Name: …… **(** **)**

ASSUMPTION ENGLISH SCHOOL
PRELIMINARY EXAMINATION 2019

CHEMISTRY
6092 / 01

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LEVEL: Sec 4 Express **DATE:** 3 September 2019

CLASS: Sec 4/2 **DURATION:** 1 hour

Additional materials provided: 1 sheet of OAS paper

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page and on the OAS paper.
Shade your index number on the OAS paper.

PAPER 1
MULTIPLE CHOICE QUESTIONS (40 marks)
There are 40 questions in this section.
Answer **all** questions.
For each question, there are four possible answers A, B, C and D.

Choose the correct answer and record your choice in soft or 2B pencil on the OAS paper provided.
DO NOT fold or bend the OAS paper.

For Examiner's use:	
Paper 1	/ 40

A copy of the Periodic Table is printed on page 19.

At the end of the examination, hand in your OAS paper and question booklet separately.

This Question Paper consists of 19 printed pages including this page.

Multiple Choice Questions (40 marks)

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There are **forty** questions in this section. 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 on the OAS in soft pencil.

1 Hydrogen sulfide, H_2S, is a colourless and poisonous gas which has an odour similar to that of rotten eggs. The melting point of hydrogen sulfide is –82 °C and the boiling point is –60 °C.

Which statement **correctly** describes the particles of hydrogen sulfide at –75 °C?

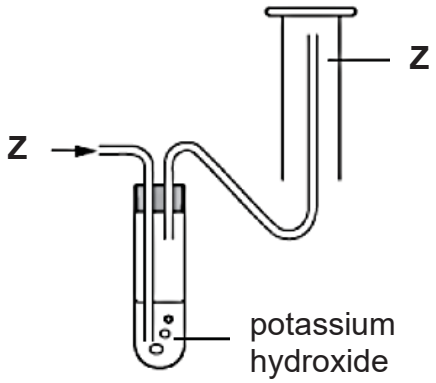
A closely packed, moving freely

B closely packed, vibrating slightly

C far apart, moving freely

D far apart, vibrating slightly

2 The following diagram shows a method to collect a sample of gas **Z**.



Which information can be deduced about gas **Z**?

1 **Z** is acidic.
2 **Z** is insoluble in water.
3 **Z** is less dense than air.

A 1 and 2

B 1, 2 and 3

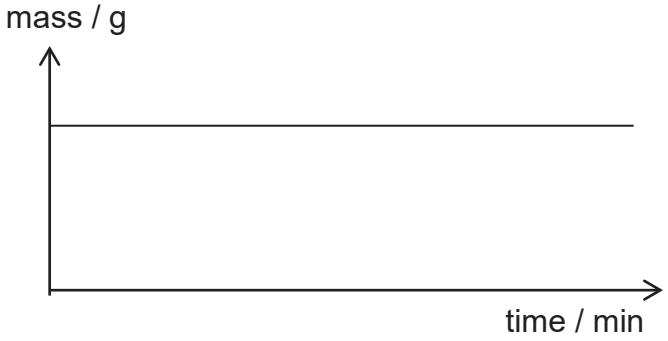
C 3 only

D none of the above

3 Two solutions were mixed in a beaker and the mass of the beaker and contents was then

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recorded at various times. The graph shows the results.



What could the two solutions be?

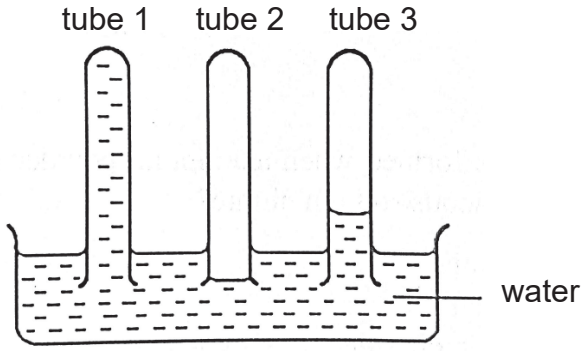
A aqueous sodium hydroxide and warm aqueous ammonium chloride

B aqueous silver carbonate and aqueous dilute hydrochloric acid

C dilute hydrochloric acid and aqueous potassium hydroxide

D dilute nitric acid and magnesium

4 Three dry test-tubes were filled with different gases of equal volume and placed in a trough of water. After a short time, the water had risen in two of the tubes as shown in the diagram.



Which gases could the tubes have contained?

	tube 1	tube 2	tube 3
A	ammonia	carbon dioxide	hydrogen
B	ammonia	hydrogen	carbon dioxide
C	carbon dioxide	hydrogen	ammonia
D	hydrogen	ammonia	carbon dioxide

5 The table below shows the information of some pure substances.

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Which of the underlined substances has been wrongly classified as an element, mixture or compound?

	Property	classification
A	White solid melts over 56 – 58 °C.	mixture
B	Green powder on heating leaves black residue and a colourless gas is evolved.	compound
C	Black powder burns in air forming a colourless gas as the only product.	element
D	Colourless substance produces two colourless gases when an electric current is passed through it.	mixture

6 In an experiment, the boiling point of a substance P was found to be 83 °C, the same as cyclohexene. To check its identity, the experiment was repeated by using one part of the substance P mixed with two parts of pure cyclohexene. The boiling point of the mixture was found to be 90 °C.

What can be deduced from these experiments?

A P is a mixture.

B P is not cyclohexene.

C P is pure cyclohexene.

D P may contain cyclohexene.

7 An element X exists as 2 kinds of isotopes X-55 and X-65. Given that its relative atomic mass is 59, which is the correct relative abundance of X-55 and X-65?

	X-55	X-65
A	25 %	75 %
B	75 %	25 %
C	40 %	60 %
D	60 %	40 %

8 Oxygen consists of two isotopes, oxygen-16 and oxygen-18.

Which statement correctly describes the two isotopes of oxygen?

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A Both oxygen-16 and oxygen-18 have the same relative atomic mass.

B Both oxygen-16 and oxygen-18 form ions with a charge of -2.

C Oxygen-16 has different chemical properties from oxygen-18.

D Oxygen-16 has electronic configuration of 2.8.6 while oxygen-18 has an electronic configuration of 2.8.8.

9 Element X is found in the Periodic Table with atomic number **p**. It forms an ionic oxide, X_2O. Element Y has an atomic number of **p+3**.

What is the formula of the oxide of Y?

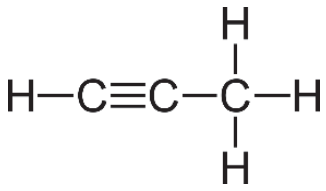
A YO

B YO_2

C Y_2O

D Y_2O_3

10 The diagram below shows the structural formula of an organic molecule.



What is the total number of shared electrons and number of electrons not involved in bonding?

	number of shared electrons	number of electrons not involved in bonding
A	12	2
B	12	6
C	16	2
D	16	6

11 Two isotopes of chlorine are ^{35}Cl and ^{37}Cl.

Using these isotopes, how many different relative molecular masses are possible for the compound with molecular formula CH_3Cl_3?

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A 2

B 3

C 4

D 5

12 The equation below shows the reaction between element X and dilute sulfuric acid.

$$X\,(s) + H_2SO_4\,(aq) \rightarrow XSO_4\,(aq) + H_2\,(g)$$

Which particles are responsible for conducting electricity in dilute sulfuric acid and compound XSO_4?

	H_2SO_4	XSO_4
A	electrons	positive ions and negative ions
B	electrons	electrons
C	positive ions and electrons	electrons
D	positive ions and negative ions	positive ions and negative ions

13 Which of the following has 7.2×10^{23} atoms?

A 0.2 mol of magnesium metal

B 0.3 mol of ammonia gas

C 3.0 mol of carbon dioxide gas

D 4.0 mol of hydrogen chloride

14 Bones contain a complex mixture of calcium salts, protein and other material. When a bone is strongly heated in air, the only residue is calcium oxide.

From a sample of 50 g of bone, 14 g of calcium oxide were obtained.

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What is the percentage by mass of calcium in the bone?

A 10.0 %

B 14.0 %

C 20.0 %

D 23.3 %

15 0.2 moles of XSO_4 combines with 21.6 g of water to form the hydrated salt of formula $XSO_4.nH_2O$.

What is the value of n?

A 3

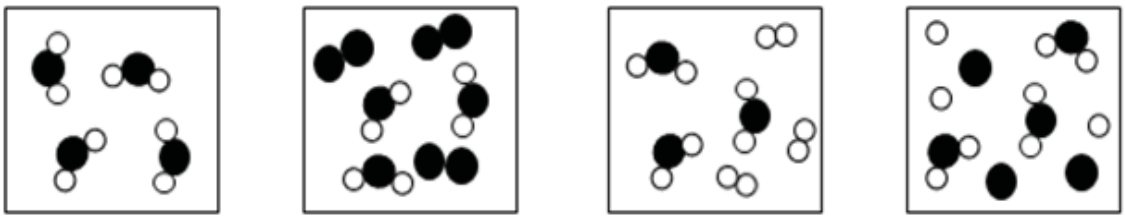
B 6

C 9

D 12

16 100 cm^3 of hydrogen is mixed and burnt in 100 cm^3 of oxygen.

Which diagram represents the particles that remain in the reaction vessel?



A B C D

17 When 42.0 g of sodium hydrogen carbonate, $NaHCO_3$ (M_r = 84), was strongly heated, 3.00 dm^3 of carbon dioxide gas was released.

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

What was the percentage yield of carbon dioxide?

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[All volumes are measured at room temperature and pressure.]

