

The following annotations may be used when marking:

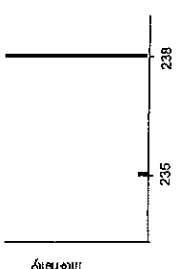
- X = incorrect response (errors may also be underlined)  
 ^ = omission mark  
 bod = benefit of the doubt (where professional judgement has been used)  
 ecf = error carried forward (in consequential marking)  
 con = contradiction (in cases where candidates contradict themselves in the same response)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

Abbreviations, annotations and conventions used in the Mark Scheme:

- / = alternative and acceptable answers for the same marking point  
 ; = separates marking points  
 NOT = answers not worthy of credit  
 ( ) = words which are not essential to gain credit  
 ( ) (underlining) = key words which must be used  
 ecf = allow error carried forward in consequential marking  
 AW = alternative wording  
 ora = or reverse argument

Question	Expected Answers	Marks
1 a i	Group 2/II/Second group/Alkaline earth (elements) ignore "s-block"	1
1 a ii	Two electrons(1); in outer(valence (sub) shell (1) NOT "orbit". second mark dependent on first but "Same number of electrons in outer shell" scores (1) NOT just "two electrons lost" without qualification to show that they are only two.	2
1 b i	(Outer) electrons further from nucleus/more shells/ more shielding (1) NOT larger atom, larger radius  thus less energy needed to pull them away/they are held less tightly (AW)/ less energy to ionise(1) must be comparative (ora throughout) mark separately	2
1 b ii	$\text{Ba}^+(\text{g}) \rightarrow \text{Ba}^{2+}(\text{g}) + \text{e}^-$ Balanced equation for formation of a positive ion (1) ignore nuclear symbols if correct for THIS mark Fully correct (1) State symbols correct (1) score if at least one scored before.	2
1 c i	$\text{SrCO}_3(\text{s}) \rightarrow \text{SrO}(\text{s}) + \text{CO}_2(\text{g})$ Equation (1) ignore "+ heat" State symbols (1) if equation correct	2
1 c ii	$M_r \text{SrCO}_3 = 148$ (1) stated or implied Amount $\text{SrCO}_3 = 29.6/148 (= 0.20 \text{ mol})$ (1) ecf from equation or from $M_r$ Volume $\text{CO}_2 = 4.8 \text{ dm}^3$ . (1) ecf includes unit ignore sf 8.8(g) without working scores (2)	3
1 c iii	magnesium carbonate	1
1 d	electrons lose energy/ move to lower energy/drop back/return to ground state (1) electrons in energy levels (1) NOT "shell" here (allow elsewhere) energy emitted as light/emits photons/emits (e-m) radiation (1) related to something falling (AW) frequency/wavelength depends on difference in energy levels/ $(\Delta)E = h\nu$ (1)  2nd and 4th marking points available to those talking about absorption spectra	4

Question	Expected Answers	Marks
2 a i	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$ <p>allow -OH</p>	1
2 a ii	$\begin{array}{c} \text{H} \\ \cdot\cdot \\ \text{H} \cdot \text{C} \cdot \text{O} \cdot \text{H} \\ \cdot\cdot \\ \text{H} \end{array}$ <p>allow <math>\cdot\cdot</math> along line of bond</p> <p>lone pairs on oxygen (1); rest of molecule</p>	2
2 a iii	<p>104 – 110 (Accept without degree sign)</p> <p>ecf from diagram - 120 for one lone pair, NOT 180 from no lone pairs</p>	1
2 b	alkane(s)	1
2 c i	(fuel) ignites/catches fire/burns/lights/explodes/combusts (AWY)(1) reaction with air implied without a spark/flame/ by itself/spontaneously/automatically/ion compression (1) IGNORE references to heat and high temperature second mark depends on reaction being mentioned	2
2 c ii	straight chain/unbranched NOT long chain ora	1
2 d i	13	1
2 d ii	C <sub>13</sub> H <sub>26</sub> O <sub>2</sub> C <sub>13</sub> (with ecf) and O <sub>2</sub> (1); H <sub>26</sub> (1). allow (1) for correct total of C, H, O in a structural formula	2
2 e i	incomplete/ not enough oxygen(1); combustion (of the fuel/hydrocarbons/carbon)(1)	2
2 e ii	oxygen ACCEPT O = O, -O- NOT O <sub>2</sub> , "molecule" six marking points, place dot over each one scored. Two dots per mark, round UP. enthalpy change/energy (or heat) given out/energy (NOT heat) change. when 1 mole; in context is burnt/combusted/oxidised/ (enthalpy change) of combustion; in excess oxygen/complete combustion; standard conditions; 1 atm pressure/298 K both these together can score the "standard conditions" sub-mark also.	1
2 f	33.4 (4)(kJ) Accept 33	3
2 g i	33.4 (4)(kJ) Accept 33	1
2 g ii	Ans to (g)(i) x 214 (1) for number: 33.4 gives 7150 (7148) 33.44 gives 7160 (7156) (1) for negative sign mark separately. for > 4 sf (and "number" mark scored), write "sf" in body of script near mark. Do NOT deduct marks	2

