

[92/301] 1985

CERTIFICATE OF SIXTH YEAR STUDIES

CHEMISTRY

PAPER

Friday, 10th May—9.30 a.m. to 12.00 noon



Dalziel High School
Chemistry Department



1985 CSYS

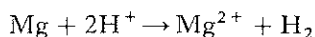
1. Which of the following electron configurations represents that of an atom in its ground state?

- A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$
- B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
- C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4d^2$

2. A solution of a weak diprotic acid is to be standardised. Which of the following properties must be possessed by a base to be suitable as a primary standard for this purpose?

- A One mole of the base must neutralise one mole of the acid.
- B It must have high purity and stability.
- C It must be about the same strength as the acid.
- D It must have exactly the same molarity as the acid.

3. The action of magnesium on hydrochloric acid solution can be represented by the equation



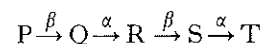
When excess magnesium is added to 500 cm³ of a solution of hydrochloric acid, 1 mole of hydrogen gas is produced. What is the molarity of the solution?

- A 0.5
- B 1.0
- C 2.0
- D 4.0

4. What volume of 0.2 M potassium sulphate is required to make, by dilution with water, one litre of a solution with a K⁺ (aq) concentration of 0.1 M?

- A 100 cm³
- B 125 cm³
- C 250 cm³
- D 500 cm³

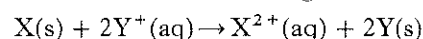
5. If the following represents a radioactive decay series



Which of the following pairs must be isotopes?

- A P and R
- B Q and T
- C P and S
- D None of the above are isotopes.

6. For a cell in which the following reaction occurs



the E° value is 1.5 V. (F = 96 500 coulombs)

The value of ΔG° for this reaction is

- A +289.5 kJ
- B +144.8 kJ
- C -144.8 kJ
- D -289.5 kJ

7. $\text{Ag}^+(\text{aq}) + \text{Fe}^{2+}(\text{aq}) \rightarrow \text{Fe}^{3+}(\text{aq}) + \text{Ag(s)}$

The above reaction is thermodynamically feasible at 298 K.

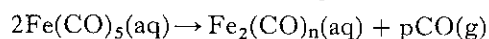
The most likely combination of signs for the ΔS° and ΔH° values in this reaction are

	ΔS°	ΔH°
A	+	+
B	-	+
C	+	-
D	-	-

8. In the 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 litres of hydrogen gas (volume measured at s.t.p.)?

- A 10 minutes
- B 20 minutes
- C 40 minutes
- D 90 minutes

9. When an aqueous solution of iron pentacarbonyl, $\text{Fe}(\text{CO})_5$, is irradiated with ultra-violet light the following reaction occurs.



If a solution containing 0.01 mole of iron pentacarbonyl undergoes complete conversion, 112 cm^3 of carbon monoxide (measured at s.t.p.) is released.

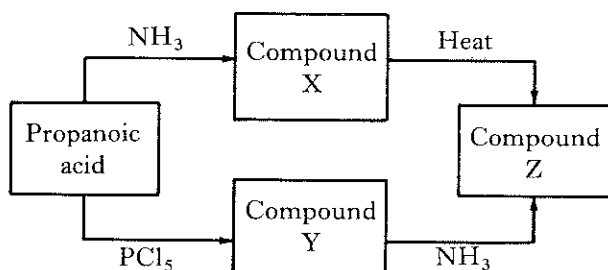
The value of n is

- A 1
- B 4
- C 6
- D 9

10. Which of the following species has the same shape as an ammonia molecule?

- A BH_3
- B CH_3^-
- C CH_3^+
- D CO_3^{2-}

11.



The formula for Z will be

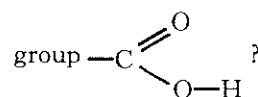
- A $\text{CH}_3\text{CH}_2\text{CONH}_2$
- B $\text{CH}_3\text{CH}_2\text{CN}$
- C $\text{CH}_3\text{CH}_2\text{COONH}_4$
- D $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$

12. Two isomeric esters, X and Y, have the molecular formula $\text{C}_4\text{H}_8\text{O}_2$. Ester X on hydrolysis with sodium hydroxide solution gives $\text{CH}_3\text{CH}_2\text{COONa}$ and ester Y on similar treatment gives $\text{CH}_3\text{CH}_2\text{OH}$.

