



SUBJECT: **Chemistry**
 PAPER NUMBER: I
 DATE: 28th August 2024
 TIME: 9:00 a.m. to 11:05 a.m.

Useful data:

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

The molar volume for gases at stp = 22.4 dm³

Specific heat capacity of water = 4.2 J g⁻¹ °C⁻¹

Faraday constant = 96500 C mol⁻¹

Avogadro constant, L = 6.02 x 10²³

$\Delta H = mc\Delta\theta$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- A Periodic Table is printed on the back of this booklet.

For examiners' use only:

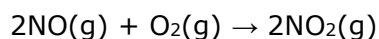
Question	1	2	3	4	5	6	7	8	9	10	11	12	Total
Score													
Maximum	6	6	6	6	6	6	6	6	6	6	20	20	100

Section A: Answer ALL questions.

1. a. Nitric acid, HNO_3 , is a very useful chemical in the laboratory. Give an equation to show the reaction of dilute nitric acid with magnesium oxide, MgO .

_____ (2)

- b. Nitrogen oxide, NO , is given out by car engines when these do not work efficiently. This gas will quickly react with the oxygen in the air as shown in the equation.



- i. What can be observed during this reaction?

_____ (1)

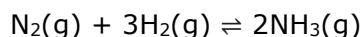
- ii. State why nitrogen dioxide is a pollutant.

_____ (1)

- c. Explain why nitrogen gas is used in industry in packets of foods, such as snacks, or to pack freezer foods.

_____ (1)

- d. In industry nitrogen gas and hydrogen gas react together on a large scale in the presence of a catalyst to form ammonia.



- How can nitrogen gas be obtained in large amounts?

_____ (1)

(Total: 6 marks)

6

2. a. i. A container of volume 2 dm^3 contains helium gas at a pressure of 1 atm and a temperature of $24 \text{ }^\circ\text{C}$. Calculate the new volume if the pressure is increased to 1.5 atm while keeping the same temperature.

 _____ (4)

- ii. State the name of the gas law that applies in this and similar situations.

_____ (1)

- b. Explain what causes the pressure inside the container mentioned in part a.i.

 _____ (1)

(Total: 6 marks)

6

3. Consider the statements in the table below. Not all of them are correct. Write TRUE or FALSE next to each statement as appropriate.

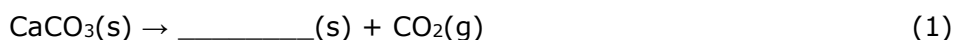
	Statement	True or False
a.	The nucleus of an atom is positively charged.	
b.	Neutrons are smaller than electrons.	
c.	The first shell in an atom can fill up to two electrons.	
d.	Isotopes have the same number of protons and a different number of neutrons.	
e.	Atoms with one electron in the outermost shell, like those in Group 1, tend to gain electrons to complete the octet.	
f.	The elements in Group 7 have a valency 1.	

(Total: 6 marks)

6

4. Iron is extracted from its ore, Fe₃O₄, using a blast furnace.

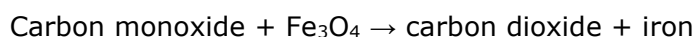
a. Calcium carbonate is added to the blast furnace and heated to produce carbon dioxide. Complete the following equation:



b. The carbon dioxide produced in part 4.a. is heated with charcoal to produce carbon monoxide. Complete and balance the following equation:



c. Carbon monoxide and Fe₃O₄ react together to produce iron. The reaction can be represented as:



i. The reaction is a redox reaction. Give the name or formula of the substance reduced. Explain.

Name or formula: _____ (1)

Explanation: _____ (1)

_____ (1)

ii. Give the physical state of the iron when it is inside the blast furnace.

_____ (1)

(Total: 6 marks)

6

Please turn the page.

5. During the electrolysis of dilute sodium chloride solution, hydrogen gas and oxygen gas are produced.

a. Give the polarity of the electrode at which oxygen gas is produced.

_____ (1)

b. What material can be used for the electrodes?

_____ (1)

c. Give a balanced half equation for the reaction that occurs in part a.

_____ (2)

d. Explain why sodium is **not** discharged during the electrolysis of dilute sodium chloride solution.

