

[92/288]

1978

CERTIFICATE OF SIXTH YEAR STUDIES

# CHEMISTRY

Paper

Monday, 15th May—9.30 a.m. to 12.30 p.m.



Dalziel High School  
Chemistry Department



# 1978 CSYS

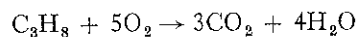
1. Which of the following configurations must represent an atom in the excited state?

- A  $1s^2 \dots\dots\dots 3p^6 3d^2 4s^2$   
 B  $1s^2 \dots\dots\dots 3p^6 3d^4$   
 C  $1s^2 \dots\dots\dots 3p^6 4s^1$   
 D  $1s^2 \dots\dots\dots 3p^6 3d^1 4s^2 4p^5$

2. Approximately how many molecules are there in 6 g methane?

- A  $1 \times 10^{23}$   
 B  $2.25 \times 10^{23}$   
 C  $6 \times 10^{23}$   
 D  $36 \times 10^{23}$

3. A mixture of 1 volume of propane and 8 volumes of oxygen is sparked in a closed tube. The reaction occurring is



What is the molar ratio of the remaining gases at 100 °C?

	Propane	Oxygen	Carbon Dioxide	Steam
A	0	0	3	4
B	0	0	3	0
C	0	3	3	4
D	1	6	3	4

Questions 4 and 5 refer to the following table which gives approximate values (in kJ mol<sup>-1</sup>) for the first, second and third ionisation energies of five elements labelled P, Q, R, S and T.

Element	E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>
P	500	4600	6900
Q	600	1200	4900
R	2100	4000	6100
S	400	3900	4600
T	400	2400	3400

4. Which one of these elements readily forms a solid compound MCl<sub>2</sub>?

- A P  
 B Q  
 C R  
 D S

5. The element T reacts vigorously with chlorine to give a compound. Which of the following statements regarding this compound is **not** true?

- A The compound forms a conducting solution in water.  
 B The compound normally exists as separate molecules.  
 C The compound is a white solid.  
 D The compound is a crystalline solid.

6. Which of the following groupings is found in nylon?

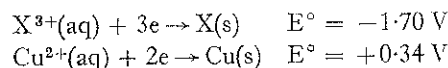
- A —COOH  
 B —CONH—  
 C —CN  
 D —CH<sub>2</sub>COCH<sub>2</sub>—

7. An indicator used in an acid-alkali titration changes colour at pH 4.4. What is the concentration, in moles per litre, of hydrogen ions in the solution at the end point shown by this indicator?

- A  $4.4 \times 10^{-1}$   
 B  $2.5 \times 10^{-4}$   
 C  $2.5 \times 10^{-5}$   
 D  $4.0 \times 10^{-5}$

8. Two half-cells are connected by a salt bridge. In the first half-cell metal X is in a solution of X<sup>3+</sup> ions. In the second half-cell Cu is in a solution of Cu<sup>2+</sup> ions.

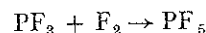
The E° values are as follows:



In the reaction taking place when X and Cu are joined by a wire, which of the following is oxidised?

- A X  
 B X<sup>3+</sup>  
 C Cu  
 D Cu<sup>2+</sup>

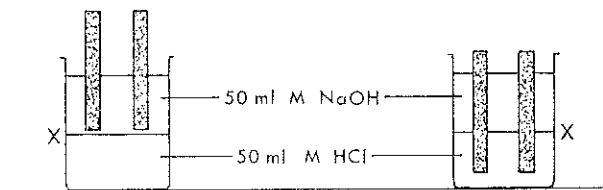
9. What is the change in the three dimensional arrangement of the bonds round the P atom in the following reaction?



- A Planar to pyramidal  
 B Pyramidal to tetrahedral  
 C Pyramidal to square planar  
 D Pyramidal to bipyramidal

10.  $2\text{Ag}^+(\text{aq}) + \text{Sn}^{2+}(\text{aq}) \rightleftharpoons 2\text{Ag}(\text{s}) + \text{Sn}^{4+}(\text{aq})$   
Which of the following procedures, applied to this constant volume equilibrium system, would cause silver metal to dissolve? The addition of excess of
- silver ions
  - tin(II) ions
  - solid silver
  - tin(IV) ions.

