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Centre Number						Candidate Number					
Candidate Signature											

For Examiner's Use

General Certificate of Education
June 2008
Advanced Level Examination



CHEMISTRY
Unit 6a Synoptic Assessment

CHM6/W

Thursday 19 June 2008 9.00 am to 10.00 am

For this paper you must have:

- an objective test answer sheet,
- 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 answer book 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

- 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.

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.

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 Which one of the following solids contains covalent bonds but not ionic bonds?
- A $\text{C}_6\text{H}_5\text{COOH}$
- B CuSO_4
- C NH_4Br
- D $\text{CH}_3\text{NH}_3\text{Cl}$
- 2 Which one of the following has the same electronic arrangement as Li^+ ?
- A Na^+
- B Be^{2+}
- C F^-
- D Ne
- 3 What is the final pH of the solution obtained when 0.200 mol of sodium propanoate is added to 1.00 dm^3 of a $0.100 \text{ mol dm}^{-3}$ solution of propanoic acid ($K_a = 1.30 \times 10^{-5} \text{ mol dm}^{-3}$)?
- A 6.59
- B 5.19
- C 4.59
- D 2.84

The Periodic Table of the Elements

- The atomic numbers and approximate relative atomic masses shown in the table are for use in the examination unless stated otherwise in an individual question.

[illegible]

Gas constant $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Table 1
Proton n.m.r chemical shift data

Type of proton	δ/ppm
RCH_3	0.7–1.2
R_2CH_2	1.2–1.4
R_3CH	1.4–1.6
RCOCH_3	2.1–2.6
ROCH_3	3.1–3.9
RCOOCH_3	3.7–4.1
ROH	0.5–5.0

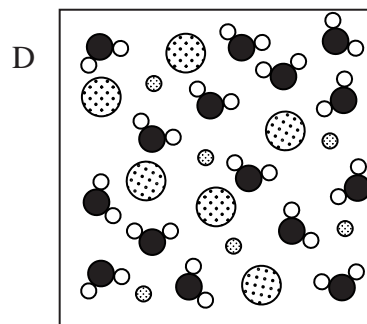
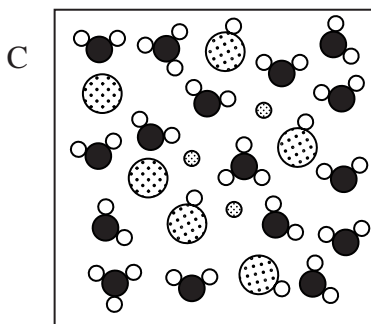
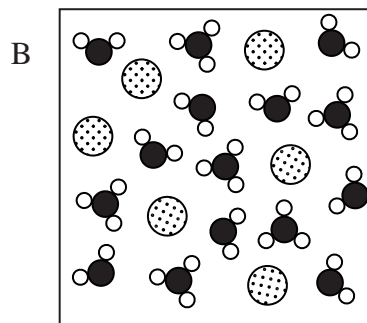
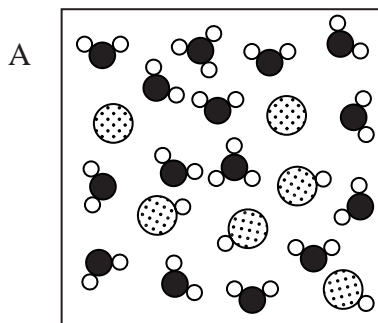
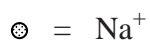
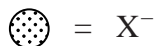
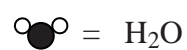
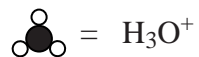
Table 2
Infra-red absorption data

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

Questions 4 to 6

The diagrams represent some dilute aqueous solutions.

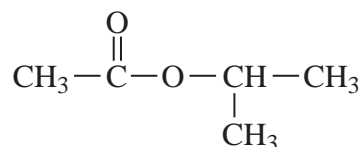
In all cases, only a few of the large numbers of water molecules are shown.



Which one of the diagrams represents

- 4 a solution of a strong acid?
- 5 a solution of a salt formed by neutralising a strong acid with sodium hydroxide?
- 6 a solution of a weak acid partially neutralised by sodium hydroxide?

