O

GAN ENG SENG SCHOOL
Mid-Year Examination 2018

GESS

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092/01
7 May 2018
1 hour

Secondary 4 Express

Paper 1 Multiple Choice

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the OTAS.

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

Read the instructions on the OTAS 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.

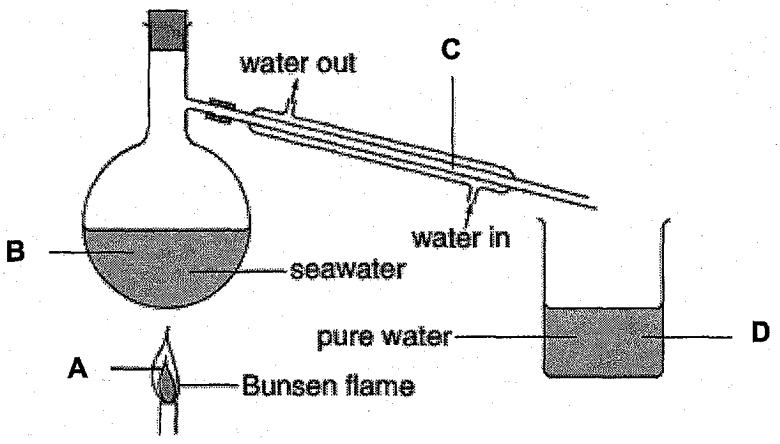
A copy of the Periodic Table is on page 14.

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

Total Marks
40

1 The diagram shows how to obtain pure water from seawater.

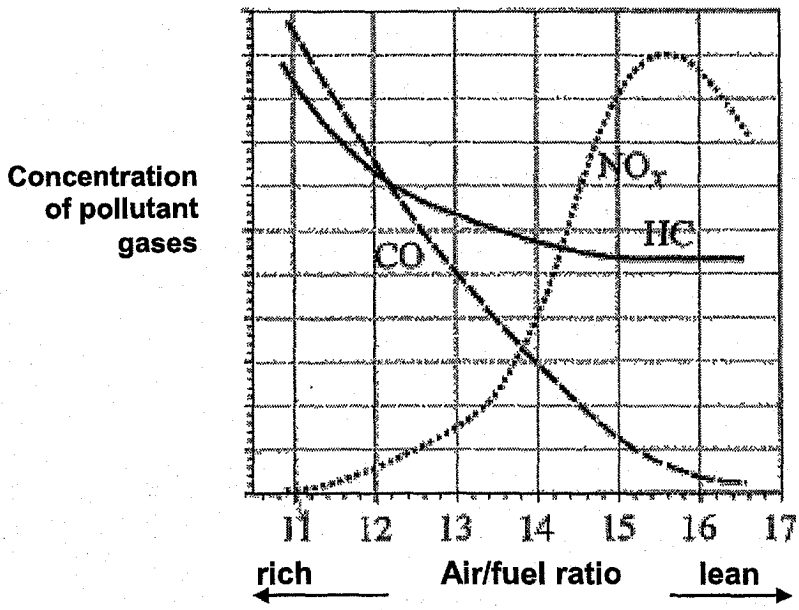
Where do water molecules lose energy?



Refer to the following to answer questions **2** and **3**.

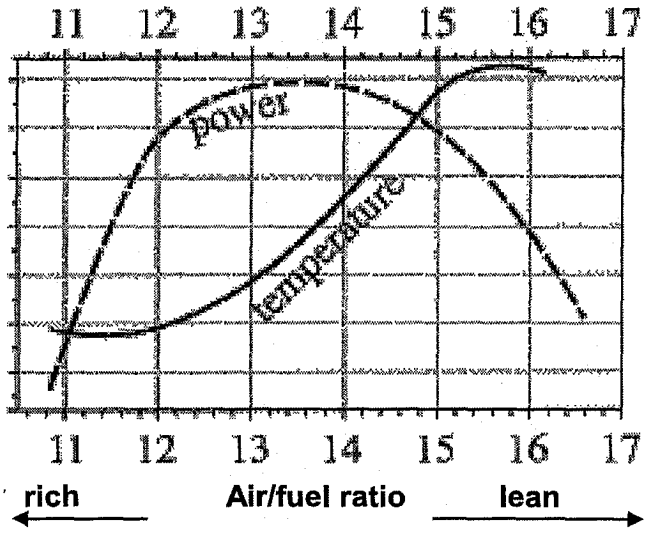
2 In a car engine, petrol vapour is mixed with air and undergoes combustion. When different amounts of petrol are mixed with air, different amounts of pollutant gases will be formed.

Graph I shows how the production of carbon monoxide (CO), nitrogen oxides (NO*x*) and hydrocarbons (HC) is dependent on the ratio of air to petrol.



Graph I

Graph II shows how the engine power and temperature vary with the different ratios of air to fuel of the fuel mixture.



Graph II

Which of the following is not true?

A The amount of carbon monoxide decreases as the air to fuel ratio increases.
B The emission of nitrogen oxides increases as temperature of engine increases.
C Increasing the proportion of air in the mixture will increase the amount of hydrocarbons emitted.
D Increasing the proportion of air in the mixture will increase the level of nitrogen oxides produced.

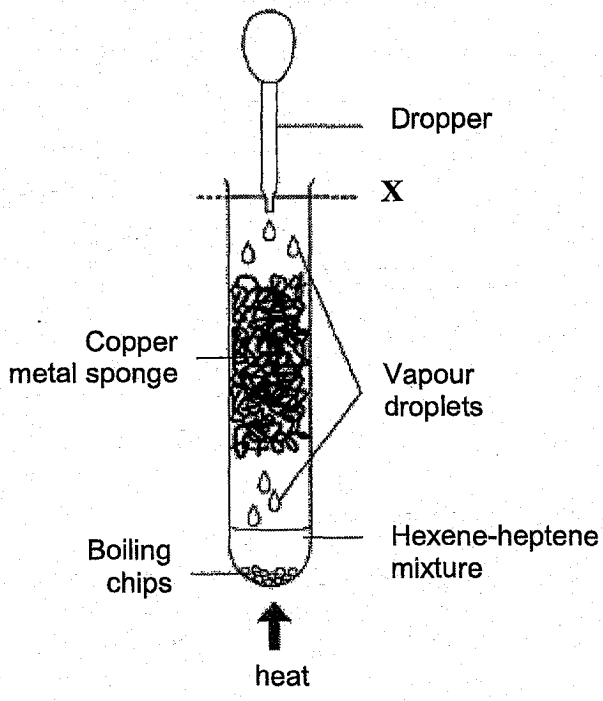
3 Which of the following conclusions **cannot** be drawn based on the information from the graphs?

A A fuel-rich mixture and low combustion temperature will reduce nitrogen oxide formation.
B The overall levels of the three pollutants are best reduced by increasing the air-to-fuel ratio.
C A fuel-lean mixture reduces the carbon monoxide and hydrocarbons but reduces the engine output.
D A fuel-rich mixture reduces the level of nitrogen oxides emitted but reduces the engine power output.

Refer to the following to answer questions **4** and **5**.

1-hexene and 1-heptene are two members of the alkene class of hydrocarbons.

A small amount of mixture of 1-hexene and 1-heptene was placed in a boiling tube and gently heated to boiling in a sand bath using the following setup:



Droplets were formed and could be seen condensing on the sides of the tube. When the vapour condensation line reached the level marked **X**, the hot vapours were very slowly withdrawn and condensed by using a small dropper.

4 What is the purpose of the copper metal sponge?

A Minimises contact of the mixture with air.
B Prevents the two compounds from escaping.
C Acts as a catalyst to speed up the reaction of the two compounds.
D Provides a large surface area for repeated vapourisation and condensation.

5 What process is demonstrated in this experiment?

A Cracking
B Combustion
C Addition reaction
D Fractional distillation

6 Which of the following does not affect the rate at which a gas spreads throughout a room?

A Boiling point of gas
B Temperature of gas
C Molecular mass of gas
D Density

7 Three elements, **X**, **Y** and **Z** have consecutive increasing atomic numbers.

If element **Y** is a noble gas, what will be the symbol for the ions formed by elements **X** and **Z** in their compounds?

A X^- and Z^+
B X^{2-} and Z^{2+}
C X^+ and Z^-
D X^{2+} and Z^{2-}

8 Potassium ferrate, K_2FeO_4, has been described as a 'green oxidising agent' because the by-products generated are environmentally-friendly.

What are the ions in this compound?

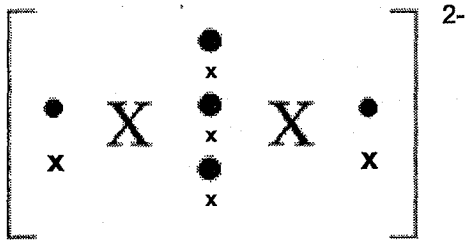
A K^+, FeO_4^{2-}
B K_2^+, FeO_4^-
C K^+, Fe^{6+}, O^{2-}
D K_2^+, Fe^{2+}, O^{2-}

9 Peeling onions often causes tearing of the eyes due to the release of a sulfide compound. Peeling them under running water reduces the problem. Which of the following statements are true of the sulfide compound?

I. It is soluble in water
II. It has low boiling point.
III. It has small and light ions with weak bonding.
IV. It is a covalent compound with weak covalent bonds.

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

10 Element **X** forms the ion X_2^{2-} with the following structure:



What is the formula of the covalent compound **X** forms with chlorine?

A XCl
B XCl_2
C XCl_3
D XCl_4

11 What is the maximum concentration of H^+ ions in 0.250 mol/dm^3 of phosphoric(V) acid, H_3PO_4?

A 0.125 mol/dm^3 **B** 0.250 mol/dm^3
C 0.500 mol/dm^3 **D** 0.750 mol/dm^3

12 Heating iron in dry chlorine gas results in the formation of an iron(II) chloride. Experimental determination gives a reading of 34.5% by mass of iron in the Iron(II) chloride formed. What is the charge of the iron in the chloride?

A 2- **B** 2+
C 3- **D** 3+

13 Which of the following results is obtained when 100 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid is added to 60.0 g of granular solid lead(II) carbonate?

A No visible reaction.
B Colourless solution with effervescence is produced.
C Colourless solution with white precipitate
D A colourless solution with white precipitate, effervescence and granular remains.

14 Which of the following pairs of aqueous reagents is **not** suitable for preparing insoluble salts?

A Sulfuric acid and calcium chloride
B Aluminium chloride and silver nitrate
C Barium hydroxide and copper(II) sulfate
D Lithium carbonate and iron(II) sulfate

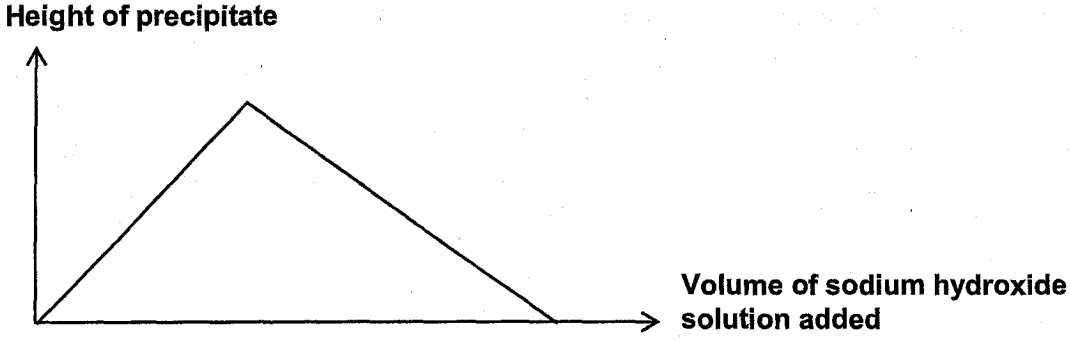
15 A salt has the formula $NH_4Fe(SO_4)_2.12H_2O$. Excess aqueous sodium hydroxide was added to an aqueous solution of the salt in a test tube and the mixture was then warmed gently. Which of the following would **not** be observed?

