

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY**Higher Grade—PAPER I****Tuesday, 11th May—9.30 a.m. to 11.00 a.m.****READ CAREFULLY**

1. Check that the answer sheet provided is for Chemistry Higher I.
2. Fill in the details required on the answer sheet.
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 (1978 edition).
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.

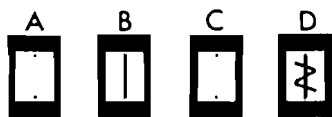
SAMPLE QUESTION

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. Which one of the following ions would be deflected **most** in a mass spectrometer?

- A mass number 12, charge 1+
- B mass number 12, charge 2+
- C mass number 16, charge 1+
- D mass number 16, charge 2+

2. Which one of the elements listed below has the following properties?

- (i) It can conduct electricity.
- (ii) When burned in oxygen and the product added to water, the resulting solution has a pH less than 7.

- A Carbon
- B Sodium
- C Sulphur
- D Aluminium

3. How many litres of oxygen at s.t.p. are needed to burn completely 1 mole of calcium?

- A 11.2
- B 16.0
- C 22.4
- D 32.0

4. Electrolysis of solutions of the sodium halides gave the following products. All solutions had the same concentration.

Compound	Positive electrode	Negative electrode
sodium fluoride	oxygen	hydrogen
sodium chloride	chlorine	hydrogen
sodium bromide	bromine	hydrogen
sodium iodide	iodine	hydrogen

Which one of the following conclusions can be made?

- A Fluoride ions will not part with their electrons easily.
- B Sodium fluoride is not an ionic compound.
- C Sodium fluoride causes the greatest ionisation of water.
- D Fluorine is the least reactive of the halogens.

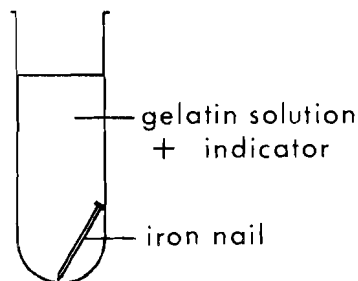
5. To compare the mobilities of H^+ (aq) and Na^+ (aq) the electrical conductivities of suitable solutions are measured. Which of the following pairs should be chosen?

- A 0.5 M HCl and 1 M NaCl
- B 1 M HCl and 1 M NaOH
- C 1 M HNO_3 and 1 M $NaNO_3$
- D 0.5 M H_2SO_4 and 1 M Na_2SO_4

6. A metal (melting point 601 K, density 11.3 g cm^{-3}) was obtained by electrolysis of its molten chloride (melting point 774 K, density 5.84 g cm^{-3}). During the electrolysis, how would the metal occur?

- A As a solid on the surface of the electrolyte
- B As a liquid on the surface of the electrolyte
- C As a solid at the bottom of the electrolyte
- D As a liquid at the bottom of the electrolyte

The diagram below refers to **questions 7 and 8**



The indicator is red in the presence of OH^- (aq) and blue in the presence of Fe^{2+} (aq)

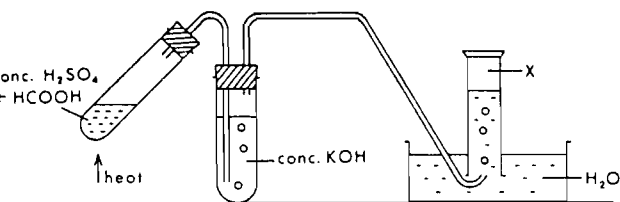
7. Which of the following metals, when placed in contact with the nail, would be expected to cause a blue colour to appear most quickly in the indicator?

- A Tin
- B Copper
- C Magnesium
- D Iron

8. Which of the following substances when present in the gelatin would be expected to cause a blue colour to appear most quickly?
- A Starch
 - B Sucrose
 - C Calcium carbonate
 - D Sodium chloride
9. The pH of a given solution is 5. Which of the following, when added to the given solution, would increase its pH?
- A Water
 - B 1 M hydrochloric acid
 - C Sodium chloride crystals
 - D 1 M ethanoic acid
10. When 50 ml 0.1 M sulphuric acid are added to 50 ml 0.1 M potassium hydroxide, the most that can be said about the pH of the resulting solution is that it will be
- A above 8
 - B between 6 and 8
 - C exactly 7
 - D below 6.
11. A pupil found that when he neutralised 50 ml lithium hydroxide solution with 2 M hydrochloric acid, the final volume of the mixture was 110 ml. Which of the following statements is true?
- A 10 ml water are formed during the reaction.
 - B The lithium hydroxide solution is more concentrated than the hydrochloric acid.
 - C The final solution has a pH greater than 7.
 - D The final volume is about 100 ml when the salt formed has been filtered off.
12. Which of the following pairs of solutions, when mixed, is most likely to give rise to a precipitate? (The Data Book could be helpful here.)
- A Sodium chloride and barium nitrate
 - B Potassium sulphite and sodium hydroxide
 - C Copper(II) sulphate and potassium nitrate
 - D Calcium bromide and sodium sulphate
13. The preparation of a sample of calcium chloride by the addition of excess calcium to dilute hydrochloric acid would not be entirely satisfactory because
- A calcium chloride is insoluble in water
 - B calcium is too difficult to oxidise
 - C calcium will react with the water and not with the acid
 - D a mixture of calcium chloride and calcium hydroxide is formed.
14. When sulphuric acid reacts with copper carbonate, carbon dioxide is given off. In this reaction the sulphuric acid is acting as
- A a typical acid
 - B a dehydrating agent
 - C an involatile acid
 - D an oxidising agent.

