JUNYUAN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY FOUR EXPRESS

CANDIDATE NAME

CLASS 4 E

INDEX NUMBER

CHEMISTRY

6092

PAPER 1 Multiple Choice

xx September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in soft pencil.
Do not use paper clips, glue or correction fluid.

There are forty questions on 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 separate 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 booklet.
A copy of the Periodic Table is printed on page 18.
The use of an approved scientific calculator is expected, where appropriate.

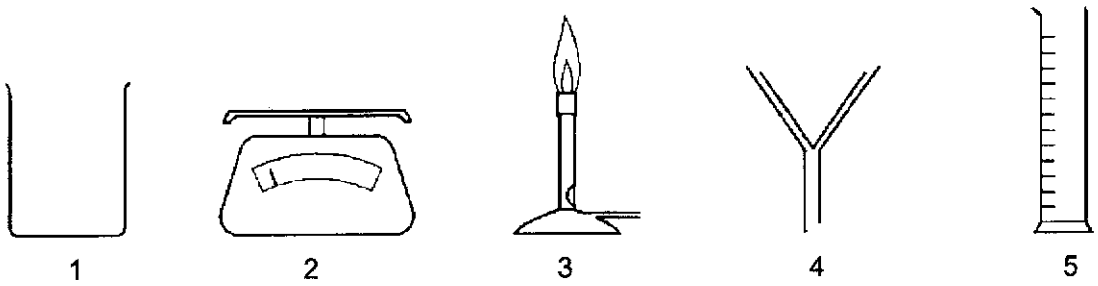
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1 Lead(II) iodide is insoluble in water.

Lead(II) iodide is prepared by adding aqueous lead(II) nitrate to potassium iodide.

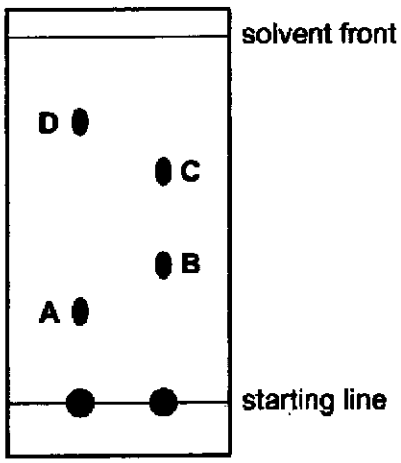
Which pieces of apparatus are needed for the preparation and collection of solid lead(II) iodide from 20 cm^3 of aqueous lead(II) nitrate?



A 1, 2 and 4 **B** 1, 3 and 5 **C** 1, 4 and 5 **D** 2, 4 and 5

2 Some substances may be separated using paper chromatography. The diagram shows the results of running two mixtures in a suitable solvent.

Which spot has an R_f value of 0.38?



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3 Compound X is a crystalline solid at room temperature and pressure. An aqueous solution of X is tested as shown.

test	test result
acidify with dilute nitric acid, then add aqueous barium nitrate	no visible change
add aqueous ammonia	white precipitate, soluble in excess

What could be the identity of X?

A ammonium carbonate

B sodium sulfate

C calcium nitrate

D zinc chloride

4 Gases are separated from liquid air by fractional distillation.

The boiling points of four gases are shown.

Which gas is both monatomic and a liquid at -200 °C?

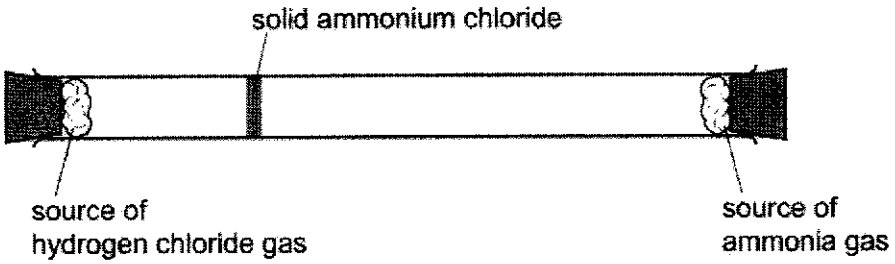
	gas	boiling point / °C
A	argon	-186
B	helium	-269
C	neon	-246
D	nitrogen	-196

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5 Hydrogen chloride gas, HCl, reacts with ammonia gas, NH_3, to form solid ammonium chloride.

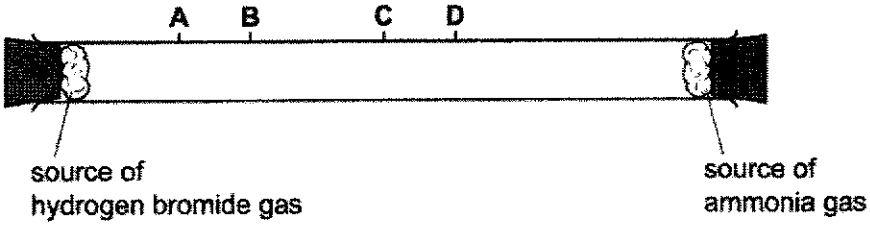
The apparatus is set up as shown.

After a few minutes, solid ammonium chloride forms where the two gases meet.



The experiment is repeated using hydrogen bromide, HBr, in place of hydrogen chloride.

How far along the tube does the solid ammonium bromide form?



6 The table shows the numbers of particles present in the nuclei of four atoms or ions.

	protons	neutrons	electronic structure
1	18	22	2.8.8
2	19	20	2.8.8
3	19	21	2.8.8.1
4	20	20	2.8.8.2

Which two particles belong to the same element?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

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7 Element X has a proton number of 20 and a nucleon number of 40. X reacts with element Y to form an ionic compound.

Which equation shows the process that takes place when X forms ions?

A $X + e^- \rightarrow X^+$

B $X + 2e^- \rightarrow X^{2+}$

C $X \rightarrow X^+ + e^-$

D $X \rightarrow X^{2+} + 2e^-$

8 A covalent molecule M contains a total of four shared electrons.

What is M?

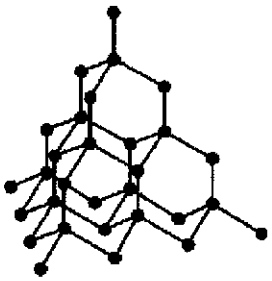
A ammonia, NH_3

B hydrogen chloride, HCl

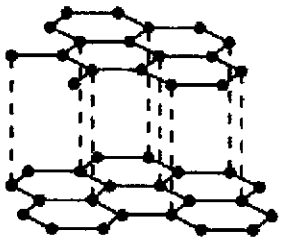
C methane, CH_4

D water, H_2O

9 Which pair of statements about diamond and graphite is correct?



diamond



graphite

A Diamond and graphite are both pure carbon. They are both macromolecules.

B Diamond and graphite can both be used as electrodes. Graphite is also used as a lubricant.

C Diamond has covalent bonds. Graphite has ionic bonds.

D Diamond is hard with a high melting point. Graphite is soft with a low melting point.

10 Which of the following contains the greatest mass of oxygen?

A 0.2 mol of aluminium nitrate, $Al(NO_3)_3$

B 0.3 mol of potassium sulfate, K_2SO_4

C 0.4 mol of sodium nitrate, $NaNO_3$

D 0.5 mol of magnesium carbonate, $MgCO_3$

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11 Compound X has a composition by mass of 63.6 % nitrogen and 36.4 % oxygen.

What is the empirical formula of X?

A N_2O **B** NO **C** NO_2 **D** N_2O_4

12 Calcium carbonate reacts with dilute hydrochloric acid according to the equation shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

10 g of calcium carbonate is reacted with 100 cm^3 of 1 mol/dm^3 hydrochloric acid.

The following statements are made.

1 1.20 dm^3 of carbon dioxide is formed.
2 5.55 g of calcium chloride is formed.
3 4.80 g of carbon dioxide is formed.
4 No calcium carbonate is left when the reaction is completed.

Which statements about the reaction are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

13 The reaction for the conversion of bromoethane to ethanol is shown.

$$C_2H_5Br + NaOH \rightarrow C_2H_5OH + NaBr$$

In an experiment, 10.90 g of bromoethane is converted to 3.45 g of ethanol.

