Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

General Certificate of Education
June 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

CHEMISTRY **CHM6/W**
Unit 6a Synoptic Assessment

Tuesday 25 June 2002 Morning Session

In addition to this paper you will require:
an objective test answer sheet;
the AQA Periodic Table (Reference CHEM/PT/EX);
a calculator.

Time allowed: 1 hour

Instructions

- Use a blue or black ball-point pen. Do **not** use pencil.
- Fill in the boxes at the top of this page.
- Answer **all** 40 questions.
- For each item there are four responses. When you have selected the response which you think is the best answer to a question, mark this response on your answer sheet.
- Mark all responses as instructed on your answer sheet. If you wish to change your answer to a question, follow the instructions on your answer sheet.
- Do all rough work in this book, **not** on your answer sheet.
- Make sure that you hand in **both** your answer sheet **and** this answer book at the end of this examination.

Information

- Each correct answer will score one mark. No deductions will be made for wrong answers.
- This paper carries 10 per cent of the total marks for Advanced Level.
- The following data may be required.
  Gas constant R = 8.31 J mol^{-1} K^{-1}
- Graph paper is available from the Invigilator.

Advice

- Do not spend too long on any question. If you have time at the end, go back and answer any question you missed out.

THERE ARE NO QUESTIONS ON THIS PAGE

Multiple choice questions
Each of Questions **1** to **21** consists of a question or an incomplete statement followed by four suggested answers or completions. You are to select the most appropriate answer in each case.

1 The boiling points of the halogens increase down Group VII because

A covalent bond strengths increase.

B bond polarities increase.

C the surface areas of the molecules increase.

D electronegativities increase.

2 An aqueous solution of a sodium salt gave no precipitate when treated with either silver nitrate solution or barium chloride solution. Which one of the following could be the formula of the sodium salt?

A NaI

B Na_2SO_4

C NaBr

D NaF

3 Which one of the following is the electronic configuration of the strongest reducing agent?

A $1s^2\ 2s^2\ 2p^5$

B $1s^2\ 2s^2\ 2p^6\ 3s^2$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

4 On heating, magnesium reacts vigorously with element **X** to produce compound **Y**. An aqueous solution of **Y**, when treated with aqueous silver nitrate, gives a white precipitate that is readily soluble in dilute aqueous ammonia. What is the minimum mass of **X** that is needed to react completely with 4.05 g of magnesium?

A 11.83 g

B 5.92 g

C 5.33 g

D 2.67 g

5 Which one of the following has the most covalent character?

A MgF_2

B $MgBr_2$

C AlF_3

D $AlBr_3$

6 Which one of the following statements about the reaction below is **false**?

$$[Cu(H_2O)_6]^{2+} + EDTA^{4-} \rightleftharpoons [Cu(EDTA)]^{2-} + 6H_2O$$

A $[Cu(EDTA)]^{2-}$ is a more stable complex than $[Cu(H_2O)_6]^{2+}$

B Both $[Cu(H_2O)_6]^{2+}$ and $[Cu(EDTA)]^{2-}$ are octahedral complexes.

C There is an increase in entropy when the reaction occurs.

D There is a redox reaction.

Questions 7 to 11

The following information concerns the equilibrium gas-phase synthesis of methanol.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

At equilibrium, when the temperature is 68 °C, the total pressure is 1.70 MPa.
The number of moles of CO, H_2 and CH_3OH present are 0.160, 0.320 and 0.180, respectively.

Thermodynamic data are given below.

Substance	$\Delta H_f^{\ominus}$/kJ mol^{-1}	$S^{\ominus}$/J K^{-1} mol^{-1}
CO(g)	–110	198
H_2(g)	0	131
CH_3OH(g)	–201	240

7 Possible units for the equilibrium constant, K_p, for this reaction are

A no units

B kPa

C MPa^{-1}

D kPa^{-2}

8 The mole fraction of hydrogen in the equilibrium mixture is

A 0.242

B 0.485

C 0.653

D 0.970

9 With pressures expressed in MPa units, the value of the equilibrium constant, K_p, under these conditions is

A 1.37

B 1.66

C 2.82

D 4.80

10 Which one of the following statements applies to this equilibrium?

A The value of K_p increases if the temperature is raised.

