Mark Scheme (Results)

Summer 2017

Pearson Edexcel IAL
In Chemistry (WCH01) Paper 01
The Core Principles of Chemistry

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General marking guidance

- This mark scheme provides a list of acceptable answers for this paper. Candidates will receive credit for all correct responses but will be penalised if they give more than one answer where only one is required (e.g. putting an additional cross in a set of boxes). If a candidate produces more written answers than the required number (two instead of one, three instead of two etc), only the first answers will be accepted. Free responses are marked for the effective communication of the correct answer rather than for quality of language but it is possible that, on some occasions, the quality of English or poor presentation can impede communication and loose candidate marks. It is sometimes possible for a candidate to produce a written response that does not feature in the mark scheme but which is nevertheless correct. If this were to occur, an examiner would, of course, give full credit to that answer.
- 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.

Section A (multiple choice)

Question Number	Correct Answer	Mark
1	**1. The only correct answer is C** ***A*** *is not correct because 1kg = 10^6 mg so no conversion factor is needed.* ***B*** *is not correct because 1kg = 10^6 mg so no conversion factor is needed.* ***D*** *is not correct because 1kg = 10^6 mg so no conversion factor is needed.*	**(1)**

Question Number	Correct Answer	Mark
2	**2. The only correct answer is C** ***A*** *is not correct because this does not count the 3 ions per mol of Na_2SO_4* ***B*** *is not correct because this assumes there are 2 ions per mol of Na_2SO_4* ***D*** *is not correct because this assumes there are 7 ions per mol of Na_2SO_4*	**(1)**

Question Number	Correct Answer	Mark
3	**3. The only correct answer is D** ***A*** *is not correct because this is based on mass, not mol* ***B*** *is not correct because the Li:O ratio is wrong* ***C*** *is not correct because the Li:P ratio is wrong*	**(1)**

Question Number	Correct Answer	Mark
4	**4. The only correct answer is C** ***A*** *is not correct because the mol of O have not been calculated* ***B*** *is not correct because the mol of O have not been calculated* ***D*** *is not correct because the molar ratio Cr:O has been inverted*	**(1)**

Question Number	Correct Answer	Mark
5	**5. The only correct answer is A** ***B*** *is not correct because the ratio of* SO_2*:*SO_3 *is 1:1 and oxygen is in excess* ***C*** *is not correct because the ratio of* SO_2*:*SO_3 *is 1:1 and oxygen is in excess* ***D*** *is not correct because the ratio of* SO_2*:*SO_3 *is 1:1 and oxygen is in excess*	**(1)**

Question Number	Correct Answer	Mark
6	**6. The only correct answer is B** ***A*** *is not correct because Be has no unpaired electrons* ***C*** *is not correct because Cl has one unpaired p electron* ***D*** *is not correct because Ca has no unpaired electrons*	**(1)**

Question Number	Correct Answer	Mark
7	**7. The only correct answer is D** ***A*** *is not correct because this ion has 20 protons and* S^{2-} *has 16* ***B*** *is not correct because this ion has 17 protons and* S^{2-} *has 16* ***C*** *is not correct because this ion has 19 protons and* S^{2-} *has 16*	**(1)**

Question Number	Correct Answer	Mark
8	**8. The only correct answer is D** ***A*** *is not correct because* Na^+ *has less polarising power than* Al^{3+} ***B*** *is not correct because* Na^+ *has less polarising power than* Al^{3+} ***C*** *is not correct because* F^- *is smaller than* I^- *and less easily polarised*	**(1)**

Question Number	Correct Answer	Mark
9	**9. The only correct answer is C** ***A*** *is not correct because electrons are removed from level 2 before level 1* ***B*** *is not correct because electrons are removed from 2p before 2s* ***D*** *is not correct because electrons are removed from 2s before 1s*	**(1)**