What is the percentage yield of ethanol? [M_r: C_2H_5Br, 109; C_2H_5OH, 46]

A 32 % **B** 42 % **C** 75 % **D** 100 %

14 Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

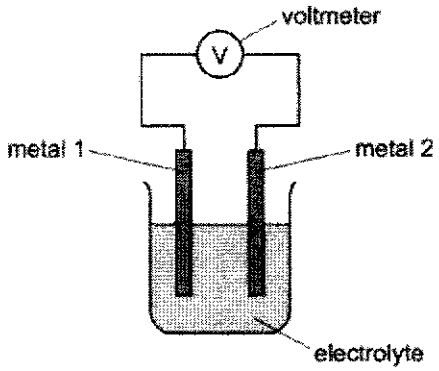
Which row shows what is likely to happen in this electrolysis and why it happens?

	change occurring	explanation
A	Oxygen is discharged at the anode.	OH^-(aq) loses electrons more easily than does Cl^-(aq).
B	During electrolysis, the pH of the electrolyte increases.	With the discharge of H^+(aq) ions, OH^-(aq) ions remain.
C	Solid sodium is discharged at the cathode.	Na^+(aq) is present in aqueous solution.
D	The products stay the same if the aqueous sodium chloride is replaced by molten sodium chloride.	Na^+ and Cl^- are present in both molten and aqueous sodium chloride.

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15 Pairs of metals are connected together to make a simple cell, as shown.



The table shows the reading on the voltmeter when different metals are used.

		metal 2			
		beryllium	cerium	cobalt	manganese
metal 1	beryllium	0.00 V	+0.64 V	-1.57 V	-0.67 V
	cerium		0.00 V	-2.21 V	-1.30 V
	cobalt			0.00 V	+0.90 V
	manganese				0.00 V

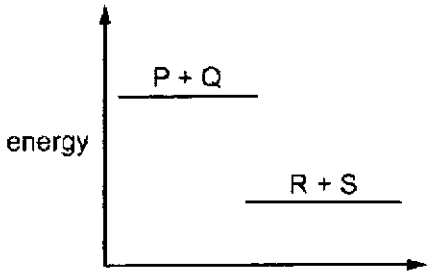
If metal 2 is more reactive than metal 1, the voltage measured is positive.

What is the order of reactivity?

	most reactive →			least reactive
A	cerium	beryllium	cobalt	manganese
B	cerium	beryllium	manganese	cobalt
C	cobalt	manganese	beryllium	cerium
D	cobalt	manganese	cerium	beryllium

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16 The energy level diagram for the reaction between P and Q to form R and S is shown.



Which row describes the energy changes involved and the type of reaction?

	energy changes involved	type of reaction
A	more energy is given out when the bonds in the products are formed than is absorbed to break the bonds in the reactants	endothermic
B	more energy is given out when the bonds in the products are formed than is absorbed to break the bonds in the reactants	exothermic
C	more energy is absorbed to break the bonds in the reactants than is given out when the bonds in the products are formed	endothermic
D	more energy is absorbed to break the bonds in the reactants than is given out when the bonds in the products are formed	exothermic

17 Nitrogen trifluoride, NF_3, is used in the manufacturing of certain types of solar panels. The equation for the formation of nitrogen trifluoride is shown.

$$N_2 + 3F_2 \rightarrow 2NF_3$$

type of bond	bond energy (kJ/mol)
N≡N	+950
F–F	+150
N–F	+280

Using the table of bond energies, what is the energy change for this reaction?

A -560 kJ/mol

B -280 kJ/mol

C +280 kJ/mol

D +3080 kJ/mol

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18 Marble chips react with hydrochloric acid in an exothermic reaction.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

When excess marble chips are added to dilute hydrochloric acid, the rate of the reaction starts off fast, then gets slower until the reaction stops.

Why does the reaction rate get slower?

A The concentration of the hydrochloric acid is decreasing.

B The concentration of calcium chloride is increasing.

C The calcium carbonate is completely used up.

D The temperature of the mixture decreases.

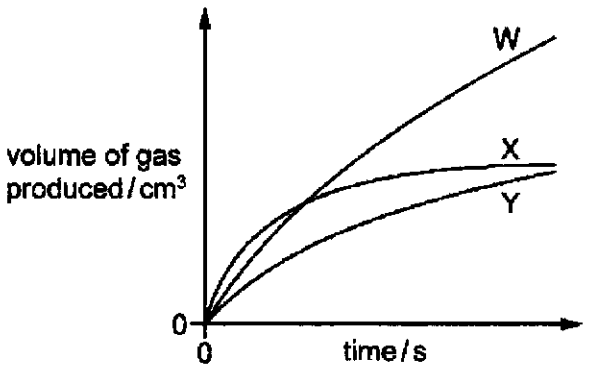
19 Three experiments are carried out in which the same mass of magnesium is reacted with the same volume of dilute sulfuric acid at room temperature. The magnesium is in excess.

experiment 1 Large pieces of magnesium are used.

experiment 2 Small pieces of magnesium are used.

experiment 3 Large pieces of magnesium are used but the concentration of the acid is increased.

Graphs of the results are shown.



Which row is correct?

	experiment 1	experiment 2	experiment 3
A	W	X	Y
B	X	Y	W
C	Y	W	X
D	Y	X	W

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20 The reaction between magnesium and carbon dioxide is shown in the equation.

$$2Mg + CO_2 \rightarrow 2MgO + C$$

Which statement describes what happens in this reaction?

A Carbon is oxidised.

B Magnesium is reduced.

C Neither oxidation nor reduction happens.

D The carbon in carbon dioxide is reduced.

21 Gas X turns acidified potassium manganate(VII) from purple to colourless.

Gas Y turns aqueous potassium iodide from colourless to brown.

What do these observations show about gas X and gas Y?

	gas X	gas Y
A	oxidising agent	oxidising agent
B	oxidising agent	reducing agent
C	reducing agent	oxidising agent
D	reducing agent	reducing agent

22 An alloy of copper and zinc is added to an excess of dilute hydrochloric acid. The resulting mixture is then filtered.

Which observations are correct?

	filtrate	residue
A	colourless solution	none
B	colourless solution	red-brown
C	blue solution	grey
D	blue solution	non

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23 Three chemicals, P, Q and R, were each dissolved in water. The table shows some of the reactions of these solutions.

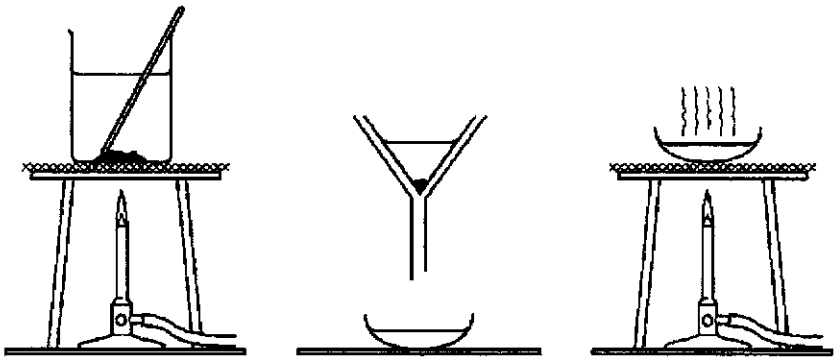
solution	reaction when solid sodium carbonate is added	reaction when heated with solid ammonium chloride
P	gas evolved	no reaction
Q	no reaction	gas evolved
R	no reaction	no reaction

The pH of the three solutions was also measured.

What are the likely pH values of these solutions?

	P	Q	R
A	2	7	13
B	2	13	7
C	7	2	13
D	13	7	2

24 The diagram shows the steps in the preparation of a salt.



step 1 step 2 step 3

Which salt can be prepared by this method?

A barium sulfate

B copper(II) sulfate

C potassium sulfate

D sodium sulfate

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25 Three different elements react by losing electrons. The ions formed all have the electronic configuration, 2.8.

Which statement about these elements is correct?

A They are noble gases.

B They are transition elements.

C They are in the same group.

D They are in the same period.

26 Sodium is a Group I metal.

Which property, that is typical of most metals, is not shown by sodium?

A conductor of electricity

B high melting point

C malleable

D shiny

27 Palladium is an element with the atomic number of 46. Some of its properties, and the properties of its compounds, can be predicted from its position in the Periodic Table.

Which row is correct?

	predicted property of palladium	predicted property of palladium compounds
A	Its density is similar to the density of sodium.	Some of them can act as catalysts.
B	Its density is similar to the density of sodium.	They are white in the solid state.
C	It is present in compounds in more than one oxidation state.	Some of them can act as catalysts.
D	It is present in compounds in more than one oxidation state.	They are white in the solid state.

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28 The metal beryllium does not react with cold water.

It reacts with hydrochloric acid but cannot be extracted from its ore by using carbon.

Where is beryllium placed in the reactivity series?

magnesium

A

zinc

B

iron

C

copper

D

29 Four equations are shown.

1 $C + O_2 \rightarrow CO_2$

2 $CaCO_3 \rightarrow CaO + CO_2$

3 $SiO_2 + 2CO \rightarrow Si + 2CO_2$

4 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Which equations represent reactions that take place in the blast furnace where iron is extracted from haematite?