The esters are

- | | | |
|---|-------------------|----------------------|
| | X | Y |
| A | methyl propanoate | and ethyl ethanoate |
| B | propyl methanoate | and ethyl ethanoate |
| C | methyl butanoate | and ethyl propanoate |
| D | butyl methanoate | and ethyl propanoate |

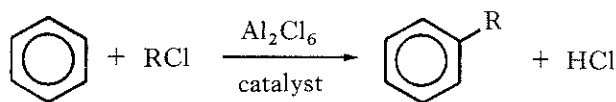
13. Which statement is true about the carboxyl



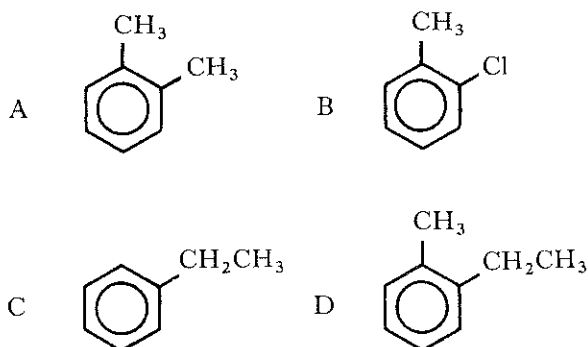
- A The $\begin{array}{c} \diagup \\ \text{C=O} \end{array}$ and ---O---H groups each retain their own properties, unaffected by the other.
- B The properties of the $\begin{array}{c} \diagup \\ \text{C=O} \end{array}$ are changed but the ---O---H is unaffected.
- C The properties of the ---O---H are changed but the $\begin{array}{c} \diagup \\ \text{C=O} \end{array}$ is unaffected.
- D The properties of the $\begin{array}{c} \diagup \\ \text{C=O} \end{array}$ and ---O---H are each affected by the other.

[Turn over

14.



Treatment of methylbenzene with chloromethane will give



15. Which statement about ethanol and its isomeric ether is true?

They

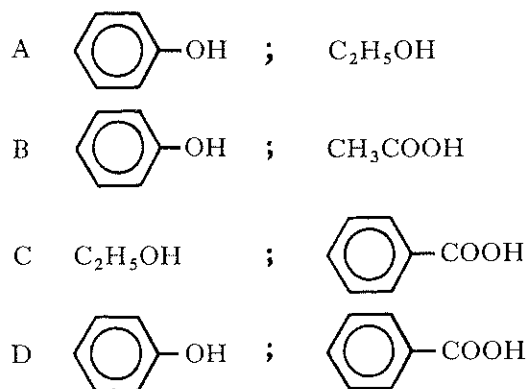
- A have similar volatilities
- B have the same solubility in water
- C produce similar infra-red spectra
- D produce the same products when burned in excess oxygen.

16. An organic compound forms an addition product with sodium hydrogensulphite and another with hydrogen in the presence of a nickel catalyst.

It can be said that the compound definitely

- A can be oxidised to an acid
- B contains a carbonyl group
- C is an alkene
- D is an alkanone.

17. In which pair does the first compound have the higher K_a value?



18. Which of the following will react together to produce 1-ethoxypropane?

- A $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{CH}_3\text{CH}_2\text{COONa}$
- B $\text{CH}_3\text{CH}_2\text{ONa}$ and $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ and CH_3COONa
- D $\text{CH}_3\text{CH}_2\text{ONa}$ and $\text{CH}_3\text{CH}(\text{I})\text{CH}_3$

19. If in a 0.1 M solution of a monoprotic acid 1% of the acid molecules dissociate, the pH of the solution is

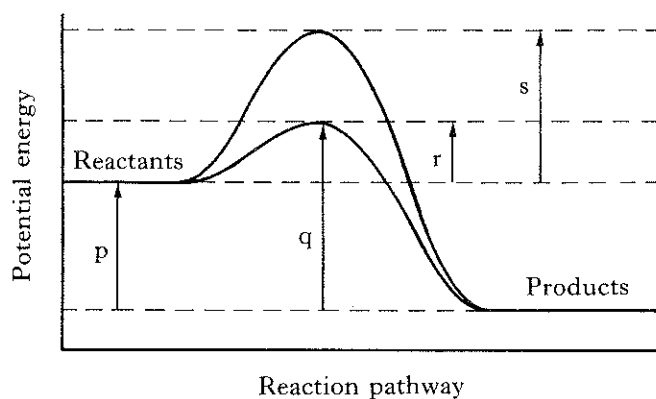
- A 1
- B 2
- C 3
- D 4

20. Why is it not practicable to use a standard ethylamine solution in a titration method to find the concentration of a propanoic acid solution?

- A The salt of the above acid and base is subject to hydrolysis by water.
- B The pH change at the end point is small.
- C An insoluble salt is formed.
- D An organic base neutralises an organic acid very slowly.

21. A solution is made by mixing 100 cm^3 0.1 M ethanoic acid and 100 cm^3 0.1 M sodium ethanoate. What will be the effect of diluting this mixture with 50 cm^3 water?
- A The molarity and pH will decrease significantly.
- B The molarity will decrease but the pH will remain fairly constant.
- C The molarity will decrease and the pH will increase significantly.
- D The molarity and pH will remain fairly constant.

22.



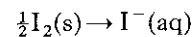
The above diagram illustrates the catalysed and uncatalysed reaction pathways for a reversible reaction. The activation energy for the reverse uncatalysed reaction is given by

- A $s - r$
- B $p + r$
- C $q - p$
- D $p + s$

Questions 23 and 24 refer to the following.

