

[92/234]

1978

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—Paper I

Monday, 15th 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 there is only ONE correct answer.
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, 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 pupil tried to verify the composition of copper(II) oxide by weighing some copper foil, heating it in air, and weighing the product. His results are likely to be unreliable because
- the copper does not oxidise completely
 - some of the copper(II) oxide would evaporate
 - the copper would melt and vapourise
 - copper does not combine with oxygen on heating.
2. Which of the following substances is commonly found as quartz?
- Silicon
 - Silicones
 - Silica
 - Aluminium silicate
3. Which of the following ions would be deflected **least** in a mass spectrometer?
- Mass number 7, charge 1^+
 - Mass number 7, charge 2^+
 - Mass number 11, charge 1^+
 - Mass number 11, charge 2^+
4. When an atom X reacts to become an ion X^-
- the diameter of the particle increases
 - the nucleus of X acquires a negative charge
 - the atomic number of X increases
 - the number of electron shells increases by 1.
5. 152 g of an oxide of a metal X was strongly heated and hydrogen gas was passed over it. When the oxide was completely reduced, 104 g of metal X remained. If the atomic weights of the metal and oxygen are approximately 52 and 16 respectively, a possible formula for the oxide (but without showing charges) could be
- X_2O_3
 - XO_2
 - X_2O
 - XO .

6. Particle	Protons	Neutrons	Electrons
1	19	20	19
2	19	22	19
3	20	20	18
4	20	22	20
5	21	22	19

Which **two** are isotopic **atoms**?

- 2 and 5
 - 3 and 4
 - 1 and 2
 - 2 and 4
7. Which of the following would be expected to react together?
- Copper and zinc sulphate solution
 - Tin and mercury(II) chloride solution
 - Silver and dilute sulphuric acid
 - Lead and iron(II) sulphate
8. In which of the following changes has a positive ion been oxidised?
- Sulphide \rightarrow sulphate
 - Nickel(II) \rightarrow nickel(III)
 - Cobalt(III) \rightarrow cobalt(II)
 - Sulphate \rightarrow sulphite
9. In which of the following does oxidation of iron take place?
- The addition of silver to iron(II) sulphate solution
 - The addition of iron to dilute sulphuric acid
 - The addition of zinc to iron(II) sulphate solution
 - The addition of iron to freshly boiled water
10. Which of the following pairs of solutions would give a neutral solution when mixed?
- 5 cm³ of 0.1 M HCl and 10 cm³ of 0.1 M NH₄OH
 - 10 cm³ of 0.1 M HCl and 5 cm³ of 0.1 M KOH
 - 5 cm³ of 0.1 M HNO₃ and 5 cm³ of 0.2 M NaOH
 - 5 cm³ of 0.1 M H₂SO₄ and 5 cm³ of 0.2 M KOH

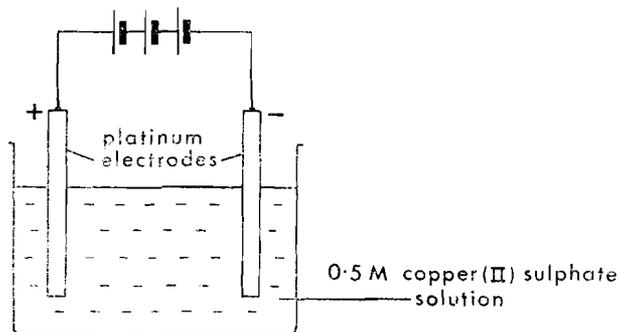
11. 50 cm³ of 1 M sodium hydroxide was added to 50 cm³ of 1 M ethanoic acid. What is the approximate pH of the mixture?
- A 4
B 6
C 7
D 9

12. One pupil attempted to make calcium nitrate by adding excess of calcium oxide to dilute nitric acid, but he found that the product was strongly alkaline. Another pupil added excess of calcium carbonate to dilute nitric acid and found the product to be nearly neutral.

The explanation is that

- A calcium oxide reacted with the water present after the neutralisation to give calcium hydroxide
B the second pupil had added too much calcium carbonate to the acid
C calcium nitrate decomposes to give an alkaline product
D calcium nitrate is the salt of a strong base and a weak acid.

13. Consider the following experiment:



The electrolysis is continued until all the blue colour has disappeared. What would be the pH of the resulting solution?

- A The same as for water
B The same as that of the copper sulphate solution
C Much greater than that of the copper sulphate solution
D Much less than that of the copper sulphate solution

14. An element conducts electricity. When it is burned in oxygen and the product is added to water the resulting solution has a pH greater than 7.

The element could be

- A carbon
B sodium
C sulphur
D iron.

15. The addition of barium nitrate solution to a solution Y gave a white precipitate which dissolved on the addition of dilute hydrochloric acid.

Which of the following ions has been shown by this experiment to be absent from Y?

- A Carbonate
B Sulphate
C Chloride
D Sulphite

16. Which one of the following statements is true of a solution of sulphur dioxide in water?

- A It does **not** react with a suspension of iodine in water.
B It has a pH greater than 7.
C It can be reduced to a solution of sulphate ions.
D It can act as an electron donor.

