

[0519/471]

1991

CERTIFICATE OF SIXTH YEAR STUDIES

# CHEMISTRY

PAPER

Friday, 17th May—9.30 a.m. to 12.00 noon

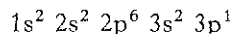


Dalziel High School  
Chemistry Department



# 1991 CSYS

1. An atom has the electron configuration



What is the charge of the most probable ion formed from this atom?

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

2. Which one of the following compounds is ionic in the pure state?

- A Hydrogen chloride
- B Calcium hydride
- C Silicon tetrafluoride
- D Boron oxide

3.  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

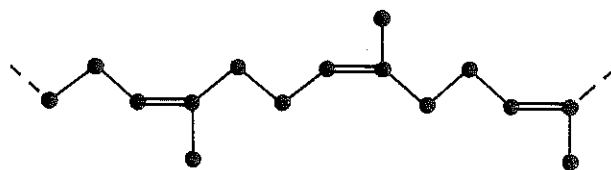
$$\Delta H^\circ = 178 \text{ kJ mol}^{-1}$$

$$\Delta S^\circ = 161 \text{ J K}^{-1} \text{ mol}^{-1}$$

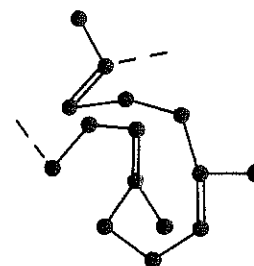
$\Delta G^\circ$  for this reaction is negative

- A at any temperature
- B only below 1100 K
- C only above 1100 K
- D at a high temperature, impossible to calculate.

4.



(a)



(b)

The diagrams represent the arrangement of the carbon atoms in (a) stretched rubber, and in (b) unstretched rubber.

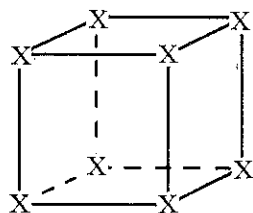
The stretching of rubber is an exothermic process. The opposite process is thermodynamically feasible and it involves

- A a decrease in entropy and an increase in enthalpy
- B an increase in entropy and a decrease in enthalpy
- C a decrease in entropy and a decrease in enthalpy
- D an increase in entropy and an increase in enthalpy.

5. The order of a reaction

- A will depend on the stoichiometry of the overall reaction
- B is the sequence of steps in the mechanism
- C can only be obtained by experiment
- D controls the speed of the overall reaction.

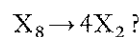
6. The element X can exist in two forms, as  $X \equiv X$ , or as  $X_8$  with the following cubic structure.



The  $X-X$  bond dissociation enthalpy is  $163 \text{ kJ mol}^{-1}$ .

The  $X \equiv X$  bond dissociation enthalpy is  $944 \text{ kJ mol}^{-1}$ .

Which of the following is the value of  $\Delta H$  for the reaction



- A  $-1820 \text{ kJ mol}^{-1}$   
 B  $+1820 \text{ kJ mol}^{-1}$   
 C  $-2472 \text{ kJ mol}^{-1}$   
 D  $+2472 \text{ kJ mol}^{-1}$
7. For the equilibrium  
 $4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g}) + 2\text{Cl}_2(\text{g})$   
 the forward reaction is exothermic.  
 Which of the following will increase the equilibrium concentration of chlorine?  
 A Heating the reaction vessel  
 B Decreasing the total pressure  
 C Adding more oxygen  
 D Adding a suitable catalyst
8.  $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + 14\text{H}^+(\text{aq}) + 6\text{e}^- \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 7\text{H}_2\text{O}(\ell)$   
 $\text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{e}^-$   
 $25 \text{ cm}^3$   $0.1 \text{ M}$   $\text{K}_2\text{Cr}_2\text{O}_7$  were required to react completely with an acidified solution of  $\text{Fe}^{2+}$ .  
 How many moles of  $\text{Fe}^{2+}$  did the original solution contain?  
 A  $0.0025$   
 B  $0.025$   
 C  $0.015$   
 D  $0.150$

