

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER I

Monday, 11th 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.

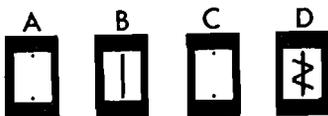
SAMPLE QUESTION

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.

1. A negatively charged particle with electronic configuration 2, 8 could be a
- A fluorine atom
 - B sodium atom
 - C fluoride ion
 - D sodium ion.

2. Consider the following table:

Particle	Protons	Neutrons	Electrons
P	26	30	23
Q	26	30	24
R	26	31	24
S	27	31	25

Which two particles are ions of the same charge and are isotopic?

- A P and Q
 - B Q and R
 - C R and S
 - D P and R
3. If 0.1 mole of equally fine granules of the following metals were reacted with equal volumes of excess 2 M hydrochloric acid, which one should give off the most hydrogen?
- A Magnesium
 - B Lithium
 - C Aluminium
 - D They should all give off the same volume.
4. Which of the following tests is sufficient to show that a sample of hydrogen is **not** pure?
- A Its density at room temperature is 0.090 kg m^{-3} .
 - B It burns with a blue flame to produce water.
 - C It turns moist pH indicator paper red.
 - D It is insoluble in water.

5. From your knowledge of the Periodic Table, which of the following would probably be present in a sample of the mineral strontianite? This mineral is mainly strontium carbonate.

- A Barium carbonate
- B Rubidium carbonate
- C Aluminium carbonate
- D Cadmium carbonate

6. When one of the following minerals was heated strongly in air, a gas of formula weight 64 was given off. The metal oxide which remained was reduced to the metal on heating in a stream of hydrogen.

The mineral was

- A copper(II) carbonate
- B lead(II) sulphide
- C calcium carbonate
- D magnesium sulphide.

7. A few drops of water are added to 1 litre of pure ethanoic acid. The resulting solution is a

- A concentrated solution of a weak acid
- B dilute solution of a strong acid
- C dilute solution of a weak acid
- D concentrated solution of a strong acid.

8. Which of the following compounds would raise the pH of soil when added to it?

- A Ammonium nitrate
- B Calcium chloride
- C Ammonium sulphate
- D Calcium hydroxide

9. A mixture of magnesium bromide and magnesium sulphate is known to contain 3 moles of magnesium and 4 moles of bromide ions. How many moles of sulphate ions are present?

- A 1
- B 2
- C 3
- D 4

10. Which of the following features identifies a substance as an addition polymer?

- A It is a straight-chain hydrocarbon.
- B It is formed by eliminating small molecules.
- C It is resoftened on heating.
- D None of these.

Questions 11 and 12 refer to the following properties of sulphuric acid:

- A a typical acid
- B an oxidising agent (electron acceptor)
- C an involatile acid
- D a dehydrating agent.

Which property is shown in the following reactions?

11. Production of nitric acid from potassium nitrate.

12. Reaction of copper metal with hot, concentrated sulphuric acid.

13. Which of the following represents the main outcome when copper is added to hot concentrated nitric acid?

- A $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$
- B $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$
- C $\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightarrow \text{NO} + 2\text{H}_2\text{O}$
- D $\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightarrow \text{NO}_2 + \text{H}_2\text{O}$

14. It is inadvisable to burn natural gas (methane) in a poorly ventilated room because

- A poisonous hydrocarbons of high molecular weight are formed
- B a mixture of methane and air is explosive
- C the incomplete combustion of methane results in the formation of hydrogen
- D a shortage of oxygen may result in the formation of carbon monoxide.

15. The gas C_3H_6 is used on an industrial scale to manufacture

- A bottled gas
- B a condensation polymer
- C an addition polymer
- D diesel fuel.

16. The ester of glycerol and stearic acid is commonly known as a

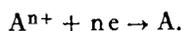
- A soapless detergent
- B soap
- C polymer
- D fat.

17. Which of the following is the structural formula of an ester?

- A $\text{CH}_3\text{CH}_2 - \text{C} \begin{array}{l} \diagup \text{H} \\ \diagdown \text{O} \end{array}$
- B $\text{CH}_3 - \text{C} \begin{array}{l} \diagup \text{O} - \text{CH}_3 \\ \diagdown \text{O} \end{array}$
- C $\text{CH}_3 - \text{C} \begin{array}{l} \diagup \text{CH}_3 \\ \diagdown \text{O} \end{array}$
- D $\text{CH}_3 - \text{C} \begin{array}{l} \diagup \text{OH} \\ \diagdown \text{O} \end{array}$