A 25 %

B 50 %

C 75 %

D 80 %

18 The table gives information about three indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
thymol blue	red	3	yellow
congo red	blue	5	red
phenolphthalein	colourless	10	red

Which colours would be obtained when each indicator was added separately to pure water?

	thymol blue	congo red	phenolphthalein
A	red	blue	red
B	yellow	blue	colourless
C	yellow	blue	red
D	yellow	red	colourless

19 The dissociation constant for an acid indicates the extent to which it dissociates into ions. The higher the dissociation constant, the stronger the acid.

The dissociation constant for some acids are given below along with two possibly correct statements.

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acid	dissociation constant
methanoic acid	1.80×10^{-4}
ethanoic acid	1.75×10^{-5}
propanoic acid	1.34×10^{-5}
bromoethanoic acid	1.30×10^{-3}

Statement 1: Increasing the length of the carbon chain makes the acid stronger.

Statement 2: Replacing a hydrogen by a bromine in ethanoic acid makes the acid stronger.

Based on the data above, which statement(s) is / are correct?

A both statements

B neither statement

C statement 1 only

D statement 2 only

20 Three elements X, Y and Z belong to the same period in the Periodic Table. The properties of their oxides are given below.

oxide of X:	soluble in both nitric acid and aqueous sodium hydroxide
oxide of Y:	insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid
oxide of Z:	changes acidified potassium manganate(VII) from purple to colourless

Based on the statements above, arrange X, Y and Z in order of <u>decreasing</u> atomic numbers in the Periodic Table.

A Y, X, Z

B X, Y, Z

C Z, Y, X

D Z, X, Y

21 Which solution contains the greatest concentration of hydrogen ions?

A 1 mol/dm^3 phosphoric(V) acid, H_3PO_4

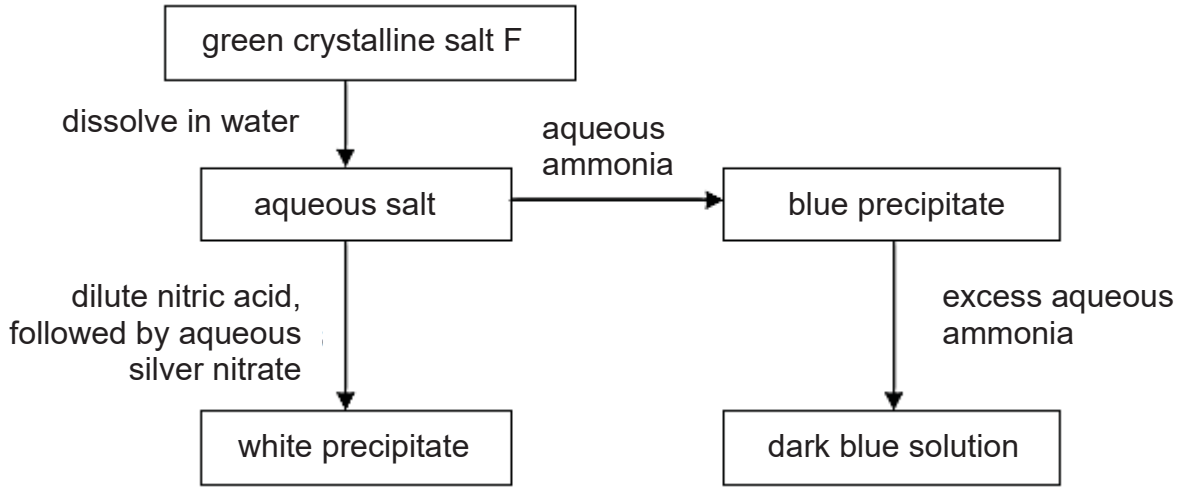
B 2 mol/dm^3 sulfuric acid, H_2SO_4

C 3 mol/dm^3 hydrochloric acid, HC*l*

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D 3 mol/dm^3 ethanoic acid, CH_3COOH

22 The scheme below shows some reactions of salt F.



What is the identity of F?

A copper(II) chloride

B copper(II) iodide

C iron(II) chloride

D iron(II) iodide

23 A salt has the chemical formula $(NH_4)_2Fe(SO_4)_2.12H_2O$.

Excess aqueous sodium hydroxide was added slowly, with shaking to a hot solution of the salt in a boiling tube until there is no further reaction. The boiling tube was then left to stand for some time.

Which observation would **not** be made?

A A green precipitate was produced.

B A pungent gas which turned damp red litmus blue was produced.

C On standing, the precipitate turned brown.

D The precipitate dissolved in excess sodium hydroxide.

24 When testing for a sulfate ion using barium nitrate, the solution must be acidified with nitric acid.

What is the purpose of the nitric acid?

A to act as a catalyst

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B to adjust the pH such that it is suitable for the reaction to occur

C to prevent precipitation of barium carbonate

D to reduce the sulfate ion

25 In which equations are the underlined substances acting as a reducing agent?

I $\underline{ZnO\ (s)} + CO\ (g) \rightarrow Zn\ (s) + CO_2\ (g)$

II $Cu\ (s) + \underline{N_2O\ (g)} \rightarrow CuO\ (s) + N_2\ (g)$

III $3\ CuO\ (s) + \underline{2\ NH_3\ (g)} \rightarrow 3\ Cu\ (s) + N_2\ (g) + 3\ H_2O\ (l)$

IV $\underline{H_2S\ (g)} + Cl_2\ (g) \rightarrow 2\ HCl\ (aq) + S\ (s)$

A **I** and **III**

B **I** and **IV**

C **II** and **III**

D **III** and **IV**

26 Three mixtures are made.

1 $C + Fe_2O_3$
2 $Cu + Fe_2O_3$
3 $Mg + Fe_2O_3$

The mixtures are heated strongly.

Which of the elements C, Cu and Mg are reactive enough to reduce the iron(III) oxide to iron?

A C and Cu only

B C and Mg only

C C, Cu and Mg

D Cu and Mg only

27 The table below refers to four metals and some of their compounds.

metal	action of dilute acid on metal	effect of hydrogen on heated oxide	action of metal on a solution of sulfate of J
G	hydrogen evolved	reduced	no reaction

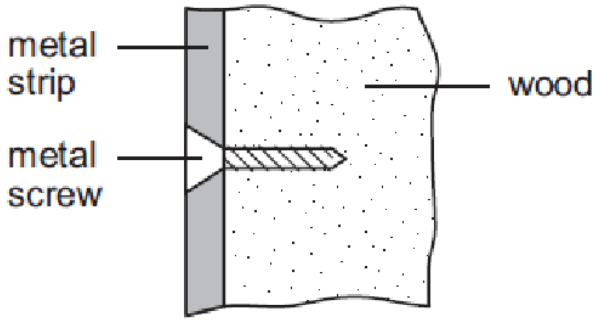
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H	no reaction	reduced	no reaction
I	hydrogen evolved	no reaction	J formed
J	hydrogen evolved	no reaction	no reaction

Which one of the following is the order of thermal stability of their carbonate towards heating?

	highest thermal stability		→	lowest thermal stability
A	H	G	J	I
B	H	J	G	I
C	I	J	G	H
D	I	G	J	H

28 An old railway carriage is being restored. Metal strips are secured on to the outside of the wooden carriage by means of screws. After a few weeks exposed to the wind and rain, the screws are heavily corroded but the metal strips are not.



Which two metals would give this result?

	screws	strips
A	aluminium	steel
B	copper	aluminium
C	copper	steel
D	steel	aluminium

29 An electric current was passed through molten calcium chloride, producing 2.00 g of calcium metal at the cathode.

What mass of chlorine was produced at the anode?

A 2.78 g

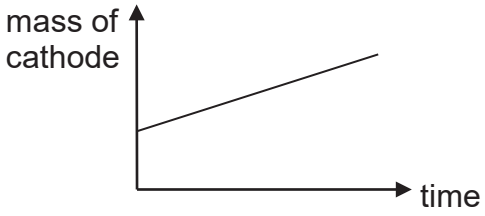
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B 3.55 g

C 4.00 g

D 8.50 g

30 An aqueous solution T is electrolysed. The current is constant and the cathode is weighed at regular intervals. The graph below is obtained when the mass of cathode is plotted against time.



Which of the following will **not** produce the graph above?

	cathode	anode	solution T
A	graphite	graphite	dilute sulfuric acid
B	graphite	graphite	copper(II) nitrate solution
C	copper	copper	copper(II) nitrate solution
D	graphite	silver	silver nitrate solution

31 The formation of liquid water from hydrogen and oxygen occurs in three stages.

Stage I $2\ H_2\ (g) + O_2\ (g) \rightarrow 4\ H\ (g) + 2\ O\ (g)$
Stage II $4\ H\ (g) + 2\ O\ (g) \rightarrow 2\ H_2O\ (g)$
Stage III $2\ H_2O\ (g) \rightarrow 2\ H_2O\ (l)$

Which stage(s) is / are endothermic?