B The value of K_p increases if the pressure is raised.

C The yield of methanol decreases if the temperature is lowered.

D The yield of methanol decreases if the pressure is lowered.

11 The standard entropy change for this reaction is

A $-220\ J\ K^{-1}\ mol^{-1}$

B $+220\ J\ K^{-1}\ mol^{-1}$

C $-89\ J\ K^{-1}\ mol^{-1}$

D $+89\ J\ K^{-1}\ mol^{-1}$

Questions 12 to 13

The compound lithium tetrahydridoaluminate(III), $LiAlH_4$, is a useful reducing agent. It behaves in a similar fashion to $NaBH_4$. Carbonyl compounds and carboxylic acids are reduced to alcohols. However, $LiAlH_4$ also reduces water in a violent reaction so that it must be used in an organic solvent.

12 Which one of the following concerning the violent reaction between $LiAlH_4$ and water is **false**?

A A gas is produced.

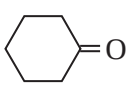
B The activation energy for the reaction is relatively high.

C The reaction has a negative free-energy change.

D Aqueous lithium ions are formed.

13 Which one of the following can be reduced by $LiAlH_4$ to a primary alcohol?

A



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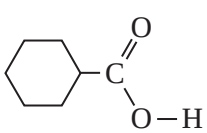

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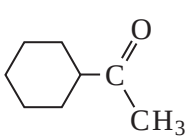

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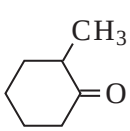


14 Which one of the following can act as an oxidising agent but not as a reducing agent?

A CH_3CHO

B Fe^{2+}

C I^-

D MnO_4^-

15 Propene reacts with hydrogen bromide to form a mixture of saturated organic products. The proton n.m.r. spectrum of the major organic product has

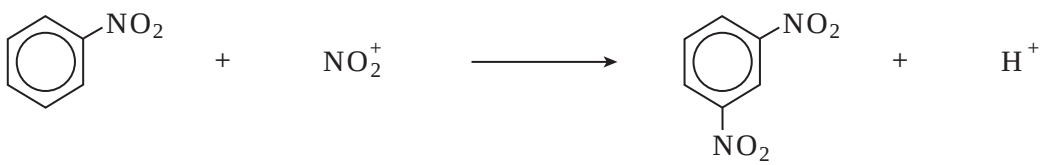
A 3 peaks with relative intensities 3 : 2 : 2

B 2 peaks with relative intensities 3 : 4

C 3 peaks with relative intensities 3 : 1 : 3

D 2 peaks with relative intensities 6 : 1

16 1,3-Dinitrobenzene can be prepared by heating nitrobenzene with a mixture of fuming nitric acid and concentrated sulphuric acid. The reaction can be represented by the following equation.



If the yield of the reaction is 55%, the mass of 1,3-dinitrobenzene produced from 12.30 g of nitrobenzene is

