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Mark Scheme (Results)
Summer 2007

GCE

GCE Chemistry Nuffield (6251) Paper 01

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General Guidance on Marking

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.

Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

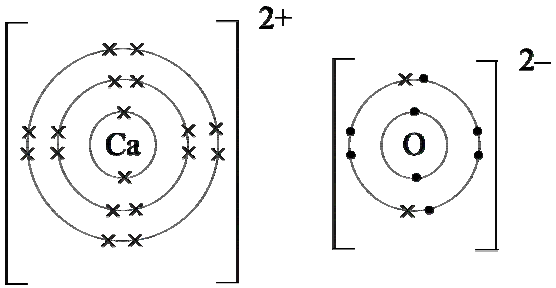
Using the mark scheme

The mark scheme gives you:

- 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.

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.

1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) 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.
3 [ ] words inside square brackets are instructions or guidance for examiners.
4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
5 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.

	EXPECTED ANSWER	ACCEPT	REJECT	MARK
1.	(a) $Ca(NO_3)_2(s) \rightarrow CaO(s) + 2NO_2(g) + \frac{1}{2}O_2(g)$	Doubled up version or multiples		**(1)**
	(b) (i) Blue	purple	Green Green-blue	**(1)**
	(ii) OH^- / HO^- / ^-OH/^-HO			**(1)**
2.	 Brackets not essential Electrons correct for both ions **(1)** Charges (allow 2+ or +2 and 2— or —2) **(1)**	Electrons can all be dots and/or crosses Either ion completely correct (i.e. electrons and charge) **(1)** Charges can be shown outside structure, or inside against symbol		**(2)**
3.	(a) Protons: H^- 1, 2; Li^+ 3, 2 1 mark per row **(2)** Allow **(1)** for correct electrons column			**(2)**
	(b) H^- is larger **(0)** Same number of electrons for each ion ……. **(1)** H^- has only 1 proton to hold them in place, whereas Li^+ has 3 protons to pull them in more tightly **(1)** "nuclear charge" can be used instead of "protons" 3 points to consider: —1 per error, or omission, from total of 2 H^- has a lower proton: electron ratio than Li^+ **(1 max)** H^- has fewer protons than electrons, whereas Li^+ has more protons than electrons **(1 max)** 2 correct key points, but Li^+ larger **(1 max)** Allow TE from (a) if, and only if protons for Li^+ **>** protons for H^- **and** number of electrons are the same for each ion	H^- is smaller, based on 0 for the electrons in table (i.e. misread as H^+) plus justification **(1 max)**		**(2)**

		EXPECTED ANSWER	ACCEPT	REJECT	MARK
4.	(a)	Red / crimson / carmine	Magenta / cherry red	Pink	**(1)**
	(b)	During the flame test promoted/excited electrons return to ground state, whereas during ionisation electrons leave "permanently"/completely Flame test: electrons move to higher shells / are excited then fall back again / return to lower shells / to ground state (releasing energy), i.e. electrons "up then down" Ionisation: electrons leave (permanently), i.e. electrons "out" Any false statement regarding energy changes loses the mark, eg "electrons are promoted to higher shells releasing energy ……"			**(1)**
5.	(a)	$[CH_3COOH] = \frac{1000}{25.0} \times 0.020 = 0.8(0)$ (mol dm^{-3})	Correct answer with no working.		**(1)**
	(b)	Neutralisation			**(1)**
					(Total for Section A: 13 marks)