Questions 11, 12 and 13 refer to the following situation:  
50 ml of M HCl is placed in a beaker and sugar (a non-electrolyte) is added to increase the density of the solution. 50 ml of M NaOH is slowly added to form a layer on top of the dense acid layer. Assume that no mixing has taken place.



11. A pair of carbon electrodes attached to a battery (d.c.) and in series with an ammeter is lowered into the solution **almost** down to level X. The products at the electrodes are

	Positive Electrode	Negative Electrode
A	hydrogen	sodium
B	oxygen	hydrogen
C	oxygen	sodium
D	hydrogen	oxygen

12. The conductivity in the upper layer was noted before the electrodes were lowered towards the bottom of the beaker. The meter reading when the electrodes had been lowered was
- exactly doubled
  - exactly halved
  - more than doubled
  - more than halved.

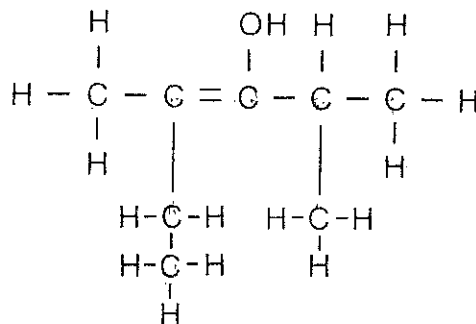
13. The electrodes were left in place and the two layers thoroughly mixed. The meter reading in Question 12
- is unchanged
  - becomes half
  - becomes less than half
  - becomes double.

The processes in questions 14, 15 and 16 may be placed in one of the following categories:

- $\Delta H$  positive,  $\Delta S$  positive
- $\Delta H$  positive,  $\Delta S$  negative
- $\Delta H$  negative,  $\Delta S$  positive
- $\Delta H$  negative,  $\Delta S$  negative.

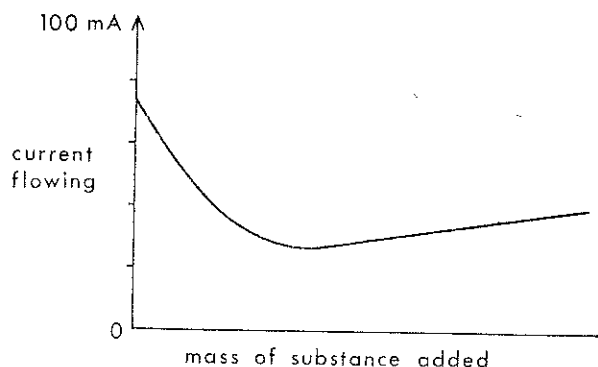
Note—A category may be used more than once.

- The condensation of ether vapour.
- The reduction of carbon dioxide with carbon.
- The dissociation of ammonium chloride.
- If a compound of this structure was obtained, which of the following names would be most appropriate?



- 2-ethyl-4-methyloct-2-en-3-ol
- 2-ethyl-4-methylpent-2-en-4-ol
- 2, 4-dimethylhex-3-en-3-ol
- 2, 4-diethylhex-2-en-3-ol

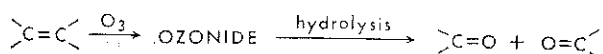
18.



The current flowing through a 2M solution of nitric acid varies as shown in the graph when which of the solids listed is added to it?

- A Zinc
- B Copper(II) oxide
- C Potassium hydroxide
- D Calcium hydroxide

19. Alkenes react with ozone ( $O_3$ ) to form ozonides which can be hydrolysed to give carbonyl compounds.



Which of the following alkenes will produce a mixture of propanone and ethanal when acted upon in this way?

- A  $CH_3CH=CHCH_2CH_3$
- B  $CH_2CH=CHCH_3$
- C  $CH_3C(CH_3)=CH_2$
- D  $CH_3CH=C(CH_3)_2$

20. Which one of the undermentioned hydrides has all the following properties?

- (i) It does not decompose on contact with air at room temperature;
- (ii) It dissolves in water to give an alkaline solution only;
- (iii) It is produced with great difficulty by direct combination of its elements.

- A Silicon hydride
- B Sodium hydride
- C Sulphur hydride
- D Nitrogen hydride

21. Comparing equal masses of radium chloride and radium bromide, each containing  $^{226}\text{Ra}$ , they would have

- A different intensities of radiation and different half-lives
- B the same intensities of radiation and different half-lives
- C different intensities of radiation and the same half-lives
- D the same intensities of radiation and the same half-lives.