Question	Expected Answers	Marks
3 a	protons 92 (1); neutrons 146 (1); electrons 92 (ecf from protons)(1)	3
3 b i	$2\text{Ca} + \text{UF}_4 \rightarrow 2\text{CaF}_2 + \text{U}$ Any equation (balanced or not) indicating "calcium plus uranium fluoride (any formula) giving calcium fluoride (any formula) plus uranium" (1) (IGNORE charges) Correct formula for calcium fluoride (1) Correctly balanced (with correct formulae) (1) NOT with charges ignore ss	3
3 b ii	<p>Amount U = 1000/238 (= 4.20 mol) (1)</p> <p>Amount Ca = Twice (ecf) this: (8.40 mol) (1) MUST follow from equation, if written</p> <p>Mass = (8.4ecf x 40) = 336 g (1)</p> <p>168g scores (2) with no working (or (3) if ecf from equation)</p> <p>672g scores (3) with no working if ecf from equation.</p> <p>Max 4 sf. Check with 2g(iii). IF SECOND sf error, do not award final mark. Write "sf" in body of script by mark. (Otherwise ignore sf)</p>	3
3 c	 <p>Peaks at 235 and 238 (1); 238 larger than (more than double) 235 (1) Extra peaks are "con".</p>	2
3 d	<p>Amount O = 11.9/16 (= 0.744 mol)</p> <p>Amount U = 88.1/238 (= 0.37 mol) (1);</p> <p>Answer UO<sub>2</sub> (ecf) (1) Allow O<sub>2</sub>U NOT UO<sub>2</sub></p> <p>Some relevant working needed (eg one mass/A<sub>r</sub>). Otherwise UO<sub>2</sub> on its own scores (1)</p>	2
3 e i	$238 \text{ U} \rightarrow 234 \text{ Th} + 4 \text{ He}$ (1) for $^4_2\text{He}$ correct or $^4_2$ (either side of equation) ALLOW $^4_2\text{He}^{2+}$ (1) for consistent element and Z in product (unless U given) (1) for completely correct (no charges)	3
3 e ii	<p>very little radiation/ long half-life/ long time to decay(1); NOT scarce</p> <p>—particles have small penetrating power (in air)/small range/absorbed by skin (AW)</p> <p>(1)</p> <p>NOT "stopped by paper" alone. NOT "low energy".</p>	2
3 f	<p>93 Kr</p> <p>36</p> <p>(1) for 93; (1) for rest.</p>	2

Question	Expected Answers	Marks
4 a	Speeds up chemical reaction (1); Unchanged (at the end)/ not used up/ not affected itself/lowers activation enthalpy/energy/provides alternative route (1) IGNORE "does not take part"	2
4 b i	Nitrogen (NOT "from fuel" - con) and oxygen react/burn/combust (1); (accept "nitrogen oxidised" or balanced equation) in the heat/spark/high temperature (of the engine) (1) Mark separately "in exhaust" is con.	2
4 b ii	750 dm <sup>3</sup> must have units	1
4 b iii	Fewer moles/molecules (on right hand side) (1); fewer ways of arrangement (IGNORE type of particles)/ increased order/ decreased disorder/less chaotic/ more organised(1) Mark separately	2
4 b iv	Bonds form (1) NOT sufficient on diagram only between <u>nitrogen</u> (atoms)(1) and <u>carbon</u> and <u>oxygen</u> (atoms) (1) NOT molecules ALLOW oxygen atoms combine and oxidise carbon for second mark the products diffuse away from/leave surface/bonds break with surface (AW)(1) NOT sufficient on diagram only products are carbon dioxide and nitrogen (names or correct formulae) (1)(if on diagram, correct bonds must be shown. (eg C=O)	5
4 c	(Lead compounds) are adsorbed (NOT absorbed) (on to surface)/ bond to surface/ bind to surface(1); NOT deposits/ covers. (chemical process at surface implied) stopping catalyst working / poisoning catalyst/ stopping reactants reaching reacting with catalyst surface /catalyst becomes inactive/useless(AW) implies stopped totally(1)	2
4 d	needs to be hot/ high temperature/warmed up ora ACCEPT answers in terms of kinetic theory	1
4 e	any pair: (unburnt) hydrocarbons/C <sub>x</sub> H <sub>y</sub> / formula >C <sub>3</sub> sulphur oxide/ sulphur dioxide/ sulphur trioxide/SO <sub>x</sub> . (NOT other formulae or names) hydrogen sulphide carbon particles lead compounds water	2
	smog /greenhouse gas *toxic (allow for any hydrocarbon) acid rain *toxic/respiratory problems (allow for any oxide of sulphur) NOT greenhouse toxic lung disease. toxic greenhouse gas* scores (1) only * allow effects of greenhouse gases or acid rain	