

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

- Please ensure that you use the final version of the Mark Scheme. You are advised to destroy all draft versions.
- Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.
- The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

X = incorrect response (errors may also be underlined)
 ^ = omission mark
 bod = benefit of the doubt (where professional judgement has been used)
 ecf = error carried forward (in consequential marking)
 con = contradiction (in cases where candidates contradict themselves in the same response)
 sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

5. In cases where candidates are required to give specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

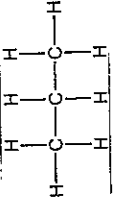
6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

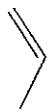
Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit () = words which are not essential to gain credit = (underlining) key words which <u>must</u> be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument
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Question	Expected Answers	Marks
1 a i	(nuclear) fusion	1
1 a ii	they result in the formation of other/larger/heavier elements/atoms/nuclei (not helium) NOT generation of light in the Sun ALLOW references to fusion processes on Earth giving energy.	1
1 b i	2	1
1 b ii	same number/amount of protons/one proton/ same atomic number (1); NOT same element. IGNORE references to electrons different numbers of neutrons/ mass number/one and two neutrons/ (1) 3/2 neutrons is "con" unless 3 neutrons in b(i) IGNORE different masses/ atomic masses	2
1 c i	radioactive	1
1 c ii	3 He (1) for each number, (1) for symbol (ecf unless H) 2 ALLOW ${}^2_1\text{H} + {}^1_1\text{H}$ for 2 marks. 3 n scores 1 for the "3". Award one less mark if positive ion shown.	3
1 d i	enables position to be found/enables following/ tracing of isotope/sample/ substance (AW, or implied)	1
1 d ii	Geiger (-Muller) counter/tube. ACCEPT Geiger phonetically. Ignore qualifications (eg "Miller") spark counter/ photographic plate	1
1 e i	black/dark lines/gaps (1); on coloured background /continuous spectrum/spectrum of visible light (AW)(1) second mark depends on first	2
1 e ii	electrons (must be present)	1
1 e iii	horizontal energy levels (two lines minimum)(1); smaller separation at top (three levels acceptable) (1);vertical line going up between levels (1); lines going down as well (unless correctly labelled) are "con". two (or more) lines upwards of different length (1); arrows from side (except labels) are "con" Circular model → can award all except first mark.	4

2 a i		1
2 a ii	$C_3H_8 + 5O_2 \rightarrow 3O_2 + 4H_2O$ (1) for products (1) for completely correct. ecf from (i) ALLOW doubled Bonds broken: $2 \times C-C = 694$ $8 \times C-H = 3304$ $5 \times O=O = 2490$ Total 6488 (1) award if seen, ignore sign Bonds made $6 \times C=O = 4830$ $8 \times O-H = 3712$ Total 8542 (1) award if seen, ignore sign Broken - Made (AW) (1) = -2054 kJ mol ⁻¹ (calculation assume "broken - made" unless shown), sign [must be consistent with calculation] and units(1)	2
2 a iii	Total 6488 (1) award if seen, ignore sign Bonds made $6 \times C=O = 4830$ $8 \times O-H = 3712$ Total 8542 (1) award if seen, ignore sign Broken - Made (AW) (1) = -2054 kJ mol ⁻¹ (calculation assume "broken - made" unless shown), sign [must be consistent with calculation] and units(1)	4
2 b i	alkane(s)	1
2 b ii	$120 \times 24 = 2880$ (1) Minus sign in answer (1) Mark separately	2
2 c	B(1) dimethylpropane/ 2,2 - dimethylpropane(1) NOT 2 - dimethylpropane D(1) methylbutane/ 2 - methylbutane(1) ALLOW "methyl" and errors in dashes, commas and gaps. True because bonds broken and made (AW)(1); are the same (NOT similar)/same number and type of bond/ C-C, C-H (1)	4
2 d	True because bonds broken and made (AW)(1); are the same (NOT similar)/same number and type of bond/ C-C, C-H (1)	2
2 e	autoignition/ knocking/pinking (1); less likely/ prevented/stopped (1); B ecf (unless A and C chosen)(1) (More) branched (1) Mark separately IGNORE references to volatility (1)	4
2 f	$4817 + 654 = 5471$ (accept $5400 - 5517$) (1); Negative sign and units (1) Mark separately Differences roughly the same/maths shown (1); since CH ₂ /same bonds added/ one more C/ C-C/ next member of series (1) Mark these reasons separately from value. NOT multiplication methods	4

