/01

Secondary 4 Express **02 September 2019**

Paper 1 Multiple Choice **1 hour**

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **forty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in soft pencil on the Multiple Choice Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this question paper.
The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 15.

Parent's / Guardian's Signature: ……..

This document consists of **15** printed pages and **1** blank page.

Do not turn over the page until you are told to do so.

[Turn over

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1 A student accidentally mixed 60 cm^3 of water with 60 cm^3 of oil.

Which method would allow her to obtain 30 cm^3 of the oil most easily?

A chromatography
B evaporation
C filtration
D use of a separating funnel

2 When concentrated aqueous ammonia and concentrated hydrochloric acid are placed at opposite ends of a tube, a white ring of ammonium chloride forms nearer to the hydrochloric acid.

Which conclusion about this experiment is correct?

A The boiling point of ammonia is less than that of hydrogen chloride.
B The concentration of the aqueous ammonia is less than that of the acid.
C The reactivity of ammonia is less than that of hydrogen chloride.
D The relative molecular mass of ammonia is less than that of hydrogen chloride.

3 Aqueous ammonia is added to a solution of a salt. A white precipitate is formed which dissolves in an excess of aqueous ammonia.

Which metal ion could the salt contain?

A Al^{3+}
B Ca^{2+}
C K^{+}
D Zn^{2+}

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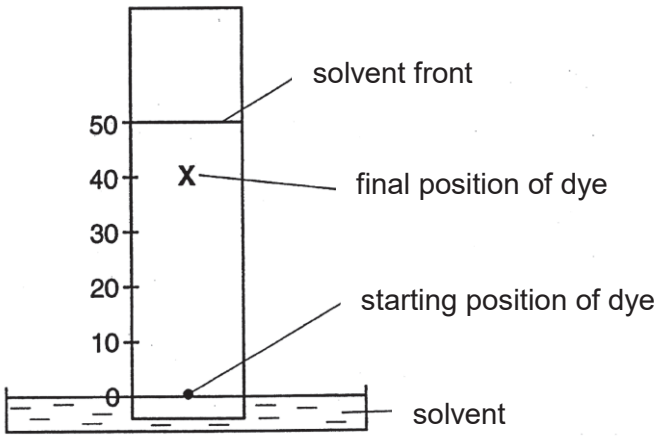
4 The diagram shows the chromatogram for a dye.



Which fraction shows the R_f value for the dye?

A $\frac{10}{50}$

B $\frac{50}{10}$

C $\frac{50}{40}$

D $\frac{40}{50}$

5 The table shows the structure of different atoms and ions.

particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Mg	12	24	12	W	12
Mg^{2+}	X	24	12	12	10
F	9	19	9	Y	9
F^-	9	19	9	10	Z

What are the values of W, X, Y and Z?

	W	X	Y	Z
A	10	10	9	9
B	10	12	10	9
C	12	10	9	10
D	12	12	10	10

[Turn over

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6 Metals have positive ions in a 'sea of electrons'.

Which metal atom contributes the most electrons to the 'sea of electrons'?

A aluminium
B barium
C rubidium
D zinc

7 Which two elements react together to form a compound that can conduct electricity only when it is in the molten or aqueous states?

element	electronic structure
R	2, 4
T	2, 8
X	2, 8, 1
Z	2, 8, 7

A R and T
B T and X
C X and Z
D Z and R

8 Element J forms an acidic, covalent oxide.

Which row shows how many electrons there could be in the outer shell of an atom of J?

	number of outermost electrons			
	1	2	6	7
A	✓	✓	x	x
B	✓	x	✓	x
C	x	x	✓	✓
D	x	✓	x	✓

9 The chemical formulae of two substances, W and X, are given.

W $NaAlSi_3O_8$
X $CaAl_2Si_2O_8$

Which statements are correct?

1 W and X contain the same amount of oxygen.
2 W contains three times as much silicon as X.
3 X contains twice as much aluminium as W.

A 1 and 2
B 1 and 3
C 2 and 3
D 1, 2 and 3

[Turn over

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10 An atmospheric pollutant can be removed by the process of reduction.

Which pollutant is removed by this process?

A carbon monoxide in a catalytic convertor
B nitrogen dioxide in acid rain by reaction with calcium carbonate
C nitrogen oxide in a catalytic convertor
D sulfur dioxide from flue gases by reaction with calcium carbonate

11 Which quantity is the same for one mole of ethanol and one mole of ethane?

A mass
B number of atoms
C number of molecules
D volume at r.t.p

12 What is the volume of hydrogen produced at room temperature and pressure, when 4.6 g of sodium is reacted with an excess of water?

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

A 1.2 dm^3
B 2.4 dm^3
C 4.8 dm^3
D 12 dm^3

13 The Apollo moon missions used hydrazine, N_2H_4, as rocket fuel. Hydrazine is made by reacting ammonia with sodium chlorate(I), NaC*l*O.

$$2NH_3(g) + NaClO(s) \longrightarrow N_2H_4(g) + NaCl(s) + H_2O(l)$$

If 28 g of hydrazine is made from 34 g of ammonia, what is the percentage yield of hydrazine?

A 12.5%
B 17.0%
C 87.5%
D 100%

14 When pink cobalt(II) chloride crystals are heated, they form steam and a blue solid.
When water is added to the blue solid, it turns pink and becomes hot.

Which terms describe the pink cobalt(II) chloride crystals and the reactions?

	pink cobalt(II) chloride	reactions
A	aqueous	irreversible
B	anhydrous	reversible
C	hydrated	irreversible
D	hydrated	reversible

[Turn over

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15 Which pairs of statements correctly describe the differences between the conduction of electricity during electrolysis and the conduction of electricity by metals?

	conduction during electrolysis	conduction by metals
1	The current is due to the movement of both positive and negative ions.	The current is due to the movement of electrons.
2	Charged particles move towards both electrodes.	Charged particles move in one direction only.
3	It results in a chemical change.	It does not result in a chemical change.

A 1, 2 and 3 are correct
B 1 and 2 only are correct
C 2 and 3 only are correct
D 1 only is correct

16 When the wick of a candle is touched by a lit match, the candle begins to burn. When the match is removed, the candle continues to burn.