18. Which one of the following would be most likely to yield a steady stream of hydrogen when added to magnesium?
- A Aqueous ammonium chloride
 B Aqueous sodium chloride
 C Aqueous sodium ethanoate
 D Trichloromethane
19. 56 g of an oxide of lead was strongly heated and hydrogen gas was passed over it. When the oxide was completely reduced, 52 g lead remained. A possible formula for the oxide is
- A Pb_2O_3
 B PbO_2
 C Pb_2O
 D PbO .
20. Which of the following statements is true about an aqueous solution of ammonia?
- A It has a pH of less than 7.
 B It is completely ionised.
 C It contains an excess of hydroxide ions.
 D It reacts with acids producing ammonia gas.
21. Which of the following does **NOT** exist in another isomeric form?
- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 B $\text{CH}_3\text{CH}_2\text{CH}_3$
 C CH_3CHCH_3
 D CH_3CHCl_2
22. Some oxygen is admitted to a mass spectrometer. Which of the following ions will be deflected **least**?
- A $^{16}\text{O}^+$
 B $^{16}\text{O}_2^+$
 C $^{18}\text{O}^+$
 D $^{18}\text{O}_2^+$
23. What is produced when a $^{35}_{17}\text{Cl}$ atom captures a neutron and then emits γ -radiation?
- A $^{36}_{18}\text{Ar}$
 B $^{36}_{17}\text{Cl}$
 C $^{35}_{18}\text{Ar}$
 D $^{31}_{15}\text{P}$
24. In the electrolysis of a solution of copper(II) sulphate using copper electrodes, the passage of one Faraday of electricity (96 500 C) results in the mass of the negative electrode
- A increasing by approximately 64 g
 B decreasing by approximately 64 g
 C increasing by approximately 32 g
 D decreasing by approximately 32 g.
25. The equation for the combustion of carbon monoxide is
- $$2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}).$$
- What volume of carbon dioxide would be obtained by the combustion of 28 cm^3 carbon monoxide? (All volumes measured at s.t.p.)
- A 28 cm^3
 B 42 cm^3
 C 56 cm^3
 D 84 cm^3
26. When excess of a carbonate was treated with acid, 11.2 litres carbon dioxide were evolved at s.t.p. Approximately how many moles of hydrogen ions had reacted?
- A 0.25
 B 0.5
 C 1.0
 D 11.2

27. The electrode potential series is normally written with the ion-electron equations in the form:



Where in the series are the best reducing agents?

- A On the left of the equation and with a very positive E°
- B On the right of the equation and with a very positive E°
- C On the left of the equation and with a very negative E°
- D On the right of the equation and with a very negative E°
28. From the table of electrode potentials on page 30 of the Data Book, which of the following is the e.m.f. between electrodes connecting the two half cells $Cu/Cu^{2+}(aq)$ and $Ag/Ag^+(aq)$ under standard conditions?
- A 0.46 V
- B 0.64 V
- C 0.96 V
- D 1.14 V

Questions 29 and 30 refer to the following:

- A non-polar bonding
- B polar covalent bonding
- C hydrogen bonding
- D van der Waals forces.

Which of the above is mainly responsible for holding the following pairs together?

29. Two adjacent water molecules in an ice crystal.
30. The carbon atom and a chlorine atom in a molecule of tetrachloromethane (CCl_4).
31. When a Group I metal atom X reacts to become an ion X^+
- A the diameter of the particle increases
- B the positive charge of the nucleus increases
- C the atomic number of X decreases
- D the number of occupied electron shells decreases by 1.

The following types of structures are to be used for **questions 32 and 33**:

- A covalent (discrete molecules)
- B covalent (network structure)
- C ionic
- D metallic.

32. Which type describes a substance melting at 771 K which conducts electricity when molten, but not when solid?
33. Which type describes a substance melting in the region 2300 K which does **not** conduct electricity in the solid state, or when molten?
34. Which of the following atoms has the least attraction for electrons?
- A Lithium
- B Caesium
- C Fluorine
- D Iodine

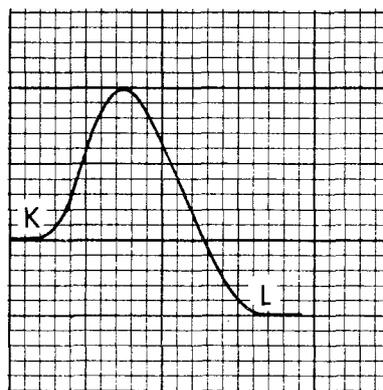
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Questions 35 and 36 refer to the reaction which takes place when chlorine is passed into a solution of potassium iodide containing starch.

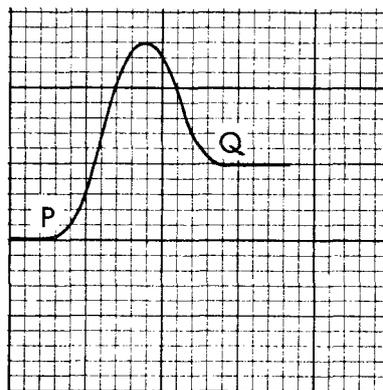
35. What is observed in this reaction?
- The liquid turns deep blue.
 - A yellow precipitate forms.
 - A white precipitate forms.
 - The liquid turns pale yellow.
36. What is the most likely explanation of the reaction between chlorine and potassium iodide solution?
- The iodide ion has a smaller radius than the iodine atom.
 - The iodide ion has a stronger hold on its outer electrons than does the chloride ion.
 - The element with the greater number of electrons will always give electrons to an element with fewer electrons per atom.
 - Chlorine is more electronegative than iodine.
37. Which of the following is most likely to prove a satisfactory method of obtaining fluorine?
- Heating gaseous hydrogen fluoride
 - Treating a fluoride with a reducing agent
 - Adding chlorine to sodium fluoride solution
 - Passing electricity through molten sodium fluoride
38. A piece of magnesium is dropped into some ethanoic acid and the evolution of hydrogen gas is noted. If a few drops of water are added, the bubbles of hydrogen come off faster because
- the ethanoic acid is more highly ionised in the presence of water
 - the magnesium ribbon reacts with water faster than it reacts with pure ethanoic acid
 - the magnesium salt formed is insoluble in ethanoic acid but soluble in water
 - the water dissolves the magnesium oxide on the surface of the metal.

