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Centre Number		Candidate Number	
Candidate Signature			

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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.

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**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.

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- 1 Which one of the following solids contains covalent bonds but not ionic bonds?
- A  $\text{C}_6\text{H}_5\text{COOH}$
  - B  $\text{CuSO}_4$
  - C  $\text{NH}_4\text{Br}$
  - D  $\text{CH}_3\text{NH}_3\text{Cl}$
- 2 Which one of the following has the same electronic arrangement as  $\text{Li}^+$ ?
- A  $\text{Na}^+$
  - B  $\text{Be}^{2+}$
  - C  $\text{F}^-$
  - D Ne
- 3 What is the final pH of the solution obtained when 0.200 mol of sodium propanoate is added to  $1.00 \text{ dm}^3$  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.

I		II		III		IV		V		VI		VII		0				
1.0 <b>H</b> Hydrogen 1															4.0 <b>He</b> Helium 2			
6.9 <b>Li</b> Lithium 3	9.0 <b>Be</b> Beryllium 4	6.9 <b>Li</b> Lithium 3													20.2 <b>Ne</b> Neon 10			
23.0 <b>Na</b> Sodium 11	24.3 <b>Mg</b> Magnesium 12	relative atomic mass													35.5 <b>Cl</b> Chlorine 17			
		atomic number													39.9 <b>Ar</b> Argon 18			
39.1 <b>K</b> Potassium 19	40.1 <b>Ca</b> Calcium 20	47.9 <b>Ti</b> Titanium 22	45.0 <b>Sc</b> Scandium 21	50.9 <b>V</b> Vanadium 23	52.0 <b>Cr</b> Chromium 24	54.9 <b>Mn</b> Manganese 25	55.8 <b>Fe</b> Iron 26	58.9 <b>Co</b> Cobalt 27	58.7 <b>Ni</b> Nickel 28	63.5 <b>Cu</b> Copper 29	65.4 <b>Zn</b> Zinc 30	69.7 <b>Ga</b> Gallium 31	72.6 <b>Ge</b> Germanium 32	74.9 <b>As</b> Arsenic 33	79.0 <b>Se</b> Selenium 34	79.9 <b>Br</b> Bromine 35	83.8 <b>Kr</b> Krypton 36	
85.5 <b>Rb</b> Rubidium 37	87.6 <b>Sr</b> Strontium 38	91.2 <b>Zr</b> Zirconium 40	88.9 <b>Y</b> Yttrium 39	92.9 <b>Nb</b> Niobium 41	95.9 <b>Mo</b> Molybdenum 42	98.9 <b>Tc</b> Technetium 43	101.1 <b>Ru</b> Ruthenium 44	102.9 <b>Rh</b> Rhodium 45	106.4 <b>Pd</b> Palladium 46	107.9 <b>Ag</b> Silver 47	112.4 <b>Cd</b> Cadmium 48	114.8 <b>In</b> Indium 49	118.7 <b>Sn</b> Tin 50	121.8 <b>Sb</b> Antimony 51	127.6 <b>Te</b> Tellurium 52	126.9 <b>I</b> Iodine 53	131.3 <b>Xe</b> Xenon 54	
132.9 <b>Cs</b> Caesium 55	137.3 <b>Ba</b> Barium 56	178.5 <b>Hf</b> Hafnium 72	138.9 <b>La</b> Lanthanum 57	180.9 <b>Ta</b> Tantalum 73	183.9 <b>W</b> Tungsten 74	186.2 <b>Re</b> Rhenium 75	190.2 <b>Os</b> Osmium 76	192.2 <b>Ir</b> Iridium 77	195.1 <b>Pt</b> Platinum 78	197.0 <b>Au</b> Gold 79	200.6 <b>Hg</b> Mercury 80	204.4 <b>Tl</b> Thallium 81	207.2 <b>Pb</b> Lead 82	209.0 <b>Bi</b> Bismuth 83	210.0 <b>Po</b> Polonium 84	210.0 <b>At</b> Astatine 85	222.0 <b>Rn</b> Radon 86	
223.0 <b>Fr</b> Francium 87	226.0 <b>Ra</b> Radium 88		227 <b>Ac</b> Actinium 89															

