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Mark Scheme (Results)

Summer 2013

GCE Chemistry 6CH01/01
The Core Principles of Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:

  i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
  ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
  iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A

Question Number	Correct Answer	Reject	Mark
1	C		**1**

Question Number	Correct Answer	Reject	Mark
2	C		**1**

Question Number	Correct Answer	Reject	Mark
3	D		**1**

Question Number	Correct Answer	Reject	Mark
4	B		**1**

Question Number	Correct Answer	Reject	Mark
5	A		**1**

Question Number	Correct Answer	Reject	Mark
6	B		**1**

Question Number	Correct Answer	Reject	Mark
7	A		**1**

Question Number	Correct Answer	Reject	Mark
8	C		**1**

Question Number	Correct Answer	Reject	Mark
9	B		**1**

Question Number	Correct Answer	Reject	Mark
10	D		**1**

Question Number	Correct Answer	Reject	Mark
11	C		**1**

Question Number	Correct Answer	Reject	Mark
12	A		**1**

Question Number	Correct Answer	Reject	Mark
13	A		**1**

Question Number	Correct Answer	Reject	Mark
14	C		**1**

Question Number	Correct Answer	Reject	Mark
15	D		**1**

Question Number	Correct Answer	Reject	Mark
16a	D		**1**

Question Number	Correct Answer	Reject	Mark
16b	C		**1**

Question Number	Correct Answer	Reject	Mark
16c	A		**1**

Question Number	Correct Answer	Reject	Mark
16d	D		**1**

Question Number	Correct Answer	Reject	Mark
17	B		**1**

Total for Section A = 20 Marks

Question Number	Acceptable Answers	Reject	Mark
18(a)	<table><tr><td>Isotope</td><td>$^{131}I_{53}$</td><td>$^{127}I_{53}$</td></tr><tr><td>Number of protons</td><td>53</td><td>53</td></tr><tr><td>Number of neutrons</td><td>78</td><td>74</td></tr></table>		**2**

Question Number	Acceptable Answers	Reject	Mark
18(b)	Xenon / Xe / $_{54}$Xe / Xe_{54} / $^{131}_{54}Xe$	Anything else including: $^{130}Xe_{54}$ Xe^- Iodine / I with or without numbers Hydrogen / H with or without numbers Te	**1**

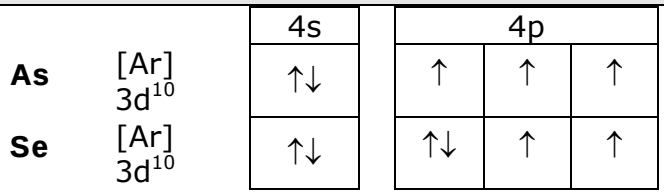
Question Number	Acceptable Answers	Reject	Mark
18(c)	Potassium iodide / KI Accept any soluble, non-toxic iodide or iodate Wrong name, correct formula (0) Correct name, wrong formula (0)	HI KI_3 Wrong formulae like CaI, MgI Wrong name like calcium idodate BaI_2 (toxic) AgI (insoluble) Potassium iodine	**1**

Question Number	Acceptable Answers	Reject	Mark
18(d)	Country /ALLOW state **and** justification Both needed for one mark e.g. Japan / New Zealand / California etc Country / state at risk from Earthquake / tsunami / flooding Further examples: Italy with volcanoes Afghanistan / middle eastern / African countries terrorist / (nuclear) weapon threat / war zone / political instability / abuse of nuclear power. USA /America / Jamaica etc risk of hurricane / tornado California San Andreas fault	…population density …landslide …too hot … surrounded by other countries Antarctica	**1**