A A pungent gas was detected.
B A green precipitate was formed.
C A reddish brown precipitate was obtained.
D A piece of moist litmus paper placed at the mouth of the test tube turned blue.

16 A compound **Q** formed white precipitate when acidified aqueous silver nitrate is added. Aqueous ammonia was used to identify the presence of the other ion and there is no visible change. Identify compound **Q**.

A Calcium chloride
B Ammonium nitrate
C Calcium nitrate
D Zinc chloride

17 An aqueous solution of a salt **X** is placed in a test tube and sodium hydroxide solution is gradually added. The height of the precipitate in a test tube is plotted against the volume of sodium hydroxide solution added.



What could be **X**?

A Aluminium sulfate
B Calcium nitrate
C Iron(II) sulfate
D Ammonium nitrate

18 The formula for hydrated copper(II) nitrate is $Cu(NO_3)_2.xH_2O$. It contains 36.5% water of crystallisation by mass.

What is the value of x?

A 4 **B** 5
C 6 **D** 7

19 Element **X** is found in Group IV of the Periodic table. Which of the following could not be a formula for a compound of **X**?

A **XO**
B $\mathbf{XO_2}$
C $\mathbf{XO_3^{2-}}$
D $\mathbf{XO_4}$

20 Which of the following statements best explains why 99.99% copper is used in manufacturing high quality electrical wires for audio equipment?

A Copper is a good conductor of electricity.
B Copper is a very reactive metal.
C 99.99% copper is less ductile and cannot be stretched easily.
D Copper is of high purity and is able to conduct electric current.

21 Which of the following statements about Group VII is **false**?

A Colours of elements become darker down the Group.
B Densities of elements increase down the Group.
C Melting points of elements increase down the Group.
D Number of valence electrons of elements increases down the Group.

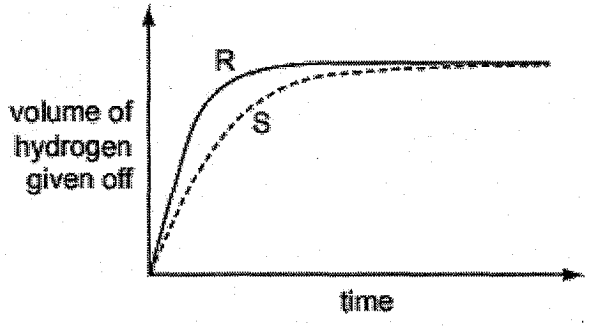
22 Methane gas reacts extremely slowly with air at room temperature. If a piece of warm platinum is held in a methane-air mixture, methane ignites. Which of the following statements correctly describes the reaction with platinum?

I The activation energy is low.
II The energy change is greater.
III The energy of the reactants is lower than expected.
IV The rate of reaction is faster.

A **I** and **II**
B **I** and **IV**
C **I**, **II** and **IV**
D **I**, **II**, **III** and **IV**

23 A student investigates the rate of reaction between magnesium and excess sulfuric acid. The volume of hydrogen given off in the reaction is measured over time.

The graph shows the results of two experiments, **R** and **S**.



Which change in conditions would cause the difference between **R** and **S**?

A Catalyst is added into **S**.
B The acid is more concentrated in **R** than in **S**.
C The magnesium is less finely powdered in **R** than in **S**.
D The temperature in **R** is lower than in **S**.

24 Which statement is correct for the element of proton number 19?

A It is a gas that dissolves in water.
B It is a hard metal that is not very reactive with water.
C It is a non-metal that burns quickly in air.
D It is a soft metal that is highly reactive with water.

25 Statement 1: Alloying iron with other materials to form stainless steel prevents iron from rusting by excluding oxygen.

Statement 2: Painting, oiling and electroplating are all methods of preventing iron from rusting.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.
B Both statements are correct but statement 2 does not explain statement 1.
C Statement 1 is correct but statement 2 is incorrect.
D Statement 2 is correct but statement 1 is incorrect.

26 The reactions shown may occur in the air during a thunder-storm.

$$N_2 + O_2 \rightarrow 2NO$$

$$2NO + O_2 \rightarrow 2NO_2$$

$$NO + O_3 \rightarrow NO_2 + O_2$$

Which row shows what happens to the reactant molecules in each of these reactions?

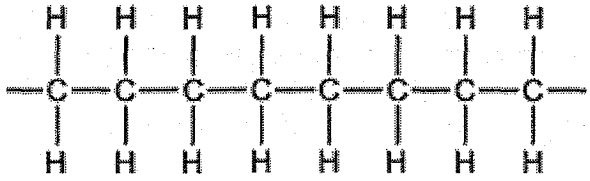
	N_2	NO	O_3
A	oxidised	oxidised	oxidised
B	oxidised	oxidised	reduced
C	reduced	reduced	oxidised
D	reduced	reduced	reduced

27 Iron is extracted from hematite in a blast furnace.

Which reaction contributes most of the heat in the blast furnace as it increases the temperature to over 1500°C?

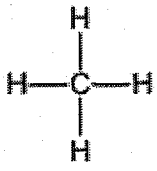
A calcium carbonate → calcium oxide + carbon dioxide
B calcium oxide + silicon dioxide → calcium silicate
C carbon + oxygen → carbon dioxide
D carbon dioxide + carbon → carbon monoxide

28 The diagram shows part of the molecule of a polymer.

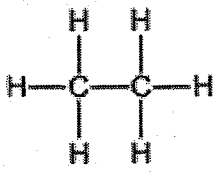


Which diagram shows the monomer from which this polymer could be manufactured?

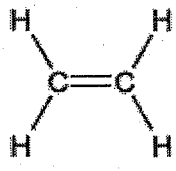
A



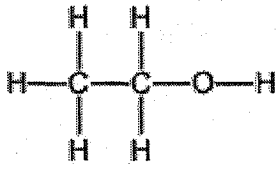
B



C



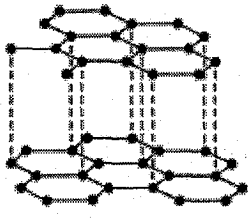
D



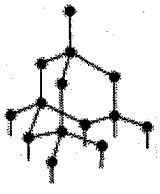
29 Slate has a layered structure and is slippery.

Which diagram shows a structure that closely resembles slate?

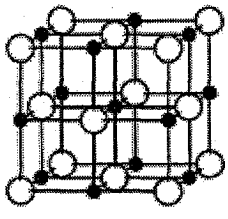
A



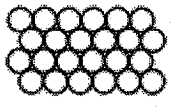
B



C



D



30 In separate experiments conducted, a gaseous halogen was bubbled into an aqueous solution of a halide salt.

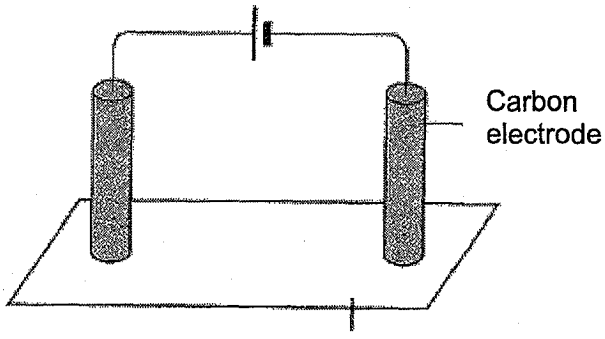
The following results were observed.

	Halides	
Halogen	**Y^-**	**Z^-**
X_2	No observable reaction	Displaced as Z_2
Y_2	No observable reaction	Displaced as Z_2
Z_2	No observable reaction	No observable reaction

What is the arrangement of halogens **X**, **Y** and **Z** in Group VII in order of decreasing reactivity?

A X, Y, Z
B Y, X, Z

31 Two carbon electrodes are placed on a piece of red litmus paper soaked in concentrated sodium chloride solution as shown:

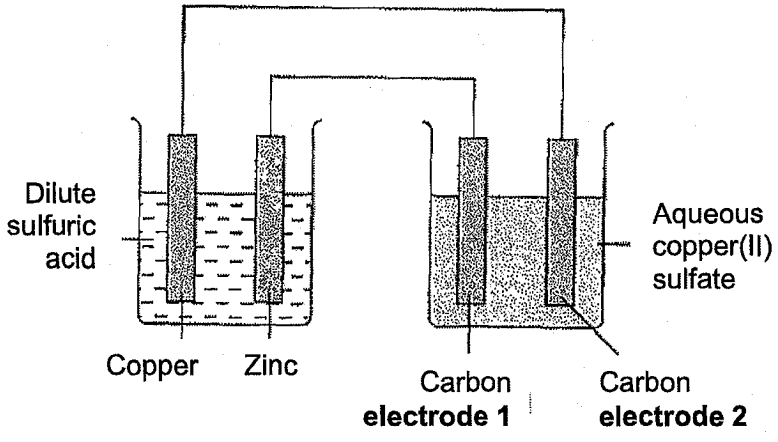


Litmus paper soaked in concentrated sodium chloride solution

What are the observations of the litmus paper at the respective electrodes?

	Cathode	Anode
A	Litmus paper is bleached.	Litmus paper turns blue.
B	Litmus paper turns blue.	Litmus paper is bleached.
C	Litmus paper turns blue.	Litmus paper remains red.
D	Litmus paper remains red.	Litmus paper remains red.

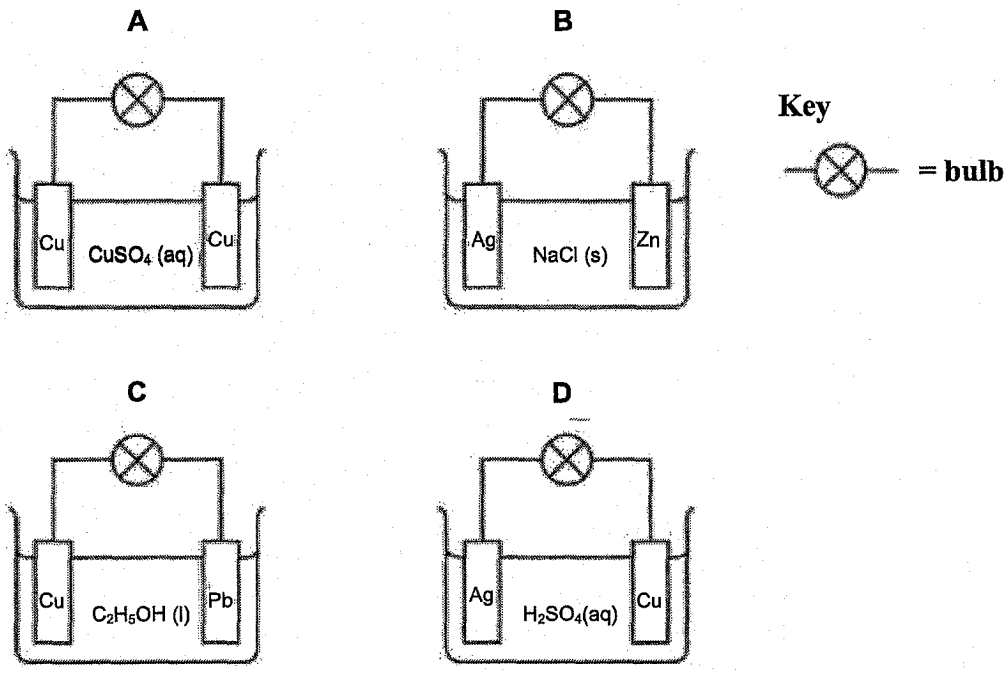
32 Two simple cells were set up as shown:



Two substances were discharged at the carbon electrodes. What were these two substances?

