Mark Scheme (Results)
January 2010

GCE

GCE Chemistry (6CH01/01)

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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.

Using the Mark Scheme

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 <u>meaning</u> 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.

6CH01/01

Section A

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

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

Question Number	Correct Answer	Reject	Mark
3	A		**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 (a)	B		**1**

Question Number	Correct Answer	Reject	Mark
6 (b)	A		**1**

Question Number	Correct Answer	Reject	Mark
6 (c)	D		**1**

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

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

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

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

Question Number	Correct Answer	Reject	Mark
14 (a)	A		**1**

Question Number	Correct Answer	Reject	Mark
14 (b)	D		**1**

Question Number	Correct Answer	Reject	Mark
14(c)	B		**1**

Question Number	Correct Answer	Reject	Mark
14 (d)	B		**1**

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

Section B

Question Number	Acceptable Answers	Reject	Mark
16 (a)	$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$ ALLOW $MgCO_3(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + CO_2(g) + H_2O(l)$ All formulae and balancing (1) State symbols – mark independently; can be given even if eg $MgCl_2$ formula incorrect or for $H_2CO_3(aq)$(1) $CO_3^{2-}(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$ (1 mark max) ALLOW 1 missing/incorrect state symbol		**2**

Question Number	Acceptable Answers	Reject	Mark
16 (b)	Any two from Bubbles (of gas)/ fizzing/ effervescence (1) Solid disappears/ disintegrates /gets smaller /dissolves OR $MgCO_3$ disappears (if given as solid in (i)) (1) IGNORE clear solution forms Mixture gets warmer/cooler OR temperature change occurs/ heat change occurs(1)	Carbon dioxide /gas given off Precipitate forms (no TE for $MgCl_2(s)$) Just “exothermic”	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (i)	Moles acid = ((25 x 2/ 1000)) = 0.05/0.050 / 5×10^{-2} Ignore units and sf		**1**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (ii)	Mass Mg CO_3 = ((0.05 x 84.3÷2)) = 2.1075/ 2.108 /2.11/2.1 (g) ALLOW TE from (c)(i) and (a) ALLOW Moles acid x 84.3 ÷2 for TE(from (i) (1) (4.2(15)) if factor of 2 missing for TE from (a)) Ignore sf except 1 sf Ignore units	2 / 2.12(g)	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (iii)	To ensure all **acid** reacts/ all **acid** is used up / to ensure product is neutral/ it (HCl) is neutralised	All reactants used up To ensure reaction is complete (without reference to HCl) To ensure yield is high To ensure magnesium carbonate is in excess	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (iv)	Filter ALLOW centrifuge/ decant/ pour off / (use) filter paper Ignore comments about heating solution first to concentrate it	Sieve Collect $MgCl_2$ in filter paper Use filter paper to dry crystals Evaporate	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (v)	100% yield = (203.3 x 0.025) /5.08(25)g) (1) yield = $\left(\frac{3.75}{5.08} \times 100\right)$ = **74 %** (1) OR Mol magnesium chloride = $\left(\frac{3.75}{203.3}\right)$ = 0.018445/0.01845/0.0184/0.018 (1) yield = $\left(\frac{100 \text{ X } 0.01845}{0.025}\right)$ = **74 %** (1) Second mark can be given as TE if expected yield or number of moles is wrong. ALLOW 73.82/73.78/73.8 /73.6 /other answers rounding to 74 % from earlier approximations /72 (from 0.018 moles) Allow TE from (a) and or (c)(i) and or (c)(ii) If the ratio HCl to $MgCl_2$ is 1:1 ans 37 % (2) If moles of HCl in (c)(i) are wrong (2) If (a) and (c)(i) are correct 37 % scores (1) If moles $MgCO_3$ = 0.05 allow TE giving 37/ 36.9% Ignore sf except 1 sf	 70	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (c) (vi)	Some stays in solution / losses on transferring from one container to another/ loss on filtering /crystals left behind/some left on filter paper etc Any one ALLOW correct answers with other comments which are not incorrect eg “there may be some spillage and also …….”	Incomplete reaction/side reaction Lost as waste products Lost to environment Lost in manipulation? Hydrolysis Weighing errors Just “spillage”	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (d)(i)	Not 100% ionic /almost completely ionic OR (partial) covalent character/ almost no covalency OR Discrepancy in BH values indicates polarisation (of ions) (1) *Mark can be given if answer here refers to bond strength and the answer above is included in (ii)*	Magnesium chloride is covalent Magnesium chloride is partially ionic Just “polarity of ions”	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (d)(ii)	QWC I^- larger (than Cl^-) (1) so (ion) easier to polarise /distort (1) ALLOW for 2nd mark increases covalent character / more covalent than $MgCl_2$ / converse for $MgCl_2$ / description of polarisation instead of the term If clearly ions, allow reference to iodine instead of iodide (“iodine has a larger ion”) Read in conjunction with (i). Direct comparison not needed if (i) covers bonding in chloride.	Size of atoms rather than ions I_2 is larger than Cl_2 I_2 molecules are polarised Mg^{2+} is polarised Iodine more electronegative than chlorine	**2**

