[C012/SQP157]

Advanced Higher Chemistry

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

Specimen Question Paper

Reference may be made to the Chemistry Higher and Advanced Higher Data Booklet (1999 edition).

SECTION A—Part 1 Questions 1–30 and Part 2 Questions 31–33

Check that the answer sheet provided is for Chemistry Advanced Higher (Section A).

Fill in the details required on the answer sheet.

Rough work, if required, should be done only on this question paper, or on the rough working sheet provided—**not** on the answer sheet.

Instructions for completion of **Part 1** and **Part 2** are given on pages two and seven respectively.

SECTION B

All questions should be attempted.

SCOTTISH QUALIFICATIONS AUTHORITY

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SECTION A

PART 1

In questions 1 to 30 of this part of the paper, an answer is given by indicating the choice A, B, C or D by a stroke made in INK in the appropriate place in Part 1 of the answer sheet—see the sample question below.

For each question there is only ONE correct answer.

This part of the paper is worth 30 marks.

SAMPLE QUESTION

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

A fractional distillation

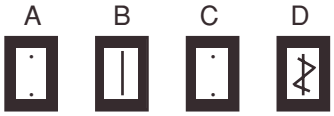
B chromatography

C fractional crystallisation

D filtration.

The correct answer is B—chromatography. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown **in the example on the answer sheet**.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should **enter a tick (✓)** to the RIGHT of the box of your choice, thus:

1. The electronic configuration of an atom X is

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$

The chemistry of X is likely to be similar to that of

A zinc

B nitrogen

C boron

D chlorine.

2. Which of the following is **not** a form of electromagnetic radiation?

A α-radiation

B γ-radiation

C U.V. radiation

D X-rays

3. When electrons occupy degenerate orbitals they do so in such a way as to maximise the number of parallel spins.

This statement is known as

A the Pauli exclusion principle

B Heisenberg's uncertainty principle

C the aufbau principle

D Hund's rule.

4. In a line spectrum, the frequency of each emission line represents

A an energy level within an atom

B a principal quantum number

C the energy released when an electron drops to a lower level

D the energy absorbed from the visible part of the electromagnetic spectrum.

5. Which of the following has the **least** number of molecules?

A 2 g of hydrogen

B 10 g of propane

C 0·5 mol of oxygen

D 0·25 mol of methane

6. In which of the following species are three atoms in a straight line?

A C_2H_4

B NH_4^+

C H_2O

D PF_5

7. Which of the following compounds would be expected to have the highest boiling point?

A $CH_3CH_2OCH_2CH_3$

B $CH_3CH_2CH_2CHO$

C $CH_3CH_2CH_2CH_2OH$

D $CH_3CH_2CH_2CH_2CH_3$

8. An aqueous solution of potassium permanganate is purple in colour.

The colour of light absorbed by this solution is

A red/orange

B blue

C purple

D yellow/green.

9. Which of the following processes is exothermic and has a positive ΔS value?

A Snow flakes forming

B Ammonia gas and hydrogen chloride gas forming solid ammonium chloride

C Ethoxyethane (diethyl ether) evaporating

D Carbon burning

10. The second ionisation energy of sulphur is represented by

A $S^{2+}(g) \rightarrow S^{3+}(g) + e^-$

B $S(g) \rightarrow S^{2+}(g) + 2e^-$

C $S(g) \rightarrow S^{2+}(g) + 2e^-$

D $S^+(g) \rightarrow S^{2+}(g) + e^-$

11. The reaction $X + 2Y \rightarrow Z$ has a rate law of the form

$$\text{Rate} = k[X][Y].$$

If the reaction proceeds by a two-step process, then the rate-determining step might be

A $X + Y \rightarrow$ intermediate

B $X + 2Y \rightarrow$ intermediate

C $X + Y \rightarrow Z$

D $XY + Y \rightarrow Z$.

12. The radioactive decay series which ends with ^{204}Pb after 7 alpha and 6 beta emissions must have commenced with

A ^{232}Th

B ^{226}Th

C ^{226}Ra

D ^{232}Cm

13. Which is a correct statement about a catalyst? For a chemical reaction, it

A does not alter the value of the activation energy

B alters the value of the equilibrium constant

C does not affect the reaction mechanism

D alters the value of the rate constant.

14. Which of the following will produce an alkaline solution in water?

A Sodium chloride

B 2-Aminopropane

C Ammonium chloride

D Ethylammonium chloride

15. Which of the following carbonyl compounds can be reduced to $(CH_3)_2CHCH_2OH$?

A Butanal

B Butanone

C 2-Methylpropanal

D 3-Methylbutanone

16. Which of the following could be used as a dopant in pure silicon to form an n-type semiconductor?

A Boron

B Carbon

C Germanium

D Arsenic

17. At room temperature, caesium chloride has a structure in which each ion is surrounded by 8 oppositely charged ions (structure A). Above 445 °C, the structure becomes one in which each ion is surrounded by 6 oppositely charged ions (structure B).

Which of the following is true of the reaction represented by the equation:

structure A $\rightarrow$ structure B?