A I only

B II only

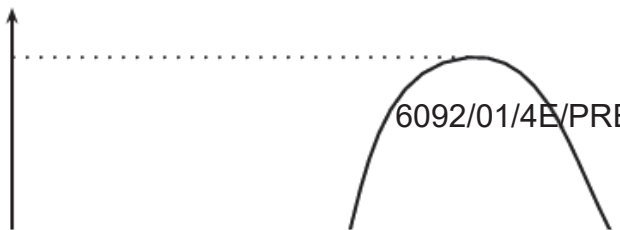
C III only

D I, II and III

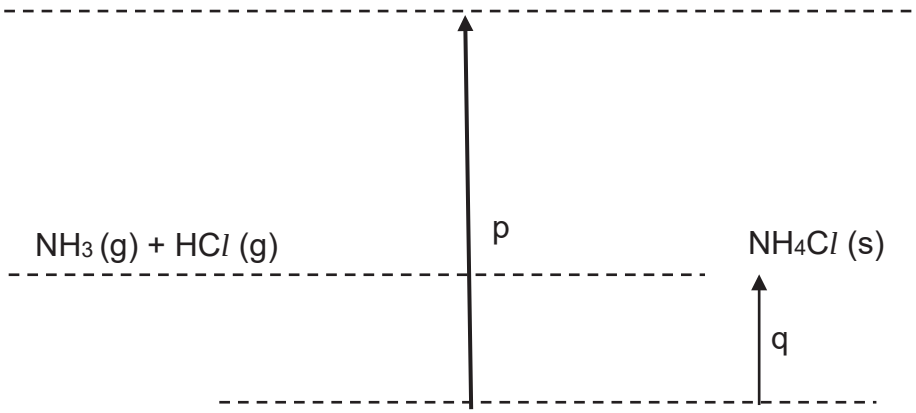
32 The equation and energy profile diagram for the reaction between ammonia and dilute hydrochloric acid are shown.

$$NH_3\ (g) + HCl\ (g) \rightleftharpoons NH_4Cl\ (s)$$

energy / kJ mol^{-1}



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progression of reaction

Which statement about the reaction is **incorrect**?

A The activation energy for the reverse reaction is p – q.

B The activation energy for the forward reaction is p.

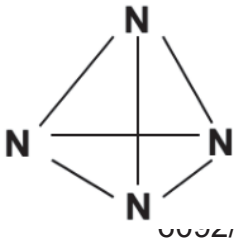
C The enthalpy change for the reverse reaction is p – q.

D The enthalpy change for the forward reaction is positive.

33 Nitrogen exists as the molecule N≡N. Nitrogen forms a molecule N_4 as shown below.

Chemical equation: $2\ N_2 \rightarrow N_4$

Structure of N_4:



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By considering the bonds formed and the bonds broken, what would be the value for the energy change, for the above reaction?

[Bond energies: N−N, 160 kJ/mol; N≡N, 994 kJ/mol]

A −1348 kJ

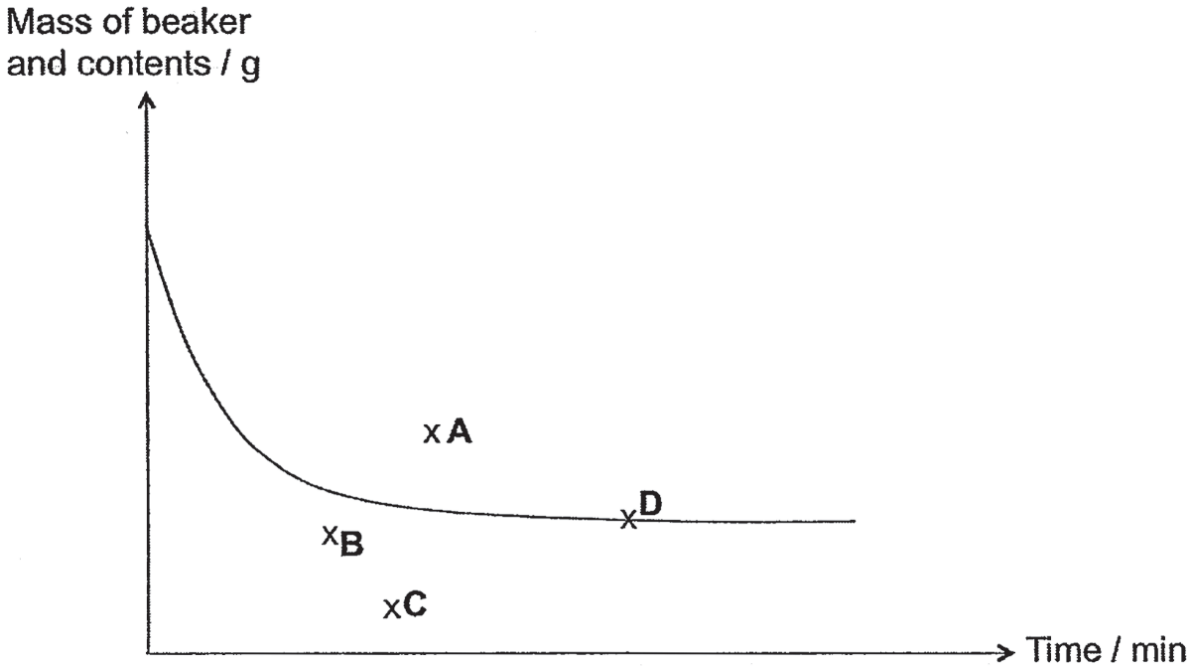
B +1028 kJ

C +1348 kJ

D +2628 kJ

34 In experiment 1, excess zinc carbonate was added to 100 cm^3 of 1.0 mol/dm^3 sulfuric acid in a beaker. The mass of the beaker and its contents were recorded at regular time intervals, and a graph was plotted as shown below.

In experiment 2, excess zinc carbonate was added to 100 cm^3 of 2.0 mol/dm^3 nitric acid in a beaker. At which of the points on the graph shown will the mass in experiment 2 reach a constant?



35 In the Haber process for the manufacture of ammonia, which statements are correct?

I The catalyst used is a transition metal.
II Unreacted nitrogen and hydrogen are circulated back into the system.
III Both reactants are obtained from the fractional distillation of liquefied air.
IV The reaction is never complete and yield achieved is only about 10 – 15%.

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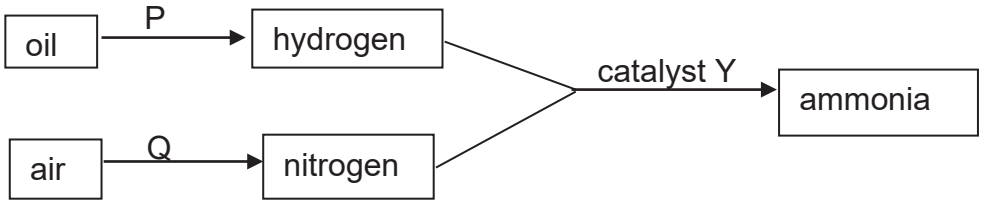
A I, II and III

B I, II and IV

C II, III and IV

D all of the above

36 The diagram shows the manufacture of ammonia using hydrogen and nitrogen in the presence of catalyst.



What are the processes P and Q and catalyst Y?

	process P	process Q	catalyst Y
A	cracking	fractional distillation	iron
B	cracking	fractional distillation	nickel
C	fractional distillation	fractional distillation	iron
D	fractional distillation	cracking	nickel

37 A sample of air along the Pan Island Expressway (PIE), where there is fast moving traffic, is collected and its composition is examined.

Which gas is least likely to be one of the components in the sample of air?

A carbon monoxide

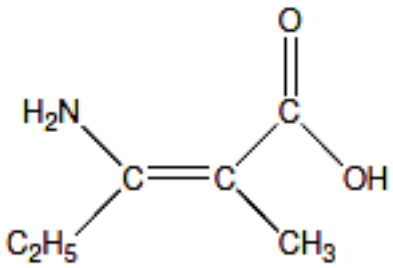
B nitrogen dioxide

C nitrogen monoxide

D sulfur dioxide

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38 Which statements about the organic molecule below are true?



1 It will undergo complete combustion to form carbon dioxide and water only.
2 It forms an alcohol in the presence of steam under high pressure and with the use of a suitable catalyst.
3 It can undergo both addition and condensation polymerisation.

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

39 How many moles of hydrogen chloride are formed when one mole of methane reacts with a large excess of chlorine in sunlight?

A 1

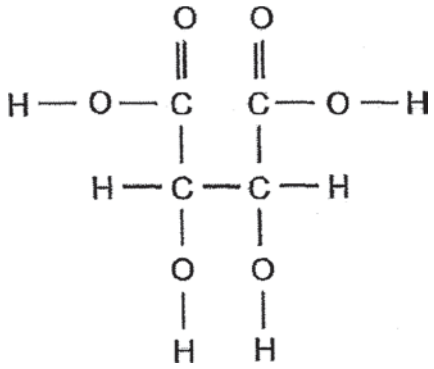
B 2

C 3

D 4

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40 The diagram below shows the structural formula of tartaric acid ($C_4H_6O_6$).



Which salt(s) could be formed upon reacting tartaric acid with potassium hydroxide?

1 $C_4H_5O_6K$
2 $C_4H_4O_6K_2$
3 $C_4H_3O_6K_3$
4 $C_4H_2O_6K_4$

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

– 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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LEVEL: Sec 4 Express **DATE:** 27 August 2019

CLASS: Sec 4/2 **DURATION:** 1 hour 45 minutes

Additional materials provided: Nil

INSTRUCTIONS TO CANDIDATES
Do not open this booklet until you are told to do so.
Write your NAME and INDEX NUMBER at the top of this page.

This paper consists of 2 sections.

SECTION A
SHORT STRUCTURED QUESTIONS (50 marks)
Answer **all** questions in the spaces provided on the question paper.

SECTION B
FREE RESPONSE QUESTIONS (30 marks)
Answer all **three** questions, the last question is in the form of an either / or and only one of the alternatives should be attempted. Write your answers in the spaces provided on the question paper.

For Examiner's use:	
Paper 1	**/** 40
Section A	**/** 50
Section B	**/** 30
Paper 2	**/** 80
Paper 3	**/** 40
Total	**/ 160**
100%	**/ 100**

A copy of the Periodic Table is printed on page 23.

This Question Paper consists of 23 printed pages including this page.

Section A – Short-Structured Questions (50 marks)

[Turn Over

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

1 The data in the table below describes two properties of some substances.
The letters are **not** the actual symbols of the elements in the Periodic Table.

substance	appearance at room temperature and pressure	products of burning in oxygen at 1 atm
A	black solid	carbon dioxide
B	colourless gas	water
C	colourless gas	(does not burn in oxygen)
D	yellow solid	sulfur dioxide
E	colourless liquid	carbon dioxide and water
F	silvery metal	$\mathbf{F}_2\mathrm{O}$

Use the letters **A**, **B**, **C**, **D**, **E** or **F** to answer the following questions. You may use the letters once, more than once or none at all.