What is the role of the match in the reaction involving the candle wax?

A It acts as a catalyst.
B It increases the rate of combustion.
C It lowers the activation energy barrier.
D It supplies the activation energy.

17 Which of the following statements is **not** true?

A An endothermic reaction requires a constant supply of heat as long as the reaction proceeds.
B An exothermic reaction only needs heat to initiate.
C Photosynthesis is an exothermic reaction.
D Reactions with high activation energies do not occur spontaneously and may require heat or the addition of catalyst to initiate the reaction.

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18 Hydrogen is increasingly being investigated as a fuel for the future. It burns in oxygen to produce water.

Which of the following describe(s) the advantages of carrying out the above reaction in a fuel cell rather than burning hydrogen and converting the heat into electricity?

1 It reduces pollution to the environment.
2 Less energy is wasted or lost during conversion.
3 It increases the ease of storage and handling of hydrogen.

A 1 only
B 2 only
C 1 and 3 only
D 2 and 3 only

19 The table compares the properties of four different fuels.

property	ethanol	hydrogen	methane	petrol
molar mass (g/mol)	46	2	16	114
density (kg/*l*)	0.79	8.4×10^{-5}	6.4×10^{-4}	0.69
enthalpy change (kJ/mol)	−1360	−285	−891	−5460

Which of the following shows the correct order of fuels which produce decreasing amounts of energy when 1 g of the compound is completely burnt?

A hydrogen, methane, ethanol, petrol
B hydrogen, methane, petrol, ethanol
C methane, hydrogen, ethanol, petrol
D methane, hydrogen, petrol, ethanol

20 Which set of conditions is ideal for the manufacture of ammonia in the Haber process?

	pressure / atm	temperature / °C	ratio of $H_2 : N_2$
A	250	450	3 : 1
B	250	450	1 : 3
C	450	250	3 : 1
D	450	250	1 : 3

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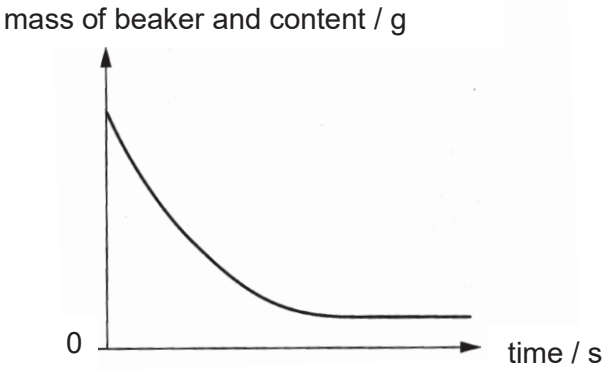
21 Two reagents were mixed in a beaker and the mass of the beaker and its content was recorded as the reaction progressed. The graph shows the result that was obtained.



Which of the following reactions could **not** have produced the graph?

A $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$

B $ZnCO_3(s) + 2HNO_3(aq) \longrightarrow Zn(NO_3)_2(aq) + CO_2(g) + H_2O(l)$

C $NaNO_2(aq) + NH_4Cl(aq) \longrightarrow NaCl(aq) + 2H_2O(l) + N_2(g)$

D $(NH_4)_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2NH_3(aq) + 2H_2O(l)$

22 A poorly ventilated flour mill has a higher risk of explosion as compared to a bakery with similar ventilation.

What could be the most likely reason for the higher risk of explosion in the poorly ventilated flour mill?

A The flour mill has a higher temperature than the bakery.

B The flour mill has more gaseous pollutants than the bakery.

C The flour mill has more fine particles of flour in the air as compared to the bakery.

D The flour mill has more oxygen in the air than the bakery.

23 To reduce atmospheric pollution, the waste gases from a coal-burning power station are passed through powdered calcium carbonate.

Which waste gas will **not** be removed by the powdered calcium carbonate?

A carbon monoxide

B nitrogen dioxide

C phosphorus(V) oxide

D sulfur dioxide

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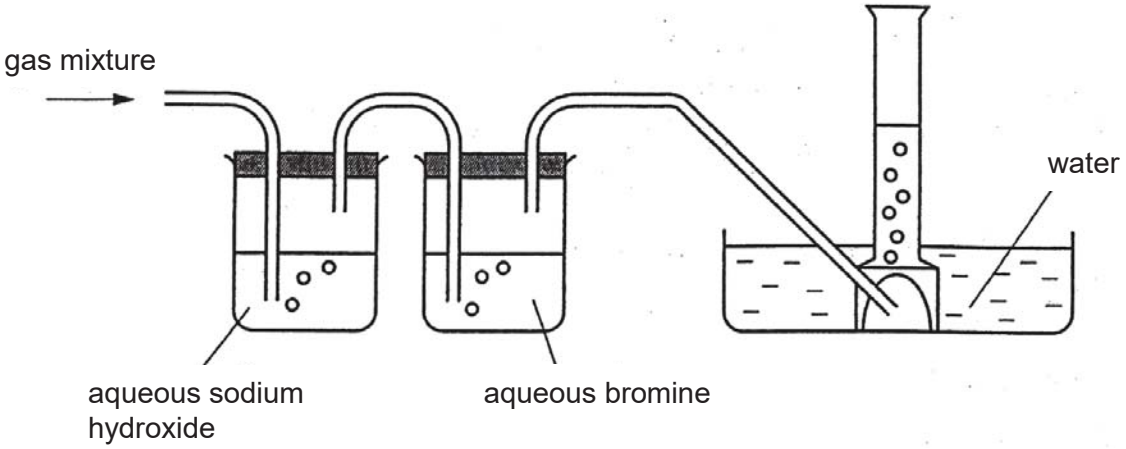
24 A gaseous mixture of ethene, hydrogen and sulfur dioxide is passed through the apparatus shown. Only one of the gases is collected.



What is a property of the gas collected?

A burns with a lilac flame
B extinguishes a lighted splint with a “pop” sound
C relights a glowing splint
D turns purple acidified potassium manganate(VII) colourless

25 The elements W, X, Y and Z have increasing proton numbers. They are all in period 3 of the Periodic Table but are not necessarily next to each other.