17. On which of the following properties of concentrated sulphuric acid does the preparation of nitric acid from potassium nitrate mainly depend?

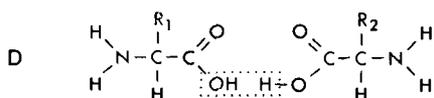
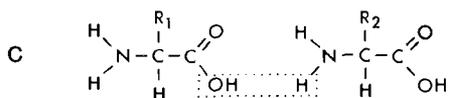
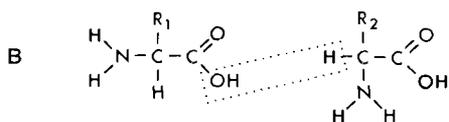
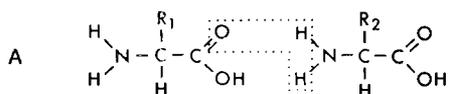
- A It is an oxidising agent.
B It is a dehydrating agent.
C It has a high boiling point.
D It is only slightly ionised.

18. When a molecule of the compound $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$ reacts with bromine to form a saturated compound, the number of atoms of bromine used would be

- A 2
B 4
C 6
D 8.

Questions 19 and 20 refer to the following gases.

- A Hydrogen
 B Ammonia
 C Carbon monoxide
 D Sulphur dioxide
19. Which burns easily forming only one product that is gaseous at s.t.p.?
20. Which, when bubbled into dilute hydrochloric acid, would cause the pH to increase?
21. When ammonia gas is passed over hot copper(II) oxide the products are
 A nitrogen and hydrogen
 B nitrogen dioxide and hydrogen
 C nitrogen monoxide and steam
 D nitrogen and steam.
22. Some liquid oils can be converted into solid fats by
 A hydrolysis
 B hydrogenation
 C polymerisation
 D esterification.
23. When two amino acids condense together they eliminate water, forming a peptide link. Which of the following most simply represents this process?



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

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

25. After 15 days a sample contained 7.5×10^{21} atoms of radioactive bismuth, half-life 5 days. How many atoms were in the sample originally?

- A 2.25×10^{22}
 B 2.5×10^{21}
 C 6.0×10^{22}
 D 3.75×10^{22}

26. Radioactive $^{32}_{15}\text{P}$ decays by beta-particle emission. Which of the following statements is true of the new nucleus produced?

- A It has mass number 31.
 B It has 15 protons.
 C It has 16 neutrons.
 D It is a phosphorus nucleus.

27. Which is true of 16 g oxygen, 2 g hydrogen, **and** 71 g chlorine?

- A Each occupies the same volume at s.t.p.
 B Each contains N_A atoms.
 C Each contains N_A molecules.
 D Each may be liberated by two faradays of electricity.

28. How many litres of hydrogen at s.t.p. are needed to reduce 1 mole iron(III) oxide completely to the metal?

- A 6.0
 B 22.4
 C 44.8
 D 67.2

29. 22.4 litres of a gaseous element (measured at s.t.p.) had a mass of 160 g. The molecular weight of the element is

- A 160/22.4
- B 80/22.4
- C 80
- D 160.

30. A volume of 10 ml of carbon monoxide was passed over heated copper(II) oxide until no further reaction occurred. The volume of the gas collected, measured under the same conditions of temperature and pressure, was

- A 0 ml
- B 10 ml
- C 15 ml
- D 20 ml.

31. A mixture of sodium chloride and sodium sulphate is known to contain 0.6 mole of chloride ion and 0.2 mole of sulphate ion.

The number of moles of sodium ion present is

- A 0.4
- B 0.5
- C 0.8
- D 1.0.

32. Consider the following table of bond energies:

	kJ mol^{-1}
C—C	348
C—H	415
Si—Si	176
Si—H	318

Which of the following statements could be considered to be consistent with these values?

- A 348 kJ is the energy evolved when 1 mole of graphite sublimes
- B Methane, CH_4 , is chemically more stable than silane, SiH_4
- C Si—Si bonds are the least readily broken of those listed
- D Si—Si chains are more stable than C—C chains.

33. A grey solid

- (i) reacts with water giving off a gas, and
- (ii) can be electrolysed when fused, hydrogen being evolved at the positive electrode.

The substance is

- A selenium hydride
- B silicon hydride
- C nitrogen hydride
- D lithium hydride.

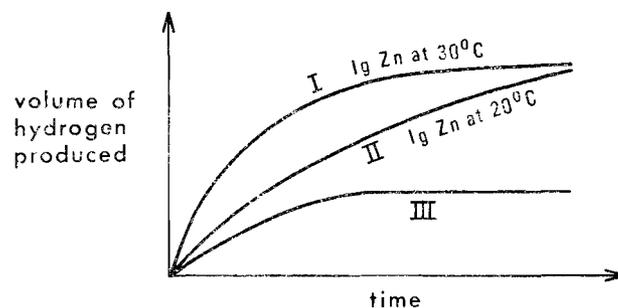
34. Sodium is obtained directly from its compounds by

- A electrolysis of sea water
- B passing hydrogen gas over the heated oxide
- C displacing it from solution with potassium
- D electrolysis of molten sodium chloride.