_____ (1)

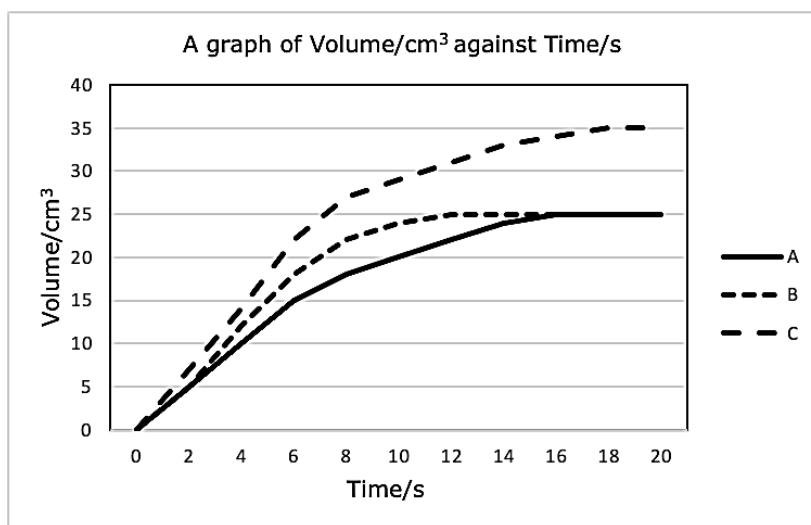
e. One of the gases produced is hydrogen. How can it be tested for?

_____ (1)

(Total: 6 marks)

6

6. Three experiments were conducted to study the change in rate of reaction between calcium carbonate and hydrochloric acid at room temperature and pressure. The results were plotted.



a. By referring to the graphs above write the letter of the graph A, B or C, that best fits the descriptions below.

	Description	Graph
i.	3 g of calcium carbonate with 1 mol dm ⁻³ hydrochloric acid.	
ii.	3 g of calcium carbonate with 0.1 mol dm ⁻³ hydrochloric acid.	
iii.	5 g of calcium carbonate with 1 mol dm ⁻³ hydrochloric acid.	

(3)

b. What is the volume of gas produced for Graph C at 12 s?

_____ (1)

c. What is the maximum volume of gas produced for Graphs A and B?

_____ (1)

d. Sketch a graph (on the axes above) to represent the reaction between 5 g calcium carbonate and 1 mol dm⁻³ hydrochloric acid at 40 °C. Label this graph D. (1)

(Total: 6 marks)

6

7. Several chemicals were weighed before and after they were heated to constant mass in a suitable container.

a. Define the term heating to constant mass.

_____ (1)

b. Write whether the mass of the substances in the container will increase, decrease, or stay the same after they are heated.

	Substance	Mass increases, decreases or stays the same
i.	A small piece of magnesium ribbon.	
ii.	Potassium hydroxide.	
iii.	Zinc(II) carbonate.	
iv.	Hydrated copper(II) sulfate crystals.	

(4)

c. State why some substances decrease in mass when heated to constant mass.

_____ (1)

(Total: 6 marks)

6

8. This question is about hydrogen.

a. Give the name of **TWO** substances that can be reacted together to produce hydrogen in the laboratory.

_____ (2)

b. Refer to the statement about hydrogen below and answer the questions that follow.

"Hydrogen [...] has the potential to supply most of the world's energy in the future, replacing the present fossil fuel-based energy infrastructure."

(adapted: <https://pubs.rsc.org/en/content/articlelanding/2023/ra/d3ra05158g>)

This question continues on next page.

i. Is hydrogen considered to be a renewable or a non-renewable source of energy?

_____ (1)

ii. Give **ONE** advantage of using hydrogen as a fuel.

_____ (1)

iii. Give **ONE** disadvantage of using hydrogen as a fuel.

_____ (1)

iv. Name the industrial process in which hydrogen is one of the starting materials.

_____ (1)

(Total: 6 marks)

6

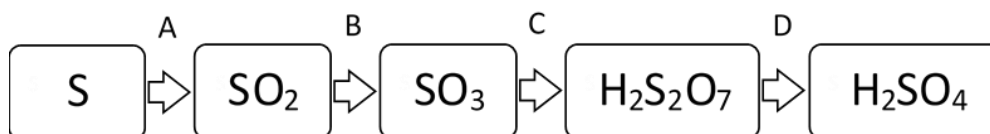
9. State whether these statements are TRUE or FALSE.

