

1973

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—Paper II

Thursday, 10th May—1.30 p.m. to 4.00 p.m.

Marks may be deducted for bad spelling, and bad punctuation, and for writing that is difficult to read.

Working should be shown in all answers involving calculations.

Necessary data will be found in the book of Mathematical Tables and Science Data.

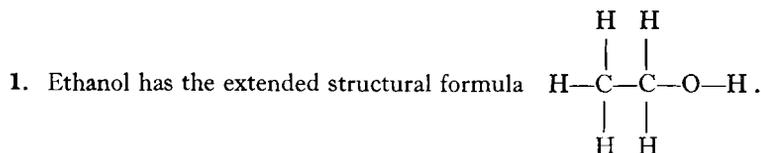
[175]

PART A

All questions should be attempted. It should be noted, however, that some questions contain a choice.

It is suggested that about one hour be spent on this part of the paper.

Marks

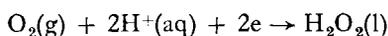


Write such a formula for

- (a) propan-1-ol
- (b) propanal
- (c) propanoic acid.

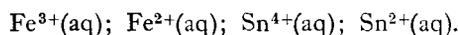
(3)

2. The half-reaction



has a Standard Reduction Electrode Potential of +0.68 V.

Which ONE of the following reagents should be able to convert hydrogen peroxide (H_2O_2) into oxygen gas? (Use page 40 of the Data Book.)

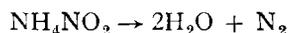


For the reagent you choose, write a half-reaction equation showing its reaction.

(2)

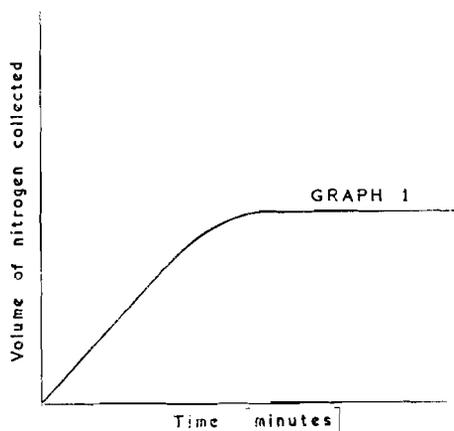
3. EITHER

Ammonium nitrite decomposes thus when heated:



The rates of decomposition of 100 cm³ samples of each solution were followed under three different sets of conditions:

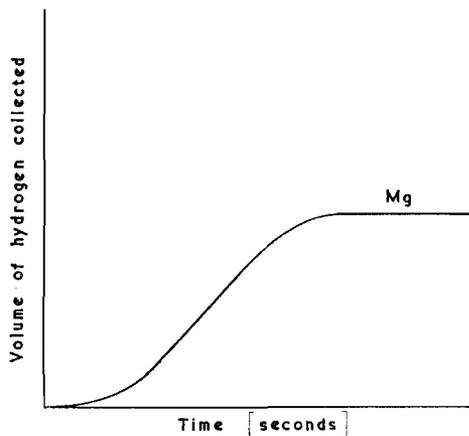
	Concentration of solution	Temperature of solution
GRAPH 1	5.0%	80 °C
GRAPH 2	5.0%	90 °C
GRAPH 3	2.5%	80 °C



Draw **one** sketch showing all three graphs, labelling each clearly. Pay particular attention to the final volumes of nitrogen, and the slopes of the graphs. (No graph paper required)

(4)

