

[92/238]

1980

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER I

Tuesday, 13th May—9.30 a.m. to 11.00 a.m.

READ CAREFULLY

1. Check that the answer sheet provided is made out in your name and is for Chemistry.
2. Fill in the details required in the answer sheet. (This is needed for checking purposes.)
3. In this paper a question is answered by indicating the choice A, B, C or D (or E in the case of questions 49 and 50) by a stroke made with a pencil in the appropriate place in the answer sheet—see the sample question below.
4. For each question choose ONE answer which you think is correct.
5. Reference may be made to the booklet of Mathematical Tables and Science Data provided.
6. Rough working, if required, should be done only on this question paper, or on the rough working sheet provided—NOT on the answer sheet.

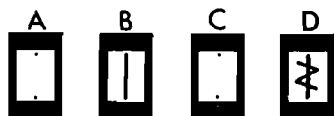
SAMPLE QUESTION

To show that the ink in a ball-point pen consists of a mixture of dyes the method of separation would be

- A fractional distillation
- B chromatography
- C fractional crystallisation
- D filtration.

The correct answer is **B**—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown in the example on the answer sheet.

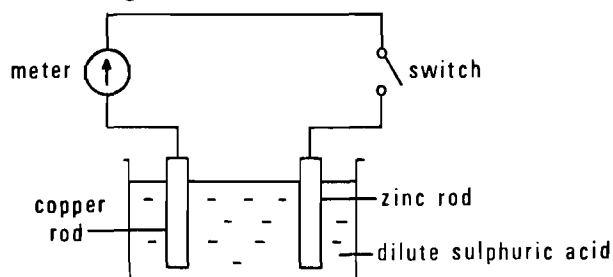
If after you have recorded your answer you decide that you have made an error and wish to make a change you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus if you want to change an answer **D** to an answer **B** your answer sheet would look like this:



If you want to change back to an answer which has already been scored out you should completely erase all marking with a rubber and re-mark your choice.

- From which of the following are metals seldom extracted?
 - Silicates
 - Oxides
 - Carbonates
 - Sulphides

Questions 2, 3 and 4 refer to the situation shown in the diagram.



- With the switch open as shown, what would be observed at the metal rods?
 - Blue colour at copper rod
 - Gas evolved at zinc rod
 - Gas evolved at copper rod
 - Gas evolved at both rods
- With the switch closed, which of the following is correct? Electrons flow from
 - zinc to copper in the external circuit
 - copper to zinc in the external circuit
 - zinc to copper in the solution
 - copper to zinc in the solution.
- With the switch still closed, which of the following is correct?
 - Copper is oxidised.
 - Zinc is oxidised.
 - Copper is reduced.
 - Zinc is reduced.
- Which of the following statements is **not** true about isotopes?
 - Their electron arrangements are the same.
 - The masses of their nuclei are different.
 - Their numbers of protons are different.
 - Their nuclear charges are the same.

- Which one of the following best conducts electricity?
 - 10 M ethanoic acid
 - 2 M ammonium hydroxide
 - 1 M sodium nitrate
 - 1 M nitric acid
- A metal (melting point 1240°C , density 7.20 g cm^{-3}) was obtained by electrolysis of its just molten chloride (melting point 650°C , density 2.48 g cm^{-3}). During the electrolysis, where and in what form would the metal appear?
 - As a solid on the surface of the electrolyte
 - As a liquid on the surface of the electrolyte
 - As a solid at the bottom of the electrolyte
 - As a liquid at the bottom of the electrolyte
- In general, covalent substances have lower melting points than ionic substances because
 - ionic bonds are stronger than covalent bonds
 - covalent compounds are composed of non-metals which have low melting points
 - bonds between molecules are weaker than bonds between ions
 - covalent bonds have no electrostatic attractive forces.
- In which of the following structures would the nails corrode before the roof itself?
 - Zinc roof with copper nails
 - Iron roof with copper nails
 - Zinc roof with iron nails
 - Copper roof with iron nails

Questions 10 and 11 refer to the experiment below.

The following oxides were shaken up with water which contained universal indicator, and the pH of the solution was measured.

- Barium oxide
 - Carbon dioxide
 - Sulphur dioxide
 - Copper oxide
- Which of the oxides would form a solution with a pH greater than 7?
 - Which of the oxides would **not** alter the pH of the water?