		True or False
a.	Copper is not attacked by water or steam.	
b.	Copper reacts with dilute hydrochloric acid.	
c.	Iron reacts with water and oxygen to form iron(II) oxide.	
d.	Both copper and iron are transition metals.	
e.	Copper can be purified using electrolysis.	
f.	Iron reacts with chlorine to give iron(II) chloride.	

(Total: 6 marks)

6

10. Refer to the reaction scheme below to answer the questions that follow.



a. Name the industrial process shown in the reaction scheme above.

_____ (1)

b. Write a balanced equation for the formation of sulfur dioxide from sulfur.

_____ (2)

c. Name reagent D.

_____ (1)

d. Give the common name of the $\text{H}_2\text{S}_2\text{O}_7$.

_____ (1)

e. Give **ONE** reason why sulfur trioxide is **not** reacted directly with water to produce sulfuric acid.

_____ (1)

(Total: 6 marks)

6

Section B: Answer ALL questions.

11. a. Consider the following hydrocarbons:

C_2H_4	C_3H_6	C_2H_6	C_6H_{10}	C_8H_{18}
A	B	C	D	E

i. Name substances A and B.

_____ (2)

ii. Is substance A a saturated or an unsaturated organic compound?

_____ (1)

iii. From the list above, choose **TWO** substances that are liquids at room temperature and pressure.

_____ (2)

iv. Describe the type of flame obtained when substance D is burnt in a plentiful supply of air.

_____ (2)

v. Give **ONE** reason for the observation you named in part 11.a.iv.

_____ (1)

b. Substance B reacts with chlorine gas.

i. Write a balanced equation for this reaction.

_____ (2)

ii. Name the type of reaction occurring between B and chlorine.

_____ (1)

iii. Give the formula of another substance, **not** listed above, that performs the same reaction as in part 11.b.i. but belongs to a different homologous series.

_____ (1)

c. Substance A can be converted to substance C.

i. Name the reagent needed for this reaction.

_____ (1)

ii. Give the name of the catalyst and the temperature needed for this reaction.

_____ (2)

iii. Give the displayed formula of structure C.

_____ (1)

d. Petrol is a mixture of alkanes. Substance E is one of the compounds present in petrol.

i. Name the process by which petrol is obtained from crude oil.

_____ (1)

ii. In refineries, cracking produces alkanes and alkenes. Describe how bromine water, which is orange-coloured, can be used to distinguish between an alkane and an alkene.

_____ (2)

iii. Give **ONE** environmental effect of using petrol as a fuel.

_____ (1)

(Total 20 marks)

20

12. a. i. Draw the bonding in sodium chloride, showing outer electrons only.

(4)

ii. Give the name of the bonding present in sodium chloride.

_____ (1)

iii. Draw the structure of sodium chloride showing the different particles clearly.

(3)

iv. Sodium chloride has a very high melting point. Give **TWO** reasons for this.

Reason 1: _____ (1)

Reason 2: _____ (1)

b. i. Draw a dot-cross diagram to show the bonding in an oxygen molecule, showing outer electrons only.

(2)

ii. Give **ONE** reason why oxygen is a non-conductor of electricity.

_____ (1)

iii. Why is oxygen a gas at room temperature?

_____ (1)

c. Diamond and graphite are allotropes of carbon.

i. Explain the term allotrope.

_____ (2)

ii. Diamond is **not** a conductor of electricity but graphite is a conductor of electricity. Explain this difference by referring to both substances.

_____ (2)

iii. Diamond has a high sublimation temperature. Explain the term sublimation.

