

1975

Chemistry

S.Y. I

CERTIFICATE OF SIXTH YEAR STUDIES

CHEMISTRY

Paper

Thursday, 8th May—9.30 a.m. to 12.30 p.m.



Dalziel High School
Chemistry Department

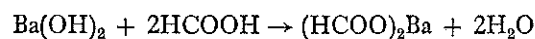


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[216]

1. One mole of calcium chloride contains
- A three moles of atoms
 - B one mole of molecules
 - C the Avogadro Number of positive ions
 - D the Avogadro Number of positive charges.
2. One mole of which of these substances on complete hydrogenation absorbs the largest volume of gas?
- A Benzene
 - B Cyclohexane
 - C Hex-1-ene
 - D Ethyne

3. From the equation



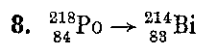
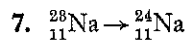
how many moles of barium hydroxide will react completely with 500 cm³ 4 M methanoic acid?

- A 1
 - B 2
 - C 4
 - D 8
4. If a mixture of 22.4 l methane and 22.4 l oxygen (measured at s.t.p.) is exploded in a closed container the reaction is
- $$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$$
- What would be the approximate volume of gas at s.t.p. at the end of the reaction?
- A 44.8 l
 - B 33.6 l
 - C 22.4 l
 - D 11.2 l
5. In an electrolysis of an aqueous solution of potassium sulphate 1 faraday of electricity was passed every 60 minutes. How long did it take to release 7.47 l hydrogen gas? (Volume measured at s.t.p.)
- A 10 minutes
 - B 20 minutes
 - C 40 minutes
 - D 1 hour 30 minutes
6. The initial radioactivity reading from a 2 g sample of actinium chloride is 120 counts per minute. If the half-life of actinium is 6 hours how long will it take a 1 g sample of the chloride to reach a reading of 15 counts per minute?
- A 12 hours
 - B 18 hours
 - C 24 hours
 - D 48 hours

Questions 7 and 8 refer to the following types of nuclear reaction:

- A β emission
- B α emission
- C α emission followed by β emission
- D neutron capture followed by γ emission

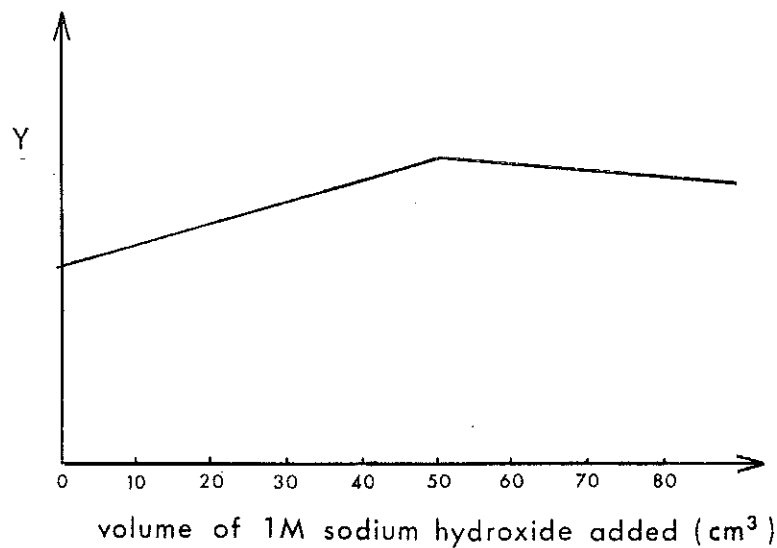
Which of the above are responsible for the following nuclear transformations?



9. Which would suffer the greatest deflection in a mass spectrometer?

- A ${}^3_1\text{H}^+$
- B ${}^4_2\text{He}^{2+}$
- C ${}^{14}_7\text{N}^{2+}$
- D ${}^{14}_6\text{C}^{4+}$

10. The graph below shows the change in measurement Y as alkali is added to 50 cm³ 1 M hydrochloric acid.



Which of the following does Y represent?

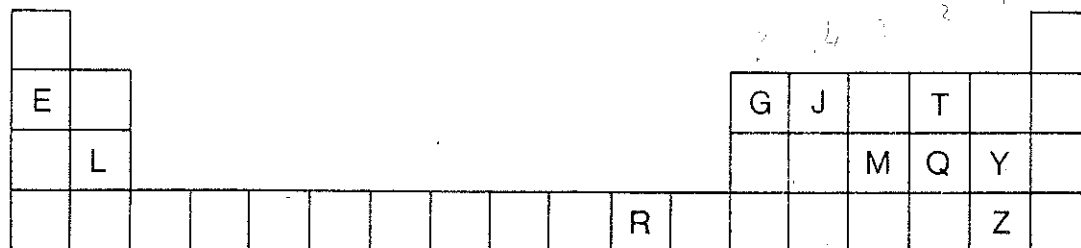
- A Temperature
- B Conductivity
- C Entropy
- D pH

[Turn over

11. Which will **NOT** give a redox reaction when mixed?

- A Silver and concentrated nitric acid
- B Copper and concentrated hydrochloric acid
- C Magnesium and lead(II) nitrate solution
- D Zinc and sulphuric acid

Questions 12 and 13 refer to the Periodic Table as shown in the diagram below. The letters are not the actual symbols for the elements.



12. Which element is most likely to form an oxy-anion of formula XO_4^- ?

- A G
- B J
- C M
- D Y

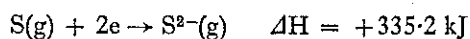
13. Which of the following pairs of elements would form a **COVALENT** compound in which the ratio of the atoms is 1:1?