- 7 The largest mass of silver chloride is precipitated when an excess of silver nitrate solution is added to
- A 25.0 cm³ of a 0.800 mol dm⁻³ solution of hydrochloric acid.
- B 50.0 cm³ of a 0.500 mol dm⁻³ solution of sodium chloride.
- C 50.0 cm³ of a 0.200 mol dm⁻³ solution of magnesium chloride.
- D 30.0 cm³ of a 0.300 mol dm⁻³ solution of iron(III) chloride.
- 8 Titanium ore is processed to give a concentrate containing 95%, by mass, of titanium(IV) oxide. The percentage by mass of titanium in this concentrate is
- A 25
- B 39
- C 57
- D 76
- 9 Four possible thermal decomposition reactions of N₂O₅(s) are shown below. Which one of the following reactions has the largest mole fraction of oxygen gas in its product mixture?
- A $\text{N}_2\text{O}_5(\text{s}) \rightarrow \text{N}_2\text{O}_3(\text{g}) + \text{O}_2(\text{g})$
- B $\text{N}_2\text{O}_5(\text{s}) \rightarrow \text{N}_2\text{O}_4(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$
- C $\text{N}_2\text{O}_5(\text{s}) \rightarrow 2\text{NO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$
- D $\text{N}_2\text{O}_5(\text{s}) \rightarrow \text{NO}_2(\text{g}) + \text{NO}(\text{g}) + \text{O}_2(\text{g})$
- 10 Which one of the statements about the following ester is correct?



- A It is a chain isomer of pentanoic acid.
- B It is a functional group isomer of ethyl propanoate.
- C It can be hydrolysed to produce an alcohol that can also be formed by the acid-catalysed hydration of propene.
- D It can be hydrolysed to produce an alcohol that is resistant to oxidation by acidified potassium dichromate(VI).

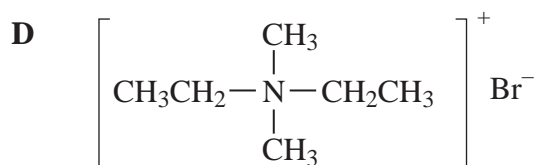
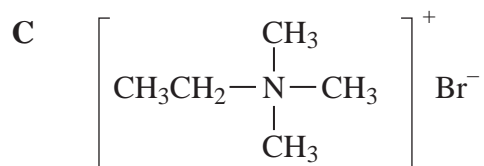
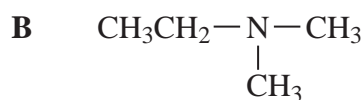
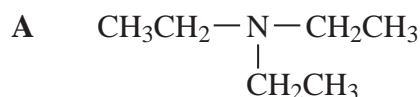
11 Which one of the following reactions produces a compound that could be used as a monomer in the formation of an addition polymer that contains chlorine atoms?

- A** The addition of one molecule of HCl to 1,2-dichloroethene.
- B** The addition of one molecule of HCl to propene.
- C** The elimination of one molecule of HCl from 2-chloropropane.
- D** The elimination of one molecule of HCl from 1,2-dichloroethane.

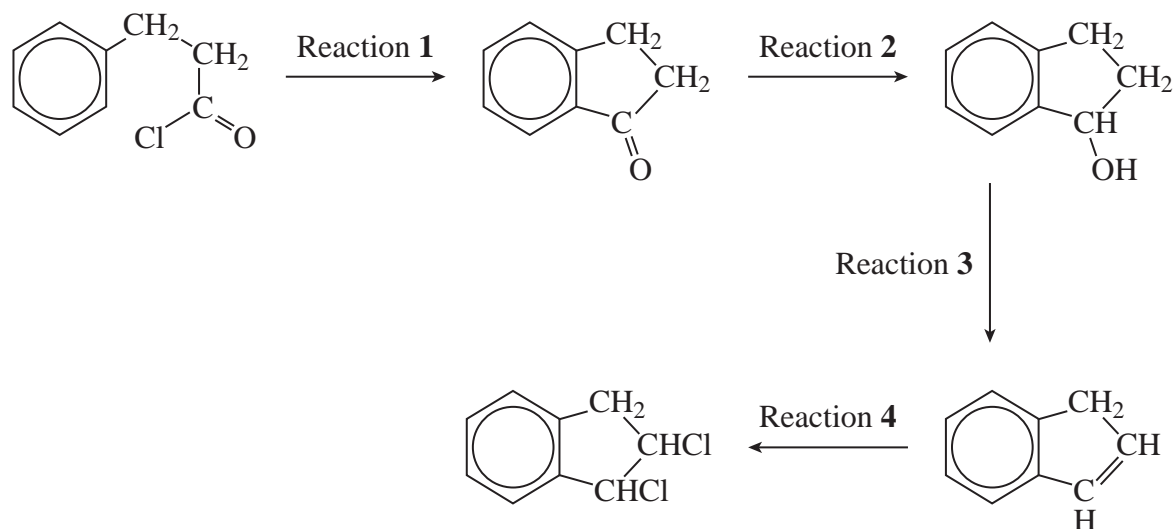
12 Which one of the following reacts with butanedioic acid to form a condensation polymer?