12. When 10 cm³ M HCl were added to 10 cm³ M NaOH solution, a rise in temperature of 6 °C was observed. If 10 cm³ M H₂SO₄ were used instead of the HCl, the temperature rise would be about
- A 3 °C
 - B 6 °C
 - C 12 °C
 - D 18 °C.
13. Concentrated sulphuric acid is added to each of the following solids. In which case is heating essential to bring about a reaction?
- A Sucrose
 - B Copper
 - C Sodium chloride
 - D Copper(II) sulphate crystals
14. Which of the following statements is true about an aqueous solution of sulphur dioxide?
- A It turns universal indicator blue.
 - B It is completely ionised.
 - C It contains more hydrogen ions than hydroxide ions.
 - D It reacts with alkalis producing sulphur dioxide gas.
15. Dilute sulphuric acid (2M) is dropped on to a powdered mixture of zinc and zinc carbonate. Which of the following would be the most likely composition of the gas evolved?
- A Carbon dioxide only
 - B Hydrogen only
 - C Hydrogen and carbon dioxide
 - D Carbon dioxide and sulphur dioxide
16. Which of the following best explains why graphite is used as a lubricant?
- A It contains only covalent bonds.
 - B The lattice unit is a six-membered ring.
 - C The lattice is held together partly by van der Waals' forces.
 - D It has a low melting point.
17. Which of the following statements about CO₂ is **false**?
- A It is a fuel.
 - B It has a linear molecule.
 - C It may be formed by oxidation of carbon monoxide.
 - D Its aqueous solution has a pH less than 7.
18. A hydrocarbon of molecular formula C₅H₁₀ does **not** decolourise bromine water. Which one of the following could it be?
- A Pentane
 - B Pentene
 - C Cyclopentane
 - D None of these
19. The products formed when a gas was burnt in air gave a white precipitate with calcium hydroxide solution and turned anhydrous copper(II) sulphate blue. Which of the following gases could it be?
- A Methane
 - B Carbon monoxide
 - C Hydrogen
 - D Ammonia
20. The reaction represented by the equation
- $$3\text{H}_2 + \text{N}_2 \rightarrow 2\text{NH}_3$$
- is exothermic.
- In the presence of the appropriate catalyst which set of conditions would give the best yield of ammonia at equilibrium?
- A 800 atmospheres and 2000 °C
 - B 1 atmosphere and 500 °C
 - C 1 atmosphere and 2000 °C
 - D 800 atmospheres and 500 °C
21. Hydrogen is **NOT** given off when magnesium reacts with
- A very dilute hydrochloric acid
 - B very dilute nitric acid
 - C concentrated hydrochloric acid
 - D concentrated nitric acid.

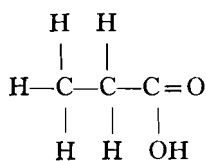
22. Which of the following descriptions is **NOT** true of proteins?

- A Natural, condensation polymers
- B Built up from identical monomer units
- C Can be hydrolysed
- D Built up from amino acids

23. Which of the following is a monosaccharide?

- A Glucose
- B Cellulose
- C Sucrose
- D Starch

24. To which of the following classes does the compound belong?



- A Alcohols
- B Acids
- C Hydrocarbons
- D Carbohydrates

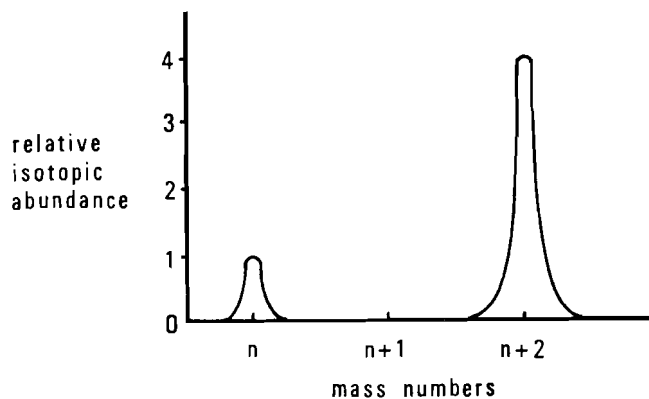
25. Which of the following hydrocarbons when burnt in excess of oxygen produces the same number of moles of carbon dioxide as of water?

- A C_2H_4
- B CH_4
- C C_2H_6
- D C_2H_2

26. Some oxygen is admitted to a mass spectrometer. Which of the following ions will be deflected most?

- A $^{16}\text{O}^+$
- B $^{16}\text{O}_2^+$
- C $^{18}\text{O}^+$
- D $^{18}\text{O}_2^+$

27.



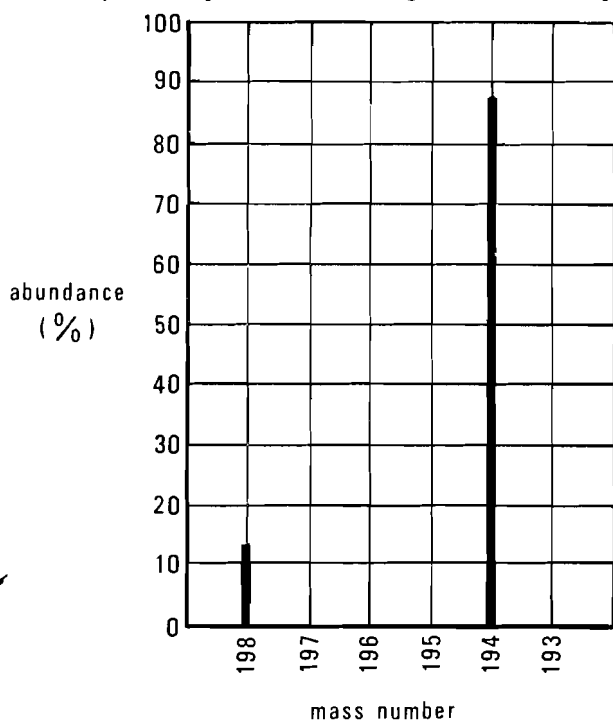
The above diagram shows the mass spectrum of an element. The approximate atomic mass of this element is

- A $n + 0.4$
- B $n + 1.0$
- C $n + 1.6$
- D $n + 2.0$

28. $^{27}_{13}\text{Al}$ can absorb an α -particle with the emission of a neutron. What is the product of this reaction?