Which statement is correct?

A The chloride of Z is ionic.
B The oxides of W and Z are both amphoteric.
C W and Y contain the same number of shells of electrons.
D X and Y could be in the same Group in the Periodic Table.

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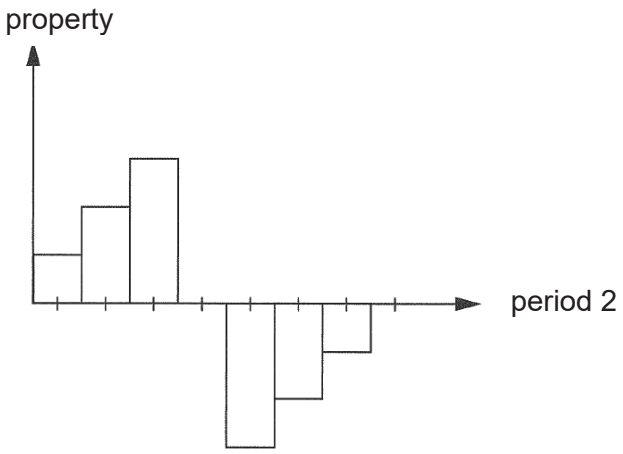
26 The atomic radii of four Group I elements of the Periodic Table are given below in picometres.

element	atomic radius / pm
P	231
Q	152
R	248
S	186

What are the possible melting points of the four elements?

	melting point (°C) of element			
	P	Q	R	S
A	39	98	64	180
B	64	180	39	98
C	98	64	39	180
D	180	98	64	39

27 The bar graph below shows the trend in a property for elements across period 2 of the Periodic Table.



Which of the following properties could be represented by the bar graph?

A charge of ion

B melting point

C size of ion

D valency

[Turn over

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28 Which metal should be used in the sacrificial protection of the hull of a boat made from iron?

A calcium
B copper
C lead
D zinc

29 What is a disadvantage of recycling metals?

A Collection and transportation costs money.
B Metal ores are a finite resource.
C Most metals corrode slowly in the environment.
D Scrap metal melts when heated.

30 The welding of railway tracks was done in the past with the aid of a chemical reaction known as the Thermite reaction. The Thermite reaction involves the displacement of a metal from its solid oxide by another metal.

Which of the following equations could represent the Thermite reaction?

A $Al_2O_3 + 3Zn \longrightarrow 3ZnO + 2Al$
B $2Fe + Al_2O_3 \longrightarrow 2Al + Fe_2O_3$
C $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$
D $MgO + Zn \longrightarrow Mg + ZnO$

31 Metal A is higher than metal B in the reactivity series.

Which of the following statements is true?

A Metal A is a stronger oxidising agent than metal B.
B Metal A forms a stronger acid than metal B.
C Metal A forms more stable compounds than metal B.
D Metal A takes in more energy than metal B when reacting to form compounds.

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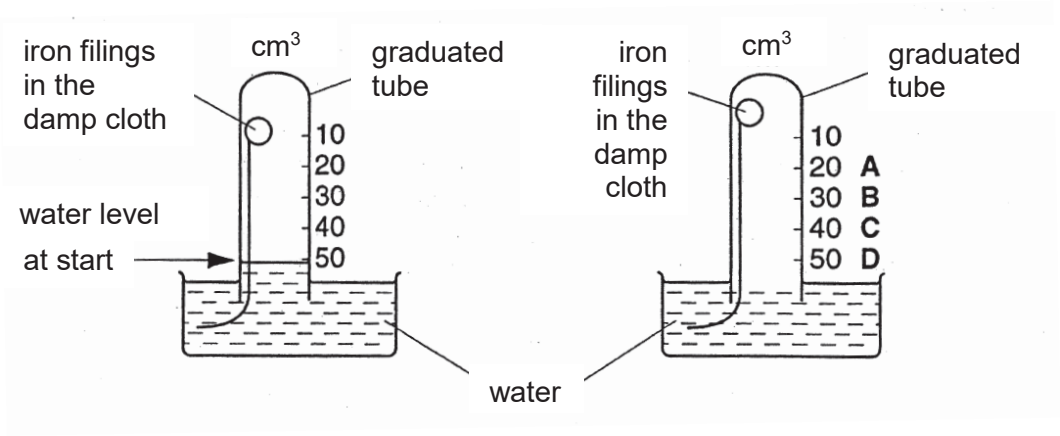
32 Iron filings are wrapped in a damp cloth and left to rust in the apparatus as shown.

Which letter indicates the water level when rusting has been completed?



33 The average temperatures of the Earth have been observed to be increasing very gradually.

Which of the following statements describe the environmental consequences of an increase in global warming?

1 depletion of the ozone layer
2 increase in the acidity of the soil, leading to poor cop output
3 increase in droughts and wildfires, and heavier rainfall
4 increase melting of glaciers and ice caps, leading to increase in sea levels

A 1 and 2 only
B 3 and 4 only
C 1, 3 and 4 only
D 2, 3 and 4 only

34 Anhydrous ammonia, also known as ‘the other hydrogen’, has been described as the closest thing to a perfect transportation fuel. Its combustion does not produce any environmental pollutants.

Which of the following are possible products obtained from the combustion of ammonia?

A nitrogen and hydrogen only
B nitrogen and water only
C nitrogen oxides and hydrogen only
D nitrogen oxides and water only

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35 Photosynthesis and respiration are important natural processes.

Which of the following statements is correct?

A Carbon dioxide is formed by the reaction of glucose with water during photosynthesis.
B Carbon dioxide is removed from the air by respiration.
C Glucose reacts with water to form oxygen during respiration.
D Photosynthesis produces glucose and oxygen.

36 Which of the following is the same for all the members of a homologous series?

A empirical formula
B general formula
C molecular formula
D physical properties

37 Which of the following alkenes can form an alcohol which can only have three structural isomers?

A butene
B ethene
C pentene
D propene

38 A mixture containing 1 mole of ethene and 4 moles of oxygen is ignited, in a sealed container at 100°C. The reaction is as shown below.

$$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(g)$$

What is the total number of moles of gas at the end of the reaction?