\* 58 – 71 Lanthanides

140.1 <b>Ce</b> Cerium 58	140.9 <b>Pr</b> Praseodymium 59	144.2 <b>Nd</b> Neodymium 60	144.9 <b>Pm</b> Promethium 61	150.4 <b>Sm</b> Samarium 62	152.0 <b>Eu</b> Europium 63	157.3 <b>Gd</b> Gadolinium 64	158.9 <b>Tb</b> Terbium 65	162.5 <b>Dy</b> Dysprosium 66	164.9 <b>Ho</b> Holmium 67	167.3 <b>Er</b> Erbium 68	168.9 <b>Tm</b> Thulium 69	173.0 <b>Yb</b> Ytterbium 70	175.0 <b>Lu</b> Lutetium 71
232.0 <b>Th</b> Thorium 90	231.0 <b>Pa</b> Protactinium 91	238.0 <b>U</b> Uranium 92	237.0 <b>Np</b> Neptunium 93	239.1 <b>Pu</b> Plutonium 94	243.1 <b>Am</b> Americium 95	247.1 <b>Cm</b> Curium 96	247.1 <b>Bk</b> Berkelium 97	252.1 <b>Cf</b> Californium 98	(252) <b>Es</b> Einsteinium 99	(257) <b>Fm</b> Fermium 100	(258) <b>Md</b> Mendelevium 101	(259) <b>No</b> Nobelium 102	(260) <b>Lr</b> Lawrencium 103

† 90 – 103 Actinides

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

**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

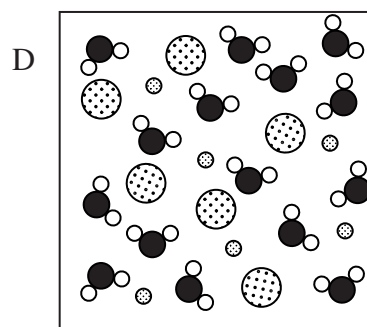
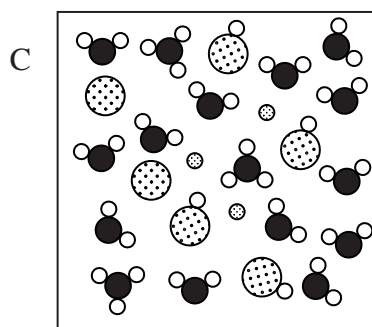
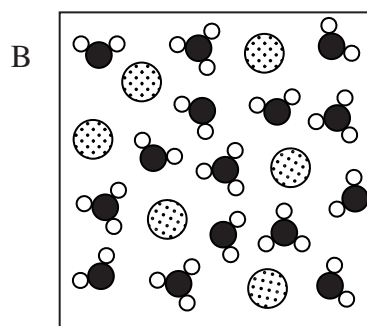
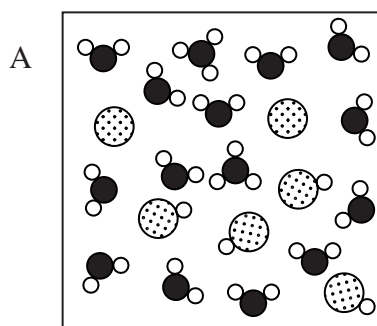
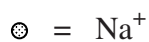
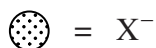
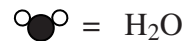
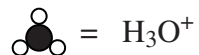
**Table 2**  
Infra-red absorption data

Bond	Wavenumber/ $\text{cm}^{-1}$
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.

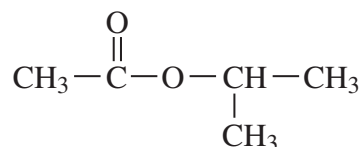


Which one of the diagrams represents

- 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?

Turn over ►

- 7 The largest mass of silver chloride is precipitated when an excess of silver nitrate solution is added to
- A 25.0 cm<sup>3</sup> of a 0.800 mol dm<sup>-3</sup> solution of hydrochloric acid.
- B 50.0 cm<sup>3</sup> of a 0.500 mol dm<sup>-3</sup> solution of sodium chloride.
- C 50.0 cm<sup>3</sup> of a 0.200 mol dm<sup>-3</sup> solution of magnesium chloride.
- D 30.0 cm<sup>3</sup> of a 0.300 mol dm<sup>-3</sup> 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 N<sub>2</sub>O<sub>5</sub>(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).