35. Which of the following reagents will **NOT** give a reaction when added to a solution containing iodide ions?

- A Chlorine water
- B Potassium chloride
- C Bromine water
- D Silver nitrate solution

36. The graphs below represent the reaction of granulated zinc with a very slight excess of 2 M hydrochloric acid.

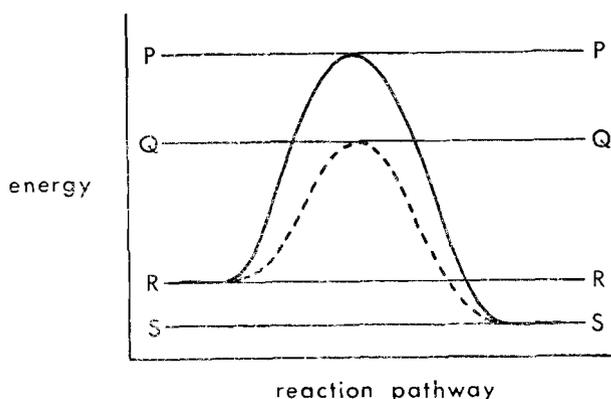


Which of the following statements is true?

- A Increasing the temperature increases the total mass of hydrogen produced.
- B Increasing the temperature increases the initial rate of reaction.
- C If the experiment were repeated at 10 °C curve III would be obtained.
- D If the experiment were repeated at 20 °C with 0.5 g of zinc the initial rate of reaction would be the same as in experiment II.

[Turn over

Questions 37 and 38 refer to the following diagram in which the unbroken line represents the reaction $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$ and the broken line the same reaction under different conditions.



37. What conditions are indicated by the broken line?

- A Higher pressure
- B Lower temperature
- C Lower concentrations
- D Use of a catalyst

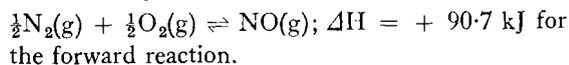
38. What is the interval QP?

- A Energy of activation for reaction without a catalyst
- B Heat of reaction for reaction without a catalyst
- C Bond dissociation energy
- D None of these

39. Which of the following reactions is **unaffected** by light energy?

- A The combination of $\text{H}_2(\text{g})$ and $\text{Cl}_2(\text{g})$
- B The decomposition of freshly prepared $\text{AgCl}(\text{s})$
- C The combination of $\text{N}_2(\text{g})$ and $\text{H}_2(\text{g})$
- D The synthesis of carbohydrates in plants

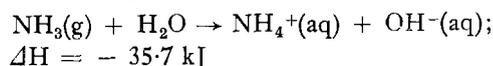
40. The synthesis of nitric oxide can be represented by the following equation.



Which of the following deductions can be made?

- A The products have less energy than the reactants
- B A catalyst is unlikely to help the reaction
- C An increase of pressure will favour the forward reaction
- D Lower temperatures will move the equilibrium to the left

41. Ammonia gas reacts with water as follows:



The solubility of ammonia in water will be increased by

- A increasing pressure and cooling
- B decreasing pressure and cooling
- C decreasing pressure and warming
- D increasing pressure and warming.

42. Which of the following hydrocarbons has a molecular formula different from that of the other three?

- A 2, 2-dimethyl-3, 3-dimethyl-butane
- B 3-ethyl-pentane
- C 2, 3-dimethyl-pentane
- D 2, 2-dimethyl-3-methyl-butane

43. $\text{X} + \text{Br}_2 \rightarrow \text{C}_4\text{H}_8\text{Br}_2$

The above equation represents a reaction in which an unknown compound X reacts with and rapidly decolourises bromine water.

X is most likely to be an

- A alkane
- B alkyl halide
- C alkene
- D alkyne.

44. Which of the following statements is true of methanol?

- A It gives an alkene with concentrated sulphuric acid.
- B It does not react with phosphorus pentachloride.
- C It boils at a temperature greater than 100°C .
- D On oxidation it gives a monocarboxylic acid.

Questions 45 and 46 refer to the compounds of which the formulae are given below:

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- B $(\text{CH}_3)_3\text{CCH}_2\text{OH}$
- C $\text{CH}_2\text{CHCHOHCH}_2\text{CH}_3$
- D $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$.

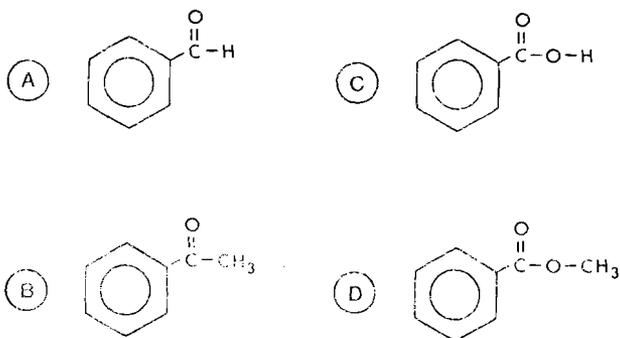
45. Which of the above is an isomer of pentan-3-ol?

46. Which of the above can be oxidised to butanoic acid?

47. Which of the following would react with sodium producing hydrogen gas?

- A Propanol
- B Propane
- C Propanal
- D Propanone

48. Which of the following is an acid?



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. 1 M solutions of the following substances were electrolysed using copper electrodes. In which case(s) would the negative electrode gain weight?