A $\Delta H^\circ > 0$ and $\Delta S^\circ < 0$

B $\Delta H^\circ > 0$ and $\Delta S^\circ > 0$

C $\Delta H^\circ < 0$ and $\Delta S^\circ < 0$

D $\Delta H^\circ < 0$ and $\Delta S^\circ > 0$

18. Which of the following has the greatest number of lone pairs of electrons?

A NH_2^-

B NH_4^+

C CH_3^-

D H_3O^+

19. Which one of the following pairs could be used to produce a buffer solution?

A Ethanoic acid and methanoic acid

B Ammonia and ammonium chloride

C Hydrochloric acid and sodium chloride

D Ammonia and methylamine

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

A NaCl

B NaH

C LiI

D $MgBr_2$

21. Which of the following statements about benzene is correct?

A Benzene readily attracts nucleophilic reagents.

B The benzene molecule contains carbon-carbon bonds of two different lengths.

C Benzene does not react with electrophilic reagents.

D The benzene molecule is planar.

22. The transition metal salts MnF_2, FeF_2, CoF_2 have identical crystal structures because the metals

A have similar ionisation energies

B are transition metals

C have incomplete subshells

D have similar ionic radii.

23. Which of the following analytical techniques depends on the vibrations within molecules?

A Mass spectroscopy

B Infra-red spectroscopy

C Nuclear magnetic resonance spectroscopy

D Atomic emission spectroscopy

24. The pH of the buffer solution obtained by mixing $500\,cm^3$ of $0{\cdot}1\ mol\,l^{-1}$ ethanoic acid with $500\,cm^3$ of $0{\cdot}1\ mol\,l^{-1}$ sodium ethanoate is

A 3·8

B 4·8

C 7·0

D 9·2.

25. A medicine which enhances the body's natural responses can be classified as

A an agonist

B an antagonist

C a pharmacophore

D an antibiotic.

26. $C(s) + O_2(g) \rightarrow CO_2(g)$

$\Delta H^\circ = -394\,kJ\,mol^{-1}$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$

$\Delta H^\circ = -286\,kJ\,mol^{-1}$

$C_6H_{14}(\ell) + 9\frac{1}{2}O_2(g) \rightarrow 6CO_2(g) + 7H_2O(\ell)$

$\Delta H^\circ = -4160\,kJ\,mol^{-1}$

Using the above data, the standard enthalpy of formation of hexane is

A $-3480\,kJ\ mol^{-1}$

B $+3480\,kJ\ mol^{-1}$

C $-206\,kJ\ mol^{-1}$

D $+206\,kJ\ mol^{-1}$.

Questions 27 and 28 refer to the following.

Iodate ions (IO_3^-) are reduced to iodine by iodide ions.

$IO_3^-(aq) + 6H^+(aq) + 5e^- \rightarrow \frac{1}{2}I_2(s) + 3H_2O(\ell)$

$I^-(aq) \rightarrow \frac{1}{2}I_2(s) + e^-$

The iodine formed above can be estimated by reaction with thiosulphate ions ($S_2O_3^{2-}$).

$2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2e^-$

$\frac{1}{2}I_2(s) + e^- \rightarrow I^-(aq)$

27. How many moles of I_2 are produced by completely reducing one mole of IO_3^- by iodide ions?

A 0·5

B 1·0

C 2·5

D 3·0

28. How many moles of $S_2O_3^{2-}$ will react with one mole of I_2?

A 1

B 2

C 3

D 5

29. The bond dissociation energy of HBr is $362\,kJ\,mol^{-1}$. In which of the following are 362 kJ released?

A $HBr(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}Br_2(g)$

B $HBr(g) \rightarrow H(g) + Br(g)$

C $\frac{1}{2}H_2(g) + \frac{1}{2}Br_2(g) \rightarrow HBr(g)$

D $H(g) + Br(g) \rightarrow HBr(g)$

30. Chromatographic separations depend on the partition equilibrium between two phases, one stationary and the other mobile. Which of the following is correct for the separation of amino acids using paper chromatography?

	Stationary phase	Mobile phase
A	Amino acids	Solvent
B	Paper	Amino acids
C	Water in the paper	Solvent
D	Water in the paper	Amino acids

SECTION A

PART 2

In questions 31 to 33 of this part of the paper, an answer is given by circling the appropriate letter (or letters) in the answer grids provided on Part 2 of the answer sheet.

In some questions, two letters are required for full marks.

If more than the correct number of answers is given, marks may be deducted.

In some cases the number of correct responses is NOT identified in the question.

This part of the paper is worth 10 marks.

SAMPLE QUESTION

A CH_4	B H_2	C CO_2
D CO	E C_2H_6	F N_2

(*a*) Identify the diatomic **compound(s)**.

A	B	C
(D)	E	F

The one correct answer to part (*a*) is D. This should be circled.

(*b*) Identify the **two** substances which burn to produce **both** carbon dioxide **and** water.

(A)	B	C
D	(E)	F

As indicated in this question, there are **two** correct answers to part (*b*). These are A and E.
Both answers are circled.

(*c*) Identify the substance(s) which can **not** be used as a fuel.