Question Number	Correct Answer	Mark
10(a)	**10(a). The only correct answer is B** ***A*** *is not correct because* $CaCO_3(s)$ *should not be shown as separated ions* ***C*** *is not correct because* $CaCO_3(s)$ *should not be shown as separated ions* ***D*** *is not correct because* $CaCl_2(aq)$ *should be shown as separated ions and spectators then cancelled out*	**(1)**

Question Number	Correct Answer	Mark
10(b)	**10(b). The only correct answer is A** ***B*** *is not correct because calcium chloride cannot be removed by distillation* ***C*** *is not correct because calcium chloride cannot be removed by distillation* ***D*** *is not correct because the excess solid calcium carbonate must be removed before evaporating*	**(1)**

Question Number	Correct Answer	Mark
10(c)	**10(c). The only correct answer is B** ***A*** *is not correct because this does not use the molar masses and the value is based on 10.4/14.7* ***C*** *is not correct because the 2:1 ratio of HCl:$CaCl_2$ is not used* ***D*** *is not correct because it is not based on the theoretical yield of calcium chloride being 14.7g*	**(1)**

Question Number	Correct Answer	Mark
11	**11. The only correct answer is C** ***A*** *is not correct because melting temperatures decrease down Group 1* ***B*** *is not correct because the melting temperature of P is less than Si* ***D*** *is not correct because the melting temperature of Ar is less than the others*	**(1)**

Question Number	Correct Answer	Mark
12	**12. The only correct answer is C** ***A*** *is not correct because it has used a wrong sign in the calculation and then divided the answer by 2* ***B*** *is not correct because it has used a wrong sign in the calculation* ***D*** *is not correct because the wrong sign for enthalpy change has been used*	**(1)**

Question Number	Correct Answer	Mark
13	**13. The only correct answer is D** ***A*** *is not correct because there are 6 C atoms in the longest chain* ***B*** *is not correct because there are 6 C atoms in the longest chain* ***C*** *is not correct because the chain should be numbered from the end which gives lowest numbers for the side chains*	**(1)**

Question Number	Correct Answer	Mark
14	**14. The only correct answer is B** ***A*** *is not correct because in the double bond the first C atom has 2H attached* ***C*** *is not correct because in the double bond the first C atom has 2Cl attached* ***D*** *is not correct because in the double bond one C atom has* $2CH_3$ *attached*	**(1)**

Question Number	Correct Answer	Mark
15	**15. The only correct answer is A** ***B*** *is not correct because the molecular formula* C_5H_8 *cannot be simplified* ***C*** *is not correct because the molecular formula* C_5H_{12} *cannot be simplified* ***D*** *is not correct because the molecular formula* C_5H_{12} *cannot be simplified*	**(1)**

Question Number	Correct Answer	Mark
16	**16. The only correct answer is D** ***A*** *is not correct because hydrogen peroxide does not react with propene to give a diol* ***B*** *is not correct because oxygen and water do not react with propene to give a diol* ***C*** *is not correct because aqueous sodium hydroxide does not react with propene to give a diol*	**(1)**

Question Number	Correct Answer	Mark
17	**17. The only correct answer is A** ***B*** *is not correct because bromine, not HBr, is needed to produce dibromopropane* ***C*** *is not correct because bromine, not HBr, is needed to produce bromopropanol* ***D*** *is not correct because bromine water, not HBr, is needed to produce bromopropanol*	**(1)**

Question Number	Correct Answer	Mark
18	**18. The only correct answer is B** ***A*** *is not correct because another alkene is required to react with ethene* ***C*** *is not correct because another alkene is required to react with ethene* ***D*** *is not correct because an alkene with 3C atoms is required to react with ethene*	**(1)**

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
19a(i)	$\frac{(6.10\times54 + 92.0\times56 + 1.90\times57)}{100}$ **(1)** = (5589.7 /100) =**55.9** Final answer must be to 3 SF IGNORE Units **(1)** Correct answer with no working shown scores (2)	 55.89/ 55.90	**(2)**