- A** The product from the reaction of epoxyethane with water.
- B** The product from the reaction of ethanoic anhydride with water.
- C** The product from the reaction of ethanal with HCN
- D** The product from the reaction of ethene with bromine.

13 Which one of the following is formed when an excess of bromomethane reacts with diethylamine?



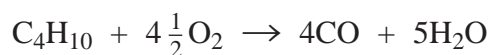
14 A sequence of reactions is shown below.



A correct list of substances for the sequence is

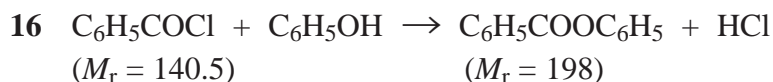
	Reaction 1	Reaction 2	Reaction 3	Reaction 4
A	CH_3COCl	NaBH_4	conc H_2SO_4	Cl_2
B	AlCl_3	HCl	NaOH	Cl_2
C	AlCl_3	NaBH_4	conc H_2SO_4	HCl
D	AlCl_3	NaBH_4	conc H_2SO_4	Cl_2

15 An equation for the incomplete combustion of butane in oxygen is



The volume in dm^3 of oxygen at 295 K and 100 kPa required to burn 0.10 mol of butane to form steam and carbon monoxide only is

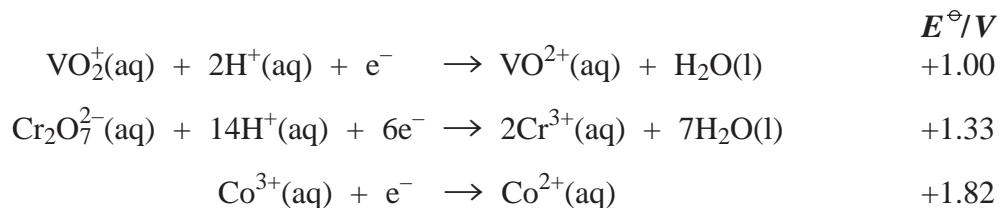
- A** 8.6
- B** 11
- C** 12
- D** 16



In the reaction above, 1.20 g of the acyl chloride produced 0.800 g of the ester. The percentage yield was

- A 47.3
B 66.7
C 71.0
D 94.0
- 17 The compound CF_3CHBrCl is a general anaesthetic called halothane. The number of structural isomers, including halothane, having the molecular formula $\text{C}_2\text{HBrClF}_3$ is
- A 2
B 3
C 4
D 5
- 18 Which one of the following statements is correct?
- A HI has a higher boiling point than HCl because HI has stronger hydrogen bonding.
B PCl_5 is hydrolysed by water to form a weakly acidic solution.
C The reducing ability of the halide ions increases as the size of the anion increases.
D The solubility of the Group II hydroxides decreases as the size of the cation increases.
- 19 Which one of the following statements is correct?
- A $[\text{Al}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$ will react with an excess of $\text{NH}_3(\text{aq})$ to form $[\text{Al}(\text{NH}_3)_6]^{3+}(\text{aq})$.
B In the electrolysis of aluminium oxide, aluminium metal and oxygen gas are formed in the mole ratio 2:3.
C When concentrated $\text{NH}_3(\text{aq})$ is added to AgBr , $[\text{Ag}(\text{NH}_3)_2]^+(\text{aq})$ is formed.
D In the reduction of TiCl_4 by sodium, nitrogen is used as an inert atmosphere.

20 Consider the half-equations given below.



Which one of the following statements is **not** correct?