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

30 Methanol is made by reacting carbon monoxide with hydrogen. The reaction is reversible.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

What combination of temperature and pressure gives the highest equilibrium yield of methanol?

	temperature / °C	pressure / atmospheres
A	200	10
B	200	200
C	500	10
D	600	200

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31 Which pair of gases could be removed from the atmosphere using calcium carbonate?

A CO_2 and O_3

B CO and SO_2

C CH_4 and NO_2

D NO_2 and SO_2

32 Oxides of nitrogen, such as NO and NO_2, are formed in the petrol engines of cars.

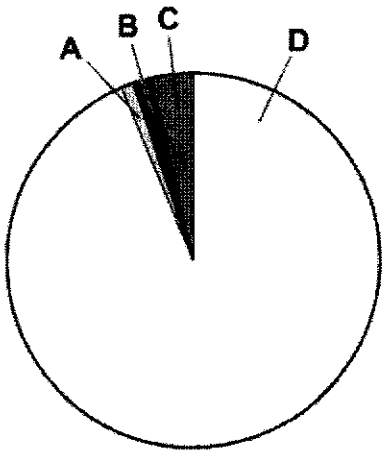
They are removed from the exhaust gases by reactions in the car's catalytic converter.

Which row describes how oxides of nitrogen are formed in a petrol engine, and a reaction that happens in the catalytic converter?

	how oxides of nitrogen are formed	a reaction that happens in the catalytic converter
A	by the reaction between nitrogen and oxygen from the air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
B	by the reaction between nitrogen and oxygen from the air	$2NO + 2H_2 \rightarrow N_2 + 2H_2O$
C	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2NO + 2CO \rightarrow N_2 + 2CO_2$
D	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2NO + 2H_2 \rightarrow N_2 + 2H_2O$

33 The pie chart represents the composition of natural gas.

Which sector represents methane?



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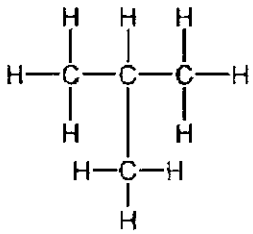
34 When a molecule of a saturated hydrocarbon is cracked, it forms two molecules, X and Y.

Which row is correct?

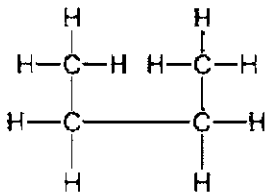
	X	Y
A	H_2O	C_nH_{2n}
B	H_2O	C_nH_{2n+2}
C	H_2	C_nH_{2n}
D	H_2	C_nH_{2n+2}

35 Which diagram shows a branched-chain isomer of butane?

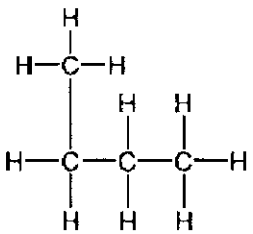
A



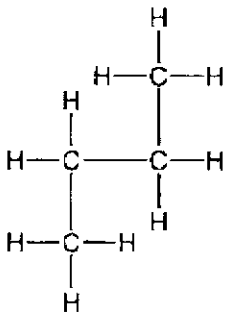
B



C



D



36 Which organic compound requires the least number of moles of oxygen for the complete combustion of one mole of the compound?

A C_3H_7OH **B** C_3H_7COOH **C** C_3H_8 **D** C_4H_8

37 Chlorine reacts with methane.

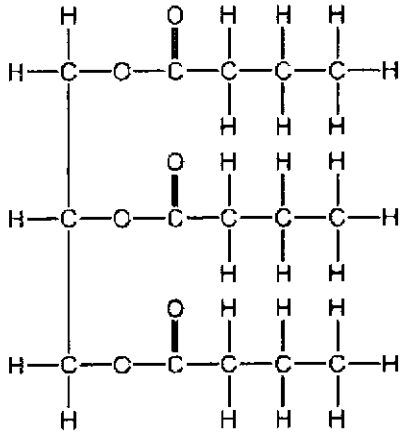
Which row is correct?

	chemical equation	conditions required
A	$Cl_2 + CH_4 \rightarrow CH_2Cl_2 + H_2$	methane and chlorine gases are mixed in the presence of ultraviolet light
B	$Cl_2 + CH_4 \rightarrow CH_2Cl_2 + H_2$	methane is bubbled into concentrated aqueous chlorine
C	$Cl_2 + CH_4 \rightarrow CH_3Cl + HCl$	methane and chlorine gases are mixed in the presence of ultraviolet light
D	$Cl_2 + CH_4 \rightarrow CH_3Cl + HCl$	methane is bubbled into concentrated aqueous chlorine

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38 Fats are essential components of the human diet.

The diagram shows a fat molecule.



Which description of this fat molecule is correct?

A saturated carboxylic acid

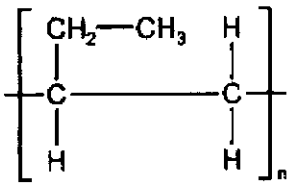
B saturated ester

C unsaturated carboxylic acid

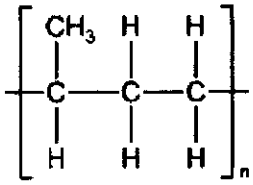
D unsaturated ester

39 Which partial structure is correct for the product of polymerization of butane, $CH_2{=}CHCH_2CH_3$?

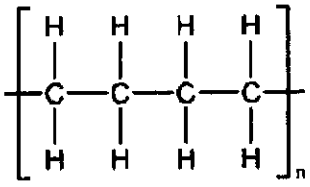
A



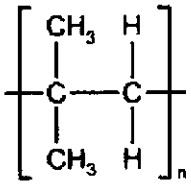
B



C



D

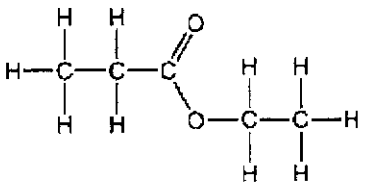
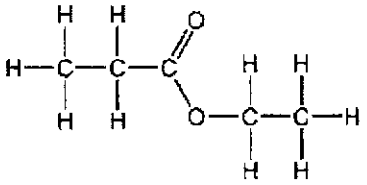
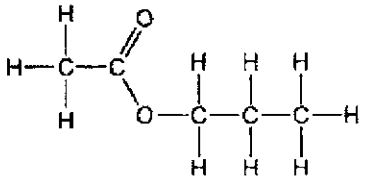
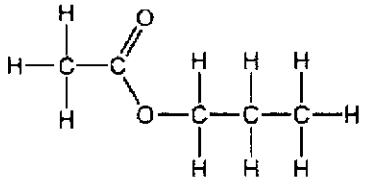


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40 Ethanoic acid is reacted with propanol.

What is the name and structure of the ester produced?

	name	structure
A	propyl ethanoate	
B	ethyl propanoate	
C	propyl ethanoate	
D	ethyl propanoate	

End of Paper

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 thullum 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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JUNYUAN SECONDARY SCHOOL
Secondary Four Express
Preliminary Examination 2021

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092 / 02

Paper 2

23 Aug 2021

1 hour 45 min

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, 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 workings.
Do not use staples, paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

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

Section B
Answer all **three** questions, the last question is in the form either/or.
Write your answers in the spaces provided.

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 in page 21.

For Examiner's Use	
Section A	
Section B	
Total	/80

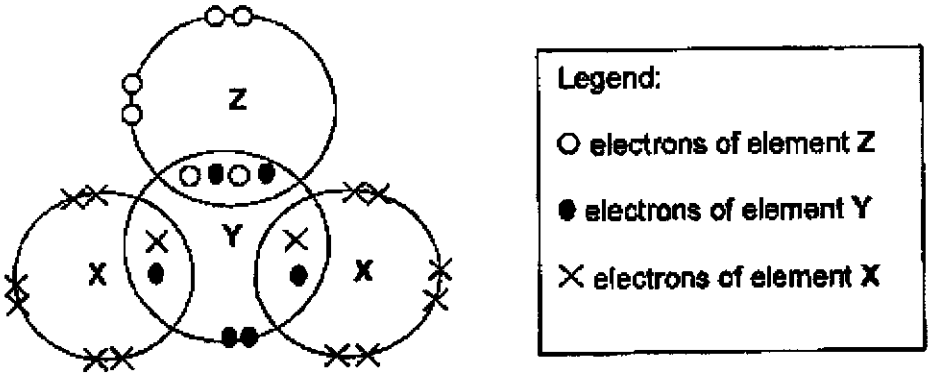
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Section A

Answer all questions in this section in the spaces provided.
The total mark for this section is 50.

A1 The bonding in compound YZX_2, formed between atoms Y, Z, and X, is shown below.



(a) State the Groups that elements X and Z belong to in the Periodic Table.

Element X: .....[1]

Element Z: .....[1]

(b) Element Z has the smallest atomic radius in its Group. Identify element Z.

