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Mark Scheme (Results)
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GCE

GCE Chemistry Nuffield (6251) Paper 1

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Registered Office: One90 High Holborn, London WC1V 7BH

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General Marking Guidance

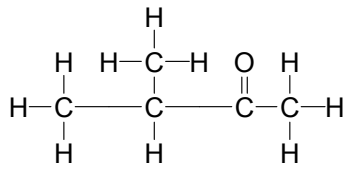
- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should 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

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.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	methanal	Formaldehyde metanal	Methanol methone	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Pentan-3-ol Ignore punctuation	3-pentanol pentane-3-ol	Penta-3-ol Pent-3-ol Pentan-3-al Penten(e)-3-ol	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	 Ketone + five carbon atoms (could be straight chain) (1) Branched chain + rest of molecule(1)	Allow 1 CH_3 group not displayed	Aldehyde If any hydrogen atoms missing (1 max)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	2-methylbutan(e)-3-one/ 3-methylbutan(e)-2-one Ignore punctuation	2-methylbutanone 3-methylbutanone Allow TE from (a) provided it is a ketone e.g. pentan-2-one, pentan-3-one	2-methylbuta(-3)one 2-methylbut(-3-)one 2-methylbutan-2-one methylbutanone	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	$C_5H_{12}O$	$C_5H_{11}OH$	Structural or displayed formula	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	The reactants don't distil over before they can react Owtte	Higher % of alcohol will be oxidised/not all of the alcohol will react/maximum chance of oxidising More time to oxidise to condense (any evaporated) reactants	BP of alcohol low Explanation of what happens during refluxing To get a higher yield Discussion of rate of reaction	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	p 1 n 1 e 1 3 correct 2 marks 2 correct 1 mark 1 correct 0 marks			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	$\frac{(97.22 \times 1 + 2.78 \times 2)}{100}$ (1) = 1.028 (1) Answer **must** be to 4 sig figs	Correct answer with no working Ignore units	1.0278 (1 mark awarded for correct method)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	A acid-base (and neutralisation)(1) B redox (reaction) (1)	reduction of WO_3 and oxidation of hydrogen/ oxidation & reduction	Neutralisation on its own reduction or oxidation alone. Ionisation dehydration	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	Oxidised because sodium loses an electron	Oxidation number of sodium increased	Addition of hydrogen	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)	Group 1 because forms 1+ ion/ Only 1 outer most electron (1) Group 7 because forms 1- ion/ one electron short of noble gas structure (1) Must make clear when adding or losing an electron which groups indicated. Max (1) if not.	Only 1 covalent bond		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(i)	- 253 (^{0}C)	- 253.16 / - 253.2 (^{0}C)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(ii)	Advantage non-polluting as only **water** produced (at point of combustion) (1) Disadvantage gas is difficult to store (in car) / difficult to liquefy (1) OR Recognition that it is a gas and hence presents storage problems	No carbon emissions No greenhouse gas given off Explosive	Not a toxic product Extremely volatile Environmentally friendly Not harmful to the environment Very exothermic reaction (Highly) flammable Highly exothermic Expensive Very reactive Not as exothermic as hydrocarbons Adaption of vehicle/engine/ petrol station	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	Chromium / Cr	cromium	Chromate/chromate (VI)/CR/cR	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)	Group 2 II/alkaline earth metals 2+ Ba^{2+} two	+2		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	$Ba^{2+}(aq) + CrO_4^{2-}(aq) \rightarrow BaCrO_4(s)$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(i)	50 (cm^3) Moles of barium chloride = moles of potassium chromate = 0.005 (1) Volume of barium chloride = 50(cm^3) (1)	Answer with no working 0.05 dm^3	 0.05 dm^{-3}	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(ii)	Filter (1) to remove insoluble (barium chromate) (1) Either Heat/boil to drive off most of the water/to concentrate solution (1) Allow to cool/ crystallise and dry between filter papers / in an oven (1) Or Heat/boil (1) to drive off **all** of the water from the solution (1)	If filtering not mentioned at the start then maximum 2	Leave some water for water of crystallisation (max 3)	