- 1 Copper chloride
- 2 Sodium hydroxide
- 3 Nickel sulphate
- 4 Calcium nitrate

50. Which of the following must be present for photosynthesis to occur in a plant?

- 1 Carbon dioxide
- 2 Chlorophyll
- 3 Water
- 4 Oxygen

[END OF QUESTION PAPER]

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1978

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—Paper II

Monday, 15th 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

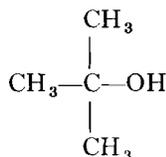
All questions should be attempted. It should be noted, however, that some questions contain a choice.

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

Marks

1. Answer EITHER A OR B.

A. Write the systematic name for the following compound.



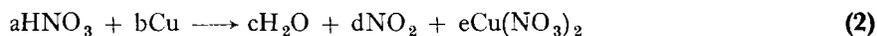
(2)

OR

B. Write the extended structural formula of 1,3-dibromobutane.

(2)

2. Find values for a, b, c, d and e such that the following equation will be balanced.



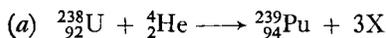
3. What is the mass in grams of:

(a) 10 moles of sodium atoms;

(b) 0.02 moles of hydrogen molecules?

(3)

4. Complete the following nuclear equations and identify X and Y.



(4)

5. Answer EITHER A OR B.

A. What is the theoretical volume of ammonia gas at s.t.p. liberated when 1.32 g of pure ammonium sulphate is heated with excess sodium hydroxide?

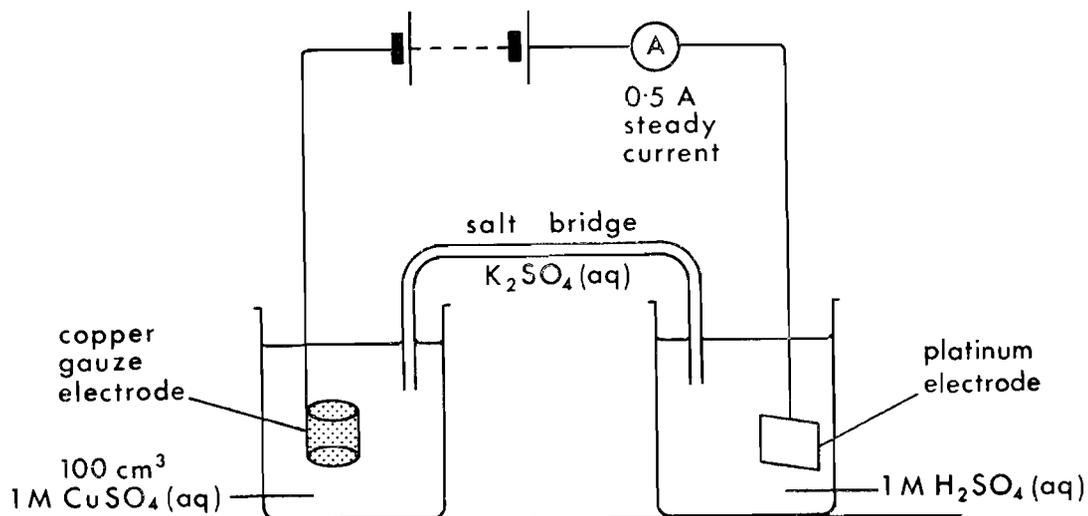
(4)

OR

B. 10 cm³ of butane gas were mixed with 75 cm³ of oxygen and exploded. Calculate the volume and composition of the gas remaining, if all measurements were made at s.t.p.

(4)

6.



Calculate the time required (to the nearest minute) for all the Cu²⁺(aq) ions to be discharged as copper on the negative electrode assuming this to be the only reaction occurring at that electrode.

(6)

7. Caesium can be obtained on a small scale using the following reaction:



(a) Why is it easy to separate caesium from this reaction mixture?

1

(b) Why does the large scale extraction of alkali metals from their ores normally require an electrolytic process?

1
(2)

8. Lithium iodide is moderately soluble in non-polar solvents whereas caesium fluoride is not. On the basis of this evidence, explain the difference in bonding in the two compounds.

(2)

9. Consider the heat of sublimation of carbon in the Data Book, page 38.

(a) Why is an energy input necessary?

1

(b) Name one other factor besides heat which must be taken into account in attempting to sublime carbon experimentally.

1

(c) If carbon sublimates at the temperature of a coal fire how is it able to give out heat?