(a) Which substance is most likely to be hydrogen?

……. [1]

(b) Which substance is most likely to be a compound?

……. [1]

(c) **(i)** Name another oxide that may be produced when substance **A** burns in oxygen.

……... [1]

(ii) State the nature of the oxide from **(c)(i)**.

……. [1]

(d) **(i)** Gas **C** is an element that does not burn in oxygen. Suggest the name of this substance **C**.

……... [1]

(ii) Explain your answer in **(d)(i)**.

……. [1]

(e) Predict the electrical conductivity of $\mathbf{F}_2\mathrm{O}$ in the solid state.

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With reference to its structure and bonding, explain why.

……

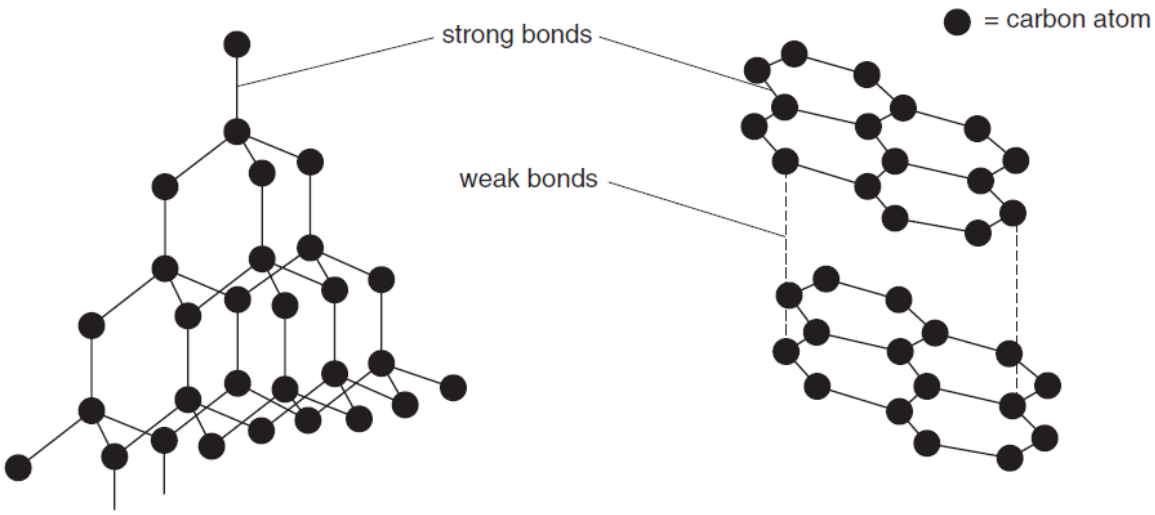
……

……

…… [2]

[Total: 8]

2 The structures of diamond and graphite are drawn below.



diamond graphite

(a) Diamond has a melting point of about 3700 °C and graphite has a melting point of about 3300 °C.

(i) In terms of structure and bonding, explain why diamond has a high melting point.

……

……

……

……

…… [2]

(ii) Suggest why the melting point of graphite is lower than that of

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diamond.

……...

……...

……... [1]

(b) When graphite is burnt in air, it produces carbon dioxide.

(i) Draw the electronic structure of carbon dioxide. Only the outer electrons are required.

[2]

(ii) In terms of structure and bonding, explain why graphite can conduct electricity.

……...

……...

……...

……... [2]

(iii) Describe how one can determine that the carbon dioxide obtained from the burning of graphite is pure.

test ……...

observation ……. [1]

[Total: 8]

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3 A pupil compared two solutions of monobasic acids, **HX** and **HY**, and obtained the following results.

	0.1 mol/dm^3 HX	**0.1 mol/dm^3 HY**
electrical conductivity/ mA	90	15
pH	1.0	3.5

(a) What can you deduce regarding the strength of the acids?
Explain your answer.

……

……

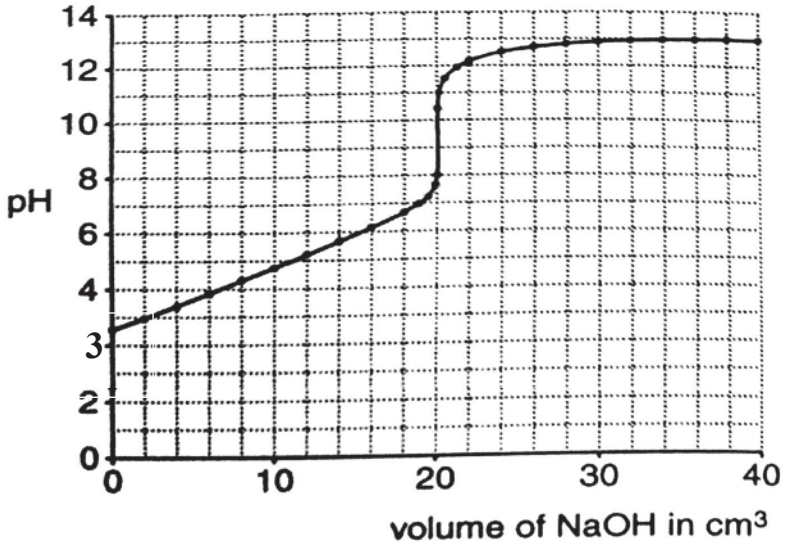
……

……

…… [3]

(b) A pH meter and a data logger are used to monitor the pH changes during a series of titrations. In each titration, the same concentration of sodium hydroxide solution is added from a burette into a solution of 20 cm^3 of **HX** and **HY** acid solutions. During the titrations, the pH does not change smoothly. The data logger gives a graph for the titration with **HY.**

Sketch the graph on the same axes below to show the change in pH between sodium hydroxide and **HX** solutions until the reaction stops. Clearly label the graph with **HX.**

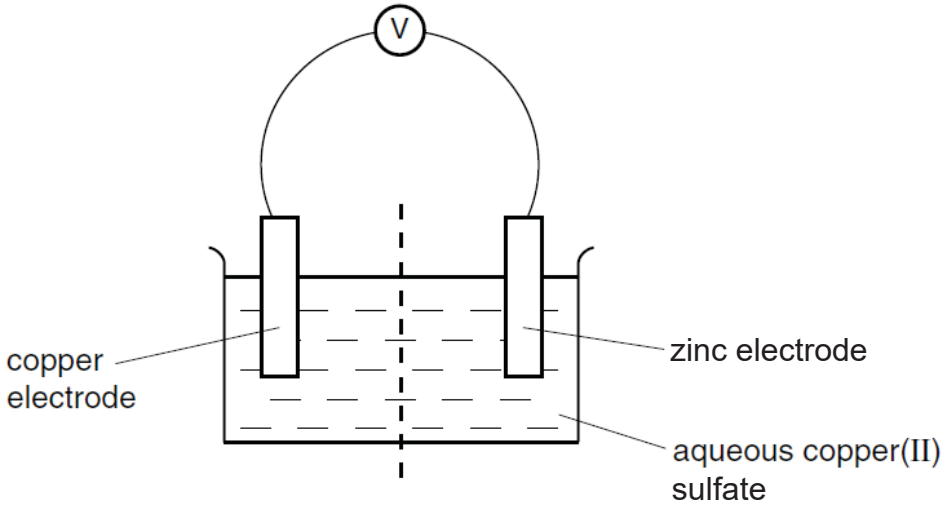


[1]

[Total: 4]

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4 This reaction can be used to generate electricity in a cell.



(a) Draw an arrow on the diagram to show the direction of the flow of electrons in the wire. [1]

(b) Write the ionic equation for the reaction at the copper electrode.

…… [1]

(c) The voltage of the cell was measured when the following metals replaced the zinc electrode.

copper iron silver zinc

Complete the table by entering the metals in the correct order.

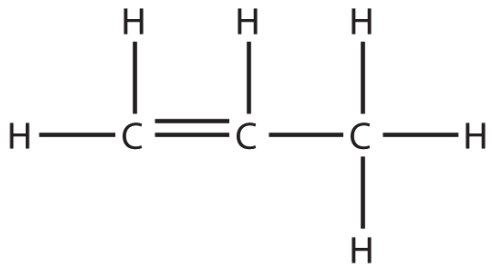
meter reading / V	*metal*
+1.10	
+0.78	
0.00	
–0.46	

[2]

[Total: 4]

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5 The diagrams below show the structure of propene.



(a) Calculate the mass of bromine liquid required to react with 1 g of propene.

mass of bromine liquid = …….. g [2]

(b) Propene can undergo addition polymerisation to form polymer X.
Draw the structure of the polymer X.

[1]

(c) A sample of polymer X was analysed and found to have an average relative molecular mass of 7350.