_____ (2)

(Total: 20 marks)

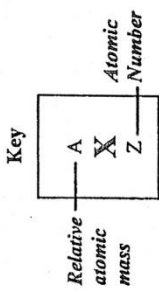
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PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
1 H 1	9 Be 4	11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
23 Na 11	24 Mg 12	27 Al 13	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
39 K 19	40 Ca 20	45 Sc 21	48 Ti 22	51 V 23	52 Cr 24	55 Mn 25	56 Fe 26
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	93 Nb 41	96 Mo 42	99 Tc 43	101 Ru 44
133 Cs 55	137 Ba 56	139 La 57	178.5 Hf 72	181 Ta 73	184 W 74	186 Re 75	190 Os 76
223 Fr 87	226 Ra 88	227 Ac 89	65 Zn 30	63.5 Cu 29	59 Ni 28	59 Co 27	59 Ni 28
			65 Zn 30	63.5 Cu 29	59 Ni 28	59 Co 27	59 Ni 28
			115 In 49	108 Ag 47	106 Pd 46	103 Rh 45	106 Cd 48
			119 Sn 50	108 Ag 47	106 Pd 46	103 Rh 45	112 Cd 48
			204 Pb 82	197 Au 79	195 Pt 78	192 Ir 77	201 Hg 80
			207 Pb 82	197 Au 79	195 Pt 78	192 Ir 77	207 Pb 82
			209 Bi 83	201 Hg 80	195 Pt 78	192 Ir 77	209 Bi 83
			210 At 85	201 Hg 80	195 Pt 78	192 Ir 77	210 At 85
			222 Rn 86	201 Hg 80	195 Pt 78	192 Ir 77	222 Rn 86



140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103



SUBJECT:	Chemistry
PAPER NUMBER:	IIB
DATE:	28 th August 2024
TIME:	4:00 p.m. to 6:05 p.m.

Useful data:

Standard temperature and pressure (STP): 0 °C and 1 atm (760 mm Hg)

The molar volume for gases at STP = 22.4 dm³

Specific heat capacity of water = 4.2 J g⁻¹ °C⁻¹

Faraday constant = 96500 C mol⁻¹

Avogadro constant, L = 6.02 x 10²³

$$\Delta H = mc\Delta\theta$$

$$Q = It$$

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions from Section A. Write all your answers for Section A in the spaces provided in this booklet.
- Answer **TWO** questions from Section B. Write all your answers for Section B in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- A Periodic Table is printed on the back of this booklet.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Score															
Maximum	6	6	6	6	6	6	6	6	6	6	20	20	20	20	100

Section A: Answer ALL questions.

1. This question is about methods of separation. Choose the appropriate method from the following terms to complete the table below:

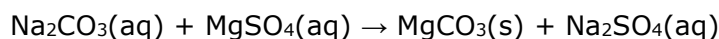
fractional distillation simple distillation	separating funnel filtration	sublimation chromatography
--	---------------------------------	-------------------------------

	Experiment	Method
a.	to obtain water from a mixture of oil and water without heating	
b.	to determine the colours in black ink	
c.	to separate ammonium chloride and salt	
d.	to obtain different substances from crude petroleum	
e.	to obtain water from a mixture of chalk and water	
f.	to obtain ethanol from a mixture of ethanol and water	

(Total: 6 marks)

6

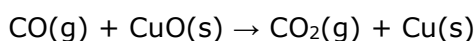
2. a. Sodium carbonate reacts with magnesium sulfate according to the equation:



Give a balanced ionic equation for the reaction, including state symbols.

_____ (3)

b. When carbon monoxide is passed over hot copper(II) oxide the following reaction occurs:



i. CuO has changed to Cu. State the type of reaction that occurred. Explain this change in terms of oxidation states.

 _____ (2)

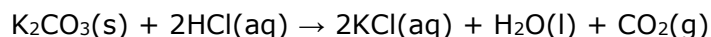
ii. Mention **ONE** observation that can be made during this reaction.

_____ (1)

(Total: 6 marks)

6

3. a. Carbon dioxide may be prepared by the reaction between dilute hydrochloric acid and potassium carbonate.



- i. Draw a diagram to show how the experiment is carried out. Your diagram must show
- the reaction vessel,
 - the contents, and
 - the gas syringe to collect the gas.

(3)

- ii. Why is carbon dioxide gas **not** collected over water?

_____ (1)

- b. Carbon dioxide is an acidic gas but carbon monoxide is a neutral gas. Explain this statement.

Acidic gas: _____ (1)

Neutral gas: _____ (1)

(Total: 6 marks)

6

4. Methane, CH₄, is the first compound in the homologous series of alkanes.

- a. Give the general formula for alkanes.