39. Which reaction has the greatest activation energy?

- $K \rightarrow L$
- $L \rightarrow K$
- $P \rightarrow Q$
- $Q \rightarrow P$



reaction pathway



reaction pathway

40. In a catalysed, reversible reaction, equilibrium is reached when
- molecules of reactants cease to change into molecules of products
 - the concentrations of reactants are equal to the concentrations of products
 - the concentrations of reactants and products are constant
 - the catalyst has lowered the activation energy of the forward reaction until it is equal to that of the reverse reaction.

41. Hydrogen and chlorine react explosively when exposed to sunlight. The initial step brought about by the light energy is

- A $\text{H}_2 \rightarrow \text{H}\cdot + \text{H}\cdot$
- B $\text{H}_2 \rightarrow \text{H}^+ + \text{H}^-$
- C $\text{Cl}_2 \rightarrow \text{Cl}\cdot + \text{Cl}\cdot$
- D $\text{Cl}_2 \rightarrow \text{Cl}^+ + \text{Cl}^-$

42. $\text{Br}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{Br}^-(\text{aq}) + 2\text{H}^+(\text{aq}) + \text{OBr}^-(\text{aq})$
Assume that the above equation describes the equilibrium which exists in a dilute solution of bromine in water. If excess of sodium hydroxide solution were added, followed by the addition of excess of dilute sulphuric acid, which of the following would occur?

- A Formation of a cream coloured precipitate, followed by its disappearance
- B Evolution of bromine vapour, followed by decolorisation
- C Disappearance of the original colour, followed by its reappearance
- D Intensification of the original colour followed by evolution of gas

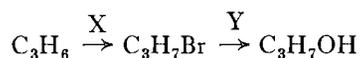
43. Hydrogen bonding occurs in liquid samples of

- A ethane
- B ethanol
- C ethene
- D ethyl ethanoate.

44. Which of the following statements is true about the straight-chain alkanes?

- A Only the lower members burn.
- B They polymerise readily.
- C The melting points increase with molecular weight.
- D They form addition compounds with the halogens.

45. Consider the sequence:



In the above sequence of reactions the reagents X and Y are, respectively,

- A Br_2 and H_2SO_4
- B HBr and H_2SO_4
- C Br_2 and aqueous KOH
- D HBr and aqueous KOH .

46. If the substance $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ is completely reacted with hydrogen in the presence of a catalyst, what would be the product?

- A Ethane
- B Butane
- C Butene
- D Propane

47. The compound $\text{CH}_3\text{CH}_2\text{CH}_2\text{ONa}$ is formed by reaction between

- A sodium and propanoic acid
- B sodium and propan-1-ol
- C sodium hydroxide and propene
- D sodium hydroxide and propanal.

[Turn over

48. Propan-1-ol is converted to propanal by warming it with potassium dichromate acidified with sulphuric acid. The function of the acid/dichromate mixture is to
- A reduce the alcohol
 - B dehydrate the alcohol
 - C act as a catalyst
 - D oxidise the alcohol.

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 response 4 only is correct
- E if some other response or combination of responses is correct.

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

- 1 They are formed by oxidation of primary alcohols.
- 2 They contain a carboxyl group.
- 3 They may contain the structure  where R is an alkyl group.
- 4 They will reduce Fehling's or Benedict's solution.

50. For which of the following reactions will a change of pressure affect the concentrations of gases in the equilibrium mixture?

- 1 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
- 2 $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
- 3 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$
- 4 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$

[END OF QUESTION PAPER]

[92/246]

1981

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Monday, 11th 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.

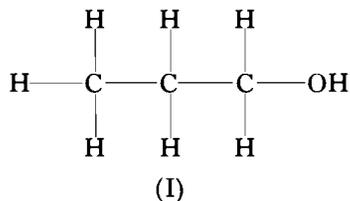
PART A

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.