9. When a  ${}^{235}_{92}\text{U}$  atom loses an alpha particle followed by a beta particle, it becomes

- A  ${}^{231}_{91}\text{Pa}$   
 B  ${}^{229}_{89}\text{Ac}$   
 C  ${}^{233}_{91}\text{Pa}$   
 D  ${}^{231}_{89}\text{Ac}$

10. Which of the following changes is likely to be endothermic?

- A  $\text{K}(\text{g}) \rightarrow \text{K}^+(\text{g}) + \text{e}^-$   
 B  $\text{Ni}^{2+}(\text{g}) + 6\text{H}_2\text{O}(\ell) \rightarrow \text{Ni}(\text{H}_2\text{O})_6^{2+}(\text{aq})$   
 C  $\text{Ni}^{2+}(\text{g}) + 2\text{Cl}^-(\text{g}) \rightarrow \text{NiCl}_2(\text{s})$   
 D  $\text{C}(\text{g}) + 4\text{H}(\text{g}) \rightarrow \text{CH}_4(\text{g})$

11. In the equilibrium  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ , the forward reaction is endothermic.

Which one of the following causes an increase in the value of the equilibrium constant?

- A An increase of pressure  
 B The removal of  $\text{NO}_2$   
 C An increase of temperature  
 D A decrease of temperature

12. The bond dissociation enthalpy of  $\text{H}-\text{Cl}$  is  $431 \text{ kJ mol}^{-1}$ .

In which of the following processes is  $431 \text{ kJ}$  released?

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

13. Which of the following will produce the most acidic solution in water?

- A Aluminium sulphate  
 B Sodium hydrogencarbonate  
 C Ammonium carbonate  
 D Potassium chloride

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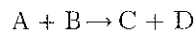
14. Which one of the following electron configurations does **not** represent that of a neutral atom in its lowest energy state?

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

15. Which one of the following reactions has a standard enthalpy change equal to the standard enthalpy of formation of strontium chloride?

- A  $\text{Sr}(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow \text{SrCl}_2(\text{s})$
- B  $\text{Sr}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{SrCl}_2(\text{s})$
- C  $\text{Sr}^{2+}(\text{g}) + 2\text{Cl}^-(\text{g}) \rightarrow \text{SrCl}_2(\text{s})$
- D  $\text{Sr}^{2+}(\text{aq}) + 2\text{Cl}^-(\text{aq}) \rightarrow \text{SrCl}_2(\text{s})$

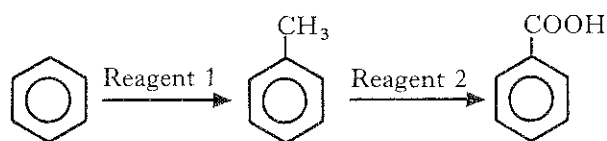
16. The following reaction is first order with respect to each of the reactants.



Which of the following is correct?

- A The rate of the reaction is independent of the concentration of either A or of B.
  - B The overall reaction is first order.
  - C If the initial concentrations of A and B are both doubled, the rate of the reaction will be doubled.
  - D As the reaction proceeds, its rate will decrease.
17. What volume of 0.25 M calcium nitrate solution is required to make, by dilution with water, 500 cm<sup>3</sup> of a solution with a nitrate ion concentration of 0.1 M?
- A 50 cm<sup>3</sup>
  - B 100 cm<sup>3</sup>
  - C 200 cm<sup>3</sup>
  - D 250 cm<sup>3</sup>

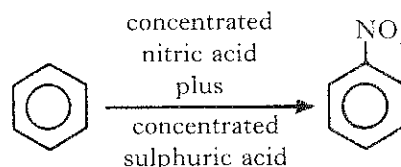
18.



Which are the reagents above?