- A EY
- B YZ
- C LQ
- D RT

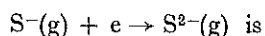
14. If for



and for



then the enthalpy change for the reaction



- A + 128.6 kJ
- B - 128.6 kJ
- C + 541.8 kJ
- D - 541.8 kJ.

15. Which of the following reactions is most likely to exhibit an overall decrease in entropy?

- A Combustion of an alkene
- B Dissolution of an electrovalent solid
- C Dilution of an acid
- D Polymerisation of an alkene

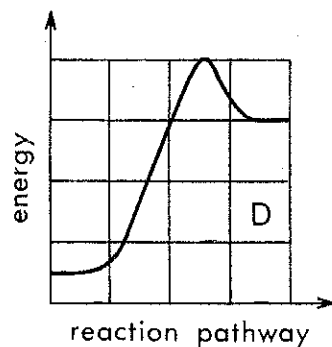
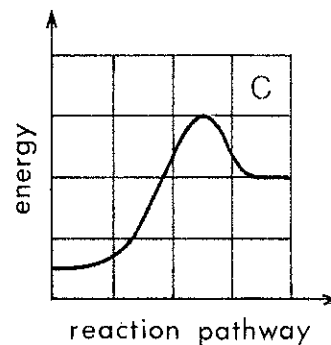
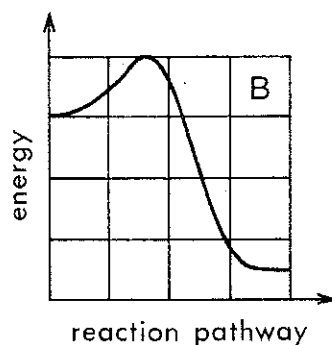
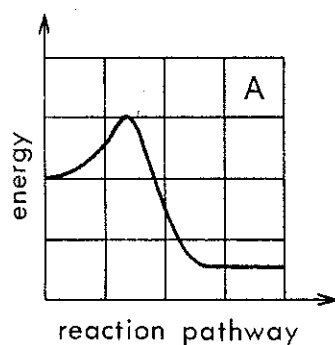
16. For a certain reaction

$$\Delta H = + 17.6 \text{ kJ and } \Delta S = + 0.077 \text{ kJ K}^{-1}$$

This reaction will

- A never be spontaneous
- B be spontaneous at all temperatures
- C be spontaneous below some definite temperature
- D be spontaneous above some definite temperature.

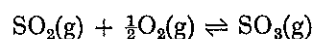
17.



Which of the above energy diagrams could represent a reaction with an activation energy of $+ 20 \text{ kJ mol}^{-1}$ and a heat of reaction of $- 50 \text{ kJ mol}^{-1}$?

[Turn over

18. Consider the equilibrium reaction

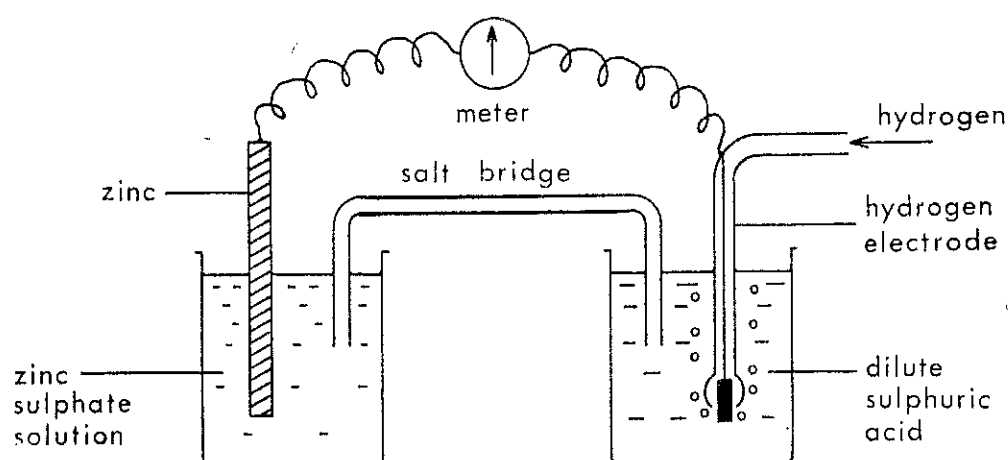


For the forward reaction $\Delta H = -97 \text{ kJ}$.

Which of the following changes would **NOT** increase the equilibrium yield of sulphur trioxide?

- A An increase of pressure
- B An increase in the concentration of sulphur dioxide
- C A decrease of temperature
- D The introduction of a catalyst

19.



In the circuit shown above which of the following is the main current carrying process taking place via the salt bridge?

- A Electrons flow from the hydrogen electrode to the zinc electrode.
- B Sulphate ions migrate from the hydrogen electrode to the zinc electrode.
- C Hydrogen ions migrate from the hydrogen electrode to the zinc electrode.
- D Electrons flow from the zinc to the hydrogen electrode.

20. The following data illustrate that the infra-red absorption frequency of the

$\begin{array}{c} \text{O} \\ || \\ -\text{C}- \end{array}$ group depends on the groups to which it is bonded.