- A When $\text{VO}_2^+(\text{aq})$ forms $\text{VO}^{2+}(\text{aq})$, the oxidation state of vanadium changes from +5 to +4.
- B Acidified potassium dichromate(VI) can oxidise $\text{VO}^{2+}(\text{aq})$ to $\text{VO}_2^+(\text{aq})$ under standard conditions.
- C The electron arrangement of a Co^{3+} ion is $[\text{Ar}]3\text{d}^6$.
- D An acidified solution containing $\text{VO}_2^+(\text{aq})$ ions can oxidise $\text{Co}^{2+}(\text{aq})$ to $\text{Co}^{3+}(\text{aq})$ under standard conditions.

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.

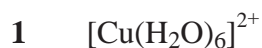
B if **1** and **3** only are correct.

C if **2** and **4** only are correct.

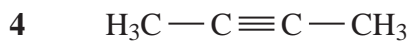
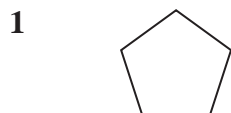
D if **4** only is correct.

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

21 A substitution reaction occurs when ammonia reacts with

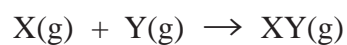


22 Hydrocarbons which contain 85.7% by mass of carbon include



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 Gas X reacts with gas Y according to the following equation



The rate equation for the reaction is

$$\text{rate} = k[\text{X}][\text{Y}]^2$$

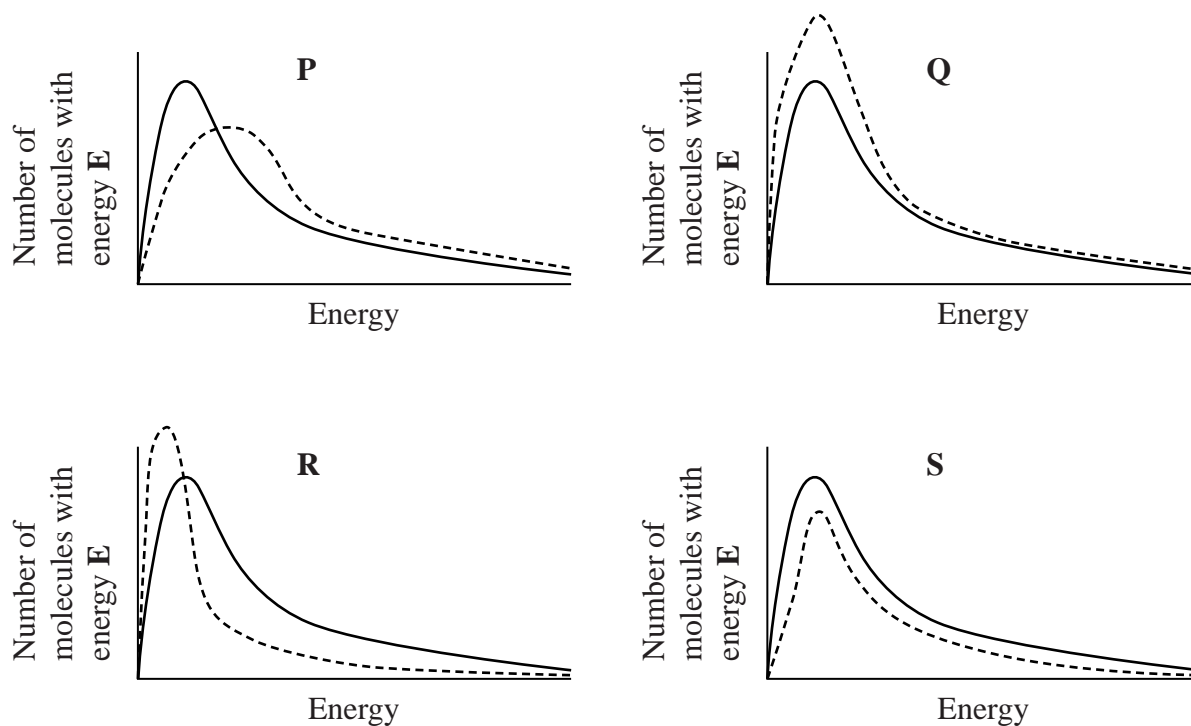
At constant temperature, correct statements include

- 1** doubling the concentration of X, keeping the concentration of Y constant, will double the rate of reaction.
- 2** halving the concentration of Y, keeping the concentration of X constant, will decrease the rate by a factor of 8.
- 3** trebling the concentration of both X and Y will increase the rate by a factor of 27.
- 4** quadrupling the concentration of Y, keeping the concentration of X constant, will increase the rate by a factor of 64.