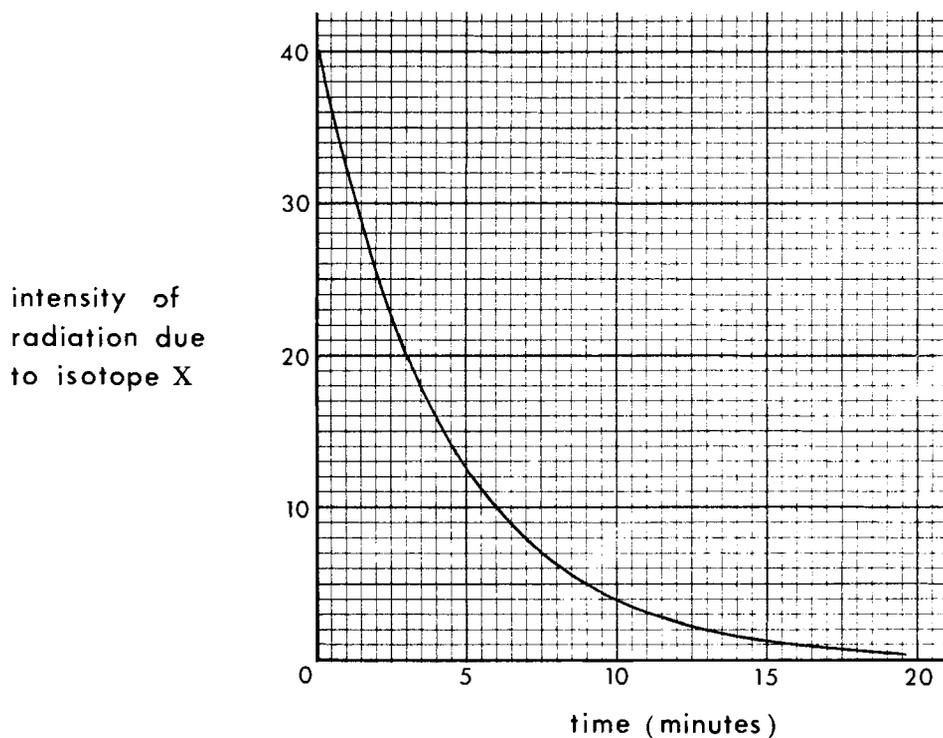
Marks

1. Primary alcohols may be oxidised to carboxylic acids in two stages. Write the structural formula and the systematic name of each product obtained by oxidation of compound (I).



(2)

2. A radioisotope X decays to give a **stable** product. The approximate decay curve is shown below.



- (a) What is the half-life of isotope X? (Answer to the nearest minute.) 1
- (b) Use the tables on page 37 of the Data Book to identify X. 1
- (c) Copy the graph into your answer book (no graph paper required), and add a **dotted** line to show the decay curve of ^{210}Tl , assuming that it starts at the same intensity of radiation as isotope X. 2

(4)

3. Answer **EITHER A OR B**.

- A. Write a balanced chemical equation for the reaction of sodium chloride with concentrated sulphuric acid. From the equation calculate the volume of hydrogen chloride gas which would be liberated, theoretically, at s.t.p., by treating 1.0 g of sodium chloride in this manner. (3)

OR

- B. Write a balanced chemical equation for the complete combustion of ethane. From the equation calculate the volume of oxygen required for the combustion of 3 litres of ethane. (All volumes measured at s.t.p.) (3)

4. A set of compounds can be classified in the following way:

<i>Compounds containing metallic elements</i>	<i>Compounds not containing metallic elements</i>
calcium oxide sodium hydroxide zinc oxide barium hydroxide	hydrogen chloride sulphur dioxide ammonia carbon dioxide

These compounds can be classified in at least two other ways. Draw **two** tables. In each table, classify the given compounds into two groups. (Each group should contain at least **two** of the given compounds.) (4)

5. An oxide of xenon has been discovered with the formula XeO_3 . The standard electrode potential in **acid** solution for the reduction of XeO_3 to xenon gas is + 1.8 V.

- (a) Write a balanced ion-electron equation for the reduction of xenon oxide to xenon gas. 2
 (b) From the table of standard reduction potentials, (Data Book, page 30), choose a reagent which would be a more powerful oxidising agent than xenon oxide. 1
 (3)

6. You are given two white solids, ammonium sulphate and ammonium chloride.

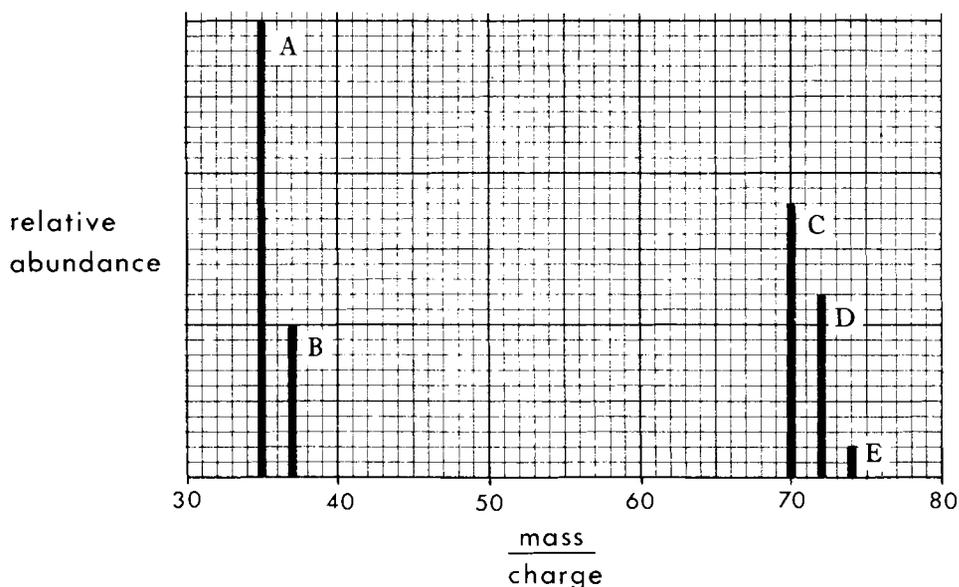
- (a) Which experimental test would show that both the compounds are ammonium salts? State the result. 2
 (b) Which test would distinguish between ammonium sulphate and ammonium chloride? State the result in each case. 2
 (4)

7. Sodium metal can be obtained from the sea.

Outline the steps in a method which could be used to produce sodium metal from sea water. (4)

[Turn over

8. The diagram shows the mass spectrum of chlorine.



If peak A represents the ion $^{35}\text{Cl}^+$, suggest possible **ions** which would give the peaks B and D.