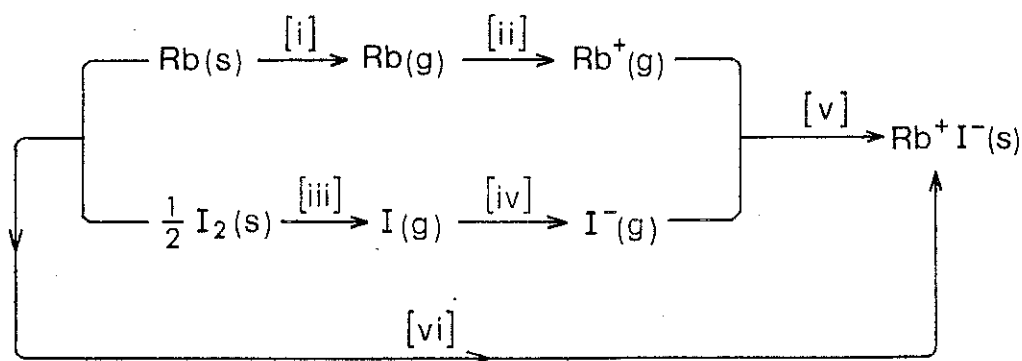
Groups	Absorption frequency (cm^{-1})
$\begin{array}{c} \text{O} \\ \\ -\text{CH}_2-\text{CH}_2-\text{C}-\text{CH}_2-\text{CH}_2- \end{array}$	1715
$\begin{array}{c} \text{O} \\ \\ -\text{CH}_2-\text{CH}_2-\text{C}-\text{H} \end{array}$	1725
$\begin{array}{c} \text{O} \\ \\ -\text{CH}_2-\text{CH}_2-\text{C}-\text{Cl} \end{array}$	1800
$\begin{array}{c} \text{O} \\ \\ -\text{CH}=\text{CH}-\text{C}-\text{H} \end{array}$	1685
$\begin{array}{c} \text{O} \\ \\ -\text{CH}_2-\text{CH}_2-\text{C}-\text{CH}=\text{CH}- \end{array}$	1675

Which of the following would you expect to be the absorption frequency of the

$\begin{array}{c} \text{O} \\ || \\ -\text{C}- \end{array}$ group in the compound $\text{CH}_2=\text{CH}-\begin{array}{c} \text{O} \\ || \\ \text{C}-\text{Cl} \end{array}$?

- A 1820 cm^{-1}
- B 1800 cm^{-1}
- C 1760 cm^{-1}
- D 1675 cm^{-1}

Questions 21 and 22 refer to the energy changes in the reaction sequence illustrated below.



21. In the cycle which of the following steps are both endothermic?

- A (i) and (iii)
- B (iv) and (v)
- C (i) and (v)
- D (iii) and (iv)

[Turn over

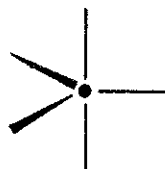
22. Which step or combination of steps represents the heat of formation of rubidium iodide?

- A (v)
- B (vi)
- C (ii) + (iv) + (v)
- D (i) + (ii) + (iii) + (iv)

23.



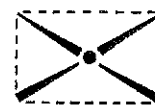
A



B



C



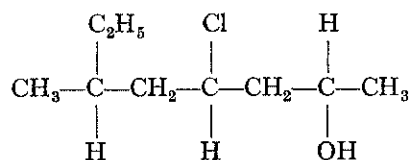
D

Which of the above diagrams represents the arrangement of bonds and lone pairs of electrons around sulphur in SF₄?

24. Which of the following is likely to favour the solution of a salt MX in water?

- A Small lattice energy of MX
- B High melting point of MX
- C Large ionisation energy of M
- D Small hydration energy of M⁺

25.



What is the systematic name of the above compound?

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

26. A white crystalline compound, soluble in water, was found to react with both dilute hydrochloric acid and sodium hydroxide solution.

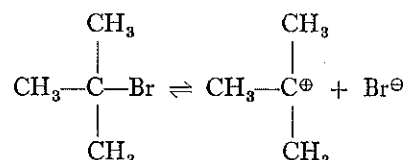
Which of the following might it have been?

- A Aniline
- B Aminoethanoic acid
- C Ethylamine
- D Ethylammonium chloride

27. Which of the following compounds could **NOT** be oxidised by acidified potassium dichromate solution?

- A $\text{CH}_3\text{—CH}_2\text{—C} \begin{array}{l} \text{O} \\ // \\ \text{OH} \end{array}$
- B $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{OH}$
- C $\text{CH}_3\text{—CH}_2\text{—C} \begin{array}{l} \text{O} \\ // \\ \text{H} \end{array}$
- D $\text{CH}_3\text{—CH}(\text{OH})\text{—CH}_3$

28. The rate determining step for the hydrolysis of 2-bromo-2-methylpropane is as follows:



Which of the following statements is false?

For this hydrolysis

- A increasing the concentration of the alkyl halide will increase the rate
- B increasing the concentration of hydroxide ions has no effect on the rate
- C increasing the concentration of bromide ions will decrease the rate
- D increasing the polarity of the solvents will decrease the rate.
29. Which one of the following is an electrophile?
- A F^-
- B NH_3
- C BF_3
- D H_2O
30. When bromine adds to propene, what is the first step in the reaction?
- A Homolytic fission of the Br—Br bond
- B Heterolytic fission of the Br—Br bond
- C Homolytic fission of the C=C bond
- D Heterolytic fission of the C=C bond
31. Which one of the following substances would react under suitable conditions with butyl magnesium bromide to give hexan-2-ol?
- A $\text{CH}_3\text{CH}_2\text{OH}$
- B CH_3CHO
- C CH_3COOH
- D CO_2

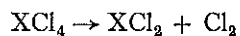
32. Which of the following changes in oxidation state will be associated with the **largest positive** ΔG value?