.....[1]

(c) Element Y has 16 protons. State the period in which element Y is found in the Periodic Table.

.....[1]

(d) Aluminium forms a compound with element X. Write the chemical formula of this compound.

.....[1]

(e) Another element, V, has 1 more proton than element X. State a property that element V is likely to have.

.....

.....[1]

[Total: 6]

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A2 **(a)** In order to make computer processing easier, a system using proton (atomic) numbers rather than names or formulae has been developed. The following examples illustrate this code system.

name	formula	code
sodium chloride	NaC*l*	11,17
iron(II) bromide	$FeBr_2$	26, 35(2)
aluminium oxide	Al_2O_3	13(2), 8(3)

Use this system to complete the table below.

name	formula	code
	KF	
		29,6,8(3)
nitrogen dioxide		

[3]

(b) A sample of chlorine gas was found to consist of isotopes C*l*-35 and C*l*-37. A calculation of the relative atomic mass of chlorine was found to be 36.5.

(i) Define isotopes.

.....[1]

(ii) For the two chlorine isotopes, compare and contrast:

- the relative abundance,
- and the atomic structure.

.....

.....

.....

.....[3]

[7 marks]

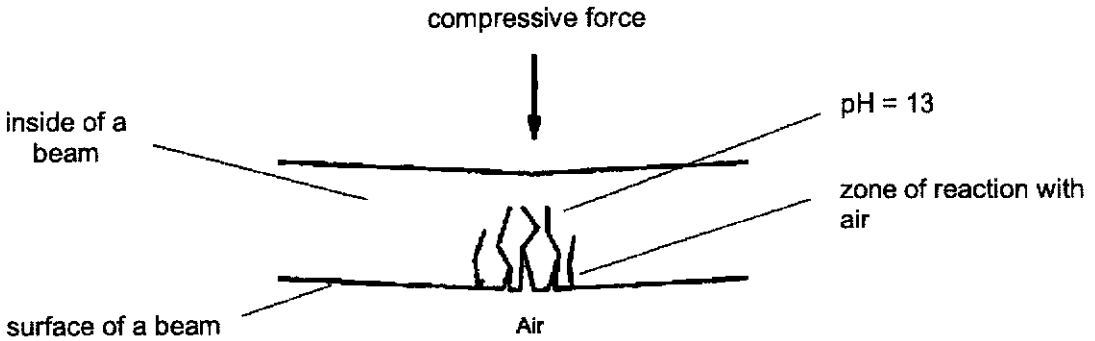
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A3 Concrete is an excellent building material that is commonly used in Singapore. It is made from cement, sand and water. Concrete is slightly porous. When rainwater soaks through concrete, some of the uncombined calcium oxide in the cement, dissolves to form aqueous calcium hydroxide.

(a) Write a balanced chemical equation, with state symbols for this reaction.

.....[2]

The diagram below shows the cross-section of a cracked concrete beam after a rainfall. Over time, air diffuses through the cracks to create a zone of reaction.



(b) Explain why the pH in a wet concrete beam is high.

.....

.....[1]

(c) Explain why there will be a chemical reaction when air diffuses into a wet concrete beam.

.....

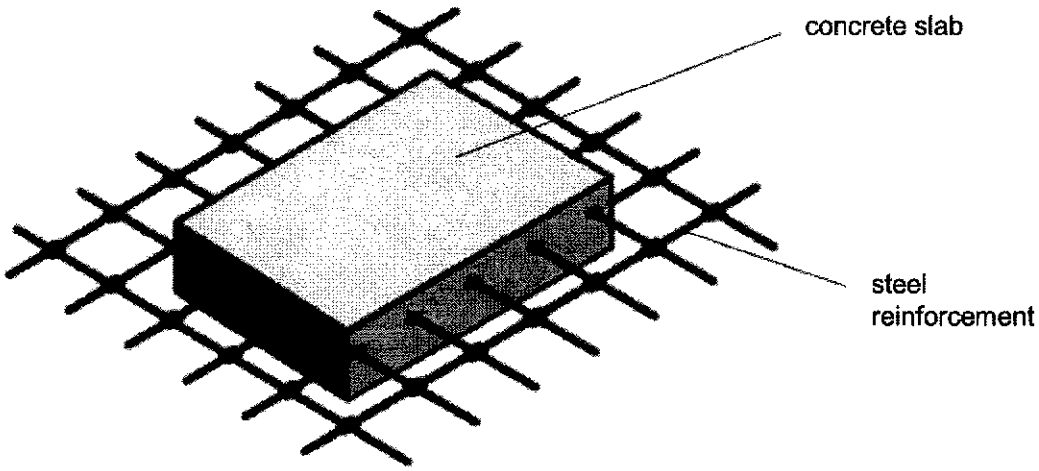
.....

.....[2]

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5

To strengthen concrete and prevent cracks, steel reinforcement is often used as seen in the diagram below.



Source: http://www.ashireporter.org/HomeInspection/Articles/Commercial-Inspection-CONCRETE-101/1068#crack-pattern.gif

(c) In terms of its structure, explain why steel is able to act as a reinforcement against compressive forces.

.....

.....

.....[2]

(d) Some modern structures, especially those situated near the sea, use fiberglass reinforcement instead of steel. Why is this so?

.....

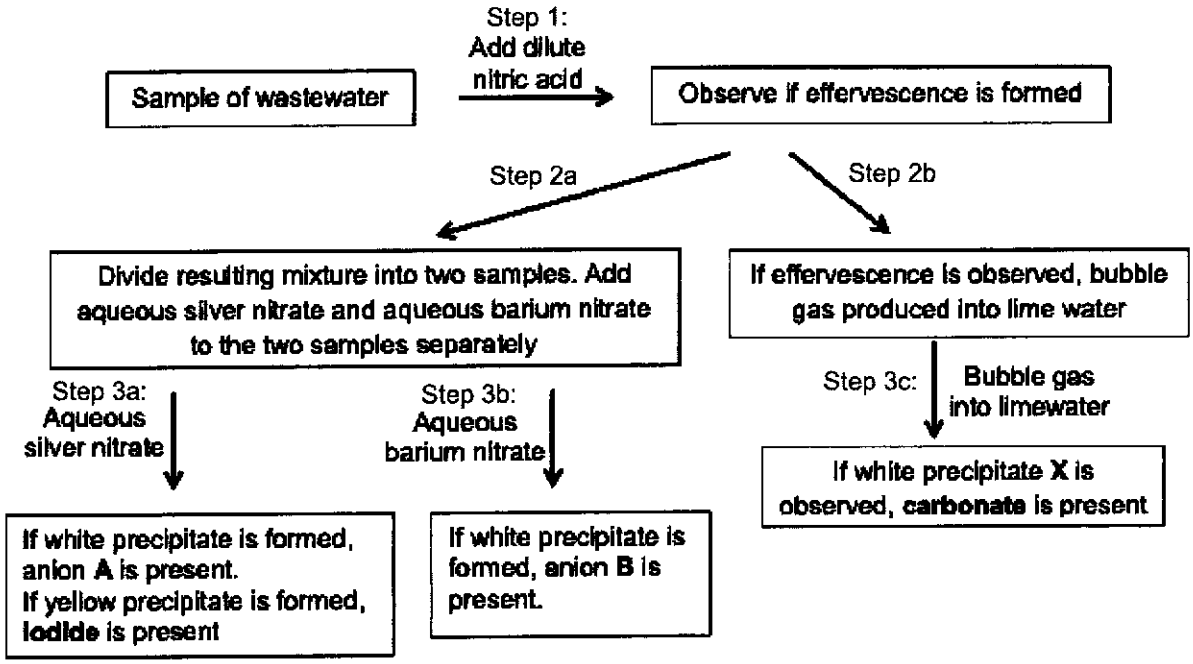
.....[1]

[Total: 8]

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A4 A student wishes to identify the anions that are present in a sample of wastewater. The following flowchart shows how he can identify the anions that are present:



(a) For anions A and B, write ionic equations for the formation of white precipitates described above. (Use the actual chemical symbols of the ions involved.)

.....

.....[2]

(b) A student noticed that the test for the anion, nitrate, has been missed out in the flowchart above. He suggests that after observing if there is effervescence (i.e step 1), the resulting mixture should be divided into three samples to include a test for nitrate.

Explain why this will not give conclusive results.

.....

.....

.....[2]

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(c) The wastewater contains only aluminium and calcium cations. Draw a flowchart that would enable him to confirm the identity of both ions, using aqueous sodium hydroxide and aqueous ammonia.