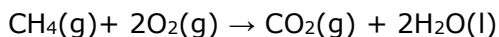
_____ (1)

- b. Methane is the simplest alkane. Explain how the boiling point of alkanes changes as the number of carbon atoms (the value of 'n') increases.

_____ (1)

This question continues on next page.

c. Methane burns in a plentiful supply of air to give carbon dioxide and water.



Calculate the volume of oxygen, measured at STP, that is required for 2 moles of methane to burn completely.

_____ (3)

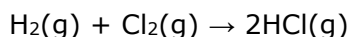
d. When methane burns, it is important that there is a plentiful supply of air or oxygen. Explain.

_____ (1)

6

(Total: 6 marks)

5. In an experiment, 100 cm³ of hydrogen gas and 150 cm³ of chlorine gas are placed in a closed gas jar. A reaction occurs and hydrogen chloride is formed.



a. i. Calculate the volume of hydrogen chloride formed if all the gases are at the same temperature and pressure.

_____ (2)

ii. One of the reactants is in excess. Which gas is in excess and by how much is it in excess?

Gas in excess: _____ (1)

Volume in excess: _____ (1)

iii. State the gas law that applies for the calculation in part 5.a.i.

_____ (1)

b. Mention **ONE** observation that can be observed in the gas jar during the reaction.

_____ (1)

6

(Total: 6 marks)

6. Metals are good conductors of electricity.

a. Name the type of bonding present in metals.

_____ (1)

b. Mention **TWO** other physical properties besides conduction of electricity, common to all metals.

_____ (2)

c. In the box below draw a labelled diagram of the layered structure present in metals.



(2)

d. With reference to the diagram in part 6.c., state the feature which enables metals to be conductors of electricity.

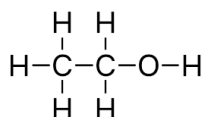
_____ (1)

(Total: 6 marks)

6

7. This question is about organic compounds.

a. Consider the following compound.



i. Give the systematic name of this compound.

_____ (1)

ii. Name the homologous series to which this compound belongs.

_____ (1)

This question continues on next page.

iii. Draw the structural formula of the functional group isomer of this compound.

(1)

b. Carboxylic acids react with alcohols in the presence of a catalyst to produce water and an ester.

i. Give the name of the reaction taking place.

(1)

ii. Give the name of the catalyst used in this reaction.

(1)

iii. If the ester produced is ethyl ethanoate, identify the carboxylic acid which is reacted with ethanol.

(1)

(Total: 6 marks)

6

8. Underline the correct word to complete the phrases.

a. Sodium hydroxide pellets are (deliquescent / efflorescent) as they absorb water vapour to form a concentrated solution. (1)

b. Concentrated sulfuric acid becomes dilute when it absorbs water vapour as it is (hygroscopic / deliquescent). (1)

c. All nitrates are (insoluble / soluble) in water. (1)

d. Seawater can be purified by (reverse osmosis / filtration) to make it fit for drinking. (1)

e. In the presence of water, anhydrous copper(II) sulfate changes colour from white to (pink / blue). (1)

f. When no more sugar can dissolve in water, the solution formed becomes (saturated / dilute). (1)

(Total: 6 marks)

6

9. This question is about sulfur and its compounds.

a. Name the **TWO** allotropes of sulfur.

_____ (2)

b. Complete and balance the following equation for the reaction of hydrochloric acid with sodium sulfite.



c. The test for sulfur dioxide involves bubbling the gas through acidified potassium dichromate solution. State the colour changes which occur in this reaction.

_____ (2)

(Total: 6 marks)

6

10. Various tests were conducted on substance X.

A white solid X gave a lilac colour when a flame test was performed.

On heating X, no change was observed.

An aqueous solution of X was made and on adding calcium chloride solution, an immediate white precipitate A was formed.

Solid X was also reacted with dilute hydrochloric acid, giving a colourless solution and a colourless gas B which turned lime water milky. When the colourless solution was evaporated to dryness, a white solid C remained.

a. Fill in the table below by giving the name of the unknown substances.

