Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **May/June 2020**

MARK SCHEME

Maximum Mark: 100

Published

Students did not sit exam papers in the June 2020 series due to the Covid-19 global pandemic.

This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

Mark schemes should usually be read together with the Principal Examiner Report for Teachers. However, because students did not sit exam papers, there is no Principal Examiner Report for Teachers for the June 2020 series.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the June 2020 series for most Cambridge IGCSE™ and Cambridge International A & AS Level components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	'List rule' guidance (see examples below) For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided • Any response marked *ignore* in the mark scheme should not count towards ***n*** • Incorrect responses should not be awarded credit but will still count towards ***n*** • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

6 <u>Calculation specific guidance</u>

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form, (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 <u>Guidance for chemical equations</u>

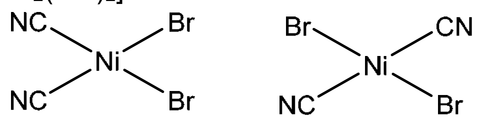
Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

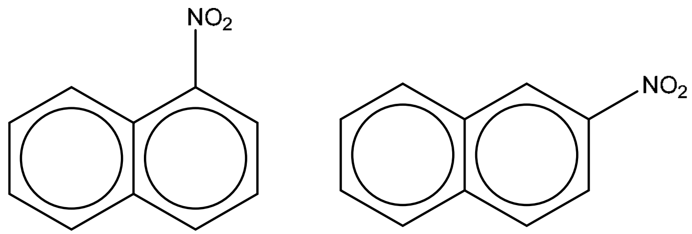
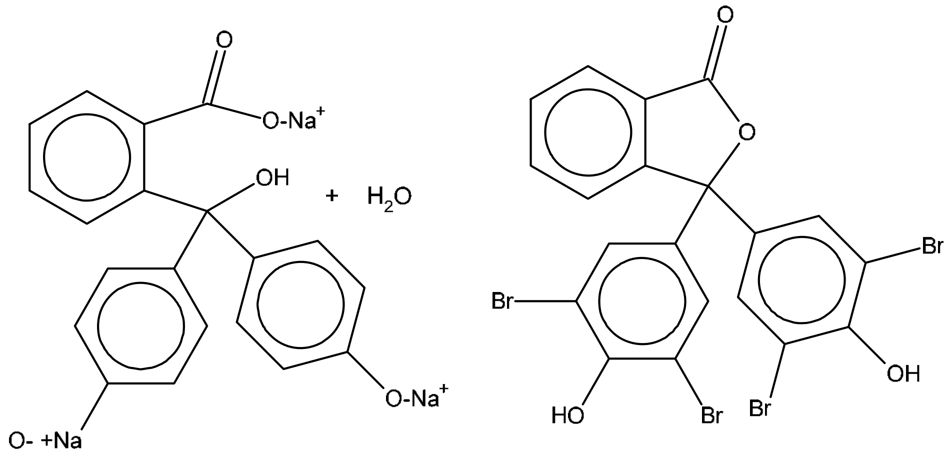
Question	Answer	Marks
1(a)(i)	**M1** (a species) that donates/uses a many lone pairs/more than one lone pair **M2** to form a dative/coordinate to a metal atom/metal ion/TM/TE/metal **OR** **M1** (a species) that donates/uses lone pairs to form many/more than one **M2** dative/coordinate bond to a metal atom/metal ion/TM/TE/metal	**2**
1(a)(ii)	structure of EDTA any **six** atoms circled of 2 N & 4 O	**1**
1(a)(iii)	**M1** $K_{stab1} = \dfrac{[[CdEDTA]^{2-}]}{[[Cd(H_2O)_6]^{2+}][EDTA^{4-}]}$ **M2** units = $mol^{-1}\ dm^3$	**2**
1(b)(i)	$K_{eq4} = K_{stab3}/K_{stab2}$	**1**
1(b)(ii)	**M1** $\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$ $\Delta G^{\ominus} = 0.84 – (298*0.0809)$ **M2** $\Delta G^{\ominus}$ = **-23.3** ($kJ\ mol^{-1}$) **3sf min**	**2**
1(b)(iii)	more negative as $T\Delta S$ increases **OR** more negative as ΔS is positive	**1**