OR



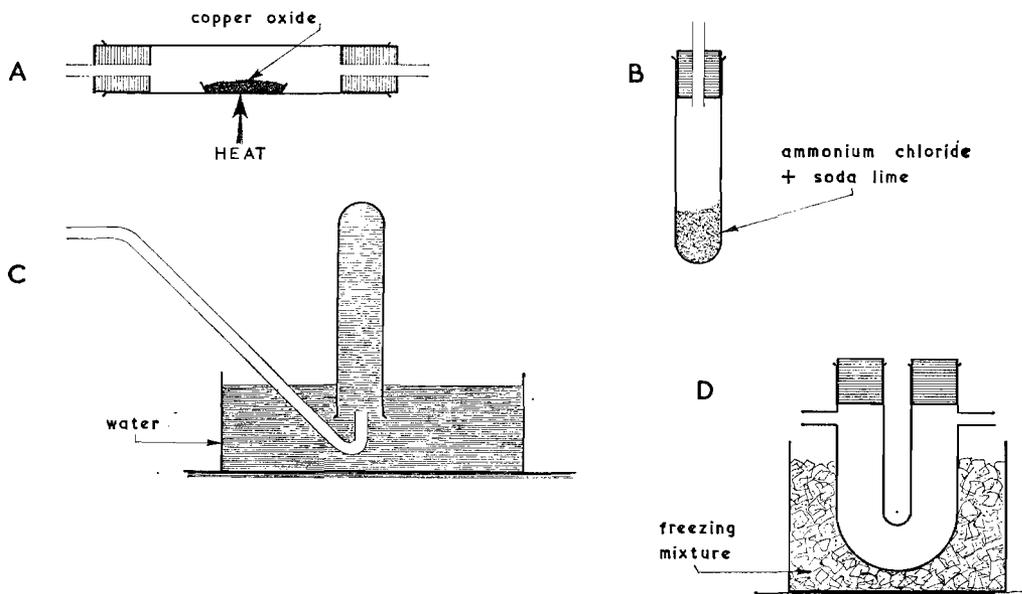
Marks

The above graph shows how the volume of hydrogen released increases with time as **1 mole of magnesium** reacts with excess dilute hydrochloric acid.

Copy the graph into your answer book (no graph paper required) and add corresponding graphs for **1 mole of zinc** and for **1 mole of sodium** reacting. Label each clearly. Assume that the three metals have similar sizes of granules. (4)

4. When dry ammonia is passed over hot copper(II) oxide, the products are copper, nitrogen and water. Show how the following pieces of apparatus could be connected to do this experiment in such a way that the nitrogen and water are collected separately.

All that is required in your answer is the order of the letters e.g. A B C D.

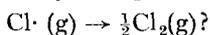


(2)

5. (a) $2\text{H}^+(\text{aq}) + 2\text{e} \rightarrow \text{H}_2(\text{g})$ Reaction A
 $2\text{H}^-(\text{aq}) \rightarrow \text{H}_2(\text{g}) + 2\text{e}$ Reaction B

The above reactions occur during electrolysis. At which electrode, positive or negative, would you expect each reaction to occur?

- (b) What chemical change is represented by the equation



Explain clearly what is meant by the symbols on both sides. (4)

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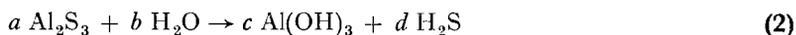
6. EITHER

What is the mass in g of 2.5 moles of nitrogen molecules? (2)

OR

How many moles of carbon are present in 11 g of carbon dioxide? (2)

7. Find the values of a , b , c and d such that the following equation would be balanced:



8.
$$3\text{CuO} + 2\text{NH}_3 \rightarrow 3\text{Cu} + 3\text{H}_2\text{O} + \text{N}_2$$

When 477 g of copper(II) oxide react with ammonia according to the above equation, calculate

- (a) the mass of copper produced
(b) the volume of nitrogen produced at s.t.p. (5)

9. A sample of 3.48 g of tungsten oxide on reduction gave 2.76 g of tungsten (symbol W, atomic weight 184). Find the empirical (simplest) formula for tungsten oxide. (3)

10. EITHER

Lithium hydroxide is used in a manned space-craft to prevent a build-up of carbon dioxide in its atmosphere. Write an equation to illustrate this reaction.

How could almost all the carbon dioxide be recovered again? (3)

OR

- (a) Aluminium does not corrode as quickly as some less reactive metals. Why not?
(b) Ordinary solder does not adhere to aluminium. Why not?
(c) A special solder containing an abrasive does adhere. Why? (3)

11. EITHER

Write the formulae for:

- (a) ammonia
(b) methylamine
(c) any amino-acid.