- | <i>Reagent 1</i>                         | <i>Reagent 2</i>  |
|--|---|
| A $\text{CH}_4 + \text{AlCl}_3$          | $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}^+(\text{aq})$ |
| B $\text{CH}_3\text{Cl} + \text{AlCl}_3$ | $\text{KMnO}_4 + \text{H}^+(\text{aq})$                   |
| C $\text{CH}_4 + \text{AlCl}_3$          | $\text{O}_2 + \text{H}_2\text{O}$                         |
| D $\text{CH}_3\text{Br} + \text{AlCl}_3$ | $\text{H}_2\text{O}$                                      |

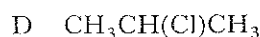
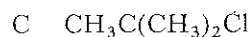
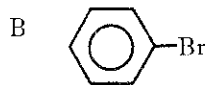
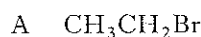
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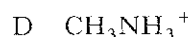
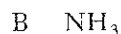
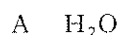
Which species initially attacks the benzene molecule in the above reaction?

- A  $\text{NO}_3^-$
  - B  $\text{NO}_2^+$
  - C  $\text{HSO}_4^-$
  - D  $\text{NO}_2$
20. A carbonyl compound, X, produced the compound  $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$  on reduction. Which of the following was X?
- A Butanal
  - B Butan-2-one
  - C 2-methylpropanal
  - D 3-methylbutanone

21. Which halide will be most resistant to attack by nucleophilic reagents?



22. Which of the following will **not** act as a ligand in the formation of complexes with transition metal ions?



23. Which of the following statements is true?

A The oxidation state of manganese in the  $\text{MnO}_4^{2-}$  ion is higher than in the  $\text{MnO}_4^-$  ion.

B The oxidation state of chromium in the  $\text{Cr}_2\text{O}_7^{2-}$  ion is the same as in the  $\text{CrO}_4^{2-}$  ion.

C The oxidation state of iron in the  $\text{Fe}(\text{CN})_6^{3-}$  ion is lower than in the  $\text{Fe}(\text{CN})_6^{4-}$  ion.

D The oxidation state of nickel in the  $\text{Ni}(\text{NH}_3)_6^{2+}$  ion is higher than in the  $\text{Ni}(\text{H}_2\text{O})_6^{2+}$  ion.

24. What is the likely structure of an antimony (V) chloride molecule?

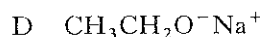
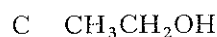
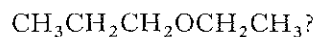
A Linear

B Tetrahedral

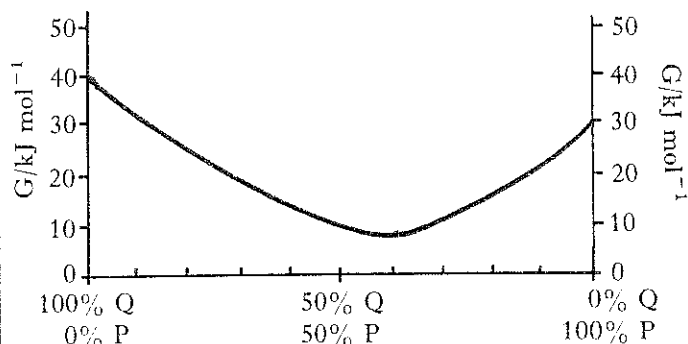
C Trigonal bipyramidal

D Octahedral

25. Which of the following is most suitable for converting  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$  into



Questions 26 and 27 refer to the diagram below.



26. Assuming that P and Q are in their standard states when 100% of either is present, what is the value of  $\Delta G^\circ$ , in  $\text{kJ mol}^{-1}$ , for the reaction represented by the stoichiometric equation



A +10

B -10

C -20

D -30

27. The equilibrium constant for the reaction in question 26 above is

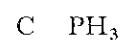
A 0.67

B 0.75

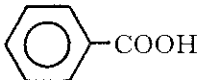
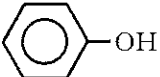
C 1.33

D 1.50.

28. A Lewis base may be regarded as a substance which is capable of donating an unshared pair of electrons to form a covalent bond. Which of the following could act as a Lewis base?



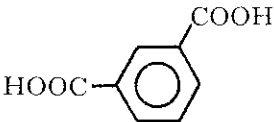

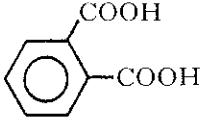
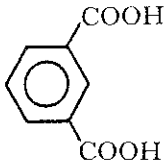
29. Which of the following acids is the strongest?