Question Number	Acceptable Answers	Reject	Mark
19a(ii)	X = Fe / iron. ALLOW Fe^{+} protons: 26; electrons: 25; neutrons: 30 **MP1** Identity of X **and** proton number **(1)** **MP2** number of electrons **and** neutrons No TE for MP2 for wrong element **(1)**	Fe with negative charge	**(2)**

Question Number	Acceptable Answers	Reject	Mark
19a(iii)	X^{2+}/ Fe^{2+} forms IGNORE any atomic numbers or mass numbers	Fe^{2-} Silicon, Si, Ni, Si^{+}, N_2^{+}	**(1)**

Question Number	Acceptable Answers	Reject	Mark
19a(iv)	The isotopes have the same number of electrons **(1)** (therefore) same number of electrons in outer shell / valence electrons (so the same chemical properties) **(1)** Isotopes have the same electronic configuration/structure scores (2) IGNORE Same number of protons/ different number of neutrons		**(2)**

Question Number	Acceptable Answers	Reject	Mark
19b(i)	Sample is vaporised / converted to a gas / atomised ALLOW sample is sublimed **(1)** (Atoms are) bombarded with (high energy) electrons / electron removed with electron gun / electron removed with electron beam **(1)**	'vaporised to form ions'	**(2)**

Question Number	Acceptable Answers	Reject	Mark
19b(ii)	**MP1** Reference to acceleration, deflection, detection in correct order IGNORE Additional comments on vaporisation and ionisation **(1)** **MP2 and 3** Acceleration: (ions pass through slit in negatively) charged plate / electric field / electronic field **(1)** Deflection: (ions pass through) a magnetic field ALLOW magnet / electromagnet **(1)**	Incorrect order Analysing Just positively charged plate 'electron field'	**(3)**

(Total for Question 19 =12 marks)

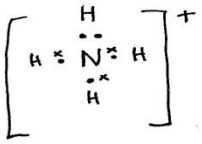
Question Number	Acceptable Answers	Reject	Mark
20a(i)	**MP1** Metallic (bonding) **and** Na has delocalised / mobile electrons / free electrons ALLOW Sea of electrons **(1)** **MP2** attracting the positive ions / attracting the metal ions / attracting the nuclei **(1)** Second mark depends on first	Intermolecular forces Attraction in any sort of bonding other than metallic	**(2)**

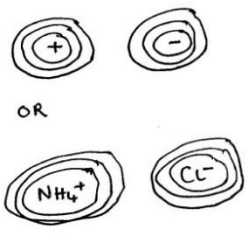
Question Number	Acceptable Answers	Reject	Mark
20a(ii)	Ionic bonding **and** (electrostatic) force /attraction between oppositely charged ions OR + and — ions OR Na^+ and Br^- ions OR cations and anions	Intermolecular forces between ions Attraction of differently charged ions Sodium and bromine	**(1)**

Question Number	Acceptable Answers	Reject	Mark
20a(iii)	Ionic (bonding) is stronger than metallic (bonding) (in this case) OR Bonding in NaBr is stronger (than in Na) ALLOW Attraction in NaBr is stronger Reverse argument	Any reference to incorrect types of bonding	**(1)**

Question Number	Acceptable Answers	Reject	Mark
20a(iv)	**Electrical conductivity**: Sodium conducts (in solid or liquid state) NaBr does not conduct when solid/ only conducts when molten / in (aqueous) solution OR **Thermal conductivity** : Na good, NaBr poor Sodium conducts heat is insufficient OR **Malleability/ Ductility**: Na malleable/ ductile, NaBr brittle ALLOW **Hardness** Na soft; NaBr harder **Density** Na low ; NaBr higher Name of property and correct for Na or NaBr **(1)** Correct for the second substance **(1)** IGNORE Explanations for differences	NaBr cannot conduct heat Chemical properties Colour Solubility	**(2)**