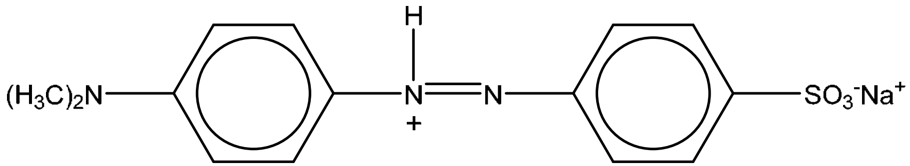
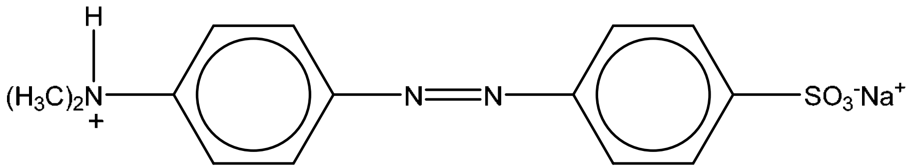
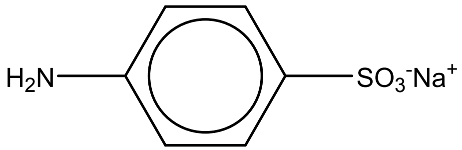
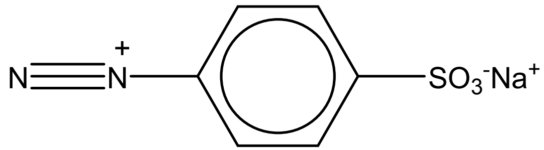
Question	Answer	Marks
2(a)	**M1** solubility decreases down the group **M2** ΔH_{latt} and ΔH_{hyd} both become less exothermic / more endothermic **M3** ΔH_{latt} changes less (than ΔH_{hyd} as SO_4^{2-} being larger than M^{2+}) **M4** ΔH_{sol} becomes less exothermic / less negative	**4**

Question	Answer	Marks
2(b)	**M1** CaO_2 **and** Ca^{2+} has a smaller ionic radii/ Ca^{2+} has a higher charge density **M2** anion/O_2^{2-} becomes more polarised /distorted	**2**
2(c)	$Mg(IO_3)_2 \rightarrow MgO + 2.5O_2 + I_2$	**1**
2(d)(i)	**M1** $K_{sp} = [Ca^{2+}][IO_3^-]^2$ **M2** units = $mol^3\ dm^{-9}$	**2**
2(d)(ii)	$K_{sp} = 4 \times (5.6 \times 10^{-3})^3$ $K_{sp} =$ **7.03×10^{-7}** 2sf min	**1**
2(d)(iii)	**M1** $Ca(IO_3)_2$ **AND** as solubility of $Ca(IO_3)_2$ decreases **M2** due to common ion effect	**2**
2(e)	**M1** moles $S_2O_3^{2-}$ = $0.002 \times 12.4/1000$ = 2.48×10^{-5} moles of I_2 = 1.24×10^{-5} **M2** moles of IO_3^- = 4.13×10^{-6} in 50 cm^3 moles of IO_3^- = 2.07×10^{-5} in 250 cm^3 mass of $NaIO_3$ = $2.07 \times 10^{-5} \times 197.9$ **M3** mass of $NaIO_3$ = **0.0041**	**3**
2(f)	It is feasible as the E_{cell} will be positive/+0.12 V	**1**
2(g)(i)	**M1** Rate = $k[IO_3^-][SO_3^{2-}][H^+]$ **M2** units = $mol^{-2}dm^6s^{-1}$	**2**
2(g)(ii)	0.10	**1**

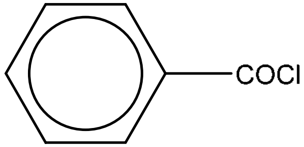
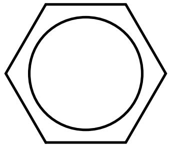
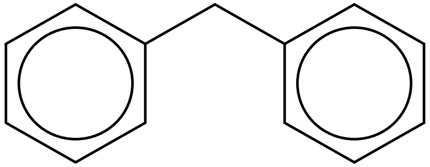
Question	Answer	Marks
3(a)	3d (Ni^{2+}) ↑↓ ↑↓ ↑↓ ↑ ↑	**1**
3(b)	**M1** **d** orbitals **split** into **two levels/** lower and upper orbitals **M2** **electron**(s) promoted / excited to a higher d–orbital **M3** frequency of light **absorbed** **M4** observed colour is complement of light absorbed	**4**
3(c)(i)	(addition of NH_3) increases [OH^-] (due to ionisation of NH_3 in water) and shifts equilibrium 1 to the right (forming $Ni(OH)_2$)	**1**
3(c)(ii)	(a large excess of NH_3) shifts eqm 2 to the right (forming $[Ni(NH_3)_6]^{2+}$) **AND** the [Ni^{2+}]/[$[Ni(H_2O)_6]^{2+}$] decreases and eqm 1 shifts to the left (causing the ppt to dissolve)	**1**
3(d)	**M1** two correct structures cis & trans for $[NiBr_2(CN)_2]^{2-}$  **M2** type of stereoisomerism: cis-trans/geometric	**2**