A 16.90 g

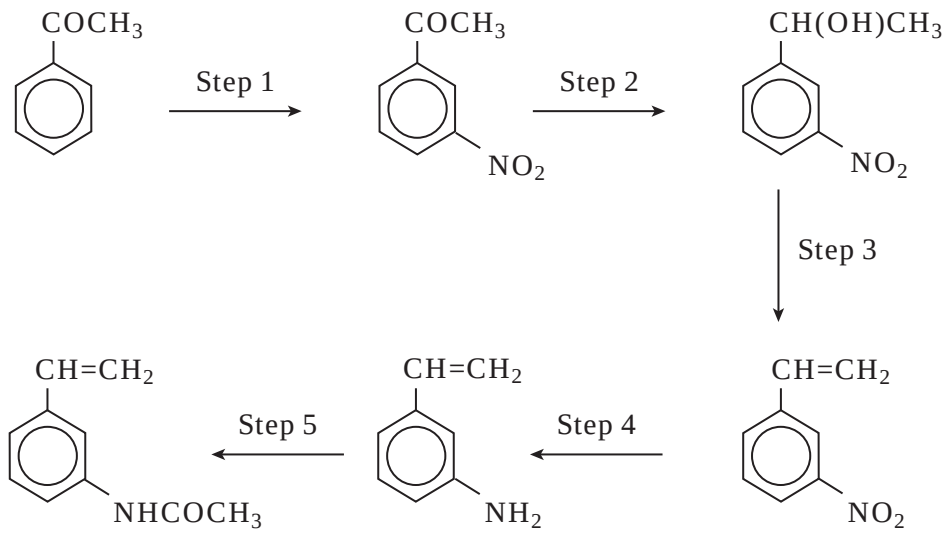
B 16.80 g

C 9.30 g

D 9.24 g

Questions 17 to 19

Refer to the following reaction sequence:



17 Which one of the following types of reaction is **not** involved in the above sequence?

A acylation

B oxidation

C reduction

D dehydration

18 Which one of the following types of reaction mechanism is **not** involved in the above sequence?

A electrophilic addition

B electrophilic substitution

C addition–elimination

D elimination

19 Which one of the following would be the most appropriate to carry out Step 2?

A H_2/Ni

B Sn/HCl

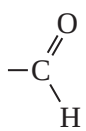
C $NaBH_4$

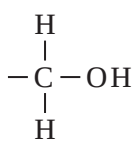
D Fe/HCl

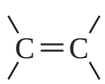
20 Certain chemical tests were performed on the pain-relief drug ibuprofen. The results of these tests are given in the table below.

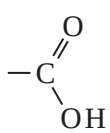
Test	**Result**
Aqueous sodium carbonate	Effervescence
Bromine water	Remained orange
Acidified potassium dichromate(VI) and heat	Remained orange
Fehling's solution and heat	Remained blue

Which one of the following functional groups do these results suggest that ibuprofen contains?

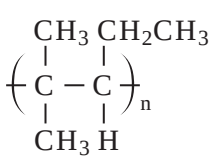
A 

B 

C 

D 

21 The correct name for the alkene monomer which forms the polymer shown below is



A 2-methyl-3-ethylpropene

B 2-methylpent-2-ene

C 2-methylpent-3-ene

D 4-methylpent-2-ene

THERE ARE NO QUESTIONS ON THIS PAGE

Multiple completion questions
For each of Questions **22** to **40 one or more** of the options given may be correct. Select your answer by means of the following code.

A if (1), (2) and (3) only are correct.

B if (1) and (3) only are correct.

C if (2) and (4) only are correct.

D if (4) alone is correct.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

22 The following information concerns the gas-phase reaction of nitrogen monoxide with hydrogen.

$$2NO(g) + 2H_2(g) \rightleftharpoons N_2(g) + 2H_2O(g)$$

A series of experiments was carried out in a reaction vessel at constant temperature.
The initial rate of reaction increased by a factor of 2 when the initial pressure of NO was doubled and that of H_2 was halved.
The initial rate decreased by a factor of 2 when the initial pressure of H_2 was doubled while that of NO was halved.
When both pressures were halved, the initial rate fell by a factor of 8.

Which of the following assertions is/are true?

(1) The overall order of reaction is 2.

(2) The reaction is first order in hydrogen.

(3) The reaction is first order in nitrogen monoxide.

(4) The overall order of reaction is 3.

23 Processes accompanied by an increase in entropy include

(1) decomposing ammonia gas into hydrogen and nitrogen.

(2) melting ice.

(3) dissolving magnesium sulphate in water.