A	B	(C)
D	E	(F)

There are **two** correct answers to part (*c*). These are C and F.
Both answers are circled.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and circle the answer you now consider to be correct. Thus, in part (*a*), if you want to change an answer **D** to an answer **A**, your answer sheet would look like this:

(A)	B	C
~~(D)~~	E	F

If you want to change back to an answer which has already been scored out, you should enter a tick (✓) in the box of the answer of your choice, thus:

~~(A)~~	B	C
✓ ~~(D)~~	E	F

31. The boxes in the grid below contain the formulae for certain compounds.

A PCl_5	B CO_2	C Al_2O_3
D Na_2O	E NaH	F CCl_4

(*a*) Identify the amphoteric compound.

(*b*) Identify the compound(s) which react(s) with water to produce a gas.

32. The boxes in the grid below contain the symbols of atoms and ions of certain transition metals in the gas state.

A Ti^{3+}	B V	C Ni
D Fe^{3+}	E Co^{2+}	F Mn^{2+}

(*a*) Identify the **two** species having the same electronic configuration.

(*b*) Identify the species having only 3 unpaired electrons.

33. The boxes in the grid below contain descriptions of the shapes of some molecules and ions.

A linear	B pyramidal	C bent or V-shaped
D tetrahedral	E trigonal bipyramidal	F trigonal planar

Identify the shape of each of the following species.

(*a*) C_2H_2

(*b*) NH_4^+

(*c*) PCl_5

(*d*) CO_2

SECTION B

1. The table below gives information about complex ions containing vanadium.

Ion	Colour
$[V(H_2O)_6]^{2+}$	violet
$[V(H_2O)_6]^{3+}$	green
$[VO]^{2+}$	blue
$[VO_2]^{+}$	

(*a*) Name the complex ion, $[V(H_2O)_6]^{2+}$. **1**

(*b*) Determine the oxidation number of vanadium in the $[VO]^{2+}$ ion. **1**

(*c*) Write down the electronic configuration for vanadium in the $[VO]^{2+}$ ion in terms of s, p and d electrons. **1**

(*d*) Suggest why you would expect the $[VO_2]^{+}$ ion to be colourless. **1**

(*e*) Describe briefly how colorimetric analysis could be used to determine the concentration of $[V(H_2O)_6]^{3+}$ in solution. **3**

(7)

2. Before 1947, "silver" coins were made from an alloy of silver, copper and nickel. To determine the silver composition, a coin weighing 10·00 g was dissolved in nitric acid and the resulting solution diluted to 1000 cm^3 in a standard flask. 0·20 mol l^{-1} hydrochloric acid was added to 100 cm^3 of this solution until precipitation of silver(I) chloride was complete.

The precipitate was recovered by filtration, washed, dried and found to have a mass of 0·60 g.

(*a*) Calculate the percentage by mass of silver in the coin. **3**

(*b*) How would you confirm that precipitation was complete? **1**

(4)

3. 250 cm^3 of sulphurous acid solution was prepared by dissolving 1·60 g of sulphur dioxide in water at 298 K.

(*a*) Calculate the concentration, in mol l^{-1}, of the acid solution. **2**

(*b*) Using your answer to (*a*) and page 12 of the Data Booklet, calculate the pH of the acid solution. **2**

(4)

Marks

4. Consider the following reactions and their values for $\Delta G°$ and $\Delta H°$ at 298 K.

Reaction	$\Delta G°$/kJ mol^{-1}	$\Delta H°$/kJ mol^{-1}
(i) $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g)$	–95	–92
(ii) $2Al(s) + 1\frac{1}{2}O_2(g) \rightarrow Al_2O_3(s)$	–1576	–1669
(iii) $NH_4Cl(s) \rightarrow NH_4^+(aq) + Cl^-(aq)$	–7	+16

(*a*) Reaction (ii) has the greatest difference between the values of $\Delta G°$ and $\Delta H°$. Suggest a reason for this large difference. **1**

(*b*) Calculate the final temperature when one mole of ammonium chloride is added to one litre of water at 298 K. **2**

(*c*) Calculate the entropy change, $\Delta S°$ for reaction (i) at 298 K. **2**

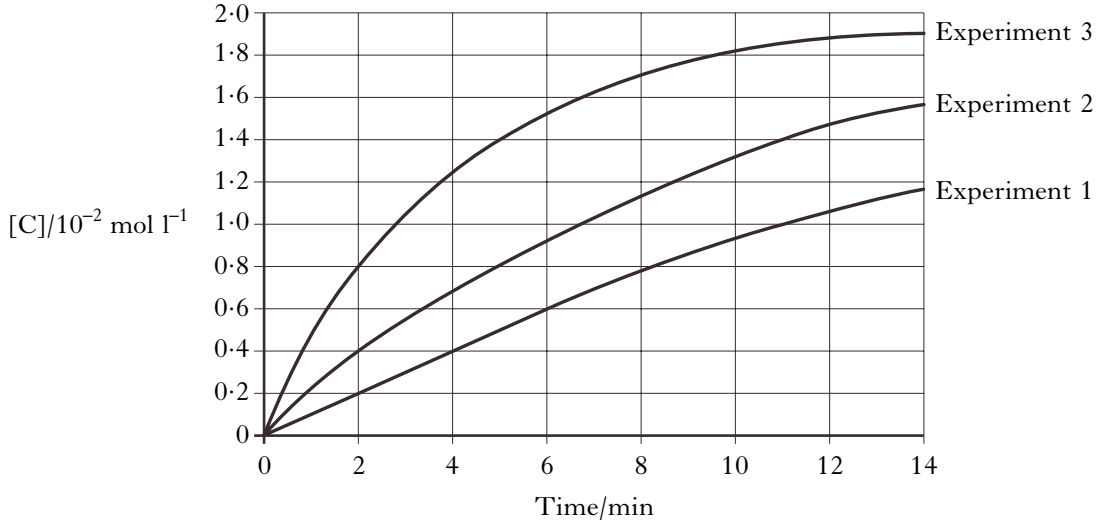
(5)