	Electrode 1	Electrode 2
A	Copper metal	Hydrogen gas
B	Hydrogen gas	Copper metal
C	Copper metal	Oxygen gas
D	Oxygen gas	Copper metal

33 In which circuit does the bulb light?



34 What are the main gases that escape from the top of the blast furnace in the manufacture of iron by the blast furnace?

A Nitrogen, steam and oxygen
B Oxygen, carbon dioxide and steam
C Nitrogen, carbon monoxide and carbon dioxide
D Carbon monoxide, carbon dioxide and nitrogen monoxide

35 A molten compound is electrolysed. Two atoms of X are deposited at the negative electrode at the same time as three atoms of Y are deposited at the positive electrode.

These results show that:

X is a ...**1**...;
Y is a ...**2**...;

the formula of the compound is ...**3**... .

How are gaps **1**, **2** and **3** correctly completed?

	1	2	3
A	Metal	Non-metal	X_3Y_2
B	Metal	Non-metal	X_2Y_3
C	Non-metal	Metal	X_3Y_2
D	Non-metal	metal	X_2Y_3

36 Zinc reacts with acids to form salts. Which of the following solutions would give the slowest rate of reaction when reacted with zinc?

A 0.0500 mol sulfuric acid in 500 cm^3 of water.
B 0.0250 mol sulfuric acid in 100 cm^3 of water.
C 0.0500 mol hydrochloric acid in 200 cm^3 of water.
D 0.0250 mol hydrochloric acid in 75 cm^3 of water.

37 Which compound will react with steam, in the presence of catalyst, to produce the alcohol $CH_3CH_2CH_2OH$?

A CH_3CHCH_2 **B** $CH_3CHCHCH_3$
C $CH_3CH_2CH_2CH_3$ **D** CH_3CH_2COOH

38 Which type of reaction does this equation show?

$$C_3H_8 + F_2 \rightarrow C_3H_7F + HF$$

A Hydration
B Neutralisation
C Addition
D Substitution

39 An unsaturated hydrocarbon with six carbon atoms contains only three C=C double bonds. This hydrocarbon is reacted with excess bromine at a room temperature.

What is the formula of the resulting hydrocarbon?

A $C_6H_8Br_3$ **B** $C_6H_{10}Br_3$
C $C_6H_8Br_6$ **D** C_6H_{14}

40 A hydrocarbon is found to contain about 80% of carbon by mass. What is the hydrocarbon?

A Methane **B** Ethene
C Propane **D** Hexene

END OF PAPER

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 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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GAN ENG SENG SCHOOL
Mid-Year Examination 2018

G.E.S.S ONWARD FOUNDED A.D.1954

CANDIDATE NAME

CLASS | | **INDEX NUMBER** | |

CHEMISTRY

6092/02
3 May 2018
1 hour 45 minutes

Paper 2

Secondary 4 Express

Candidates answer on the Question Paper.
Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions 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 on page 20.

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

	For Examiner's Use
Section A	.....
Section B	
B7	.....
B8	.....
B9 *Either / OR	.....
*Circle where appropriate	
Total	**80**

Section A (50 marks)

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

A1 The table below shows some information about elements **A-F**. The letters are **not** the chemical symbols of the elements.

Element	Colour	Melting point / °C	Boiling point / °C	Conducts electricity	Density / g/cm^3
A	Dull grey	1415	2898	Yes	2.0300
B	Pale yellow	-219	-188	No	0.0017
C	Orange brown	-7	59	No	3.1000
D	Shiny brown	1074	2927	Yes	8.9200
E	Shiny grey	1540	2861	Yes	7.8700
F	Colourless	-157	-153	No	0.0033

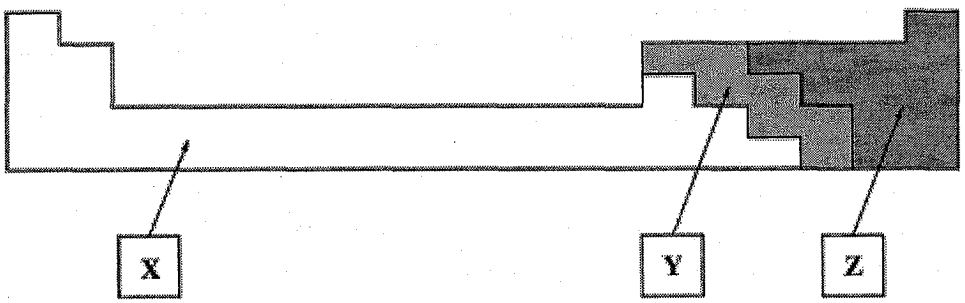
(a) (i) State which of the elements **A-F** are gases at room temperature. [1]

.....

(ii) Give the letter of the element **A-F** that has the biggest difference between melting point and boiling point. [1]

.....

(iii) The diagram shows an outline of the Periodic Table.



Element **A** is found in area **Y** of the Periodic Table shown above. Explain how the information in the table above supports this statement. [2]

.....

.....

.....

(b) Methane reacts violently with fluroine according to the following equation.

$$CH_4\,(g) + 4F_2\,(g) \rightarrow CF_4\,(g) + 4HF\,(g) \qquad \Delta H = -1904\ kJ/mol$$

Mean bond energies are given in the table shown below.

Bond	C-H	C-F	H-F
Mean bond energy / kJ/mol	412	484	562

A student suggested that one reason for the high reactivity of fluorine is a weak F-F bond.

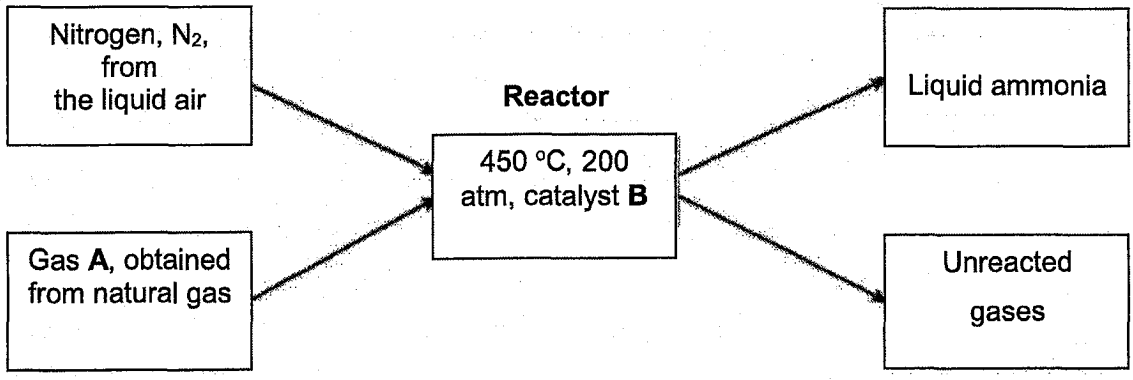
Is the student correct? Justify your answer with calculations using the above data. [4]

(c) Write an ionic equation for the reaction between potassium and cold water. [1]

.....

[Total: 9]

A2 Ammonia is produced during the Haber process. The reaction is summarised in the diagram below.



(a) Give the name of gas **A**. ..... [1]

(b) Name the catalyst **B** and explain why it is used. [2]

.....

.....

(c) The yield of ammonia is only 28% therefore 72% of the gases remain unreacted. [2]

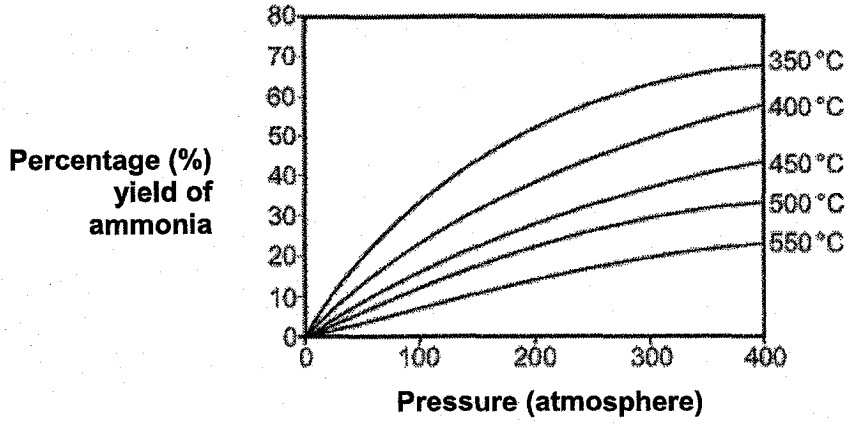
Describe what happens to these unreacted gases and explain why this is important.

.....

.....

.....

(d) The following graph below shows the effect of temperature and pressure on the yield of ammonia during the Haber process.



Describe how the yield of ammonia varies with temperature and pressure. [2]

(e) **(i)** Construct an equation for the production of ammonia in a Haber process. State symbols are required. [1]

.....

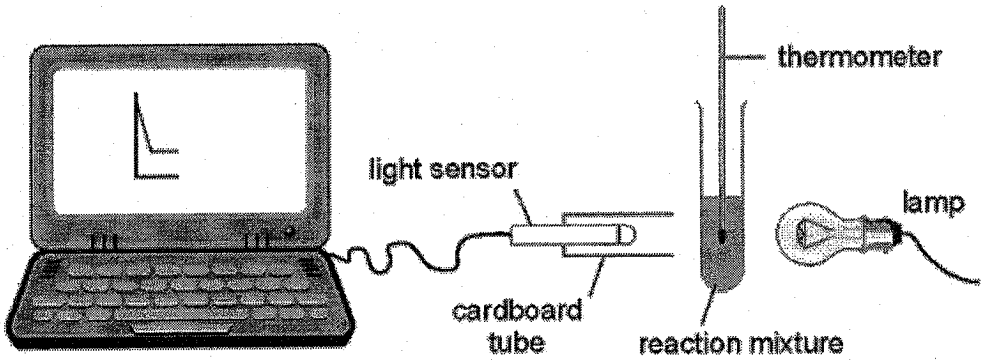
(ii) Explain if the above process is a redox reaction. Use oxidation number in your explanation. [2]

.....

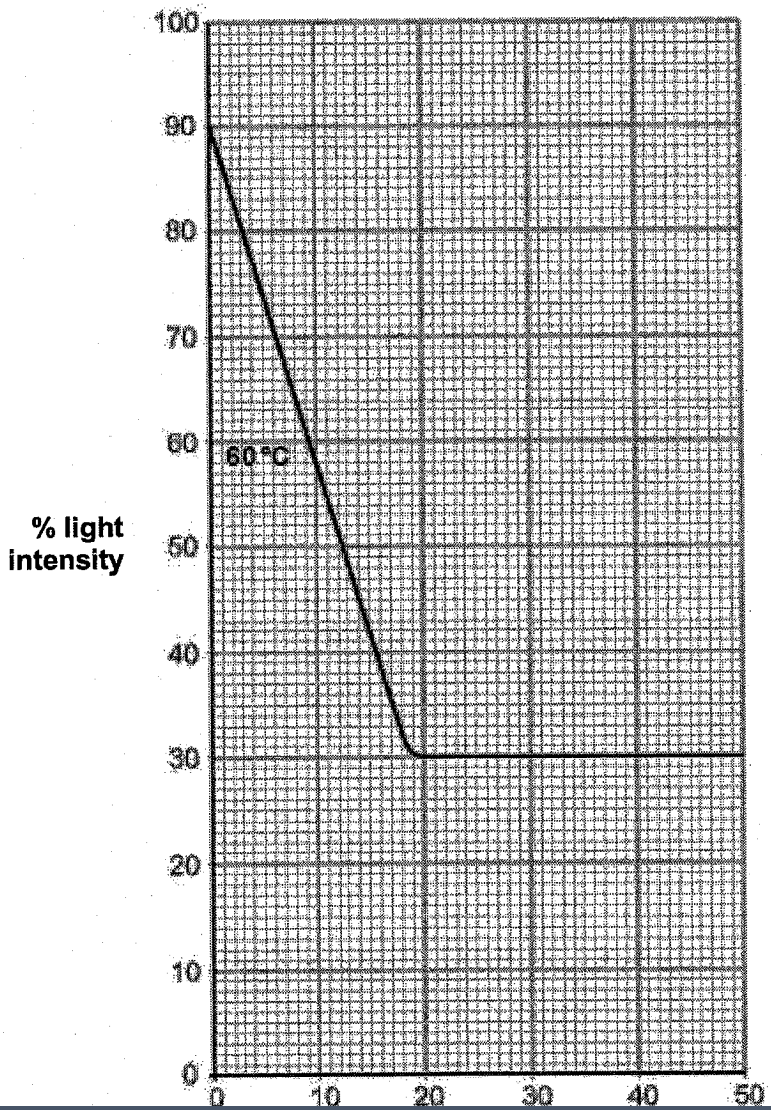
.....