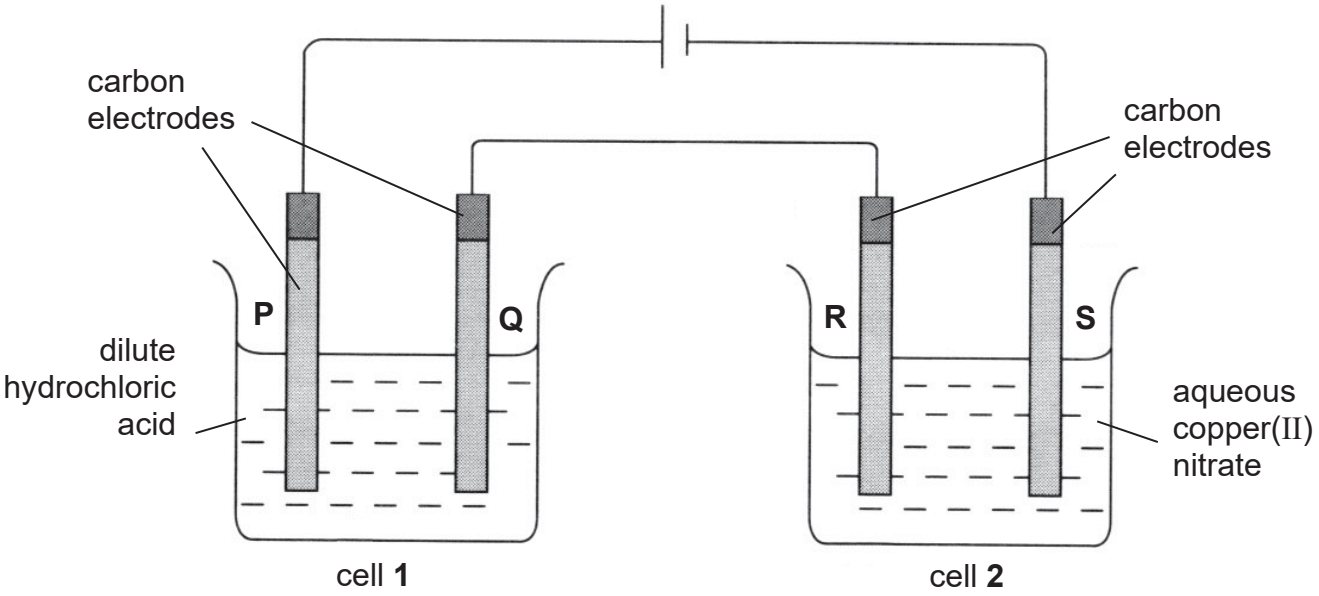
How many carbon atoms are present in an average chain?

number of carbon atoms = …….. [2]

[Total: 5]

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6 The following experiment was set up to study the electrolysis of dilute hydrochloric acid and aqueous copper(II) nitrate using carbon electrodes as shown in the diagram below.



(a) Write the half equations at electrodes **P** and **S**.

electrode **P** .....

electrode **S** ..... [2]

(b) With reference to the diagram, explain why there is a change in the pH of the electrolyte in cell **2** after some time.

.....

.....

.....

..... [2]

[Total: 4]

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7 Three methods for preparing salts are listed below:

method 1: precipitation
method 2: reacting excess metal with dilute acid
method 3: titration

(a) Place a tick (✓) in **one** box in each row to show the correct method to use to prepare each of the following salts.

salt	method 1	method 2	method 3
ammonium chloride			
lead(II) sulfate			
sodium sulfate			
zinc nitrate			

[2]

(b) Copper(II) chloride is a salt that cannot be prepared using any one of the three methods shown above.

(i) Explain why copper(II) chloride cannot be prepared by any one of the three methods shown above.

……...

……...

……...

……... [2]

(ii) Suggest an experimental procedure to prepare a dry sample of copper(II) chloride using suitable reagents commonly found in a laboratory.

……...

……...

……...

……...

……...

……... [3]

[Total: 7]

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8 Sulfur dioxide is used to manufacture sulfuric acid, by a three-stage process called the Contact Process. The first stage is to convert sulfur dioxide to sulfur trioxide. During this process, sulfur dioxide gas and sulfur trioxide gas are released to the environment.

$$2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g) \qquad \Delta H = -197\ kJ/mol$$

(a) The above reaction takes place at a moderate temperature of 450 °C. Suggest why this temperature is used in the Contact Process instead of a lower or higher temperature.

.....

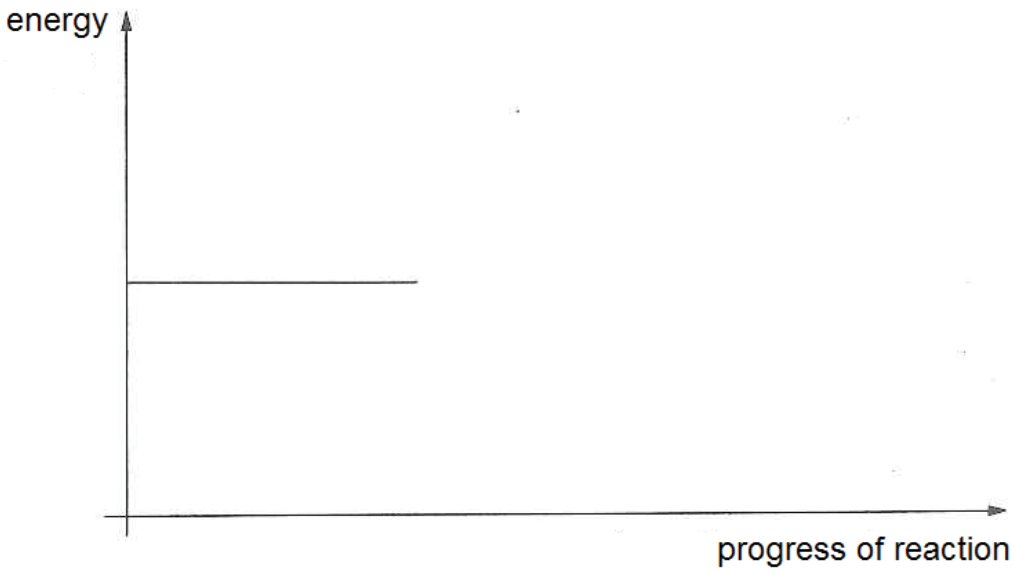
.....

..... [2]

(b) Complete the energy profile diagram for the forward reaction in the production of sulfur trioxide.

Your diagram should include

- the **formulae of the reactants and products** of the reaction,
- a label for **the activation energy of reaction**,
- a label for **the enthalpy change of reaction**.



[2]

(c) Using ideas about colliding particles, state and explain how the rate changes when the pressure is increased.

.....

.....

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…… [2]

(d) The product of the Contact Process is concentrated sulfuric acid (98%) with only 2% of the mass being water.

Explain why it is possible to transport sulfuric acid of such high concentration using steel tanks but not for dilute sulfuric acid.

……

……

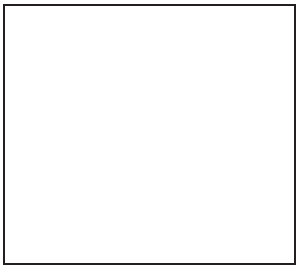
…… [2]

(e) Suggest a possible metal that can be used as a catalyst for this reaction, stating your reason clearly.

……

…… [1]

(f) Draw in the box below, the particulate diagram showing the particles of sulfur trioxide.



[1]

[Total: 10]

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SECTION B: FREE-RESPONSE QUESTIONS [30 MARKS]

Answer **all** the questions in the spaces provided. The last question is in the form of an EITHER / OR and only one of the alternatives should be attempted.

9 The Drive for Cleaner Emissions by John Uhrich

The air pollutants emitted by a car come from undesirable chemical reactions that occur during fuel combustion inside the engine. In the most common type of combustion reaction, gasoline or diesel, reacts with oxygen to form water and carbon dioxide. During this reaction, the chemical energy of the fuel is released and harnessed to run the engine.

$$C_xH_y + (x + \frac{y}{4})\ O_2 \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O$$

Petrol and diesel are both obtained by fractional distillation of crude oil. However, they differ in their composition. Diesel is a fraction of crude oil that is removed at a higher boiling point than petrol.

In petrol engines, oxygen (from the air) and fuel are designed to be almost exactly stoichiometrically balanced, so that, ideally, there is no excess of either reactant at the end of the reaction. Car manufacturers must ensure that the reactants are balanced as the reactants can have a large effect on the amount of pollution a car produces. For instance, the presence of too little oxygen can result in incomplete fuel combustion, which produces carbon monoxide and unburnt hydrocarbon, both of which are considered pollutants when present in the air at ground level. Also, nitrogen from the air is quite inert, but if too much oxygen is present (more than the stoichiometric amount) at high temperatures, the extra oxygen can react with the nitrogen to produce other pollutants, called nitrogen oxides.

To reduce the potentially harmful pollutants that are created as by-products of combustion, the exhaust passes through a catalytic converter, which converts carbon monoxide, unburnt hydrocarbons, and various nitrogen oxides into less-harmful chemical compounds before they are released into the air.

There are two kinds of catalytic converter – two-way catalytic converter and three-way catalytic converter.

