

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

General Certificate of Education  
June 2005  
Advanced Level Examination



**CHEMISTRY**  
**Unit 6a Synoptic Assessment**

**CHM6/W**

Tuesday 28 June 2005 Morning Session

**In addition to this paper you will require:**

- an objective test answer sheet;
- a black ball-point pen;
- a calculator.

Time allowed: 1 hour

**Instructions**

- Use a 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 question paper at the end of this examination.
- The Periodic Table/Data Sheet is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

**Information**

- The maximum mark for this paper is 40.
- 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  $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

**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.

**NO QUESTIONS APPEAR ON THIS PAGE**



**Table 1**  
Proton n.m.r chemical shift data

Type of proton	$\delta/\text{ppm}$
$\text{RCH}_3$	0.7–1.2
$\text{R}_2\text{CH}_2$	1.2–1.4
$\text{R}_3\text{CH}$	1.4–1.6
$\text{RCOCH}_3$	2.1–2.6
$\text{ROCH}_3$	3.1–3.9
$\text{RCOOCH}_3$	3.7–4.1
$\text{ROH}$	0.5–5.0

**Table 2**  
Infra-red absorption data

Bond	Wavenumber/ $\text{cm}^{-1}$
$\text{C—H}$	2850–3300
$\text{C—C}$	750–1100
$\text{C=C}$	1620–1680
$\text{C=O}$	1680–1750
$\text{C—O}$	1000–1300
$\text{O—H}$ (alcohols)	3230–3550
$\text{O—H}$ (acids)	2500–3000

**Multiple choice questions**

Each of Questions 1 to 20 consists of a question or an incomplete statement followed by four suggested answers or completions. You are asked to select the most appropriate answer in each case.

- 1 When 0.10 g of propane was burned the quantity of heat evolved was 5.0 kJ. The enthalpy of combustion of propane in  $\text{kJ mol}^{-1}$  is
- A -800  
B -1500  
C -2200  
D -2900
- 2 Which one of the following statements is correct?
- A The first ionisation energies of the elements in Period 3 show a general decrease from sodium to chlorine.  
B The electronegativities of Group 2 elements decrease from magnesium to barium.  
C The strength of the intermolecular forces increases from hydrogen fluoride to hydrogen chloride.  
D The ability of a halide ion to act as a reducing agent decreases from fluoride to iodide.
- 3 Bromine has the isotopes  $^{79}\text{Br}$  and  $^{81}\text{Br}$ , which are in almost equal abundance. Which one of the following statements is correct?
- A The electronegativity of  $^{79}\text{Br}$  is less than that of  $^{81}\text{Br}$ .  
B The first ionisation energy of  $^{79}\text{Br}$  is less than that of  $^{81}\text{Br}$ .  
C The atomic radius of  $^{81}\text{Br}$  is greater than that of  $^{79}\text{Br}$ .  
D The mass spectrum of  $\text{C}_2\text{H}_5\text{Br}$  has molecular ion peaks with  $m/z = 108$  and 110.

**Turn over** ►

**Questions 4 and 5**

Use the information about the following solutions to answer Questions 4 and 5 below.

**Solution F:** This is a mixture of 1 mol of propanoic acid, 1 mol of methanol and 2 mol of water.

**Solution G:** This was originally the same mixture as solution F but it has been left to reach equilibrium.

4 Compared to the pH of solution F, the pH of solution G will be

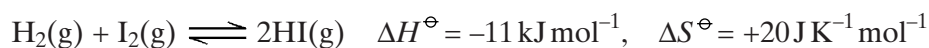
- A considerably lower.
- B slightly lower.
- C slightly higher.
- D exactly the same.

5 Solution G was found to contain 0.5 mol of propanoic acid. Which one of the following is the value of the equilibrium constant ( $K_c$ ) for the following equilibrium?



- A 0.2
- B 1
- C 5
- D 10

6 Refer to the following reaction



Which one of the following statements is correct?

- A This is a redox reaction.
- B The reaction is **not** feasible below 298 K
- C At equilibrium, the yield of hydrogen iodide is changed by increasing the pressure.
- D At equilibrium, the yield of hydrogen iodide increases as the temperature is increased.

- 7 25.0 cm<sup>3</sup> of ethanedioic acid required 22.5 cm<sup>3</sup> of 0.100 mol dm<sup>-3</sup> potassium hydroxide solution for complete neutralisation.