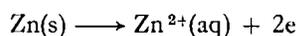
2
(4)

[Turn over

10. Examine the following table.

		$\Delta H \text{ kJ mol}^{-1}$
(1)	$\text{Zn(s)} \longrightarrow \text{Zn(g)}$	+130
(2)	$\text{Zn(g)} \longrightarrow \text{Zn}^{2+}(\text{g}) + 2\text{e}$	+2640
(3)	$\text{Zn}^{2+}(\text{g}) \longrightarrow \text{Zn}^{2+}(\text{aq})$	-2090

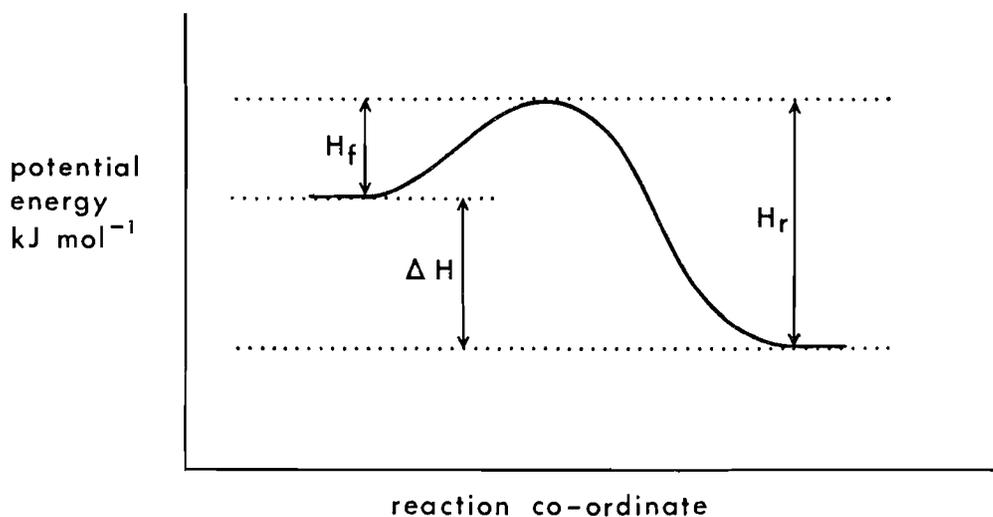
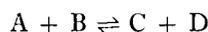
- (a) Name the energy changes occurring in steps (1), (2) and (3).
 (b) Calculate ΔH for the reaction



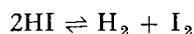
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2
(5)

11. The diagram below shows the energy changes for the reaction



- (a) Using the symbols in the diagram, construct a simple equation to show how the activation energy for the forward reaction can be calculated.
 (b) How can H_f and H_r be decreased with no change in ΔH ?
 (c) Give a reason why some collisions of particles A and B result in no reaction.
 (d) For the following reaction



draw a structural diagram to represent a possible activated complex.

1

1

1

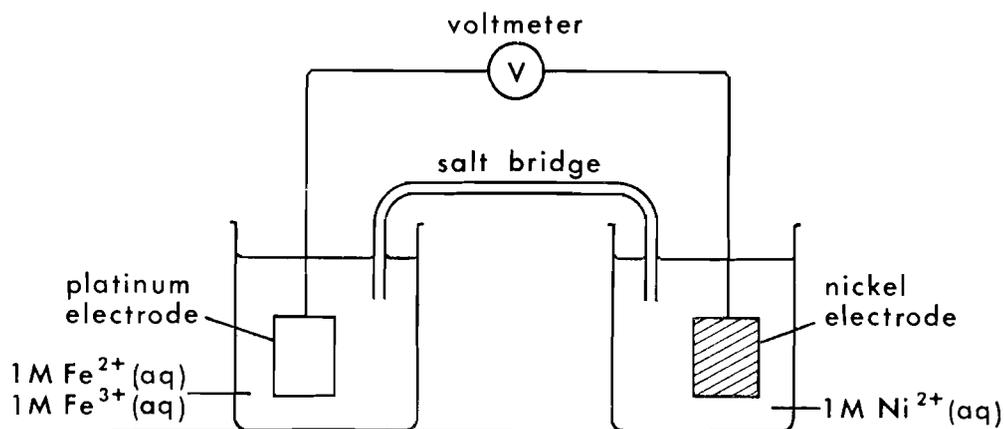
1
(4)

12. Identify the acids X, Y and Z, and state the concentration required in each case.

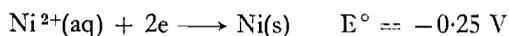
Test	Acid X	Acid Y	Acid Z
ADD COPPER	No change observed	Brown gas evolved	No change observed
ADD SODIUM CHLORIDE	No change observed	No change observed	Colourless choking gas evolved
ADD MANGANESE DIOXIDE	Green choking gas evolved	No change observed	No change observed

(4)

13.



Given that:



use the Data Book to answer the following questions.

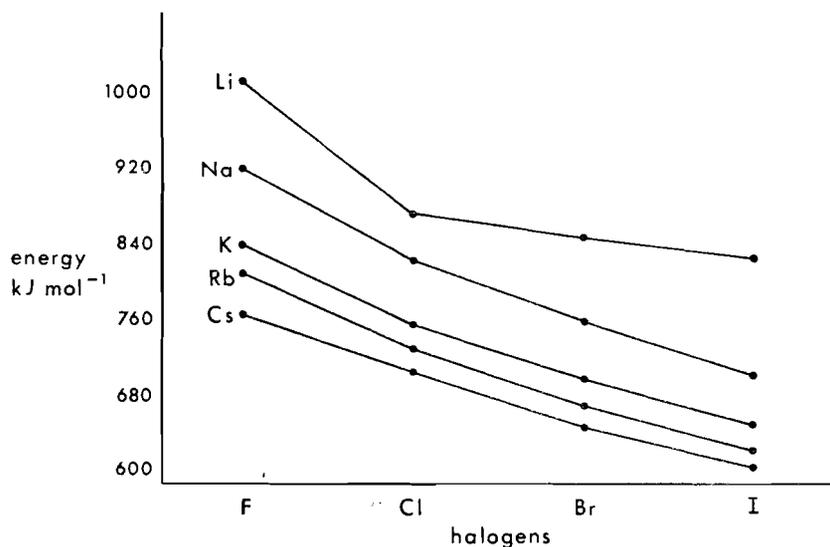
- (a) What will be the reading on the voltmeter? 1
- (b) Write ion electron equations for the reactions occurring in the beakers and deduce the equation for the overall reaction of the cell. 2