[Total: 10]

A3 Sodium thiosulfate solution reacts with dilute hydrochloric acid forming a yellow precipitate. This reaction was investigated using the equipment below.



5 cm^3 of dilute hydrochloric acid was added to 10 cm^3 of sodium thiosulfate solution at 60 °C and the light intensity was measured over time. The results are shown on the grid below.



7

(a) Explain why the light intensity decreases as the reaction takes place. [2]

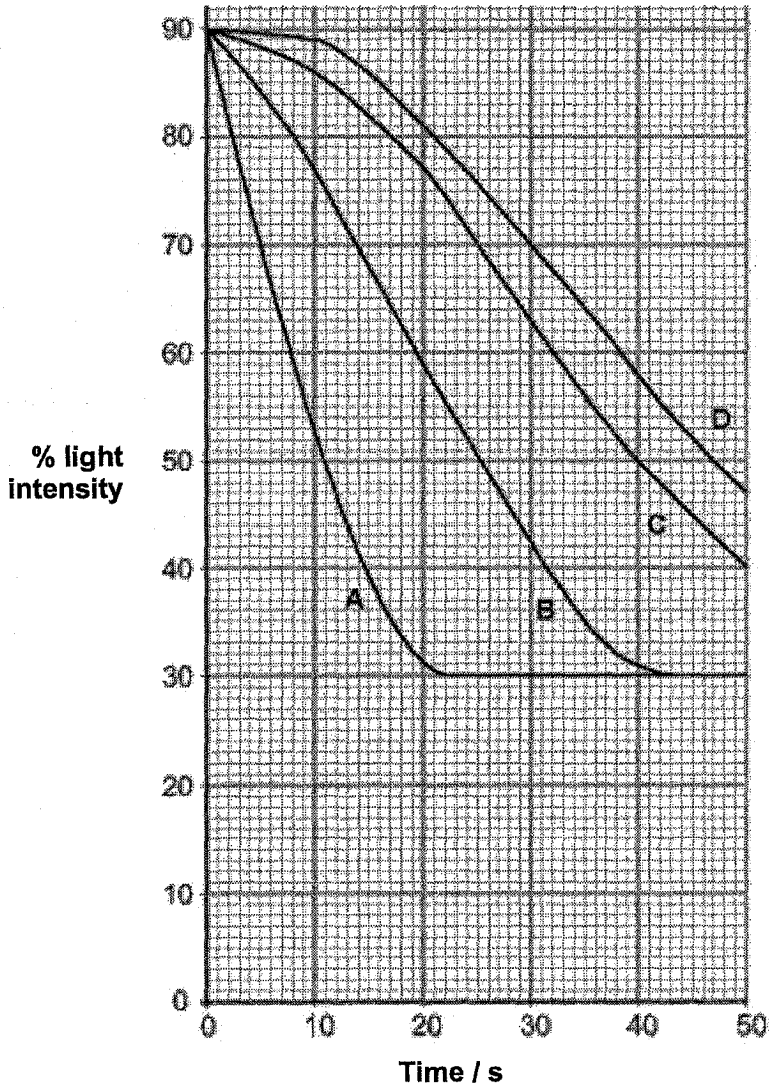
.....

.....

(b) Suggest one possible reason why the light intensity does not fall to 0%. [1]

.....

(c) In a separate experiment, 5 cm^3 of dilute hydrochloric acid was added separately to 10 cm^3 of sodium thiosulfate solution at four different temperatures. All other factors were kept the same. The results are shown on the grid below.



(i) Provide the letter **A**, **B**, **C** or **D** from the graph shown that represents the reaction carried out at the highest temperature. Explain your choice. [1]

(ii) The rate of reaction can be calculated using the formula: [1]

Rate = 1 / time

The reaction is considered to be complete when the percentage light intensity reaches 30%. Calculate the mean rate for experiment **B**.

(iii) Using collision theory, provide a conclusion you can draw from the above investigation. [3]

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(d) A chemist carried out an experiment to find out the reactivity of the metals. Below shows the time taken for limewater to form white precipitate for each metal carbonate.

Metal carbonate	Time taken to form white precipitate / s
Copper carbonate	10
Magnesium carbonate	40
Zinc carbonate	24

Explain these results in terms of reactivity of the metals. [2]

.....

.....

.....

[Total: 10]

A4 An alcohol **G** was known to be one of the following.

HOHOCHCH=CHCHOHOH	Alcohol **1**
$CH_3CH_2CH_2CH_2OH$	Alcohol **2**

A sample of 1.20 g of alcohol **G** was burned in excess oxygen. 1.79 g of carbon dioxide was formed.

(a) Calculate the mass of carbon present in the sample of alcohol **G**. [1]

(b) The mass of hydrogen in the sample is 0.0812 g. Assuming that the rest of the sample is oxygen, calculate the mass of oxygen in the sample. [1]

(c) Use your answers above to find the empirical formula of alcohol **G**. [2]

(d) State the identity of alcohol **G**. Explain clearly how you reached this conclusion. [1]

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.....

(b) **(i)** In an experiment, a chemist calculated the maximum yield of aspirin is 400 g. The chemist did the experiment but only made 250 g of aspirin. Calculate the percentage yield of aspirin for this experiment.

Show clearly how you work out your answer and suggest one possible reason why the chemist did not have a percentage yield of 100%. [2]

.....

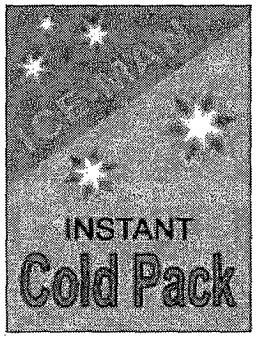
.....

(ii) Suggest how the use of catalyst might reduce costs in the industrial production of aspirin. [1]

.....

.....

(c) Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water. Inside the bag is a smaller bag containing solid ammonium nitrate. The outer bag is squeezed so that the inner bag bursts.

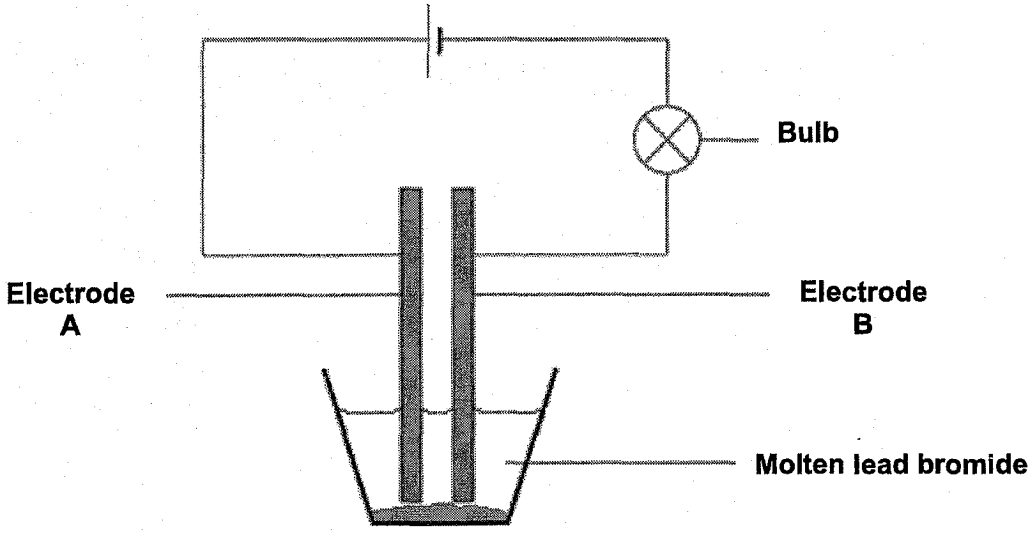
Explain why the bag becomes cold. [2]

.....

.....

[Total: 7]

A6 The diagram below shows the apparatus used during electrolysis of molten lead (II) bromide.



(a) Suggest a reason why lead (II) bromide must be molten in order for electricity to flow. [1]

.....

.....

(b) Write the half equation for the reaction taking place at the electrode **A**. [1]

.....

(c) **(i)** State, in terms of electrons, what happens to the ions at the electrode **B**. [1]

.....

.....

(ii) Describe an observation you would expect at the electrode **B**. [2]

.....

.....

(iii) Electrolysis is allowed to continue for some time before the apparatus is cooled to room temperature. The bulb remains lit. [1]

Explain this observation.

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.....

Section B (30 marks)

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

B7 The investigation of hydrocarbons

Information 1

From its modest beginning in 1980, the U.S. ethanol industry has grown tremendously in response to surging domestic use and worldwide demand.

The table below shows two different identified processes to produce ethanol.

Process 1	Process 2
Fermentation of a sugar solution by yeast in a reaction vessel. The reaction vessel has to be emptied, cleaned and refilled every few days. The process produces a 15% ethanol solution in water daily.	Reaction of ethene (from crude oil) with steam in a reactor. The reaction is only stopped if there is a fault in the reactor. The process produces 100% pure ethanol.

Information 2

An advertisement for crisps claimed that they are healthier because they are cooked in certain oils. A student found the following information about four oils that are used to make crisps.

	Rapeseed oil	Sunflower oil	Olive oil	Corn oil
Saturated fat / %	6.6	12.0	14.2	14.4
Poly-unsaturated fat / %	29.3	63.3	8.1	51.3
Melting point / °C	+5	-18	-12	-15

One hypothesis is that oils are thought to be healthier if they are:

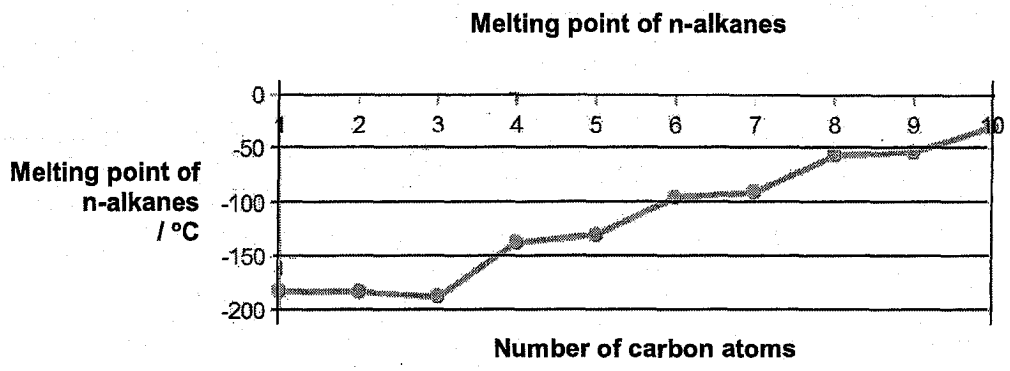
- Low in saturated fat.
- High in poly-unsaturated fat.