Question Number	Acceptable Answers	Reject	Mark
20b(i)	Covalent: The (bonding) electrons come (equally) from both atoms **(1)** Dative covalent: The (bonding) electrons come from one atom **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
20b(ii)	 N joined to four H with three correct N-H single bonds, i.e. with a dot and a cross **(1)** Datively covalently bonded H (lone pair on N shared with fourth H) **and** a + charge on this H / on the whole ion / on the N ALLOW 2 crosses for dative bond **(1)** IGNORE Arrow from N to H indicating dative covalent Lack of square brackets	Just diagram for ammonia	**(2)**

Question Number	Acceptable Answers	Reject	Mark
20b(iii)	(Electron density contour) lines go round ion and not around other nuclei/ do not overlap/ do not fuse/ do not intercept/ OR There is a gap between particles/ ions with no electron density lines IGNORE Number of circles ALLOW Diagram  		**(1)**

(Total for Question 20 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
21a(i)	Answers between 7000 and 8500, including 7000 and 8500 ($kJ\ mol^{-1}$)		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21a(ii)	$Mg^{2+}(g) \rightarrow Mg^{3+}(g) + e^{(-)}((g))$ ALLOW $Mg^{2+}(g) - e^{(-)}((g)) \rightarrow Mg^{3+}(g)$ Gaseous states for both magnesium species **(1)** Rest of equation correct **(1)**		**(2)**

Question Number	Acceptable Answers			Reject	Mark
21b(i)	(Enthalpy change of)			EA of Cl_2	**(3)**
	ΔH_1	Atomisation of Mg and (2x) atomisation of ½ Cl_2 / Cl / chlorine / Cl_2 ALLOW ΔH_{at} for (enthalpy change of) atomisation OR Bond enthalpy Cl-Cl for ΔH_{at} Ignore state symbols	**(1)**		
	ΔH_3	(2x) (first) electron affinity of Cl / chlorine (2x) EA of Cl ALLOW Electron affinity of 2 Cl	**(1)**		
	ΔH_5	Formation (of $MgCl_2$) ΔH_f (of $MgCl_2$)	**(1)**		

Question Number	Acceptable Answers	Reject	Mark
21b(ii)	(+)2189 (kJ mol^{-1})	-2189 (kJ mol^{-1})	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21b(iii)	ΔH_4 = -641.3 –(391.1 + 2189 – 697.6) **(1)** = **- 2523.8/ -2524** (kJ mol^{-1}) **(1)** Final answer without working scores 2 Correct value with + sign scores 1 TE on incorrect value in (b)(ii) for 2 marks: (b)(ii) = +1451, (b)(iii) = **-1785.8** (b)(ii) = -2189, (b)(iii) = **(+)1854.2** If no value has been calculated in (b)(ii), ΔH_4 = -334.8 - ΔH_2 This scores **(1)**	incorrect unit, but allow the minor slip eg kJ mol^{-}	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***21c(i)**	Ca atom has a larger radius (than Mg)/ has more electron shells (than Mg) / has (outer) electrons which are further from nucleus OR The (outer shell) electrons in Ca are more shielded **(1)** (Outer shell) electrons experience less attraction from the nucleus OR require less energy/ are easier to remove **(1)** ALLOW reverse argument IGNORE References to charge density	Ca ions larger Just "Ca is larger (than Mg)" The molecules are larger	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***21c(ii)**	**MP1** Mg^{2+} has higher charge density / same charge but smaller (radius) than Ca^{2+}/ distance between ions is smaller IGNORE Mg^{2+} has higher polarising power than Ca^{2+} **(1)** **MP2** So attracts Cl^- more strongly (in $MgCl_2$)/ so more energy is released when bond forms **(1)** MP2 depends on MP1 ALLOW reverse argument	Atomic radius 'attracts chlorine' References to incorrect type of bond/force	**(2)**