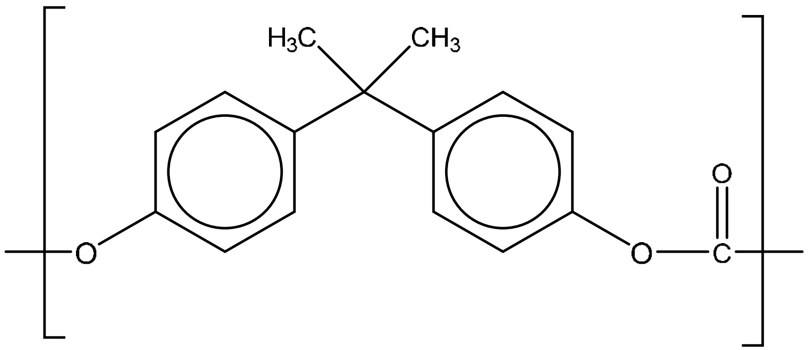
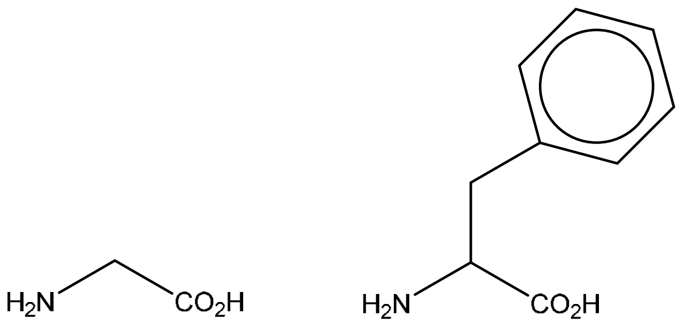
Question	Answer	Marks
4(a)(i)	• trigonal planar • tetrahedral. • trigonal planar Award one mark for two correct statements, award two marks for three correct statements	**2**

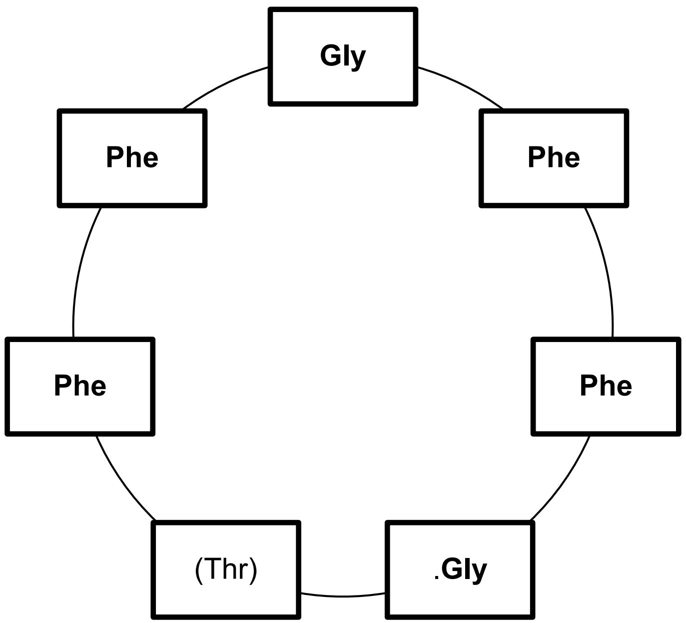
Question	Answer	Marks
4(a)(ii)	 Both structures required	1
4(b)	$C_{10}H_8 + 9[O] \rightarrow C_8H_4O_3 + 2CO_2 + 2H_2O$	1
4(c)	condensation/ addition-elimination	1
4(d)(i)	phenol **AND** ester	1
4(d)(ii)	 **M1** correct hydrolysis product of ester **M2** (di)phenoxide salt **M3** bromination of **both** phenol rings at position 2 or/and 6 **M4** hydrolysis **AND** (electrophilic) substitution	4

Question	Answer	Marks
4(e)	**M1** $[H^+] = 10^{-8.8} = 1.585 \times 10^{-9}$ **M2** $[In^-]/[HIn] = 5.0 \times 10^{-10}/1.585 \times 10^{-9} = 0.315$	2
4(f)(i)	bond circled between the two Ns, or N=N or –N=N–	1
4(f)(ii)	 **or** 	1
4(g)(i)	 **R**  **S** Award one mark for each correct structure	2
4(g)(ii)	**M1** step 1 Sn and HC*l* conc. and heat **M2** step 2 $NaNO_2$ and HC*l* and 0-10 °C	3