[Turn over

15.



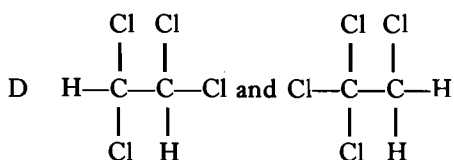
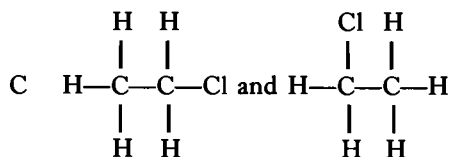
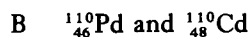
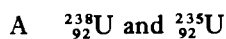
The gas collected (X) is most likely to be

- A CO
- B CO₂
- C SO₂
- D SO₃

16. In the reaction between bromine water and sodium sulphite solution, which of the following ions is oxidised?

- A OH⁻
- B SO₃²⁻
- C Na⁺
- D Br⁻

17. Which of the following pairs are isomers?



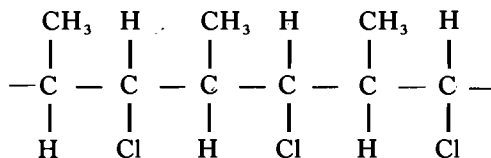
18. A compound burned in oxygen to give water vapour and carbon dioxide. What is the most that we can conclude about the compound?

- A It is a hydrocarbon.
- B It is a carbohydrate.
- C It contains carbon and hydrogen.
- D It contains carbon, hydrogen and oxygen.

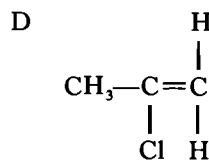
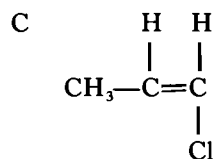
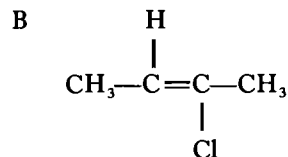
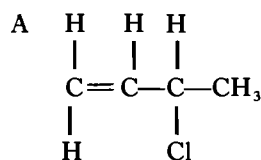
19. 8 g of a hydrocarbon was shown on analysis to contain 6 g carbon. Which of the following could be its molecular formula?

- A CH₄
- B C₂H₄
- C C₆H₂
- D C₆H₈

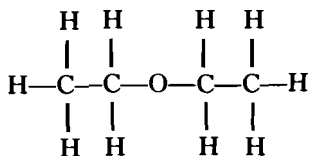
20.



Which of the following monomers could polymerise to give the above polymer?



21. The formula



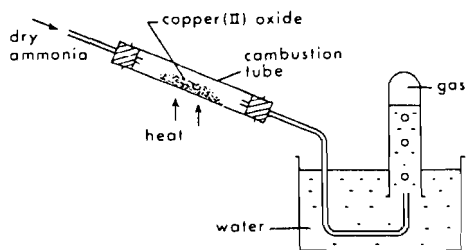
represents

- A an alcohol
- B an ester
- C a ketone
- D none of the above types of compound.

22. Which of the following tests could you use to distinguish between dilute nitric acid and dilute hydrochloric acid?

- A Find the pH of the liquid.
- B Add alkali and observe the change of conductivity.
- C Add zinc and test for hydrogen.
- D Add calcium carbonate and test for carbon dioxide.

23.



Ammonia was passed over the red-hot copper(II) oxide. As soon as the air was displaced, the test tube was put in position. The gas collected was

- A nitrogen
- B nitrogen monoxide
- C nitrogen dioxide
- D hydrogen.

Questions 24 and 25 refer to the compounds of which the molecular formulae are

- A $\text{C}_3\text{H}_7\text{OH}$
- B $\text{C}_2\text{H}_5\text{COOH}$
- C $\text{C}_2\text{H}_5\text{CHO}$
- D CH_3COCH_3

24. Which of the above compounds gives a positive test with Fehling's (or Benedict's) solution?

25. Which of the above compounds gives carbon dioxide on addition of sodium carbonate?

26. Which of the following statements about nylon and polystyrene is **false**?

- A Both give off carbon dioxide and water vapour on burning.
- B Both are thermoplastic.
- C Both are condensation polymers.
- D Both are colourless solids.

27. During neutron bombardment of ${}_{12}^{24}\text{Mg}$ some atoms capture a neutron at the same time emitting a proton. The new atom formed is

- A ${}_{12}^{23}\text{Mg}$
- B ${}_{11}^{23}\text{Na}$
- C ${}_{11}^{24}\text{Na}$
- D ${}_{13}^{25}\text{Al}$

28. How many faradays of electricity are required to deposit one mole of copper at the negative electrode from a solution of Cu^{2+} ions?

- A $\frac{1}{2}$
- B 2
- C Avogadro's Number/2
- D 2/Avogadro's Number

29. 1.2 g of magnesium are added to 200 cm^3 of 1 M hydrochloric acid. What is the volume of hydrogen produced at s.t.p.? The atomic weight of magnesium is 24.