A two-way catalytic converter has two simultaneous reactions:

a) Conversion of carbon monoxide to carbon dioxide

$$2\ CO + O_2 \rightarrow 2\ CO_2$$

b) Conversion of unburnt hydrocarbons to carbon dioxide and water

$$C_xH_y + (x + \frac{y}{4})\ O_2 \rightarrow x\ CO_2 + \frac{y}{2}\ H_2O$$

A three-way catalytic converter has three simultaneous reactions:

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a) Decomposition of nitrogen oxides to nitrogen and oxygen:

$$2\ NO_x \rightarrow x\ O_2 + N_2$$

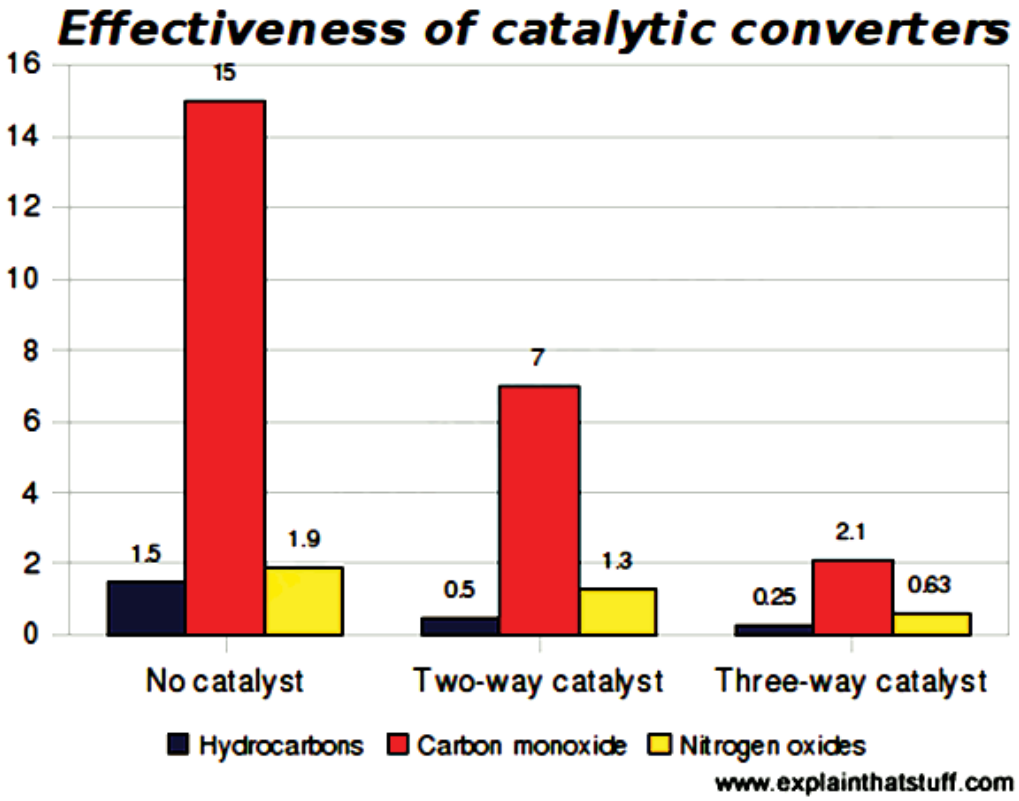
b) Conversion of carbon monoxide to carbon dioxide:

$$2\ CO + O_2 \rightarrow 2\ CO_2$$

c) Conversion of unburnt hydrocarbons to carbon dioxide and water:

$$C_xH_y + (x + \tfrac{y}{4})\ O_2 \rightarrow x\ CO_2 + \tfrac{y}{2}\ H_2O$$

The chart shows pollutants in grams per kilometre at 80,000 kilometres.



Sources: https://www.catalyticconverters.com/types/ , http://www.explainthatstuff.com/catalyticconverters.html

(a) Octane, C_8H_{18}, is a common hydrocarbon found in gasoline.

(i) Write a balanced chemical equation to show the complete combustion of octane.

..... [1]

(ii) Calculate the minimum volume of oxygen gas required to

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completely react with 3 moles of octane at room temperature and pressure.

volume of oxygen gas = …….. dm^3 [2]

(iii) Using the chemical equation in **(a)(i)**, show that the combustion of octane is a redox reaction.

……

……

……

…… [2]

(b) The article says "Petrol and diesel are both obtained by fractional distillation of crude oil. However, they differ in their composition. Diesel is a fraction of crude oil that is removed at a higher boiling point than petrol."

Based on the statement, what can you infer about the difference in the number of carbon atoms in petrol and diesel fraction?

How does the number of carbon atoms have effect on the boiling point?

Explain your reasoning.

……...

……...

……...

……...

……... [3]

(c) A car manufacturer has plans to install a catalytic converter in the

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manufactured car. Which of the two catalytic converters would you recommend the manufacturer to install?

Explain your reasoning.

……

……

…… [1]

(d) What additional environmental problem does a two-way catalytic converter cause?

……

…… [1]

[Total: 10]

10 Nitrogenous fertilisers are soluble salts used to increase crop yield. Two commonly

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used nitrogenous fertilisers are ammonium chloride and ammonium phosphate.

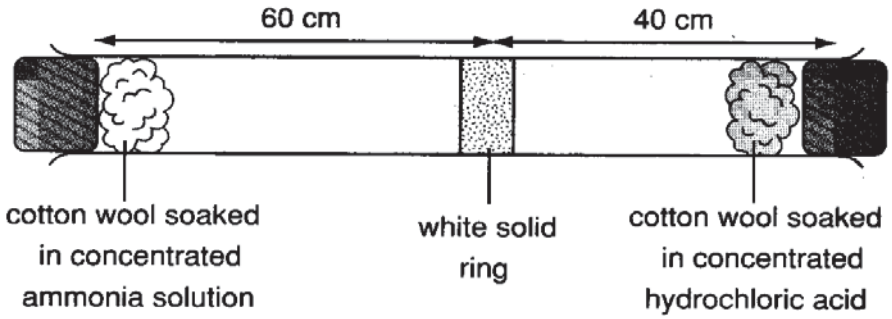
(a) Ammonium chloride can react with sodium hydroxide.
Write an ionic equation for this reaction.

…… [1]

(b) Calculate the percentage mass of nitrogen in ammonium chloride.

percentage mass of nitrogen = …….. % [1]

(c) A metre-long tube was set up with a plug of concentrated ammonia solution at the left end and a plug of concentrated hydrochloric acid at the right end. After a while, the two gases (ammonia and hydrogen chloride gas) met and a white solid of ammonium chloride was produced as shown.



(i) Explain why the white solid ring of ammonium chloride is formed at the specific location.

……

……

…… [2]

(ii) Explain the change in time taken for the white solid to appear when the above setup is carried out at a higher temperature.

……

…… [1]

(d) Aqueous ammonium chloride was added to aqueous bromine. State the observation for this reaction, if any, and suggest a reason for the

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outcome.

……

……

…… [2]

(e) Suggest in steps, a method to separate a mixture of solid ammonium chloride and solid sodium chloride. You may draw a labelled diagram to support your answer.

……

……

……

…… [2]

(f) State a trend in physical properties of the halogens.

……

…… [1]

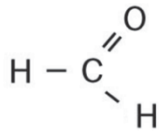
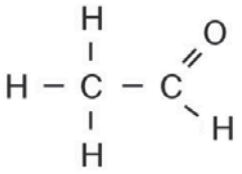
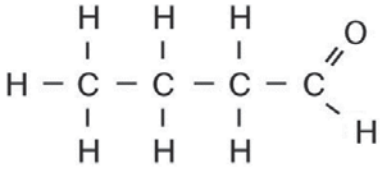
[Total: 10]

EITHER

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11 Organic acids are commonly used in the preservation of food.

Organic acids can be made from the atmospheric oxidation of aldehydes in air.
The names and structural formulae of the aldehydes are shown in the table below.

aldehyde	chemical formula	structural formula
methanal	CH_2O	
ethanal	C_2H_4O	
butanal	C_4H_8O	

(a) **(i)** Complete the table above to show the name, chemical formula and structural formula of the aldehyde that occurs between ethanal and butanal. [1]

(ii) Using the data given, explain in two ways how you can tell that these compounds are from the same homologous series.

……...

……...

……... [2]

(b) Give the name of an oxidising agent that can oxidise methanal to methanoic acid. Explain what you would observe when the oxidation process is completed.

oxidising agent ……..

observation …… [2]

(c) The organic acids made from aldehydes can then undergo condensation reactions with alcohols to make esters. One such example is butyl ethanoate,

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which gives an apple smell present in perfumes.

(i) Explain the term '*condensation reaction*'.

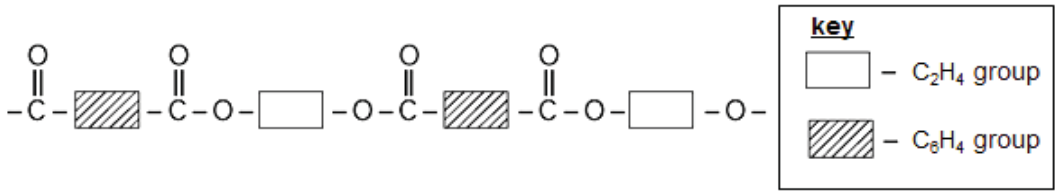
……...

……... [1]

(ii) Draw the full structural formula of butyl ethanoate.

[1]

(d) Terylene, a synthetic polyester, is also made from the condensation reaction of organic acids and alcohols. It contains the ester linkage which is strong and durable and is commonly used in the manufacture of sleeping bags and clothings. The structure of Terylene is shown below.



(i) Give **one** similarity and **one** difference between the condensation reaction of the formation of butyl ethanoate and the formation of Terylene.

similarity ……..

……...

difference ……

……... [2]

(ii) The strength and durability of Terylene can also cause environmental problems. Suggest why.

……...

……... [1]

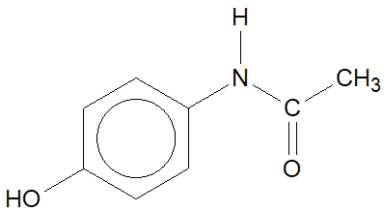
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OR

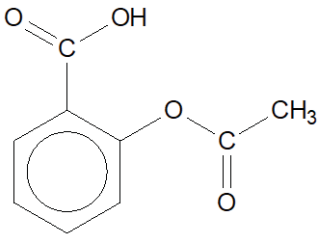
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11 Chromatography is the general name applied to a series of separation methods that employ a system with two phases of matter; a mobile phase and a stationary phase. Analytes in a mixture to be separated interact with the stationary phase with different affinities. While moving through the system, carried along by the mobile phase (solvent), analytes with a low affinity for the stationary phase will tend to move along rapidly, while those with a high affinity will tend to lag behind. Thin Layer Chromatography (TLC) is a fast and inexpensive form of chromatography that has many uses in the organic laboratory. The retention factor (R_f) is simply the fractional distance the solute spot moves along the plate relative to the solvent front. The stationary phase in TLC is typically an adsorbant made of silica gel.