Question	Answer	Marks
5(a)	**M1** ratio of the concentration of a solute in the two immiscible solvents /liquids **M2** at equilibrium	2

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>5(b)(i)</td><td>M1 79.4 = (0.4-x/25)/(x/125)
M2 x = 0.0237 g [2] min 2sf</td><td>2</td></tr>
<tr><td>5(b)(ii)</td><td>(higher as) benzophenone is more non-polar/more soluble in octan-1-ol ora</td><td>1</td></tr>
<tr><td>5(c)(i)</td><td>J =  K = 
Award one mark for each correct structure</td><td>2</td></tr>
<tr><td>5(c)(ii)</td><td>step 1 PCl_5 OR $SOCl_2$ OR PCl_3 + heat</td><td>1</td></tr>
<tr><td>5(d)(i)</td><td></td><td>1</td></tr>
<tr><td>5(d)(ii)</td><td>M1 step 3 electrophilic substitution
M2 step 3 benzene and $AlCl_3$ (and heat)</td><td>2</td></tr>
<tr><td>5(d)(iii)</td><td>step 4 oxidation</td><td>1</td></tr>
<tr><td>5(e)(i)</td><td>5 peaks</td><td>1</td></tr>
<tr><td>5(e)(ii)</td><td><table><tr><td>environment of carbon atom</td><td>chemical shift range (δ)</td></tr><tr><td>carbonyl / RCOR</td><td>190–220</td></tr><tr><td>arene / benzene</td><td>110–160</td></tr></table>Award one mark for each correct for each row</td><td>2</td></tr>
</table>

Question	Answer	Marks
6(a)(i)	condensation	**1**
6(a)(ii)		**1**
6(a)(iii)	id-id forces/London forces **AND** permanent dipole-dipole forces	**1**
6(b)	**M1** (secondary structure by) hydrogen bonding between CO and NH groups **M2** (tertiary structure by) interactions between R groups **and** one example of a named intermolecular force	**2**
6(c)	**M1** (hydrogen bonding between) base pairs **M2** A with T **and** C with G	**2**
6(d)	hydrolysis **and** by action of light/UV	**1**
6(e)(i)	 Award one mark for each correct structure	**2**

Question	Answer	Marks
6(e)(ii)	 correct labelling as shown	**1**
6(e)(iii)	electrophoresis **and** thin-layer / paper chromatography [1]	**1**

Question	Answer	Marks
7(a)(i)	• energy change • when one electron is added • to each atom /ion in one mole of • gaseous atoms /ions Award one mark for two correct statements. Award two marks for four correct statements	**2**
7(a)(ii)	**M1** energy change when 1 mole of an ionic compound is formed **M2** from gas phase ions/ gaseous ions	**2**

Question	Answer	Marks
7(b)	**M1** use of data (with no multipliers) 31, 131, -2678 **M2** extraction of data 908, 1730, 193 **M3** use of (2 x-325) **M4** evaluation of <u>their</u> expression correctly, as shown $\Delta H_f(ZnBr_2)$ = 131 + (908 +1730) + 193 + 31 + (2 x-325) + (-2678) = **-335** kJ mol^{-1} [4]	**4**
7(c)(i)	Br^- is a largest ion/larger ion than Cl^- so attraction between Br^- and Zn^{2+} is smaller	**1**
7(c)(ii)	O^{2-} is a smallest ion/smaller ion than Cl^- **AND** O^{2-} has the highest charge/ higher charge than Cl^- (so attraction between O^{2-} and Zn^{2+} is larger)	**1**

Question	Answer	Marks
8(a)(i)	**M1** potential difference between two half-cells/two electrodes in a cell **M2** under conditions of 1 atm., 298 K, (all) solutions being 1 mol dm^{-3}	**2**
8(a)(ii)	**both** platinum	**1**
8(a)(iii)	$E^{\ominus}_{cell}$ = 1.82 – 1.36 = **(+)0.46 V**	**1**
8(a)(iv)	$2Co^{3+} + 2Cl^- \rightarrow Cl_2 + 2Co^{2+}$	**1**
8(b)	**M1** Q= 2.5 x 30 x 60 C = 4500 C **AND** 96500 **OR** 579000 seen moles of CO_2= 4500/579000 = 7.8 x10^{-3} or 7.77 x 10^{-3} **M2** volume of CO_2 = 7.77 x 10^{-3} x 24000 = **187 cm^3**	**2**