The concentration of ethanedioic acid is

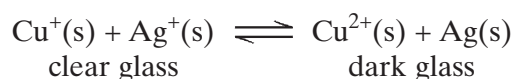
- A 0.0225 mol dm<sup>-3</sup>  
B 0.0450 mol dm<sup>-3</sup>  
C 0.0560 mol dm<sup>-3</sup>  
D 0.0900 mol dm<sup>-3</sup>
- 8 Which one of the following molecules is **not** planar?
- A BF<sub>3</sub>  
B NCl<sub>3</sub>  
C C<sub>2</sub>H<sub>4</sub>  
D HCHO
- 9 Which one of the following statements is **not** correct?
- A The electrical conductivity of aluminium is greater than that of magnesium.  
B Al<sub>2</sub>O<sub>3</sub> dissolves in molten cryolite.  
C The [Al(H<sub>2</sub>O)<sub>5</sub>(OH)]<sup>2+</sup>(aq) ion will react with H<sup>+</sup>(aq) ions and with OH<sup>-</sup>(aq) ions.  
D Aluminium chloride is an ionic compound with a high melting point.
- 10 Which one of the following reactions does **not** involve donation of an electron pair?
- A  $\text{H}^+ + \text{CH}_3\text{NH}_2 \rightarrow \text{CH}_3\text{NH}_3^+$   
B  $\text{AlCl}_3 + \text{Cl}^- \rightarrow \text{AlCl}_4^-$   
C  $\text{CH}_3\text{Cl} + \text{CN}^- \rightarrow \text{CH}_3\text{CN} + \text{Cl}^-$   
D  $\frac{1}{2}\text{Cl}_2 + \text{I}^- \rightarrow \text{Cl}^- + \frac{1}{2}\text{I}_2$

Turn over ►

**Questions 11 and 12**

Use the information below to answer Questions **11** and **12**.

Photochromic glass contains silver ions and copper ions. A simplified version of a redox equilibrium is shown below. In bright sunlight the high energy u.v. light causes silver atoms to form and the glass darkens. When the intensity of the light is reduced the reaction is reversed and the glass lightens.



**11** Which one of the following is a correct electron arrangement?

- A**  $\text{Cu}^+$  is  $[\text{Ar}]3\text{d}^94\text{s}^1$
- B**  $\text{Cu}$  is  $[\text{Ar}]3\text{d}^{10}4\text{s}^2$
- C**  $\text{Cu}^{2+}$  is  $[\text{Ar}]3\text{d}^84\text{s}^1$
- D**  $\text{Cu}^+$  is  $[\text{Ar}]3\text{d}^{10}$

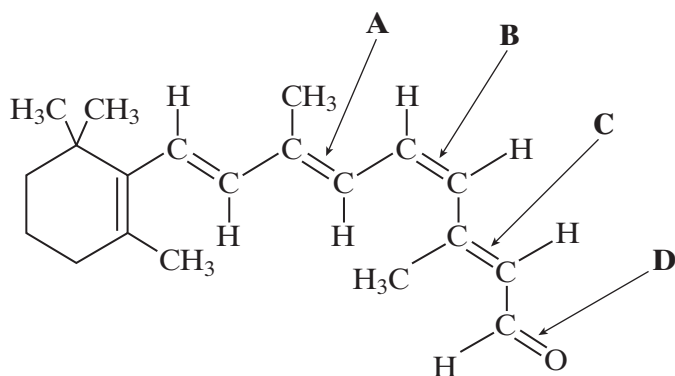
**12** When the photochromic glass darkens

- A** the  $\text{Ag}^+$  ion is acting as an electron donor.
- B** the  $\text{Cu}^+$  ion is acting as a reducing agent.
- C** the  $\text{Ag}^+$  ion is oxidised.
- D** the  $\text{Cu}^+$  ion is reduced.

- 13 Silver oxide,  $\text{Ag}_2\text{O}$ , can be reduced by passing hydrogen gas over the heated oxide. The maximum mass of silver that could be obtained from 2.32 g of silver oxide is

- A 2.02 g
- B 2.06 g
- C 2.12 g
- D 2.16 g

- 14 The compound *cis*-retinal is shown below.

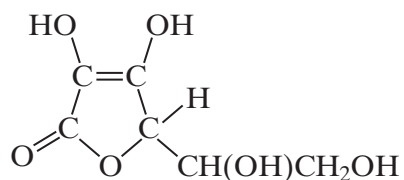


Which one of the labelled bonds leads to the prefix in the name?