- A 0.56 litre
- B 1.12 litres
- C 2.24 litres
- D 2.35 litres

[Turn over

30. In which of the following reactions will the total volume of products be less than the total volume of reactants? (All volumes corrected to s.t.p.)

- A Steam plus carbon to give hydrogen and carbon monoxide.
- B Hydrogen plus chlorine to give hydrogen chloride.
- C Nitrogen plus oxygen to give nitrogen monoxide.
- D Nitrogen plus hydrogen to give ammonia.

31. One mole of calcium chloride contains

- A three moles of atoms
- B one mole of molecules
- C the Avogadro number of positive ions
- D the Avogadro number of negative ions.

32. At the same temperature and pressure which of the following gases contains the **smallest** number of molecules?

- A 100 g fluorine
- B 100 g nitrogen
- C 100 g oxygen
- D 100 g hydrogen

33. Which of these gases has the lowest density at s.t.p.?

- A CO
- B NO
- C N₂
- D C₂H₂

34. β -particles emitted by certain radioactive atoms are

- A electrons from the outer shell
- B electrons from the nucleus
- C particles consisting of 2 protons and 2 neutrons
- D electromagnetic radiations of very short wavelength.

35. The half life of tritium, ${}^3_1\text{H}$, is 12.4 years. In a bottle of old wine, the ${}^3_1\text{H}$ level was found to be $\frac{1}{16}$ th of that in new wine.

The wine was approximately

- A 40 years old
- B 50 years old
- C 60 years old
- D 100 years old.

36. $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \Delta H = -395.2 \text{ kJ mol}^{-1}$
 $\text{CO(g)} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) \Delta H = -284.3 \text{ kJ mol}^{-1}$

What is ΔH for

$\text{C(s)} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CO(g)}$?

- A $-679.5 \text{ kJ mol}^{-1}$
- B $-110.9 \text{ kJ mol}^{-1}$
- C $+110.9 \text{ kJ mol}^{-1}$
- D $+679.5 \text{ kJ mol}^{-1}$

37. From the information given below which of the following elements is most likely to form an ion of the type X^{2+} ?

	1st Ionisation Energy kJ mol^{-1}	2nd Ionisation Energy kJ mol^{-1}	3rd Ionisation Energy kJ mol^{-1}
A	1690	3380	6060
B	500	4560	6920
C	600	1160	4930
D	580	1830	2760

38. When a Group I metal atom reacts to become an ion X^+
- A the diameter of the particle decreases
 - B the positive charge of the nucleus increases
 - C the atomic number of X decreases
 - D the number of electron shells increases by 1.

In questions 39 and 40 which of the following types of bond is broken in melting the solids mentioned?

- A Covalent
- B Ionic
- C Hydrogen
- D Polar covalent

You may use each response once, more than once, or not at all.

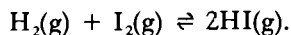
39. Caesium fluoride.

40. Hydrogen fluoride.

41. In which case is hydrogen behaving as an oxidising agent?

- A $H_2 + CuO \rightarrow H_2O + Cu$
- B $H_2 + C_2H_4 \rightarrow C_2H_6$
- C $H_2 + Cl_2 \rightarrow 2HCl$
- D $H_2 + 2Na \rightarrow 2NaH$

42. Hydrogen and iodine at $500^\circ C$ react according to the equation



Vessel X initially contains 1 mole H_2 + 1 mole I_2 .

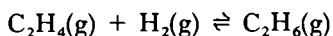
Vessel Y initially contains 2 moles HI.

X and Y are left at $500^\circ C$ till no further change occurs.

Which of the following statements is then true?

- A X will contain more hydrogen than Y.
- B X will contain less iodine than Y.
- C X and Y will contain the same amount of hydrogen iodide.
- D Y will contain 1 mole of iodine.

43. For the following system:

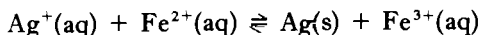


$$\Delta H \text{ for the forward reaction} = -138 \text{ kJ mol}^{-1}$$

Which change will increase the equilibrium concentration of $C_2H_4(g)$?

- A Increase in pressure
- B Increase in temperature
- C Addition of $H_2(g)$
- D Addition of a catalyst

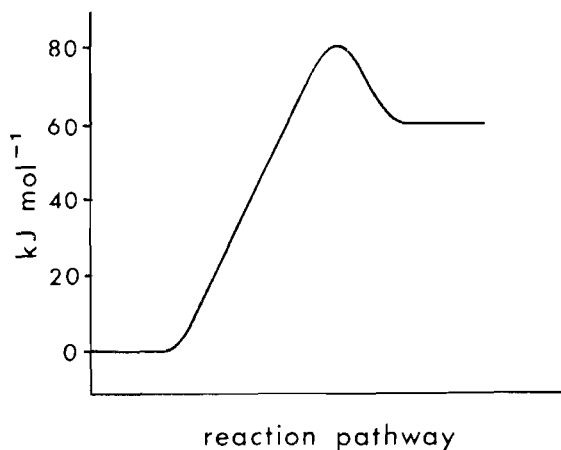
44. Consider the equilibrium:



Which of the following, when added to the equilibrium mixture, would lead to an increase in the mass of silver deposited?