(3)

[Turn over

14. Answer EITHER A OR B.

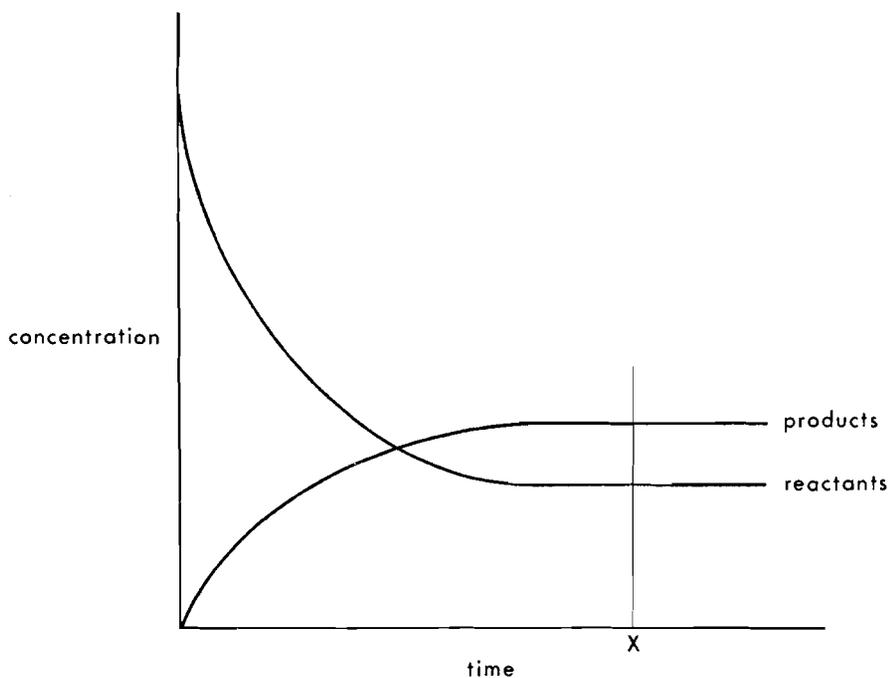
- A. The diagram shows the amount of energy required to dissociate one mole of each of the crystalline alkali halides.



- (a) How does this energy vary with the atomic number of the halogen? 1
- (b) For each halogen, how does this energy vary with the atomic number of the alkali metal? 1
- (c) In what way does the atomic radius of the halide ion affect the bond strength? 1
- (3)**

OR

- B. The diagram shows the general behaviour of the concentrations of reactants and products as a chemical reaction progresses.

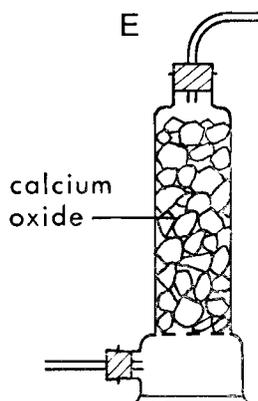
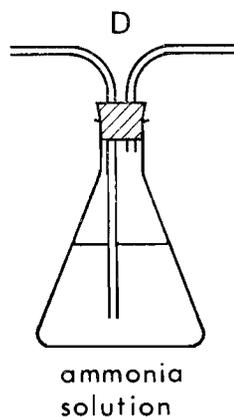
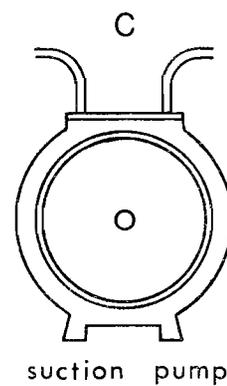
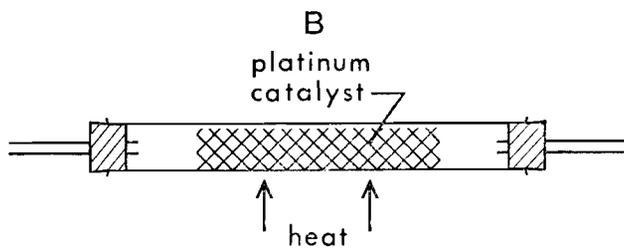
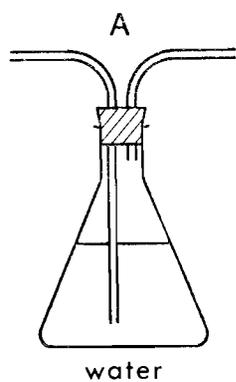


- (a) At what stage are the concentrations varying most rapidly? 1
- (b) At what stage is the reaction at time X? 1
- (c) What happens to the rate of change of concentration of the reactants as the reaction proceeds? 1
- (3)**

15. Arrange the following pieces of apparatus so that they can be used to produce an acid.

Do not draw the apparatus, but answer by putting the letters in order, e.g. A, B, C, D, E.