(2)

9. Answer **EITHER A OR B**.

A. The table below gives the ionisation energies of lithium, sodium, and potassium.

Ionisation energy kJ mol^{-1}	1st	2nd	3rd	4th
lithium	526	7310	11800	—
sodium	502	4560	6920	9540
potassium	425	3060	4440	5880

- (a) Why does the first ionisation energy decrease lithium \rightarrow sodium \rightarrow potassium? 1
- (b) Why is the second ionisation energy for each element much greater than the first ionisation energy? 1
- (c) Why is there no value given for the fourth ionisation energy of lithium? 1

(3)

OR

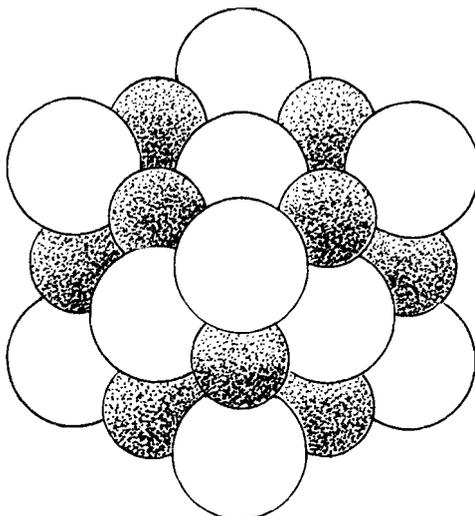
B. The table below gives the ionic radii of the elements lithium to neon.

Ion	Li^+	Be^{2+}	B^{3+}	C^{4+}	N^{3-}	O^{2-}	F^-	Ne
Radius (nm)	0.068	0.035	0.023	0.016	0.171	0.132	0.133	—

- (a) Why do the values decrease from lithium to carbon? 1
- (b) Why is there a large increase from carbon to nitrogen? 1
- (c) Why is there no value given for neon? 1

(3)

10. The diagram below represents a model of the structure of an alkali metal halide.



- (a) Does the model represent the structure of caesium chloride or of sodium chloride? 1
- (b) Why is nickel(II) oxide more likely to have a crystal structure similar to that of sodium chloride rather than that of caesium chloride? Refer to the Data Book (page 29). 2
- (3)

11. Answer **EITHER A OR B**.

- A. Calculate the heat of formation of cyclohexane (C_6H_{12}). Use the information on heats of combustion in the Data Book (pages 33 and 35). (5)

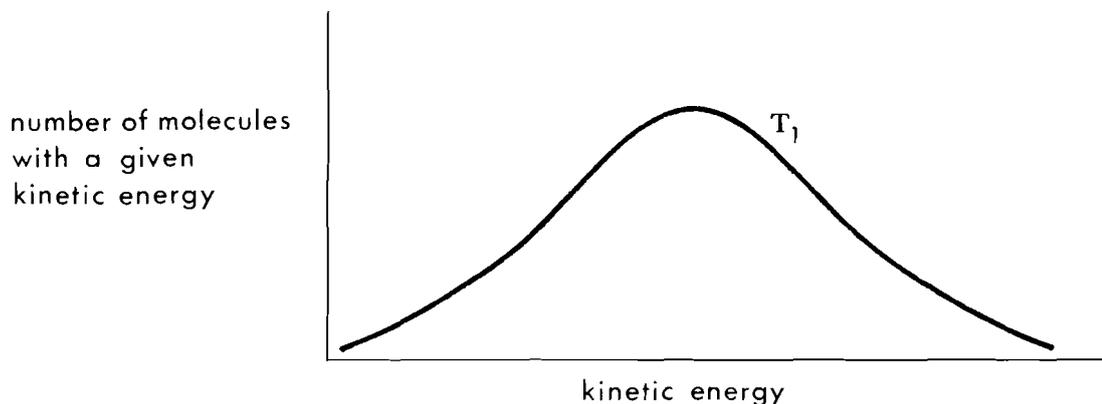
OR

- B. Calculate the mean bond dissociation energy of the C—Cl bond in tetrachloromethane (CCl_4). Use the heat of formation of tetrachloromethane, the mean bond energy of the Cl—Cl bond and the heat of sublimation of carbon as given in the Data Book (pages 31 and 35). (5)

[Turn over

12. For a reaction between oxygen and a hot metal at a given temperature T_1 , it has been calculated that only a very small proportion of the oxygen molecules hitting the metal surface actually react. Raising the temperature to T_2 produces a marked increase in the reaction rate.

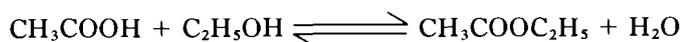
The diagram below shows the energy distribution of the oxygen molecules at the lower temperature T_1 .



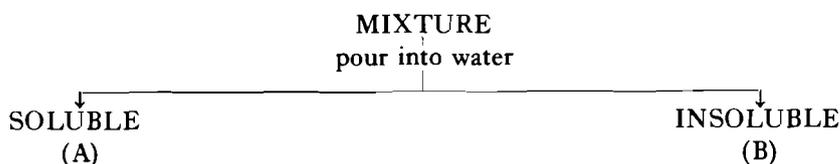
- (a) Explain why so few of the molecules hitting the metal surface actually react. 1
- (b) Copy the diagram into your answer book (no graph paper required) and shade the approximate area under the curve representing the number of molecules which react. 1
- (c) Add a **dotted** line showing the energy distribution of the oxygen molecules at a higher temperature T_2 . 1
- (3)

13. Plutonium-242 is radioactive, emitting α -particles. Calculate the number of alpha particles lost by 1.00 g of plutonium in a time equal to one half-life. (3)

14. Preparation of ethyl ethanoate from ethanoic acid and ethanol results in an equilibrium mixture:



The following scheme shows the first stage of a procedure to separate the components of this mixture.