5. A set of experiments were carried out at constant temperature to investigate the reaction:

$$A + B \rightarrow C$$

The results are shown below.

Experiment	Initial [A]/mol l^{-1}	Initial [B]/mol l^{-1}
1	0·1	0·1
2	0·2	0·1
3	0·1	0·2



(*a*) By comparing the average rate over the first two minutes, determine the order of the reaction with respect to

(i) A **1**

(ii) B. **1**

(*b*) Write the rate equation (rate expression) for this reaction. **1**

(3)

Marks

6.

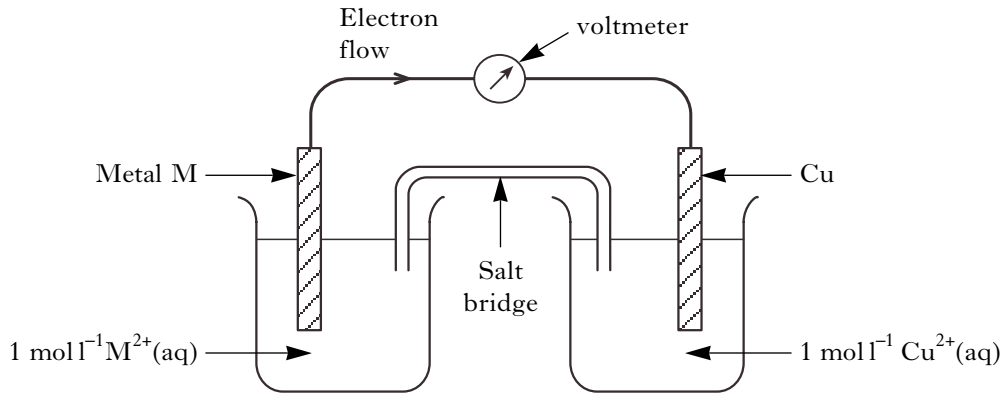
Process	$\Delta H°/kJ\ mol^{-1}$
$K(s) \rightarrow K(g)$	(w)
$K(g) \rightarrow K^+(g) + e^-$	(x)
$\frac{1}{2}Br_2(g) \rightarrow Br(g)$	(y)
$Br(g) + e^- \rightarrow Br^-(g)$	(z)

(*a*) Use the Data Booklet to find values for (w), (x), (y) and (z). **2**

(*b*) Write an equation which represents the process for which $\Delta H°$ is the lattice enthalpy for potassium bromide. **1**

(3)

7.



The emf of the above cell operating under standard conditions is 0·57 V.

(*a*) Calculate the free energy change for this cell operating under standard conditions. **2**

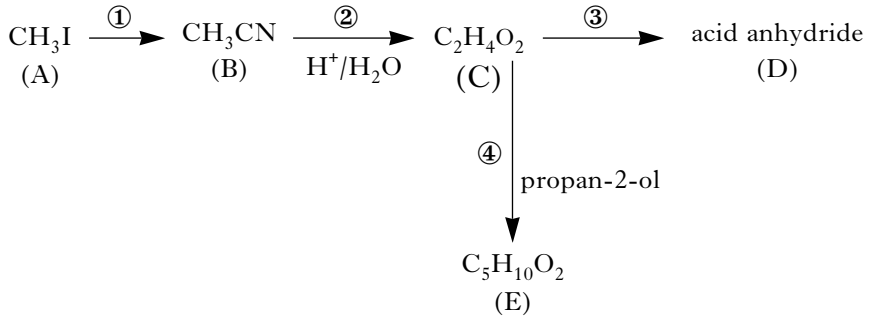
(*b*) Calculate the standard reduction potential for the half-cell reaction

$$M^{2+}(aq) + 2e^- \rightarrow M(s)$$ **1**

(3)

Marks

8. Starting from iodomethane, the following reactions can be carried out.



(*a*) Reaction ① is an example of nucleophilic substitution.
Which nucleophile would be used for this substitution? **1**

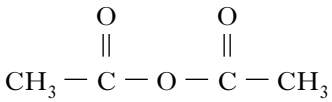
(*b*) What type of reaction is reaction ②? **1**

(*c*) Draw the full structural formula for ester (E). **1**

(*d*) Acid anhydrides can be thought of as the condensation product of two acid molecules.

$$C_2H_4O_2 \quad + \quad C_2H_4O_2 \quad \rightarrow \quad C_4H_6O_3 \quad + \quad H_2O$$

The acid anhydride (D) has the following structure.