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
6.	(a)	(i)	Compounds with the same **molecular** formula/number and type of atoms, but different structural/structures/displayed formulae/arrangements NOT "same chemical formula ……..", unless qualified Must be a generalised definition, and not refer specifically to e.g. hydrocarbons			**(1)**
		(ii)	**B** and **E**			**(1)**
	(b)	(i)	Butan**a**l	Butan-1-al	Butan**o**l / butan-1-ol Butan-1-one	**(1)**
		(ii)	D / Butan-1-ol/ $CH_3CH_2CH_2CH_2OH$			**(1)**
		(iii)	Sodium/potassium dic**(h)**romate((VI)) **(1)** If oxidation number given, must be correct Sulphuric acid **(1)** Ignore concentrated/dilute [Mark independently]	$Na_2Cr_2O_7$ / $K_2Cr_2O_7$. Acidified dichromate **(1 max)** H_2SO_4	Correct name together with wrong formula **(0)**	**(2)**
		(iv)	(Warm) both with Benedict's solution **(1)** In the case of B (only), it turns (from blue) to give a red/orange/brown/green/yellow **(**precipitate**) (1)** 2nd mark dependent on 1st	Answer using Fehling's test/$Cr_2O_7^{2-}$ + H^+ Tollens reagent gives a silver mirror		**(2)**
	(c)	(i)	But-1-ene (allow any separator between "t", "1" and "e" or an absence of a separator)	1-butene	Butane/butan-1-ene	**(1)**
		(ii)	Dehydration / elimination			**(1)**
		(iii)	Aluminium ((III)) oxide / alumina	Al_2O_3/pumice/phosphoric acid /H_3PO_4/P_2O_5/P_4O_{10}		**(1)**
		(iv)	**A**/methanol has only one /doesn't have enough carbons / carbon atoms, so no (C=C) double bond possible / alkene cannot be formed Both of these points needed for the mark.			**(1)**

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
	(d)	(i)	$C_{11}H_{22}O$			**(1)**
		(ii)	Secondary **(1)** The carbon atom holding the hydroxyl / OH / alcohol / functional group is attached to **two** other carbon atoms / R groups **(1)** Must mention group explicitly and not use eg "it's" 2nd mark dependent on 1st	Carbon atom holding the hydroxyl group is attached to (only) one hydrogen / has CHOH grouping	Hydroxide/HO^-	**(2)**
		(iii)	Likely to be insoluble/ not very soluble (no mark for this alone — but must be mentioned) Only "simple" alcohols are soluble in water Valid answer based on intermolecular forces	OH group joined to a large (non polar / hydrophobic) (carbon) chain / ring OR lots of / (too) many carbon atoms		**(1)**
						(Total 16 marks)
7.	(a)	Group 1 / alkali metals **(1)** (Relatively) large "jump" / gap / difference between E_{m1} and E_{m2} **(1)** 2nd mark dependent on 1st		Substantial drop for 1st ionisation energy from Q to R		**(2)**
	(b)	6915-9000 (kJ mol^{-1}) (actual value: 7733 kJ mol^{-1}) **(1)** 500-730 (kJ mol^{-1}) (actual value: 578 kJ mol^{-1}) **(1)**				**(2)**
	(c)	**Q** must be a noble gas /in group 8/0, since **Q** and **R** have consecutive atomic numbers (and **R** is in group 1)		**Q** as it has a **very** high / the highest **first** ionisation energy **NOT** "high ionisation energies" (generally)		**(1)**
	(d)	$R^{2+}(g) \longrightarrow R^{3+}(g) + e(^-)((g))$ symbols and charges **(1)** state symbols **(1)** [Mark independently]		$R^{2+}(g) - e^- \longrightarrow R^{3+}(g)$		**(2)**
	(e)	Outermost electron(s) for an atom of **X** is /are in a shell further from the nucleus / shell of higher energy than that of **R**.		Answer based on "better shielding" from inner electrons		**(1)**
						(Total 8 marks)

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
8.	(a)	$(1s^2)\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ …….. **(1)** …….. $3d^8\ 4s^2$ / $4s^2\ 3d^8$ **(1)**				**(2)**
	(b)	M_r[Ni] = (58 × 0.6902) + (60 × 0.2732) + (62 × 0.0366) Or correct fraction using percentages **(1)** = 58.6928 (calculator value) = 58.7 (3 s.f.) **(1)** No 2nd mark if units given, e.g. g, % etc		58.6928 / 58.693 / 58.69 M_r[Ni] = 59, if working shown	60 /Incorrectly rounded answer, e.g. 58.692, 58.70, 58.6	**(2)**
	(c)	5.9 g of nickel = $\frac{5.9}{59}$ = 0.10 (mol) **(1)** From equation, 0.40 mol of CO required Volume of CO = 0.40 × 24 = 9.6 dm^3 / 9600 cm^3 **(1)** Correct units needed for 2nd mark, eg $dm^3\ mol^{-1}$/dm^{-3} **(0)** Allow TE for 2nd mark, from wrong number of moles (i.e. 4 × number of moles × 24 dm^3)		Allow full marks for answer based on A_r[Ni] calculated in (b)		**(2)**
	(d)	(i)	$Ni + 2H^+ \longrightarrow Ni^{2+} + H_2$ Ignore state symbols	$Ni + 2H_3O^+ \rightarrow Ni^{2+} + 2H_2O + H_2$		**(1)**
		(ii)	Hydrogen is flammable / explosive **(1)** keep away from flames **(1)** OR nickel can cause allergic reaction / nickel **powder**/**dust** is harmful/irritant/toxic/carcinogenic **NOT** corrosive/dangerous **(1)** wear gloves / mask **(1)**			**(2)**