- A Iron(III) sulphate
- B Iron(III) nitrate
- C Iron(II) sulphate
- D Sulphuric acid

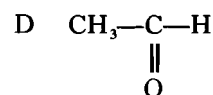
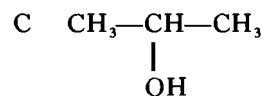
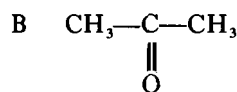
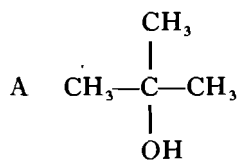
45. What is the heat of reaction (enthalpy of reaction, ΔH) for the forward process represented by the diagram below?



- A -60 kJ mol^{-1}
- B -20 kJ mol^{-1}
- C $+60 \text{ kJ mol}^{-1}$
- D $+80 \text{ kJ mol}^{-1}$

[Turn over

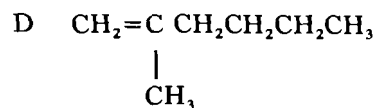
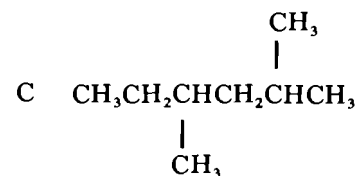
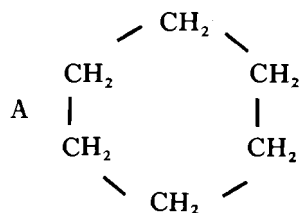
46. Which compound represented by the following structures is most likely to be oxidised to give one carboxylic acid only?



47. A sample of ethanoic acid is thought to be badly contaminated with ethanol. Which of the following tests on the sample would tend to support this belief?

- A It burns in air to form carbon dioxide and water vapour.
 B When small pieces of sodium are added, hydrogen is evolved.
 C When it is refluxed with acidified potassium dichromate solution, a colour change is observed.
 D When phosphorus pentachloride is added, white fumes are evolved.

48. Which compound is a member of the same homologous series as the compound represented by the molecular formula C_3H_8 ?



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 a (are) correct description(s) of the role of catalysts in reversible reactions?

- 1 They decrease the time required for the equilibrium to be established.
 2 They alter the position of equilibrium.
 3 They lower the activation energies of the forward and backward reactions.
 4 They increase the rate of the forward reaction more than that of the backward reaction.

50. Which of the following is a (are) redox reaction(s)?

- 1 $\text{Zn} + \text{CuSO}_4 \rightarrow \text{ZnSO}_4 + \text{Cu}$
 2 $2\text{Na}_2\text{S}_2\text{O}_3 + \text{I}_2 \rightarrow \text{Na}_2\text{S}_4\text{O}_6 + 2\text{NaI}$
 3 $\text{SnCl}_2 + \text{HgCl}_2 \rightarrow \text{Hg} + \text{SnCl}_4$
 4 $\text{AgNO}_3 + \text{KCl} \rightarrow \text{KNO}_3 + \text{AgCl}$

[END OF QUESTION PAPER]

[92/238]

1982

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Tuesday, 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.

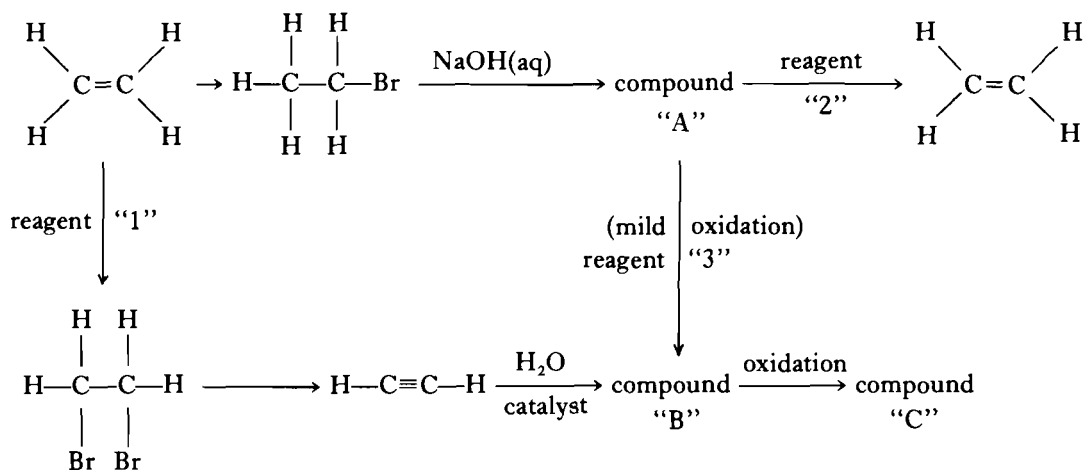
Necessary data will be found in the book of Mathematical Tables and Science Data (1978 edition).