- A $^{30}_{14}\text{Si}$
- B $^{28}_{15}\text{P}$
- C $^{30}_{15}\text{P}$
- D $^{31}_{16}\text{S}$

29. The mass spectrum below was obtained from a 48-day old sample of an α -emitting radioactive isotope.



What is the half-life of the isotope?

- A 6 days
 B 16 days
 C 24 days
 D 32 days
30. The molecular formula for a gas is X_3 . How many X atoms will be present in 5.6 litres of X_3 at s.t.p.?
- A $\frac{1}{4} \times 6 \times 10^{23}$
 B $\frac{3}{4} \times 6 \times 10^{23}$
 C $1 \times 6 \times 10^{23}$
 D $3 \times 6 \times 10^{23}$
31. A mixture of 50 cm³ carbon monoxide and 40 cm³ carbon dioxide is heated with excess copper(II) oxide until no further reaction occurs. What is the total volume of gas after the reaction? (All volumes are measured at s.t.p.)
- A 40 cm³
 B 50 cm³
 C 90 cm³
 D 140 cm³

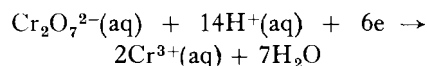
32. A gaseous hydrocarbon has a density of 1.25 g per litre at s.t.p. Its molecular formula is
- A C₂H₄
 B C₃H₆
 C C₄H₈
 D C₅H₁₀

33. When 3.0 g of ethane gas (formula weight = 30) is burned, 156 kJ of energy are given out. What is the heat of combustion of ethane?

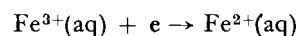
- A $\frac{22.4 \times 3.0 \times 156}{30}$ kJ mol⁻¹
 B $\frac{22.4 \times 30 \times 156}{3.0}$ kJ mol⁻¹
 C $\frac{3.0 \times 156}{30}$ kJ mol⁻¹
 D $\frac{30 \times 156}{3.0}$ kJ mol⁻¹

In connection with questions 34 and 35 consult the table of reduction electrode potentials given on page 30 of the Data Book.

34. The e.m.f., using platinum electrodes between the two half cells in which the reactions



and



take place, is under standard conditions

- A (1.33/6 - 0.77) V
 B (1.33 - 0.77) V
 C 1/6(1.33 + 0.77) V
 D 1/6(1.33 - 0.77) V.
35. $\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$
 $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
 Which one of the following reactions takes place in solution?
- A Bromide ions + acidified dichromate ions \rightarrow bromine + chromium(III) ions
 B Bromine + chromium (III) ions \rightarrow bromide ions + acidified dichromate ions
 C Bromine + acidified dichromate ions \rightarrow bromide ions + chromium(III) ions
 D Bromide ions + chromium(III) ions \rightarrow bromine + acidified dichromate ions

36. When an atom X of an element in Group VII reacts to become X^-
- the diameter of the particle decreases
 - the charge of the nucleus does not change
 - the atomic number of X decreases
 - the number of electron shells increases by 1.

Questions 37, 38 and 39 refer to the following list of bonding types.

- Ionic
- Metallic
- Covalent, discrete molecules
- Covalent, network solid

Choose the type of bonding which predominates in the following cases.

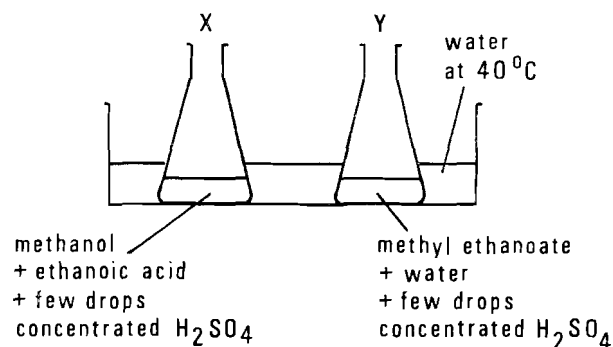
37. A substance which melts at 843°C and boils at 1540°C . When an electric current is passed through the molten substance no decomposition occurs.
38. A substance of melting point 2300°C , boiling point 2550°C , which does not conduct electricity.
39. A substance melting at 1074°C and boiling at 1740°C . The passage of an electric current through the molten substance results in decomposition.
40. A white solid dissolves in water to give a solution of pH 10. When dilute hydrochloric acid is added to the solution an effervescence is observed.
The white solid could be
- sodium sulphate
 - sodium carbonate
 - sodium ethanoate
 - sodium hydroxide.
41. A potassium ion has one more electron than
- an argon atom
 - a calcium ion
 - a chlorine atom
 - a sulphide ion.

42. Liquid petrol does not ignite spontaneously when exposed to the air because
- the ΔH for the combustion of petrol is positive
 - reaction between petrol and oxygen requires a lead-based catalyst
 - the reactants are in different physical states
 - not enough molecules possess sufficient energy.

43. The decomposition of magnesium carbonate by heat can be prevented from going to completion by
- absorbing the carbon dioxide produced in lime water
 - removing magnesium oxide as it is formed
 - carrying out the reaction in a small, closed vessel
 - reducing the pressure in the reaction vessel.