	EXPECTED ANSWER		ACCEPT	REJECT	MARK
	(iii)	**<u>Stop marking when operation no longer "works", e.g. distil/add $CaSO_4$/boil solution to dryness</u>** **Boil**/**heat** (**NOT** warm) to drive off some of the water/to concentrate (not to dryness) **(1)** leave/set aside for some time/overnight (to crystallise) / allow to cool (must be evident that some solution remains afterwards) **(1)** Collect crystals by decantation/filtration/use of tweezers **(1)** Dry crystals between (sheets of) filter paper (must imply an "active process" – leaving on filter paper isn't enough) / use of **warm** oven, not just "oven" **(1)** 4 key points → 3 3 key points → 2 2 key points → 1 1 or 0 key point → 0			**(3)**
	(iv)	$M_r[NiSO_4.7H_2O]$= 59+32+64+(7×18) = 281 (g mol^{-1}) **(1)** 2.95 g of Ni = $\frac{2.95}{59}$ = 0.050 mol Mass of crystals formed = 0.050 × 281 = 14.1 **(g) (1)** Ignore units, e.g. g mol^{-1} Allow TE from incorrect $M_r[NiSO_4.7H_2O]$, i.e. 0.05 × M_r Allow full credit for answer based on accurate A_r[Ni], e.g. 58.7	14.05 g answer to between 2 and 4 sig. fig		**(2)**
					(Total 14 marks)

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
9.	(a)	(i)	$E[Ca(OH)_2] = 25.0 \times 4.2 \times 16.5 = 1730$ (J) $E[CaO] = 25.0 \times 4.2 \times 25.5 = 2680$ (J) **Both** correct for 1 mark Ignore negative signs in front of values / missing/wrong units	1732.5 / 1733 / 1700 J 2677.5 / 2678 / 2700 J Answers in kJ acceptable	1732 J 2677 J	**(1)**
		(ii)	$\frac{1.00}{74.0} = 0.0135$ mol Answer must be decimalised	0.014	$\frac{1}{74}$ / 0.01	**(1)**
		(iii)	$\Delta H_1 = -\frac{1732.5}{0.0135} = -130$ (kJ mol^{-1}) (2 s.f.) $\Delta H_2 = -\frac{2677.5}{0.0135} = -200$ (kJ mol^{-1}) (2 s.f.) 1st mark for method (dividing energy by number of moles) 2nd mark for both answers given to 2 sig fig and including negative signs. 2nd mark is dependant on 1st	Allow TE from (a)(i) and (a)(ii)		**(2)**

	EXPECTED ANSWER			ACCEPT	REJECT	MARK
	(b)	(i)	$\Delta H_{reaction} = \Delta H_1 - \Delta H_2$ /relevant values being subtracted **(1)** $= -130 - (-200) = +70$ kJ mol^{-1} **(1)** Mark independently For 2nd mark: correct arithmetic, sign and units needed	Allow TE from (a)(iii) Ignore sig. figs.		**(2)**
		(ii)	Using a **glass beaker** / no lid is likely to lead to heat loss **(1)** (glass) **beaker** has significant heat capacity **(1)** No apparent check made to ensure that $Ca(OH)_2$ was heated long enough/difficult to know whether $Ca(OH)_2$ was fully decomposed **(1)** The likely use of an insufficiently accurate **thermometer (1)** Any TWO valid and agreed sources of error			**(2)**
		(iii)	Measuring temperatures of <u>solids</u> **(**with a lab thermometer**)** isn't accurate / is difficult **(1)** Bunsen/high temperatures are involved (above bpt. of Hg/ethanol) so lab thermometers can't be used **(1)** Difficult to know when $Ca(OH)_2$ has fully decomposed (1) Given high temperatures involved, impossible to use thermometer to measure energy taken in by the $Ca(OH)_2$ **(1)** Any ONE of these			**(1)**
						(Total 9 marks)