Total for Question 18 = 5 Marks

Question Number	Acceptable Answers	Reject	Mark
19(a)	$As(g) - e^{(-)} \rightarrow As^{+}(g)$ OR $As(g) \rightarrow As^{+}(g) + e^{(-)}$ Entities **(1)** All species gaseous **(1)** providing a reasonable attempt at an ionization energy Examples: $As(g) + e^{(-)} \rightarrow As^{+}(g)$ $As(g) - e^{(-)} \rightarrow As^{-}(g)$ $As^{2+}(g) - e^{(-)} \rightarrow As^{3+}(g)$ IGNORE state symbol of electron ALLOW upper case / large S in arsenic ALLOW $As(g) + e^{(-)} \rightarrow As^{+}(g) + 2e^{(-)}$ **(2)**	$As(g)+e^{(-)} \rightarrow As^{-}(g)$ (electron affinity)	**2**

Question Number	Acceptable Answers	Reject	Mark
19(b)	AsH_3 / H_3As **(1)** H_2Se / SeH_2 **(1)** IGNORE charges ALLOW upper case / large S in arsenic **NOTE:** If two or more answers given for one element mark that element on a plus minus basis	SE for Selenium	**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	 One mark for each row Arrows may be half-headed Arrows must be in same direction if in singly occupied boxes (can be down) ALLOW two arrows for Se in any 4p box Selenium two arrows must show opposite spins		**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	**For parts c(ii),d and e it is important to keep in mind the two elements involved in each part** **As and Se** **First mark:** EITHER In Se, (spin) pairing has occurred (for the first time in that p sub-shell) OR electron removed from orbital containing two electrons **(1)** ALLOW sub-shell for orbital **Second mark:** EITHER (Increase in) repulsion (so electron lost more easily) OR Half-filled (sub-) shell/allow orbital (particularly) stable (in As) ALLOW orbital for sub-shell **(1)** Mark each point independently IGNORE reference to distance from nucleus and shielding		**2**

Question Number	Acceptable Answers	Reject	Mark
19(d)	**Se and Kr** **First mark:** EITHER The nuclear charge is increasing (Nuclear must be stated or clearly implied) OR number of protons / atomic number is increasing **(1)** **Second mark:** (Outermost) electron closer to nucleus / electron is removed from the same (sub)shell / electron experiences similar shielding / (atomic) radius is smaller/ smaller **atom** **(1)** ALLOW reverse arguments for selenium IGNORE Kr has full outer shell	Ionic radius Molecule (unless monatomic)	**2**

Question Number	Acceptable Answers	Reject	Mark
19(e)	**Kr and Rb** Any two from: The **electron** (in Rb) (removed) is further from the nucleus **(1)** The **electron** is in a higher / new / another / 5s (energy quantum) shell / energy level **(1)** **More** shielded **(1)** IGNORE any reference to stability of krypton or larger atomic radius of Rb / full outer shell of Kr It is possible that two answers may be offered together in one sentence e.g. Rb outer electron is in another shell further from nucleus (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
19(f)	Krypton / Kr	Anything else	**1**

Total for Question 19 = 13 Marks

Question Number	Acceptable Answers	Reject	Mark
20(a)(i)	$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$ Left hand side **(1)** right hand side **(1)** If SO_4^{2-} are on both sides max one mark ALLOW correct entities and balancing with no or incorrect state symbols for one mark. ALLOW multiples It is sometimes difficult to be sure of the '2' on the Cu^{2+}. Give BOD provided $2H^+$ on the left of the equation	Charges within water molecule	**2**

Question Number	Acceptable Answers	Reject	Mark
20(a)(ii)	1.749/1.75/1.7 with or without working scores 2 If answer incorrect look for Mass = 79.5 x 0.02 OR =1.59 (1) OR TE from incorrect mass for one mark Their mass x 1.1= their correct answer to 2/3/4SF (g) (1) Accept crossed 7's ALLOW both ways of writing 4 and be generous if 4 looks like 9	1.74 1.8	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	Add in small portions / use a spatula / use a **small** spoon / slowly / gradually **(1)** To prevent (mixture / acid) boiling over / frothing / spilling / splashing / splash back **(1)** Mark independently Bubbles are neutral IGNORE add carefully / cautiously alone	Spitting / violent reaction / fizzing Because reaction is exothermic alone Bubbles of carbon dioxide	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	Dip in glass rod. Remove and allow to cool. See if crystals form ALLOW any workable suggestion Examples: See crystals / salt forming around edge of beaker Depth of colour of solution increases Solution / colour becomes darker Solution / colour becomes deeper blue Dark blue solution Reduce volume by at least half / until crystals form	Solution thickens Precipitate forming	**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(iii)	Blue	Any mention of green or other colour	**1**