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 a structural formula for pentanoic acid. | 1 |
| (b) Draw structural formulae for two other isomers of pentanoic acid and give their systematic names. | 3 |
| | (4) |
| 2. Aluminium sulphide is decomposed by water to form aluminium hydroxide and hydrogen sulphide. Write a balanced chemical equation for this reaction. | (2) |
| 3. Answer EITHER A OR B . | |
| A. ${}_{84}^{210}\text{Po}$ decays to ${}_{82}^{206}\text{Pb}$ by α -emission. How many lead atoms will have been formed from 1 g of polonium after three half-lives? | (4) |
| OR | |
| B. (i) How many molecules are contained in 8 g of oxygen gas? | 2 |
| (ii) How many sodium ions are contained in 50 cm ³ of molar sodium hydroxide solution? | 2 |
| | (4) |
| 4. Ethanol is oxidised to ethanoic acid by passing a mixture of ethanol vapour and air over hot copper. Draw an apparatus you might use for this reaction, collecting the ethanoic acid in aqueous solution. (Your diagram should show how the ethanol/air mixture is produced, and how the ethanoic acid may be collected). | (3) |
| 5. Ammonia gas dissolves in water to form an alkaline solution:
$\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
(ΔH for the forward reaction is -30.6 kJ)
How would each of the following changes affect the equilibrium position:
(a) Increasing the temperature;
(b) Increasing the pressure;
(c) Adding an aqueous acid? | (3) |
| 6. Explain in terms of bonding why carbon dioxide is a gas at room temperature, while silicon dioxide is a high melting solid. | (2) |



(a) Draw the extended structural formulae of compounds A, B and C.

(b) Name the reagents 1, 2 and 3.

(6)

8. The collision theory states that for two molecules to react, they must first collide with one another. Name two conditions necessary for a reaction to follow from this collision.

(2)

9. A substance, X, when melted and electrolysed, produced hydrogen at the **positive** electrode.

(a) Write an ion-electron equation for the change taking place at the positive electrode.

(b) What happens when X is placed in water?

(2)

[Turn over

10. Answer **EITHER A OR B**.

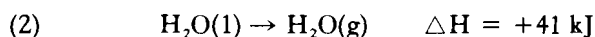
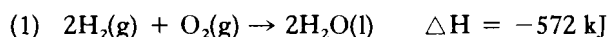
A. The table below gives the heats of combustion (enthalpies of combustion) of three alcohols.

Alcohol	ΔH (kJ mol ⁻¹)
methanol	-726
ethanol	-1370
propanol	-2020

- (a) Estimate the heat of combustion of butanol. 1
- (b) Calculate the amount of heat liberated by the complete combustion of 1 g of propanol. 2
- (c) Dimethyl ether (CH₃—O—CH₃) has the same molecular formula as ethanol. Why then does it have a different heat of combustion? 2
- (5)**

OR

B. Given that:



- (a) What is the value of the heat of formation (enthalpy of formation) of water? 1
- (b) (i) Using bond energies in the Data Book (page 31), state the energy required to break:
- 1 mole of H₂(g),
1 mole of O₂(g),
and 1 mole of H₂O(g)
- into atoms in the gaseous state. 2
- (ii) Using your answers to (b)(i) above and equation (2), calculate the heat of formation of water. 2
- (Note—the answer here will **not** be identical to the answer you gave in (a)). 2
- (5)**

11. Identify x and y in the following equations:



12. The same quantity of electricity is passed through solutions of

- (a) silver nitrate (b) sulphuric acid.

If 0.54 g of silver is deposited in (a), deduce the volume of hydrogen (measured at s.t.p.) produced in (b). (4)

13. Write a balanced equation for the complete combustion of propane. If 15 cm³ propane are burned completely with 95 cm³ oxygen, what will be the volume and composition of the resulting gases? (All volumes at s.t.p.) (3)

14. 1 g of magnesium is added to 0.5 M hydrochloric acid.

Using the **same axes** (volume of hydrogen evolved against time) draw graphs to show the differences you would expect for the reaction, given

- (a) the magnesium in excess;
 (b) the acid in excess.

(No graph paper necessary.)

(3)

15. Answer **EITHER A OR B**.

A. Predict which of the following would be successful in oxidising iodide ions in aqueous solution. (Refer to the Data Book, page 30.)

- (a) aqueous copper(II) chloride;
 (b) acidified potassium permanganate solution;
 (c) aqueous iron(II) sulphate.

1

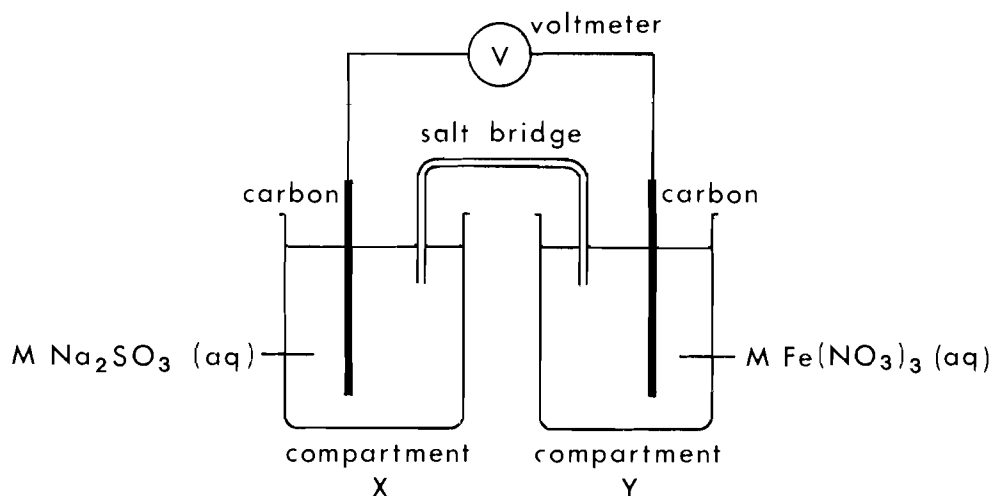
Write the ion-electron equations for any reaction you have chosen and combine these to give the overall ionic equation.