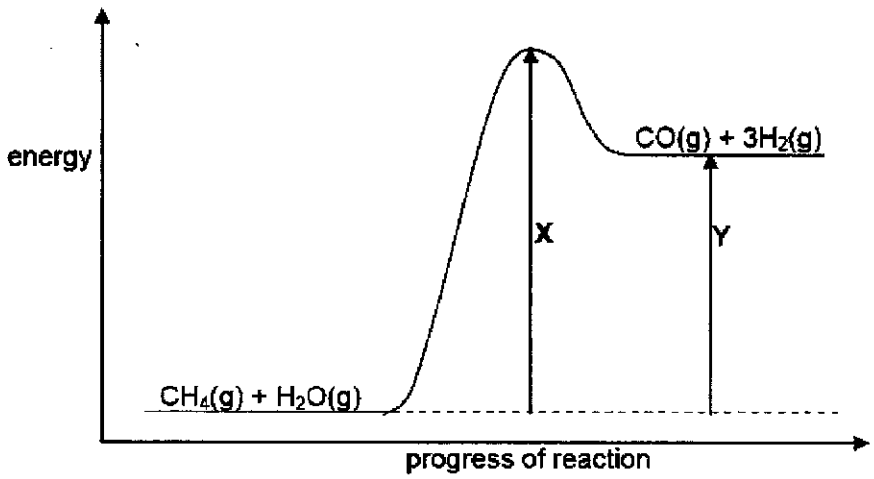
[3]

[Total: 7]

A5 Hydrogen has many industrial uses. One possible way to manufacture hydrogen involves the reaction between methane and steam.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

The diagram shows the energy profile diagram for this reaction.



(a) State one industrial use of hydrogen.

.....[1]

(b) What do the arrows, X and Y, represent in the diagram?

X: .....

Y: .....[2]

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(c) A student wrote the following statement:

"In the reaction between methane and steam, the amount of energy released for bond forming is smaller than the amount of energy absorbed for bond breaking."

Do you agree with the student? Explain your answer with reference to the energy profile diagram.

.....

.....

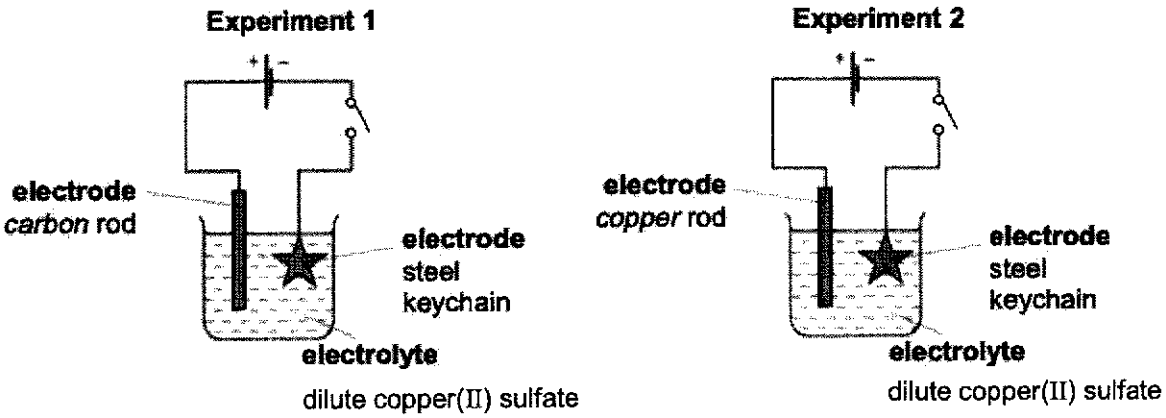
.....[2]

(d) If a catalyst can be found for this reaction, draw on the diagram above, how the energy profile will be change.

[1]

[Total: 6]

A6 A student set up two experiments for electroplating steel keychains with copper. She closed both circuits for a period of time.



(a) Complete the table of information about the experiments.

experiment	electrodes	ionic equation, for reaction at each electrode
1	carbon rod	
	steel keychain	
2	copper rod	
	steel keychain	

[3]

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(b) Describe and explain the observations seen in the electrolyte in each experiment.

Experiment 1:

.....

.....

.....

Experiment 2:

.....

.....

.....[4]

(c) The student repeated Experiment 2 with another keychain. However, she left the keychain in the setup without closing the switch for days.

Describe and explain one change she would observe of the keychain.

.....

.....

.....

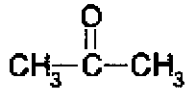
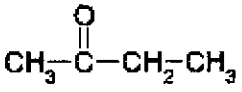
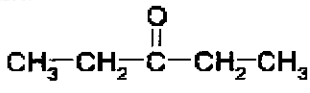
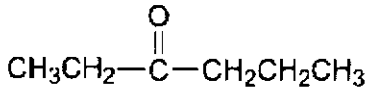
.....[3]

[Total: 10]

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A7 Ketones are a homologous series of organic compounds.

The table shows the names, formulae and boiling points of some ketones.

name	structural formula	boiling point / °C
2-propanone		56
2-butanone		80
3-pentanone		
3-hexanone		123

(a) Deduce the general formula and functional group of the ketone homologous series.

general formula ..... functional group ..... [2]

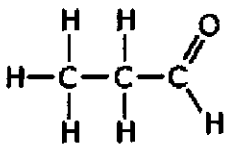
(b) Predict the boiling point of 3-pentanone.

.....[1]

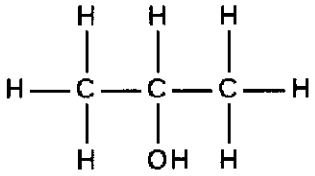
(c) Using the information above, deduce the significance of the number "3" in the name "3-hexanone".

.....[1]

(d) 2-propanone, propanal (an aldehyde) and 2-propanol are all compounds of carbon, hydrogen and oxygen.



propanal



2-propanol

State with reasons, which of these three compounds are isomers of each other.

.....

.....

.....[2]

[Total: 6]

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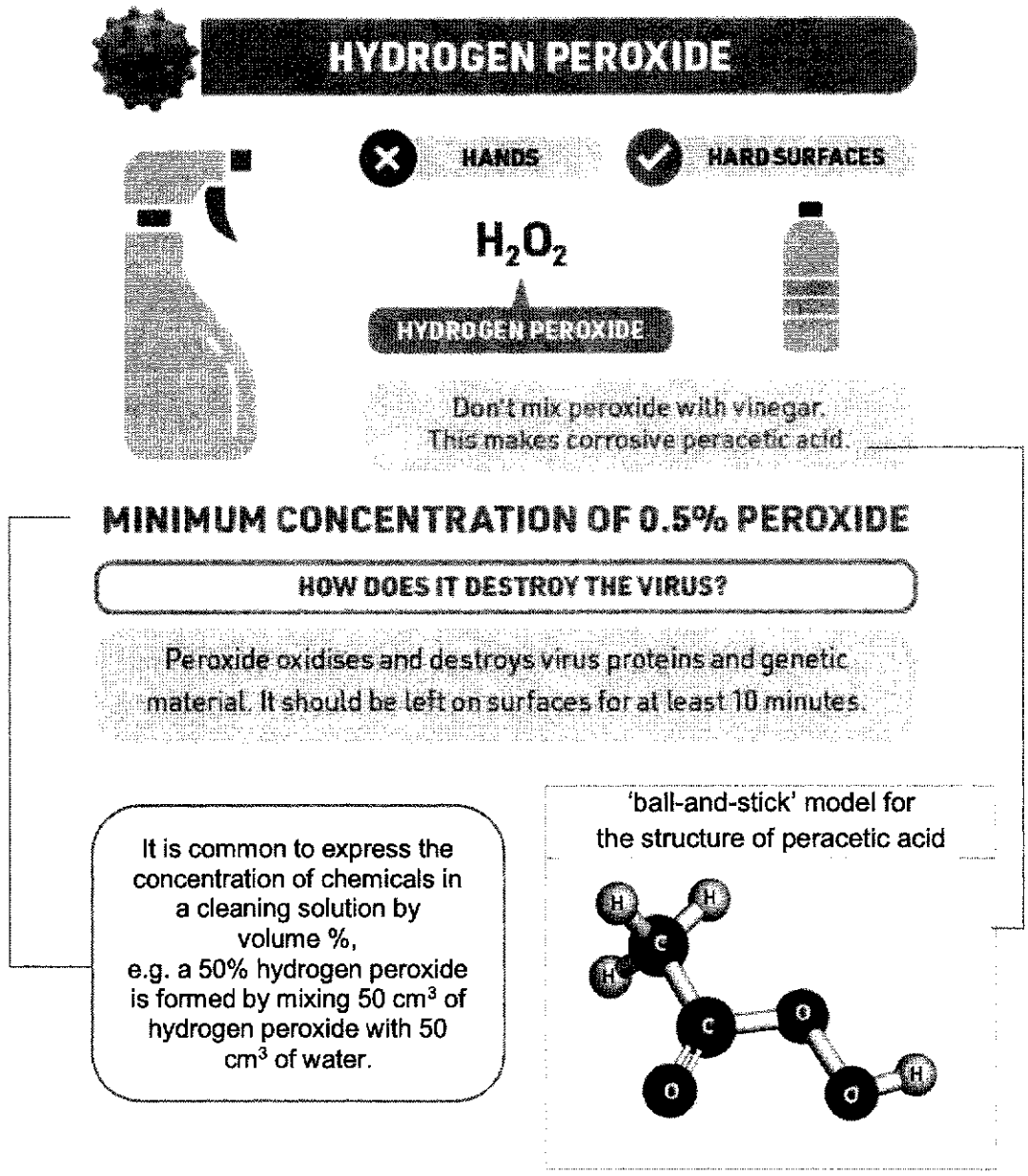
SECTION B

Answer all three questions from this section.