- A  $\text{CH}_3\text{COOH}$   
B   
C  $\text{ClCH}_2\text{COOH}$   
D 

30. Which of the following has completely planar (flat) molecules?

- A Naphthalene  
B Methylbenzene (toluene)  
C Cyclohexane  
D Hexane

31. Which of the following, with ethan-1,2-diol, is most suitable for the manufacture of polyester fibre?

- A   
B   
C   
D 

32. Which of the following can be used to distinguish directly between  $\text{C}_2\text{H}_5\text{CHO}$  and  $\text{CH}_3\text{COCH}_3$ ?

- A Bromine  
B 2,4-dinitrophenylhydrazine  
C Ammoniacal silver(I) nitrate  
D Sodium hydrogensulphite

33. Which of the following is true about zinc?

- A Its atoms have completely filled 3d orbitals.  
B It exhibits more than one oxidation state.  
C It has many coloured compounds.  
D It displaces Al from solutions containing  $\text{Al}^{3+}$ .

34. The purple colour of an aqueous solution of potassium permanganate is due to

- A emission of energy when electrons are transferred from the oxygen to the manganese atom  
B absorption of the red and blue components of white light  
C emission of energy and the promotion of d electrons in the permanganate ion  
D absorption of energy when electrons are transferred from the oxygen to the manganese atom.

35. A catalyst is normally added to a reaction mixture to

- A give a better yield at equilibrium  
B provide an alternative reaction mechanism  
C slow down an unwanted side-reaction  
D reduce the enthalpy change for the reaction.

36. *Indicator    Colour in acid    Colour in alkali*

- A            Violet            Red  
B            Yellow            Blue  
C            Yellow            Red  
D            Red                Yellow

Which indicator transmits only the lower frequencies of the visible spectrum at low pH?

37. Which of the following is true for the metal titanium?

- A It is extracted from its ore by reducing it with carbon.
- B It is manufactured by the electrolysis of molten ore.
- C It is extracted directly from its ore by reducing it with magnesium.
- D The ore is treated first with chlorine to produce a chloride.

To answer Questions 38 to 40 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.

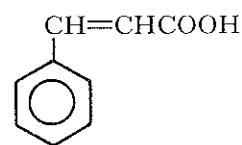
If only 3 is correct, select C.

Otherwise select D.

38. Following the progress of the neutralisation of  $25 \text{ cm}^3$   $1.0 \text{ M}$  hydrochloric acid by an alkaline solution (by continuously recording the pH of the resultant solution) can give information which would help to

- 1 choose a suitable indicator
- 2 estimate the strength of the alkali
- 3 calculate the molarity of the alkaline solution.

39.

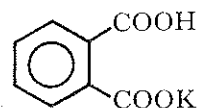


The above compound should react with

- 1 methanol
- 2 acidified potassium permanganate solution
- 3 Fehling's or Benedict's reagent.

40. A buffer solution can be made from

- 1 propanoic acid and sodium propanoate
- 2 potassium hydrogen phthalate



- 3 sulphuric acid and sodium sulphate.

[END OF QUESTION PAPER]

1. Examine the data in this table.

COMPOUND	RELATIVE MOLECULAR MASS	BOILING POINT/K
propane	44	231
pentane	72	309
heptane	100	371
hexan-1-ol	102	430
propoxypropane	102	364

- (a) Explain the trend in the boiling points of the first three compounds. 2
- (b) Explain why hexan-1-ol has a much higher boiling point than heptane and propoxypropane. 2
- (c) Either propoxypropane or hexan-1-ol could be used to extract organic compounds from plant material.

After extraction, the solvent must be removed. Suggest an advantage propoxypropane has over hexan-1-ol.

1  
(5)



## 2. Answer EITHER A OR B.

- A. Crystals of hydrated sodium carbonate left exposed to the atmosphere gradually lose some of their water of crystallisation. The formula of the crystals may be given by  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ , where  $x$  has a numerical value between 0 and 10.