**TURN OVER FOR THE NEXT QUESTION**

Turn over ►

- 15 How many different alkenes are formed when 2-bromo-2-methylbutane reacts with ethanolic potassium hydroxide?
- A 2  
B 3  
C 4  
D 5
- 16 Which one of the following is a pair of functional group isomers?
- A  $\text{CH}_3\text{COOCH}_2\text{CH}_3$  and  $\text{CH}_3\text{CH}_2\text{COOCH}_3$   
B  $(\text{CH}_3)_2\text{CHCH}(\text{CH}_3)_2$  and  $(\text{CH}_3)_3\text{CCH}_2\text{CH}_3$   
C  $\text{CH}_3\text{CH}_2\text{OCH}_3$  and  $(\text{CH}_3)_2\text{CHOH}$   
D  $\text{ClCH}_2\text{CH}_2\text{CH}=\text{CH}_2$  and  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{Cl}$
- 17 Which one of the following is **not** a correct statement about vitamin C, shown below?



- A It is a cyclic ester.  
B It can form a carboxylic acid on oxidation.  
C It decolourises a solution of bromine in water.  
D It is a planar molecule.

- 18 Which one of the following reactions will produce an organic compound that has optical isomers?
- A dehydration of butan-2-ol by heating with concentrated sulphuric acid
  - B reduction of pentan-3-one by warming with  $\text{NaBH}_4$
  - C addition of  $\text{Br}_2$  to 3-bromopropene
  - D reduction of 2,3-dimethylpent-2-ene with  $\text{H}_2$  in the presence of a nickel catalyst
- 19 In a reaction which gave a 27.0% yield, 5.00 g of methylbenzene were converted into the explosive 2,4,6-trinitromethylbenzene (TNT) ( $M_r = 227.0$ ). The mass of TNT formed was
- A 1.35 g
  - B 3.33 g
  - C 3.65 g
  - D 12.34 g
- 20 Which one of the following pairs reacts to form an organic product with only 2 singlets in its proton n.m.r. spectrum?
- A ethene and bromine
  - B propan-2-ol and acidified potassium dichromate(VI)
  - C ethanol and concentrated sulphuric acid
  - D epoxyethane and water in the presence of dilute sulphuric acid

**TURN OVER FOR THE NEXT QUESTION**

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**Multiple completion questions**

For each of Questions **21** to **40**, **one or more** of the options given may be correct. Select your answer by means of the following code.

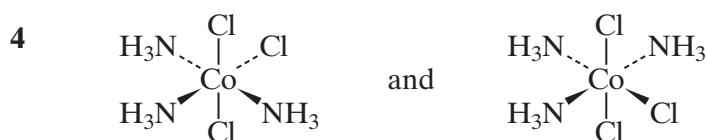
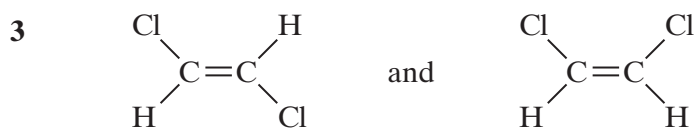
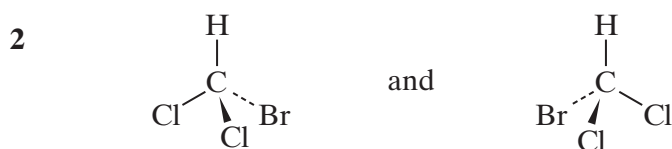
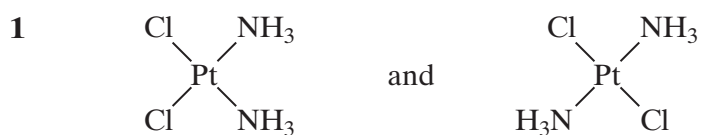
- A** if **1, 2** and **3** only are correct.  
**B** if **1** and **3** only are correct.  
**C** if **2** and **4** only are correct.  
**D** if **4** only is correct.

Directions summarised			
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>1, 2</b> and <b>3</b> only correct	<b>1</b> and <b>3</b> only correct	<b>2</b> and <b>4</b> only correct	<b>4</b> only correct

- 21** Reactions with a positive entropy change include the complete combustion in oxygen of (all reactants and products are in the gas phase)
- 1 hydrogen.
  - 2 ethane.
  - 3 carbon monoxide.
  - 4 methanol.
- 22** Calcium hydride,  $\text{CaH}_2$ , is an ionic compound that contains  $\text{H}^-$  ions. The Born–Haber cycle for the formation of  $\text{CaH}_2$  from  $\text{Ca}(\text{s})$  and  $\text{H}_2(\text{g})$  does **not** involve
- 1 the sublimation energy of calcium.
  - 2 the first ionisation energy of calcium.
  - 3 the atomisation energy of hydrogen.
  - 4 the ionisation energy of hydrogen.