Question Number	Acceptable Answers	Reject	Mark
16 (e) (i)	$\frac{(100 \times 20)}{10^6} = 2 \times 10^{-3}$(g) ALLOW 0.002(g) 1/500 (g) 2×10^{-6} kg IGNORE % as unit	$2 \times 10^{-3} = 0.0002$	**1**

Question Number	Acceptable Answers	Reject	Mark
16 (e) (ii)	(More) soluble (in water)/ (more) soluble in blood stream/ can be given as solution/ won't produce gas in stomach / won't react with stomach acid/ doesn't produce CO_2 Converse answers for $MgCO_3$ Or other valid answers ALLOW can be given in liquid form	$MgCl_2$ is a liquid $MgCO_3$ is too reactive	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (a) (i)	Moles N = $\frac{14.42}{14}$ = 1.03 Moles H = 3.09 Moles S= $\frac{33.06}{32.1}$ = 1.03 (1) ALLOW Moles S= $\frac{33.06}{32}$ = 1.03 Moles O = $\frac{49.43}{16}$ = 3.09 (1) (Ratio 1:3:1:3) IGNORE sf/rounding for moles NH_3SO_3 any order (1) Correct answer, no working (3) If O omitted, giving NH_3S (2)		**3**

Question Number	Acceptable Answers	Reject	Mark
17 (a) (ii)	NH_3SO_3 (any order) since molar mass = empirical formula mass/ since empirical formula mass =97/ with some other justification TE from (i) $N_2H_6S_2$, as empirical formula mass =49, approx half molecular mass		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	Look for workable method. Don't penalise lack of labels on simple equipment eg test tubes. Workable way of making and collecting gas eg flask or tube + connection/ below inverted funnel with tube of water above Labelling of reactants not needed (1) Suitable (labelled) apparatus for measuring volume eg Gas syringe/ inverted burette or measuring cylinder containing water (1)	Uncalibrated tubes	**2**

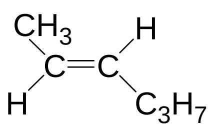
Question Number	Acceptable Answers	Reject	Mark
17 (b) (ii)	$\left(\frac{66}{24\,000}\right) = 2.75 \times 10^{-3}$ / 0.00275 / 0.0028	0.003	**1**

Question Number	Acceptable Answers	Reject	Mark
17 (b) (iii)	1 mol sulfamic acid $\rightarrow$ 0.5 mol H_2 OR ratio sulfamic acid : hydrogen gas = 2:1 OR 5.5 (x 10^{-3})(moles) = (2 x 2.75 (x 10^{-3})) (moles) OR TE using ratio calculated from (ii) (1) Each H_2 comes from 2 H^+ (So 1 sulfamic acid $\rightarrow$ 1 H^+) (1)	ratio sulfamic acid : hydrogen ions = 2:1	**2**

Question Number	Acceptable Answers	Reject	Mark
17 (c) (i)	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ ALLOW $H^+ + CO_3^{2-} \rightarrow HCO_3^-$ $2H^+ + CO_3^{2-} \rightarrow H_2CO_3$		**1**

Question Number	Acceptable Answers	Reject	Mark
17 (c) (ii)	**Less** easy to spill solid (in storage) OR doesn't spread if spilt OR easy to sweep up if spilt OR **less** corrosive/ **less** strongly acidic than HCl ALLOW Weaker (acid) / HCl is a stronger acid	Just "it is a solid" Less reactive (unless with comment on acid strength) HCl produces poisonous gas / Cl_2 Less concentrated Has higher pH Just "HCl is harmful/irritant/corrosive" Just "sulfamic acid is not harmful/irritant/corrosive"	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (a)	Allow formulae throughout instead of names **Test :** add bromine (water) /bromine solution ALLOW bromine gas /bromination (1) **Result:** no change with hexane / stays orange brown/ stays red brown/ stays yellow and goes colourless with hex-1-ene(1) 2^{nd} mark cq on 1st OR **Test :** add (acidified) potassium manganate((VII)) (solution) (1) ALLOW potassium permanganate for potassium manganate(VII) **Result:** no change with hexane/stays purple and goes colourless / brown with hex-1-ene (1) OR **Test :** add alkaline potassium manganate((VII)) (solution) (1) ALLOW potassium permanganate for potassium manganate(VII) **Result:** no change with hexane/stays purple and goes green with hex-1-ene (1)	Smokiness of flame Bromide Iodine Goes clear	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (b) (i)	 ALLOW Partially or fully displayed as long as the two H are trans Allow bonds which go closer to the H than to C of alkyl groups on l.h.s.		**1**