A 2
B 3
C 4
D 5

39 Four drops of Universal Indicator were added to a solution of glucose that has undergone fermentation.

Which of the following is observed?

A The Universal Indicator is decolourised.
B The Universal Indicator remains green.
C The Universal Indicator turns purple.
D The Universal Indicator turns red.

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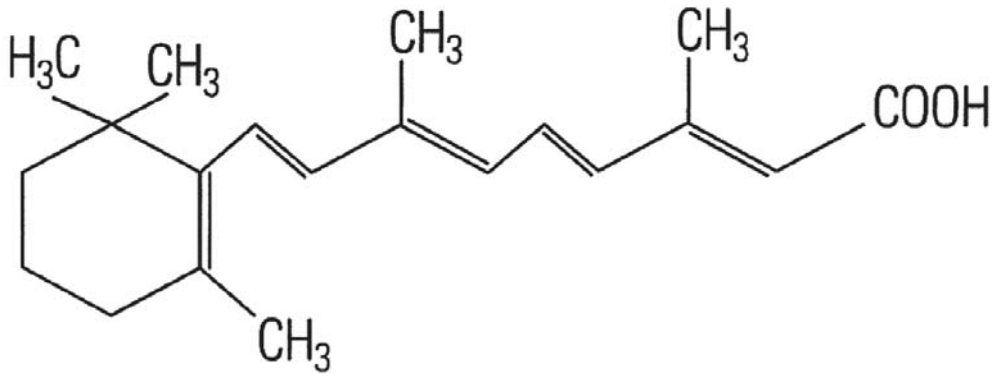
40 Vitamin A is an important vitamin required by humans to prevent problems such as night blindness. The structure of Vitamin A is as shown below.



Which of the following pairs of reagents will **not** react with Vitamin A?

A aqueous bromine, sodium carbonate
B ethanol, sodium hydroxide
C hydrogen gas with nickel, chlorine gas in UV light
D magnesium, steam

END OF PAPER

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The Periodic Table of Elements

Group

I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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SENG KANG SECONDARY SCHOOL
PRELIMINARY EXAMINATION

CHEMISTRY (REVISED) 6092/02

Secondary 4 Express

04 September 2019

Paper 2 Theory

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer all **three** questions, the last question is in the form either/or.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 22.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Section A	**/ 50**
1	/ 5
2	/ 6
3	/ 7
4	/ 9
5	/ 6
6	/ 5
7	/ 12
Section B	**/ 30**
8	/ 12
9	/ 8
10E	/ 10
10OR	/ 10
Total	**/ 80**
Total %	**/ 100**

Parent's / Guardian's Signature: ……...

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Do not turn over the page until you are told to do so.

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Section A

Answer **all** the questions in this section in the spaces provided.

1 The structures of some substances containing nitrogen are shown in Fig. 1.1.

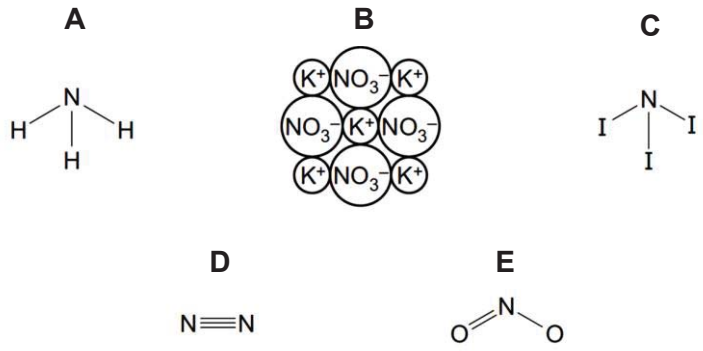

Fig. 1.1

Answer the following questions by choosing from the structures **A**, **B**, **C**, **D** or **E**.
You can use each structure once, more than once or not at all.

Which structure represents

(a) an acidic oxide,

..... [1]

(b) a salt,

..... [1]

(c) a gas which turns damp red litmus paper blue,

..... [1]

(d) a compound which is formed under conditions of high temperature and pressure in car engines,

..... [1]

(e) a molecule containing halogen atoms?

..... [1]

[Total: 5]

[Turn over

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2 Table 2.1 shows the **most common** oxidation states of some elements **A**, **B**, **C**, **D** and **E** in their compounds.

Table 2.1

element	most common oxidation states	metal or non-metal?
A	−2	
B	+2, +3, +4, +6, +7	
C	+1	non-metal
D	+3	
E	−1	

(a) Complete Table 2.1 by filling in the last column to show which elements are **metals** and which are **non-metals**. [1]

(b) Use the letters **A**, **B**, **C**, **D** and **E** to answer the following questions.

(i) Which element is most likely to be hydrogen?

……. [1]

(ii) Which element is most likely to be in Group VI?

……. [1]

(iii) Which element is most likely to form coloured compounds?

……. [1]

(c) No elements from Group 0 appear in Table 2.1.
Use the information in Table 2.1 to explain why this statement is true.

……

……

…… [2]

[Total: 6]

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3 Dilute ethanoic acid reacts with metal oxides.
Dilute hydrochloric acid also react with metal oxides.

(a) How are the reactions of the two acids with metal oxides similar?

.....

..... [1]

(b) The rate of reaction of dilute ethanoic acid with metal oxides is observed to be slower than that of dilute hydrochloric acid at the same concentration and temperature.

With your knowledge of Collision Theory, explain the observation above.

.....

.....

.....

..... [2]

(c) Table 3.1 shows some information on the mixing of three different sets of solutions.

Table 3.1

solutions that are mixed	**formula of precipitate**	**colour of precipitate**
aqueous copper(II) sulfate and aqueous sodium hydroxide		
aqueous potassium iodide and aqueous silver nitrate		
dilute sulfuric acid and aqueous barium chloride		

Complete Table 3.1. [4]

[Total: 7]

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4 Chromium is commonly used to electroplate steel objects.
Fig. 4.1 shows how this could be done.