44. The explosion of hydrogen with chlorine is initiated by light. It probably involves several stages such as:
- $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
 - $\text{H}_2 + \text{Cl}\cdot \rightarrow \text{HCl} + \text{H}\cdot$
 - $\text{H}\cdot + \text{Cl}_2 \rightarrow \text{HCl} + \text{Cl}\cdot$
 - $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$
- Which step is likely to involve the greatest activation energy?

45. Two flasks, X and Y, with their contents as shown in the diagram below, were placed in a vessel of water at 40°C .



After several hours the contents of both flasks were analysed. What result would be expected?

- Flask X contains methyl ethanoate, methanol and ethanoic acid; flask Y is unchanged.
- Flask X and flask Y both contain methyl ethanoate, methanol, and ethanoic acid.
- Flask X contains methyl ethanoate; flask Y is unchanged.
- Flask X contains methyl ethanoate; flask Y contains methyl ethanoate, methanol, and ethanoic acid.

46. What type of reaction occurs in the following case?
Propanol vapour + heated aluminium oxide
- A Addition
 - B Hydrolysis
 - C Dehydration
 - D Substitution

47. Wool can be dyed easily with picric acid (a yellow dye) and with rhodamine B (a red basic dye).

This suggests that wool

- A is a natural polymer
- B readily forms hydrogen bonds
- C contains nitrogen atoms
- D contains acidic and basic groups.

48. A compound S on oxidation, gives a compound T. T reduces Fehling's (or Benedict's) solution.

Compound S could be

- A Propan-1-ol
- B Propan-2-ol
- C Propanal
- D Propan-2-one.

In questions 49 and 50 more than one response may be correct.

Answer

- A if responses 1, 2 and 3 are correct
- B if responses 1 and 3 are correct
- C if responses 2 and 4 are correct
- D if 4 only is correct
- E if some other response or combination of responses is correct

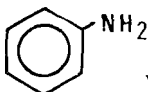
49. Which of the following statements is/are true?

1



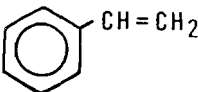
will not *readily* undergo addition reactions

2



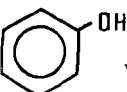
will not react with hydrochloric acid

3



will undergo addition polymerisation

4



with water gives a pH value greater than 7.

50. If an alcohol is to be oxidised to an aldehyde it is *essential* that

- 1 the -OH group is on an end carbon atom
- 2 it is a tertiary alcohol
- 3 it has the same number of carbon atoms as the desired aldehyde
- 4 the carbon chain of the alcohol is branched.

[END OF QUESTION PAPER]

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1980

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Tuesday, 13th 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.

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.

- | | <i>Marks</i> |
|---|------------------------|
| 1. (a) Draw the extended structural formula of propanal. | 1 |
| (b) To which homologous series does propanal belong? | 1 |
| (c) Does propanal have an isomer which belongs to the same series?
Explain your answer. | 2
(4) |
| 2. Find values for a, b, c and d such that the following equation will be balanced. | |
| $a \text{ B}_2\text{O}_3 + b \text{ C} \rightarrow c \text{ B}_4\text{C} + d \text{ CO}$ | (2) |
| 3. A weather balloon contains equal volumes of helium and hydrogen. If the total volume of the balloon is 89.6 litres at s.t.p., how many atoms of each gas will be present in the balloon? | (4) |
| 4. Answer EITHER A OR B . | |
| A. (a) Consult the Data Book (page 33) and state in kelvins the melting points of aluminium, silicon and phosphorus. | 1 |
| (b) Which type of structure does each element have? | 3
(4) |
| OR | |
| B. Consult the table of Ionisation Energies in the Data Book, (page 28). | |
| (a) Explain the difference in the values for the first ionisation energies of sodium and potassium. | 2 |
| (b) State the values of the second and third ionisation energies listed for magnesium. | 1 |
| (c) Explain the large difference in the stated values in (b). | 1
(4) |
| 5. (a) What is the pH (less than 7, 7, or greater than 7) of an aqueous solution of: | |
| (i) ammonium chloride; | |
| (ii) sodium sulphite? | 1 |

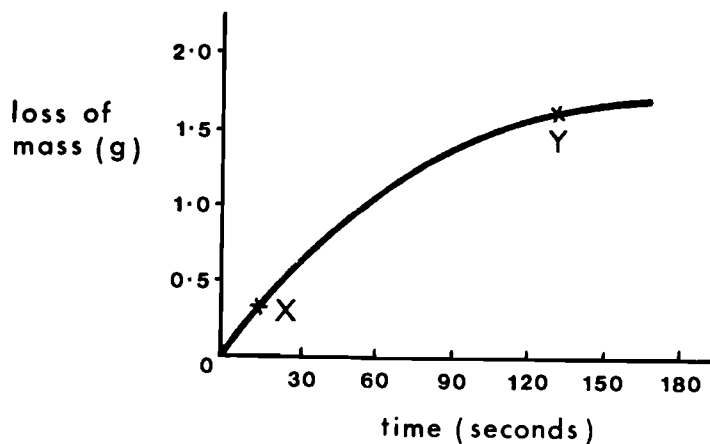
(b)

<i>Indicator</i>	<i>Colour change</i>	<i>pH range over which colour change occurs</i>
methyl red	red—yellow	4.2– 6.3
phenolphthalein	colourless—red	8.3–10.0

Decide which of the above indicators is more suitable for the following neutralisations and state the colour change in each case.