(4) converting sulphur dioxide gas into sulphur trioxide in the Contact Process.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

24 Standard free-energy changes at 2000 K are as shown below:

Reaction	$\Delta G^{\ominus}$**/kJ mol**$^{-1}$
$2Mg(s) + O_2(g) \quad 2MgO(s)$	–1140
$2Ni(s) + O_2(g) \quad 2NiO(s)$	–432
$2Zn(s) + O_2(g) \quad 2ZnO(s)$	–696

At 2000 K, which of the following is/are feasible?

(1) reduction of zinc oxide by magnesium

(2) reduction of zinc oxide by nickel

(3) oxidation of magnesium by nickel oxide

(4) oxidation of nickel by zinc oxide

Questions 25 to 28

The gas hydrogen cyanide, HCN, is toxic. In water, hydrogen cyanide is a weak acid with a pK_a of 9.4 Hydrogen cyanide gas can be dissolved in dilute aqueous sodium hydroxide with which it reacts to give an aqueous solution containing cyanide ions. Solutions containing cyanide ions are also toxic but can be rendered non-toxic by complexing the cyanide ions with iron(II) ions.

25 Hydrogen cyanide molecules in the gas phase attract each other by

(1) van der Waals' forces.

(2) ionic bonds.

(3) dipole–dipole forces.

(4) hydrogen bonds.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

26 Cyanide ions will react with

(1) C_2H_6

(2) CH_3COCH_3

(3) C_6H_6

(4) CH_3CH_2Br

27 Possible products formed when cyanide ions react with aqueous iron(II) ions include

(1) $[Fe(CN)_6]^{2-}$

(2) $[Fe(H_2O)_5CN]^{+}$

(3) $[Fe(H_2O)_5CN]^{2+}$

(4) $[Fe(CN)_6]^{4-}$

28 Which of the following is/are true concerning 500 cm^3 of aqueous HCN that has a concentration of 0.10 mol dm^{-3}?

(1) It will react completely with 2.0 g of sodium hydroxide.

(2) The pH of the solution is 5.2

(3) It can be formed by dissolving 1.35 g of HCN in water and making up to 500 cm^3 of solution.

(4) The amount of HCN in the solution can be determined accurately by titration of a 25.0 cm^3 sample with a 0.1 mol dm^{-3} solution of NaOH using methyl orange as indicator.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

29 When left to stand, a mixture of ethanoic acid and ethanol reaches equilibrium as shown in the following equation.

$$CH_3COOH(l) + CH_3CH_2OH(l) \rightleftharpoons CH_3COOCH_2CH_3(l) + H_2O(l) \quad \Delta H = -2 \text{ kJ mol}^{-1}$$

The amount of CH_3CH_2OH in a mixture at equilibrium can be increased by

(1) adding more water.

(2) raising the temperature.

(3) adding dilute aqueous sodium hydroxide.

(4) adding a catalyst.

30 In which of the following reactions does an element have its oxidation state reduced from +6 to +4?

(1) $4H^+ + SO_4^{2-} + 2I^- \quad I_2 + SO_2 + 2H_2O$

(2) $Cr_2O_7^{2-} + 14H^+ + 6Ce^{3+} \quad 2Cr^{3+} + 6Ce^{4+} + 7H_2O$

(3) $3MnO_4^{2-} + 4H^+ \quad 2MnO_4^- + MnO_2 + 2H_2O$

(4) $[Cu(H_2O)_6]^{2+} + 4Cl^- \quad [CuCl_4]^{2-} + 6H_2O$

31 Predict which of the following is/are true concerning the CH_3^- ion.

(1) It has bond angles of 120°.

(2) It is an electrophile.

(3) It has two lone pairs of electrons.

(4) It is a base.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

32 The hydrolysis of a metal aqua-cation can be described by the general equation

$$[M(H_2O)_6]^{n+} + H_2O \rightleftharpoons [M(H_2O)_5(OH)]^{(n-1)+} + H_3O^+$$

In this reaction

(1) the solvent H_2O is acting as a base by accepting a proton.