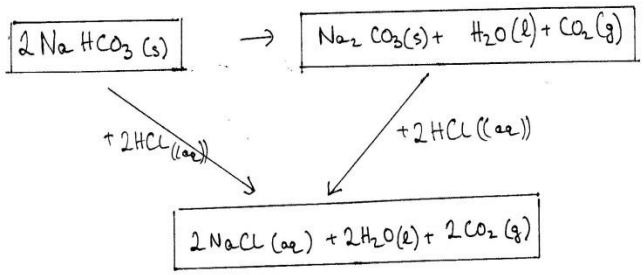
(Total for Question 21 = 13 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)	Difficult to measure energy supplied/ take measurements while heating (the sample)/ to decide when reaction is complete ALLOW Difficult to measure the temperature of a solid Difficult to measure heat supplied/ heat absorbed	Just "because requires heating" Because of heat losses	**(1)**

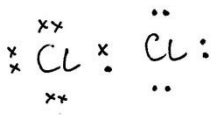
Question Number	Acceptable Answers	Reject	Mark
22b(i)	To protect from or prevent (the acid/ reaction mixture) spraying/ spitting/ splashing out/ bubbling over/ spilling with reason eg due to excessive frothing / stirring IGNORE Reaction is vigorous	Just "spilling"	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22b(ii)	Mol HCl = (100 x 1.25 / 1000) $=1.25 \times 10^{-1}$ / **0.125** **(1)** Mol $NaHCO_3$ = (8.0/84) = 0.095238/ **0.0952** Ignore SF except 1 SF **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22b(iii)	Energy transferred = (100 x 4.18 x 7.3) = **3051.4 (J) / 3.0514 kJ** Ignore sign Ignore SF except 1 or 2 SF **(1)** ΔH = + 3051.4 ÷ 0.095238 Allow TE from incorrect $NaHCO_3$ from (b) (ii) **(1)** = **+ 32040** J mol^{-1} / **+32.040/ +32.0** kJ mol^{-1} ALLOW answers using rounded values of 0.095238 e.g. **+32.120** kJ mol^{-1} if based on 0.095 **(1)** IGNORE SF Use of 0.125 mol does NOT score MP2, but will score MP3 for +24.41 kJ mol^{-1}		**(3)**

Question Number	Acceptable Answers	Reject	Mark
22b(iv)	 $2NaCl + 2H_2O + 2CO_2$ in bottom box IGNORE State symbols **(1)** Two arrows pointing downwards each with 2HCl OR Two arrows pointing downwards with 2HCl on each side of the equation in both top boxes **(1)** ALLOW Right hand arrow pointing upwards and 2HCl if (2x) (b)(iii) + 36.3 used correctly in calculation ΔH for Reaction 1 = **2**x answer to (b)(iii) –(-36.3) **(1)** = (+)100.3 (kJ mol^{-1}) **(1)** If factor of 2 missing in MP3 allow TE in MP4 = (+)68.3 (kJ mol^{-1}) TE on incorrect answer to (b)(iii) Answer of +3.05 in (b)(iii) gives (2x 3.05 +36.3) = (+)42.4 (kJ mol^{-1}) Answer of +24.41 in (b)(iii) gives (2x 24.41 +36.3) = (+)85.12 (kJ mol^{-1})	Cycles using ΔH_f	**(4)**

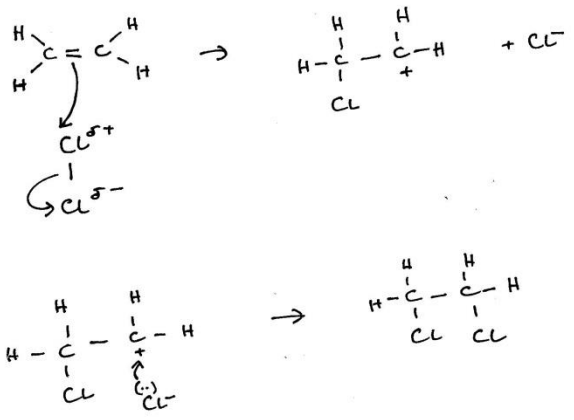
(Total for question 22 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
23a(i)	 **MP1** Diagram with 3 lone pairs of electrons per atom and one shared pair ALLOW All dots or all crosses **(1)** **MP2** One electron from the Cl-Cl bond goes to each atom to produce a (free) **radical** / the bonding electrons are divided equally between the atoms to produce a (free) **radical** **(1)**	Just Cl-Cl with half arrows	**(2)**