For certain oils and fats such as olive oil, soybean oil, or nut oils, when compared with others, such as margarine, butter, chicken fat and beef fat (the white stuff found in and around slabs of meat), the most prominent difference that was discovered was that different oils and fats have different states of matter at room temperature.

Some oils and fats are liquid at room temperature, and even when kept in the fridge, like olive oil and soybean oil. By contrast, other fats have higher melting temperatures.

The melting point of fats is the temperature at which they become liquid. **Graph 1** shows the change in melting point for saturated hydrocarbon.

Graph 1



The melting temperature is the same as freezing temperature; it is the temperature where the fat changes from a liquid to a solid.

In addition, the effect of the percentage of saturated fats within certain oils on the energy released from combustion was investigated. It was found out that as the saturation of the carbon chain increases, the energy released from combustion decreases.

Table 1: Experimental results on the four different oil used

		Rapeseed oil	Sunflower oil	Olive oil	Corn oil
Energy released from combustion (kJ/g)	Trial 1	5.05	3.48	6.55	3.95
	Trial 2	4.98	3.20	5.98	2.01
	Trial 3	4.46	2.98	6.24	3.88

Table 2: Hydrocarbon table

Name	Chemical formula	Heat of combustion (kJ/g)
Methane	CH_4	55.6
Ethane	C_2H_6	52.0
Propane	C_3H_8	50.0
Butane	C_4H_{10}	49.2

Note: Heat of combustion is also known as enthalpy change. It refers to the heat energy released when a compound undergoes complete combustion with oxygen under a given condition.

(a) Using **Information 1**,

(i) Give one advantage that Process 1 has over Process 2. [1]

.....

.....

(ii) State one advantage Process 2 has over Process 1 as a manufacturer of ethanol. [2]

.....

.....

.....

(b) Using **Information 2**,

(i) Determine which oil should be healthier. [2]

Explain your answer.

.....

.....

.....

(ii) These unsaturated oils can be hardened by an addition reaction with hydrogen at 200 °C with nickel catalyst. [2]

A student said that this hardening process would make sunflower oil healthier.

Is this student's hypothesis correct? Explain your answer.

.....

.....

.....

(iii) Using **Table 2**, describe and explain the data patterns for series of heat of combustion on the different alkanes. [2]

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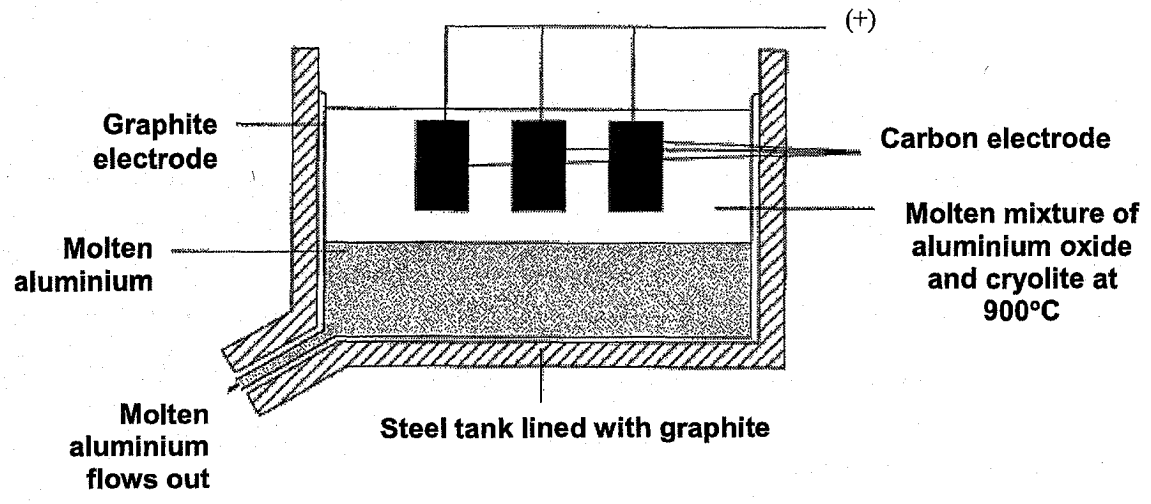
.....

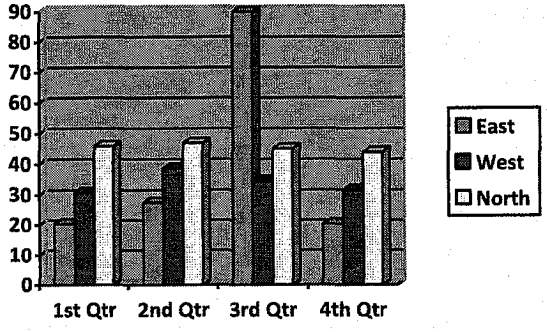
.....

(iv) Based on the information given, describe the trend of the melting point of alkanes. [1]

.....

B8 The diagram shows an electrolysis tank used to extract aluminium from aluminium oxide. Pure aluminium oxide melts at 2055 °C.





(a) Cryolite is mixed, as an impurity, with aluminium oxide. State the effect it has on the melting point of the mixture and explain why mixing cryolite is necessary. [2]

.....

.....

(b) Write half equations for the reactions that take place at the anode and cathode. [2]

Anode: .....

Cathode: .....

(c) Draw **two** arrows on the diagram to indicate the flow of electrons. Clearly label on the two electrodes. [1]

(d) What is the volume of oxygen produced, under room temperature and pressure when 540 g of aluminium is produced? [2]

(e) The carbon electrodes are replaced at regular intervals. Explain the need for this. [1]

.....

.....

(f) Draw a clearly labelled diagram to show how a metal object could be electroplated with copper. [2]

[Total: 10]

EITHER

B9 Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS. The zinc blende is first crushed to powder and then treated by froth flotation *(mineral processing, where it is used in the extraction of several metals)*.

Zinc blende reacts with oxygen in the air to produce zinc oxide and a gas which escapes as waste gas.

(a) **(i)** Explain why zinc blende is crushed to powder before treatment? [1]

.....

.....

(ii) Write a chemical equation for the reaction in **(a)(i)**. [1]

.....

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace. Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe. [3]

.....

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(ii) Give **two** reasons why the zinc produced inside the furnace is in gaseous state. [2]

.....

.....

(iii) State the name of the physical change for conversion of gaseous zinc into molten zinc. [1]

.....

(c) Rusting of steel can be prevented by coating the steel with a layer of zinc. [2]

Explain, in terms of electron transfer, why steel does not rust even if the layer of zinc is scratched and the steel is exposed to air and water.

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.....

.....

OR

B9 Petroleum is a source of many important chemicals.

(a) Name **two** industrial processes which must take place to produce alkenes from petroleum. [2]

.....

(b) Ethene and propene can both be converted into polymers.

(i) State the type of polymerisation that takes place when ethene forms a polymer. [1]

.....

(ii) Identify the empirical formula of the polymer formed from ethene. [1]

.....

(iii) Draw **two** repeat units of the polymer made from propene. [2]

(c) Most of the hydrocarbons obtained from petroleum are alkanes. The alkanes are homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}. [2]

Give two characteristics, other than having the same general formula, of members in the same homologous series.

.....

.....

(d) When one mole of chlorine, Cl_2, reacts with one mole of propane, a mixture of **two** structural isomers is formed in the **first step** of substitution. [2]

Draw **all** the structural formulas of the isomers formed when one mole of chlorine reacts with one mole of propane.

[Total: 10]

The Periodic Table of Elements

Group																	
I	II									III	IV	V	VI	VII	0
															2 He helium 4
					1 H hydrogen 1										
										5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
										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
										31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
										49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
										81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
											114 Fl flerovium –		116 Lv livermorium –		

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

3 Li lithium 7	4 Be beryllium 9																	
11 Na sodium 23	12 Mg magnesium 24																	
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							
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							
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							
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 –							

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 –

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

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GAN ENG SENG SCHOOL
Mid-Year Examination 2018

GESS

CANDIDATE NAME

CLASS

INDEX NUMBER

CHEMISTRY

6092/01
7 May 2018
1 hour

Secondary 4 Express

Paper 1 Multiple Choice

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the OTAS.

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

Read the instructions on the OTAS 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.

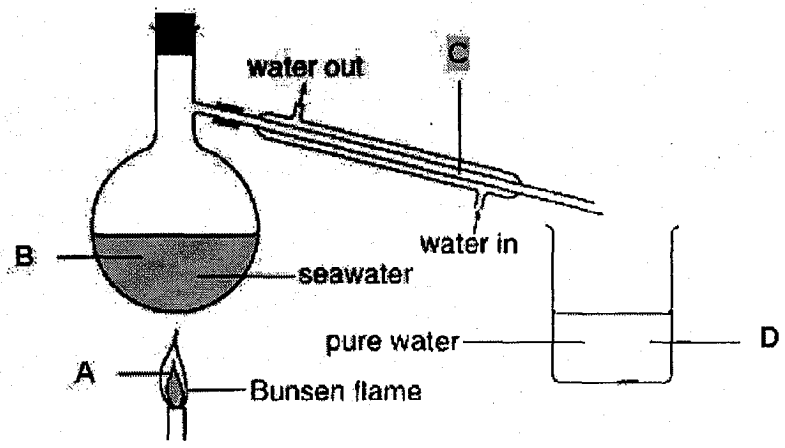
A copy of the Periodic Table is on page 14.

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

Total Marks
40

1 The diagram shows how to obtain pure water from seawater.

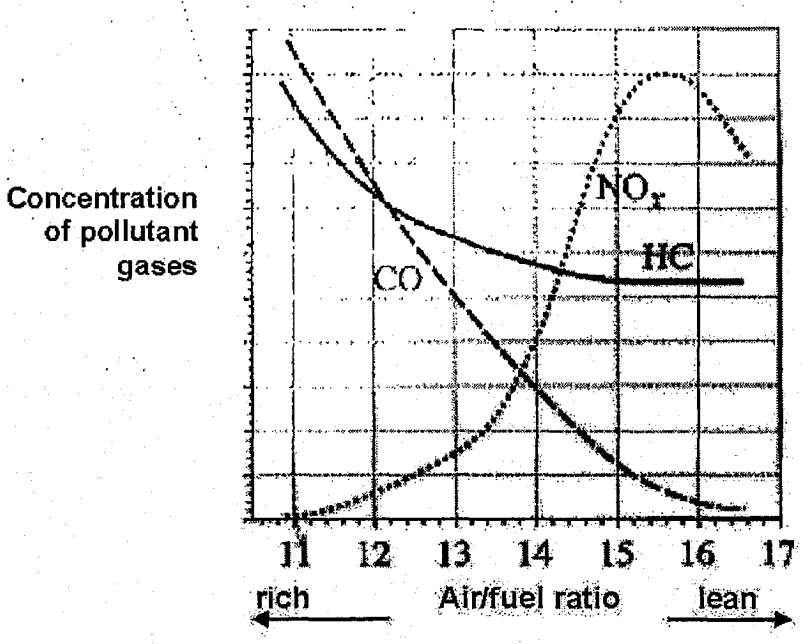
Where do water molecules lose energy?



Refer to the following to answer questions **2** and **3**.