Two gases, X and Y, are examined. Neither X nor Y is a mixture of gases.

SUBSTANCE	X	Y
pH of aqueous solution of gas (1M)	greater than 7	greater than 7
solubility in water	very soluble	very soluble
products after burning in oxygen	carbon dioxide along with other gases	no carbon dioxide—but other gases
result of bubbling into copper(II) sulphate solution	pale blue precipitate forms, which dissolves giving a deep blue solution	pale blue precipitate forms, which dissolves giving a deep blue solution

Give a possible name for X, and one for Y. (6)

OR

Liquids A and B are very poor conductors of electricity, but a mixture of the two conducts. Which of the following substances could be A and B?



Write an equation indicating why there is a change in conductivity when A and B are mixed.

Draw **two** possible structural formulae for C_6H_{12} , such that one is saturated and the other unsaturated. How would you distinguish chemically between the two? (6)

12.

Substance	Melting Point (°C)	Boiling Point (°C)	Electrical Conductivity of solid	Electrical Conductivity of melt
A	92	190	nil	nil
B	1050	2500	good	good
C	773	1407	nil	good
D	1883	2503	nil	nil

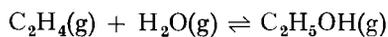
Place A, B, C and D in the appropriate categories from the following:

metallic solid
ionic solid

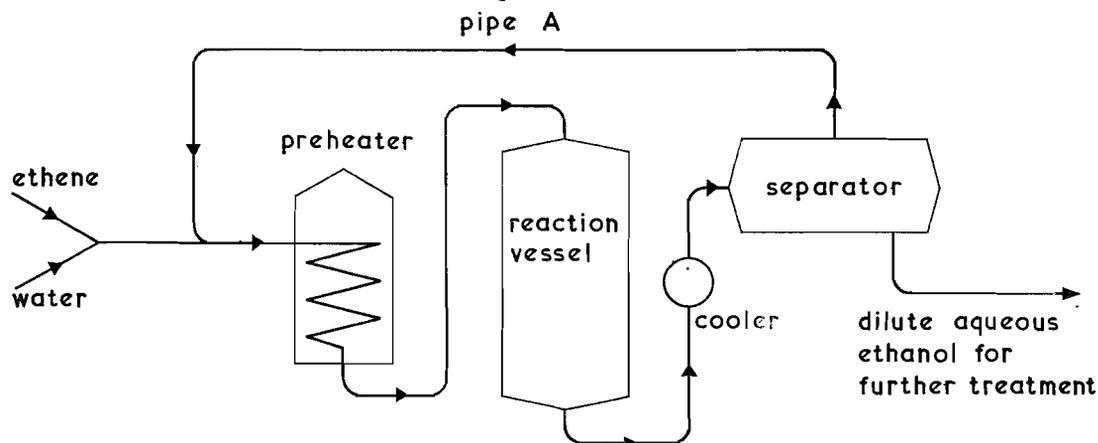
covalent network solid
covalent molecular solid

(4)

13. Ethanol is produced by reacting steam with ethene in the presence of a catalyst according to the equation:



Under practical conditions only 10% of the ethene is converted.



- Would a high or low pressure in the reaction vessel favour the production of ethanol?
- What is flowing in PIPE A?
- On what principle does the separation in the separator depend?
- What further treatment would be necessary to obtain more concentrated ethanol?

(4)

[Turn Over

14. A Chemistry set labelled "151 Safe Experiments" contains instructions for experiments involving sodium hydroxide solution. The instructions begin:

"To make a solution of sodium hydroxide dissolve a large quantity of sodium carbonate in water."

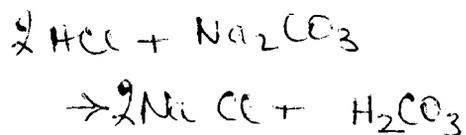
Explain why sodium carbonate solution will be suitable as a substitute for sodium hydroxide solution.