Infra-red spectra of the acid anhydride (D) and compound (C) are noticeably different. Over which wavenumber range would there be the major difference?
Give a reason for your answer. **2**

(5)

9. The mechanism for the bromination of methane is outlined below.

$Br_2 \rightarrow 2(w)$ initiation

$(w) + CH_4 \rightarrow CH_3\cdot + HBr$
$(x) + Br_2 \rightarrow CH_3Br + (w)$ } (y)

$CH_3\cdot + Br\cdot \rightarrow CH_3Br$
$CH_3\cdot + CH_3\cdot \rightarrow C_2H_6$ } (z)

(*a*) Complete the mechanism by writing the correct entries for (w), (x), (y) and (z) into your answer book. **2**

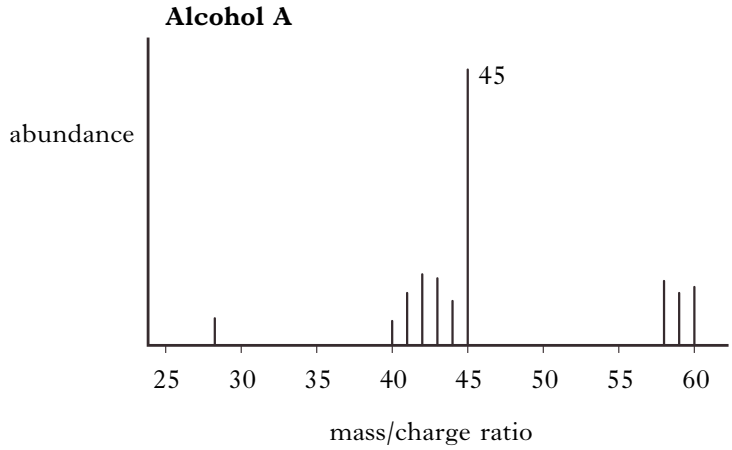
(*b*) What condition is required to bring about the initiation stage? **1**

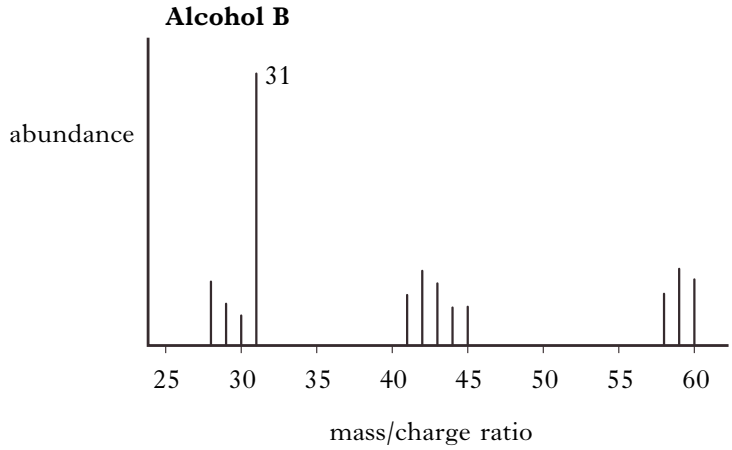
(*c*) Which type of hybridisation occurs around the carbon atoms in C_2H_6? **1**

(4)

Marks

10. The mass spectra of two isomeric alcohols A and B of relative formula mass 60 are shown below.





(*a*) Name and draw the full structural formulae for the two alcohols. **2**

(*b*) Which isomer is alcohol B? Explain your answer. **2**

(4)

11. Study this reaction sequence.

$CH_3CHOHCH_2CH_3$ ⟵ (Reagent ①) ketone ⟶ (KCN) compound X

(*a*) Name reagent ① and the type of reaction taking place. **2**

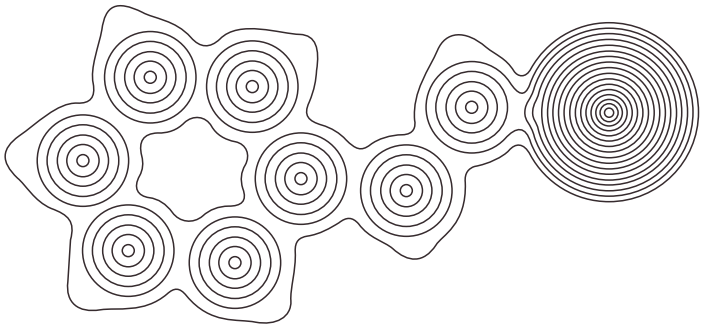
(*b*) Draw the full structural formula for compound X and hence explain why X exhibits optical isomerism. **2**

(*c*) Apart from measuring the boiling point, outline **experimental** steps which would confirm that the ketone was butanone. **2**

(6)

Marks

12. 1-chloro-2-phenylethene exists as two geometric isomers. The electron density contour map below shows one of these isomers.