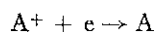
22. What volume of hydrogen at s.t.p. will be released when 6.5 g of zinc are added to 100 ml of M sulphuric acid?

- A 1120 ml
- B 2240 ml
- C 4480 ml
- D 11200 ml

23. Which would be expected to undergo the greatest deflection in a mass spectrometer?

- A  ${}^7_3\text{Li}^+$
- B  ${}^4_2\text{He}^{2+}$
- C  ${}^{14}_7\text{N}^{2+}$
- D  ${}^{14}_6\text{C}^{4+}$

24. When an electrode potential series is written with the ion-electron equations in the form



where in the series does one find a good reducing agent?

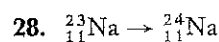
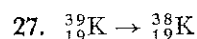
- A On the left of the equation and with a very positive  $E^\circ$   
 B On the right of the equation and with a very positive  $E^\circ$   
 C On the left of the equation and with a very negative  $E^\circ$   
 D On the right of the equation and with a very negative  $E^\circ$
25. If equal volumes of equimolar solutions of the following pairs of substances were mixed, which pair would constitute a buffer solution?
- A Ammonia and methylamine  
 B Hydrochloric acid and sodium chloride  
 C Hydrochloric acid and sodium hydroxide  
 D Ammonia and ammonium chloride
26. Which one of the following molecules contains three atoms in a straight line?
- A  $BF_3$   
 B  $CH_4$   
 C  $H_2O$   
 D  $PF_5$

Questions 27 and 28 refer to the following.

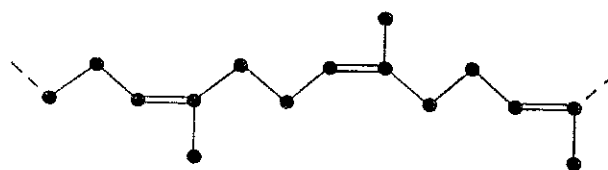
The capture of a neutron by an atomic nucleus can lead to the emission of

- A a proton  
 B an  $\alpha$ -particle  
 C  $\gamma$  radiation  
 D 2 neutrons.

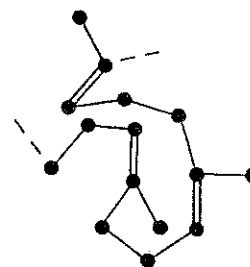
Which of the above is emitted when the following reactions take place during nuclear bombardment by neutrons?



29.



(a)



(b)

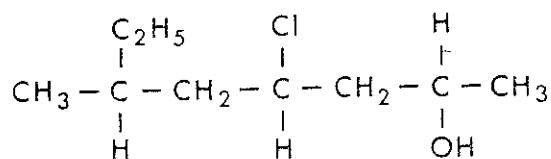
The diagrams may be regarded as representing the arrangement of the carbon atoms in (a) stretched rubber, and in (b) unstretched rubber. Stretched rubber returns spontaneously to the unstretched state because this change involves

- A an increase in entropy and a decrease in potential energy  
 B a decrease in entropy and an increase in potential energy  
 C a decrease in entropy and a decrease in potential energy  
 D an increase in entropy and an increase in potential energy.
30. Butene burns in oxygen according to the following equation
- $$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$
- If 100 cm<sup>3</sup> of butene is exploded with excess oxygen then, compared with the total volume before the reaction, the volume after the reaction will be
- A 100 cm<sup>3</sup> more  
 B 100 cm<sup>3</sup> less  
 C 300 cm<sup>3</sup> more  
 D 300 cm<sup>3</sup> less.

**Note.** All measurements are taken under the same conditions.

[Turn over

31.



What is the systematic name for the above compound?

- A 4-chloro-6-methyloctan-2-ol
- B 4-chloro-2-ethylheptan-6-ol
- C 4-chloro-2-ethylheptan-2-ol
- D 5-chloro-3-methyloctan-7-ol

Questions 32, 33 and 34 refer to the following terms.

- A Hydrolysis
- B Solvation
- C Saturation
- D Concentration

**Note.** The same term may be the answer to more than one question.

Which of the above most accurately represents

32. a term used to express quantitatively a mass-volume relationship?

33. a condition which implies the existence of equilibrium between pure solute and solution?

34. a condition arising from attraction between ions and polar water molecules in aqueous solution?