Compare the reactions of a real sodium hydroxide solution with those of the "substitute" one when mixed with:

- (a) dilute hydrochloric acid
(b) copper(II) sulphate solution.

(6)

See page seven etc. for PART B



All THREE questions should be attempted. Each question contains a choice.
Candidates are advised to spend about 1½ hours on this part.

15. Spend no more than 30 minutes on this question. Plan your answer beforehand; marks will be awarded for expressing yourself clearly.

EITHER

- A. Write an essay on "Forces of Attraction in Chemistry".

In your answer you should refer to the following topics:

Covalent Bonding (large and small structures).

Ionic (Electrovalent) Bonding.

Intermediate cases of the above.

Comparison of forces to be overcome in melting compounds containing these bonds.

Hydrogen Bonding.

Metallic Bonding.

Your answer should be illustrated by examples.

(17)

OR

- B. Write an essay on "Factors affecting the Rate of Chemical Reactions".

In your answer you should refer to the following topics:

The range of reaction rates—from very slow to very fast.

Effect on reaction rate of varying concentration, particle size and temperature.

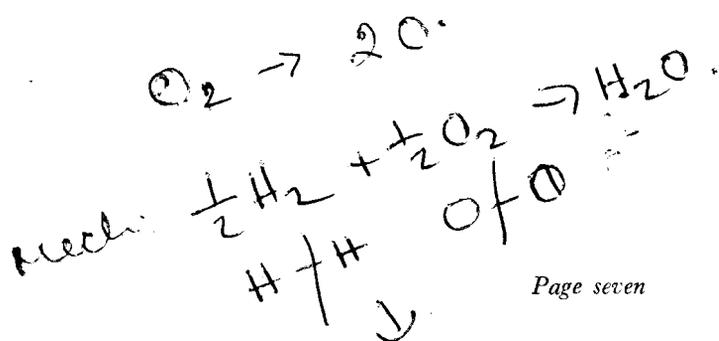
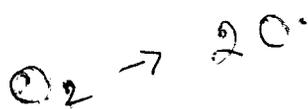
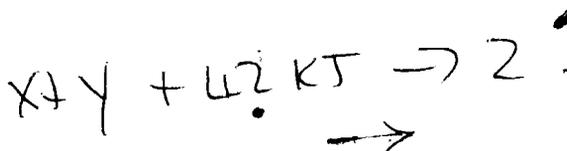
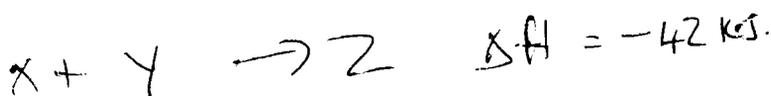
How the results can be explained by a collision theory and the idea of activation energy.

What a catalyst is and how it is thought to operate.

The meaning of the terms "the mechanism of a reaction" and "the rate-determining step".

Your answer should be illustrated by examples.

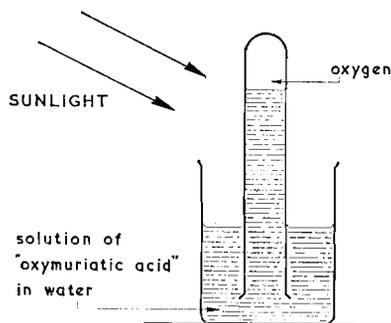
(17)



[Turn Over

16. EITHER

- A. (a) In 1785, the French chemist Berthollet described an experiment which he claimed proved that the recently prepared substance called “oxymuriatic acid”—now known to be the element chlorine—was a compound containing oxygen. He had exposed a solution of “oxymuriatic acid” in water to sunlight and after some time found that oxygen gas had collected above the liquid as the sketch shows:



Berthollet found that after the experiment the liquid in the tube was “muriatic acid”, a substance which could also be prepared from common salt and sulphuric acid.