(*a*) Write down the **molecular formula** of 1-chloro-2-phenylethene. **1**

(*b*) Which geometric isomer is shown in the electron density contour map? **1**

(*c*) Why do the hydrogen atoms not show up clearly in the electron density contour map? **1**

(3)

Marks

13. The following is an extract from *Opportunities in Chemistry*—often referred to as the Pimental Report.

"Since the 1960s we've known that high levels of cholesterol correlate with heart ailments, the major cause of death in the United States. What we need is a Pac-Man to chomp up the cholesterol in the blood and reduce "hardening" of the arteries that carry blood from the heart (atherosclerosis). Now a lowly fungus—not unlike the famous mould, penicillium—may have shown us one.

A normally functioning human cell uses a dual system for meeting its cholesterol needs. First, the cell has its own factory to manufacture cholesterol. In addition, the cell's exterior has a number of lipoprotein receptors that can grab onto cholesterol-containing lipoproteins as they pass by in the bloodstream and pull them inside. The cell fixes the number of these Pac-Man-like receptors so that just the right amount of imported cholesterol is added to the factory-made product. If the inner cell cholesterol level falls too low, more receptors are added to extract more from the blood stream.

There's an idea! If the cell's cholesterol factory could be slowed down, would the cell produce more receptors to make up the difference from the blood stream supply? A chance to test this scenario came when a biochemist discovered that certain fungi produced something that inhibited cholesterol synthesis. Chemists joined in the plot, purified the effective compound, determined its structure, and named it COMPACTIN. Knowing its structure, chemists were able to synthesise close relatives of compactin that are even more potent. Chemical tests with these new chemicals indicate that the scheme works as planned."

(*a*) What determines the number of lipoprotein receptors on the exterior of human cells? **1**

(*b*) What is an inhibitor? **1**

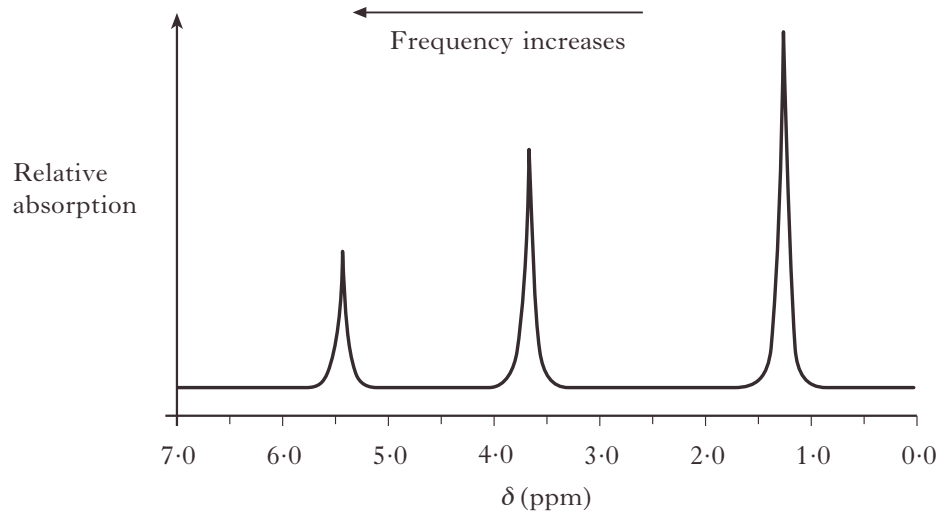
(*c*) Explain how the inhibitor inside the cells reduces the level of cholesterol in the blood. **2**

(*d*) The close relatives of compactin all have the same structural fragment which inhibit cholesterol synthesis. What name is given to such a fragment? **1**

(5)

Marks

14. The diagram shows the proton nmr spectrum of ethanol.



(*a*) Which frequency range of the electromagnetic spectrum is used to produce a proton nmr spectrum? **1**

(*b*) What value of δ, in ppm, is the absorption caused by the hydroxyl hydrogen? **1**

(*c*) Ethanol can be oxidised to ethanal. Sketch the proton nmr spectrum which would be obtained from ethanal (refer to Data Booklet page 15). **2**

(4)

[*END OF QUESTION PAPER*]

FOR OFFICIAL USE

Total

Advanced Higher Chemistry

Section A
Specimen Question Paper

NATIONAL QUALIFICATIONS

ANSWER SHEET

Full name of centre

Town

Forename(s)

Surname

Date of birth

Day Month Year

Scottish candidate number

Number of seat

Part 1

Using ink, indicate your choice of answer by a single stroke **joining the two dots** in the box, as in the following example: **A** **B** **C** **D**

	A	B	C	D		A	B	C	D
1	· ·	· ·	· ·	· ·	16	· ·	· ·	· ·	· ·
2	· ·	· ·	· ·	· ·	17	· ·	· ·	· ·	· ·
3	· ·	· ·	· ·	· ·	18	· ·	· ·	· ·	· ·
4	· ·	· ·	· ·	· ·	19	· ·	· ·	· ·	
5	· ·	· ·	· ·	· ·	20	· ·	· ·	· ·	· ·
6	· ·	· ·	· ·	· ·	21	· ·	· ·	· ·	· ·
7	· ·	· ·	· ·	· ·	22	· ·	· ·	· ·	· ·
8	· ·	· ·	· ·	· ·	23	· ·	· ·	· ·	· ·
9	· ·	· ·	· ·	· ·	24	· ·	· ·	· ·	· ·
10	· ·	· ·	· ·	· ·	25	· ·	· ·	· ·	· ·
11	· ·	· ·	· ·	· ·	26	· ·	· ·	· ·	· ·
12	· ·	· ·	· ·	· ·	27	· ·	· ·	· ·	· ·
13	· ·	· ·	· ·	· ·	28	· ·	· ·	· ·	· ·
14	· ·	· ·	· ·	· ·	29	· ·	· ·	· ·	· ·
15	· ·	· ·	· ·	· ·	30	· ·	· ·	· ·	· ·