2

(3)

OR

B.



- (a) In which direction do electrons flow in the external circuit?
 (b) Use the Data Book (page 30) to predict the voltmeter reading.
 (c) For the compartment in which **oxidation** is occurring, write the appropriate ion-electron equation.

1

1

1

(3)

16. The following table gives the approximate temperature rise (ΔT) when hydrochloric acid and sodium hydroxide solution are mixed.

Acid	Alkali	ΔT ($^{\circ}\text{C}$)
100 cm ³ M HCl	100 cm ³ M NaOH	5
20 cm ³ M HCl	20 cm ³ M NaOH	a
20 cm ³ 0.5M HCl	20 cm ³ 0.5M NaOH	b
40 cm ³ 2M HCl	40 cm ³ 2M NaOH	c
20 cm ³ 2M HCl	20 cm ³ 2M NaOH	d

Write down the values of a, b, c and d.

(2)

PART B

All questions should be attempted. Each question contains a choice.

Candidates are advised to spend about 1½ hours on this part.

Marks

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

A. Study the following data which relate to the Periodic Table.

Table 1

Element X	Li	Be	B	C	N	O	F
m.p. (°C)	181	1278	2300	3550	-210	-218	-220

Table 2

Chloride	LiCl	BeCl ₂	BCl ₃	CCl ₄	NCl ₃	OCl ₂	FCl
m.p. (°C)	614	405	-107	-23	-27	-20	-154
b.p. (°C)	1350	487	12	77	71	4	-101

Table 3

Halide	m.p. (°C)
LiF	842
LiCl	614
LiBr	547
LiI	450

(a) **In Table 1:**

Explain the large change in melting point from carbon to nitrogen. 2

(b) **In Table 2:**

(i) Which chloride is a gas at 0°C? 1

(ii) Which chloride is a typical ionic solid? 1

(iii) Which chloride is most likely to be a covalent solid at room temperature? 1

(iv) What happens to the polarity of the X-Cl bond as one progresses across the table from left to right? Why? 2

(c) **In Table 3:**

Explain the melting point trend observed. 2

(d) (i) **From the Periodic Table** select one **physical** property of the group VII elements (fluorine, chlorine, bromine, iodine, astatine) which illustrates a trend in the group. (The Data Book may help here.) State the trend and give an explanation. 2

(ii) Give one **chemical** reaction of the elements (or their compounds) which shows that iodine belongs to the same group as chlorine and bromine. 2

(e) In the early forms of the Periodic Table, potassium with an atomic weight of 39.1 was placed immediately before argon, atomic weight 39.9. Later, however, the order was reversed.

(i) What explanation can be given for the apparent anomaly in the atomic weights of potassium and argon? 2

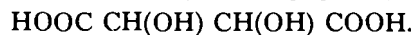
(ii) Give a reason for believing that these elements are now in their correct positions. 1

(16)

OR

Marks

B. Grapes are a source of tartaric acid which has the formula



Tartaric acid, mixed with sodium hydrogen carbonate, is an ingredient of baking powders and health salts because the mixture effervesces when water is added.

Being a diprotic (dibasic) acid, it gives rise to two series of salts—tartrates and hydrogen tartrates.

- (a) Draw the extended structural formula of tartaric acid. 1
- (b) What is meant by a diprotic (dibasic) acid? 1
- (c) Why is “baking powder” used in baking? 2
- (d) Another diprotic acid is found to contain 26.7% carbon, 71.1% oxygen and 2.2% hydrogen by weight.
- (i) Calculate the empirical formula for this acid.
- (ii) Write down the molecular formula for this acid. 3
- (e) Write the structural formulae for
- (i) potassium tartrate;
- (ii) potassium hydrogen tartrate. 2
- (f) The pH of sodium potassium tartrate solution is greater than 7. What conclusion can you draw about the strength of tartaric acid? Give your reasoning. 2
- (g) When heated, an aqueous mixture of sodium potassium tartrate and hydrogen peroxide produces oxygen slowly. When a cobalt salt is present in the original mixture, the solution is pink. On warming, oxygen is rapidly released and the colour changes to green. As the effervescence subsides the colour changes to pink again. Explain these observations in terms of catalysis. 3
- (h) Sodium potassium tartrate may be used for making Fehling’s solution, an alternative to Benedict’s solution.
- (i) Name a class of organic compound which gives a positive Fehling’s or Benedict’s test.
- (ii) Which type of chemical reaction is involved here? 2

(16)