16.0 g of the crystals were dissolved in water and made up to 250 cm<sup>3</sup> of solution in a standard flask. To determine the value of  $x$  in the formula, 25 cm<sup>3</sup> of the sodium carbonate solution were titrated with 1.0 M hydrochloric acid. 15.0 cm<sup>3</sup> of the acid were required for neutralisation.

- (a) Calculate

(i) the mass of sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) in 16.0 g of the crystals. 4

(ii) the value of  $x$  in the formula  $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$ . 2

- (b) When 7.5 cm<sup>3</sup> of 1.0 M hydrochloric acid are added slowly to 25.0 cm<sup>3</sup> of the sodium carbonate solution, the hydrogen carbonate ion ( $\text{HCO}_3^-$ ) is formed. This ion can act as a buffer.

Using suitable equations, show how the  $\text{HCO}_3^-$  ion can act in this way. 2

**(8)**

## OR

- B. In an experiment to find the percentage of iron in an iron ore, 2.650 g of the ore were dissolved in hydrochloric acid. A powerful oxidising agent was then added and the solution diluted to 250 cm<sup>3</sup> in a standard flask. 25.0 cm<sup>3</sup> of this solution were then transferred to a conical flask and when a few drops of ammonium thiocyanate solution were added, a red colour appeared. The solution was titrated with 0.10 M titanium(III) sulphate solution until the red colour just disappeared.

The titration results were as follows.

	TITRE/cm <sup>3</sup>
1	24
2	22.65
3	22.60
4	22.65

Note: Titanium(III) is a powerful reducing agent itself being oxidised to titanium (IV).

- (a) In what oxidation state is the iron when the thiocyanate complex is red? 1
- (b) Write the two ion-electron half equations for the reactions which occur during the titration. 2
- (c) (i) What volume of titanium(III) sulphate solution should be used for any calculation? Explain your answer. 2
- (ii) Calculate the percentage of iron in the ore. 3

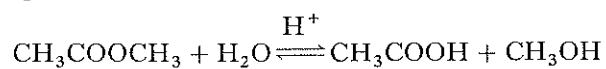
**(8)**

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3. An aqueous solution of methyl ethanoate has a concentration of  $0.300 \text{ mol l}^{-1}$ . The ester solution was hydrolysed using an acid catalyst and the reaction rate determined at different times. The results of the experiment are shown in the table.

TIME/s	ESTER CONCENTRATION $[\text{mol l}^{-1}]$	REACTION RATE $\times 10^5 [\text{mol l}^{-1} \text{s}^{-1}]$
560	0.262	6.25
1300	0.210	5.04
3000	0.147	3.50
4650	0.100	2.40
6600	0.058	1.65

- (a) (i) Use the results to plot a graph which can be used to deduce the order of the reaction with respect to the methyl ethanoate. 2
- (ii) State the order of the reaction with respect to methyl ethanoate. 1
- (iii) From the graph, determine the rate constant for the reaction. 3
- (b) The stoichiometric equation for the reaction is

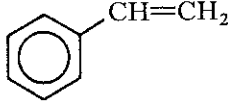



Describe a practical technique which could be used to follow the progress of the reaction. 3

(9)

4. The formulae of certain substances are shown below. All the questions relate to these substances. The answer to each question will be a letter (or group of letters) corresponding to the box(es) in the grid. A box may be used more than once in different answers.

Correct boxes, and no more, are required to obtain each mark.

<p>A</p> $\begin{array}{c} \text{H} & \text{H} & \text{H} \\   &   &   \\ \text{H}-\text{C} & -\text{C} & -\text{C}-\text{H} \\   &   &   \\ \text{OH} & \text{OH} & \text{OH} \end{array}$	<p>B</p> $\text{CCl}_2\text{F}_2$	<p>C</p> $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$
<p>D</p> $\text{CH}_3\text{OH}$	<p>E</p> $\begin{array}{c} \text{H} & \text{H} \\   &   \\ \text{H}-\text{C} & -\text{C}-\text{H} \\   &   \\ \text{OH} & \text{OH} \end{array}$	<p>F</p> 
<p>G</p> $\text{Cl}-\overset{\text{O}}{\parallel}{\text{C}}(\text{CH}_2)_4\overset{\text{O}}{\parallel}{\text{C}}-\text{Cl}$	<p>H</p> 	<p>I</p> $\text{CH}_3\text{CH}=\text{CH}_2$

Which box(es) contain(s) a compound

- used to make explosives;
- used in engine cooling systems as an antifreeze;
- used to make polyamides;
- used to make antiseptics;
- used to make addition polymers;
- which causes blindness if drunk and is found in methylated spirits;
- used in some aerosols and as a coolant in refrigerators?