Question Number	Acceptable Answers	Reject	Mark
20(b)(iv)	(The ions are arranged in a) regular (way) / lattice OR The ions are arranged in the same way / have same arrangement / have uniform arrangement The term structure is neutral and should be ignored IGNORE statements about ions attracting or repelling	The ions are arranged in a similar / fixed way	**1**

Question Number	Acceptable Answers	Reject	Mark
20(c)(i)	249.6 g mol^{-1} ALLOW 249.5 g mol^{-1} ALLOW 250 g mol^{-1} value **(1)** units **(1)** Common wrong values are 159.5 / 6, 185.5 / 6, 249 ALLOW unit mark with any or no value. ALLOW g / mol for unit	g/mol^{-1}	**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)(ii)	Max yield = 249.6 x 0.02 = 4.992(g) **(1)** Percentage yield = $\frac{2.7 \times 100}{4.992}$ = (54.0865) = 54% **(1)** If 249.5 is used = (54.1082) = 54% OR 2.7 / 249.6 = 0.01082 **(1)** Percentage yield = 0.01082 x 100/0.02 = 54% **(1)** ALLOW TE from any value in (i), and note 159.6 gives 84.6% 185.6 gives 72.7% IGNORE SF except one SF Correct answer, no working scores (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
20(c)(iii)	(Copper(II) sulfate is soluble) so some remains in solution / some remains on the **filter paper** IGNORE other transfer errors Incomplete crystallization / not all the crystals are formed	Experimental error/ incomplete reaction Filtering alone Efflorescence	**1**

Question Number	Acceptable Answers	Reject	Mark
20(d)	This is a (chemical) test for (the presence of) water Invisible ink Moisture / humidity test Test to see if solutions are aqueous	Check to see if substance is hydrated Drying agent Quantitative measurements of water content.	**1**

Total for Question 20 = 15 Marks

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	25 x 4.18 x 11 = 1149.5 (J) ALLOW 1.1495 **kJ** Otherwise ignore units even if incorrect IGNORE sign IGNORE SF except one or two SF	1149.5 **kJ**	**1**

Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	-115 kJ mol^{-1} ALLOW -115000 J mol^{-1} Sign with correct value **(1)** Units and three significant figures **(1)** Mark independently ALLOW TE from (i) -114 kJ mol^{-1} (rounding error) scores 1 -115.0 kJ mol^{-1} scores 1 Values of -4600 and -3.86 are quite common ALLOW K and j in any case in units	J or kJ alone	**2**

Question Number	Acceptable Answers	Reject	Mark
21(b)	$2NaHCO_3(s) \square Na_2CO_3(s)+CO_2(g)+H_2O(l)$ 2HCl(aq) (2HCl(aq)) $2NaCl(aq) + 2CO_2(g) + 2H_2O(l)$ **First mark** Arrow from products in top line to lower line and correct entities **(1)** $NaCl + CO_2 + H_2O$ **Second mark** **2**$NaCl$**(aq)** + **2**CO_2**(g)** + **2**H_2O**(l)** Correct state symbols and balancing **(1)** ΔH^o = **+**91.6 OR +91.7 (kJ mol^{-1}) ALLOW no positive sign only if correct Working with correct signs given **(3)** OR **Third mark** Correct use of Hess's Law (in numbers or symbols) consistent with arrow direction **(1)** **Fourth mark** **2x**(-115) = ΔH^o - 321.6 Correct multiples and numbers **(1)** ALLOW 2 x any number (including -4600 and -3.86) except 2 x +/- 321.6 Notice Third and Fourth marks can be scored by $\Delta H^o = 2(-115) - (-321.6)$		**5**