The last question is in the form of either/or and only one of the alternatives should be attempted.
The total mark for this section is 30.

B8 Hydrogen peroxide is a common chemical found in the laboratories and in solutions used in our daily lives. The following sources of information illustrate how hydrogen peroxide can be used in managing the spread of the coronavirus and also as a bleaching agent.

Source 1:



Adapted from info source:
https://www.compoundchem.com/2020/03/31/destroy-coronavirus/

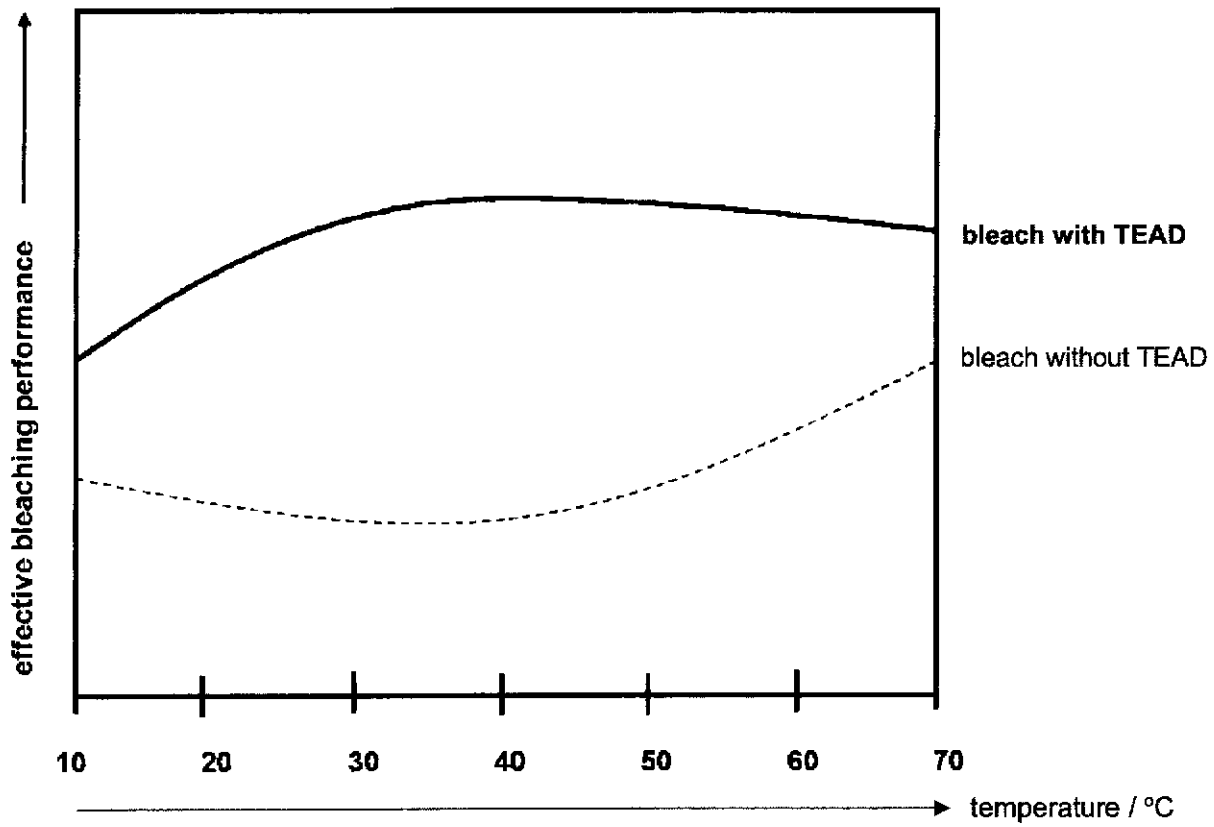
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Source 2:

Hydrogen peroxide is often found in bleaching solutions as it exhibits strong bleaching properties upon its decomposition into oxygen gas and water. A compound called TEAD is then added to the bleach solution to improve bleaching performance.

The graph below shows the performance of a hydrogen peroxide containing bleach solution, at different temperatures, with and without TEAD.



(a) Draw a "dot-and-cross" diagram to show the bonding in hydrogen peroxide. You are required to show only the outermost electrons.

[2]

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(b) A bottle of hydrogen peroxide solution of concentration 1.0 mol/dm^3 is found in the lab.

(i) Find the concentration of the hydrogen peroxide in g/dm^3. [Mr of H_2O_2 = 34]

[1]

(ii) Using your answer in **b(i)** and given that the density of hydrogen peroxide liquid is 1.45 g/cm^3, show, using calculations, whether the bottle of hydrogen peroxide solution meets the minimum concentration required for disinfecting surfaces.

[2]

(c) Based on the structure of peracetic acid, predict two properties that it will have.

.....

.....

.....[2]

(d) Describe the trend in the bleaching performance between the bleaches using TEAD and without using TEAD with respect to temperature.

.....

.....

.....

.....[2]

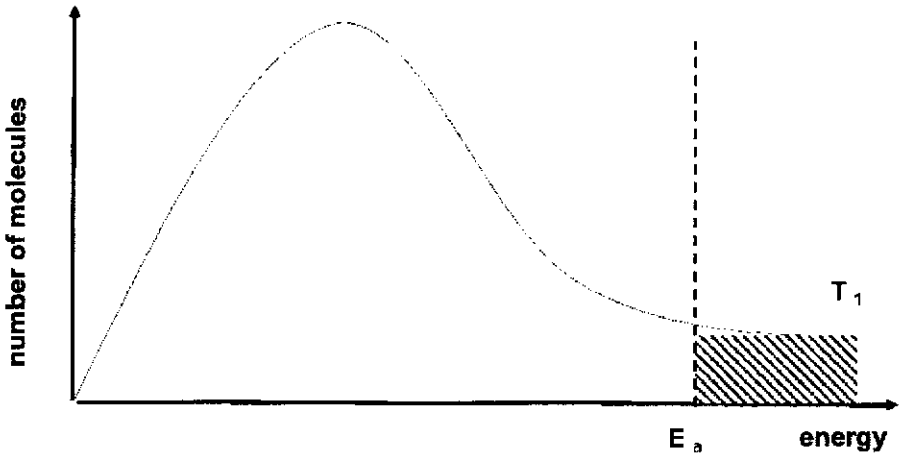
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(e) The graph below shows the distribution of energy of the particles in the bleach at a given temperature T_1.

Unshaded portion below the curve:
- represents colliding particles with energy less than E_a.

Shaded portion below the curve:
- represents colliding particles with energy equal or more than E_a.



(i) On the diagram itself, draw another vertical dotted line to mark the new E_a when a suitable catalyst is added and the temperature remains at T_1. Label the new E_a as E_a(catalyst).

[1]

(ii) Shade the new portion below the curve that represent effective collisions among particles after the catalyst is added.

[1]

(iii) What does your answer in **(e)(ii)** suggest about the effect of adding a catalyst?

.....

.....[1]

[Total: 12]

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B9 Mercury, Venus and Earth are the three inner planets in the solar system with Mercury closest to the sun. Venus is both the closest planet to Earth and the planet closest in size to Earth. With an average surface temperature of 462 °C, Venus is by far the hottest planet in the Solar System. Table 9.1 below shows the atmospheric composition on Venus.

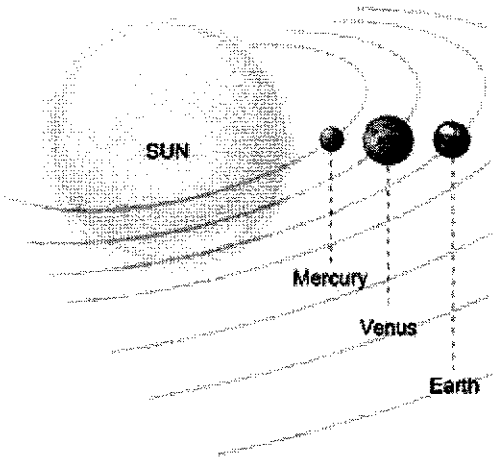


Table 9.1: percentage composition of the atmosphere on Venus

gas	percentage composition
carbon dioxide	96.5
nitrogen	3.5
sulfur dioxide	0.0150
argon	0.0070
water vapour	0.0020
carbon monoxide	0.0017
helium	0.0012
neon	0.0007

(a) Describe how the percentage composition of the atmosphere on Venus differs from that on Earth, with respect to carbon dioxide and nitrogen.