2 g	named pollutant (1) Two sets from: oxides of sulphur/ named oxide/ formula/SO _x oxides of nitrogen/ named oxide/ formula/NO _x CO/carbon monoxide/C/ carbon/soot hydrocarbons	how it arises in petrol engine(1) <i>(ignore any treatment of CO₂)</i> sulphur (compounds) in fuel burn/ oxidise/ react with air nitrogen (in air, implied) burns/oxidises/ reacts with air incomplete combustion incomplete combustion	indication of how LPG might differ (not necessarily correct) (1) discuss presence/absence of sulphur compounds. in LPG mention of spark/heat/temperature of engine in LPG <i>simple comparison if temp point made earlier</i> discuss likelihood in LPG engine discuss likelihood in LPG engine	6
2 g QWC	At least two sentences Logical At least two of these words/phrases used correctly: <i>sulphur compounds, burn/oxidise/react/combust, temperature/heat/spark of engine, hydrocarbon/fuel, incomplete combustion</i>			1
2 h	Tick with Q in body of script, "1Q" in margin energy density may be less/ need to keep it liquefied/pressurised/ higher flammability/ loss of fuel by evaporation NOT storage as a gas NOT cost			1
2 i i	increase IGNORE qualifications			1
2 i ii	more ways of arranging (1); the molecules/ particles (1) NOT atoms depends on first mark more disorder/ more random distribution score (1)			2

3 a i	$\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$	2
3 a ii	$\text{Ca}(\text{OH})_2$	1
3 a iii	alkali(ne)/base/basic (1)	1
3 a iv	pH paper/Universal indicator/named indicator /pH meter/ pH test (1) Result: correct colour/ pH>7 (1) NOT "alkaline" alone. or a test involving precipitation: Suitable reagent (1); ppt (1) $M_r \text{CaCO}_3 = 100$ (1)	2
3 b i	Moles $\text{CaCO}_3 = 2.5 \times M_r$ (1); 0.025 scores first two marks. Moles x 24 ecf (1) 0.6 dm ³ /600 cm ³ tube or flask joined without leaks (and clear passage of gas shown) to (1) gas syringe or collection over water (in calibrated tube) (1)	3
3 b ii	labels: solid (must be in flask or tube) (can be shown as line on flask or tube)(1); heat source, provided something is being heated (1) Mg 2.8.2 (1) ALLOW 1s ² 2s ² 2p ⁶ 3s ² or [Ne] 3s ² Ca 2.8.8.2 (1) ALLOW 1s ² 2s ² 2p ⁶ 3s ² 3p ⁶ 4s ² or [Ar] 4s ²	4
3 c i	two electrons in outer shell (1)	2
3 c ii	all form 2+ ions (1) ALLOW if given in 3 c ii carbonate is 2- (1) "ion charges cancel/ balance" scores (1) if neither of the others scored "all Group 2 metals have same charge on their ions (AW) scores (1)	1
3 c iii	magnesium carbonate/MgCO ₃ /magnesium/Mg	2
3 d i	more soluble/ increases	1
3 d ii	two double bonds only round carbon (1); two dots and two crosses anywhere between atoms rest of detail on oxygens (1) lone pairs must be paired	2
3 e i	180° (1); ecf from diagram (but 180 scores with wrong/no diagram)	4
3 e ii	two groups of electrons/areas of electron density(1); ecf from diagram, not necessarily consistent with angle repel (1); in context of electrons get as far away from each other as they can (1) allow if referring to oxygen atoms	4

4 a i	speeds up a reaction (1) unchanged (chemically) at end/ not used up/ lowers activation energy/enthalpy/ provides alternative route (1) Mark separately	2
4 a ii	heterogeneous	1
4 b i	$\text{C}_{10}\text{H}_{22}(\text{l}) \rightarrow \text{C}_3\text{H}_6(\text{l}) + \text{a CH compound which balances equation (1)}$ if structural formulae/full structural formulae given, maximum 2 marks, but IGNORE if these are given in addition to molecular formulae	3
4 b ii	 (1) for three carbons; (1) for one double bond (mark separately) ecf from formula in b (i) Correct with blobs scores (1)	2
4 c	Three from: Make shorter /smaller molecules/chains/alkanes (1) more volatile/burn more easily (1); improved octane rating/ less auto-ignition/knocking (1) insufficient short chain (alkanes) in crude oil/ Supply demand implied/shorter chains are more useful than long chains (1)	3