- (a) Name the substances present at (A) and (B). 2
- (b) Write the extended structural formula of ethyl ethanoate. 1
- (3)

15. The table below gives some information about two oxides of nitrogen, both of which can be prepared by the action of nitric acid on copper.

Gas	Formula	Density	Reaction with oxygen	Reaction with water
nitrogen monoxide	NO	about the same density as air	reacts to form NO ₂	none
nitrogen dioxide	NO ₂	denser than air	none	reacts to form HNO ₃ and HNO ₂

- (a) Write balanced chemical equations for the reactions occurring between:

- (i) nitrogen monoxide and oxygen;
 (ii) nitrogen dioxide and water.

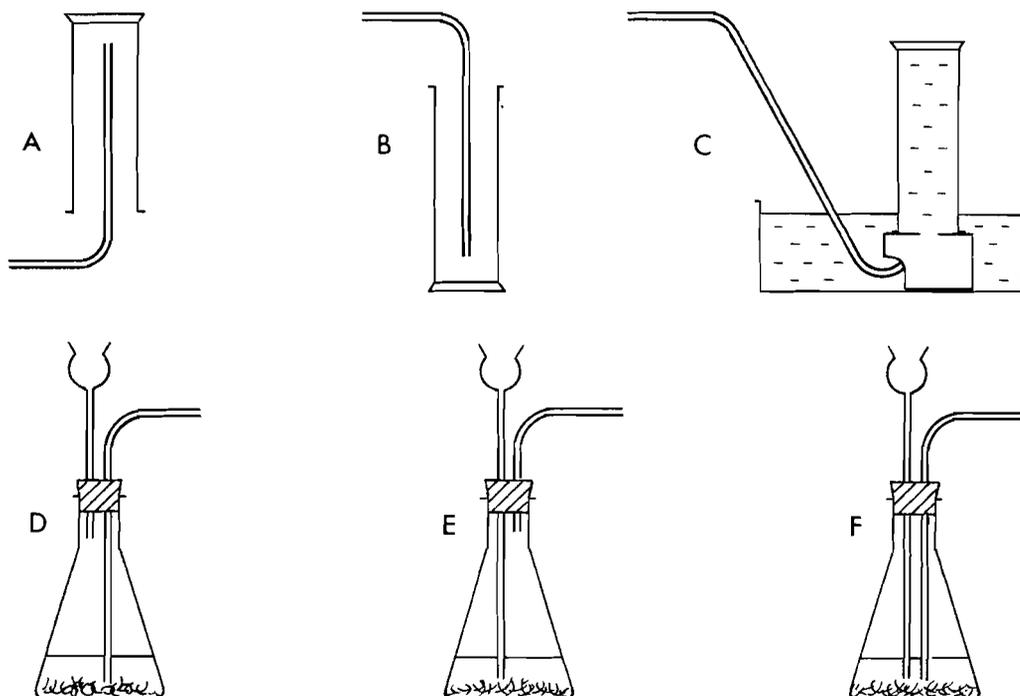
2

- (b) From the apparatus shown below, list, **using the appropriate letters**, those pieces of equipment you would use to prepare and collect samples of:

- (i) nitrogen monoxide;
 (ii) nitrogen dioxide.

2

(4)



[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

16. Answer EITHER A OR B.

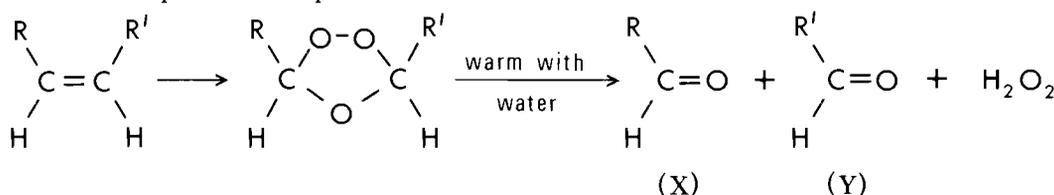
- A. (a) Ozone is a polymorph of oxygen with the chemical formula O₃. It is found in the upper atmosphere and may be produced in the laboratory by the action of electrical discharge on **dry** oxygen:



Pure ozone boils at -112°C and reacts vigorously in contact with carbon-containing compounds. At room temperature, ozone slowly decomposes to oxygen. Ozone is a powerful oxidising agent, reacting with lead(II) sulphide to form lead(II) sulphate and oxygen. Two uses of the gas are to purify air in underground tunnels and for sterilising water.