.....

.....

.....[2]

(b) Suggest why Venus has a much higher temperature than Mercury despite being further away from the Sun.

.....

.....

.....[2]

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(d) Suggest one property of metal that need to be taken into consideration when using it to make a space probe to land on Venus. Explain your answer.

.....

.....

.....[2]

(e) Describe a test to show that the atmosphere on Venus contains sulfur dioxide.

.....

.....

.....[2]

[Total: 8]

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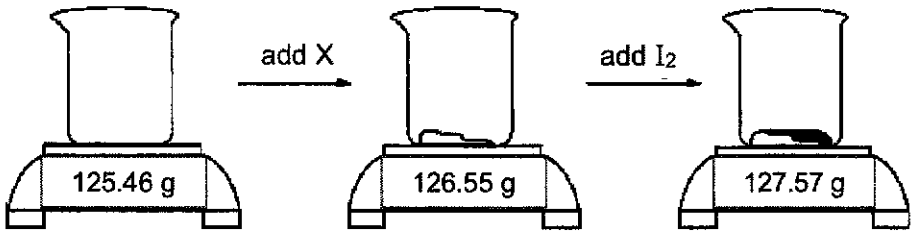
EITHER

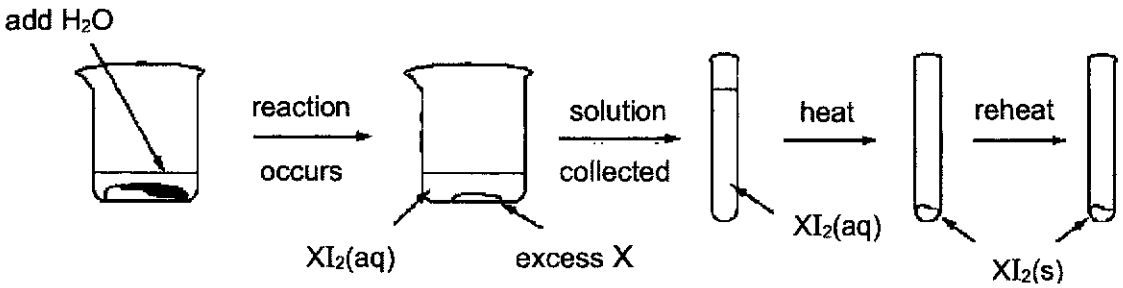
B10 A student conducted an experiment to determine the molar mass of an unknown metal, X. The student mixes solid iodine with an excess of metal X. When water is added to the mixture, a reaction occurs between iodine and the metal to form a water-soluble compound, XI_2.

The equation can be represented below:

$$X + I_2 \rightarrow XI_2$$

The reaction proceeds until all of the iodine is used up. The XI_2 solution is collected and heated to remove the water and the product is dried and weighed to a constant mass. The experimental steps are represented in the diagram and the results are tabulated below.





mass of beaker / g	125.46
mass of beaker + metal X / g	126.55
mass of beaker + metal X + I_2 / g	127.57
mass of XI_2 only (first weighing) / g	1.28
mass of XI_2 only (second weighing) / g	1.28

(a) Calculate the number of moles of I_2 used.

[2]

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(b) Calculate, to the nearest whole number, the molar mass of the unknown metal, X. Identify metal X.

Molar mass of X is .....

Metal X is .....[4]

(c) The student hypothesized that

"the compound formed in the reaction, XI_2, is ionic."

Briefly suggest how the student could test out this hypothesis in the laboratory.

.....

.....

.....[2]

(d) The student also predicted that chlorine gas will react with metal X more vigorously than solid iodine at room temperature.

With reference to the trends observed in the Periodic Table, justify if this prediction would be true.

.....

.....

.....[2]

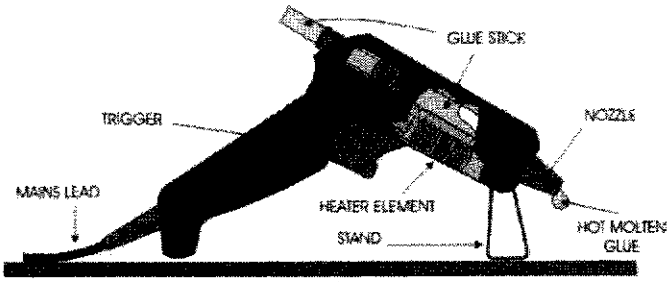
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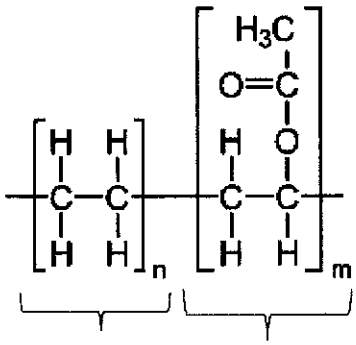
OR

B10 Hot glue, a form of thermoplastic adhesive in solid cylindrical sticks are melted in the electric glue gun with a continuous-duty heating element. The glue is sticky when hot, and solidifies within a minute.



SECTIONAL DRAWING OF A HOT GLUE GUN

The glue is a polymer known as ethylene vinyl acetate (also known as EVA). EVA is a polymer made up of two different polymers joined together. It is a copolymer of poly(ethylene) and poly(vinyl acetate). The structural formula of EVA is as shown below.



Poly(ethylene) Poly(vinyl acetate)

(a) Draw the full structural formula of the monomer used to form

(i) poly(ethylene),

(ii) poly(vinyl acetate).

monomer of poly(ethylene) monomer of poly(vinyl acetate)

[2]

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(b) A sample of EVA polymer made with 20% by mass of vinyl acetate was analysed and found to have an average relative molecular mass of 12040.

How many carbon atoms are present in an average chain?

Show your working clearly.

[4]

(c) **(i)** Two organic molecules, **M** and **N** can be used to synthesize the monomer of poly(vinyl acetate).

Draw the full structural formula of these organic molecules, **M** and **N**.

[2]

(ii) State the conditions needed for the reaction between organic molecules, **M** and **N** to occur.

.....[1]

(iii) Zinc granules were added into two beakers, each containing one of the molecules, **M** and **N**. Only one of the beakers showed a reaction.

Describe what was observed for the beaker which showed a reaction when zinc was added.

.....

.....[1]

[Total: 10]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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	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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6092 PURE CHEMISTRY PRELIM 2021 ANS SCHEME

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

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Paper 1 B

1-5		6-10		11-15		16-20		21-25		26-30	

Note to all students:
Markers for national exams have commented on students' handwriting that are too small to be read. Let's have some consideration for the people reading and grading your scripts.

Section A

<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Remarks</th></tr>
<tr><td>A1a</td><td>Element X: Group VII / Halogens
Element Y: Group VI</td><td>1
1</td><td></td></tr>
<tr><td>b</td><td>Oxygen</td><td>1</td><td></td></tr>
<tr><td>c</td><td>Period 3</td><td>1</td><td></td></tr>
<tr><td>d</td><td>AlX_3</td><td>1</td><td></td></tr>
<tr><td>e</td><td>It is inert
OR
It has low boiling and melting point.</td><td>1</td><td></td></tr>
<tr><td>A2a</td><td><table><tr><th>name</th><th>formula</th><th>code</th></tr><tr><td>Potassium fluoride</td><td>KF</td><td>19, 9</td></tr><tr><td>Copper(II) carbonate</td><td>$CuCO_3$</td><td>29,6,8(3)</td></tr><tr><td>nitrogen dioxide</td><td>NO_2</td><td>7, 8(2)</td></tr></table></td><td>Every 2 correct answers = 1m</td><td></td></tr>
<tr><td>bi</td><td>Atoms of the same element (same number of protons)
with different number of neutrons.</td><td>1</td><td></td></tr>
<tr><td>bii</td><td>There is a higher percentage of Cl-37 atoms compared to Cl-35 atoms in the gas sample.

Both Cl-35 and Cl-37 contain 17 protons in the nucleus and 17 electrons in the electron shells.