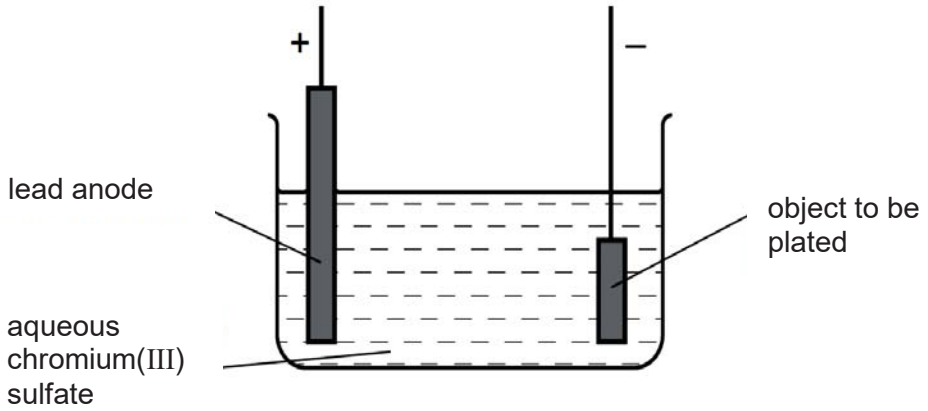

Fig. 4.1

(a) Give **two** reasons why steel objects are plated with chromium.

1 ……..

2 …….. [2]

(b) Deduce the chemical formula for chromium(III) sulfate.

…… [1]

(c) Construct the ionic half-equation, with state symbols, for the reaction at the cathode.

…… [2]

(d) Effervescence is observed at the anode.
Identify the gas that is produced at the anode, and state the chemical test that can be carried out to confirm the identity of the gas.

name of gas: …… [1]

chemical test: ……..

…… [1]

[Turn over

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(e) During electroplating, it is necessary to add more aqueous chromium(III) sulfate but during copper plating using a copper anode, it is **not** necessary to add more aqueous copper(II) sulfate.

Explain the difference.

……

……

…… [2]

[Total: 9 marks]

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5 The Ostwald Process is a chemical process for manufacturing nitric acid, HNO_3. It is done via two stages.

The following chemical equation illustrates the chemical reaction that occurs in Stage One.

Stage One: $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -905.2$ kJ

(a) Draw an energy profile diagram for the reaction in Stage One, and you are to indicate the enthalpy change and activation energy clearly.

[2]

(b) In terms of oxidation states, explain why Stage One is a redox reaction.

……

……

…… [2]

(c) Stage Two consists of **two** steps.

Step 1: $2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

In **Step 2**, NO_2 that is produced in **Step 1** is absorbed by water readily to form dilute nitric acid as well as nitrogen monoxide, which is recycled to be used in **Step 1**.

(i) Construct a chemical equation to show the reaction in **Step 2**.

……..... [1]

(ii) Name a physical process that can be carried out to increase the concentration of the dilute nitric acid that is obtained at the end of Stage Two.

……. [1]

[Total: 6]

[Turn over

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6 Chlorine can react with many substances and has different uses in our daily life.

(a) **(i)** Name the products that are formed when aqueous chlorine reacts with aqueous potassium bromide.

……. [1]

(ii) State **one** observation that you can **see** from the reaction in **(a)(i)**.

……. [1]

(b) An oxide of chlorine was analysed. A 0.366 g sample was found to contain 0.224 g of oxygen.

Calculate the empirical formula of this oxide.

empirical formula of this oxide is ……... [3]

[Total: 5]

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7 A kiln is a special kind of oven for firing things like pottery and bricks.
Fig. 7.1 shows a rotary lime kiln used to make lime from limestone. The chemical name for limestone is calcium carbonate. Limestone is fed in at the top of the kiln and lime comes out at the bottom.

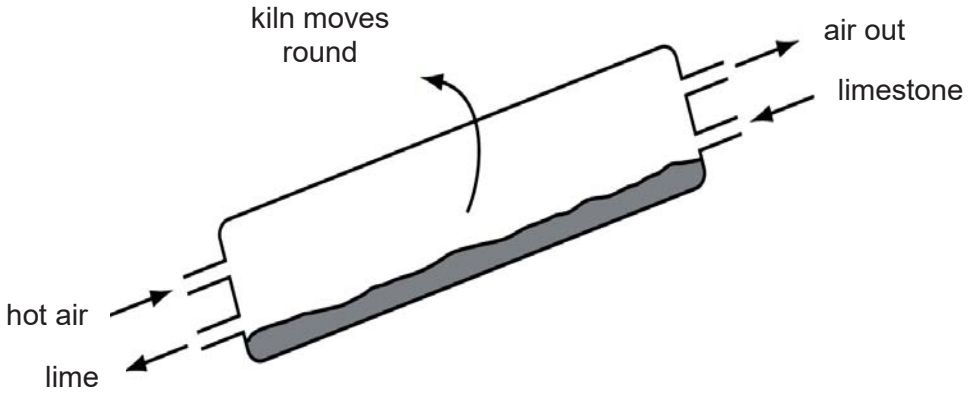

Fig. 7.1

(a) State the chemical name for lime.

..... [1]

(b) State the name of the type of chemical reaction that takes place in the rotary kiln.

..... [1]

(c) Suggest why the air coming out of the kiln has a greater percentage of carbon dioxide than the air entering the kiln.

.....

..... [1]

(d) State **one** use for lime.

..... [1]

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(e) A student compared the rates of reaction of three metal carbonates. She measured the volume of gas released using the apparatus shown in Fig. 7.2.

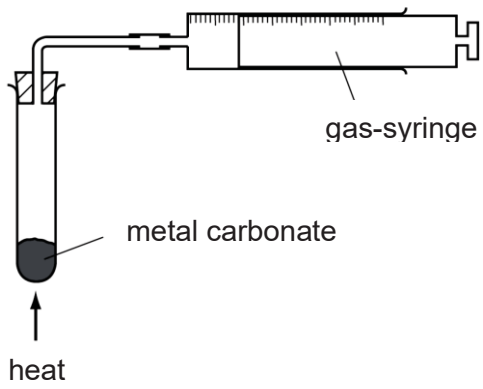

Fig. 7.2

State **one** thing that must be kept constant if the rates of the three reactions are to be compared in a fair way.