- (i) $\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g}) \quad \Delta H = +30\text{ kJ}$
- (ii) $\frac{1}{2}\text{I}_2(\text{g}) \rightarrow \text{I}(\text{g}) \quad \Delta H = +76\text{ kJ}$
- (iii) $\text{I}(\text{g}) \rightarrow \text{I}^-(\text{g}) \quad \Delta H = -298\text{ kJ}$
- (iv) $\text{I}^-(\text{g}) \rightarrow \text{I}^-(\text{aq}) \quad \Delta H = -306\text{ kJ}$

23. What is the enthalpy change in kJ for the following reaction?



- A +498
- B -498
- C -513
- D -528

24. Which of the above equations represents the enthalpy of sublimation of iodine?

- A (i)
- B (ii)
- C (iii)
- D (iv)

25. When one mole of phosphorus pentachloride was heated to 523 K in a closed vessel, 50% of the pentachloride dissociated as shown.



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

- A 1.0
- B 1.5
- C 2.0
- D 2.5

26. Which of the following compounds has the highest degree of ionic character?

- A hydrogen chloride
- B lithium hydride
- C phosphorus hydride
- D silicon chloride

[Turn over

27. Which of the following would be expected to have the highest entropy at 298 K?
- A Fe
 B Cu
 C Mg
 D Na

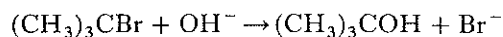
28. For a solution of ammonia in water the dissociation constant is

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]}$$

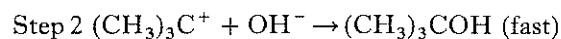
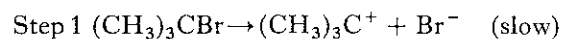
If solid ammonium chloride is added

- A the dissociation constant and pH decrease
 B the pH increases
 C the dissociation constant remains unchanged
 D neither dissociation constant nor pH will alter.

29. A suggested mechanism for the reaction



is a two-step process.



This mechanism has been proposed from the fact that

- A rate = $k[(\text{CH}_3)_3\text{CBr}]$
 B rate = $k[(\text{CH}_3)_3\text{CBr}][\text{OH}^-]$
 C rate = $k[(\text{CH}_3)_3\text{C}^+][\text{Br}^-]$
 D rate = $k[(\text{CH}_3)_3\text{C}^+][\text{OH}^-]$

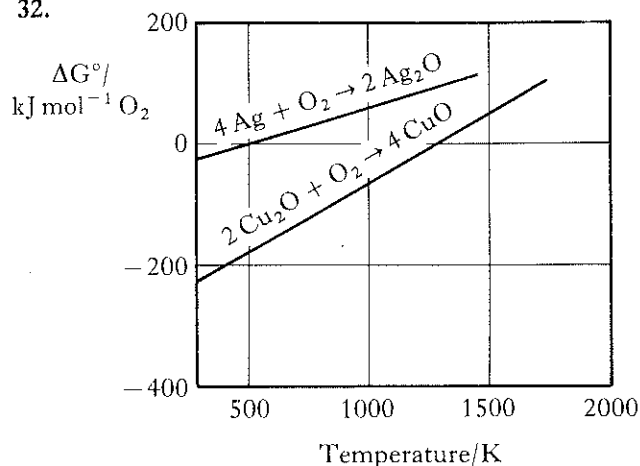
30. The combination of nitrogen monoxide and oxygen was studied under experimental conditions.

Initial concentration of NO/mol l ⁻¹	Initial concentration of O ₂ /mol l ⁻¹	Initial rate of NO ₂ formation/mol l ⁻¹ s ⁻¹
1.6 × 10 ⁻⁵	3.2 × 10 ⁻⁵	1.1 × 10 ⁻¹⁰
1.6 × 10 ⁻⁵	6.4 × 10 ⁻⁵	2.2 × 10 ⁻¹⁰
3.2 × 10 ⁻⁵	3.2 × 10 ⁻⁵	4.4 × 10 ⁻¹⁰

The experimental data are consistent with the rate equation

- A rate = $k[\text{NO}_2]^2$
 B rate = $k[\text{NO}][\text{O}_2]$
 C rate = $k[\text{NO}][\text{O}_2]^2$
 D rate = $k[\text{NO}]^2[\text{O}_2]$
31. Which of the following would give an alkaline solution with water?
- A CH₃COCl
 B CH₃OCH₃
 C (CH₃CO)₂O
 D CH₃COOK

32.



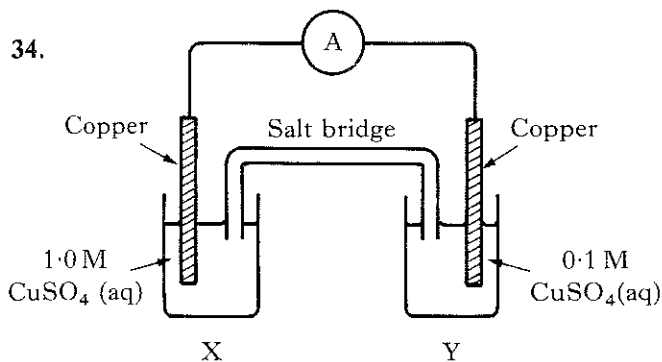
From the diagram above it can be concluded that

- A the formation of silver(I) oxide is endothermic above 500 K
- B metal oxidation reaction rates increase steadily with increasing temperature
- C the reduction of silver(I) oxide is *not* feasible at 1000 K
- D the conversion of copper(I) oxide to copper(II) oxide is feasible below 1200 K.