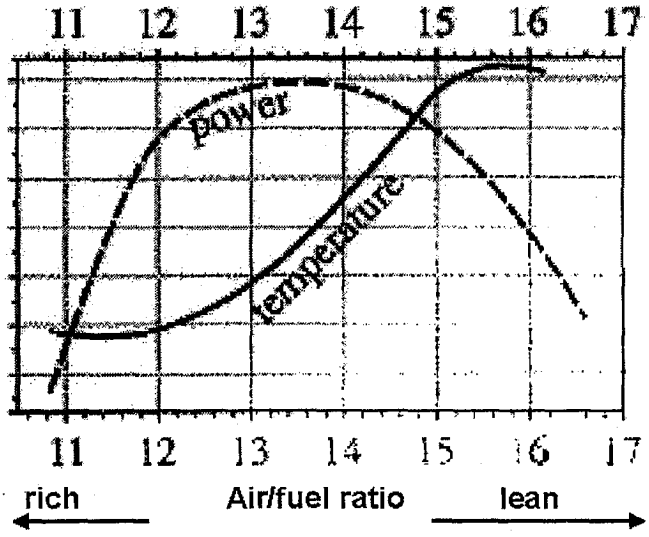
2 In a car engine, petrol vapour is mixed with air and undergoes combustion. When different amounts of petrol are mixed with air, different amounts of pollutant gases will be formed.

Graph I shows how the production of carbon monoxide (CO), nitrogen oxides (NO*x*) and hydrocarbons (HC) is dependent on the ratio of air to petrol.



Graph I

Graph II shows how the engine power and temperature vary with the different ratios of air to fuel of the fuel mixture.



Graph II

Which of the following is not true?

A The amount of carbon monoxide decreases as the air/ratio fuel ratio increases.
B The emission of nitrogen oxides increases as temperature of engine increases.
C Increasing the proportion of air in the mixture will increase the amount of hydrocarbons emitted.
D Increasing the proportion of air in the mixture will increase the level of nitrogen oxides produced.

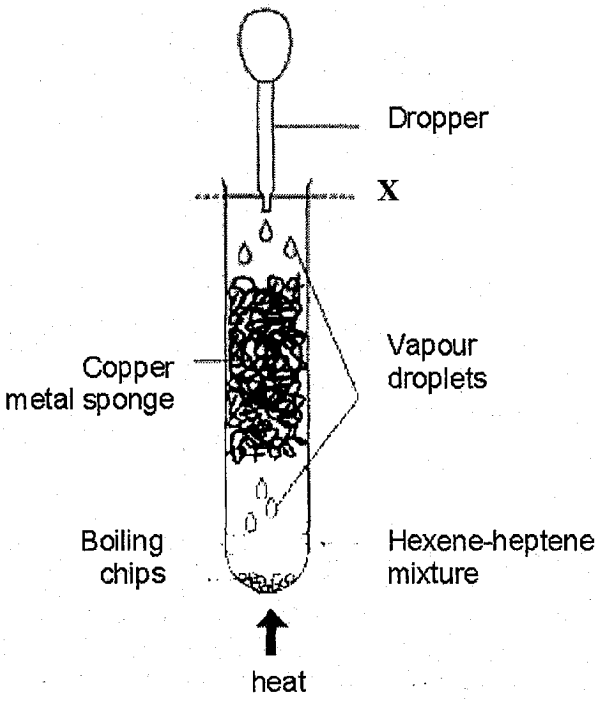
3 Which of the following conclusions **cannot** be drawn based on the information from the graphs?

A A fuel-rich mixture and low combustion temperature will reduce nitrogen oxide formation.
B The overall levels of the three pollutants are best reduced by increasing the air-to-fuel ratio.
C A fuel-lean mixture reduces the carbon monoxide and hydrocarbons but reduces the engine output.
D A fuel-rich mixture reduces the level of nitrogen oxides emitted but reduces the engine power output.

Refer to the following to answer questions **4** and **5**.

1-hexene and 1-heptene are two members of the alkene class of hydrocarbons.

A small amount of mixture of 1-hexene and 1-heptene was placed in a boiling tube and gently heated to boiling in a sand bath using the following setup:



Droplets were formed and could be seen condensing on the sides of the tube. When the vapour condensation line reached the level marked **X**, the hot vapours were very slowly withdrawn and condensed by using a small dropper.

4 What is the purpose of the copper metal sponge?

A Minimises contact of the mixture with air.
B Prevents the two compounds from escaping.
C Acts as a catalyst to speed up the reaction of the two compounds.
D Provides a large surface area for repeated vapourisation and condensation.

5 What process is demonstrated in this experiment?

A Cracking
B Combustion
C Addition reaction
D Fractional distillation

6 Which of the following does not affect the rate at which a gas spreads throughout a room?

A Boiling point of gas
B Temperature of gas
C Molecular mass of gas
D Density

7 Three elements, **X**, **Y** and **Z** have consecutive increasing atomic numbers.

If element **Y** is a noble gas, what will be the symbol for the ions formed by elements **X** and **Z** in their compounds?

A X^- and Z^+
B X^{2-} and Z^{2+}
C X^+ and Z^-
D X^{2+} and Z^{2-}

8 Potassium ferrate, K_2FeO_4, has been described as a 'green oxidising agent' because the by-products generated are environmentally-friendly.

What are the ions in this compound?

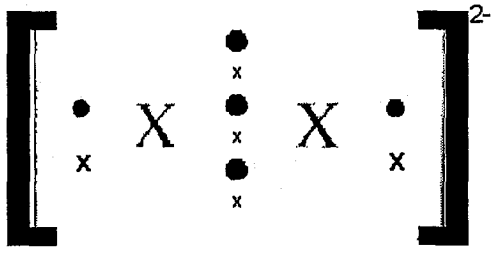
A K^+, FeO_4^{2-}
B K_2^+, FeO_4^-
C K^+, Fe^{6+}, O^{2-}
D K_2^+, Fe^{2+}, O^{2-}

9 Peeling onions often causes tearing of the eyes due to the release of a sulfide compound. Peeling them under running water reduces the problem. Which of the following statements are true of the sulfide compound?

I. It is soluble in water
II. It has low boiling point.
III. It has small and light ions with weak bonding.
IV. It is a covalent compound with weak covalent bonds.

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

10 Element **X** forms the ion X_2^{2-} with the following structure:



What is the formula of the covalent compound **X** forms with chlorine?

A XCl
B XCl_2
C XCl_3
D XCl_4

What is the maximum concentration of H^+ ions in 0.25 mol/dm^3 of phosphoric(V) acid, H_3PO_4? 0.25 x 3 = 0.750

A 0.125 mol/dm^3
B 0.250 mol/dm^3
C 0.500 mol/dm^3
D 0.750 mol/dm^3

Heating iron in dry chlorine gas results in the formation of an iron(II) chloride. Experimental determination gives a reading of 34.5% by mass of iron in the Iron(II) chloride formed. What is the charge of the iron ion in the chloride? 34.5% = 56 / (56+106.5)

A -2
B +2
C -3
D +3

13 Which of the following results is obtained when 100 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid is added to 60 g of granular solid lead(II) carbonate?

A No visible reaction.
B Colourless solution with effervescence is produced.
C Colourless solution with white precipitate
D A colourless solution with white precipitate, effervescence and granular remains.

Which of the following pairs of aqueous reagents is not suitable for preparing insoluble salts? Salts containing group I metals are soluble

A Sulfuric acid and calcium chloride
B Aluminium chloride and silver nitrate
C Barium hydroxide and copper(II) sulfate → barium sulfate and copper(II) hydroxide
D Lithium carbonate and iron(II) sulfate → Lithium sulfate and iron(II) carbonate

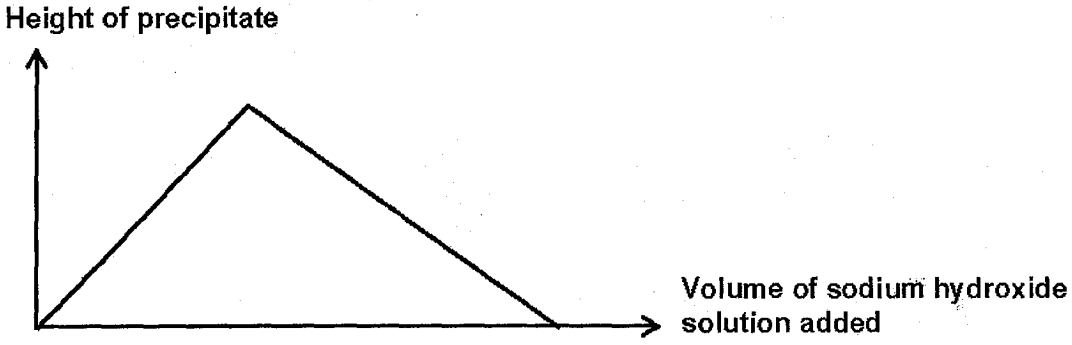
A salt has the formula $NH_4Fe(SO_4)_2.12H_2O$. Excess aqueous sodium hydroxide was added to an aqueous solution of the salt in a test tube and the mixture was then warmed gently. Which of the following would **not** be observed? Fe = +3 (reddish brown iron ion)

A A pungent gas was detected.
B A green precipitate was formed.
C A reddish brown precipitate was obtained.
D A piece of moist litmus paper placed at the mouth of the test tube turned blue.

A compound **Q** formed white precipitate when acidified aqueous silver nitrate is added. Aqueous ammonia was used to identify the presence of the other ion and there is no visible change. Identify compound **Q**.

A Calcium chloride
B Ammonium nitrate
C Calcium nitrate
D Zinc chloride

17 An aqueous solution of a salt **X** is placed in a test tube and sodium hydroxide solution is gradually added. The height of the precipitate in a test tube is plotted against the volume of sodium hydroxide solution added.



What could be **X**?

A Aluminium sulfate (soluble salt, Al is soluble in excess sodium hydroxide)
B Calcium nitrate
C Iron(II) sulfate
D Ammonium nitrate

18 The formula for hydrated copper(II) nitrate is $Cu(NO_3)_2.xH_2O$. It contains 36.5% water of crystallisation by mass.

What is the value of x?

A 4 **B** 5
C 6 **D** 7

19 Element **X** is found in Group IV of the Periodic table. Which of the following could not be a formula for a compound of **X**?

A XO
B XO_2
C XO_3^{2-}
D XO_4

20 Which of the following statements best explains why 99.99% copper is used in manufacturing high quality electrical wires for audio equipment?

A Copper is a good conductor of electricity.
B Copper is a very reactive metal.
C 99.99% copper is less ductile and cannot be stretched easily.
D Copper is of high purity and is able to conduct electric current.

21 Which of the following statements about Group VII is **false**?

A Colours of elements become darker down the Group.
B Densities of elements increase down the Group.
C Melting points of elements increase down the Group.
D Number of valence electrons of elements increases down the Group.

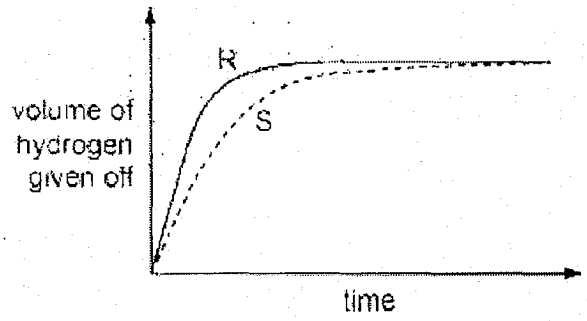
22 Methane gas reacts extremely slowly with air at room temperature. If a piece of warm platinum is held in a methane-air mixture, methane ignites. Which of the following statements correctly describes the reaction with platinum?

I The activation energy is low.
II The energy change is greater.
III The energy of the reactants is lower than expected.
IV The rate of reaction is faster.

A I and II
B I and IV
C I, II and IV
D I, II, III and IV

23 A student investigates the rate of reaction between magnesium and excess sulfuric acid. The volume of hydrogen given off in the reaction is measured over time.