(2)



[Turn over

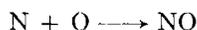
PART B

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

Marks

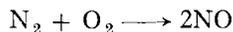
16. Answer EITHER A OR B.

- A. Today, Avogadro's Law—that equal volumes of different gases at the same temperature and pressure contain equal numbers of atoms or molecules—is a scientific commonplace. Previously in the nineteenth century the words atom and molecule had been used in a confused manner. Avogadro appeared to have been the first scientist to distinguish between them. Only after this could serious attempts be made to calculate atomic weights. In honour of the contribution to science made by Avogadro, the modern unit, the mole, is defined in terms of the "Avogadro Number", i.e. the amount of substance of a system which contains as many "elementary entities" as there are atoms in 0.012 kg of carbon-12. John Dalton, a contemporary, rejected Avogadro's Law as "confused". Dalton illustrated his objections using the following reaction:



Dalton showed experimentally that the volume of nitric oxide produced is equal to the volume of the starting materials. But, argued Dalton, if Avogadro's law is applied to the above equation then the volume of nitric oxide should be half that of the starting materials.

It was much later that the correct equation for the reaction was found to be:



- | | |
|--|----------|
| (a) What did Avogadro do which allowed accurate atomic weights to be calculated? | 2 |
| (b) What was Dalton's view of nitrogen and oxygen? | 1 |
| (c) What type of particle had Dalton failed to identify? | 1 |
| (d) When applying Avogadro's Law what standard temperature and pressure would you use? | 2 |
| (e) What would be meant by "elementary entities" as applied to (i) sodium chloride; (ii) carbon dioxide? | 2 |
| (f) How many moles of nitric oxide would be formed if one mole of nitrogen was mixed and exploded with half a mole of oxygen? | 1 |
| (g) Why is the standard carbon-12 and not simply carbon? | 2 |
| (h) A gas of volume 400 ml was found to have a mass of 1.27 g at s.t.p. What is the molecular weight of the gas? Identify the gas. | 4 |
| (i) If 10 ml of N ₂ is sparked with 8 ml of O ₂ and the reaction goes to completion, what will be the final composition of the reaction mixture? | 2 |

(17)

OR

- B. Dalton's Atomic Theory (1808) expressed current opinion regarding the nature of atoms and his insistence upon the importance of atomic weights gave a useful guide for classifications. Dobereiner (1829) attempted a simple classification in his law of triads, "elements of similar character often possess atomic weights which are in arithmetical progression":

Ca	Sr	Ba	—	40	88	137
Cl	Br	I	—	35	80	127

Newlands (1863) arranged the then known elements in order of increasing atomic weights. He noticed that the "eighth one starting from a given one is a kind of repetition of the first".

e.g. Element	Li	Be	B	C	N	O	F
Atomic weight	7	9	11	12	14	16	19

Element	Na	Mg	Al	Si	P	S	Cl
Atomic weight	23	24	27	28	31	32	35

Newlands' scheme seemed to break down because he applied the "octet rule" to the known elements and he did not appreciate that gaps had to be left for undiscovered elements. Lothar Meyer (1869) used a graphical approach plotting atomic volume against atomic weight. The curve he obtained was periodic. The chemist Mendeleef (1869) published a more widely based approach in which he predicted the properties of yet unknown elements with astonishing accuracy. Thus, he predicted that "Eka-boron" would be a metal, forming a sulphate $E_2(SO_4)_3$, and would have an oxide that would dissolve in acids but not in alkalis. He was correct.

The process of discovering new elements has continued to this day with the recent discovery of natural radioactive elements with atomic numbers of 116, 124 and 126. These are the first natural elements to have been discovered which are heavier than uranium.