33. The transition metal salts $\text{Mn}^{2+}(\text{F}^-)_2$, $\text{Fe}^{2+}(\text{F}^-)_2$, $\text{Co}^{2+}(\text{F}^-)_2$ have identical crystal structures because the metal ions have

- A the same nuclear charge
- B similar radii
- C the same number of d electrons
- D similar colours.

34.



Which of the following will occur in the above cell?

- A The blue colour in Y will become less intense.
- B The molarity of the solution in X will increase.
- C The mass of the electrode in Y will decrease.
- D Electrons will flow from X to Y through A.

35. Manganese has an oxidation number of +5 in

- A MnO_4^-
- B MnO_4^{2-}
- C MnO_4^{3-}
- D $[\text{Mn}(\text{CN})_6]^{3-}$

36. Three isomers with the empirical formula $\text{CrCl}_3(\text{H}_2\text{O})_6$ have been isolated. Analysis of one isomer showed that one third of the total chlorine content was precipitated as silver(I) chloride by the addition of excess silver(I) nitrate solution.

The formula of this isomer is

- A $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}(\text{Cl}^-)_3$
- B $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]^{2+}(\text{Cl}^-)_2 \cdot \text{H}_2\text{O}$
- C $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]^+(\text{Cl}^-)_2 \cdot 2\text{H}_2\text{O}$
- D $[\text{Cr}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$

37. A green hydrated ion has four unpaired electrons in its 3d orbitals.

The ion is

- A V^{3+}
- B Fe^{2+}
- C Cr^{3+}
- D Ni^{2+}

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.

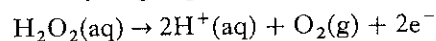
Otherwise select D.

38. In a line spectrum the frequency of each emission line represents

- 1 an energy level within an atom
- 2 the kinetic energy possessed by an electron in an atom
- 3 the energy change when an electron moves to a lower energy level.

39. The reaction between permanganate ions and hydrogen peroxide(H_2O_2) in acidic solution has a negative ΔG value.

The hydrogen peroxide is oxidised thus:



Which of the following can be said with certainty about the reaction?

- 1 One mole of permanganate ions will oxidise 2.5 moles of hydrogen peroxide.
- 2 The products will appear to be colourless.
- 3 The reaction will take place instantaneously at 20°C .

40. The voltage of a cell can be affected by changes in

- 1 temperature
- 2 concentration of cell solution(s)
- 3 pressure of gas in a gas electrode.

[END OF QUESTION PAPER]

- Marks*
1. The ions Na^+ , F^- , Mg^{2+} and O^{2-} are isoelectronic.
 - (a) Write in full orbital notation the electron configuration of these ions. 1
 - (b) Identify another chemical species with this electron configuration. 1
 - (c) State Hund's Rule of maximum multiplicity. 1

The first ionisation energies of carbon, nitrogen and oxygen are listed on page 4 of your Data Booklet.

Explain how they provide evidence that Hund's Rule applies to the electron configuration of these elements. 1

(4)

 2. Answer **EITHER A OR B**.
 - A. The following method is used to measure the amphetamine sulphate content of a drug sample.

Accurately weigh the sample (about 0.4 g) and dissolve in water (120 cm³). Add 2 M sodium hydroxide (2 cm³) and distil off the volatile base into 0.1 M hydrochloric acid (50 cm³). Titrate the excess acid with 0.1 M sodium hydroxide, using methyl red as indicator.

The equation for the reaction involving amphetamine sulphate is:

$$(\text{C}_9\text{H}_{13}\text{N})_2\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow 2\text{C}_9\text{H}_{13}\text{N} + \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$$

amphetamine
 - (a) Why is there no contradiction in the use of the words "accurately" and "about" given in the first line of the method? 1
 - (b) State whether high accuracy is required in measuring the volume of
 - (i) the water used to dissolve the sample,
 - (ii) the 2 M sodium hydroxide,
 - (iii) the 0.1 M hydrochloric acid,
 - (iv) the volume of 0.1 M sodium hydroxide used in the titration. 2
 - (c) 0.41 g of a drug sample was treated as above. The final titre was 30 cm³ 0.1 M sodium hydroxide.