		Name of substance	
i.	A		(1)
ii.	B		(1)
iii.	C		(1)
iv.	X		(1)

b. Give a balanced equation for the reaction of gas B with limewater.

_____ (2)

(Total: 6 marks)

6

Please turn the page.

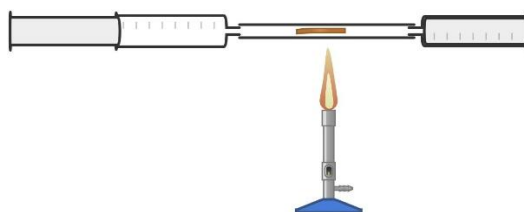
Section B: Answer TWO questions from this section.

11. This question is about the composition of air.

a. Air is made of up of a mixture of gases such as oxygen, nitrogen and carbon dioxide.

- i. Which is the most abundant gas in air? (1)
- ii. What is the percentage of oxygen in air? (1)
- iii. Name a gas that can be found in polluted air only. (1)
- iv. Give **ONE** source of the gas you named in part a.iii. (1)

b. Several experiments can be conducted in the laboratory to show the presence of some of these gases in air. A volume of 100 cm³ of air is passed back and forth over a heated reddish-brown metal as shown in the diagram below.



- i. Name the metal in the combustion tube. (1)
 - ii. Does the total volume in the gas syringes increase, decrease, or remain the same after the reaction? Choose the correct answer. (1)
 - iii. Does the mass of the metal in the combustion tube increase, decrease, or remain the same after the reaction? Choose the correct answer. (1)
 - iv. Give **ONE** observation that indicates that the reaction has stopped and that no further heating is required. (1)
 - v. State **ONE** precaution that needs to be taken while doing this experiment for fair results. (1)
 - vi. Identify the gas that reacts during the experiment. (1)
 - vii. A drying agent can be used to show the presence of water vapour in air. Is magnesium oxide or calcium chloride more appropriate to remove water vapour? Give **ONE** reason for your answer. (2)
- c. Oxygen and water in the air are also responsible for rusting. Consider the following set-ups.

Set up	A	B	C	D
Test tube	Closed	Open	Closed	Open
Iron nail	Present	Present	Present	Present
Other substances		Salty water	Boiled water Layer of oil at the top	Silica gel crystals

- i. State whether the iron nail in each set-up will rust or not. (4)
- ii. In which set-up will the iron nail rust the fastest? Give **ONE** reason for your answer. (2)
- iii. Give the chemical name of rust. (1)
- iv. Give **ONE** method to prevent rusting. (1)

(Total: 20 marks)

12. This question is about electrolysis.

- a. Use words from the word bank below to complete the following statements. Write the words on your booklet in the proper order.

negative	electrolyte	chlorine	electric
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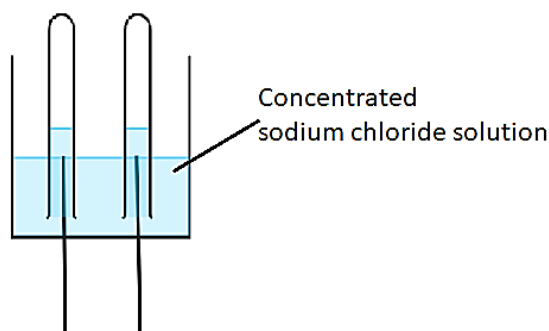
Concentrated sodium chloride solution is an ___(i)__. When an ___(ii)___ current passes through the solution, ___(iii)___ gas is produced at the positive electrode. Hydrogen gas is produced at the ___(iv)___ electrode. (4)

- b. During an electrolysis experiment with concentrated sodium chloride solution, inert graphite electrodes were used.

- i. Is the anode the positive or negative electrode? (1)
 ii. Explain why the graphite electrodes are described as 'inert'. (1)

- c. When sodium chloride crystals dissolve in water four ions are formed. One of them is OH^- . Give the other **THREE** ions present in the solution. (3)

- d. The following apparatus was set up in the laboratory for this experiment.