Cl-35 contains 18 neutrons in the nucleus but Cl-37 contains 20 neutrons in the nucleus.</td><td>1

1

1</td><td></td></tr>
<tr><td>A3a</td><td>$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$
Correct equation</td><td>1</td><td></td></tr>
</table>

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Qn	Answer	Marks	Remarks
	Correct state symbols	1	
b	Calcium hydroxide that is formed in a wet concrete beam is a **strong alkali** that **fully dissociates in water to release hydroxide ions**.	½ ½	
c	Carbon dioxide in air is an acidic oxide. It dissolves in water to form a weak acid that will neutralize the calcium hydroxide found in wet concrete.	1 1	
d	Salt speeds up the process of rusting.	1	
A4a	$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$ Deduct 1m overall if state symbols not provided or wrongly stated.	1 1	
b	Nitric acid which contains the nitrate ion has been added to the resulting mixture already. The test will always give positive results regardless of whether the original sample of wastewater contained nitrate ions.	1 1	
C	(1/2m) Add excess aqueous ammonia to the sample of wastewater → (1/2m) A white precipitate is formed which is insoluble in excess aqueous ammonia ↓ Filter (1/2m) Add aqueous sodium hydroxide in excess to the filtrate → (1/2m) White precipitate is formed, insoluble in excess aqueous sodium hydroxide	1 1 1	
A5a	Production of ammonia in Haber process OR Production of magarine with vegetable oil. *Accept any other reasonable suggestion.*	1	
b	X = activation energy	1	

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<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Remarks</th></tr>
<tr><td></td><td>Y = enthalpy change</td><td>1</td><td></td></tr>
<tr><td>c</td><td>Agree.
The energy profile diagram shows that the energy level of the products are higher than the energy level of the reactants.
This means that the reaction is endothermic and there should be greater energy absorbed for breaking bonds than energy released from bond formation.</td><td>1

1</td><td></td></tr>
<tr><td>d</td><td>Ea lowered
But same start and end point level.</td><td>1</td><td></td></tr>
<tr><td>A6a</td><td>
<table>
<tr><th>experiment</th><th>electrodes</th><th>Ionic equation, for reaction at each electrode</th></tr>
<tr><td rowspan="2">1</td><td>carbon rod</td><td>$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$</td></tr>
<tr><td>steel keychain</td><td>$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$</td></tr>
<tr><td rowspan="2">2</td><td>copper rod</td><td>$Cu(s) \rightarrow Cu^{2+}(aq) + 2e$</td></tr>
<tr><td>steel keychain</td><td>$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$</td></tr>
</table>
</td><td>1

½

1

½</td><td></td></tr>
<tr><td>b</td><td>Experiment 1:

The electrolyte solution turns from blue to colourless.
This is because, copper(II) ions that cause the blue colouration is being discharged and removed at the cathode.

Experiment 2:
The electrolyte solution remains blue.
This is because, as 1 mole of copper(II) ions are being discharged at the cathode.
1 mole of copper(II) ions are being released/formed at the anode to replenish it.</td><td>

1
1

1
1</td><td></td></tr>
<tr><td>c</td><td>The some parts of the original steel material had dissolved away.
Steel which contain iron, is more reactive than copper.
Iron will displace copper(II) ions out of the solution and form iron(II) ions instead, which dissolves into the solution.</td><td>1
1
1</td><td></td></tr>
<tr><td>7a</td><td>General formula: $C_nH_{2n}O$
Functional group: C=O</td><td>1
1</td><td></td></tr>
</table>

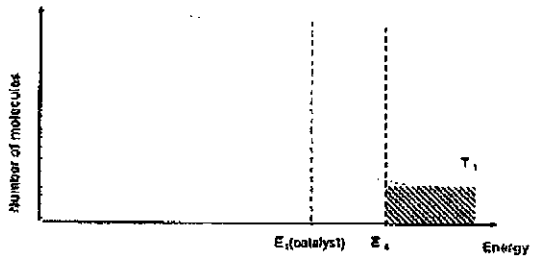
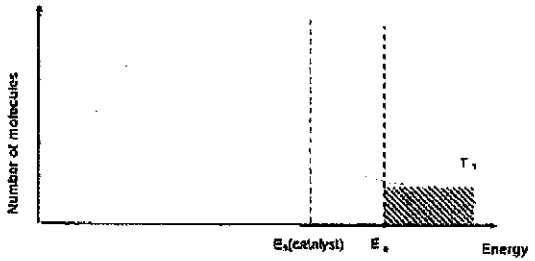
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Qn	Answer	Marks	Remarks
b	Approx 104 °C Answer must approximate to the interval difference of the data.	1	
c	It indicates the position of the carbon where the functional group is found.	1	
d	2-propanone and propanal are isomers. They have the same chemical formula of C_3H_6O. But they have different structures because the oxygen atom is bonded to the 2nd carbon in 2-propanone but in propanal, the oxygen atom is bonded to the 1st/3rd carbon.	1 1	

Section B

Qn	Answer	Marks	Comments
B8a	Correct sharing of electrons Correct distribution of unshared electrons and correct ratio of elements.	1 1	
bi	Conc of hydrogen peroxide = 1.0 x 34 = 34 g/dm^3	1	
bii	From ans in bi, 1000 cm^3 of the solution contains 34 g of H_2O_2. 1000 cm^3 of the solution contains (34/1.45 = 23.448 cm^3) of H_2O_2. Volume concentration of H_2O_2 = (23.448 / 1000) x 100 = 2.345 % Since concentration is > 0.5%, it meets the minimum concentration required.	½ 1 ½	
c	Low boiling and melting point Does not conduct electricity	1 1	
d	For bleach with TEAD: Between 10 – 40 °C, as temperature increases, the effective bleaching performance increases but starts to drop slightly as temperature increases beyond 40 °C.	½ ½	

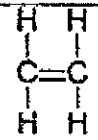
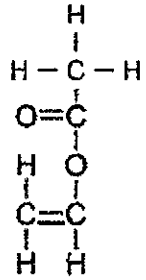
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Qn	Answer	Marks	Comments
	For bleach without TEAD: Between 10 – 35 °C, as temperature increases, the effective bleaching performance decreases but increases beyond 35 °C	 ½ ½	
ei		1	
eii		1	
eiii	The catalyst increases the proportion of colliding particles with energy equal or more than Ea.	1	
B9a	On Venus, carbon dioxide is the most abundant gas (96.5%) whereas on earth, carbon dioxide is only a very small 0.03% of the atmosphere. On Venus, nitrogen is a small percentage of 3.5 of the atmosphere but on earth, nitrogen is the most abundant gas (78%). - *Quote values or difference in gas composition* - *Provide a description on the significance of the different. (eg. Most abundant etc).*	 1 1	
b	The atmosphere of Venus is mostly made up of carbon dioxide (96.5%) which is a greenhouse gas.	1	

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Qn	Answer	Marks	Comments
	Carbon dioxide traps the heat on the planet, causing temperatures to be high.	1	
c	The material must have a high melting point. This is to withstand the high surface area temperature of Venus and prevent the probe from melting when it lands on the planet.	1 1	
d	Bubble a sample of the air from Venus through acidified potassium manganate(VII). The purple solution will turn colourless if sulfur dioxide is present.	1 1	
E B10a	Mass of I_2 = 127.57 – 126.55 = 1.02 g moles of I_2 = 1.02 / 254 = 0.0040158 = 0.00402 (3 sf)	1 1	
b	From chemical formula XI_2, mole ratio of X : I_2 = 1:1 Therefore, no. of moles of X in final dried product = 0.0040158 (same as I_2) Mass of X in final dried product = 1.28 – 1.02 = 0.26 g 0.0040158 mole of X = 0.26 g 1 mole of X (molar mass) = 0.26 / 0.0040158 = 64.7 = 65 The metal is zinc.	1 1 1 1	
c	Test the electricity conductivity of the solid compound and the aqueous compound. If the compound is unable to conduct electricity in solid state but able to conduct electricity in aqueous state, the compound is likely to be ionic in nature.		
d	Chlorine is above iodine in Group VII. Since reactivity decreases down the group for halogens, chlorine will be more reactive than iodine and react more vigorously.	½ 1 ½	

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Qn	Answer	Marks	Comments
OR B10ai		1	
aii		1	
b	Total Mr = 12040 Mass of poly(vinyl acetate) = 0.2 x 12040 = 2408 Mr of VA monomer = 86 m = 2408 / 86 = 28 no. of carbon atoms in VA = 28 x 4 = 112 Mass of poly(ethylene) = 0.8 x 12040 = 9632 Mr of ethylene monomer = 28 n = 9632 / 28 = 344 no. of carbon atoms in ethylene monomer = 344 x 2 = 688 Total number of carbon atoms = 688 + 112 = 800 *Correct mass found based on %* *Correct method of finding n and m* *Correct no. of carbon atoms for the total of each monomer type* *Correct final answer.*	 1 1 1 1	

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Qn	Answer	Marks	Comments
ci		2	
cii	Concentrated sulfuric acid catalyst and warming	1	
ciii	Bubbles will be formed	1	

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