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(i)	yellow	Orange Any combination of yellow and orange Eg golden yellow		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(ii)	Hertz Upper or lower case H	Herz HERTZ	Hurts frequency	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(iii)	7.3×10^{14} Hz			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(i)	Electrons have opposite spin		A paired spin of the electrons To show they repel each other Going in different directions Due to reverse spin Moving in opposite directions	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(ii)	Start from n=3 energy level and going upwards at least to another energy level (1) End at or just above n=∞ energy level (1)		Arrow into writing	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(iii)	No because energy levels split into two (1) (2)s and (2)p (with the 2p higher than the 2s) (1)	No because there are 2s and 2p (1) Sublevels (1) /Subshells	No because increasingly hard to remove successive electrons	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(iv)	1 electron in the n=4 energy level and 8 electrons in the n=3 energy level	2,8,8,1 for potassium n=3 full, n=4 1 electron	One more level of electrons An extra full energy level More electrons in n=3	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(c)	Nichrome / platinum wire/nickel/titanium /ceramic rod /spatula (1) and (concentrated) hydrochloric acid Put in a (Bunsen) flame/heat (1) Yellow for sodium and lilac for potassium (1)	Flame test mentioned with no details 1 out of 2 Orange/shades of mauve and purple	Glass rod Burn Mass spectrometer	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(d)	Dissolve (in water) (1) Heat until molten(1)	Make into a solution (without mentioning water) Melt it	Liquid on its own Hydrate it Heat to release ions	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)	Mg(s) + C(graphite) + $1\frac{1}{2}O_2$(g) in both left hand boxes Balancing (1) state symbols for Mg/C/O_2 must be present and correct at least once (1)	$C_{(s)}$ Everything in all boxes doubled (allow 2HCl rather than 4HCl)	Equation with CO or CO_2 in it	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(i)	$\frac{0.1}{24}$ = 4.17×10^{-3} / 0.00417	0.00416 (recurring) 0.0042	0.004 0.00416	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(ii)	Moles of HCl at the start = 0.2 (1) Moles of HCl reacted = 2 x 0.00417 = 0.00834 (1) Moles of HCl left = 0.2 – 0.00834 = 0.19166 (1) ignore sf	Transferred error from (b)(i) Eg 0.192 0.1917 0.196 (forgetting to multiply by 2) Worth max of 2	0.2	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(iii)	Axes labelled and suitable scale - must cover more than half the provided grid and time must be on the horizontal axis (1) All points plotted accurately and suitable curve/straight lines (1) From 0 to 1 minute, must be straight horizontal line. From 1 to 2 minutes, vertical or sloping line to 25.3 or above. From 2 to 6 minutes, straight line or smooth curve.		Temperature scale starting at 0°C (1 max)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(iv)	Energy change = 4.2 x 100 x 4.5 = 1.89 (kJ)	1890 (J) 1.9 (kJ) 1900 (J) With either + or – or no sign	Answers using mass=100.1g Giving 1891.89 (J) $Jmol^{-1}$ $kJmol^{-1}$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(v)	$\Delta H = \frac{-1.89}{0.00417}$ = - 453 kJ mol^{-1} (2) 1 mark for number and 1 for sign and units	TE from (b)(i) and (iv) Second mark dependent on the first		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(vi)	Either lines drawn on graph to show maximum temperature rise should be 4.5 Or Some heat loss (and so the reading of 4.3 was too small)	Max temperature between 1 and 2 minutes	Rounded up to nearest 0.5	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(i)	24 + 12 + 3 x 16 = 84 (g) (1) Number of moles = 2.2/84 = 0.0262 / 0.02619 (1) Ignore sf except if only 1 (i.e. 0.03)	0.026	0.0261 0.02	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(ii)	$\Delta H = \frac{-1.05}{0.0262}$ $= -40.1$ kJ mol^{-1}	Correct sign and units needed for mark Allow K instead of k -40.131 Allow TE from (c)(i)	40.1	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(d)	$\Delta H_f = \Delta H_1 + \Delta H_2 - \Delta H_3$ (1) $= -453 - 680 + 40$ $= -1090$ kJ mol^{-1} (1)	Only penalise missing units once -1093 transferred error: ΔH_1=(b)(v) ΔH_2= -680 ΔH_3=(c)(ii) correct answer with no working gets 2 marks	Incorrect application of Hess's Law (0)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(e)	Elements don't react together to form magnesium carbonate		Hard to measure temperature of solid	1