35. Scandium chloride is soluble in water. It might be deduced from this that all first period transition metal chlorides are soluble because

- A they have electrons in d orbitals
- B the degeneracy of the d orbitals is removed when the chlorides are added to water
- C transition metal ions have approximately the same radius
- D the hydration energy of the metal ions will increase going from left to right across the period.

36. The silicate ion  $\text{Si}_4\text{O}_{11}$  has, in effect, six negative charges. In the mineral  $\text{Ca}_2\text{Mg}_x(\text{Si}_4\text{O}_{11})_2(\text{OH})_2$ , x is

- A 4
- B 5
- C 6
- D 10.

Questions 37, 38 and 39 refer to the following:

There are four possibilities arising in the I.R. spectrum of an organic compound.

- A A peak may appear at  $2800\text{-}3000\text{ cm}^{-1}$  due to C—H bond stretching for tetrahedral carbon.
- B A peak may appear at  $3000\text{-}3100\text{ cm}^{-1}$  due to C—H bond stretching for trigonal carbon.
- C A peak may appear at  $3300\text{ cm}^{-1}$  due to C—H bond stretching for digonal carbon.
- D No peak may appear due to C—H bond stretching.

**Note.** A possibility may be quoted more than once.

Which possibility is most likely for

37. benzene?

38. P.V.C.?

39. P.T.F.E.?

To answer questions 40 to 45 use the following code.

If all the responses 1, 2 and 3 are correct, select A.

If only 1 and 2 are correct, select B.

If only 3 is correct, select C.

If any other response, or combination of responses of those given is correct, select D.

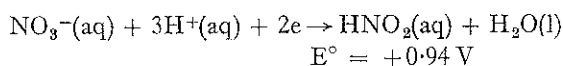
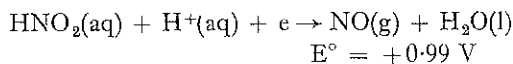
40. A change in the nature of the ligand round a transition metal ion may result in a change in

- 1 colour
- 2 degree of paramagnetism
- 3 coordination number.

41. The following techniques could be used to find out if a small piece of transparent yellow-tinted polythene contains traces of water.

- 1 X-ray crystallography
- 2 visible spectrophotometry
- 3 infra-red spectroscopy

42. The table on page 40 of the Data Book should be used in connection with this question, together with the additional redox potentials given below.

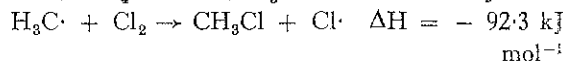
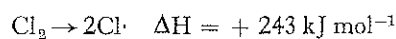


- 1 Nitrous acid ( $\text{HNO}_2$ ) can be an oxidising agent or a reducing agent.
- 2 Nitrous acid is an oxidising agent in the presence of sulphuric acid.
- 3 Nitrous acid will reduce the permanganate ion  $\text{MnO}_4^-(\text{aq})$ .

43. Which, if any, of the following procedures could be used to find out if there are any iodide ions present as an impurity in a solution of potassium chloride?

- 1 Electrolyse the solution using carbon electrodes.
- 2 Pass chlorine gas into the solution.
- 3 Add some starch solution.

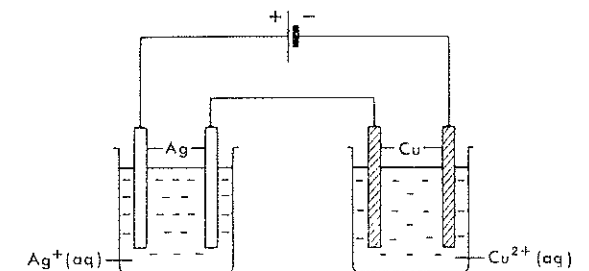
44. A possible mechanism for the chain reaction of chlorine with methane is:



Which, if any, of the following terms will describe the reaction between chlorine and methane?

- 1 Free radical
- 2 Catalytic
- 3 Endothermic

45. Consider the experiment shown below.



When the metals silver and copper are being deposited by electrolysis, which, if any, of the following factors affect(s) the relative masses of silver and copper deposited?