..... [1]

(f) The graph in Fig. 7.3 shows the volumes of carbon dioxide released when the three metal carbonates were heated.

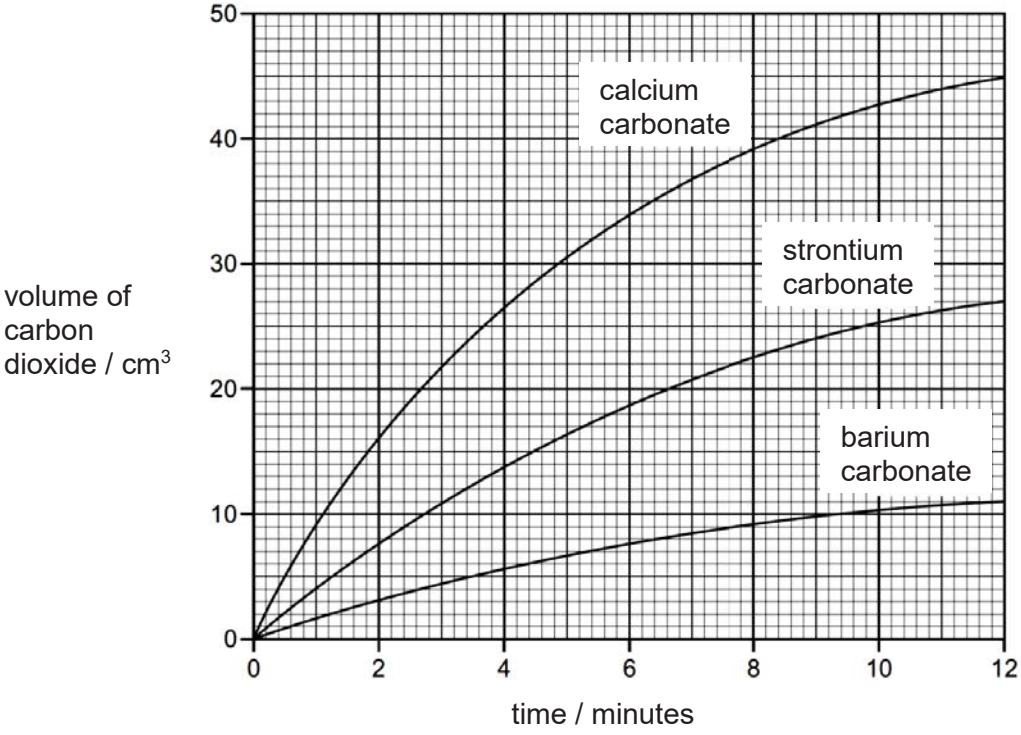

Fig. 7.3

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(f) **(i)** With reference to Fig. 7.3, which carbonate produced carbon dioxide at the highest rate?

……. [1]

(ii) What volume of carbon dioxide was produced by strontium carbonate in twelve minutes? You need to **indicate clearly** on Fig. 7.3 how you obtained the answer.

……. [1]

(iii) How do the rates of the reactions of these three metal carbonates relate to the position of calcium, strontium and barium in the Periodic Table?

…….

…….

……. [2]

(g) Describe how hydrochloric acid and limewater can be used to show that carbonate ions are present in calcium carbonate.

……

……

……

…… [3]

[Total: 12]

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Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

8 Mass spectrometry is an important technique which can identify the amount and type of chemicals present in a sample by using a machine called a mass spectrometer. In general, the two quantities that can be measured are the **mass/charge ratio (m/z)** and the **relative abundance** of particles in the sample.

Mass/charge (m/z) ratio: This is calculated by dividing the mass of an ion by its charge. For example, a sodium-23 ion, $^{23}_{11}Na^{+}$, would have a m/z value of 23. , Hence, the m/z value of an ion with a charge of 1+ is essentially its relative mass.

Relative abundance: This refers to the percentage of a particular isotope which occurs in nature. For example, in a sample of chlorine, the relative abundance of chlorine-35 is 75% and chlorine-37 is 25%.

The following steps show how mass spectrometry is done.

Step 1: Ionisation – the sample is vapourised. Energy is then used to knock off one or more electrons from atoms or molecules in the sample, changing them into positive ions. If enough energy is supplied, some bonds of the molecules are broken, and smaller ions are formed.

Step 2: Acceleration – the ions formed from **Step 1** are accelerated through the spectrometer by the use of negatively-charged plates.

Step 3: Deflection and detection – the ions are deflected by a magnetic field and are detected electrically.

Step 4: Mass spectrum – the mass spectrometer records the m/z value and relative abundance of all ions in the form of a histogram, called a mass spectrum.

Fig. 8.1 shows the mass spectrum of a pure sample of lithium.

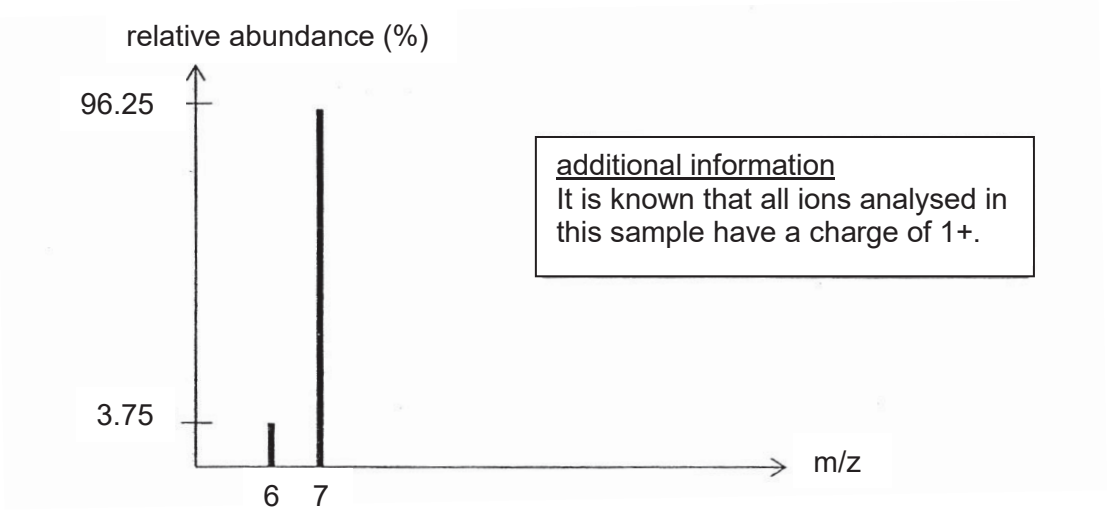

Fig. 8.1

[Turn over

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Fig. 8.2 shows the mass spectrum of a pure sample of chlorine.