Question Number	Acceptable Answers	Reject	Mark
18 (b) (ii)	QWC C=C restricts rotation/ C=C prevents twisting /C=C can't rotate/ lack of free rotation round C=C (so the groups can't change position relative to the bond) (1) Hex–2-ene has different groups on the C at each end of C=C / hex-1-ene has 2 hydrogens on the C at one end of C=C / hex-1-ene doesn't have different groups on the C at one end of C=C / hex-1-ene has no group which takes priority on the C at one end of C=C (1) (answer can be considered from either hex –1-ene or hex-2-ene)	Alkenes can't rotate Double bond is fixed Bonds can't rotate Double bond is on first carbon (unless further explanation)	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (i)	ignore signs (50 x 46 x 4.18) = 9614(J)/ 9.614 kJ (if converted to kJ units must be stated) ALLOW 9610 / 9600 /9.61 kJ /9.6 kJ	(50.32 x 46 x 4.18) = 9676(J)	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (ii)	One mark each for moles of hexane energy change sign, units, 2 sig figs (for energy change calculated) Moles hexane = **0.32/86** = (3.72×10^{-3}) (1) (9614/ 3.72×10^{-3}) = 2584000 J/ 2584 kJ (1) **ΔH = -2600 kJ mol^{-1}** /-2 600 000 J mol^{-1} / -2.6×10^{6} J mol^{-1} (1) Allow TE: **0.32g** in (i) (gives 61.53J), **ΔH = -17 kJ mol^{-1}** /-17 000 J mol^{-1} /-1.7×10^{4} J mol^{-1} **50.32g** in (i) (gives 9676J) **ΔH = -2600 kJ mol^{-1}** /-2 600 000 J mol^{-1} /-2.6×10^{6} J mol^{-1} **Rounding of moles to 4×10^{-3}** gives –**2400 kJ mol^{-1} or-15 kJ mol^{-1}** max 2 (loses moles mark) Answer alone (3) Max 2 if negative sign missing and/or more than 2 sf or error in units		**3**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (iii)	Any 2 from: • Heat losses (from calorimeter)/ poor insulation • Incomplete combustion/burning • Incomplete transfer of heat/ loss by convection • Evaporation of fuel (after weighing) • Heat capacity of calorimeter (not included)/ heat absorbed by calorimeter • Measurements not carried out under standard conditions /H_2O is gas, not liquid, in this experiment	Just “energy losses” Not all hexane burns Data books give average values Hexane is impure Human error	**2**

Question Number	Acceptable Answers	Reject	Mark
18 (c) (iv)	Error in reading temperature is less than the effect of ignoring heat loss etc ALLOW Other errors are greater than error in temperature reading / Readings are within margins of error/ The accuracy with the thermometer is not significantly different from other measurement errors / 0.1°C is insignificant compared to temperature change / Using 0.1°C thermometer does not change significant figures in final answer / Using 0.1°C thermometer does not reduce errors	Using 0.1°C thermometer gives a more precise reading but does not improve accuracy	**1**

Question Number	Acceptable Answers	Reject	Mark
18 (d) (i)	Nickel / Ni Finely divided nickel/ Raney nickel ALLOW Platinum /Pt Palladium/ Pd Rhodium/ Rh Accept one of the above answers combined with a comment such as “at high temperature”, “heat also needed”, “under pressure”, “lumps of”, “powdered” Accept combinations of above answers eg Pt and Pd	Zeolite Carbon Hydrogen Uv light	**1**

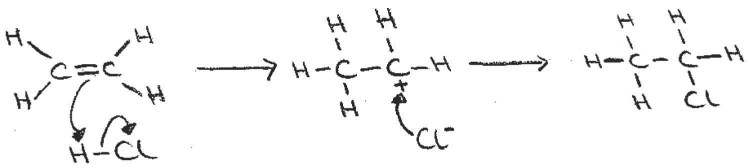
Question Number	Acceptable Answers	Reject	Mark
18 (d) (ii)	Left hand arrow, pointing down, labelled ΔH_c hex-1-ene + ΔH_c hydrogen/ -4003-286/-4289 OR Pointing up with signs given above reversed (1) Right hand arrow pointing down labelled ΔH_c hexane / -4163 OR Pointing up with signs given above reversed (1) Ignore oxygen on both arrows Arrows may be labelled ΔH_1 etc if key given or use of numbers in calculation makes this obvious. ($\Delta H_{reaction}$ – 4163 = -4003 – 286 / or words applying Hess' law correctly) $\Delta H_{reaction}$ = **-126** however obtained(1) TE: If arrows point up and signs are **not** reversed $\Delta H_{reaction}$ = **+126** Max (1)		**3**