- A Sn(II) \rightarrow Sn(IV)
- B Sn(IV) \rightarrow Sn(II)
- C Pb(II) \rightarrow Pb(IV)
- D Pb(IV) \rightarrow Pb(II)

33. Which of the following would you expect to show the **least** ionic character?

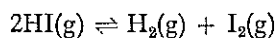
- A Lead(II) chloride
- B Lead(IV) chloride
- C Tin(II) chloride
- D Tin(IV) chloride

34. Which of the following is **most** likely to decompose thus?



- A CCl_4
- B $SiCl_4$
- C $SnCl_4$
- D $PbCl_4$

35. When one mole hydrogen iodide was heated to 800 °C, 50% of the compound dissociated as shown.



How many moles of gas were present in the equilibrium mixture?

- A 0.75
- B 1.0
- C 1.5
- D 2.0

36. Assuming complete dissociation an aqueous solution of sulphuric acid with $pH = 1$ has a molarity of

- A 0.05
- B 0.1
- C 0.5
- D 1.0.

37. Which of the following aqueous solutions has the lowest pH value?

- A 1 M CH_3COOH
- B 0.1 M CH_3COOH
- C 1 M $CH_2ClCOOH$
- D 0.1 M $CH_2ClCOOH$

38. In which of the following cases would the pH value of the mixture of equal volumes of X and Y be greater than that of Y alone?

	X	Y
A	0.1 M NH_4Cl	0.1 M NH_4OH
B	0.1 M CH_3COOH	0.1 M NaOH
C	0.1 M CH_3COONa	0.1 M CH_3COOH
D	0.1 M NH_4OH	0.1 M NaOH

39. For water

$$K_w = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$$

The magnitude of K_w is temperature dependent.

Which of the following is a correct deduction about the effect of temperature on water?

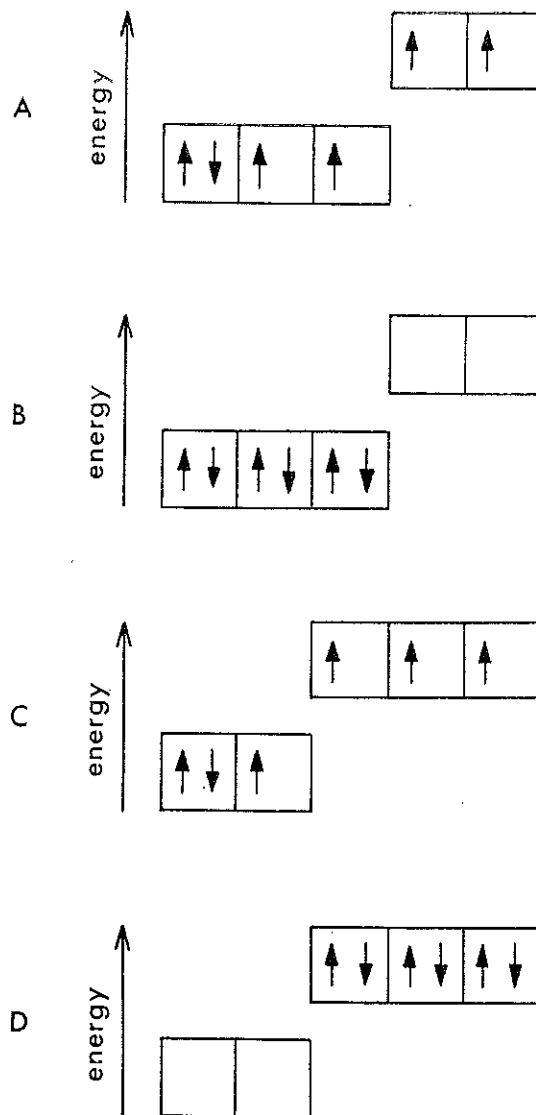
- A The concentrations of H^+ and OH^- remain equal, and the pH remains 7.
B The concentrations of H^+ and OH^- can be unequal, but the pH remains 7.
C The concentrations of H^+ and OH^- can be unequal, and the pH can differ.
D The concentrations of H^+ and OH^- remain equal, but the pH can differ.
40. Which of the following best explains why variable oxidation states are common for transition metals?
- A They are not very electropositive, and tend to form bonds with a high proportion of covalent character.
B There is usually more than one possible arrangement of the d-electrons among the five d-orbitals.
C There is a relatively small difference between successive ionisation energies for a given element.
D Transition element ions may be bonded to four or six ligands in complexes.
41. What is the oxidation state of vanadium in $[\text{VO}(\text{H}_2\text{O})_5]^{2+}$?
- A II
B III
C IV
D V
42. Which of the following ions does the electronic structure $1s^2 2s^2 2p^6 3s^2 3p^6$ represent?
- A Sc^{2+}
B Ti^{3+}
C V^{5+}
D Mn^{6+}

[Turn over

43. In which oxidation state will manganese show the highest degree of paramagnetism in the absence of any ligand field?

- A +2
- B +4
- C +6
- D +7

44. The cobalt(III) ion has six 3d electrons. Which diagram represents their arrangement in the presence of a strong octahedral ligand field?



45. Which of the following factors favours charge transfer from ligand to metal in a transition metal complex?

- A High reducing power of ligand
- B Low oxidation state of the metal
- C Large ionisation energy of ligand
- D Large radius of metal ion

46. Sodium nitrate is a colourless salt. Which of the following statements is true about sodium and nitrate ions?
- They do not absorb electromagnetic radiation.
 - They reflect all electromagnetic radiation.
 - They absorb outside the visible radiation.
 - Together they absorb all of the visible radiation.