(2) the pH of the solution will be lower if the value of n is 2 rather than 3.

(3) the equilibrium position lies more to the right if the value of n is 3 rather than 2.

(4) the oxidation state of the central metal cation has decreased from n to n–1.

33 Which of the following involve(s) the reduction of a transition metal?

(1) conversion of $[Co(H_2O)_6]^{2+}$ into $[CoCl_4]^{2-}$

(2) conversion of TiO_2 into $TiCl_4$

(3) conversion of CrO_4^{2-} into $Cr_2O_7^{2-}$

(4) conversion of MnO_4^- into MnO_4^{2-}

34 In an experiment, 0.15 mol of ethanol was added dropwise to a hot acidified solution of potassium dichromate(VI). The ethanal formed in the reaction was distilled off as it was formed.

Which of the following statements is/are correct?

(1) 6.9 g of ethanol were used in the reaction.

(2) Both ethanol and ethanal have three different proton environments.

(3) The theoretical yield of ethanal is 6.6 g.

(4) Tollens' reagent will oxidise both ethanol and ethanal to ethanoic acid.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

35 The concentration of a sample of acidified aqueous H_2O_2 can be estimated by titrating against a standard solution of $KMnO_4$ added from a burette. Under these conditions, H_2O_2 is oxidised to O_2

Which of the following statements is/are correct?

(1) The end-point is when the colour changes from purple to colourless.

(2) Dilute H_2SO_4 is a suitable acid for use in this titration.

(3) Each mole of H_2O_2 accepts one mole of electrons.

(4) $[Mn(H_2O)_6]^{2+}$ is formed in the reaction.

36 In which of the following conversions is the organic compound reduced?

(1) $CH_3COOCH_2CH_3 \xrightarrow{OH^-} CH_3CH_2OH$

(2) $(CH_3CO)_2O \xrightarrow{NH_3} CH_3CONH_2$

(3) $CH_3CH(COOH)NH_2 \xrightarrow{H^+} CH_3CH(COOH)NH_3^+$

(4) $CH_3COCH_2CH_3 \xrightarrow{H^-} CH_3CH(OH)CH_2CH_3$

37 An inorganic species acts as a nucleophile in the reaction between

(1) NH_3 and $BrCH_2CH_2CH_3$

(2) H_2O and CH_3COCl

(3) $NaBH_4$ and CH_3COCH_3

(4) HBr and $CH_3CH{=}CH_2$

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

38 Methylbenzene can be made by reacting benzene with chloromethane in the presence of aluminium chloride. The role of the aluminium chloride in this reaction can be described as

(1) electron-pair acceptor.

(2) Lewis base.

(3) catalyst.

(4) oxidising agent.

39 Correct statements about intermolecular forces include

(1) CH_3CH_2OH molecules have van der Waals' forces and permanent dipole–dipole attractions only.

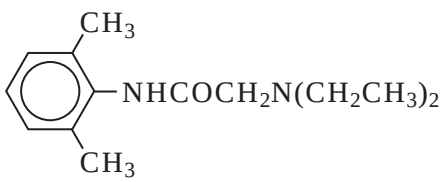
(2) $(CH_3CH_2)_3N$ molecules have van der Waals' forces and permanent dipole–dipole attractions only.

(3) $(CH_3CH_2)_2CO$ molecules have van der Waals' forces and hydrogen bonds only.

(4) CH_3CH_2Cl molecules have van der Waals' forces and permanent dipole–dipole attractions only.

Directions summarised			
A	**B**	**C**	**D**
(1), (2) and (3) only correct	(1) and (3) only correct	(2) and (4) only correct	(4) only correct

40 Xylocaine has the following structure.



True statements about xylocaine include

(1) it is soluble in dilute sodium hydroxide.

(2) it can form a quaternary ammonium salt.

(3) it contains a chiral centre.

(4) it can undergo Friedel–Crafts reactions.