- i. Copy and complete the diagram by adding a D.C. power supply (battery). (1)
- ii. On the same diagram add the following labels: (4)
- anode,
 - cathode,
 - hydrogen gas, and
 - chlorine gas.
- e. Copy and complete the following half equations which show the reactions that occur:
- i. $\text{H}^+(\text{---}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$
- ii. $2\text{Cl}^-(\text{aq}) \rightarrow \text{---}(\text{---}) + 2\text{e}^-$ (4)
- f. Hydrogen is produced instead of sodium during electrolysis. Explain this statement by referring to the position of these elements in the reactivity series. (1)
- g. When dilute sodium chloride solution was used in this experiment a different gas from chlorine was produced. This gas relighted a glowing splint. Name this gas. (1)

(Total: 20 marks)

13. This question is about equilibrium reactions.

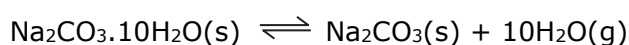
a. Answer the following questions.

i. Which letter represents a reversible reaction?

Letter	Reaction
R	combustion of alkanes
S	hydration of anhydrous cobalt(II) chloride
T	neutralization of acids
U	precipitation of silver chloride

(1)

ii. The equation for the effect of heat on hydrated sodium carbonate is as follows:



Read the following statements about the reaction.

Letter	Statement
W	Steam is evolved
X	There is a colour change from pink to yellow
Y	Anhydrous sodium carbonate is formed
Z	The reaction is reversible

Which of the above statements are correct?

- X and Z only
- W, X and Y only
- W, Y and Z only
- Y and Z only

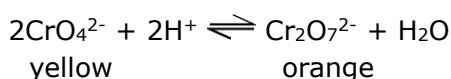
(1)

iii. When pink cobalt(II) chloride crystals are heated, a blue solid and water vapour are formed. The blue solid turns pink again when water is added to it. Choose the letter which best describes the pink cobalt(II) chloride and the reaction.

Letter	The pink cobalt(II) chloride is:	The reaction:
E	anhydrous	can be reversed
F	anhydrous	cannot be reversed
G	hydrated	can be reversed
H	hydrated	cannot be reversed

(1)

b. The chromate and dichromate ions can exist in equilibrium. This equation shows the colour changes which occur when the pH is changed.

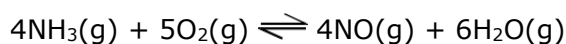


Use words from the word bank below to complete the following statements. Write the words on your booklet in the proper order.

dynamic	alkali	Le Chatelier's	right	yellow	orange	acid
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According to ___(i)___ principle, when the conditions of a ___(ii)___ equilibrium are changed, the equilibrium will shift to counteract that change. In the above reaction, addition of an ___(iii)___ to the yellow solution will shift the equilibrium to the ___(iv)___ causing the solution to become ___(v)___ . If an ___(vi)___ is added to this solution it will change back to ___(vii)___ . (7)

- c. The reaction between ammonia and oxygen is reversible and exothermic. The reaction takes place in a closed container.



- How many different gases will be present in the reaction vessel at equilibrium? (1)
- Give **ONE** reason to explain why the reaction must take place in a closed container. (1)
- Explain the effect of a decrease in pressure on the position of this equilibrium. (3)
- Explain the effect of an increase in temperature on the position of this equilibrium. (3)
- Explain why a catalyst will have no effect on the equilibrium position of this reaction. (2)

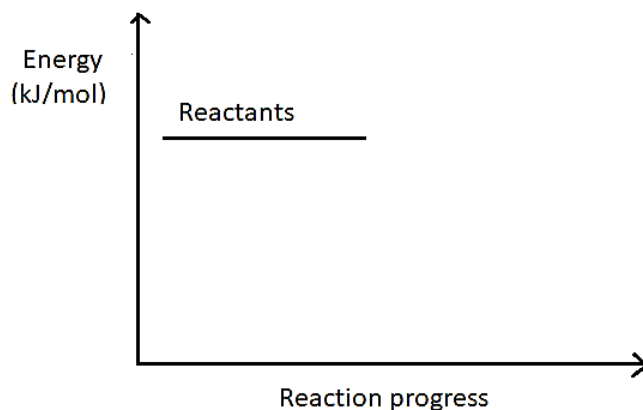
(Total: 20 marks)

14. Many reactions are usually classified as exothermic or endothermic.

- a. Complete the following sentences by inserting the appropriate words. Write the words on your booklet in the proper order.