Part 2

Using ink, indicate your choice of answer(s) by **circling the appropriate letter(s)** as in the following example:

	A	B	C
	D	(E)	F

31 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
32 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
33 a	A	B	C
	D	E	F
b	A	B	C
	D	E	F
c	A	B	C
	D	E	F
d	A	B	C
	D	E	F

[C012/SQP157]

Advanced Higher Chemistry

Specimen Marking Instructions

NATIONAL QUALIFICATIONS

SCOTTISH QUALIFICATIONS AUTHORITY

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Section A Part 1 and Part 2 (Multiple Choice and Grid Questions)
Marking Scheme

1	B		
2	A		
3	D		
4	C		
5	B		
6	D		
7	C		
8	D		
9	D		
10	D		
11	A		
12	A		
13	D		
14	B		
15	C		
16	D		
17	B		
18	A		
19	B		
20	A		
21	D		
22	D		
23	B		
24	B		
25	A		
26	C		
27	D		
28	B		
29	D		
30	C		**(30)**
31	(*a*)	C	**(1)**
	(*b*)	A and E	**(2)**
32	(*a*)	D and F	**(1)**
	(*b*)	B and E	**(2)**
33	(*a*)	A	**(1)**
	(*b*)	D	**(1)**
	(*c*)	E	**(1)**
	(*d*)	A	**(1)**

TOTAL = 40 MARKS

Section B
Marking Scheme

Marks

1. (*a*) hexaaquavanadium(II) **1**

(*b*) 4 **or** +4 **or** (IV) **1**

(*c*) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$ **1**

(*d*) contains no d electrons
or there will be no d→d transitions **1**

(*e*) Prepare solutions of the $V^{3+}(aq)$ of various known concentrations **1**

Measure absorbance of each solution using appropriate filter and plot calibration curve **1**

Measure absorbance of sample solution and read the concentration from the calibration graph **1**
(7)

2. (*a*) Mass of silver in the precipitate $= \frac{0 \cdot 60 \times 107 \cdot 9}{143 \cdot 4}$ **1**

Mass of silver in the coin $= \frac{0 \cdot 60 \times 107 \cdot 9 \times 1000}{143 \cdot 4 \times 100}$

$= 4 \cdot 51(g)$ **1**

% of silver in the coin $= 45 \cdot 1$ **1**

(*b*) Adding more drops of HCl to the filtrate (or supernatant liquid) will result in no more precipitate forming. **1**
(4)

Marks

3. (*a*) $n = \frac{\text{Mass}}{\text{FM}} = \frac{1{\cdot}60}{64{\cdot}1} = 0{\cdot}0249 \text{ mol}$ **1**

$c = n/v = \frac{0{\cdot}0249}{0{\cdot}250} = 0{\cdot}0998$ **or** $0{\cdot}1 \text{ moll}^{-1}$ **1**

(*b*) $pH = \frac{1}{2}pK_a - \frac{1}{2}\log c$ **1**

$= 0{\cdot}9 + 0{\cdot}5 = 1{\cdot}4$

or using $[H^+] = \sqrt{K_a \times c}$ 1 mark for calculating $[H^+]$ **1**

and 1 mark for calculating pH **(4)**

4. (*a*) Largest $\Delta S°$ because of conversion of gas to solid **1**

(*b*) $\Delta H° = 16 \text{ kJ mol}^{-1} = cm\Delta T$

$\Delta T = \frac{16}{4{\cdot}18 \times 1} = 3{\cdot}8$ **1**

Final temperature $= 298 - 3{\cdot}8 = 294{\cdot}2\text{K}$ **1**

(*c*) $\Delta G° = \Delta H° - T\Delta S°$ and so $\Delta S° = \frac{\Delta H° - \Delta G°}{T}$

$= \frac{-92 - (-95)}{298}$ **1**

$= 0{\cdot}0101 \text{kJ K}^{-1} \text{ mol}^{-1}$

or

$= 10{\cdot}1 \text{J K}^{-1} \text{ mol}^{-1}$ **1**

(5)

5. (*a*) (i) 1 **or** 1st order for A **1**

(ii) 2 **or** 2nd order for B **1**

(*b*) rate = $k[A][B]^2$ **or** rate $\alpha[A][B]^2$ **1**

(3)

Marks

6. (*a*) w = 88 kJ mol^{-1} ½
x = 425 kJ mol^{-1} ½
y = 97 kJ mol^{-1} ½
z = −324·6 kJ mol^{-1} ½
} units not required, as given in the question