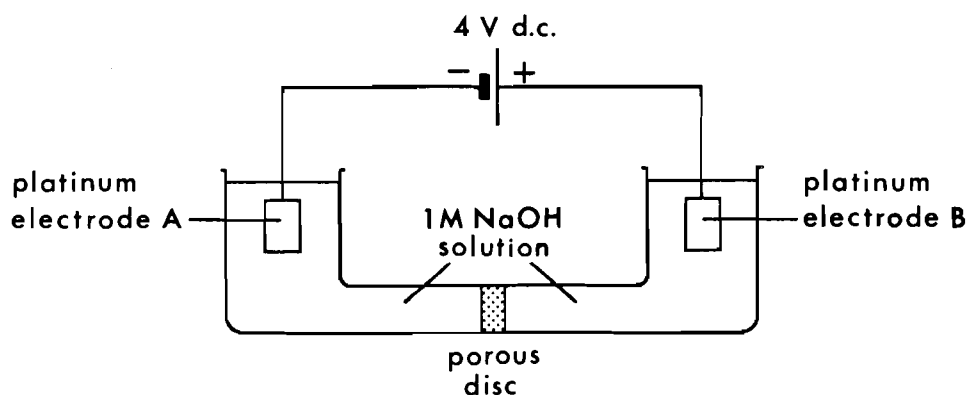
- | | |
|---|------------------------|
| (i) Dilute hydrochloric acid added to dilute ammonia solution; | |
| (ii) Dilute sodium hydroxide solution added to dilute sulphurous acid. | 2
(3) |

6. The graph shows the loss of mass, with time, which occurs when marble chips react with dilute hydrochloric acid.



- (a) How does the rate of reaction at X compare with that at Y? 1
- (b) Explain why the rate at Y is different from that at X. 1
- (c) State two other factors which affect the rates of chemical reactions. 2
- (4)**
7. (a) A neutron can interact with an atom of $^{14}_7\text{N}$ to form an atom of carbon-14. Write the full nuclear equation for this reaction. 2
- (b) Which atom is formed when an atom of carbon-14 decays by β -emission? 1
- (3)**
8. Answer **EITHER A OR B**.
- A. A sample of molten nickel(II) chloride is electrolysed using a current of 0.4 A for a time of 16 minutes 5 seconds. What mass of nickel, theoretically, will be formed? (4)
- OR**
- B. Dilute sulphuric acid is electrolysed using a current of 1.15 A for a time of 50 minutes. What volume of gas at s.t.p. will be given off, theoretically, at the negative electrode? (4)

9.



The sodium hydroxide solution in the cell is electrolysed for 20 minutes.

Use the information given in the Data Book, (page 31), to answer the following questions.

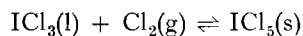
- (a) Give the ion-electron equations for the reactions taking place at electrodes A and B respectively, during electrolysis. 2
- (b) If the power supply is replaced by a voltmeter, what will be the potential developed between the two electrodes? 1

(3)

[Turn over

10. Answer EITHER A OR B.

A. The reaction

is exothermic for the formation of ICl_5 .

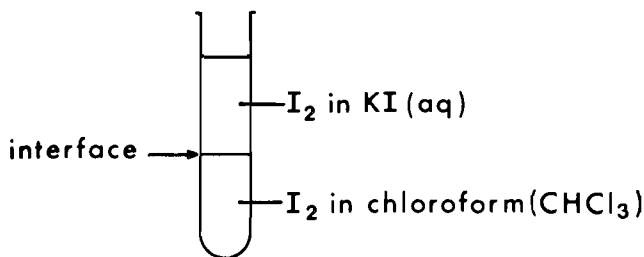
What would happen to a mixture in equilibrium if

- (a) the pressure was decreased?
 (b) the temperature was increased?
 (c) more chlorine was added?

1
 1
 1
 (3)

OR

B.



The test tube is thoroughly shaken until no further change is visible.

Explain what is happening at the interface

- (a) after equilibrium is established;
 (b) immediately after *more* chloroform is added.

2
 1
 (3)

11. In the presence of excess fluorine, xenon can form a fluoride XeF_6 . Xenon also forms an oxide XeO_3 .

Compound	ΔH_f (kJ mol ⁻¹)
XeF_6	-403
XeO_3	+403

- (a) Using the value of the heat of formation for XeF_6 and information from the Data Book, (page 31), calculate the mean bond energy of the Xe-F bond in XeF_6 .
 (b) Comment on the stability of the fluoride and of the oxide of xenon.

4
 2
 (6)

12. An alcohol, X, on mild oxidation, gives a stable, neutral compound, Y, of molecular weight 72.

- (a) Draw the extended structural formulae for X and Y.
 (b) Give the systematic name for the alcohol X.
 (c) Is X a primary, secondary or tertiary alcohol?

2
 1
 1
 (4)

13. A compound, Q, has the following percentage composition by weight:

Element	Sodium	Sulphur	Oxygen
% composition by weight	36.5	25.4	38.1

Q is soluble in water and when a solution of Q is tested with barium chloride solution, a precipitate is observed.