[Turn over

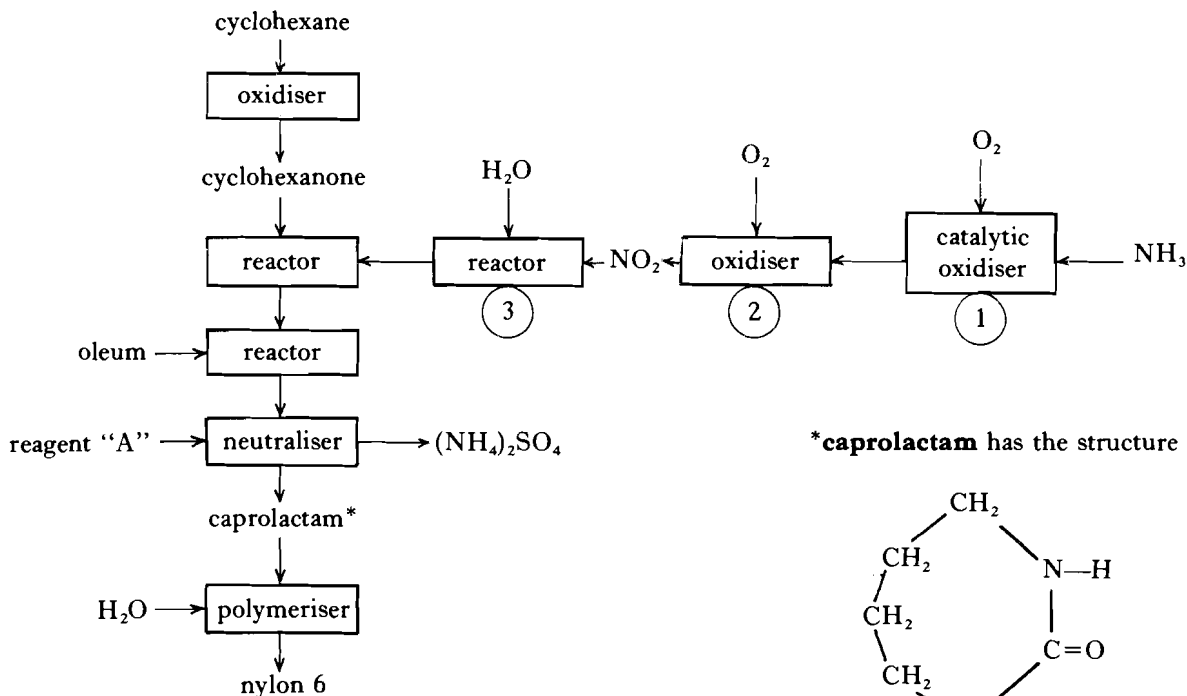
18. Answer EITHER A OR B.

A.

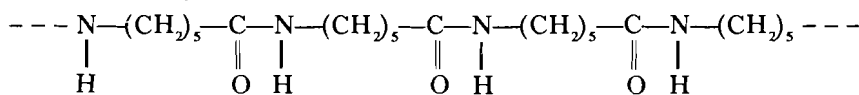
Nylon 6.

In America, nylon 6 accounts for 30% of the total nylon produced; nylon 6:6 is the remainder.

Most processes used to manufacture nylon 6 start from cyclohexane. One such process is outlined below. Use the simplified flow diagram to answer the questions which follow.

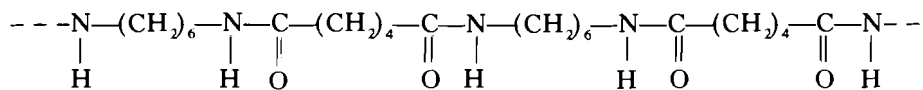


- (a) Draw the structures of cyclohexane and cyclohexanone. 2
- (b) (i) Give the reaction conditions in the catalytic oxidiser ①. 2
(ii) What is the main substance formed in the catalytic oxidiser? 1
(iii) What is the main substance formed in the reactor ③? 1
(iv) Name the industrial process involving the series of reactions occurring in ①, ② and ③. 1
- (c) Name the reagent "A" added to the neutraliser. 1
- (d) What is the major use of $(\text{NH}_4)_2\text{SO}_4$, formed at this stage? 1
- (e) (i) In the polymeriser, water in catalytic amounts reacts with a small percentage of the caprolactam, opening the ring by hydrolysis and producing a type of amino acid. Draw the structure of the amino acid produced. 1
(ii) This amino acid initiates a chain reaction with other caprolactam molecules. As a result, each ring is opened and the molecules join head to tail, to form a long chain molecule (nylon 6) which has the structure:



Draw the structure of the **repeating unit** of nylon 6. 1

(f) The structure of nylon 6:6 is:



- (i) Draw the structure of the **repeating unit** of nylon 6:6. 1
- (ii) Draw the structures of the two monomers from which nylon 6:6 is made. 2
- (iii) What type of polymerisation occurs in nylon 6:6 formation? 1
- (g) Look at the repeating units you have drawn for nylon 6 and nylon 6:6 and suggest one way in which the polymerisation to form nylon 6 differs from that to form nylon 6:6. 1
- (h) Suggest one advantage and one disadvantage of nylon compared to the natural fibre wool. 2
- (18)**