- (i) Explain why this experiment does **NOT** prove that “oxymuriatic acid” contains oxygen. (1)
 - (ii) What is the modern name for “muriatic acid”? (1)
 - (iii) Write an equation for the reaction occurring in the tube. (1)
 - (iv) Mention **one** other reaction involving chlorine which could be initiated by sunlight. (1)
- (b) You will find First Ionisation Energies for the Elements on pp. 36 and 37 of the Data Book.
- (i) What trend in first ionisation energies do you observe within the group of halogen elements? (1)
 - (ii) Representing a halogen atom by X, write an equation to show what is happening during the “first ionisation” process. (1)
 - (iii) Offer an explanation in terms of atomic structure for the trend observed. (2)
 - (iv) Suggest a reason for the lack of ionisation energy data for the element Astatine (At, atomic number 85). (1)
- (c) The following table shows the mass numbers of the naturally-occurring isotopes of the halogen elements:

<i>Element</i>	<i>Mass number of isotopes</i>
fluorine	19
chlorine	35 37
bromine	79 81
iodine	127

- (i) Use this table and the relevant data on pp. 34-35 of the Data Book to find support for the statement that “the number of neutrons in the atomic nucleus tends to be even”. (3)

- (ii) The atomic weight of bromine is 80.0. What information does this give about the isotopes ⁷⁹Br and ⁸¹Br? (1)
- (d) (i) The brown liquid iodine monochloride (ICl) is produced when iodine and chlorine are mixed. When a few drops of the brown liquid are added to a gas jar of propene, the brown colour disappears. Name and write an extended structural formula for a compound likely to be produced in this reaction. (2)
- (ii) In which direction would iodine monochloride be polarised? (2)
Would it be more or less polar than iodine monofluoride?

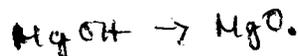
OR

B. The Scottish chemist Joseph Black (1728-1799) is mainly remembered for his pioneer work on the gas which he called "fixed air". He found that "fixed air" could be produced in several ways:

1. By heating a compound of magnesium called "magnesia alba", "calcined magnesia" being left in the vessel.
 2. By adding a dilute acid to "magnesia alba".
 3. By the burning of charcoal.
 4. By the fermentation of glucose.
- (a) Deduce the modern names for "fixed air", "magnesia alba" and "calcined magnesia". (3)
 - (b) Write an equation for the reactions described in 2 and 4 above. (2)
 - (c) Black found that 12 parts by weight of magnesia alba left 5 parts by weight of calcined magnesia. By carrying out a suitable calculation, decide whether or not this was an accurate result. (3)

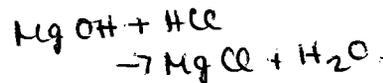
(d) Sea water contains 0.13% magnesium. The initial stage in the extraction of magnesium is the addition of alkali, which produces a precipitate of magnesium hydroxide. Outline the process by which magnesium metal is likely to be obtained from this precipitate, bearing in mind the following facts about magnesium compounds:

- magnesium oxide : melting point 2800 °C.
- magnesium hydroxide : decomposes on heating.
- magnesium chloride : melting point 708 °C. (4)



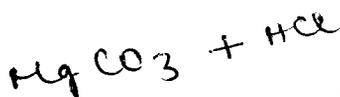
- (e) A white powder is thought to be either magnesium hydride or magnesium oxide. Explain how adding cold water would enable you to decide which it is. (2)
- (f) The crystal structure of an ionic compound is determined mainly by the "radius ratio" of the ions involved:

$$\text{radius ratio} = \frac{\text{radius of cation}}{\text{radius of anion}}$$

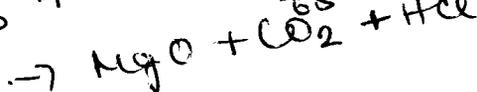


By carrying out suitable calculations using information from pp. 36-37 of the Data Book, explain why magnesium oxide is likely to have the same structure as sodium chloride.