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

23 Pairs of isomers include



**TURN OVER FOR THE NEXT QUESTION**

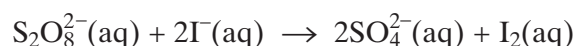
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Directions summarised			
A	B	C	D
1, 2 and 3 only correct	1 and 3 only correct	2 and 4 only correct	4 only correct

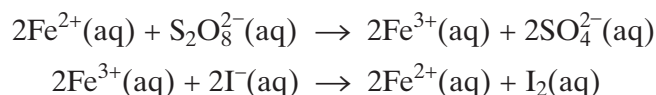
**Questions 24 to 26**

Use the following information to answer Questions 24 to 26.

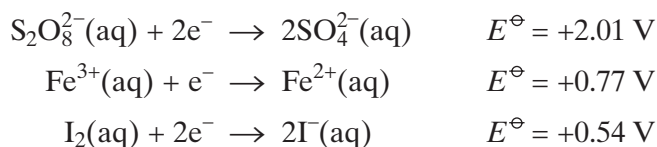
Peroxodisulphate ions ( $\text{S}_2\text{O}_8^{2-}$ ) convert iodide ions into iodine but the reaction is very slow.



The rate of the reaction can be increased by the addition of aqueous iron(II) ions that act as a catalyst.



Electrode potential data are given below.



**24** Correct statements include

- 1  $\text{S}_2\text{O}_8^{2-}$  is a more powerful oxidising agent than  $\text{Fe}^{3+}$
- 2 the oxidation state of sulphur in  $\text{SO}_4^{2-}$  is +4
- 3 the conversion of  $\text{I}^-$  into  $\text{I}_2$  is an oxidation reaction.
- 4  $\text{Fe}^{2+}$  is a more powerful reducing agent than  $\text{I}^-$

**25** Correct statements include

- 1 the electron arrangement of  $\text{Fe}^{3+}$  is  $[\text{Ar}] 3\text{d}^5$
- 2 the uncatalysed reaction is slow because it involves the reaction of two negative ions.
- 3 the oxidation state of the catalyst changes between +2 and +3
- 4 the  $\text{Fe}^{2+}$  acts as a heterogeneous catalyst.

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 Correct statements about the cell e.m.f. include

- 1 it is 2.78 V for the cell-reaction  
 $2\text{Fe}^{2+}(\text{aq}) + \text{S}_2\text{O}_8^{2-}(\text{aq}) \rightarrow 2\text{Fe}^{3+}(\text{aq}) + 2\text{SO}_4^{2-}(\text{aq})$
- 2 it is 1.47 V for the cell-reaction  
 $\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow 2\text{SO}_4^{2-}(\text{aq}) + \text{I}_2(\text{aq})$
- 3 it is 1.31 V for the cell-reaction  
 $2\text{Fe}^{3+}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow 2\text{Fe}^{2+}(\text{aq}) + \text{I}_2(\text{aq})$
- 4 the overall cell e.m.f. for the catalysed cell-reaction is the same as the cell e.m.f. for the uncatalysed reaction.

27 Molecules with a permanent overall dipole include

- 1  $\text{CH}_3\text{Cl}$
- 2  $\text{C}(\text{CH}_3)_4$
- 3  $\text{CHCl}_3$
- 4  $\text{CCl}_4$

28 Reactions in which the oxidation state of an element increases include

- 1  $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$
- 2  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$
- 3  $\text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O} \rightarrow 2\text{CrO}_4^{2-} + 2\text{H}^+$
- 4  $2\text{FeCl}_2 + \text{Cl}_2 \rightarrow 2\text{FeCl}_3$

29 Substances that release a gas when treated with aqueous sodium carbonate include

- 1  $\text{Cr}_2(\text{SO}_4)_3$
- 2  $\text{HCOOCH}_3$
- 3  $\text{HOCH}_2\text{COOH}$
- 4  $\text{FeCl}_2$

Turn over ►

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

**30** A precipitate is formed when aqueous silver nitrate, in the presence of an excess of aqueous ammonia, reacts with

- 1 NaCl(aq)
- 2 KI(aq)
- 3 (CH<sub>3</sub>)<sub>2</sub>CO(aq)
- 4 CH<sub>3</sub>CHO(aq)

**31** Concentrated sulphuric acid will

- 1 dehydrate 2-methylpropan-2-ol.
- 2 form NO<sub>2</sub><sup>+</sup> ions from concentrated nitric acid.
- 3 oxidise bromide ions to bromine.
- 4 form a buffer solution when partially neutralised with sodium hydroxide.