- (a) Calculate the empirical (simplest) formula for the compound Q. 2
- (b) Write the equation for the reaction occurring between a solution of Q and barium chloride solution. 1
- (c) What, if anything, will happen to the precipitate if hydrochloric acid is added to it? 1
- (4)**

14. The table shows two properties of aluminium halides.

	Aluminium fluoride	Aluminium chloride	Aluminium bromide
Melting point ($^{\circ}\text{C}$)	1200	192*	98
Electrical conductivity of molten substances	conducts	conducts	does not conduct

(* AlCl_3 sublimes, this melting point is obtained under pressure.)

What do you conclude about the type of bonding in:

- (a) aluminium fluoride;
- (b) aluminium chloride;
- (c) aluminium bromide? (2)

[Turn over

PART B

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

Marks

15. Answer EITHER A OR B.

A. A green hydrated compound called malachite was the subject of the following two investigations.

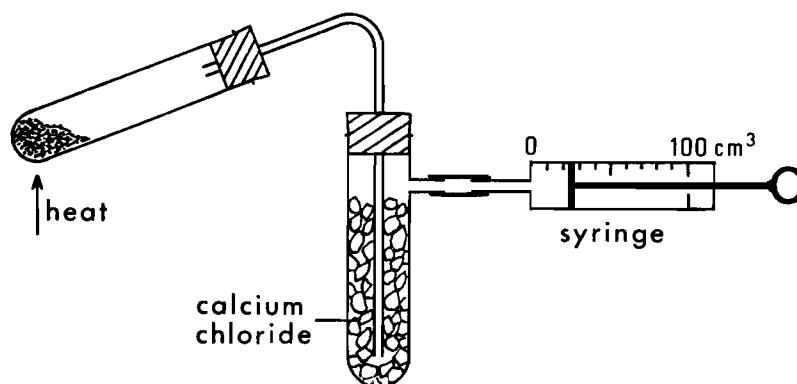
I First Investigation

On addition of acid, carbon dioxide was released. Thermal decomposition gave three products which were identified as black copper(II) oxide, carbon dioxide and water.

- (a) What does the action of acid indicate about malachite? 1
- (b) How would you confirm that 1
- (i) carbon dioxide was liberated on addition of acid; 1
- (ii) the black product was copper(II) oxide? 1

II Second Investigation

Malachite was decomposed in the following apparatus.



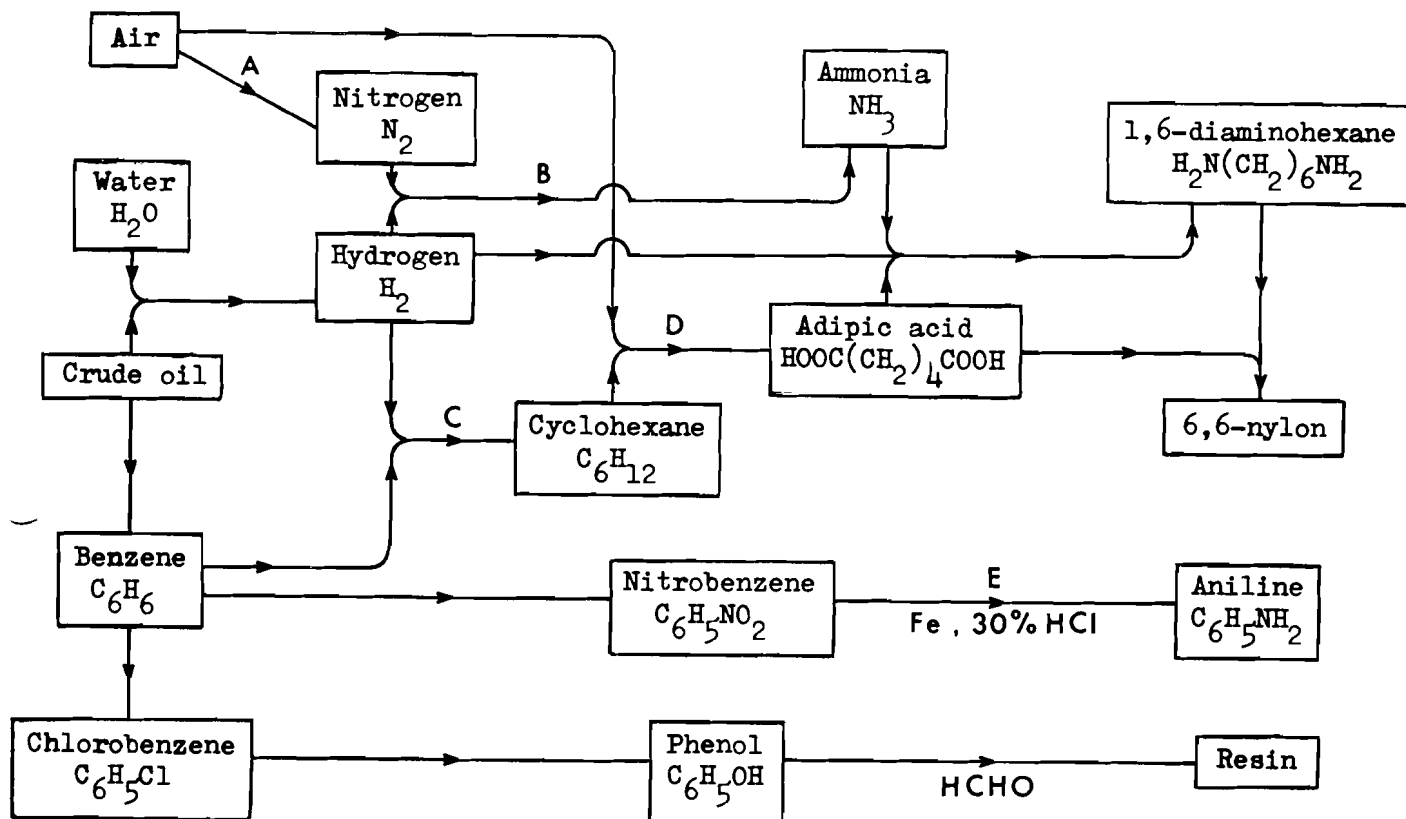
After decomposition was complete, the apparatus was allowed to cool, and the volume of carbon dioxide which had been produced was measured at s.t.p. The results were as follows:

Mass of malachite (g)	Mass of copper(II) oxide (g)	Mass of water (g)	Volume CO ₂ (cm ³)
0.559	0.398	0.045	56

- (a) How would you confirm, experimentally, that decomposition was complete? 2
- (b) What was the function of the calcium chloride? 1
- (c) How many moles of the following were formed: 2
- (i) copper(II) oxide, 1
- (ii) water, 1
- (iii) carbon dioxide? 2
- (d) (i) What was the mole ratio of copper(II) oxide: carbon dioxide: water? 1
- (ii) Write a formula for malachite using this ratio. 1
- (e) Calculate the formula weight of malachite. 1
- (f) How many moles of malachite were present in the original sample? 1
- (g) Sketch the apparatus you would use in a similar experiment to show how much carbon dioxide is released from a quantity of malachite when hydrochloric acid is added. 2

(17)

B. The following flow diagram represents the steps in the preparation of some important chemicals:



- (a) In step A, how is nitrogen normally obtained? 1
- (b) In step B, what are the reaction conditions? 3
- (c) In step C, what type of chemical reaction takes place? 1
- (d) In step D, how much adipic acid would be formed from 4,200 kg of cyclohexane? (Assume the process is 100% efficient.) 3
- (e) In step E, nitrobenzene is completely reduced to aniline. To obtain pure aniline, the acidic aqueous solution is treated with sodium carbonate, and the aniline is removed using ether, an organic solvent.
- (i) In what form is the aniline present in the acidic solution? 1
- (ii) Why has the solution to be treated with sodium carbonate? 2
- (iii) What would you observe after the addition of sodium carbonate has been completed? 1
- (iv) What can you deduce about the relative solubilities of aniline in water and ether? 1
- (f) Draw the structural formula for part of the nylon molecule. 1
- (g) Resins made from phenols and methanal are used for cation exchange, in which the resins remove cations from solutions and release an equivalent number of hydrogen ions to replace them. When formed, the resins still contain free phenolic OH groups.
- (i) Explain why the resins can be used for cation exchange. 2
- Which are the two most common ions removed from hard water by cation exchange? 1

(17)

[Turn over

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TO BE READ BY THE INVIGILATOR
BEFORE THE COMMENCEMENT
OF THE EXAMINATION

1980 SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY HIGHER GRADE - PAPER II

TUESDAY 13 MAY 1980 - 1.30 pm to 4.00 pm

PAPER NO 92/239

When you have given out the paper for Chemistry Higher II, please draw the attention of candidates to the following:

Page 7, question 15B(g), second last line:

Insert "(ii)" before the word "Which"

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16. Answer EITHER A OR B.

- A. In 1880, Mendeléef described an oxide which was basic but “not very energetic”. Analysis showed that in the oxide 76 g metal had combined with *about* 16 g oxygen.

He deduced the formula of the oxide and the atomic weight of the metal by the following arguments:—

If the formula was R_2O , R had an atomic weight of 38. The possible place in the Periodic Table for such an element was, however, occupied by K. Furthermore, the oxide would have been soluble and “energetic”.

If the formula was RO , R had an atomic weight of 76. Again possible places in the Periodic Table were filled.

If the formula was R_2O_3 , R had an atomic weight of 114. There was a gap in the Periodic Table for an element with an atomic weight of about 114. Furthermore, according to its analogy with Al_2O_3 and Tl_2O_3 , it should have feebly basic properties.

Examine the following extract from the Periodic Table as we know it today and answer the questions which follow:

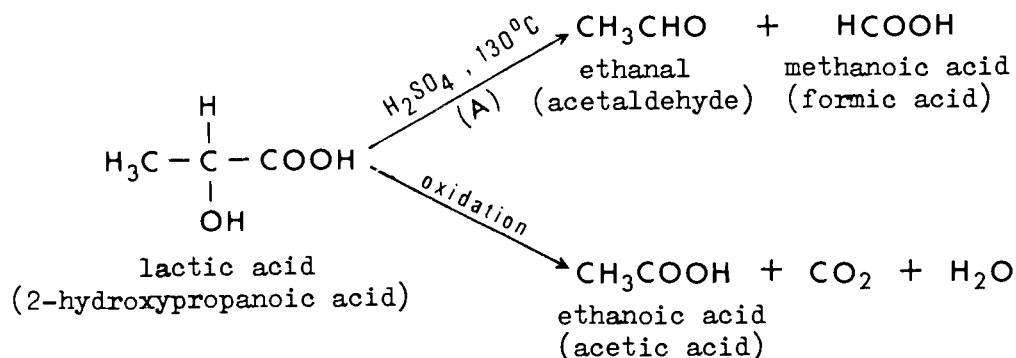
K 39.1	Ca 40.1	Sc 45.0	Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.8	Co 58.9	Ni 58.7	Cu 63.5	Zn 65.4	Ga 69.7	Ge 72.6	As 74.9	Se 79.0	Br 80.0	Kr 83.8
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9	Tc 98.9	Ru 101	Rh 103	Pd 106	Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127	Xe 131

