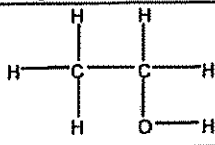
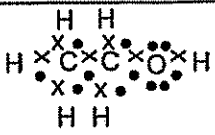
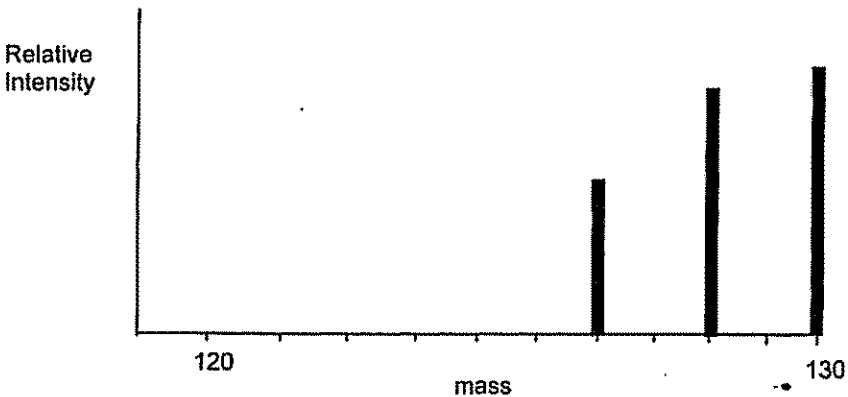


Question	Expected Answers	Marks
1 a i	 <p>(1) O-H ; rest correct (1)</p>	2
ii	 <p>shared pairs on O correct(1); lone pairs on O correct (1); rest of molecule (1) Allow C_x C. Other bonding pairs must be dot/cross. Accept circles round atoms All crosses – second mark only. No symbols max 2.</p>	3
iii	<p>104 – 110° <i>ecf</i> from diagram(1); four pairs/groups of electrons/electron regions/ areas of electron density round oxygen (oxygen must be stated or implied) (1) <i>ecf</i> from angle or diagram repel each other (1); (must be in terms of electrons) get as far apart as possible (1) (allow in terms of atoms/bonds)</p>	4
b i	<p>CH₃OCH₃ (or more displayed versions) NOT an alcohol ,even if no alcohol in a(i) idea of central oxygen (1); completely correct (1)</p>	2
ii	<p>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)</p>	3
iii	<p>ether/alkoxy/methoxy no <i>ecf</i></p>	1
c	<p>likely to auto-ignite/pink/knock (1) less/prevented(1) second mark depends on first ignore references to volatility</p>	2
d i	<p>(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 CO₂ (1) award separately</p>	2
ii	<p>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.</p>	2
e	<p>greater/increases(1); more ways of arranging (1) molecules/particles (NOT atoms) depends on second mark being scored (1) more disorder/randomness/disorganised NOT mixed scores (1) of second 2 marks</p>	3
f	<p>burner (not necessarily lit, labelled or clearly drawn) (1); draft excluder provided burner shown /lagging/lid (lid must be labelled) (1); vessel containing water (labelled) (1); and thermometer in water(1) award separately</p>	4

2 a i	coal/oil/natural gas/peat/lignite	1								
ii	they are running out/non-renewable (1) OR Use of <u>renewable</u> 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/ <u>correct</u> equation(1); in the heat/spark /high temp (1); There are no carbon (compounds) producing CO(1); There are no sulphur <u>compounds</u> producing SO ₂ (1)	5								
c i	$\text{H}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{O}$	1								
ii	Bonds broken <table style="margin-left: 20px;"> <tr> <td>H-H</td> <td>436</td> </tr> <tr> <td>0.5 O=O</td> <td>249</td> </tr> <tr> <td></td> <td>685 (1) <i>ecf from equation</i></td> </tr> </table> Bonds made <table style="margin-left: 20px;"> <tr> <td>2O-H</td> <td>928 (1) <i>ecf from equation</i></td> </tr> </table> Broken – made (AW) (1) <i>can be implied from answer</i> = -243 kJ mol ⁻¹ . (calculation, sign and unit) <i>ecf from figures given</i> (1) No working plus any wrong answer (except -486 kJ mol ⁻¹ for double equation) scores zero.	H-H	436	0.5 O=O	249		685 (1) <i>ecf from equation</i>	2O-H	928 (1) <i>ecf from equation</i>	4
H-H	436									
0.5 O=O	249									
	685 (1) <i>ecf from equation</i>									
2O-H	928 (1) <i>ecf from equation</i>									
iii	Moles H ₂ in 1 kg = 500 (1) 500 x 243(ecf) = 122 000/121500 kJ kg ⁻¹ (1) 1000(or any calculated moles) x 243(ecf) (plus calculation) scores (1) <i>ignore signs and sf</i>	2								
iv	hydrogen (ecf) is more efficient/ a better (fuel)/quantified amount of energy (eg "2.5 times more energy")/more energy per kg. <i>NOT just comparison of energy density/energy</i> <i>Assume "it" refers to octane.</i>	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 dangerous with reason eg explosion/ difficulty refuelling/refrigeration/ problems of pressurisation/thicker/larger tank/ need to refuel more often <u>with same size tank</u> (1)	4								

3 a i	${}_{88}^{226}\text{Ra} \rightarrow {}_2^4\text{He}/\alpha + {}_{86}^{222}\text{Rn}$ <p>(1) for each species</p> <p><i>If helium is wrong, allow ecf on other nuclide (except one based on Ra)</i></p> <p><i>IGNORE 2+ on helium (but NOT 2-) Do not award mark for Rn if extra particles added to equation</i></p>	3
ii	<p>(No) a-particles absorbed/stopped/low penetrating power(1); by watch (1)</p> <p><i>NOT short distance IGNORE wavelength</i></p>	2
b i	<p>2+ / +2(1);</p>	1
ii	<p>same Group/ both Group 2/ (1);</p> <p>(atoms have) <u>two</u> electrons in <u>outer</u> shell/ lose two electrons (1)</p>	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) <i>mark separately</i>	2												
c i	<table border="1"> <thead> <tr> <th>Isotope</th> <th>Protons</th> <th>neutrons</th> <th>electrons</th> </tr> </thead> <tbody> <tr> <td>Te-122</td> <td>52</td> <td>70</td> <td>52</td> </tr> <tr> <td>Te-130</td> <td>52</td> <td>78</td> <td>52</td> </tr> </tbody> </table> Both protons (1); Each neutron number (1); (1) Both electrons (1) <i>ecf from proton number</i>	Isotope	Protons	neutrons	electrons	Te-122	52	70	52	Te-130	52	78	52	4
Isotope	Protons	neutrons	electrons											
Te-122	52	70	52											
Te-130	52	78	52											
ii	4483.70 (<i>in box</i>)(1); sum 12762.8 (1); 100/99.92 (<i>gives answer 127.73</i>) (1); correct decimal places <i>award separately</i> (1) IGNORE units. 127.63 <i>NB 127.6 is shown on Periodic Table. Do not award marks for this unless working is clear.</i>	4												
iii	sticks or narrow peaks (must hit base-line ± 1 and be centred over number) at any 3 <u>correct</u> masses (1); only the top three chosen (1); heights of top three in ascending order from left to right (1) (<i>only allow when there are three lines</i>) 	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												