- (i) Sketch apparatus which could be used to deliver a stream of ozonised oxygen in the laboratory. (Assume a supply of oxygen is available.) 2
- (ii) Predict how the above equilibrium would be affected by:
 - (1) increase in pressure; 2
 - (2) increase in temperature. 2
- (iii) How could a sample of pure ozone be obtained from this mixture on the industrial scale? 1
- (iv) Write a balanced chemical equation for the reaction between lead(II) sulphide and ozone. 2
- (v) Why would ozone be better for purification of air in tunnels than, say, chlorine? 1

- (b) When ozone is bubbled into a solution of an alkene, an ozonide is formed. This compound decomposes on treatment with water as shown below:



(R, R' represents alkyl groups)

- (i) To which homologous series do the substances (X) and (Y) belong? 1
- (ii) Give the systematic names of the products (X) and (Y) which would be formed if propene (CH₃—CH=CH₂) were to be used in the above reaction sequence. 2
- (c) Hydrogen peroxide (H₂O₂), also formed in the above reaction, slowly decomposes to give water and oxygen gas. The rate of oxygen production is greatly increased by the presence of a trace of manganese dioxide.
 - (i) What volume of oxygen, at s.t.p., could be obtained theoretically from 0.17 g of hydrogen peroxide? 2
 - (ii) A solution containing 0.17 g of hydrogen peroxide is added to manganese dioxide and the volume of oxygen liberated is carefully measured. Draw a labelled diagram of the apparatus. 2
 - (iii) Sketch the graph of gas volume against time which would be obtained in this experiment. (No graph paper required.) 2

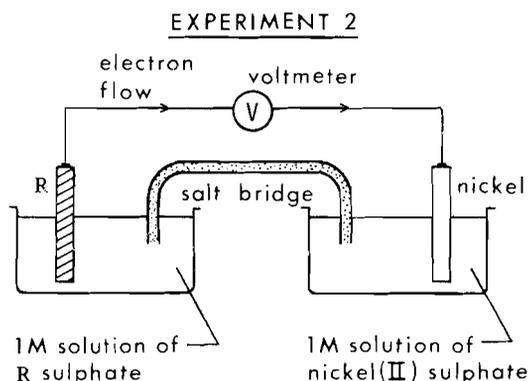
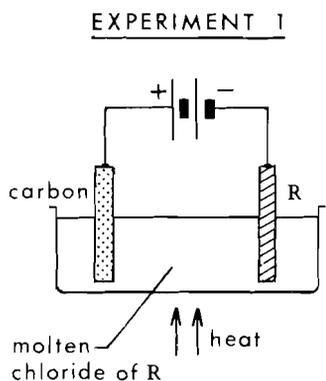
(17)

OR

B. (a) A pupil intends to find a value for Avogadro's Number by carrying out an electrolysis experiment to find the mass of nickel deposited by a measured amount of electrical charge.

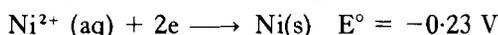
- (i) Draw a labelled diagram of the electrical circuit used, naming the material of each electrode and the electrolyte used. 2
- (ii) List all the measurements that the pupil should make in the course of the experiment. 2
- (iii) Suggest **two** points of procedure which would help to ensure an accurate result. 2
- (iv) What might be a possible effect on the experiment of using:
 - (I) a very dilute solution;
 - (II) a very small current? 2
- (v) During such an experiment, 0.118 g of nickel was deposited. How many nickel atoms would have been present in this mass? 2

(b) Suppose a new element (R), of atomic weight 52.0, has been discovered. In an attempt to find out more about R, the following experiments are set up;



- (i) In experiment 1, 2.00 g of R are deposited by 11 100 coulombs. How many coulombs will deposit 1 mole of R? 1
- (ii) What charge must the R ion have to give this result? 1
- (iii) Write the ion-electron equation for R to be included in the table of standard reduction potentials. 1
- (iv) In experiment 2, which is the more reactive metal, R or nickel? 1
- (v) The voltmeter reading is 0.51 V.

The standard reduction potential for nickel is given in the tables as:



Calculate the value of the standard reduction potential of R.

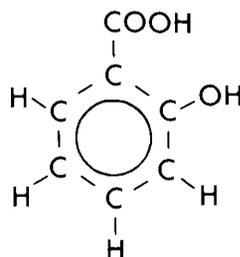
(Pay careful attention to the sign of your answer.)

3
(17)

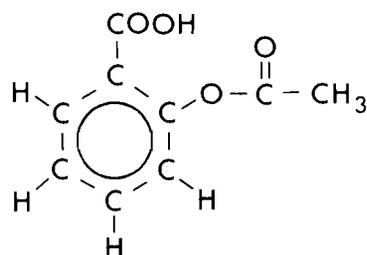
17. Answer **EITHER A OR B.**

- A. (a) Salicylic acid (sublimes at 159 °C) occurs in the form of its methyl ester (b.p. 224 °C) as a constituent of oil of wintergreen, in the North American heath plant *Gaultheria Procumbens*. Both the acid and its ester have uses in medicine.