The graph shows the results of two experiments, **R** and **S**.



Which change in conditions would cause the difference between **R** and **S**?

A Catalyst is added into **S**.
B The acid is more concentrated in **R** than in **S**.
C The magnesium is less finely powdered in **R** than in **S**.
D The temperature in **R** is lower than in **S**.

24 Which statement is correct for the element of proton number 19?

A It is a gas that dissolves in water.
B It is a hard metal that is not very reactive with water.
C It is a non-metal that burns quickly in air.
D It is a soft metal that is highly reactive with water.

25 Statement 1: Alloying iron with other materials to form stainless steel prevents iron from rusting by excluding oxygen.

Statement 2: Painting, oiling and electroplating are all methods of preventing iron from rusting.

Which is correct?

A Both statements are correct and statement 2 explains statement 1.
B Both statements are correct but statement 2 does not explain statement 1.
C Statement 1 is correct but statement 2 is incorrect.
D Statement 2 is correct but statement 1 is incorrect.

26 The reactions shown may occur in the air during a thunder-storm.

$$N_2 + O_2 \rightarrow 2NO$$

$$2NO + O_2 \rightarrow 2NO_2$$

$$NO + O_3 \rightarrow NO_2 + O_2$$

Which row shows what happens to the reactant molecules in each of these reactions?

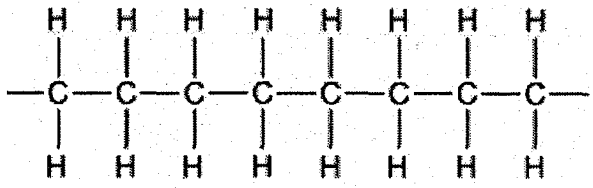
	N_2	NO	O_3
A	oxidised	oxidised	oxidised
B	oxidised	oxidised	reduced
C	reduced	reduced	oxidised
D	reduced	reduced	reduced

27 Iron is extracted from hematite in a blast furnace.

Which reaction contributes most of the heat in the blast furnace as it increases the temperature to over 1500°C?

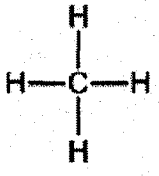
A calcium carbonate → calcium oxide + carbon dioxide
B calcium oxide + silicon dioxide → calcium silicate
C carbon + oxygen → carbon dioxide
D carbon dioxide + carbon → carbon monoxide

28 The diagram shows part of the molecule of a polymer.

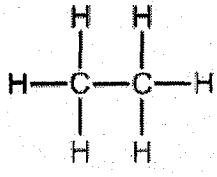


Which diagram shows the monomer from which this polymer could be manufactured?

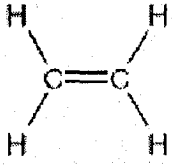
A



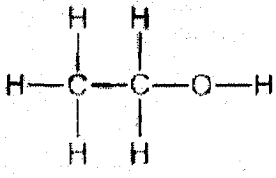
B



C



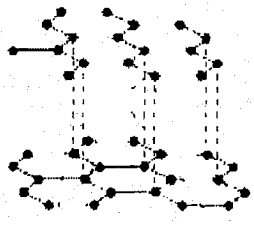
D



29 Slate has a layered structure and is slippery.

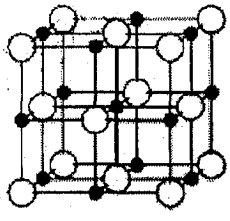
Which diagram shows a structure that closely resembles slate?

A

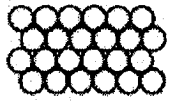


B

C



D



30 In separate experiments conducted, a gaseous halogen was bubbled into an aqueous solution of a halide salt.

The following results were observed.

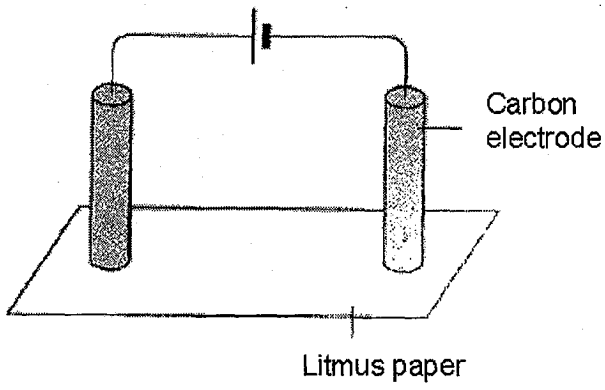
	Halides	
Halogen	**Y^-**	**Z^-**
X_2	No observable reaction	Displaced as Z_2
Y_2	No observable reaction	Displaced as Z_2
Z_2	No observable reaction	No observable reaction

What is the arrangement of halogens **X**, **Y** and **Z** in Group VII in order of decreasing reactivity?

A X Y Z

D Y, Z, X

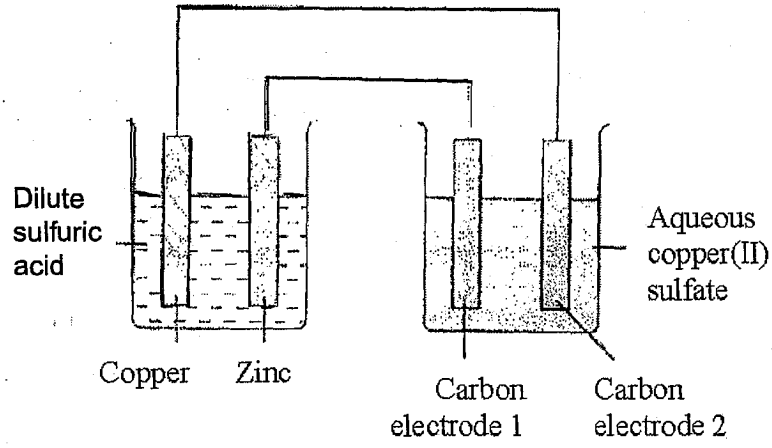
31 Two carbon electrodes are placed on a piece of red litmus paper soaked in concentrated sodium chloride solution as shown:



What are the observations of the litmus paper at the respective electrodes?

	Cathode	Anode
A	Litmus paper is bleached.	Litmus paper turns blue.
B	Litmus paper turns blue.	Litmus paper is bleached.
C	Litmus paper turns blue.	Litmus paper remains red.
D	Litmus paper remains red.	Litmus paper remains red.

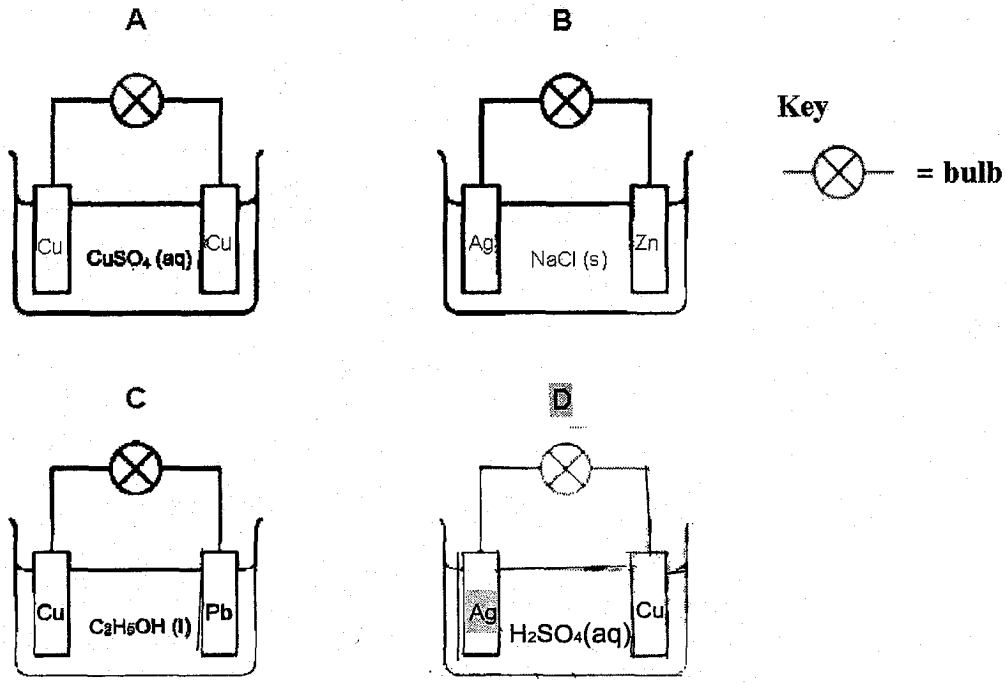
32 Two simple cells were set up as shown:



Two substances were discharged at the carbon electrodes. What were these two substances?

	Electrode 1	Electrode 2
A	Copper metal	Hydrogen gas
B	Hydrogen gas	Copper metal
C	Copper metal	Oxygen gas

33 In which circuit does the bulb light?



34 What are the main gases that escape from the top of the blast furnace in the manufacture of iron by the blast furnace?

A Nitrogen, steam and oxygen
B Oxygen, carbon dioxide and steam
C Nitrogen, carbon monoxide and carbon dioxide
D Carbon monoxide, carbon dioxide and nitrogen monoxide

35 A molten compound is electrolysed. Two atoms of X are deposited at the negative electrode at the same time as three atoms of Y are deposited at the positive electrode.

These results show that:

X is a ...**1**...;
Y is a ...**2**...;

the formula of the compound is ...**3**... .

How are gaps **1**, **2** and **3** correctly completed?

	1	2	3
A	Metal	Non-metal	X_3Y_2
B	Metal	Non-metal	X_2Y_3
C	Non-metal	Metal	X_3Y_2
D	Non-metal	metal	X_2Y_3

36 Zinc reacts with acids to form salts. Which of the following solutions would give the slowest rate of reaction when reacted with zinc?

A 0.0500 mol sulfuric acid in 500 cm^3 of water.
B 0.0250 mol sulfuric acid in 100 cm^3 of water.
C 0.0500 mol hydrochloric acid in 200 cm^3 of water.
D 0.0250 mol hydrochloric acid in 75 cm^3 of water.

37 Which compound will react with steam, in the presence of catalyst, to produce the alcohol $CH_3CH_2CH_2OH$?

A CH_3CHCH_2 B $CH_3CHCHCH_3$
C $CH_3CH_2CH_2CH_3$ D CH_3CH_2COOH

38 Which type of reaction does this equation show?

$$C_3H_8 + F_2 \rightarrow C_3H_7F + HF$$

A Hydration
B Neutralisation
C Addition
D Substitution

39 An unsaturated hydrocarbon with six carbon atoms contains only three C=C double bonds. This hydrocarbon is reacted with excess bromine at a room temperature.

What is the formula of the resulting hydrocarbon?