- (a) Why would there have been a slight error in Mendeléef’s results? **1**
- (b) Give two reasons, stated in the above passage, why the element cannot be in group 1. **2**
- (c) RO is impossible for the formula of the oxide. Give an example of an element which *could* have this formula. **1**
- (d) The oxide was not a very “energetic” base. How would you test an energetic base and what result would you expect? **1**
- (e) What is the name of the element Mendeléef was describing? **1**
- (f) What happens to the basicity of oxides going across the Periodic Table? **1**
- (g) What term is now used to describe Al_2O_3 ? **1**
- (h) The oxide possessed feebly basic properties:
- (i) Name a compound with which it would react to demonstrate this property. **1**
- (ii) Write a balanced equation for the reaction occurring in (h)(i). **2**
- (iii) What term could be used to describe this type of reaction? **1**
- (i) Why was Mendeléef’s work important? **2**
- (j) When water is added to calcium oxide (an energetic base), a vigorous reaction occurs. When the liquid obtained is filtered, and a gas added to the filtrate, the liquid goes cloudy.
- (i) What is happening to the calcium oxide when it reacts vigorously with water? **1**
- (ii) What is the filtrate commonly called? **1**
- (iii) What is the gas added to the filtrate? **1**

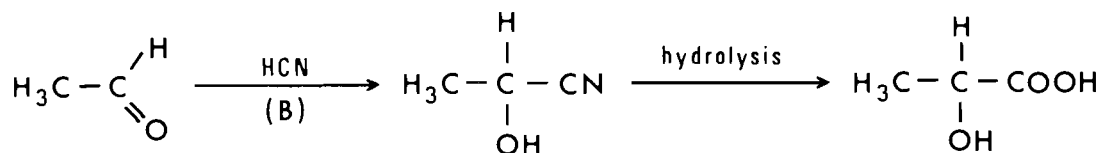
(17)

OR

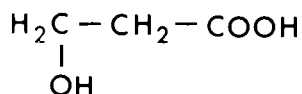
- B. In 1863, Wislicenus applied the methods of synthesis and degradation to the study of the structure of lactic acid; this acid is now called 2-hydroxypropanoic acid. He obtained unequivocal evidence for its structure by taking lactic acid from natural sources and decomposing it as shown:



Synthesis of 2-hydroxypropanoic acid from ethanal (acetaldehyde) produced lactic acid.



A possible alternative structure for lactic acid



was thereby excluded by the evidence given above. Indeed, Wislicenus synthesised this isomer and proved that it differed from lactic acid.

- (a) The name lactic acid is not a systematic name. State an advantage of systematic nomenclature. 1
- (b) What does the term "natural sources" mean when referring to organic compounds? 1
- (c) What are the two functional groups in lactic acid? 2
- (d) Explain the terms "synthesis" and "degradation". 2
- (e) Give a reason for stating that $\text{HOCH}_2\text{CH}_2\text{COOH}$ could not be the structural formula for lactic acid. 2
- (f) Give the systematic name and extended structural formula for formic acid. 2
- (g) Explain whether you think the sulphuric acid (A) used to decompose the lactic acid was concentrated or dilute. 2
- (h) What does the carbon atom in the HCN (B) do to the length of the carbon chain in the synthesis? 1
- (i) Give the name of the product which could be obtained by reacting propanal with HCN and then hydrolysing the intermediate. 2
- (j) Commercial organic compounds may be synthesised from oil-based chemicals or extracted from natural sources. What factors would influence a chemical company in their choice when large quantities of the product are needed? 2

(17)

[Turn over

17. Answer EITHER A OR B.

Candidates are asked to pay particular attention in this question to the organisation and presentation of answers. Examiners will be scrutinising the essay not simply to assess its scientific content, but also to give credit for the organisation and presentation of the material. In this last connection, the essential point is a due regard for normal English usage.

A. Write an essay on "Chemistry and the Motor Car".

Your answer should include reference to the following:

- (a) Manufacture of components, e.g. bodywork, glasswork, fabrics, tyres;
- (b) Batteries;
- (c) Oils, fuels and combustion;
- (d) Pollution;
- (e) Corrosion.

(16)**OR****B. Write an essay on "Carbohydrates".**

Your answer should include reference to the following:

- (a) Mono-, di- and polysaccharides;
- (b) Nutritional and structural carbohydrates, including their sources;
- (c) Carbohydrate tests;
- (d) Hydrolysis and condensation;
- (e) Photosynthesis and respiration;
- (f) Fermentation;
- (g) Energy sources—past, present and future.

(16)

[END OF QUESTION PAPER]