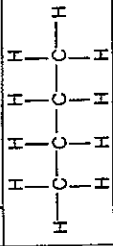
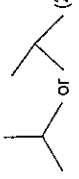


The following annotations may be used when marking:

- 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		1
1 b i	Takes up less room/ greater (energy) density ignore references to flammability, storage, transport, leakage	1
1 b ii	M_r butane = 58 (1); Mol butane = $2.9/M_r$ (= 0.05 mol) (1); ecf from M_r Volume = mol \times 24 = 1.2 dm ³ (1) ecf if there has been a clear attempt to calculate moles (OR moles clearly stated) and this value is multiplied by 24.	3
1 c i	C ₃ H ₈	1
1 c ii	alkane(s)	1
1 c iii	-2850 to -2890 (sign essential) (1); Accept -2900 (answer to 2 sf) similar gap each time (AW) (1) Can be shown on table IGNORE "same pattern", "follows trend", references to bonds Mark separately	2
1 d i	 (2 →) methylpropane (1) ignore, commas, dashes and gaps ecf from structure _____ scores 0	3
1 d ii	likely to auto-ignite/pre-ignite/pink/knock/combust spontaneously (1); less/prevented depends on first(1); methylpropane ecf from d (i)/answer to d(i) has higher rating (1); (more) branched (1) "Branched isomer" can score both of last two marking points not just "butane is straight-chained" ignore references to volatility	4
1 e	nitrogen/N ₂ from the air/ atmosphere/from compound in fuel(1); combusts/is oxidised/reacts/ combines /bonds with oxygen/O ₂ / correct equation (1); ignore "incomplete" before combustion. in the heat/spark/high/ extreme temperature (1) mark separately	3
1 f i	2CO + 2NO → N ₂ + 2CO ₂ correct species, wrongly balanced/correctly balanced with N (1); correctly balanced with N ₂ (2) allow doubled or halved etc	2
1 f ii	2. Bonds weaken/ broken/ molecules broken (1) 3. New bonds / molecules form (1) 4. Product s/ less harmful gases/ named gases/new molecules leave/ diffuse from surface / go into air(1) Can score from diagram provided words or labels are present Score more than one marking points on same line if appropriate. Sequence must be correct.	3

2 a i	11 (1) 13(1); 11(1) ecf on electron number from proton number.	3
2 a ii	protons and neutrons	1
2 b	radioactive (1); decay(1) mark separately	2
2 b ii	$^{24}_{12}\text{Mg}$ (1) for $^{24}_{12}$; (1) for element consistent with atomic number (except sodium)	2
2 c i	Geiger (- Muller)/G M/spark counter /tube/meter Allow phonetically NOT photographic plate	1
2 c ii	Two from: leukaemia/cancer/ radiation/cell/tissue/blood vessel damage/rapid division of cells (1); cells/ tissue/ molecules being ionised/ radical formation(1); mutations/ DNA damage (1) NOT "too much salt in body" etc	2
2 c iii	Longer – little radiation to measure/ lasts longer than needed (for investigation)/ longer exposure (to radiation) than necessary/ prevent repeat investigation(AW) Shorter – short burst of radiation (AW)/ decays before measurement made/isotope detected/ does not pass round body in time "(15 hours) allows enough time for measurements to be made" (AW) scores (1) if no other marks scored Incorrect interpretation of half life statement is CON	2
2 d i	$\text{Na} \rightarrow \text{Na}^+ + \text{e}^-$ or $\text{Na} + \text{e}^- \rightarrow \text{Na}^+ + 2\text{e}^-$ Ignore s.s. and correct nuclear symbol on electron or atom and ion (must be the same)	1
2 d ii	follows dotted line up to magnetic field and moves in straight line if emerges from magnetic field (1); then less curved(1) follows dotted line completely scores zero	2

3 a i	$\begin{array}{c} \text{H} \\ + \\ \text{H} : \text{C} : \text{N} : \text{N} : \text{H} \\ + \cdot \quad + \cdot \quad + \cdot \quad + \cdot \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$ <p>shared pairs (1); can be "side by side" eg $+ \cdot$ lone pairs (can be same or different symbols) (1)</p>	2
3 a ii	A 109±2 (1); B 107 – 110 (1) degree sign need not be shown.	2
3 b	M. values N_2O_4 92 methylhydrazine 46 (1); ratio 5/4 used (1); 460/184 used scores both marks calculated answer ecf* (1) must have "g" to score. 2 sig figs (1) award separately $25 \times 92 \times 5 = 62.5 \text{ g}$ 63 g to 2sf 46×4 * eg 50 g (no 5/4) scores 3 NB Watch for erroneous M. values of 204/82 giving 62.2 g (62 g to 2 sf) Can score last two marks only	4
3 c i	CH_3NHNH_2 (1) allow methylhydrazine or small errors in formula which leave meaning clear	1
3 c ii	N_2 (g) + 2O_2 (g) → N_2O_4 (l) idea of nitrogen and oxygen as reagents (can be N & O) (1); completely correct (1) State symbols (1) if either mark scored	3
3 d i	$\Delta H_1 = (5 \times -20) + (4 \times +54) = (+)116$ (1); $\Delta H_2 = (12 \times -286) + (4 \times -393) = (-)5004$ (1); (1) for both signs correct (ecf) if failure to multiply by coefficients, (1) for +34 and -679, including signs	3
3 d ii	$\Delta H = \Delta H_2 - \Delta H_1$ Allow $\text{H}_2 - \text{H}_1$ or $\Delta_2 - \Delta_1$ or numerical values from d(i)	1
3 d iii	$\Delta H = (-5004 - 116) = -5120 \text{ kJ mol}^{-1}$ (ecf* from d(i) or d(ii)) *+ sign must be given if relevant (1) *failure to multiply by coefficients in d(i) gives -713	1
3 e i	Temperature greater than 25 °C/298K/ pressure greater than 1 atm (1)	1
3 e ii	gases formed from liquids (1); more molecules/particles formed (1) NOT more substances formed or 2 reactants to 3 products	2

4 a i	basic/ alkali(ne) Allow proton acceptor/ pH high > 7 in solution	1
4 a ii	$\text{Mg(OH)}_2 + 2 \text{HCl} \rightarrow \text{MgCl}_2 + 2\text{H}_2\text{O}$ (1) for balancing if one other mark scored accept halved, doubled etc. Ignore ss.	3
4 b i	2	1
4 b ii	CaCO_3	1
4 b iii	magnesium carbonate	1
4 b iv	hydrogen/ H_2 NOT H	1
4 c i	Four from SIZE: Calcium/it has larger atom/ more electron shells/electrons further from nucleus ora (1); ATTRACTION: electron(s) held less tightly/more shielding/ less attraction to nucleus/protons ora (1); EASE OF LOSS: electron(s) more easily lost/got rid off ion formed more easily/ less energy needed to remove electron(s) ora (1) REACTIVITY: more reactive ora(1); Group 2/ Mg and Ca/ Metals react by losing electrons (1)	4
4 c ii	$\text{Mg}^+(g) \rightarrow \text{Mg}^{2+}(g) + e^-/e$ balanced equation for formation of a positive Mg ion/any $\text{Mg}^+ \rightarrow \text{Mg}^{2+}$ (1); ignore correct nuclear symbols correct equation (1); allow correct nuclear symbols on electron only state symbols (1); if at least one mark already scored	3