Calculate the

 - (i) number of moles of excess 0.1 M hydrochloric acid, 1
 - (ii) number of moles of $\text{C}_9\text{H}_{13}\text{N}$ in the distillate, 1
 - (iii) number of moles of amphetamine sulphate and hence the percentage of it in the drug sample. 3

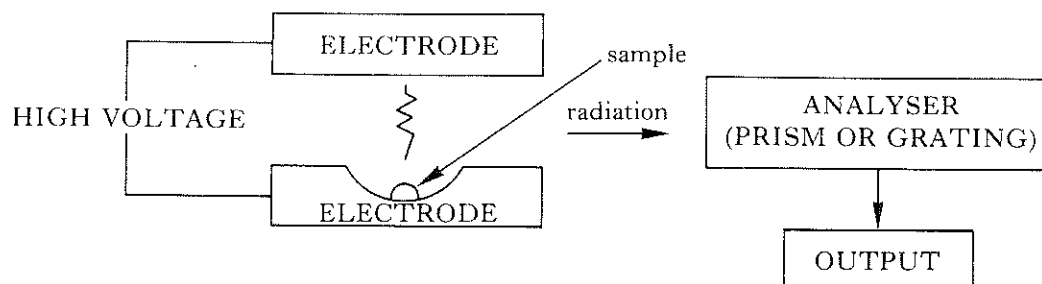
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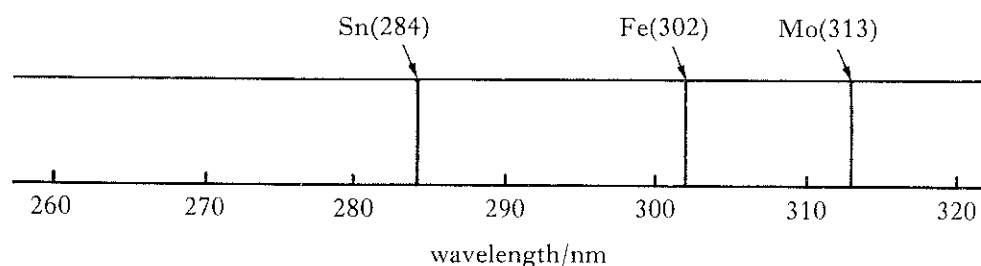
 - B. A barium salt (4.18 g) was heated strongly in a crucible over a bunsen flame. Only oxygen was evolved during this time and on heating to constant mass and cooling in a desiccator, the residue of barium chloride was found to weigh 2.83 g.
 - (a) Explain what is meant by "heating to constant mass". 1
 - (b) Calculate the number of moles of barium chloride formed. 2
 - (c) What volume of oxygen (measured at s.t.p.) is driven off in the reaction? 2
 - (d) Use the experimental results to establish the formula of the original barium salt. 2
 - (e) Account for the use of a desiccator in this experiment. 1

(8)

3. The following technique is used to detect trace elements in steels and other alloys. The metal sample is sparked as shown.



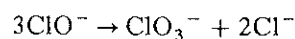
The output from one sample was as shown:



- (a) In which region of the spectrum do these lines lie? 1
- (b) Calculate the energy (in kJ mol^{-1}) of the line due to tin. 3
- (c) Explain how this sparking procedure relates to the formation of the lines in the spectrum. 2
- (d) Give **one** reason why elements are added in trace amounts to steels. 1
- (7)**
4. The overall entropy changes in feasible chemical reactions must take into account the chemical system **and** the surroundings.
- (a) Describe what is meant by an "entropy change". 1
- (b) What thermodynamic condition must operate for all feasible reactions? 1
- (c) Here are data for three reactions carried out at 298K and 1 atmosphere pressure.
- | Reaction | $\Delta H^\circ/\text{kJ mol}^{-1}$ | $\Delta G^\circ/\text{kJ mol}^{-1}$ |
|--|-------------------------------------|-------------------------------------|
| 1 $\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \rightarrow 2\text{HI}(\text{g})$ | 51.8 | 2.6 |
| 2 $\text{H}_2(\text{g}) + \text{Br}_2(\text{l}) \rightarrow 2\text{HBr}(\text{g})$ | -72.4 | -106.4 |
| 3 $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ | -184.6 | -190.6 |
- (i) Calculate the standard entropy change for reaction 1. 3
- (ii) Comment on the trend in entropy changes from reaction 1 to reaction 3 and account for the trend. 2
- (iii) In which of the three reactions would you expect the equilibrium mixture under standard conditions to contain more reactants than products? 1
- (8)**

[Turn over

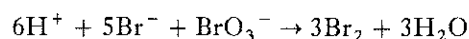
5. (a) Hypochlorite ions can form chlorate and chloride ions according to:



In a reaction rate investigation the rate expression was determined as:

$$-\frac{d[\text{ClO}^-]}{dt} = k[\text{ClO}^-]^2$$

- (i) Explain what is meant by $-\frac{d[\text{ClO}^-]}{dt}$. 1
- (ii) What is the overall order of this reaction? 1
- (iii) State whether the chlorine has been oxidised or reduced in the conversion of ClO^- to ClO_3^- . 1
- (b) The stoichiometry for the reaction of bromide ions with bromate ions in acid solution is:



Rate measurements on several reaction mixtures provided relative rate data:

Reaction mixture	0.1 M H^+/cm^3	0.1 M Br^-/cm^3	0.1 M $\text{BrO}_3^-/\text{cm}^3$	$\text{H}_2\text{O}/\text{cm}^3$	Relative rate
1	90	75	15	120	1
2	90	150	15	45	2
3	180	75	15	30	4
4	90	75	30	105	4

If the rate expression is given in the form:

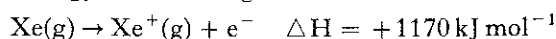
$$\text{rate} = k[\text{H}^+]^x[\text{Br}^-]^y[\text{BrO}_3^-]^z$$

suggest values for x , y and z from the experimental data. 3

(6)

6. (a) $\text{Ar(s)} \rightarrow \text{Ar(g)} \quad \Delta H = +7.4 \text{ kJ mol}^{-1}$

- (i) Why is ΔH positive? 1
- (ii) Why is the magnitude of ΔH so small? 1
- (b) (i) Sketch the three-dimensional shape of the negative ion in the noble gas compound $\text{Xe}^+\text{PtF}_6^-$. 1
- (ii) The first ionisation energy of xenon is given as follows:



Molecular oxygen has an almost identical first ionisation energy ($\Delta H = +1180 \text{ kJ mol}^{-1}$).

Write the equation for this ionisation. 1

- (iii) From parts (b) (i) and (ii) above, deduce a formula for a compound containing only oxygen, platinum and fluorine. 1

(5)

7. (a) Sodium chloride is an example of a crystal structure with "6:6 coordination".

Explain what is meant by this term.

1

- (b) Lattice formation energies may be calculated for compounds on the basis of bonding models and the following formula:

$$\text{lattice energy} = \frac{-LMz^+z^-e^2}{4\pi\epsilon_0r}$$

where z^+ and z^- are the charges on the ions and r is the distance separating the centres of ions in the lattice.

(L , e , π and ϵ_0 are all constants and M is also a constant for a particular arrangement of ions in a lattice.)

<i>Compound</i>	<i>Lattice formation energy/kJ mol⁻¹</i>	
	<i>Calculated value</i>	<i>Experimental value</i>
NaCl	-766	-769
KCl	-692	-698
AgCl	-769	-916

- (i) Refer to the formula for lattice energy to explain why sodium chloride has a larger negative value for lattice formation energy than potassium chloride.
- (ii) Offer an explanation for the large discrepancy between the calculated and the experimental values for silver chloride.
- (iii) Lattice formation energy cannot be determined by one experiment. Use a Born-Haber cycle to outline how an experimental value for lattice formation energy can be obtained for sodium chloride.

1

1

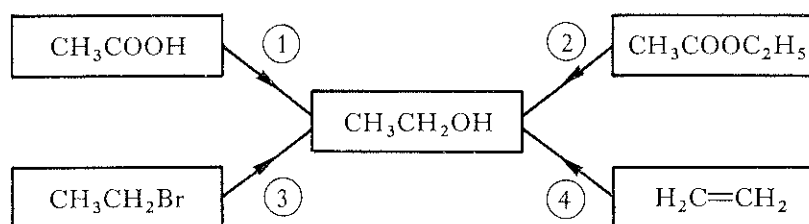
4

(7)

[Turn over

8. Answer EITHER A OR B.

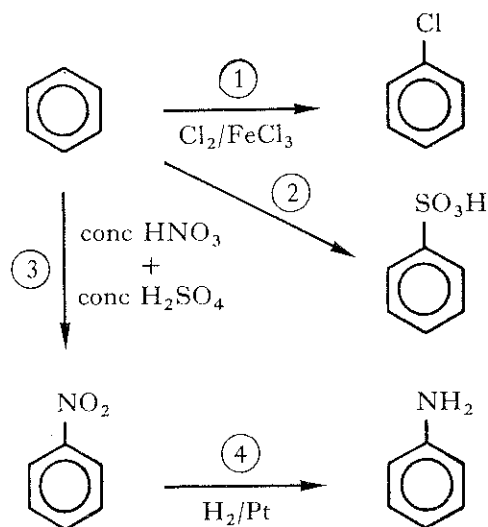
A. Ethanol may be prepared on a laboratory scale by several routes.



- (a) Route ① is a *reduction*. What type of reaction takes place in
- (i) route ②, 1
- (ii) route ④? 1
- (b) Aqueous sodium hydroxide is a suitable reagent for route ③.
- (i) Outline the mechanism for the reaction. 2
- (ii) For which of the other three routes would aqueous sodium hydroxide be suitable? 1
- (c) During the 1980s, Britain's chemical industries will make ethanol almost entirely from ethene produced from crude oil.
- What are the two main stages in producing ethene from crude oil? 1
- (d) In Brazil, route ④ is reversed so that ethene is made on an industrial scale from ethanol.
- Suggest which raw material is used in that country to produce the ethanol. 1
- (7)**