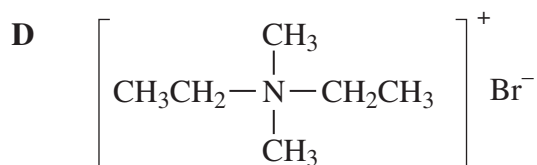
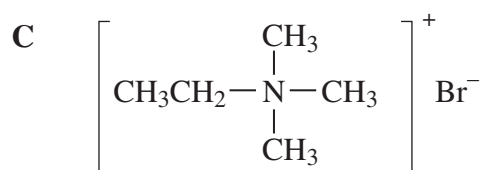
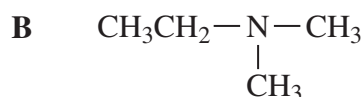
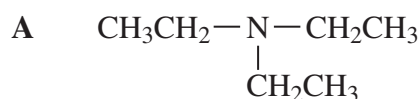
11 Which one of the following reactions produces a compound that could be used as a monomer in the formation of an addition polymer that contains chlorine atoms?

- 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.

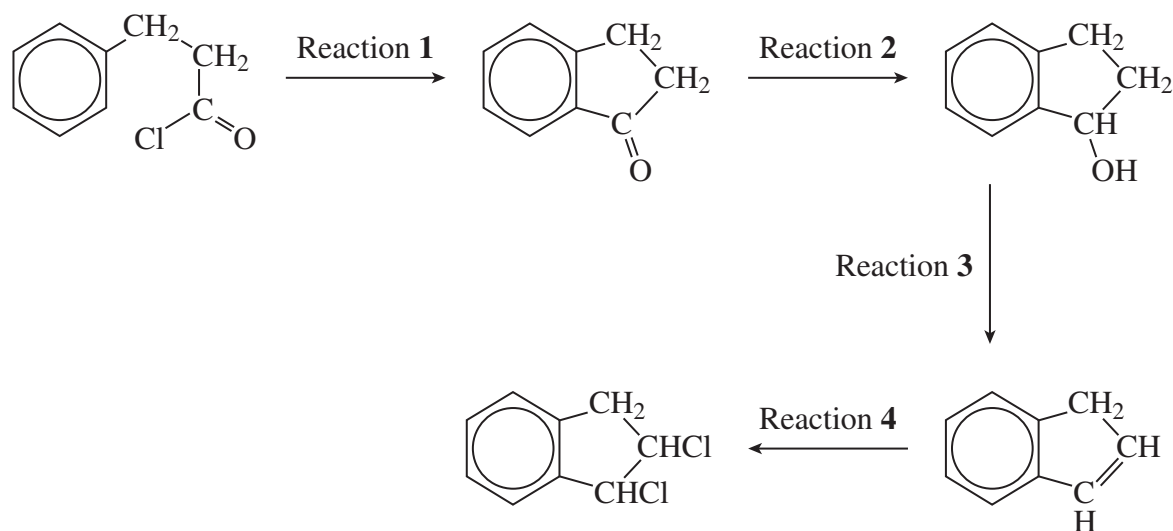
12 Which one of the following reacts with butanedioic acid to form a condensation polymer?

- 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?



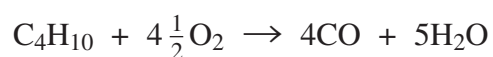
14 A sequence of reactions is shown below.



A correct list of substances for the sequence is

	Reaction 1	Reaction 2	Reaction 3	Reaction 4
<b>A</b>	CH <sub>3</sub> COCl	NaBH <sub>4</sub>	conc H <sub>2</sub> SO <sub>4</sub>	Cl <sub>2</sub>
<b>B</b>	AlCl <sub>3</sub>	HCl	NaOH	Cl <sub>2</sub>
<b>C</b>	AlCl <sub>3</sub>	NaBH <sub>4</sub>	conc H <sub>2</sub> SO <sub>4</sub>	HCl
<b>D</b>	AlCl <sub>3</sub>	NaBH <sub>4</sub>	conc H <sub>2</sub> SO <sub>4</sub>	Cl <sub>2</sub>

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



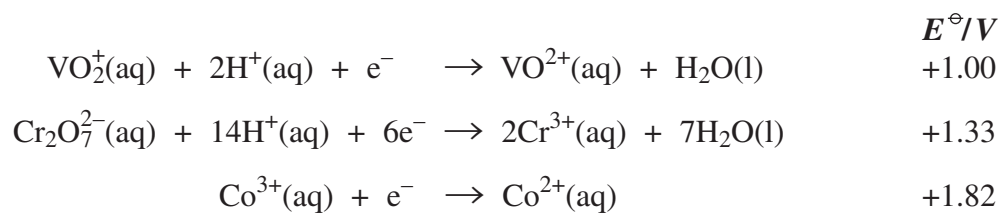
The volume in dm<sup>3</sup> of oxygen at 295 K and 100 kPa required to burn 0.10 mol of butane to form steam and carbon monoxide only is

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





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  $\text{Co}^{3+}$  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.