**32** Reactions that involve simultaneous oxidation and reduction of the same species include

- 1  $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$
- 2  $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + \text{Cl}_2 + 2\text{H}_2\text{O}$
- 3  $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$
- 4  $14\text{HI} + 2\text{H}_2\text{SO}_4 \rightarrow 7\text{I}_2 + \text{S} + \text{H}_2\text{S} + 8\text{H}_2\text{O}$

**33** Species that contain two or more co-ordinate bonds include

- 1 Al<sub>2</sub>Cl<sub>6</sub>
- 2 [Fe(H<sub>2</sub>O)<sub>5</sub>(OH)]<sup>2+</sup>
- 3 CuCl<sub>4</sub><sup>2-</sup>
- 4 PCl<sub>6</sub><sup>-</sup>

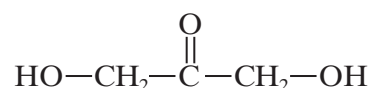
Directions summarised			
A	B	C	D
1, 2 and 3 only correct	1 and 3 only correct	2 and 4 only correct	4 only correct

- 34** One mole of each of the following compounds was burned completely in an excess of oxygen. Exactly 9 mol of oxygen were required by
- 1  $C_5H_{12}O$
  - 2  $C_6H_{12}$
  - 3  $C_6H_{14}$
  - 4  $C_6H_{14}O$
- 35** Hydrogen bonding occurs in liquid samples of
- 1 propanal.
  - 2 propanoic acid.
  - 3 propanoic anhydride.
  - 4 propylamine.
- 36** Correct statements about the ion  $CH_3CH_2^+$  include
- 1 it is a fragment formed from butanone in the mass spectrometer.
  - 2 it acts as the electrophile in the reaction of benzene with  $CH_3CH_2Cl$  in the presence of  $AlCl_3$
  - 3 it is formed in the reaction of ethene with  $HBr$
  - 4 it is formed in the acid-catalysed dehydration of butan-2-ol.
- 37** Correct statements about the compound  $CH_3COCH_2CH_2COOCH_3$  ( $M_r = 130$ ) include
- 1 it contains 36.9% of oxygen by mass.
  - 2 it has two singlets and two triplets in its proton n.m.r. spectrum.
  - 3 it has two strong absorptions between  $1680$  and  $1750\text{ cm}^{-1}$  in its infra-red spectrum.
  - 4 it has a major peak at  $m/z = 57$  in its mass spectrum.

Turn over ►

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

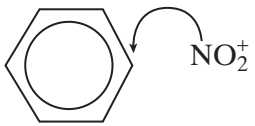
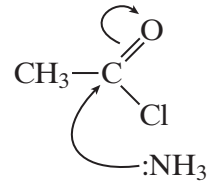
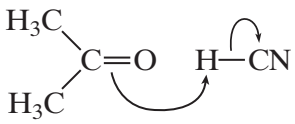
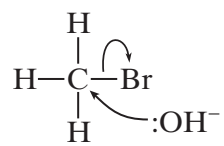
38 The compound DHA, shown below, is used in the cosmetics industry to produce fake sun-tan.



Correct statements about DHA include

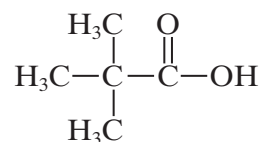
- 1 it can be oxidised readily by acidified  $\text{K}_2\text{Cr}_2\text{O}_7$
- 2 it shows a broad absorption between  $3230$  and  $3550\text{cm}^{-1}$  in its infra-red spectrum.
- 3 it undergoes nucleophilic addition with  $\text{HCN}$
- 4 it has 4 peaks in its n.m.r. spectrum with areas in the ratio of 1:2:2:1

39 Correct mechanistic steps in the reactions between the following reagents include

	Reagents	Step
1	benzene and nitric acid	
2	ethanoyl chloride and ammonia	
3	propanone and hydrogen cyanide	
4	bromomethane and sodium hydroxide	

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 Correct statements about the following compound include



- 1 it can be oxidised with acidified potassium dichromate(VI).
- 2 it has two singlet peaks in the proton n.m.r. spectrum with areas in the ratio of 9:1
- 3 it has the systematic name 1,1,1-trimethylethanoic acid.
- 4 it will form a salt with methylamine.

**END OF QUESTIONS**

**THERE ARE NO QUESTIONS PRINTED ON THIS PAGE**