To answer questions 47-50 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 some other response or combination of responses of those given is correct, select D.

47. The following compounds can exist in isomeric forms:

- $\text{CH}_3\text{CH}_2\text{CH}_3$
- CH_3CHCl_2
- $\text{CH}_3\text{CH}=\text{CH}_2$.

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

- x-ray crystallography
- visible spectrophotometry
- infra-red spectroscopy.

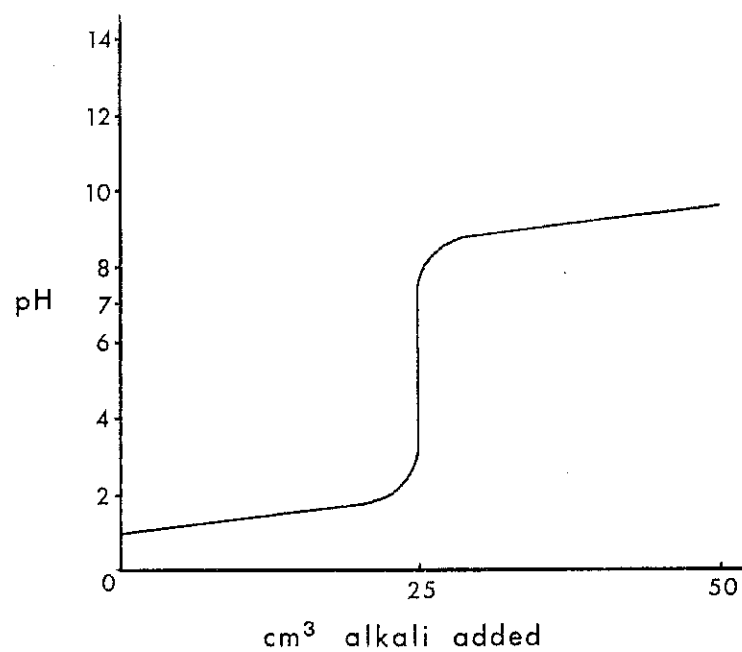
49. A solution of a sodium compound has a pH of 8.5. Addition of an aqueous solution of barium chloride to this solution gave a white precipitate which dissolved in dilute hydrochloric acid.

The compound could be

- sodium carbonate
- sodium sulphite
- sodium sulphate.

[Turn over

50.



The graph shows the change of pH as 50 cm³ 0.1 M alkali is added to 25 cm³ 0.1 M acid.

The following are statements about the neutralisation.

1. Methyl orange could be used to detect the end point.
2. Sodium hydroxide could be the alkali used.
3. Phenolphthalein would change from pink to colourless during the titration.

[END OF QUESTION PAPER]

1. (a) Describe qualitatively the enthalpy and entropy changes which occur
- as ice melts
 - as water boils
 - during the solution of sodium hydroxide pellets in water.

(7)

- (b) The following table shows the Heats of Solution, and the solubilities of sodium chloride, sodium bromide and sodium iodide.

	$\Delta H_{\text{solution}}$ kJ mol ⁻¹	Solubility (g per 100 cm ³ water)	
		at 0 °C	at 100 °C
sodium chloride	+ 5.36	35.7	39.1
sodium bromide	+ 0.90	79.5	121.0
sodium iodide	- 5.91	158.7	256.8

- Offer an explanation for the trend in the values for $\Delta H_{\text{solution}}$. (4)
 - Comment on whether the changes in solubility with temperature are as you would have predicted from the Heats of Solution. Give an explanation for your answer. (4)
- (c) The entropy change and free energy change during the formation of water from "normal" hydrogen (mass number 1.01) are -164 J mol^{-1} and -237 kJ mol^{-1} respectively. The corresponding changes for the formation of "heavy" water from deuterium (mass number 2.01) are -171 J mol^{-1} and -295 kJ mol^{-1} respectively (all values at 25 °C).
- Calculate the enthalpy change which occurs during the formation of "normal" water. (2)
 - Calculate the enthalpy change which occurs during the formation of "heavy" water. (2)
 - Offer an explanation for the difference in these values. (1)

Marks

6.97
x 6

41.82

4.2 x 10⁴
= 6.20

2.8
+ 1.5

4.3

2.856 x 10⁻⁹
= 2.856 x 10⁻⁷

x 0.5

2. (a) The emission spectra of the elements lithium, sodium and potassium are found to be similar in pattern. In each case the spectral lines come closer with decreasing wavelength and finally converge at the values below:

lithium 229.9 nm; sodium 241.2 nm; potassium 285.6 nm

- (i) Explain the formation of a line in the spectrum of lithium. (3)
- (ii) Why do the spectral lines come closer together? (2)
- (iii) Calculate the energy associated with the line 285.6 nm in the spectrum of potassium. (3)
- (iv) What is the significance of the convergence limit for potassium? (The information on page 36 of the Data Book may assist you.) (1)
- (v) Why do the three spectra have different convergence limits? (1)
- (vi) Why are the three spectra similar to each other? (1)

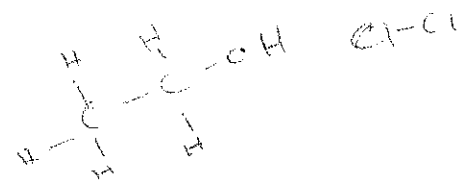
(b) When chlorine, an oxidising agent, dissolves in a nucleophilic polar solvent such as ethanol, the solution has a much more intense colour than when a non-polar solvent is used.