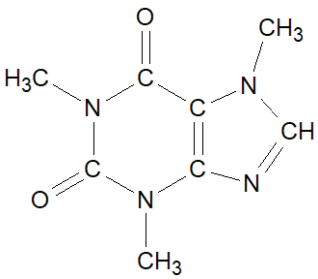
Analgesics are substances that relieve pain. The most common of these is aspirin. Other common analgesics include acetaminophen. In many cases these analgesics are used in combination to enhance or complement their individual affects; e.g., acetaminophen. Additionally, to counteract the acidic properties of aspirin, an inorganic buffering agent is added to some preparations. In some cases, caffeine is added to counteract the sedative effects of the analgesic.



acetaminophen



aspirin



caffeine

TLC will be used to analyse a commercial analgesic tablet. The above-mentioned compounds will also be run on the same TLC for comparison. The retention factor value for each standard and each analyte spot produced by the commercial analgesic tablet will be determined. This will then allow the compounds used in the analgesic tablet to be identified.

Literature values of the compounds are listed as followed.

compound	melting point / °C	retention factor
acetaminophen	168.0	0.333
aspirin	136.0	0.639
caffeine	236.1	0.125

The retention factor values are obtained after each of the components, **X**, **Y** and **Z**, are isolated and were analysed using TLC.

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compound	melting point / °C	retention factor
X	132.1 – 132.2	0.676
Y	166.2 – 168.2	0.378
Z	234.3 – 235.5	0.189

Source: *https://infohost.nmt.edu/~jaltig/TLC.pdf*

(a) Use the literature information provided to name the components, **X, Y** and **Z.**

X ……..……..... **Y** ……..…….....

Z ……..……..... [2]

(b) Based on the literature R_f values, which compound has the highest affinity to the stationary phase, silica gel?

Explain your reasoning.

……..

……..

…….. [2]

(c) What can you conclude about the literature melting points and the experimental melting points?

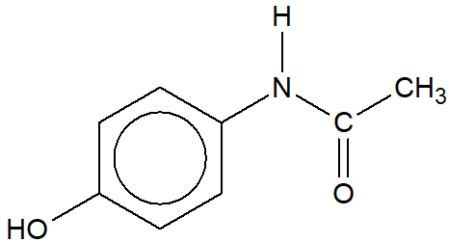
Explain your reasoning.

……..

……..

…….. [2]

(d) A way to produce acetaminophen is to react two molecules to form an amide linkage. This process is similar to the process of esterification.



(i) Name the conditions required to produce acetaminophen.

……...

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……... [1]

(ii) Draw the structure of the two molecules that can form acetaminophen.

[2]

(iii) In practice, when the two molecules react in **(d)(ii)**, the yield of acetaminophen is never 100%.

Suggest a reason why.

……...

……... [1]

[Total: 10]

– 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		**Key** proton (atomic) number atomic symbol name relative atomic mass									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 –		

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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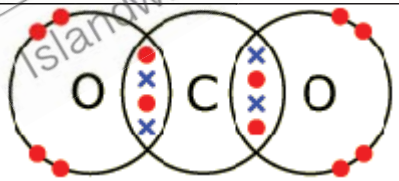
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6092 Chemistry Preliminary Examination 2019 Marking Scheme

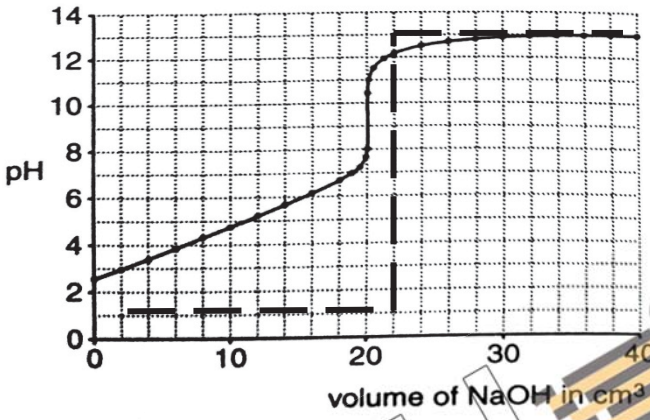
Multiple-Choice Questions [40 M]

1	2	3	4	5	6	7	8	9	10
A	C	C	B	D	B	D	B	B	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	D	B	C	B	B	B	D	D	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	A	D	C	D	B	C	A	B	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	C	B	D	B	A	A	C	D	B

Section A: Short-Structured Questions [50 M]

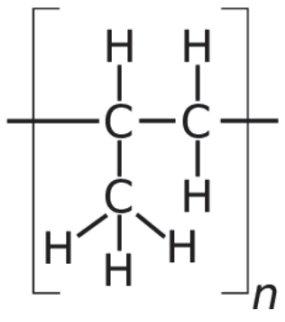
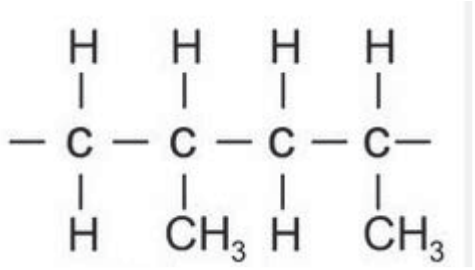
1	**(a)**	B		**[1]**
	(b)	E		**[1]**
	(c)	**(i)**	Carbon monoxide	**[1]**
		(ii)	neutral	**[1]**
	(d)	**(i)**	Any noble gas (e.g. helium, neon, argon, etc)	**[1]**
		(ii)	It has a complete valence shell / complete outermost shell / noble gas configuration and does not need to gain / lose / share electrons.	**[1]**
	(e)	It is an ionic compound. Since its ions are held / fixed in an ionic lattice structure, no mobile ions are available to act as charge carriers. Hence F_2O does not conduct electricity in the solid state.		**[1]** **[1]**
2	**(a)**	**(i)**	Each C atom is bonded to 4 other C atoms by strong covalent bonds in a tetrahedral structure; large amount of energy is needed to break these strong bonds, resulting in a high melting point	**[1]** **[1]**
		(ii)	The network of covalent bonds is less extensive than diamond / each carbon atom is bonded to 3 carbon atoms in graphite while each carbon atom is bonded to 4 carbon atoms in diamond	**[1]**
	(b)	**(i)**	 **[1]: Electrons involved in bonding are drawn correctly** **[1]: No other valence electrons are drawn**	**[2]**
		(ii)	Each C atom is bonded covalently to 3 other atoms in a hexagonal structure. Free moving electron from each C atom can act as charger carriers to move across layers to conduct electricity.	**[1]** **[1]**
		(iii)	test: measure the melting point / boiling point of carbon dioxide observation: melting point / boiling point is fixed OR melting point / boiling point matches the recorded melting point / boiling point in scientific data. Award [1] only if both test and observation are correct.	**[1]**

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3	**(a)**	1.HX is a strong acid due to its: lower pH; higher electrical conductivity OR HY is a weak acid due to its: higher pH. lower electrical conductivity; 2. Strong acid dissociates completely in water to form H^+ ions. Weak acid dissociates partially in water to form H^+ ions. 3. The higher concentration of H^+ ions contributes to its high conductivity; The low concentration of H^+ ions contributes to its low electrical conductivity. *Answers like difference of pH2 or higher or lower pH did not score marks.*	**[1]** **[1]** **[1]**
	(b)	 Graph should show the same volume of NaOH ; Starts at pH 1 ; Ends at pH 12	**[1]**
4	**(a)**	zinc to copper in the wire	**[1]**
	(b)	Cu^{2+} (aq) + 2e → Cu(s)	**[1]**
	(c)	*meter reading / V* | *metal* +1.10 | **Zinc** +0.78 | **Iron** 0.00 | **Copper** -0.46 | **Silver** **Award [1] for every 2 correct answers**	**[2]**
5	**(a)**	Mr of propene = 3(12) + 6(1) = 42 Number of moles of propene = 1/42 = 0.0238095238 mol Number of moles of bromine = Number of moles of propene ∴ mass of bromine = 0.0238095238 x 2(80) = 3.80952380952 ≈ 3.81 g (3 s.f.)	**[1]** **[1]**