The formula of the acid may be represented:



- (i) The properties of this acid are a combination of the properties of two simpler aromatic compounds. Give the names **or** draw the structures of the two simpler aromatic compounds. 2
- (ii) Draw the structure of the ester formed when salicylic acid reacts with methanol. 1
- (iii) Give the formula **or** the structure of the compound which will be formed when 1 mole of salicylic acid reacts with 2 moles of sodium hydroxide. 1
- (iv) Outline a method for extracting oil of wintergreen from the crushed plant material. 2
- (b) Methanol and salicylic acid can be obtained from the ester by hydrolysis.
- (i) What is meant by the term “hydrolysis”? 1
- (ii) Which reagent would be used to hydrolyse the ester at a reasonable rate? 1
- (iii) The methanol can be separated from the other substances in this mixture by distillation. Which impurity is most likely to be mixed with the methanol after distillation? 1
- (iv) Name a reagent which would react with the methanol in the distillate but not with the impurity present. What observable changes would occur in this reaction? 2
- (v) How could you obtain a sample of salicylic acid from the mixture left after the methanol has been distilled off? 2
- (c) Acetylsalicylic acid is widely used as a pain killer under its commercial name “Aspirin”. Its formula may be written as:

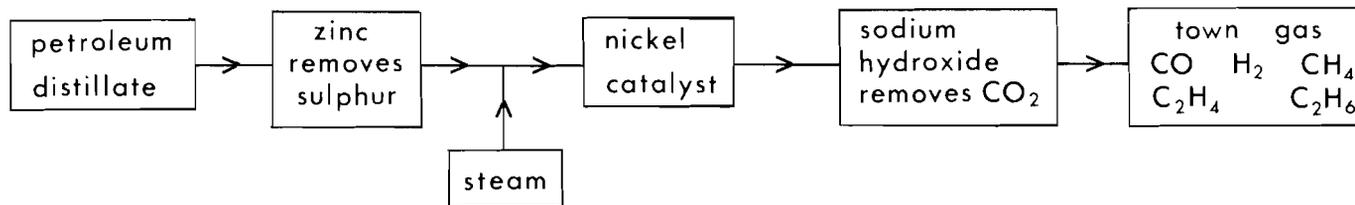


- (i) If each tablet contains 0.001 g of “Aspirin”, calculate the number of moles in each tablet. 2
- (ii) So called “Soluble Aspirin” is the sodium salt of this acid. How could you convert acetylsalicylic acid into “Soluble Aspirin”? 1
- (iii) Why is this form more likely to be soluble in water? 1

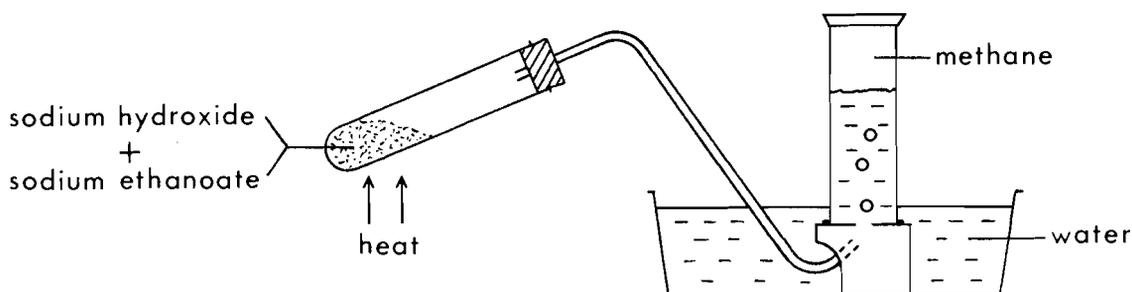
(17)

OR

B. (a) The following diagram represents the production of town gas from petroleum distillate (hydrocarbons with 6 to 14 carbon atoms in the molecule).



- (i) Why is it essential to remove the sulphur before the petroleum vapour reaches the catalyst? 1
- (ii) What function does the catalyst serve? 1
- (iii) Name the type of chemical reaction being catalysed. 1
- (iv) Why is it desirable to remove the carbon dioxide? 1
Give the balanced chemical equation for this reaction (removal of CO_2). 3
- (v) How could the constituents of town gas be separated? 1
- (vi) One of the dangers of this method of town gas production is the possibility of the formation of poisonous nickel carbonyl (formula weight = 171 a.m.u.). Calculate the molecular formula of this substance if 0.855 g of it contains 0.24 g of carbon, 0.32 g of oxygen and the remainder nickel. 3
- (b) Town gas is more useful in the chemistry laboratory than natural gas since it can be used as a reducing agent.
- (i) Draw a labelled diagram of the apparatus you could use to reduce copper(II) oxide with town gas. 2
- (ii) Town gas contains ethene. How could the town gas mixture be treated so that it would **not** decolourise bromine water? 1
- (c) When a mixture of sodium ethanoate and sodium hydroxide is heated, methane gas is given off leaving sodium carbonate.



- (i) Write the balanced chemical equation for this reaction. 2
- (ii) What is the maximum volume (at s.t.p.) of methane obtainable from 4.00 g of sodium ethanoate? 2

(17)

[Turn over

18. Answer **EITHER A OR B**.

- A. Choose **one metal** and **one non-metal** from the following list, and write an essay comparing them:

magnesium, aluminium, sulphur, chlorine.

Base your essay on the following:

- (a) Extraction of the elements chosen;
- (b) Uses of the elements (N.B. **not** compounds of the elements);
- (c) Bonding in the elements;
- (d) The bonding and properties of the oxides of the elements. (16)

OR

- B. Write an essay on "The historical development of atomic theory". Base your essay on the following:

- (a) Evidence for
 - (i) small particles in matter,
 - (ii) the charged nature of matter,
 - (iii) electrons;
- (b) The experiment leading to the idea that the atom has a nucleus;
- (c) Evidence for isotopes.
(The names of famous scientists involved in the work should be given wherever possible.) (16)

[END OF QUESTION PAPER]