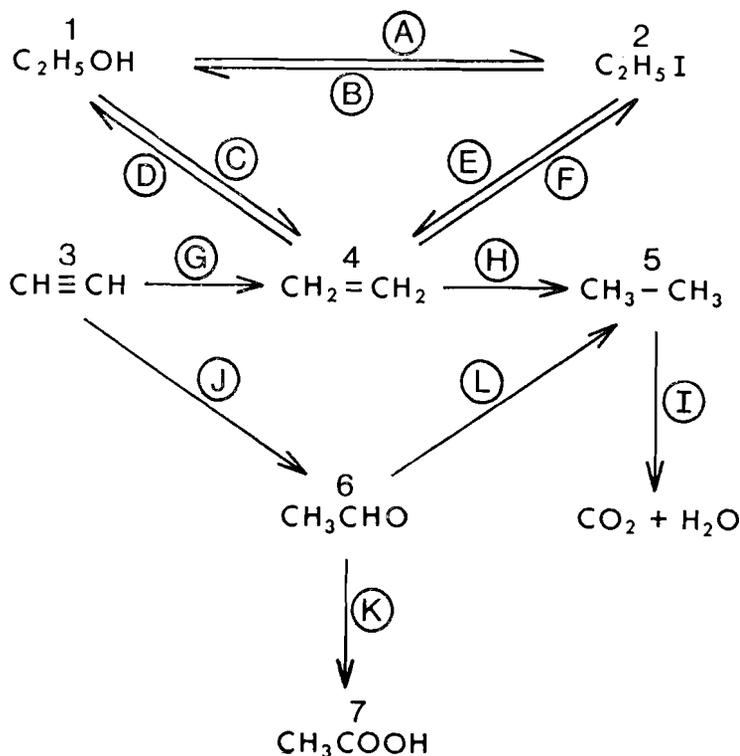
- (a) The chemists named in the passage used atomic weights as the main guide for classification. What property is now used? 1
- (b) According to modern classification which two groups, as given above, had been described by Dobereiner? 2
- (c) From Newlands' table select one element as "the first" and another appropriate element as "the eighth": describe two chemical properties for these elements to show what is meant by "repetition". 2
- (d) Which group was not present in Newlands' table? 1
- (e) What was the major mistake made by Newlands? 1
- (f) Explain, with reference to the alkali metals, what Lothar Meyer meant by the term periodic. 2
- (g) What name was given to "Eka-boron" when it was discovered? 1
- (h) Describe one common feature for elements in (i) a period; (ii) a group. 2
- (i) The elements in a modern Periodic table reach 103. Why then are the newly discovered elements described in the passage as the first to have been discovered since uranium? 1
- (j) The elements 116, 124 and 126 decay by β -emission. What does this suggest? 1
- (k) A sample of barium chloride, $BaCl_2$, weighing 1.00 g reacted with silver nitrate solution and all the chloride was recovered as 1.37 g of $AgCl$. Show how this experimental result can be used to calculate the atomic weight of barium. 3

(17)

[Turn over

17. Answer EITHER A OR B.

A. Examine the flow diagram shown below, then answer the questions following:



- (a) Why are some of the compounds in the above diagram connected by double arrows and others only by single arrows? 1
- (b) What is the name of the alkanol (alcohol) in the above scheme? 1
- (c) Name one reagent in each case which could be used to bring about the reactions A, B, C and E. 4
- (d) State the types of reaction involved in steps H and K respectively. 2
- (e) From the scheme, select a compound which is used as a raw material in the polymer industry. 1
- (f) Which reaction in the scheme does not involve a change from one homologous series to another? 1
- (g) Using a chemical test in each case, how would you distinguish between
- compounds (4) and (5)
 - compounds (1) and (6)?
- 2
- (h) Compound (1) can be converted directly into compound (7) by treatment with a mixture of hot, concentrated sulphuric acid and sodium dichromate over a period of about half an hour.
- Sketch the apparatus you would use to bring about the conversion of compound (1) to compound (7).
 - By means of a second sketch, indicate how you would modify your apparatus in order to isolate compound (7) from the reaction mixture.
- 3
- (i) In a particular experiment the measured molecular weight of compound (7) is found to be 120. Explain this result and draw a diagram to support your explanation. 3

(18)

OR

B. The chemistry of selenium and, to a lesser extent, tellurium, resembles that of sulphur. From a knowledge of sulphur chemistry together with the aid of the Data Book, answer the following questions.

- (a) Write the formula for sodium selenide. **1**
- (b) State briefly how you would obtain a sample of selenium dioxide from the element and write the equation. **2**
- (c) Which of the three elements sulphur, selenium, tellurium, is the most metallic in character. From the Data Book, quote two pieces of evidence to support your answer. **3**
- (d) Comment on the pH of a solution of selenium dioxide in water, and write a balanced equation for the reaction which would occur between such a solution and a solution of sodium hydroxide. **3**
- (e) Given that:

$$\text{SeO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e} \longrightarrow \text{H}_2\text{SeO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \quad E^\circ = +1.15 \text{ V},$$
 (i) Write the formula for selenic acid. **1**
 (ii) Is the selenate ion a stronger or a weaker oxidising agent than the sulphate ion? Explain your answer. **2**
 (iii) Write a balanced equation for the reaction which would occur between an aqueous solution of selenate ions (acidified) and an aqueous solution of iodide ions. **2**
- (f) Predict how concentrated selenic acid will react with:
 (i) common salt;
 (ii) copper. **4**
- (18)**

18. Answer EITHER A OR B.

A. Write an essay on "Oxidation and Reduction".

Your answer should include reference to the following points:

- (a) definitions of oxidation and reduction;
 (b) displacement of one element by another;
 (c) half-reactions;
 (d) electron transfer;
 (e) electrode potentials;
 (f) oxidising and reducing agents;
 (g) oxidation states (numbers). **(15)**

OR

B. Write an essay on "The Halogens".

Your answer should include reference to the following points:

- (a) trends in the properties of the Group 7 elements;
 (b) electronegativity of the halogens;
 (c) metallic and non-metallic halides;
 (d) hydrogen halides;
 (e) uses of the halogens and their compounds. **(15)**

[END OF QUESTION PAPER]