- 1 The charges on the silver and copper ions
- 2 The relative mobilities of the silver and copper ions
- 3 The atomic weights of silver and copper

46. Which of the following ions is most paramagnetic?

- A  $\text{Ti}^{3+}$
- B  $\text{Mn}^{2+}$
- C  $\text{Co}^{2+}$
- D  $\text{Ni}^{2+}$

47. Which of the following is likely to have the greatest lattice energy?

- A Sodium chloride
- B Rubidium chloride
- C Magnesium fluoride
- D Calcium fluoride

48. The ionic product for water

$$K_w = [\text{H}^+][\text{OH}^-] = 10^{-14} \text{ mol}^2 \text{ l}^{-2}$$

10 ml of a solution of sodium hydroxide of pH 12 was diluted to 1000 ml with pure water. 10 ml of the resulting solution was again diluted to 1000 ml with pure water. This was repeated for a third time. What is the approximate pH of the resulting solution?

- A 6
- B 7
- C 8
- D 9

49. The bond dissociation energy of HBr is 364 kJ mol<sup>-1</sup>. In which of the following processes are 364 kJ **released**?

- A  $\frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Br}_2(\text{g}) \rightarrow \text{HBr}(\text{g})$
- B  $\text{HBr}(\text{g}) \rightarrow \frac{1}{2}\text{H}_2(\text{g}) + \frac{1}{2}\text{Br}_2(\text{g})$
- C  $\text{H}\cdot(\text{g}) + \text{Br}\cdot(\text{g}) \rightarrow \text{HBr}(\text{g})$
- D  $\text{HBr}(\text{g}) \rightarrow \text{H}\cdot(\text{g}) + \text{Br}\cdot(\text{g})$

50. In an experiment to find the value of x in BaCl<sub>2</sub>·xH<sub>2</sub>O by dehydration of the crystalline hydrate, the balance being used was reading 2% too high. Assuming all the other experimental procedures were correct the value of x **calculated** would be

- A too high
- B too low
- C correct
- D impossible to predict regarding error.

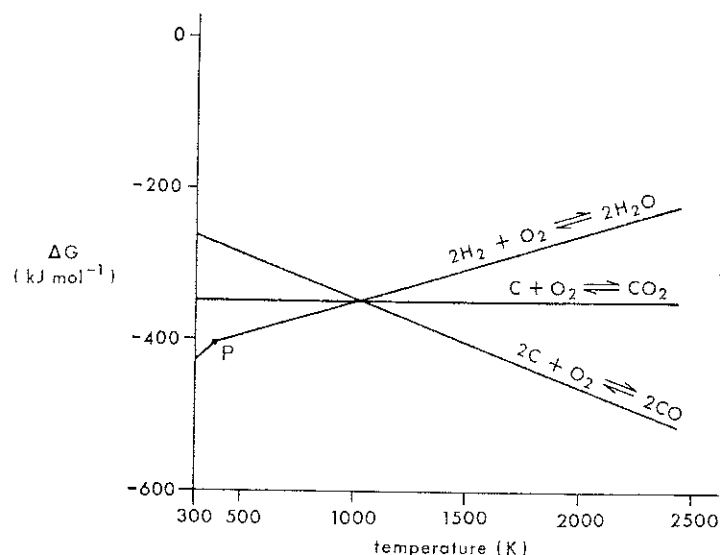
[END OF QUESTION PAPER]



1. (a)  $\Delta G = \Delta H - T\Delta S$

- (i) What names are given to  $\Delta G$ ,  $\Delta H$ , T and  $\Delta S$ ? (2)
- (ii) State the units of  $\Delta G$  and of T. (1)
- (iii) Explain briefly the meaning of S in  $\Delta S$ . (1)

- (b) Consider the following diagram which shows how  $\Delta G$  (measured under certain standard conditions) varies with temperature.



In answering the following you should assume that the corresponding  $\Delta H$  and  $\Delta S$  values do not vary with temperature.

- (i) What is happening at P? (1)
- (ii) Explain why the line for  

$$\text{C} + \text{O}_2 \rightleftharpoons \text{CO}_2$$
is horizontal. (3)
- (iii) If carbon and oxygen are allowed to react at 1500 K, what is the main product? Explain your choice. (2)
- (c) Consider the following with reference to the Haber Process, all measurements being made at atmospheric pressure and at 27 °C.

