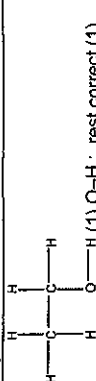



The following annotations may be used when marking:

- 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

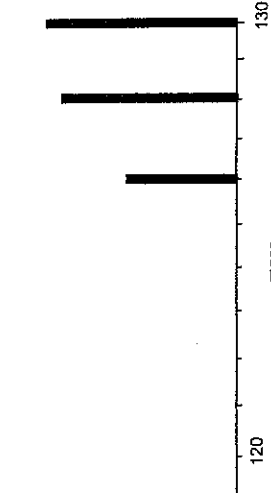
Abbreviations, annotations and conventions used in the Mark Scheme:

- / = 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
- ecf (underlining) = key words which must be used
- AW = allow error carried forward in consequential marking
- ora = alternative wording
- = = or reverse argument

Question	Expected Answers	Marks
1 a i		2
ii		3
iii	shared pairs on O correct(1); lone pairs on O correct (1); rest of molecule (1). Allow C ^x C. Other bonding pairs must be dot/cross. Accept circles round atoms. All crosses – second mark only. No symbols max. 2.	4
b i	104 – 110° ecf from diagram(1); four pairs/groups of electrons/electron regions/ areas of electron density round oxygen (oxygen must be stated or implied) (1) ecf from angle or diagram repeat each other (1); (must be in terms of electrons) get as far apart as possible (1) (allow in terms of atoms/bonds)	2
ii	CH ₃ OCH ₃ (or more displayed versions) NOT an alcohol, even if no alcohol in a(i) idea of central oxygen (1); completely correct (1)	3
iii	same molecular (depends on second mark being scored)(1); formula (1); (allow same number of same type of atoms (2)) same atoms (1) NOT same number of atoms different structural formula/structure/arrangement of atoms (1)	1
c	ether/alkoxy/methoxy no ecf	2
d i	likely to auto-ignite/pink/knock (1) less/prevented(1) second mark depends on first ignore references to volatility (more) complete/clean/efficient/less incomplete (1) combustion/burning (1) depends on first mark being scored OR oxygenates/compounds partially oxidised/have oxygen in them (1); form CO ₂ (1) award separately	2
ii	harmful to life/poisonous/toxic(1); because it lessens oxygen uptake of blood/haemoglobin/ causes suffocation/respiratory problems (AW) (1) OR photochemical smog(1); more (low level) ozone/respiratory problems/damage to plastic/rubber (1) ignore greenhouse.	2
e	greater/increases(1); more ways of arranging (1) molecules/particles (NOT atoms) depends on second mark being scored (1) more disorder/franckness/disorganised NOT mixed scores (1) of second 2 marks	3
f	burner (not necessarily lit, labelled or clearly drawn) (1); draft excluder provided burner shown lagging/liq (lid must be labelled) (1); vessel containing water (labelled) (1); and thermometer in water(1) award separately	4

2 a i	coal/oil/natural gas/peat/lignite	1
ii	they are running out/non-renewable (1) OR Use of renewable resource (1) (or example, eg wind, solar, nuclear to replace "renewable")	1
b	nitrogen monoxide is formed when nitrogen from the air (1); is oxidised/reacts (AW, NOT combusts) with oxygen/correct equation(1); in the heat/spark /high temp (1); There are no carbon (compounds) producing CO(1); There are no sulphur compounds producing SO ₂ (1)	5
c i	$H_2 + \frac{1}{2} O_2 \rightarrow H_2O$	1
ii	Bonds broken H-H 436 0.5 O=O 249 685 (1) ecf from equation Bonds made 2O-H 928 (1) ecf from equation Broken - made (AW) (1) can be implied from answer = -243 kJ mol ⁻¹ (calculation, sign and unit) ecf from figures given(1) No working plus any wrong answer (except -486 kJ mol ⁻¹ for double equation) scores zero.	4
iii	Moles H ₂ in 1 kg = 500 (1) 500×243 (ecf) = 122 000/121 500 kJ kg ⁻¹ (1) 1000(or any calculated moles) x 243(ecf) (plus calculation) scores (1) ignore signs and sf	2
iv	hydrogen (ecf) is more efficient/ a better (fuel)/quantified amount of energy (eg "2.5 times more energy"/"more energy per kg. NOT just comparison of energy density/energy Assume "it" refers to octane.	1
d	octane is a liquid (1); statement implying liquids have higher densities than gases eg liquid takes up less space/ larger quantity of hydrogen required/ less hydrogen in tank (1); hydrogen must be liquefied/(high) pressure/low temperature/stored as hydride (1) problem caused: eg explosion/ with reason eg explosion/ difficulty refuelling/refrigeration/ problems of pressurisation/thicker/larger tank/ need to refuel more often with same size tank(1)	4

3 a i	${}_{88}^{226}Ra \rightarrow 2 {}_{2}^{4}He/\alpha + {}_{86}^{222}Rn$ (1) for each species if helium is wrong, allow ecf on other nuclide (except one based on Ra) IGNORE 2+ on helium (but NOT 2-) Do not award mark for Rn if extra particles added to equation	3
ii	(No) α -particles absorbed/stopped/low penetrating power(1); by watch (1) NOT short distance IGNORE wavelength	2
b i	2++2(1);	1
ii	same Group/ both Group 2/ (1); (atoms have) two electrons in outer shell/ lose two electrons (1)	2

4 a i	6 (1); Group 6/ S/O has six (1)	2
ii	H ₂ Te/TeH ₂	1
b	(+) 880 ± 20 (1); similar gap/pattern between S and Se/ similar % decrease (1) OR answer in terms of size of atom/electrons further from nucleus/ shielding (1) mark separately	2
c i	isotope Protons/neutrons electrons Te-122 52 70 52 Te-130 52 78 52 Both protons (1); Each neutron number (1); (1) Both electrons (1) ecf from proton number	4
ii	4483.70 (in box)(1); sum 12762.8 (1); 100/99.92 (gives answer 127.73) (1); correct decimal places award separately (1) (IGNORE units). 127.63 NB 127.6 is shown on Periodic Table. Do not award marks for this unless working is clear.	4
iii	sticks or narrow peaks (must hit base-line ± 1 and be centred over number) at any 3 correct masses (1); only the top three chosen (1); heights of top three in ascending order from left to right (1) (only allow when there are three lines)	3
		
d i	properties/reactions (1); NOT similarities fit those in Groups/specific statements about Te or I and their Groups(1)	2
ii	atomic numbers/ number of protons (1); reference to comparative atomic numbers of Te and I (1)	2