(7)

[Turn over

## 5. Answer EITHER A OR B.

- A. The ionic product for water ( $K_w$ ) is usually taken to be  $10^{-14} \text{ mol}^2\text{l}^{-2}$ , but it varies with temperature. The following table shows this variation.

TEMPERATURE/K	$K_w/\text{mol}^2\text{l}^{-2}$
273	$0.114 \times 10^{-14}$
283	$0.293 \times 10^{-14}$
298	$1.008 \times 10^{-14}$
323	$5.476 \times 10^{-14}$
373	$51.3 \times 10^{-14}$

- (a) What is meant by the term "ionic product of water"? 1
- (b) Since  $K_w$  varies with temperature, the pH of pure water is not always 7.  
Calculate the pH of pure water at 373K. 3
- (c) The ionisation of water is endothermic. Explain how the information in the table supports this statement. 1

(5)

## OR

- B. Phosphoric(V) acid,  $\text{H}_3\text{PO}_4$ , is triprotic. When neutralised by sodium hydroxide solution, it can form three different salts.

- (a) Give the formulae for two of the sodium salts of the acid. 2
- (b) The first stage in the ionisation of phosphoric(V) acid has a dissociation constant of  $7.08 \times 10^{-3} \text{ mol l}^{-1}$ .  
Calculate the approximate pH of a 0.1 M solution of phosphoric(V) acid.  
(You may assume that the other two stages in the ionisation do not significantly affect the hydrogen ion concentration.) 3

(5)

6. The following equation can be used to calculate the half-cell potential of a silver half-cell at different concentrations of  $\text{Ag}^+(\text{aq})$  ions at 298K.

$$E = E^\circ + 0.0592 \log_{10}[\text{Ag}^+(\text{aq})]$$

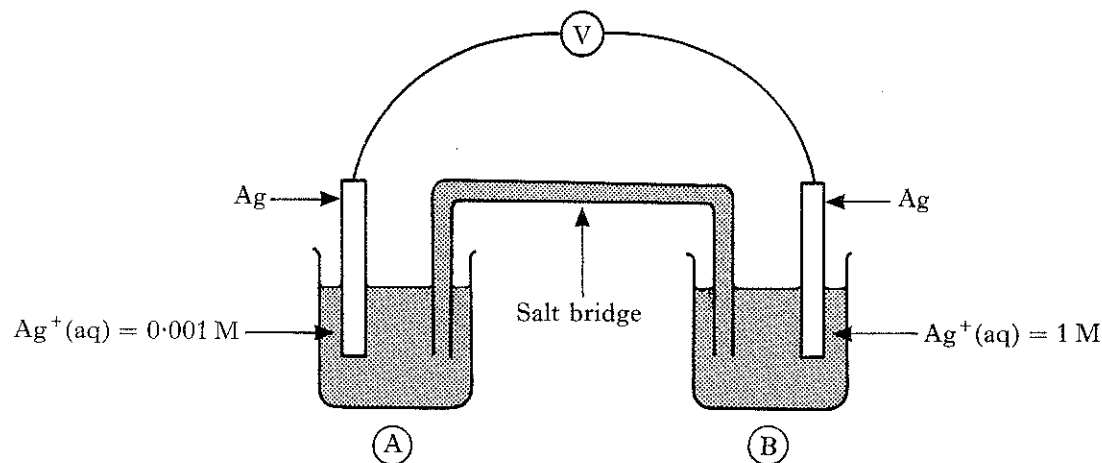
For example, with 0.001 M  $\text{Ag}^+(\text{aq})$  ions and  $E^\circ = 0.80 \text{ V}$

$$E = 0.80 + 0.0592(-3) = 0.62 \text{ V}$$

- (a) Explain why  $E = E^\circ$  when the concentration of metal ions is 1.0 M.