- (i) Suggest what is likely to be the interaction between the chlorine and a polar solvent. (2)
- (ii) Suggest why such an interaction would account for the colour of the solution. (2)

(c) (i) What information can be obtained from the X-ray diffraction pattern of an ionic crystal? (2)

(ii) Why could X-ray diffraction be used to distinguish a mixture of potassium chloride and sodium bromide from one of sodium chloride and potassium bromide? (2)

(iii) How could the measurements in (ii) give the proportions of the two solids in the mixture? (1)

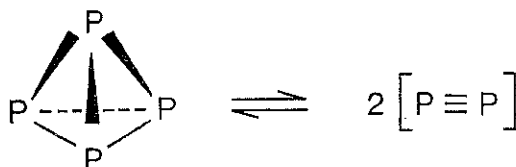
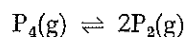


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$$E = \frac{hc}{\lambda}$$

$$= \frac{6.625 \times 10^{-34} \times 3 \times 10^8 \times 6.23 \times 10^{23}}{285.6 \times 10^{-9}}$$

3. (a) At 800 °C the following transition occurs in phosphorus.



The bond energies of P—P and P≡P are respectively 209 kJ mol⁻¹ and 523 kJ mol⁻¹.

- (i) Calculate the enthalpy change for the reaction



- (ii) Suggest why the P≡P bond energy is **not** three times the P—P bond energy. (2)

- (iii) Write down the electronic configuration of a phosphorus atom in terms of s and p orbitals. (1)

- (iv) What effect would you expect a magnetic field to have on

(a) P₄ molecules

(b) P₂ molecules

(c) P atoms?

Give a reason for your answer. (3)

- (b) Phosphorus pentachloride is found to exist as [PCl₄]⁺ [PCl₆]⁻ in the solid state, and PCl₅ in the gaseous state.

- (i) Show by diagrams the three-dimensional shapes of

(a) the PCl₄⁺ ion

(b) the PCl₆⁻ ion

(c) the PCl₅ molecule. (3)

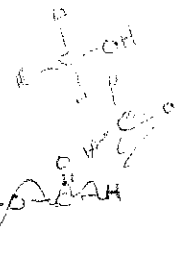
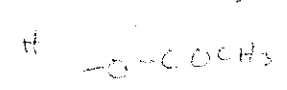
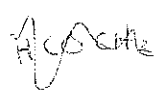
- (ii) The corresponding solid bromine compound is [PBr₄]⁺Br⁻. Suggest why the PBr₆⁻ ion does not exist. (1)

- (c) A compound of phosphorus, bromine and fluorine was believed to have the formula [PBr₄]⁺ [PF₆]⁻. The bromine in the compound was estimated by reaction with silver nitrate solution. 0.100 g of the compound gave 0.152 g silver bromide.

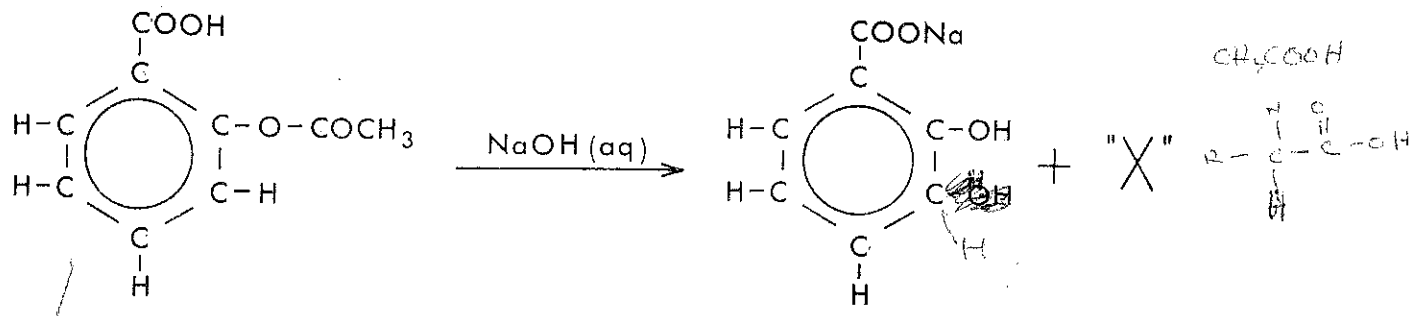
- (i) How could the ionic nature of the compound be shown? (1)

- (ii) Calculate the percentage by weight of bromine in [PBr₄]⁺[PF₆]⁻. (3)

- (iii) Show by calculation to what extent the silver nitrate analysis confirms the suggested formula. (3)



4. (a) Acetyl-salicylic acid in "Aspirin" was estimated by treating 1.00 g "Aspirin" tablets with 20.00 cm³ 0.50 M sodium hydroxide solution. The following reaction occurred:

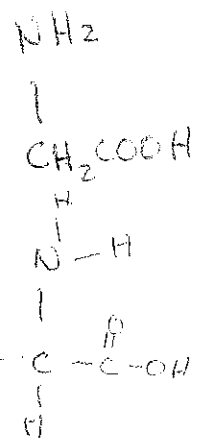


After the reaction the excess sodium hydroxide was found by titration with 0.50 M sulphuric acid, using phenol red as indicator. 4.44 cm³ sulphuric acid were required.