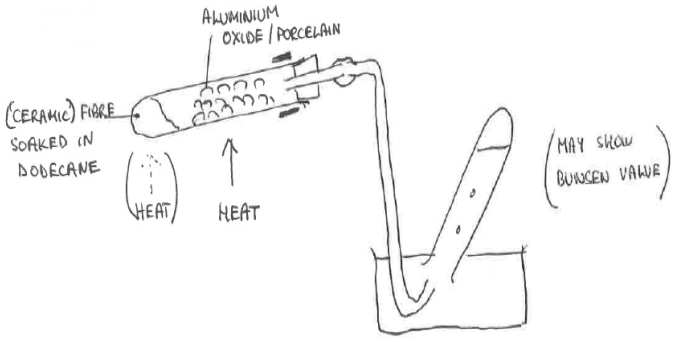
	Fifth mark $\Delta H^o = 2(-115) - (-321.6)$ $= +91.6$ (kJ mol^{-1}) OR $\Delta H^o = 2(-114.95) - (-321.6)$ $= +91.7$ (kJ mol^{-1}) Correct value for their calculation with correct sign IGNORE SF except 1 ALLOW no positive sign only if correct working with correct signs given **(1)** Omitting 2x gives +206.6 (could get 4 marks) -4600 gives -598.4 -3.86 gives +313.88		

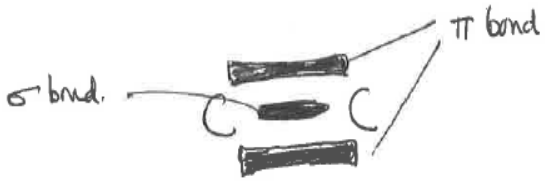
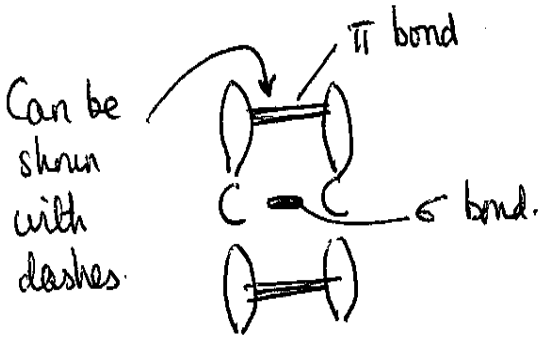
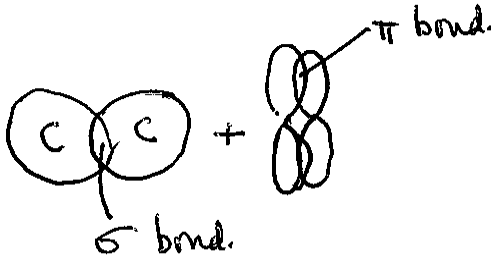
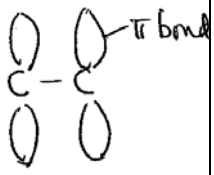
Question Number	Acceptable Answers	Reject	Mark
21(c)	((±) 0.5 x 2 x 100 /11) = (±)9.09 (%) ALLOW at 9.0909/9.091/9.1 and 9	 9.10/9.0	**1**

Question Number	Acceptable Answers	Reject	Mark
21(d)	**First mark** It is used as a raising agent / self raising flour / baking soda / baking powder OR Causes cakes / (soda) bread to rise / expand. **(1)** **Second mark** Carbon dioxide (released on heating causes cakes / bread to rise) OR It reacts with acid to form carbon dioxide (in baking powder) providing bread /cake etc is mentioned **(1)** ALLOW Used in cooking green vegetables To keep green colour	To make pastry rise Bicarbonate of soda Gas Air Neutralizing acid foods	**2**