1

- (b) This is a diagram of a concentration cell.



- (i) Calculate the e.m.f. of the cell.

1

- (ii) Which way will the electrons flow through the wires?

Explain your answer.

2

- (iii) Calculate  $\Delta G$  for the reaction in this cell.

2

- (iv) Given that  $\Delta H$  for the overall cell reaction is zero, calculate the value of  $\Delta S$  at 298K.

3

(9)

7. Using specific examples, draw diagrams of

- (a) a tetrahedral molecule;  
 (b) a tetrahedral positive ion;  
 (c) a linear three-atom molecule;  
 (d) a non-linear three-atom molecule.

(Ensure that your diagrams display the shapes of the species.)

(4)

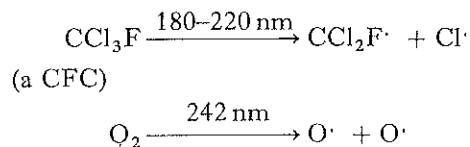
[Turn over

8. Spectrographic analysis of the purple complex ion formed in the reaction between a solution of nickel(II) sulphate and the ligand 1,2-diaminohexane shows that maximum absorption is obtained when one mole of nickel salt reacts with three moles of the ligand.

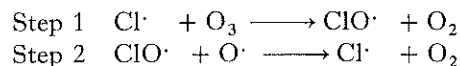
- (a) (i) What is a ligand? 1  
 (ii) Why can 1,2-diaminohexane act as a ligand? 1  
 (b) What overall shape would the complex ion have? 1  
(3)

9. The loss of ozone,  $O_3$ , from the upper atmosphere by reaction with CFCs is a result of a complex series of chemical reactions.

Initially, free radicals are produced by the following photolytic reactions:



The following steps represent the chain reaction which can now occur.

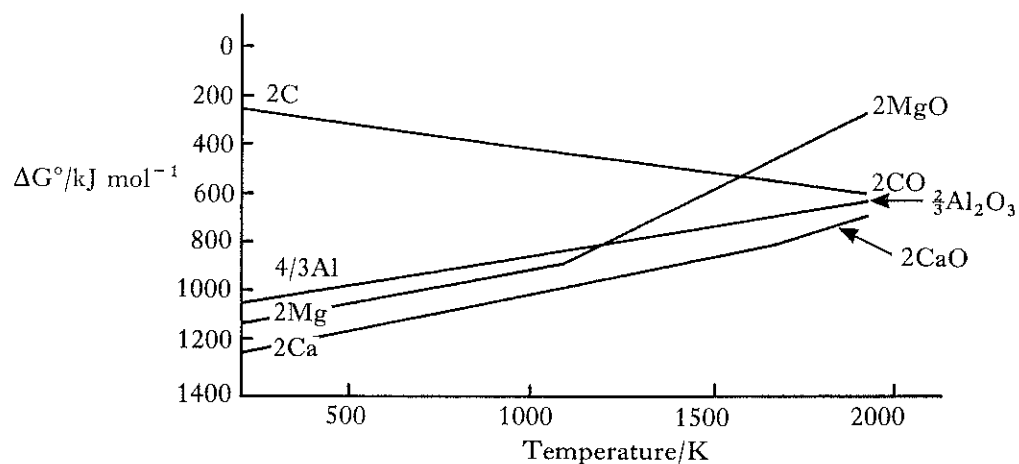


- (a) In which region of the electromagnetic spectrum does the wavelength range 180–220 nm occur? 1  
 (b) What other name can be used to describe the photolytic reaction shown here?  

$$\text{O}_2 \longrightarrow \text{O}\cdot + \text{O}\cdot$$
 1  
 (c) Why can Steps 1 and 2 be considered to represent a chain reaction? 2  
 (d) Combine Steps 1 and 2 to produce an equation which shows how the ozone layer is depleted. 1  
(5)

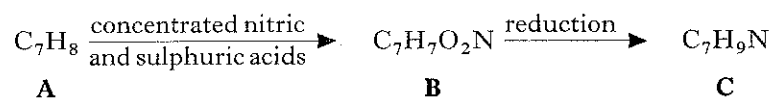
10. Aluminium is extracted from bauxite ore. In the ore, aluminium oxide is mixed with iron oxide and other impurities.