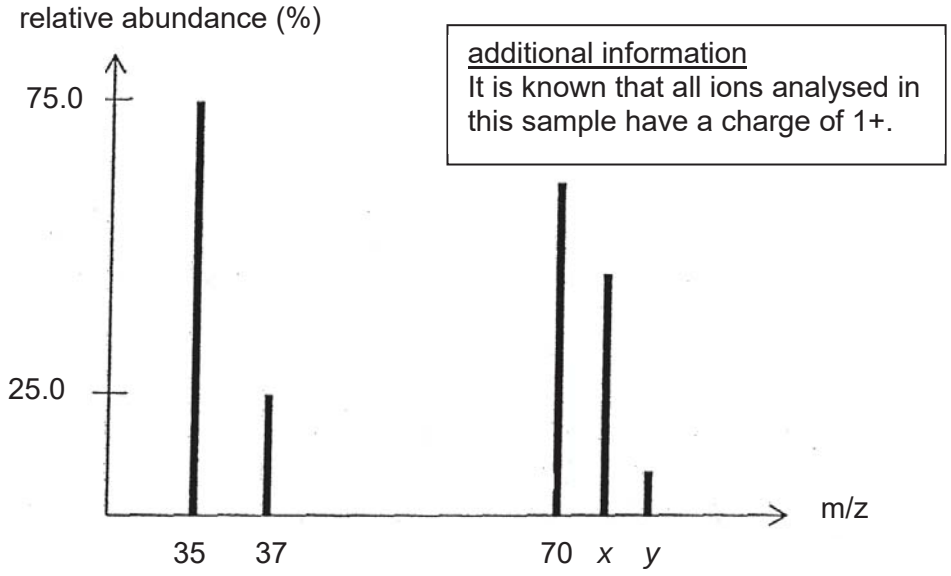

Fig. 8.2

Fig. 8.3 shows the mass spectrum of a pure sample of an unknown hydrocarbon.

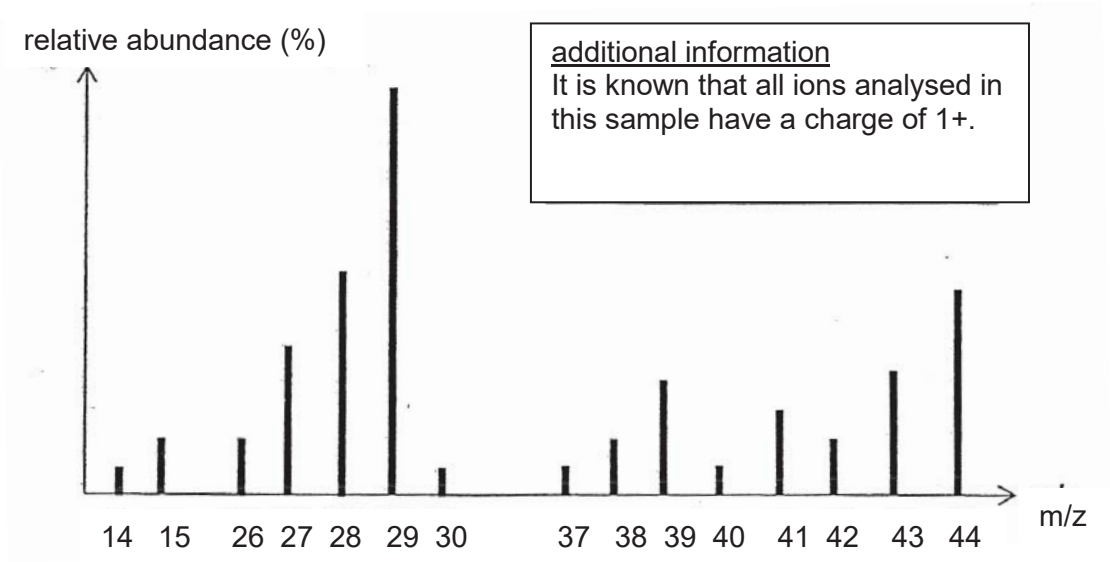

Fig. 8.3

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(a) **(i)** Explain how the data in Fig. 8.1 shows that there are two isotopes of lithium.

……

……

…… [2]

(ii) With appropriate calculation, show that the average relative atomic mass of lithium is 6.96, correct to 3 significant figures.

[1]

(b) **(i)** With reference to Fig. 8.2, calculate the values of *x* and *y*.

[2]

(ii) Chlorine-35 and chlorine-37 are the only two known isotopes of chlorine. Use the data in Fig. 8.2 to suggest why there were three additional peaks of 70, *x* and *y* on the mass spectrum of chlorine.

……

……

…… [2]

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(c) **(i)** A student comments that the unknown hydrocarbon is propane.

Explain how the data in Fig. 8.3 shows that this is true.

…….

…….

…….

……. [2]

(ii) Suggest the formula of the **ion** which has a m/z value of 14.

……. [1]

(iii) Another mass spectrometry analysis was carried out on a sample of butane.

Suggest how the results of the mass spectrum of butane would differ from that of propane.

…….

…….

…….

……. [2]

[Total: 12]

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9 Besides its use in food products, vinegar is also commonly used as a household cleaner. The chemical name of vinegar is ethanoic acid.

(a) Name the elements that are present in ethanoic acid.

…… [1]

(b) Showing only the outermost electrons, draw a 'dot-and-cross' diagram of ethanoic acid.

[2]

(c) Will ethanoic acid have a high or low boiling point?
With reference to your knowledge of chemical bonding, give a reason for your answer.

……

……

…… [2]

(d) **(i)** Name the **two** products that are formed when magnesium reacts with ethanoic acid.