OR

B. Here are some reactions involving benzene:

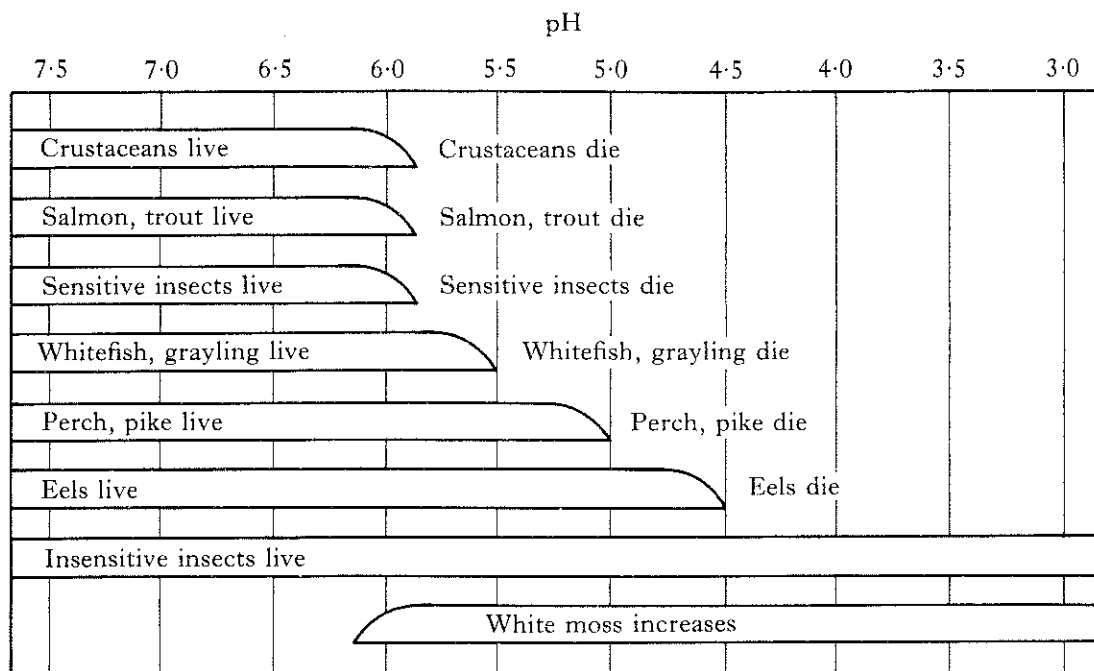


- (a) In reactions ①, ② and ③ benzene is believed to undergo electrophilic attack.
- (i) Why is benzene susceptible to such attack? 1
 - (ii) What is the electrophilic species produced by the reaction mixture in ③? 1
 - (iii) Suggest a reagent for reaction ②. 1
- (b) What is the function of
- (i) the FeCl_3 in reaction ①? 1
 - (ii) the hydrogen in reaction ④? 1
- (c) How does the base strength of the product of reaction ④ compare with that of ammonia? 1
Suggest a reason for your answer. 1
- (7)**

9. Account for the green colour of an aqueous solution of V^{3+} ions.
(Make reference to ligands, electrons and the visible spectrum in your answer.) (3)

[Turn over

10. Research has shown that the pH of water affects the ability of organisms to live in it, as shown in the table:



Changes in pH are being caused by acidic rain. This brings aluminium ions (which are toxic to organisms) into solution from the soil.

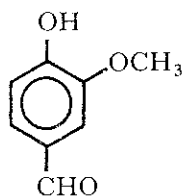
- (a) Acidity is causing problems in Scotland. Suggest a gas responsible for the acidity in rain and a likely source of the gas. 2
- (b) At what hydrogen ion concentration does water become toxic to all eels? 2
- (c) During a thunderstorm over Loch Faskally in Tayside, rain was recorded with a pH of 2.5.
 - (i) By what factor must it be diluted before grayling could start to live in it? 1
 - (ii) Explain why continued dilution with very pure water can never raise the pH above 7. 2
- (d) Suggest how the aluminium content of the water in a Highland loch might be estimated. 1

(8)

11. Answer EITHER A OR B.

A.

- (a) Ethyl methanoate is used in the confectionery trade as rum essence. Draw the extended structural formula of the molecule responsible for the flavour. 1
- (b) Vanillin, another important flavouring substance, is present in vanilla essence.



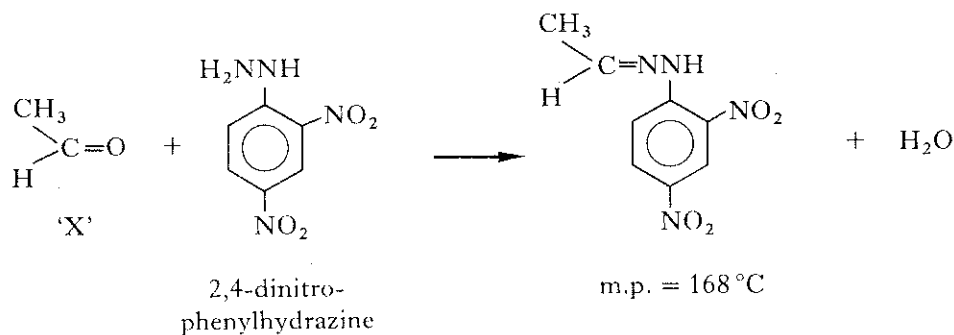
vanillin

- (i) Show the structural detail of the functional groups in the vanillin molecule. 1
- (ii) Does vanillin belong to the same class of organic compound as the rum essence? Explain. 2

(4)