A $C_6H_8Br_3$ B $C_6H_{10}Br_3$
C $C_6H_8Br_6$ D C_6H_{14}

40 A hydrocarbon is found to contain about 80% of carbon by mass. What is the hydrocarbon?

A Methane B Ethene
C Propane D Hexene

END OF PAPER

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 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 –

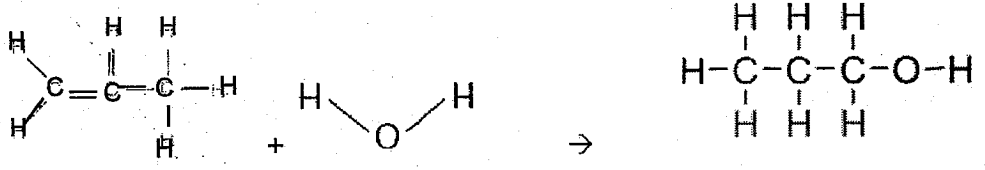
The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Mar Scheme for Paper 2

Qn	Possible answers	Mark
A1	**(i)** B and F [1] **(ii)** D [1] **(iii)** It is a metalloid/shows properties of both metal and non metal. [1] (Provide one property of a metal and one of a non metal e.g. conducts electricity but low density, dull colour accepted) – [1]	[4]
A1	**Bonds broken** 4(C–H) + 4(F–F) = 4 × 412 + 4 × F–F - [1] **Bonds formed** 4(C–F) + 4(H–F) = 4 × 484 + 4 × 562 – [1] [Enthapy change = bond break – bond make] **–1904** = [4 × 412 + 4(F–F)] – [4 × 484 + 4 × 562] [1] 4(F–F) = –1904 – 4 × 412 + [4 × 484 + 4 × 562] = 632 F–F = 632 / 4 = **158 kJ/mol**. **The student is correct.** [1] because the F–F bond energy is much less than the C–H or other covalent bonds, therefore the F–F bond is weak / easily broken.	[4]

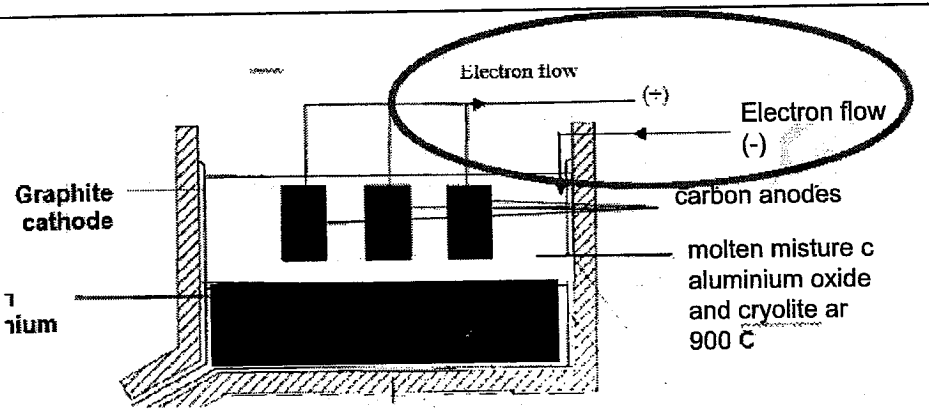
A1		**Chemical eqn** $2K (s) + 2H_2O (l) \rightarrow 2KOH (aq) + H_2 (g)$ **Ionic eqn** $2K (s) + 2H_2O (l) \rightarrow 2K^+ (aq) + 2OH^- (aq) + H_2 (g)$ [1]	[1]
A2		Hydrogen	[1]
(b		Finely divided Iron. [1] It speeds up the reaction / increase the rate of reaction. [1]	[2]
(c		It will be fed back into the reactor / recycled / returned to the reaction. [1] It helps to reduce the cost of the process / less waste of raw materials used. [1]	[2]
(d		A higher temperature will give a lower yield [1] A higher pressure will give a higher yield [1]	[2]
(e		**(i)** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ Reversible arrow and state symbols are required.	[1]
		(ii) It is a redox reaction. The oxidation number of N decreases from 0 in N_2 to -3 in NH_3. Hence nitrogen gas has been reduced. [1] The oxidation number of H increases from 0 in H_2 to +1 in NH_3. Hence hydrogen gas has been oxidised. [1]	[2]
A		Insoluble substance / precipitate formed [1] Hence, light cannot travel through / stops light / block light [1]	[2]
(b		Precipitate formed is not dense enough / thick enough / does not block all light / settled to the bottom of the tube.	[1]

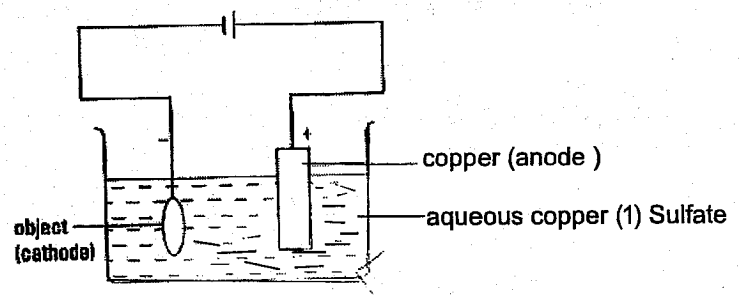
(c)	A. It is the steepest graph, indicating fastest rate of reaction / finishes in the shortest time	[1]
(c)	Time = 42s Rate = 1/42 = 0.024 s^{-1} [1, with units] NO FRACTIONS ALLOWED IN CALCULATION !	[1]
(c)	As temperature increases, particles gain heat with more kinetic energy and will move faster at a higher temperature and collide more frequently. [1] More particles possess energy greater or equal than the activation energy. [1] Therefore, there is a higher frequency of effective collision, increasing the rate of reaction [1]	[3]
(d)	A more reactive metal will form a more stable metal carbonate [1] which takes a longer time to decompose to produce carbon dioxide gas [1] where white precipitate is formed in the limewater. **Note: Metal carbonate → Metal oxide + carbon dioxide gas**	[2]
A	Mole of CO_2 = 1.79 / (12+16+16) = 0.04068 mol (leave to at least 4 sf in working) Mass of C = 0.04068 mol x 12 = **0.488 g (3sf)**	[1]
(b	1.20 – 0.488 – 0.0812 = 0.631 g **[Ecf allow from part (a)]**	[1]

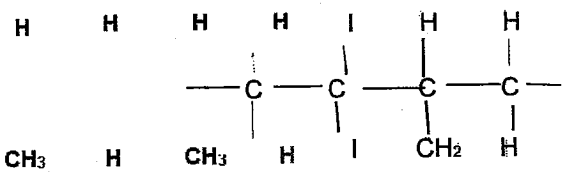
(c)	C : H : O 0.488/ 12 : 0.0812/1 : 0.6 31/16 - [1] 0.0407 : 0.0812 : 0.0394 1 : 2 : 1 Empirical formula is: **CH_2O** - [1] **[Ecf allowed from part (b) and part (a)]**	**[2]**
(d)	Since Empirical formula is: **CH_2O** **[Ecf allowed]** Mr of empirical formula is 30. For alcohol 1, 120 / 30 = 4 Hence, molecular formula will be $C_4H_8O_4$. [1] **Therefore, alcohol G is alcohol 1. – above proven.** For alcohol 2, not possible. OR Alcohol 1 has the simplest ratio that is the same as the empirical formula. [1]	**[1]**
(e)	Add aqueous bromine to alcohol 1, it decolouries OR turned from reddish brown to colourless. From alcohol 2, aq bromine remains reddish brown.	**[1]**
(f)		**[2]**

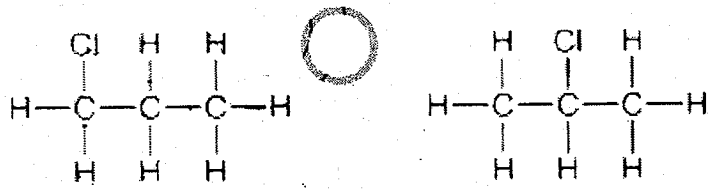
	1m – correct structure for propene and water 1m – correct structure for propanol **[accept –O-H group to be at second carbon atom]**	
A5	Moles of salicylic acid = 100 g/ 138 = 0.7246 mol [1] (working round off to 4sf) mass of aspirin = 0.7246 mol x 180 = 130.4 g = 130 g (3sf) [1]	**[2]**
A5	250 / 400 * 100 = 62.5 % [1] - Reversible reaction / Some products are lost through other reactions / reactants are contaminated / contains impurities. [1]	**[2]**
A5	Catalyst provides an alternative pathway of lesser energy, hence less energy / temperature is required, reducing the cost of production.	**[1]**
A5	It is an endothermic reaction [1] It absorbs heat energy from the surroundings / temperature mixture as the ammonium nitrate dissolves. [1]	**[2]**
A6	It allows the **ions** to be mobile / move / act as mobile charge carriers.	**[1]**
(b)	$2Br^-$ (l) → $2e^-$ + Br_2 (g) (Happens at anode, hence oxidation happens)	**[1]**
(c)	Lead (II) ions / Ions would gain electrons	**[1]**
(ii)	Increase [1] in mass / size / layer formed [1]	**[2]**

		OR Silvery [1] substance [1] R: Solid. Because it is molten state.	
(		Lead metal conducts electricity [1]	[1]
E	(i)	Raw materials are renewable / Does not use crude oil	[1]
(		Alcohol does not need to be distilled [1] as alcohol produced is pure [1]	[2]
(		The healthier oil is sunflower oil. [1] It has less saturated fat than olive oil and corn oil [1] / it has the highest value of polyunsaturated fat compared with all the other oils. [1] OR Rapeseed oil is healthiest [1] because it has the lowest value of saturated fat compared with the other oils. [1] / it has more polyunsaturated fat than both olive and corn oil [1]	[2]
(		No, hydrogen adds to the unsaturated fat and reduces the number of carbon carbon double bonds. [1] Hence there will be less polyunsaturated fat [1]	[2]
(		Heat of combustion decreases as the number of carbon atom increases. [1] More bonds are broken during the combustion of longer chain alkanes, hence less energy is released. [1]	[2]
(		Melting point increases as the number of carbon atoms increase.	[1]
E		The mixture would have a lower melting point. [1] this allow the oxide to melt at a lower temperature and make the process more economical. [1] / Save money from electrical energy that is reduced. [1]	[2]
(		Anode: $2O^{2-}(l) \rightarrow O_2(g) + 4e^-$	[2]

	Cathode: Al^{3+} (l) + 3e- → Al (l)	
(c)		[1]
(d)	The overall equation is $2Al_2O_3 \rightarrow 4Al + 3O_2$ No. of moles of Al = 540 / 27 = 20 mol No. of moles of oxygen produced = 20 / 4 x 3 = **15 mol [1]** Volume of oxygen produced = 15 x 24 dm^3 = **360 dm^3 [1]**	[2]
(e	The presence of oxygen gas reacts with the carbon anode to form oxides of carbon [1]. Or Oxidises the carbon electrode and reduce the mass. [1]	[1]

(f)	 **1m – correct terminals and label of anode and cathode** **1m – correct label of materials** **(Copper and copper sulfate solution)**	**[2]**
E B i)	Larger surface area [1] for collision to occur, hence higher rate of reaction [1].	**[2]**
(a	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$	**[1]**
(b	[1] heat produced by carbon/ coke (burning in) oxygen/ air; [1] $C + O_2 \rightarrow CO_2$ produces heat/ exothermic; OR $2C + O_2 \rightarrow 2CO$ produces heat/ exothermic [1] $ZnO + CO \rightarrow Zn + CO_2$; OR	**[3]**

	$ZnO + C \rightarrow Zn + CO$; OR $2ZnO + C \rightarrow 2Zn + CO_2$	
(b) (	Temperature (inside the furnace) is above 907 °C OR Temperature (inside the furnace) is above the boiling point (of zinc) OR 1000°C is above the boiling point (of zinc)	[1]
(b) (	Condensation	[1]
(c)	Zinc is more reactive than iron / Zinc is higher in the reactivity series than iron / Zinc reacts more readily with oxygen than iron. [1] Zinc loses electrons more easily and it is able to react with the air and water [1]	[2]
OR B9	Fractional distillation [1] and cracking [1]	[2]
(b)	Addition polymerization **[R: Additional polymerization]**	[1]
(ii)	CH_2	[1]
(iii)		[2]

	[1] chain of 4 carbon atoms with single bonds and continuation bonds; [1] correctly positioned CH_3 side chains;	
(c)	**any 2 from** - similiar chemical properties - same functional group - trend each consecutive member differ by CH_2	**[2]**
(d)	 1-chloropropane 2- chloropropane Cl either at first or second carbon atom.	**[2]**