……... [1]

(ii) Construct a chemical equation, with state symbols, for the reaction of magnesium with ethanoic acid.

……. [2]

[Total: 8]

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EITHER

10 Table 10.1 shows some information on four organic compounds.

Table 10.1

compound	molecular formula	Does it decolourise aqueous bromine?	effect on blue litmus paper
A	C_2F_4	yes	remains blue
B	$C_3H_6O_2$	no	turns red
C	$C_3H_6O_2$	yes	remains blue
D	$HO_2C\text{-}C_2H_4\text{-}CO_2H$	no	turns red

(a) **(i)** Compound **A** can be polymerised to make poly(tetrafluoroethylene) also known as poly(tetrafluoroethene). It is also commonly known as PTFE.

Name the type of polymerisation that is present in PTFE.

……. [1]

(ii) Showing **two** repeat units, draw the displayed formula of PTFE.

[1]

(iii) There are high and low grades of PTFE.
Molecules of high-grade PTFE typically have a relative molecular mass of 1.2×10^6.

By showing your working clearly, calculate how many repeat units are present in a typical molecule of high-grade PTFE.

[1]

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(iv) Low-grade PTFE molecules typically have a relative molecular mass of 1.4×10^4.

Explain why low-grade PTFE has a lower melting point than high-grade PTFE.

…….

……. [1]

(v) Describe and explain a pollution problem caused by getting rid of substances made of PTFE.

…….

…….

……. [2]

(b) Compound **B** can react with another organic compound to form ethyl propanoate.

(i) Draw the full structural formula of the organic compound which can react with compound **B** to form ethyl propanoate.

[1]

(ii) Draw the full structural formula of ethyl propanoate.

[1]

(c) Compound **C** can be polymerised with compound **D**.
During this polymerisation process, small molecules of water are eliminated.

Showing **two** repeat units, draw the structure of the polymer that is formed when compound **C** is polymerised with compound **D**.

[2]

[Total: 10]

[Turn over

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OR

10 Iron is produced in the blast furnace using the ore, haematite (melting point 1566°C), as one of the raw materials.

Titanium is produced from the ore, rutile. The chemical name for rutile is titanium dioxide (melting point 1843°C). Rutile cannot be reduced by coke and hence, it requires a different method of extraction.

Fig. 10.1 shows a quick summary of the extraction methods for iron and titanium.

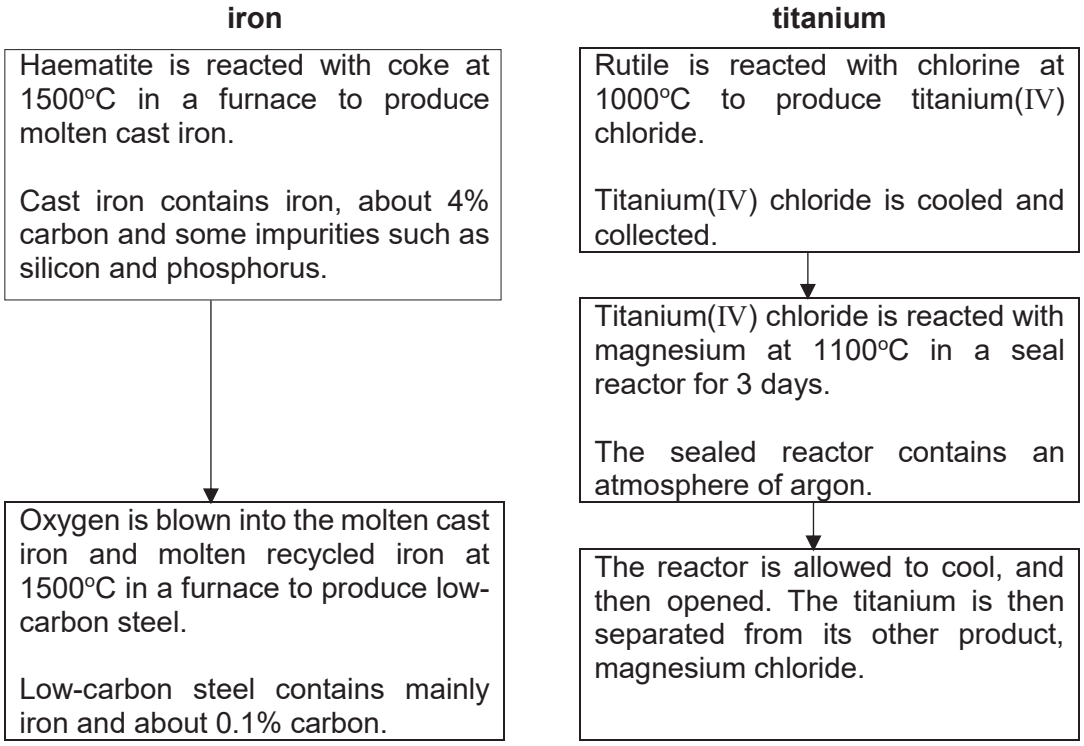

Fig. 10.1

Titanium reactors produce about 1 tonne of the metal per day.
Iron blast furnace produce about 20 000 tonnes of the metal per hour.

(a) Explain why the production of low-carbon steel uses oxygen but the production of titanium requires 'an atmosphere of argon'.

.....

.....

.....

.....

..... [3]

[Turn over

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(b) The melting point of haematite is higher than the temperature in the blast furnace.

(i) What is the chemical name for haematite?

……. [1]

(ii) Explain why haematite could remain in the molten state in the blast furnace.

…….

……. [1]

(c) There is less titanium than iron in the Earth's crust.

Other than titanium's scarcity, use the information to explain why titanium costs much more than iron.

……

……

……

……

…… [2]

(d) Suggest why water is used to flush the titanium at the last stage.

……

…… [1]

(e) Suggest the position of titanium in the Reactivity Series of Metals.
Explain your answer.

……

……

…… [2]

[Total: 10]

[Turn over

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The Periodic Table of Elements

Group

I	II											III	IV	V	VI	VII	0
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium -	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57 – 71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89 – 103 actinoids	104 Rf Rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

lume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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