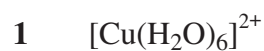
**B** if 1 and 3 only are correct.

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

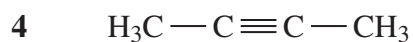
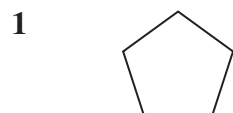
**D** if 4 only is correct.

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

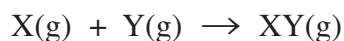


Turn over ►

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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

23 Gas X reacts with gas Y according to the following equation



The rate equation for the reaction is

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

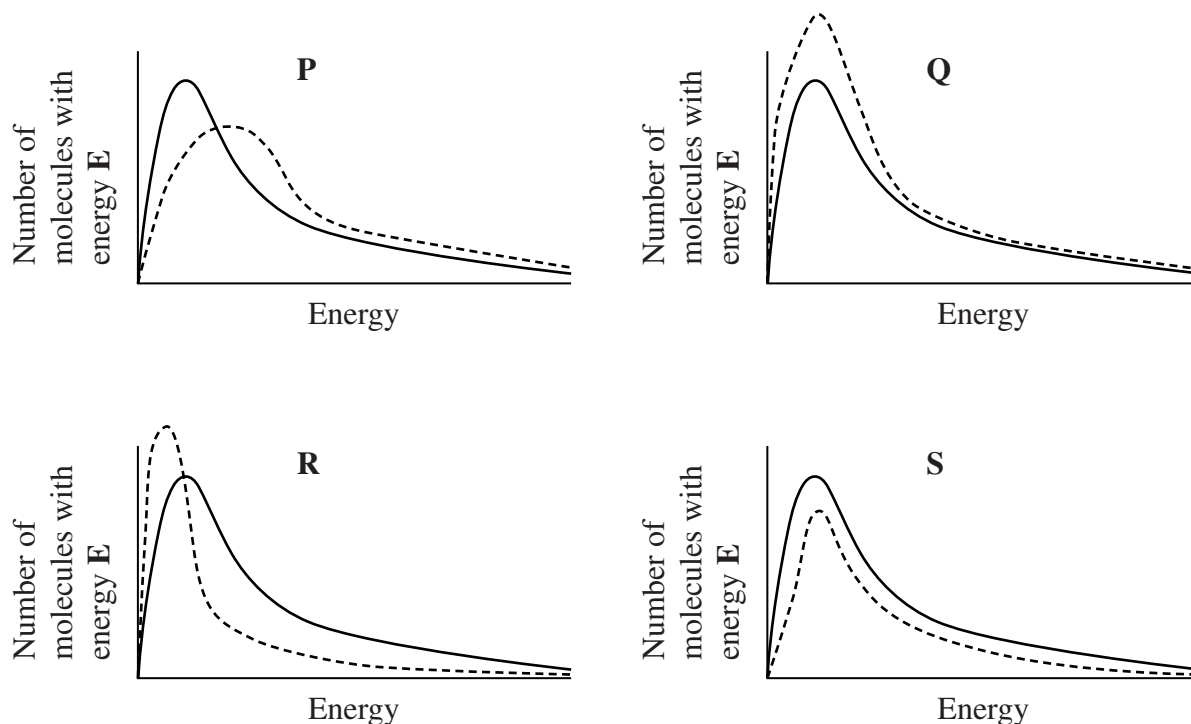
At constant temperature, correct statements include

- 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**

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

26 Substances that form acidic solutions when added to water include

- 1  $\text{AlCl}_3$
- 2  $\text{Cl}_2$
- 3  $\text{CH}_3\text{COCl}$
- 4  $\text{NaCl}$

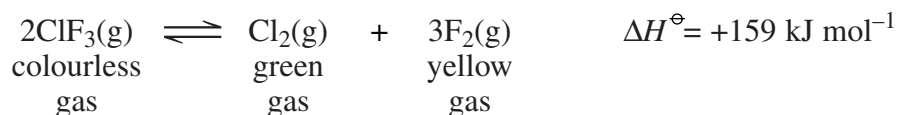
27 Species with at least one bond angle of  $90^\circ$  include

- 1  $\text{XeF}_4$
- 2  $\text{PF}_5$
- 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  $\text{Na}_2\text{CO}_3$  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:

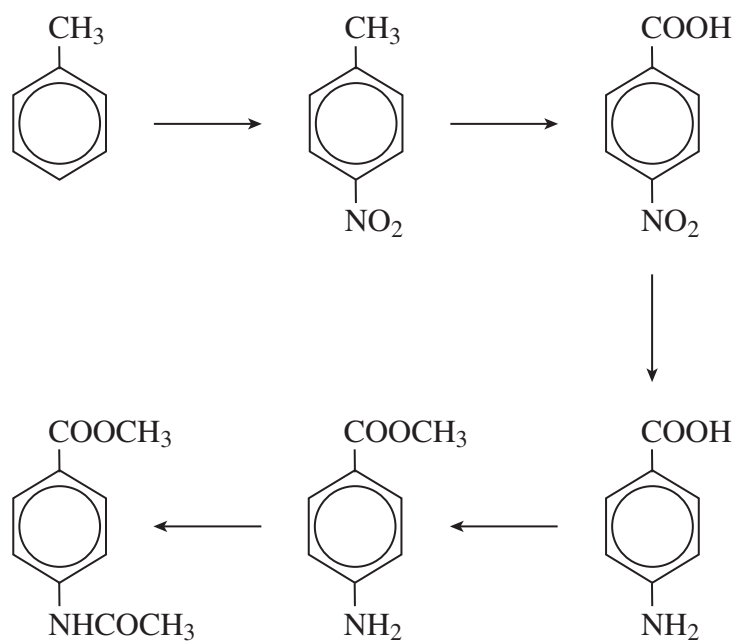


Correct statements include

- 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  $\text{Cl}_2$  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.

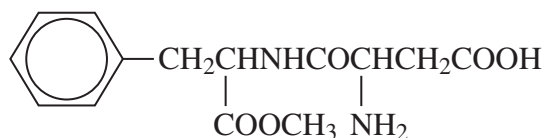
Turn over ►

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

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  $\text{CH}_3\text{CHO}$
- 2 Fe
- 3  $\text{Fe}^{2+}$
- 4  $\text{Fe}^{3+}$

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

- 1 but-2-ene and HBr
- 2 propanone and  $\text{NaBH}_4$
- 3 propanal and HCN
- 4 epoxyethane and  $\text{H}_2\text{O}$



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

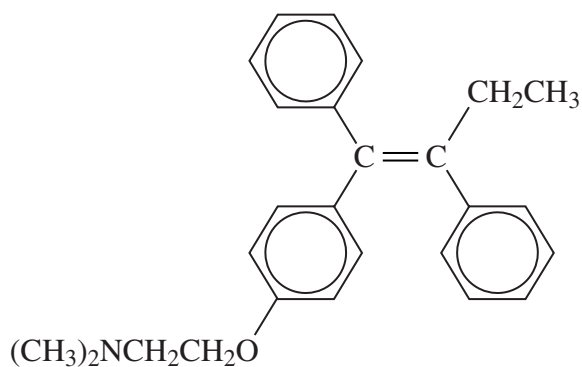
35 Compound X has the following characteristics

- it has an infra-red spectrum with a strong absorption at around  $1700\text{ cm}^{-1}$
- 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



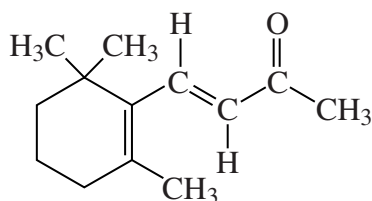
Correct statements about tamoxifen include

- 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.

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

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  $\text{CH}_3\text{CH}_2\text{CHBrCH}_3$  and  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$
- 2  $\text{CH}_3\text{CH}_2\text{COOH}$  and  $\text{HCOOCH}_2\text{CH}_3$
- 3  $\text{CH}_3\text{CH}_2\text{CH}(\text{NH}_2)\text{COOH}$  and  $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{COOH}$
- 4  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$  and  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$

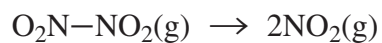
39 Correct statements include

- 1 when  $\text{SiCl}_4$  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  $\text{AlCl}_3$  is dissolved in water,  $[\text{Al}(\text{H}_2\text{O})_5(\text{OH})]^{2+}(\text{aq})$  is one of the ions formed.
- 4 when concentrated  $\text{H}_2\text{SO}_4$  reacts with solid  $\text{NaBr}$ , the only gaseous product is  $\text{HBr}$ .

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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

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



Correct statements include

- 1  $\Delta H$  is positive.
- 2  $\Delta G$  is always positive.
- 3  $\Delta S$  is positive.
- 4 the reaction is feasible at any temperature.

**END OF QUESTIONS**

**There are no questions printed on this page**