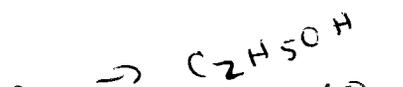
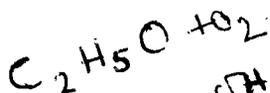
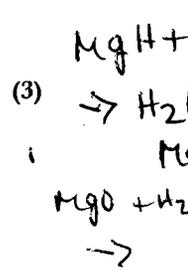
$\frac{172}{6} = 28.67$
 $\frac{1032}{6} = 172$



$\frac{172}{6} = 28.67$

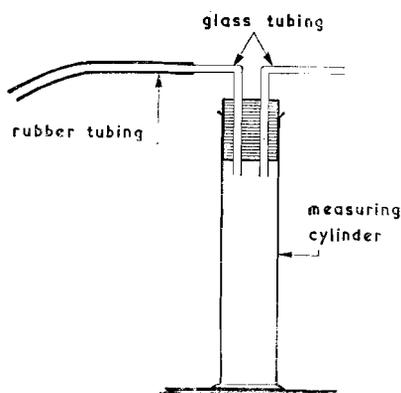


$\frac{172}{6} = 28.67$
 $\frac{1548}{6} = 258$



17. EITHER

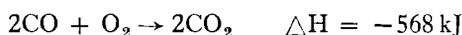
- A. (a) A pupil was given cylinders of methane, ethane and propane and was asked to compare their heats of combustion. It was suggested that he measure the volume of gas in each experiment. In addition to the usual laboratory apparatus, he was given the following:



Describe what he should now do.

(7)

- (b) The accepted value of the heat of combustion of methane is 890 kJ mol^{-1} . Given that



Calculate the energy released in the partial combustion of 1 mole of methane to produce carbon monoxide and water.

(5)

- (c) Explain what is meant by the following statements:

(i) the heat of formation of methane is $-74.8 \text{ kJ mol}^{-1}$.

(2)

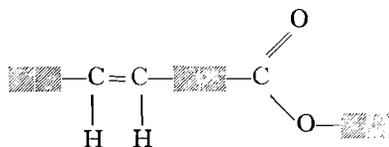
(ii) The bond energy of a C—H bond is 414 kJ mol^{-1} .

(2)

OR

- B. (a) Demand for the element nickel (Ni, atomic number 28) is increasing each year. Nickel is used in the hydrogenation of vegetable oils to produce fats. This is carried out as follows. The oil is heated to 180°C along with finely divided nickel. Hydrogen gas is passed in under 5 atmospheres pressure.

- (i) A typical vegetable oil can be represented by the structure



where represent hydrocarbon chains.

To which class of organic compounds does the oil belong?

(1)

- (ii) Draw the molecule which will be produced by the hydrogenation of the vegetable oil.
- (iii) Given a sample from the reaction vessel, how would you discover if hydrogenation was complete?
- (iv) What part does the nickel play in the hydrogenation process?
- (v) Why should it be "finely divided"?

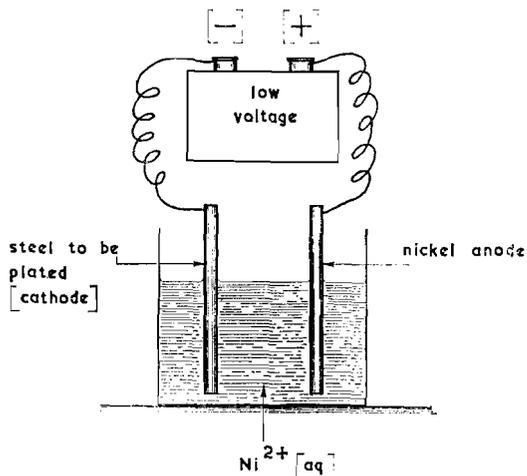
(1)

(2)

(1)

(1)

- (b) Another use for nickel is as a corrosion-resistant coating on steel. The coating is often put on as follows:



- (i) How does the steel become coated with nickel? Give an equation. (2)
- (ii) Suggest why a nickel anode is used. (2)
- (c) "During electrolysis, one mole of a substance is deposited by the passage of $96500 \times n$ coulombs of electricity, where n is the charge on the ion." Making use of this law, how could you extend the experiment described in (b) above to obtain a value for the atomic weight of nickel? (6)

[END OF QUESTION PAPER]

96500
2
173000