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 and 25

The diagrams **P**, **Q**, **R** and **S** show how a change in conditions affects the Maxwell-Boltzmann distribution of molecular energies for gas G. In each case, the original distribution is shown by a solid line and the distribution after a change has been made is shown by a dashed line.



24 Correct statements at constant volume include

- 1 the change shown in diagram **P** occurs when the temperature is decreased.
- 2 the change shown in diagram **Q** occurs when a catalyst is used.
- 3 the change shown in diagram **R** occurs when the temperature is increased.
- 4 the change shown in diagram **S** occurs when the pressure of G is decreased at constant temperature.

25 Diagrams that illustrate changes which alter the value of the rate constant for the decomposition of gas G include

- 1 **P**
- 2 **Q**
- 3 **R**
- 4 **S**

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 Substances that form acidic solutions when added to water include

- 1 AlCl_3
- 2 Cl_2
- 3 CH_3COCl
- 4 NaCl

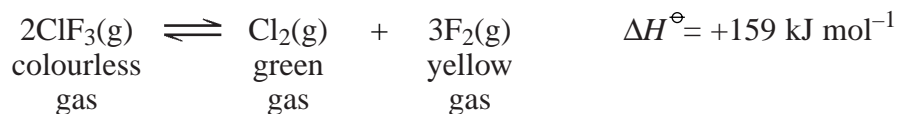
27 Species with at least one bond angle of 90° include

- 1 XeF_4
- 2 PF_5
- 3 $[\text{Co}(\text{NH}_3)_6]^{3+}$
- 4 $\text{Si}(\text{CH}_3)_4$

28 Solutions that form bubbles of a gas with solid Na_2CO_3 include

- 1 $\text{CH}_3\text{CHO}(\text{aq})$
- 2 $\text{HCOOH}(\text{aq})$
- 3 $\text{CrCl}_2(\text{aq})$
- 4 $\text{CrCl}_3(\text{aq})$

29 Chlorine trifluoride can be decomposed into its elements:

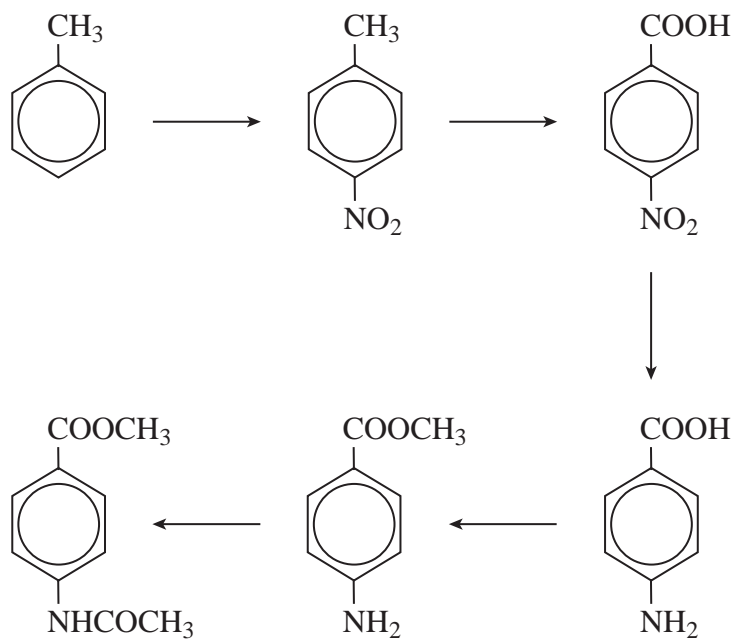


Correct statements include

- 1 the decomposition is a redox reaction.
- 2 when an equilibrium mixture is heated its colour fades.
- 3 when the pressure of an equilibrium mixture is decreased more Cl_2 is formed.
- 4 the decomposition has a negative entropy change.

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 Consider the following reaction scheme.



Types of mechanism involved in this sequence include

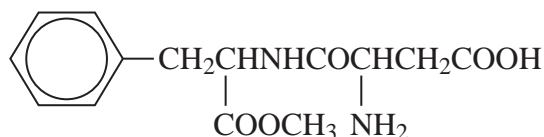
- 1 electrophilic addition.
- 2 electrophilic substitution.
- 3 nucleophilic substitution.
- 4 nucleophilic addition-elimination.