Question Number	Acceptable Answers	Reject	Mark
18 (d) (iii)	Same (number and type of) bonds are broken and made in each reaction / one C=C (and one H-H) are broken and two C-H made ALLOW reaction is –CH=CH- + $H_2 \rightarrow$ -CH_2-CH_2- each time (Similar energy change) as in each case H_2 reacts with C=C	All are alkenes going to alkanes all have the same double bond which reacts in the same way	**1**

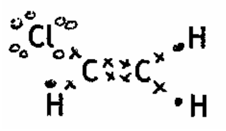
Question Number	Acceptable Answers	Reject	Mark
19 (a) (i)	Reagent: chlorine/ Cl_2 (1) Condition: uv/ sunlight (1) ALLOW light Mark independently Ignore reference to temp and pressure if given with uv light. If answers reversed/both on one line 1 out of 2	Cl Just "heat"	**2**

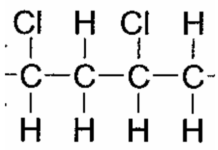
Question Number	Acceptable Answers	Reject	Mark
19 (a) (ii)	(free) radical (1) Substitution (1) Mark independently		**2**

Question Number	Acceptable Answers	Reject	Mark
19 (b) (i)	Hydrogen chloride / HCl	Hydrochloric acid Chlorine HCl (aq) Cl_2	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (b) (ii)	Curly (not half headed) arrow from C=C to H (1) Curly arrow from bond in H-Cl to Cl (1) Curly arrow from Cl^- to C^+ (1)  Partial charges on HCl not required Lone pairs on Cl^- not required It should be clear if arrows are to/ from a bond or an atom, but give allowance for precise position Correct intermediate without arrows (1) Correct addition of HBr max 2 Correct addition of HCl to propene max 2 Max 2 for addition of Cl_2 instead of HCl (forming 1,2 -dichloroethane) Max 1 for addition of Cl_2 instead of HCl forming chloroethane	Attack by $Cl^{\delta-}$ or Cl· loses 3rd mark only Correct free radical mechanism from ethane and chlorine scores 0	**3**

Question Number	Acceptable Answers	Reject	Mark
19 (c)	Higher atom economy from ethene /by electrophilic addition Higher yield from ethene Both correct for (1) From ethene only one product / all atoms are used **making product** /no unwanted products (1) For ethene yield high as no di-, tri- etc substituted products form /only one product / no by-products OR no side reactions occur OR no C_4 compounds can form (1) [Or reverse argument]	Not much product is lost	**3**

Question Number	Acceptable Answers	Reject	Mark
19 (d) (i)	 Double bond and electrons around C correct (1) Other electrons correct (1) Can be all dots or all crosses First mark can be given if C_2H_4 drawn correctly Second mark can be given if C_2H_5Cl drawn correctly Don't penalise if bonds shown as well as electrons		**2**

Question Number	Acceptable Answers	Reject	Mark
19 (d) (ii)	 ALLOW H and Cl below C chain; Cl on C2 and C3 or C1 and C4; formula above with brackets at each end and n outside end bracket End bonds should be shown, but don't penalise if these don't go through brackets H atoms should be shown	Formula not displayed One monomer unit shown in bracket with the number 2 outside bracket Cl on C1 and C2 Cl onC3 and C4	**1**

Question Number	Acceptable Answers	Reject	Mark
19 (d) (iii)	QWC Any 2 Answers could consider the following factors: • energy for manufacture • availability / abundance of raw materials • lifetime of product/ how often will it need to be replaced /metal rusts/plastic more easily punctured etc • ease of recycling /steel an excellent recyclable material • consequences of disposal / is it biodegradable? • Is it from a non-renewable resource? • Atom economy in manufacture Allow answers comparing specific properties (if correct) illustrating the relevant property Examples PVC will last longer than iron due to lack of corrosion (1) PVC comes from oil which is non-renewable (1) PVC and metals come from non-renewable sources (1) Credit any two valid points	Ignore if other answers given: cost PVC biodegradable its carbon footprint Is it environmentally friendly? Pollution comments without reference to resources needed to clean up	**2**

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