- (a) Which property of aluminium oxide enables it to be separated from the iron oxide? 1
- (b) State briefly how aluminium is obtained from the purified aluminium oxide. 1
- (c) Discuss your answer to (b) with reference to the following diagram.



3  
(5)

11. Examine this organic reaction sequence.



- (a) Give possible structural formulae for **B** and **C**. 2
- (b) What type of reaction is involved in the conversion of **A** to **B**? 1
- (3)

[Turn over

## 12. Answer EITHER A OR B.

A. Two liquids, A and B, have the molecular formula  $C_3H_8O$ . As well as other bands, the infra-red spectrum of liquid A has a broad absorption band at  $3300-3500\text{ cm}^{-1}$ . This band is absent from the spectrum of B.

(a) State which group is responsible for the broad absorption band at  $3300-3500\text{ cm}^{-1}$  in the spectrum of A. 1

(b) Draw possible full structural formulae for both A and B. 2

(c) Would the two liquids be expected to have the same value for their enthalpies of combustion?

State your reasoning. 2

**(5)**

OR

B. (a) The mass spectrum of butane shows peaks at  $\frac{\text{mass}}{\text{charge}}$  ratios of 58, 43 and 29.

Which species may give rise to these peaks? 3

(b) The mass spectrum of methylpropane also shows peaks at  $\frac{\text{mass}}{\text{charge}}$  ratios of 58 and 43.

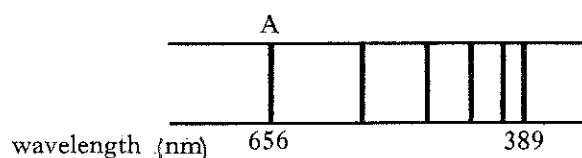
Would you also expect a peak at  $\frac{\text{mass}}{\text{charge}}$  ratio of 29?

Explain your answer. 2

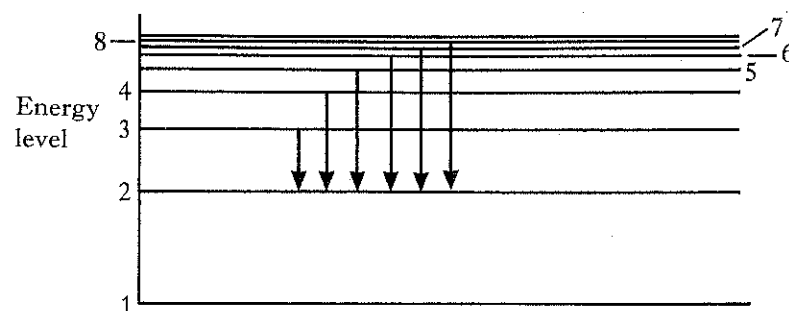
**(5)**



13. This is a simplified diagram of the Balmer Series in the emission spectrum of atomic hydrogen.



Spectral lines arise as a result of electronic transitions in atoms. The Balmer Series is produced by the transitions shown in the following diagram.



- (a) What transition corresponds to line A in the spectrum?  
Explain your answer. 2
- (b) Calculate the energy difference in  $\text{kJ mol}^{-1}$  which gives rise to line A, with wavelength 656 nm. 3
- (5)
14. Answer **A OR B OR C**.
- A.** When performing acid-alkali titrations, the choice and amount of indicator used are important in obtaining an accurate result.  
Discuss this statement. (4)
- OR**
- B.** The functional groups amino, hydroxyl and carboxyl are found in both aliphatic and aromatic compounds.  
Discuss, with possible reasons, differences in acidic and basic properties between aliphatic and aromatic compounds containing these functional groups. (4)
- OR**
- C.** Discuss the origin of colour in transition metal compounds. (4)

[END OF QUESTION PAPER]