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

31 On melting, covalent bonds must break in

- 1 poly(ethene).
- 2 bromine.
- 3 sulphur dioxide.
- 4 silicon dioxide.

32 The artificial sweetener aspartame has the structure



Correct statements about aspartame include

- 1 it can form a zwitterion.
- 2 it can undergo alkaline hydrolysis.
- 3 it contains an amide link.
- 4 it has three chiral carbon atoms.

33 Species that can act as both oxidising and reducing agents include

- 1 CH_3CHO
- 2 Fe
- 3 Fe^{2+}
- 4 Fe^{3+}

34 Reactants that form an organic product which has an asymmetric carbon atom include

- 1 but-2-ene and HBr
- 2 propanone and NaBH_4
- 3 propanal and HCN
- 4 epoxyethane and H_2O

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

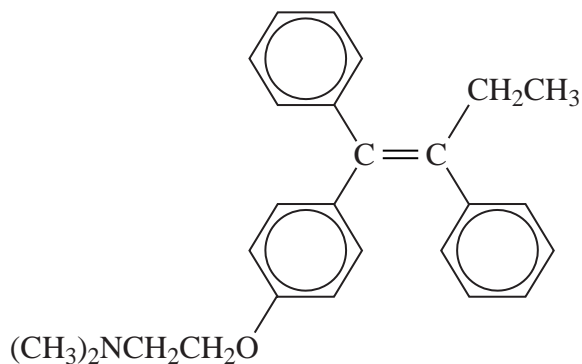
35 Compound X has the following characteristics

- it has an infra-red spectrum with a strong absorption at around 1700 cm^{-1}
- it has a proton n.m.r. spectrum with only two peaks
- it has a mass spectrum with a major peak at $m/z = 57$

Compound X could be

- 1 butanone.
- 2 pentan-3-one.
- 3 propanal.
- 4 2,2-dimethylpropanal.

36 The drug tamoxifen, which is used in the treatment of cancer, has the structure

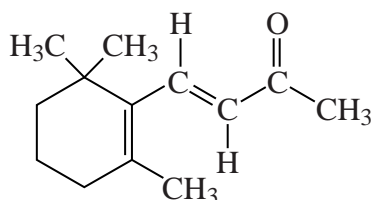


Correct statements about tamoxifen include

- 1 it can undergo electrophilic addition with bromine.
- 2 it has a stereoisomer.
- 3 it can undergo electrophilic substitution with ethanoyl chloride.
- 4 it is insoluble in hydrochloric 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

37 Ionone, shown below, is a compound responsible for the smell of raspberries.



Mechanisms involved in reactions of ionone include

- 1 electrophilic addition.
- 2 electrophilic substitution.
- 3 nucleophilic addition.
- 4 nucleophilic substitution.

38 Functional group isomers include

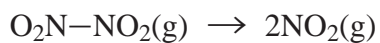
- | | | | |
|---|------------------------------------------------------------------|-----|----------------------------------------------------------------------|
| 1 | CH ₃ CH ₂ CHBrCH ₃ | and | CH ₃ CH ₂ CH ₂ CH ₂ Br |
| 2 | CH ₃ CH ₂ COOH | and | HCOOCH ₂ CH ₃ |
| 3 | CH ₃ CH ₂ CH(NH ₂)COOH | and | H ₂ NCH ₂ CH ₂ CH ₂ COOH |
| 4 | CH ₃ CH ₂ OCH ₂ CH ₃ | and | CH ₃ CH(OH)CH ₂ CH ₃ |

39 Correct statements include

- 1 when SiCl₄ is added to water, a precipitate is formed.
- 2 sulphur has a higher melting point than phosphorus because the intermolecular attractions are stronger.
- 3 when AlCl₃ is dissolved in water, [Al(H₂O)₅(OH)]²⁺(aq) is one of the ions formed.
- 4 when concentrated H₂SO₄ reacts with solid NaBr, the only gaseous product is HBr.

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 Consider the following reaction, which involves the breaking of only one covalent bond.



Correct statements include

- 1 ΔH is positive.
- 2 ΔG is always positive.
- 3 ΔS is positive.
- 4 the reaction is feasible at any temperature.

END OF QUESTIONS

There are no questions printed on this page