Substance	State	$\Delta H_f$ kJ mol <sup>-1</sup>	S J K <sup>-1</sup> mol <sup>-1</sup>
NH <sub>3</sub>	gas	-46	193
H <sub>2</sub>	gas	0	131
N <sub>2</sub>	gas	0	192

- (i) Explain why two of the figures are zero. (1)
- (ii) Write a balanced equation for the Haber Process. (1)
- (iii) Calculate the free energy change at 27 °C and at 727 °C, assuming that  $\Delta H_f$  and S do not vary with temperature.  
Which of these temperatures could be used industrially for a high yield of ammonia? State the reason for your choice. (6)
- (iv) In practice a catalyst is used. What effect (if any) does this have on the rate of reaction, on  $\Delta G$ , on  $\Delta H$  and on  $\Delta S$  for the reaction at a particular temperature and pressure? (No explanation required.) (2)

2. (a) Some swimming pool water was thought to be too highly chlorinated. In the water, the chlorine is present in two forms—free chlorine, and “fixed” chlorine in the form of chloride ions.
- (i) Given a bucket of the water, some solid KI, M/40 sodium thiosulphate solution, starch solution and the usual laboratory apparatus, outline how you would determine the amount of free chlorine per litre of the water. (3)
- (ii) In such an experiment, 25 ml of the water required 5 ml of the M/40 thiosulphate. Calculate the weight of free chlorine per litre of the water, setting out your working clearly. (4)
- (iii) Another sample was boiled to drive off the free chlorine and then cooled. Describe how you would find the concentration of the “fixed” chlorine per litre of water. (4)
- (b) How many moles of each of the following reactants could be converted to the products shown using one mole of electrons?
- (i)  $\text{MnO}_4^- \rightarrow \text{MnO}_2$
- (ii)  $\text{NO}_3^- \rightarrow \text{N}_2\text{O}$  (6)
- (c) Tranquillityte is a mineral found only on the moon. When brought back and analysed on earth, it was shown to have the formula  $\text{Fe}_8\text{Zr}_2\text{Ti}_9\text{Si}_9\text{O}_{24}$ .
- (i) What is its formula weight?
- (ii) What percentage of the mineral is zirconium?
- (iii) To which class of minerals does this belong? (3)

3. (a) (i) Copy the following table into your answer book and fill in the values of the blanks showing your energy calculations clearly underneath.

Type of Radiation	Typical Wavelength (m)	Energy ( $\text{kJ mol}^{-1}$ )
I.R.	$10^{-4}$	1.2
Visible (red)	$7 \times 10^{-7}$	—
U.V.	$10^{-9}$	—
—	$10^{-11}$	$1.2 \times 10^7$