Total for Question 21 = 11 Marks

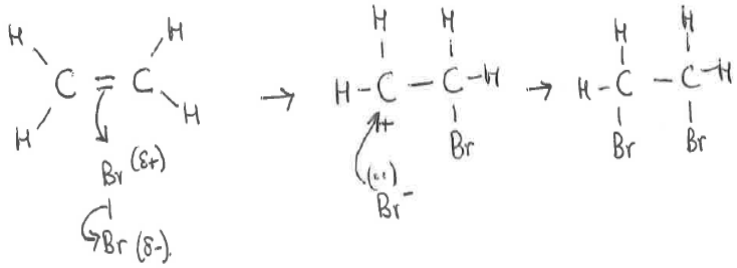
Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	$C_{12}H_{26} \rightarrow C_{10}H_{22} + C_2H_4$ IGNORE state symbols even if incorrect ALLOW displayed and structural formula for ethene		**1**

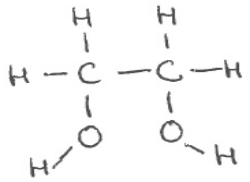
Question Number	Acceptable Answers	Reject	Mark
22 (a)(ii)	Collection over water or in gas syringe **(1)** IGNORE solid bung with delivery tube coming out / accidental sealing in drawing / clamps This is the only stand alone mark **Dependent on diagram including roughly horizontal tube:** Labelled ceramic fibre / any sort of wool (unless any named metal) (soaked in dodecane) **(1)** Aluminium oxide / porcelain pieces/catalyst / catalyst with incorrect name or incorrect formula / any named metal / anti-bump granules **(1)** Heat under catalyst/under middle of test tube **(1)**  	Delivery tube through glassware	**4**

Question Number	Acceptable Answers	Reject	Mark
22(b)	EITHER  Diagram of bonds, the single bond must be shown as a region of space and not as a single or double straight line **(1)** Labelled σ and π in correct places on correctly drawn bonds.ie this mark can only be awarded if bonds correctly drawn **(1)** OR   Labelled pi bond **(1)** Labelled sigma bond **(1)** Whichever scores more Bonds may be shown by overlap of appropriate orbitals, when any orbital or region of overlap may be labelled Only one pi lobe / bond need be labelled Carbons need not be shown Bonds may be drawn on separate diagrams	 	**2**

	IGNORE C-H bonds IGNORE any additional electron density maps IGNORE any partial charges		

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	1,2-dibromoethane **(1)** IGNORE punctuation CH_2BrCH_2Br **(1)** ALLOW displayed / skeletal formula Mark independently Bromoethane with CH_2BrCH_3 (0)	$C_2H_4Br_2$	**2**

Question Number	Acceptable Answers	Reject	Mark
22 (c)(ii)	 Arrow from double bond towards nearest bromine atom and arrow from bond between bromine atoms to furthest bromine atom **(1)** Correct formula of carbocation intermediate **(1)** Arrow from anywhere on the brom**ide** ion to positive carbon **(1)** ALLOW missing hydrogens if bonds from carbons shown ALLOW full marks for TE bromoethane formation using HBr and first arrow to H of HBr ALLOW full marks for TE 1,2 – dibromopropane		**3**

Question Number	Acceptable Answers	Reject	Mark
22(d)	 ALLOW O-H not displayed ALLOW vertical C bond to any part of OH Only penalise clear C-H-O / CH-O bond horizontally IGNORE any name whether correct or not	Skeletal formula or structural formula	**1**

Question Number	Acceptable Answers	Reject	Mark
22(e)(i)	$nCH_2=CH_2 \rightarrow (CH_2\text{-}CH_2)_n$ Left side **(1)** Right side extension bonds must be shown **(1)** Mark independently Accept $nC_2H_4 \rightarrow (CH_2\text{-}CH_2)_n$ Penalise omission of n only once ALLOW $nCH_2=CH_2 + nCH_2=CH_2 \rightarrow (CH_2\text{-}CH_2)_n$ for (2) ALLOW multiples of C_2H_4 in product	$(CH_2=CH_2)_n$ N	**2**

Question Number	Acceptable Answers	Reject	Mark
22(e)(ii)	**100%** with one of the following: …only one product OR … no by-products / no other product OR …all reactants form the product OR …as addition reaction IGNORE…same empirical formula	 No product lost / No side reaction(s) All reactants form the product**s**	**1**

Total for Question 22 = 16 Marks

Total for Paper = 80 Marks

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