OR

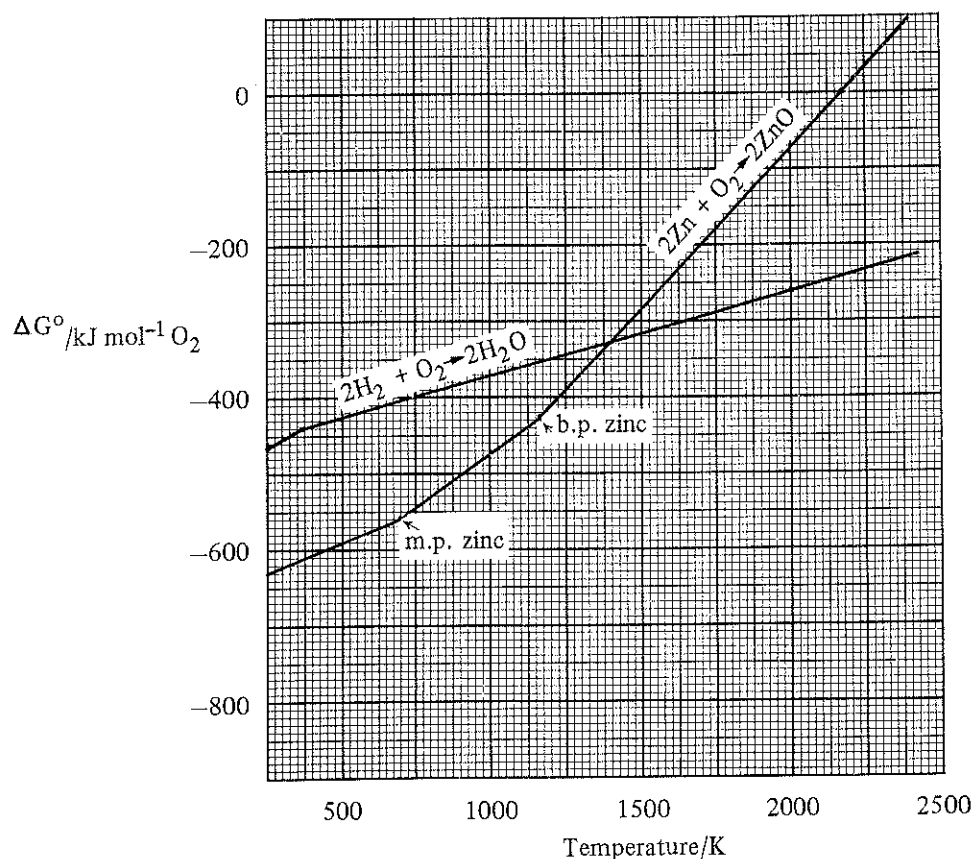
- B. Reactions with primary amines are useful in identifying compounds containing the carbonyl group since many of the products are crystalline solids with definite melting points.
e.g.



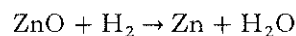
- (a) Name compound 'X'. 1
- (b) Explain why 2,4-dinitrophenylhydrazine could be classified **both** as a primary **and** as a secondary amine. 1
- (c) Explain the role of the 2,4-dinitrophenylhydrazine as a nucleophilic reagent in the reaction. 2

(4)

12. Here is an Ellingham diagram for a zinc oxide/hydrogen furnace:



The main reaction required has the equation:



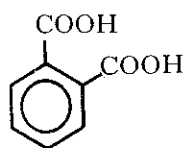
- (a) Estimate ΔG° for this reaction at 1000 K. 2
- (b) What is the minimum operating temperature for the successful reduction of zinc oxide? 1
- (c) Why does the gradient of the graph for oxidation of zinc change at the melting and boiling points of zinc? 1
- (d) The low boiling point of zinc is not typical of transition elements.
 Comment on
- (i) one other property in which zinc differs from transition metals; 1
 - (ii) why the electron configuration of zinc atoms may be considered as not typical of a transition metal. 1
- (6)**

13. Answer EITHER A OR B OR C.

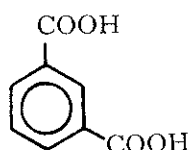
- A. Chemists are constantly searching for more efficient and cheaper industrial processes. Using examples, discuss the main features which contribute to the overall efficiency and economy of such processes. (4)

OR

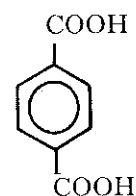
- B. Research into polyester fibre production between 1939 and 1941 led Whinfield and Dickson to experiment with ethane-1,2-diol ($\text{HOCH}_2\text{CH}_2\text{OH}$) and the three isomers of benzenedicarboxylic acid. These isomers are shown below with the names used at that time.



Phthalic acid



Isophthalic acid



Terephthalic acid

Discuss the chemistry involved in this piece of research work which led to the large scale production of the synthetic fibre "Terylene". (4)

OR

- C. Routine analysis of chlorinated water may be carried out by adding a fixed volume to a solution of potassium iodide and estimating the reaction product by a colorimetric technique. Discuss the main steps you would take to estimate the chlorine content of swimming pool water by this method. (4)

[END OF QUESTION PAPER]