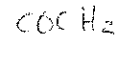
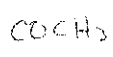
- (i) Write the name of "X". (1)
- (ii) Why is phenol red (pH range 6.8-8.4) used as indicator rather than methyl orange (pH range 3.1-4.4)? (2)
- (iii) Draw a graph to show the change in pH as 10.00 cm³ 0.50 M sulphuric acid are added to the excess sodium hydroxide solution. (1)
- (iv) How many moles of sodium hydroxide react with one mole of acetyl-salicylic acid? (1)
- (v) In the analysis how many moles of sodium hydroxide reacted with 4.44 cm³ 0.50 M sulphuric acid? (3)
- (vi) How many moles of sodium hydroxide reacted with the acetyl-salicylic acid in the tablets? (2)
- (vii) How many moles of acetyl-salicylic acid were in the tablets? (1)
- (viii) What is the percentage by weight of acetyl-salicylic acid in the sample of "Aspirin"? (3)

(b) Buffered "Aspirin", containing aminoethanoic acid (glycine), is used to counteract the acidity produced in the stomach by irritation due to the "Aspirin" tablets.

- (i) Write the structural formula for aminoethanoic acid. (1)
- (ii) What is a buffer? (1)
- (iii) Show how aminoethanoic acid could act as a buffer if there was
 - (a) an increase in acidity.
 - (b) a decrease in acidity.



[Turn over



1 mole 180g
 10.1 mole 180g
 10.2 mole 180g
 10.3 mole 180g
 $5.56 \times 10^{-3} = 5.56 \times 10^{-3} \times 180$
 $= 1.0008 \times 10^{-1}$

10.00	0.745
0.100	1.115
	2.000

108
 64
 28
 180



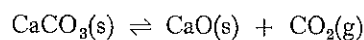
5.56×10^{-3}
 100

3×10^{-5}

5. (a) Account for the following apparent contradictions.

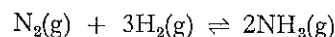
(i) When hydrogen is passed over heated iron oxide, iron and steam are produced.
When steam is passed over heated iron, iron oxide and hydrogen are produced. (2)

(ii) The equilibrium constant for the reaction



at 1000 °C suggests that only part of the calcium carbonate will decompose. When a crucible containing calcium carbonate is heated to 1000 °C, there is 100% conversion to calcium oxide. (2)

(iii) In the equilibrium



the right to left reaction is favoured by high temperatures, yet the reaction is carried out at 500 °C to produce ammonia. (2)

(b) A 0.01 M aqueous solution of benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$, a weak monobasic acid) has a pH value of 3.1.

Calculate

(i) the hydrogen ion concentration of the solution. (2)

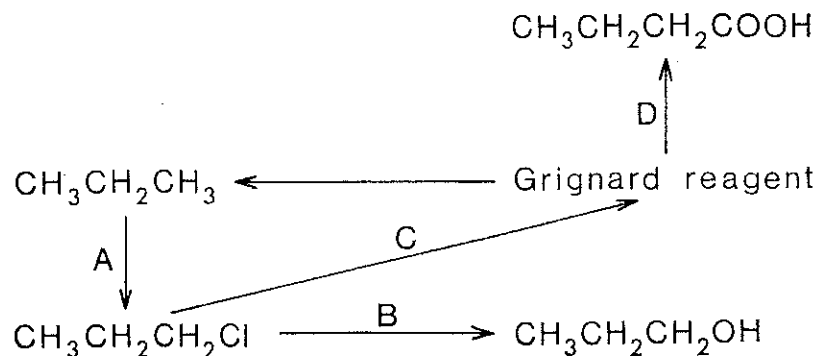
(ii) the dissociation constant of the acid (state clearly any simplifying assumptions you make). (5)

(c) When a crystal of iodine is shaken up in a mixture of equal volumes of two solvents (water containing potassium iodide, and trichloromethane), the iodine establishes an equilibrium distribution between the two solvents.

(i) What would be the effect of doubling the volume of trichloromethane used on the equilibrium constant for this partition? Explain your answer. (2)

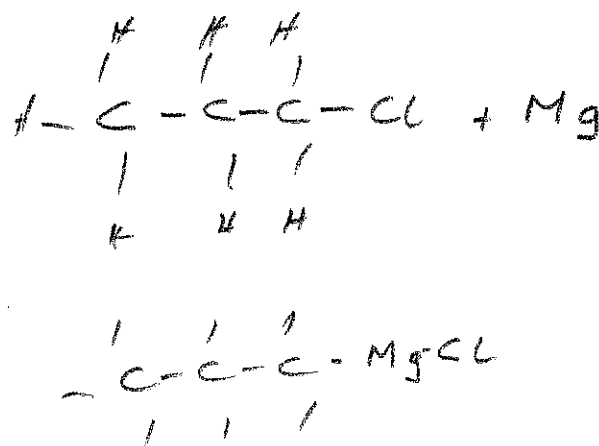
(ii) A spectrophotometer is an instrument which measures the intensity of a beam of light of a chosen wavelength. How could this instrument be used to determine the concentration of iodine in the trichloromethane layer? (5)

6. Consider the series of reactions outlined below:

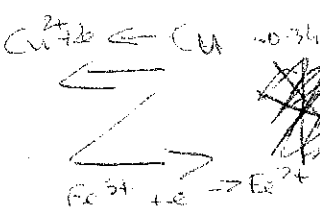
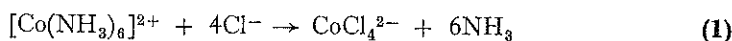