OR

[Turn over for Question 18B

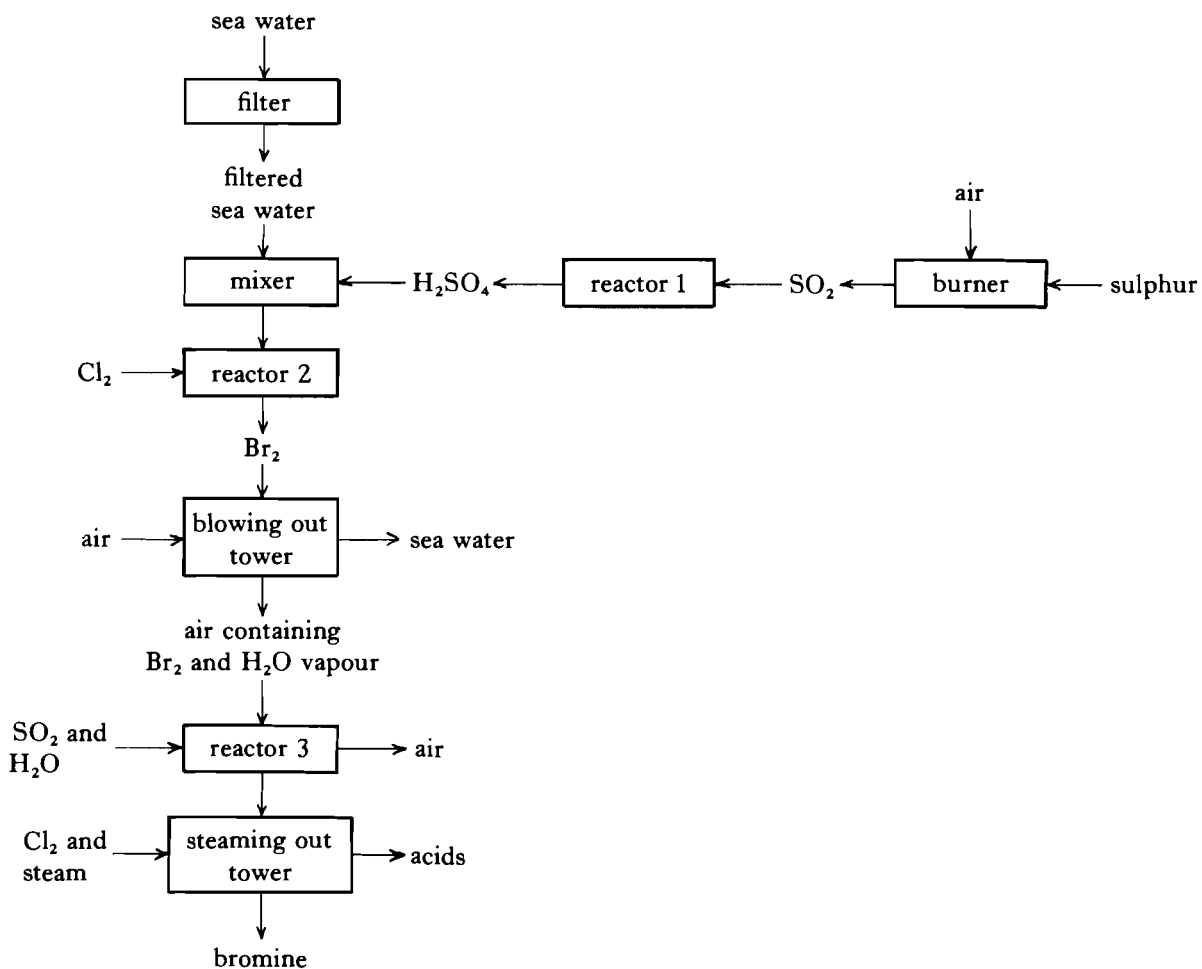
OR

B.

The extraction of bromine from sea water.

Bromine (found as 0.2% bromide ions in sea water) was, with the exception of salt, the first material to be commercially extracted from sea water.

An outline of the process is shown below. Use the simplified flow diagram to answer the questions which follow.



- (a) In reactor 1, sulphur dioxide is converted to sulphuric acid. This reaction occurs in two steps.
Write a balanced equation for the first step, and give the reaction conditions. 3
- (b) Give the ion-electron equations for the effect of chlorine on the sea water in reactor 2 and use the E° values in the Data Book (page 30) to explain why the reaction takes place. 3
- (c) Bromine will hydrolyse in water according to the equation:
$$\text{Br}_2 + \text{H}_2\text{O} \rightleftharpoons \text{HBr} + \text{HBrO}$$
Thus, half the bromine would form the bromate(I) ion (BrO^-) from which it would not be recoverable. Explain why the presence of acid in reactor 2 prevents hydrolysis of the bromine formed. 2
- (d) (i) What is happening in the “blowing out” tower? 1
(ii) What property of bromine enables this to happen? 1
- (e) In the reactor 3, a mixture of sulphur dioxide and fresh water is added to react with the bromine.
Give either a balanced equation or the separate ion-electron equations for the reaction which takes place. 2
- (f) Which two acids will emerge from the “steaming out” tower? 2
- (g) Suggest why the bromine is not collected directly from the “blowing out” tower. 1
- (h) Economically, the bromine plant should be located in an area where the sea current is in the same direction at all times. Why is this important? 1
- (i) Suggest an **economic** method by which the chlorine required for the extraction could be produced. 1
- (j) 60% of the bromine produced is used in making 1,2-dibromoethane for use in the petrol industry. Suggest one other use for bromine. 1
- (18)**

19. 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 **alcohols**.

Your answer should include reference to the following:

- (a) Ethanol as a member of a homologous series.
(b) Primary, secondary and tertiary alcohols.
(c) Polyhydric alcohols—names, formulae, uses of.
(d) Reactions of alcohols, including esterification, oxidation, tests for alcohols.
(e) Industrial manufacture of ethanol.
(f) Use and abuse of alcohol (ethanol) — social and economic implications. (16)

OR

B. Write an essay on **acids and alkalis**.

Your answer should include reference to the following:

- (a) Your understanding of the terms “acid” and “alkali”.
(b) Strong and weak acids and alkalis.
(c) Characteristic reactions of acids and alkalis.
(d) pH of acids, alkalis and salt solutions.
(e) Uses of acids and alkalis. (16)

[END OF QUESTION PAPER]