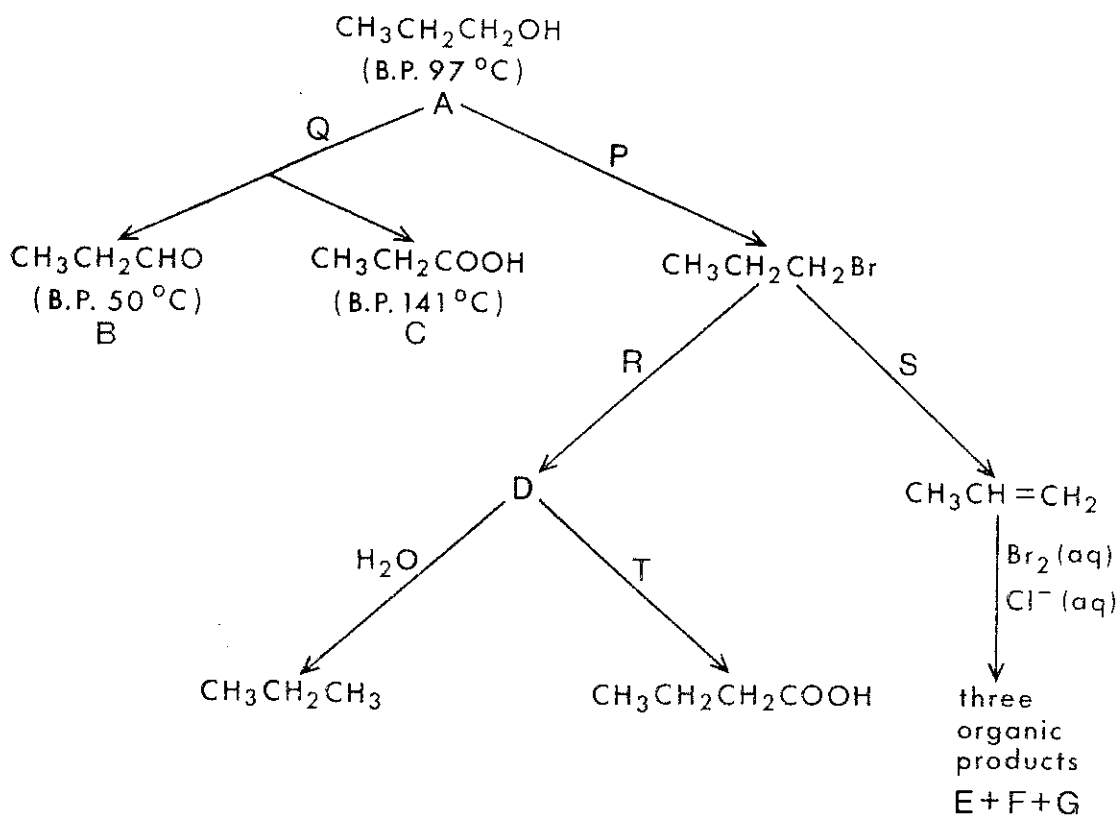
- (ii) Which radiation is the most penetrating? (1)
- (b) The following reaction can best be started using an intense beam of one of the above types of radiation:
- $$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$$
- (i) Which type of radiation would be used? (1)
- (ii) Explain briefly the effect produced by each of the other types of radiation. (3)
- (iii) Outline the mechanism of this reaction, explaining clearly your choice of first step. (4)
- (c) Lithium is made up of two isotopes, with relative atomic masses 6.015 and 7.016. The relative atomic mass of the element is 6.939.
- (i) What does “isotope” mean? (1)
- (ii) What is the “relative atomic mass” relative to? (1)
- (iii) Calculate, to the first decimal place, the percentage of each isotope in lithium. (4)

[Turn over

4. (a) Element D has electron configuration  $1s^2 2s^2 2p^1$ .  
Element E has electron configuration  $1s^2 2s^2 2p^6 3s^2 3p^4$ .
- (i) Identify D and E. (2)
- (ii) Show, with the aid of clear sketches, the shapes of the molecules formed when D and E react with excess fluorine. (4)
- (b) Consider the following data about a metal M, all in  $\text{kJ mol}^{-1}$ ;  
Heat of sublimation = 339  
1st Ionisation Energy = 745  
2nd Ionisation Energy = 1960  
Lattice Energy of MO = 4149  
Lattice Energy of  $M_2O$  = 3285  
and the following data about oxygen;  
Bond energy = 496  
Electron affinity = 702 (O to  $O^{2-}$ )
- (i) Calculate the heat of formation of MO and of  $M_2O$ . (6)
- (ii) Is it possible, from the figures, to say which of the oxides is the more stable? Explain briefly. (2)
- (iii) What other factor would have to be taken into account before you can be certain of such a prediction? Explain briefly. (2)
- (iv) Suggest one possible explanation for the relative magnitudes of the two lattice energies. (1)
- (c) In ionic solids of the type  $X^{n+}Y^{n-}$ , a radius ratio of less than 0.73 usually means a 6 co-ordinate structure, while a ratio above this means an 8 co-ordinate structure.
- (i) Explain briefly the meaning of "6 co-ordinate".
- (ii) What type of structure would you expect for rubidium bromide?
- (iii) What type of structure would you expect for iron(II) oxide? (3)

5.

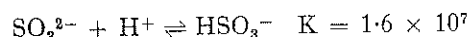
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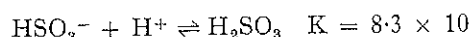
- (a) State the reagents required for
- (i) stage P; (3)
  - (ii) stage S; (1)
  - (iii) stage T. (3)
- (b) Name substance D. (1)
- (c) Describe how reaction R could be carried out. (3)
- (d) Describe, using structural formulae, the mechanism of reaction T. (3)
- (e) Give one possible structure for each of E, F and G and explain how they arise. (5)
- (f) Reaction Q can be carried out by various oxidising agents such as potassium dichromate dissolved in sulphuric acid. In this case substance A is mixed with the acidified dichromate in a flask. A condenser is also used but the apparatus has to be set up differently depending on whether B or C is required. Consider the boiling points given and
- (i) outline, by means of a sketch, how you would set up an apparatus to isolate B; (2)
  - (ii) similarly describe how you would set about isolating C. (3)