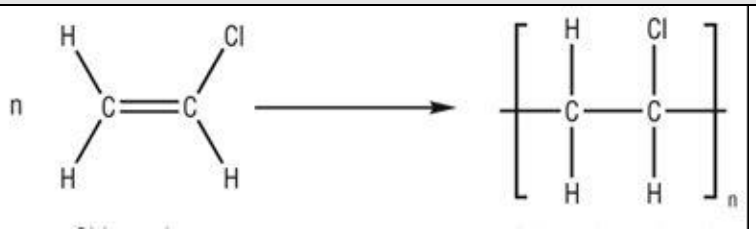
Question Number	Acceptable Answers	Reject	Mark
23a (ii)	Penalise omission of dots in correct equations only once in (ii) and (iii) $C_2H_6 + Cl\bullet \rightarrow HCl + C_2H_5\bullet$ **(1)** $C_2H_5\bullet + Cl_2 \rightarrow C_2H_5Cl + Cl\bullet$ **(1)** ALLOW • before or after the formula. TE in equation 2 if the wrong hydrocarbon is used (eg methane giving $CH_3\bullet$) TE in equation 2 for formation of further substituted chloroalkane IGNORE any curly arrows		**(2)**

Question Number	Acceptable Answers	Reject	Mark
23a(iii)	$2\ C_2H_5\bullet \rightarrow C_4H_{10}$ ALLOW TE from incorrect alkyl radical in (a)(ii) eg $2CH_3\bullet \rightarrow C_2H_6$	Equations not giving a hydrocarbon	**(1)**

Question Number	Acceptable Answers	Reject	Mark
***23b(i)**	**MP1** pi bond forms by overlap of **p** orbitals. ALLOW Correct labelled diagram **(1)** **MP2** Orbital overlap is poor so bond breaks easily OR Orbital overlap is poor as orbitals are parallel / sideways (Poor overlap must be described, not just drawn) OR Region of high electron density makes bond reactive / susceptible to attack by electrophiles **(1)**	p sub shells / pi orbital Just "it is weaker than the sigma bond" without a reason why	**(2)**

Question Number	Acceptable Answers	Reject	Mark
***23b(ii)**	 **MP1** Arrow from C=C to $Cl^{\delta+}$ **and** from Cl-Cl bond to $Cl^{\delta-}$ **(1)** **MP2** Intermediate with + charge, **and** Cl^- **(1)** **MP3** Arrow from anywhere on Cl^- to + on C and product (lone pair on Cl^- not required) ALLOW TE if partial charges are shown in MP2 (do not penalise these twice) **(1)** Correct mechanism shown with bromine or HX or an incorrect alkene scores a maximum of 2 marks.	Partial charges on intermediate and chloride No TE from a free radical mechanism	**(3)**

Question Number	Acceptable Answers	Reject	Mark
23b(iii)	1,2-dichloroethane	ethene for ethane in the name	**(1)**

Question Number	Acceptable Answers	Reject	Mark
23c	 MP1 is for correct structure of monomer **and** single repeat unit of polymer with continuation bonds **(1)** MP2 is for n in correct place of both sides of the equation and brackets round repeat unit ALLOW Multiples if balancing is correct in equation Polymer with more than one repeat unit if balanced Continuation bonds which do not go right through the bracket IGNORE Bracket round monomer Shape of brackets **(1)**		**(2)**

(Total for Question 23 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

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