(*b*) $K^+(g) + Br^-(g) \rightarrow K^+Br^-(s)$ {**or** KBr(s) }
or equation may be reversed **1**

(3)

7. (*a*) $\Delta G^\circ = -nFE^\circ$

$= -2 \times 96\,500 \times 0 \cdot 57$ **1**

$= -110$ kJ mol^{-1} (**or** kJ)

or

$= -110\,010$ J mol^{-1} (**or** J) **1**

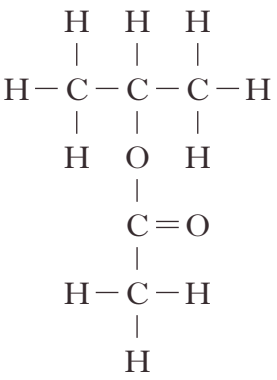
(*b*) −0·23 V **1**

(3)

8. (*a*) CN^- **or** cyanide ion (**not** potassium cyanide **or** sodium cyanide) **1**

(*b*) hydrolysis **1**

(*c*)



1

(*d*) 2500 – 3500 cm^{-1} **1**
Disappearance of OH stretch (in COOH) **1**

(5)

Marks

9. (*a*) w = Br• **or** Br ½

x = CH_3• ½

y = propagation ½

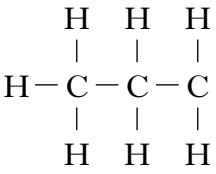
z = termination ½

(*b*) light/ultra-violet light **1**

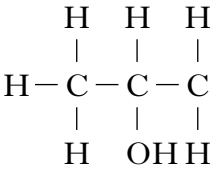
(*c*) sp^3 **1**

(4)

10. (*a*)



(½) propan-1-ol (½) **1**



(½) propan-2-ol (½) **1**

(*b*) Alcohol B is propan-1-ol. **1**

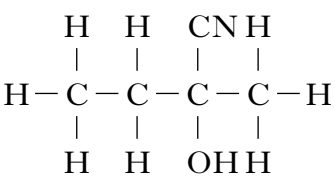
The large peak at mass/charge ratio 31 is due to $[CH\,OH]^+$. This can only come from propan-1-ol/or similar correct answer. **1**

(4)

11. (*a*) Lithal **or** lithium aluminium hydride **or** $LiAlH_4$ **1**

Reduction **1**

(*b*)



1

It has an asymmetric carbon

or there are four different groups attached to the one carbon

or two non-superimposable forms **1**

(*c*) Prepare derivative (½) **and** any 3 from the following 4 points

Separate from reaction mixture (½)

Purify **or** recrystallise (½)

Measure melting point (½)

Compare to data (½) **2**

(6)

Marks

12. (*a*) C_8H_7Cl **1**

(*b*) trans isomer **1**

(*c*) electron density too low/too few electrons/only one electron/only electron tied up in the bond etc **1**

(3)

13. (*a*) the level of cholesterol inside the cell **1**

(*b*) prevents synthesis/slows down a reaction/negative catalyst **1**

(*c*) reduces cholesterol production inside cell
increases the number of lipoprotein receptors
cholesterol removed from blood to compensate **2**

1 only = 0
any 2 = 1 mark
all 3 = 2 marks

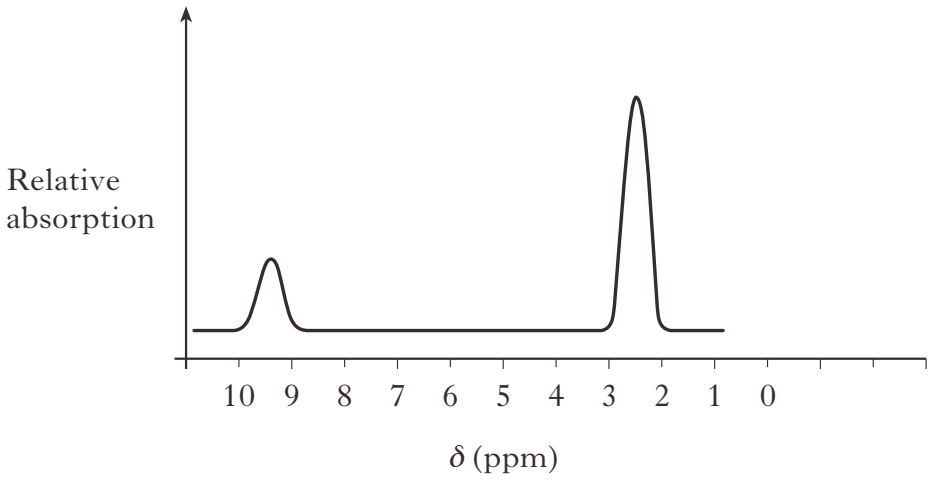
(*d*) pharmacaphore **1**

(5)

14. (*a*) Radio frequency **1**

(*b*) 5·5 ppm **1**

(*c*)



(½) for 2 peaks, (½) for 1:3 ratio (approximately)
(½) for taller peak at 2–3 δ ($C\mathbf{H}_3CHO$)
(½) for shorter peak at 9–10 δ ($CH_3C\mathbf{H}O$) **2**

(4)

[*END OF MARKING INSTRUCTIONS*]