6. (a) The reaction between sodium sulphite,  $\text{Na}_2\text{SO}_3$ , and hydrochloric acid takes place in two stages:

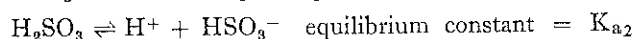
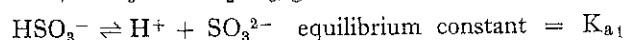
The first stage is



and the second stage is



- (i) Calculate the dissociation constants,  $K_{a1}$  and  $K_{a2}$ , and the corresponding  $\text{p}K_a$  of the two acids,  $\text{HSO}_3^-$  and  $\text{H}_2\text{SO}_3$ , given



(4)

- (ii) Which is the weaker acid? (1)
- (iii) Which one of the following would be predominant in a solution of  $\text{pH} = 0$  and which one in a solution of  $\text{pH} = 14$ :  $\text{SO}_3^{2-}$ ,  $\text{HSO}_3^-$ ,  $\text{H}_2\text{SO}_3$ ? (2)
- (iv) The  $\text{pH}$  values of both these solutions change slowly when the solutions are left exposed to the air. Suggest a reason in each case. (2)
- (b) Calculate the  $\text{pH}$  of (i)  $M$ , (ii)  $M/1000$ , solutions of phenol, given that  $\text{p}K_a = 10$  for phenol. The observed  $\text{pH}$  differs slightly from the calculated value. Suggest a reason for this, stating which of the two solutions is likely to be most affected. (5)
- (c) (i) What is meant by a buffer solution? (1)
- (ii) Explain how a solution containing ethanoic acid and its sodium salt can act as a buffer by considering the addition of (a)  $\text{HCl}$  and (b)  $\text{NaOH}$  to the buffer solution. (4)
- (iii) State one use of buffers. (1)

7. (a) Outline how aqueous solutions of (i)  $\text{FeCl}_2$  and (ii)  $\text{FeCl}_3$  could be made in the laboratory, starting from the metal in each case. (4)
- (b) Iron, in the form of  $\text{Fe}^{3+}(\text{aq})$ , is needed in trace amounts for the growth of plants. Suggest chemical explanations for the following.
- (i) Making the soil too alkaline by the addition of too much lime converts the iron into a form which is not available to plants. (2)
- (ii) Chelating agents, such as EDTA, convert the iron back into a form that the plants can use. (1)
- (c) 2.29 g of a zinc ammine of formula  $\text{Zn}(\text{NH}_3)_x(\text{SO}_4)_y$  were dissolved in water and made up to 100 ml.
- 10 ml portions were titrated with  $M/10$   $\text{HCl}$ , requiring 40 ml of acid to reach the end point.
- 50 ml of the same solution were treated with excess barium chloride solution, giving 1.165 g of precipitate.
- (i) Calculate the number of moles of ammonia in the sample. (2)
- (ii) Calculate the number of moles of sulphate ions in the sample. (2)
- (iii) Calculate the number of moles of zinc ions in the sample. (4)
- (iv) Write the empirical formula for the complex. (2)
- (d) Why is it that most zinc compounds have NO
- (i) colour (charge-transfer considerations NOT required);
- (ii) paramagnetic properties? (3)

Marks

8. Suggest chemical explanations for the following.

- (a) Xenon is more reactive than neon. (2)
- (b) The addition of sodium hydroxide solution to crude bauxite separates the aluminium oxide from the iron(III) oxide impurity. (3)
- (c) Diethyl ether (ethoxyethane,  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ ) and butan-1-ol are isomers, yet one boils at  $117^\circ\text{C}$  and the other at  $35^\circ\text{C}$ . (3)
- (d) Sodium carbonate does *not* form a neutral solution when dissolved in water. (An equation is required.) (4)
- (e) The colours in ink can be separated by chromatography. (An explanation in free energy terms is required.) (3)
- (f) The shape of the  $\text{BF}_4^-$  ion. (3)
- (g) The different enthalpies of neutralisation of the following:

Acid	Alkali	$\Delta\text{H}$ ( $\text{kJ mol}^{-1}$ )
HCl	KOH	-57.2
HCN	KOH	-11.7

(2)

[END OF QUESTION PAPER]