- (a) (i) Suggest a possible condition which would enable reaction A to occur quickly with chlorine at room temperature. (1)
- (ii) Outline a possible mechanism for reaction A which explains why the condition in (i) assists the reaction. (4)
- * (iii) The presence of a lead alkyl compound increases the rate of reaction A. Explain why. (2)
- (iv) Why is reaction A **not** a good method of preparation of chloropropane? (1)
- (b) (i) What reagent is used to allow reaction B to occur at a reasonable rate? (1)
- (ii) In reaction B why is the C—Cl bond attacked rather than the C—H bond? (1)
- (iii) How would you show experimentally the presence of another product in reaction B? (2)
- (c) (i) How would reaction C be carried out? (2)
- (ii) State any special precautions which would require to be taken. (2)
- (iii) In the course of carrying out reaction C it suddenly ceased, and propane gas was produced. Account for this. (2)
- (iv) Butanoic acid is formed from the Grignard reagent by the action of carbon dioxide followed by acidification (reaction D). Account for the reactivity of carbon dioxide, generally considered as an inactive gas, towards the Grignard reagent. (2)

[Turn over

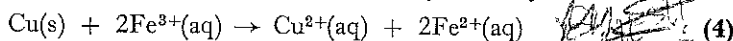


7. (a) State whether oxidation, reduction, or neither, occurs to cobalt in the reaction



(b) Use the data on page 40 of the data book to answer the following questions.

(i) Show by calculation whether the following reaction is thermodynamically feasible.



(ii) What information does the data give about the rate of reaction of zinc with silver nitrate solution. Explain your answer. (2)

(c) "The most striking feature of the chemistry of Group I is the similarity of the elements within the group. In Group IV, although similarities still exist, there are dramatic differences as the group is descended."

Illustrate this statement by setting out in your answer book the comparisons below for the four elements.

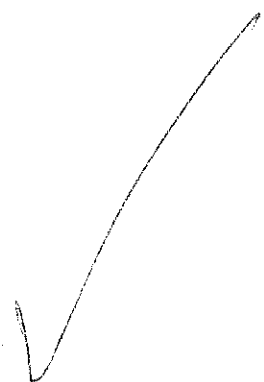
	sodium	caesium	silicon	lead
Oxidation state in compounds	+1	+1	+4	+2
Type of bonding between atoms in free elements				
General formula for hydrogen compound (showing type of bonding)				
Formula for chlorides (showing type of bonding)				

(2)

(2)

(4)

(5)



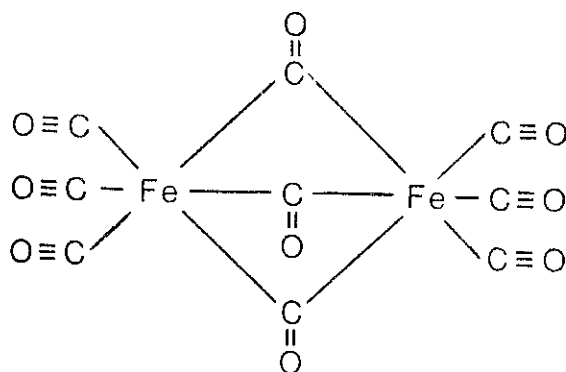
8. (a) Account for the following.

- (i) Manganese(II) oxide is a solid; manganese(VII) oxide is a liquid. (2)
- (ii) Manganese easily forms alloys with iron. (2)
- (iii) Manganese has a maximum oxidation state of +7, while that of scandium is +3. (2)

(b) (i) What is the main factor which determines the crystal structure of an ionic compound of the type A^+B^- ? (1)

(ii) Suggest why MnO , FeO , CoO and NiO all crystallise with the sodium chloride structure rather than the caesium chloride structure. (The data on pages 36 and 37 of the data book may be helpful.) (3)

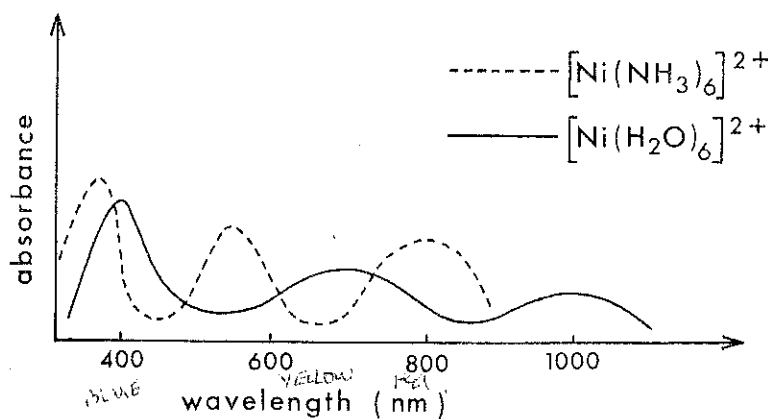
(c) An iron carbonyl is thought to have the structure



(i) What spectroscopic technique could be used to help elucidate the above structure? (1)

(ii) Explain why the technique you have chosen would help this confirmation. (2)

(d)



The graphs above show the absorption spectra for the ions $[Ni(H_2O)_6]^{2+}$ and $[Ni(NH_3)_6]^{2+}$

(i) Account for the colour of a solution containing $[Ni(H_2O)_6]^{2+}$ ions in terms of d-electrons. (4)

(ii) Account for the shift in the absorption spectra for a solution containing $[Ni(NH_3)_6]^{2+}$ ions, and for the direction of the shift. (3)

[END OF QUESTION PAPER]