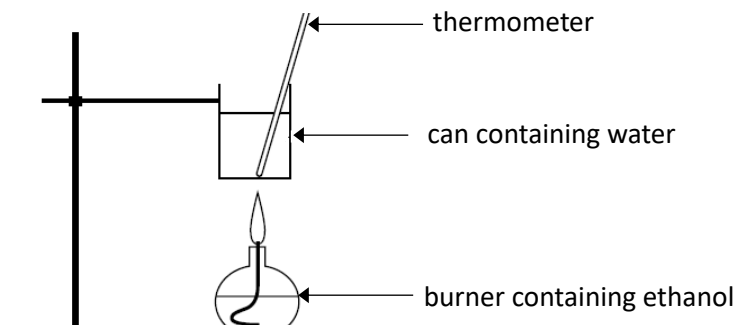
The combustion of butane is an ___(i)___ reaction because heat is ___(ii)___ . When ammonium nitrate dissolves in water the temperature decreases. This indicates that heat is ___(iii)___ so the reaction is ___(iv)___ . The change in temperature occurs because energy is taken in to ___(v)___ bonds, and then it is produced when new bonds are ___(vi)___ . (6)

- In a particular experiment, the heat of reaction was found to be $+350 \text{ kJ mol}^{-1}$.
 - Was the reaction endothermic or exothermic? (1)
 - Copy, complete and label the energy level diagram below for this reaction. (2)



This question continues on next page.

c. Another experiment was carried out to investigate the heat of combustion of ethanol. The following apparatus was set up.



(Adapted from: <https://www.alevelh2chemistry.com>)

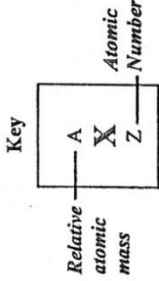
A mass of 200 g of water was measured into the copper can. In the experiment 1.75 g of ethanol were burnt. The initial temperature of the water was 18 °C. At the end of the experiment the temperature of the water was found to be 58 °C.

- i. Mention **TWO** changes that the student could make to the apparatus shown in the diagram to improve the accuracy of the results. (2)
- ii. Calculate the change in temperature of the water. (1)
- iii. Calculate the heat absorbed by the water during this experiment. Give your answer in kJ. (3)
- iv. Calculate the molar mass of ethanol. Show your working. (2)
- v. Work out the standard enthalpy of combustion of ethanol in kJ mol⁻¹. (2)
- vi. The expected value for this reaction is -1370 kJ/mol. Give **ONE** reason why the results in this experiment were lower than expected. (1)

(Total: 20 marks)

PERIODIC TABLE

I	II	III	IV	V	VI	VII	VIII
1 H 1	9 Be 4	11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10
7 Li 3	24 Mg 12	23 Na 11	28 Si 14	31 P 15	32 S 16	35.5 Cl 17	40 Ar 18
39 K 19	40 Ca 20	45 Sc 21	51 V 23	59 Ni 28	63.5 Cu 29	65 Zn 30	84 Kr 36
85 Rb 37	88 Sr 38	89 Y 39	91 Zr 40	99 Tc 43	106 Pd 46	112 Cd 48	131 Xe 54
133 Cs 55	137 Ba 56	139 La 57	178.5 Hf 72	186 Re 75	197 Au 79	201 Hg 80	222 Rn 86
223 Fr 87	226 Ra 88	227 Ac 89	48 Ti 22	55 Mn 25	56 Fe 26	59 Co 27	
			52 Cr 24	59 Ni 28	59 Co 27	65 Zn 30	
			93 Nb 41	103 Rh 45	106 Pd 46	119 Sn 50	
			181 Ta 73	192 Ir 77	195 Pt 78	207 Pb 82	
			184 W 74	190 Os 76	197 Au 79	209 Bi 83	
						210 At 85	



140 Ce 58	141 Pr 59	144 Nd 60	147 Pm 61	150 Sm 62	152 Eu 63	157 Gd 64	159 Tb 65	162 Dy 66	165 Ho 67	167 Er 68	169 Tm 69	173 Yb 70	175 Lu 71
232 Th 90	231 Pa 91	238 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103