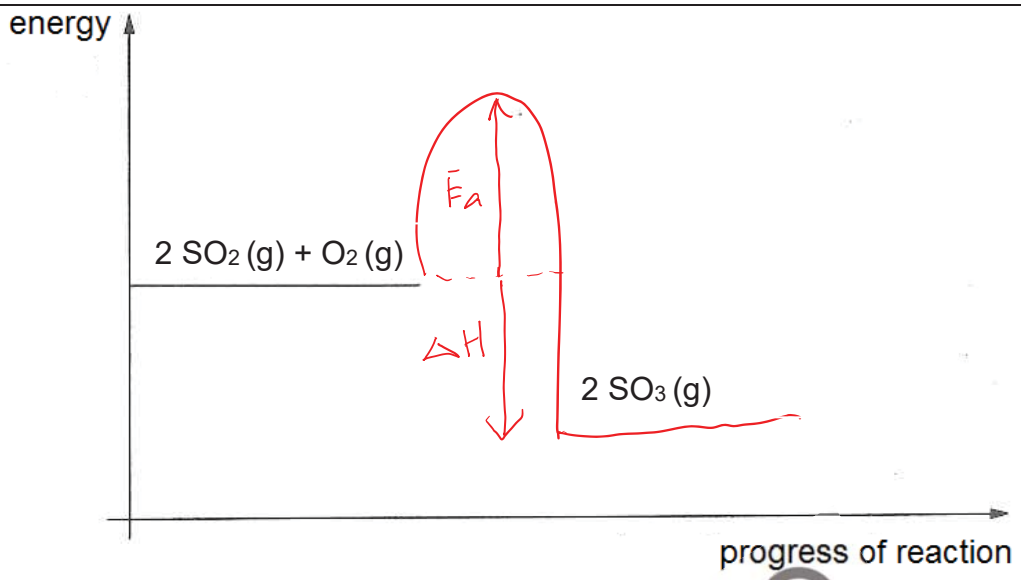
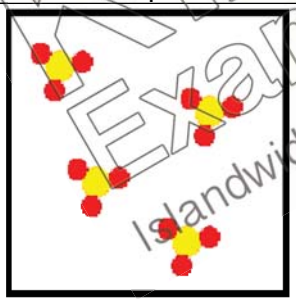
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	(b)	 or 	**[1]**
	(c)	Mr of propene = 42 Number of propene molecules = 7350 / 42 = 175 Number of carbon atoms = 175 x 3 = 525	**[1]** **[1]**
6	**(a)**	electrode **P**: $4OH^-$ (aq) → $2H_2O$ (l) + O_2 (g) + 4e electrode **S**: Cu^{2+} (aq) + 2e → Cu (s)	**[1]** **[1]**
	(b)	Hydroxide ions are discharged at electrode R (anode) to give oxygen gas. Hence, with the decrease in concentration of hydroxide ions, the pH decreases as the solution becomes less alkaline.	**[1]** **[1]**
7	**(a)**	<table><tr><th>salt</th><th>method 1</th><th>method 2</th><th>method 3</th></tr><tr><td>ammonium chloride</td><td></td><td></td><td>✓</td></tr><tr><td>lead(II) sulfate</td><td>✓</td><td></td><td></td></tr><tr><td>sodium sulfate</td><td></td><td></td><td>✓</td></tr><tr><td>zinc nitrate</td><td></td><td>✓</td><td></td></tr></table>**Award [1] for every 2 correct answers**	**[2]**
	(b)	**(i)** • Copper(II) chloride is soluble, so cannot use method 1 • Copper cannot react with dilute acid, so cannot use method 2 • Copper oxide, hydroxide and carbonate are all insoluble, so cannot use method 3 **Deduct [1] for every 1 mistake**	**[2]**
		(ii) • Add **excess** copper(II) oxide/hydroxide/carbonate to dilute hydrochloric acid • Filter the mixture • Heat the filtrate until saturated • Cool the hot filtrate to allow it to crystallize • Collect crystals and wash with cold deionised water **Award [1] for every 2 correct steps** **Award [3] for all correct steps**	**[3]**
8	**(a)**	When the temperature is too low, the speed of reaction is too low; when the temperature is too high, the cost of maintaining the high temperature is too high; (also accept: when the temperature is too high, the yield is too low)	**[1]** **[1]**

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	(b)	 • the **formulae of the reactants and products** of the reaction, • a label for **the activation energy of reaction**, • a label for **the enthalpy change of reaction**. Deduct [1] for every 1 error.	**[2]**
	(c)	When pressure increases, there are more molecules of sulfur dioxide and oxygen per unit volume; frequency of effective collisions increases so rate increases	**[1]** **[1]**
	(d)	In the absence of water (or little amount of water), most of the sulfuric acid molecules do not ionise to form hydrogen ions, hence it would not react with steel; in dilute sulfuric acid, the hydrogen ions from the acid ionises completely, reacting with the iron in steel tanks;	**[1]** **[1]**
	(e)	Any transition metal (e.g. copper, silver, gold) that is below hydrogen in reactivity series. It has multiple oxidation state.	**[1]**
	(f)		**[1]**

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Section B: Long-Structured Questions [30M]

9	**(a)**	**(i)**	$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$	**[1]**
		(ii)	Mole ratio of [allow ecf for mole ratio] $2\ C_8H_{18} : 25\ O_2$ 3 : 37.5 Number of moles of $O_2 = \frac{3}{2} \times 25$ = 37.5 mol [1] Volume of O_2 = 37.5 x 24.0 = 900 dm^3 [1]	**[2]**

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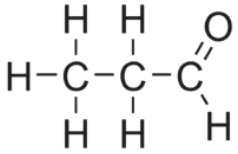
		(iii)	$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$ C_8H_{18} loses H atom / gains O atom to form CO_2, hence C_8H_{18} is reduced. O_2 gains H atom / loses O atom to form H_2O, hence O_2 is oxidised.	**[1]** **[1]**
	(b)	Diesel contains a higher number of carbon atoms than petrol [1]. As the number of carbon atoms increases, the molecular size of the hydrocarbons increases. The **intermolecular forces of attraction** between the hydrocarbons **increases**. [1] Hence **more energy** is needed to **overcome the intermolecular forces of attraction between the hydrocarbons**. Hence diesel is a fraction of crude oil that is removed at a higher boiling point than petrol. [1]	**[3]**
	(c)	Three-way catalytic converter. Based on the chart, the three-way catalytic converter produces the lowest mass of hydrocarbons, carbon monoxide and nitrogen oxides as compared to two-way catalytic converter. Hence the three-way catalytic converter is a more effective catalytic converter. [1] *OR* Three-way catalytic converter can remove hydrocarbons, carbon monoxide and nitrogen oxides while two-way catalytic converter can only remove hydrocarbons and carbon monoxide. Hence the three-way catalytic converter is a more effective catalytic converter.	**[1]**
	(d)	Nitrogen oxides are not converted in a two-way catalytic converter. As a result, the nitrogen oxides react with oxygen and dissolve in rainwater to form acid rain, which corrodes limestone buildings, destroys aquatic life and plants.	**[1]**
10	**(a)**	$NH_4^+ (aq) + OH^- (aq) \longrightarrow NH_3 (g) + H_2O (l)$	**[1]**
	(b)	Percentage mass of nitrogen in ammonium chloride = 14 / (14 + 4 + 35.5) x 100 = 26.2% (3 s.f.)	**[1]**
	(c)	**(i)** Ammonia has a relative molecular mass of 17, and is less dense than hydrogen chloride gas, with a relative molecular mass of 36.5. Hence ammonia gas diffuse faster than hydrogen chloride gas, forming the white solid ring closer to concentrated hydrochloric acid.	**[1]** **[1]**
		(ii) The white solid would appear faster as the rate of diffusion is faster;	**[1]**
	(d)	No visible change will be observed. Bromine is less reactive than chlorine and is unable to displace chloride from ammonium chloride.	**[1]** **[1]**
	(e)	Step 1: In an evaporating dish, heat gently to sublime ammonium chloride. Step 2: Place an inverted filter funnel over the evaporating dish to cool down and condense the gaseous ammonium chloride to form white solid. Diagram drawn must be labelled properly to be awarded [1]. Student will need to state step 2 to get full credit.	**[1]** **[1]**
	(f)	As we go down the group, the boiling point or melting point increases / density increases / colour intensity increases / changes from gas to liquid to solid.	**[1]**

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11 Either

(a) (i)

aldehyde	chemical formula	structural formula
propanal	C_3H_6O	

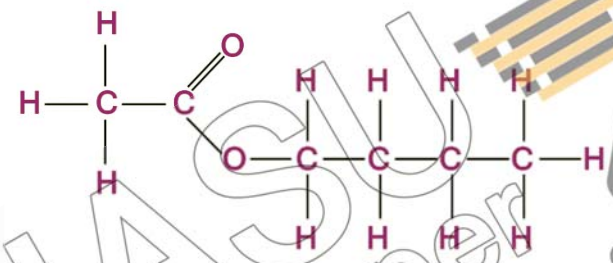
Award [1] only when all answers are correct **[1]**

(ii) These molecules have the same functional group of CHO./
These molecules have the same general formula, $C_nH_{2n}O$./
Each member's molecular formula differs from the next member by CH_2.

Award [1] for each correct answer. **[2]**

(b) Oxidising agent: acidified potassium manganate **[1]**
Observation: Violet potassium manganate decolourises. **[1]**

(c) (i) Condensation reaction occurs when the molecules join with one another covalently to form a new product, with the elimination of small molecules such as water. **[1]**

(ii)  **[1]**

(d) (i) Similarity:
Both reactions eliminate / release / produce water molecules / involve esther bond formation [1].

Difference:
Ethyl pentanoate is a simple molecule but Terylene is a macromolecule / Terylene has more than one ester linkage but ethyl pentanoate has only one. [1] **[2]**

(ii) Terylene is non-biodegradable and will remain on Earth for a long time. Hence, Terylene will take up space in landfill sites, causing land pollution. **[1]**

11 Or

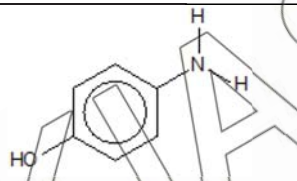
(a) X: aspirin
Y: acetaminophen
Z: caffeine
Award [1] for 1 or 2 correct answer
Award [2] for all correct answers **[2]**

(b) Based on the R_f values, caffeine has the highest affinity for the silica gel. [1]

Caffeine has the lowest R_f value as compared to aspirin and acetaminophen, this shows that the distance moved by caffeine on the TLC plate is the shortest distance. Hence this shows that caffeine has high affinity for silica gel. [1] **[2]**

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	(c)	The experimental melting points for all three compounds are lower than the literature values. [1] A possible reason is that compounds **X**, **Y** and **Z** are not 100% pure [1] Or the compounds may contain impurities.		**[2]**
	(d)	**(i)**	Concentrated sulfuric acid, warm/heat (under reflux)	**[1]**
		(ii)	 Award [1] for each correct answer	**[2]**
		(iii)	The process is similar to esterification, which is a reversible process. Hence some of the product, acetaminophen, formed is converted back to reactant particles.	**[1]**

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