

Question	Expected Answers	Marks
1 a I	Nitrogen and oxygen react/burn/combust (1) In heat/spark/high temperature(of the engine) (1) score separately  Accept “nitrogen oxidized” etc or equation (with N <sub>2</sub> ) for first mark	2
1 a ii	Incomplete combustion/not fully burnt/burning in limited supply of oxygen/not enough air(1); Of hydrocarbon/the carbon (in fuels)/fuel/petrol/ correct name or formula of hydrocarbon > C <sub>3</sub> (1)	2
1 b I	Any one set Acid rain/ forms nitric acid(1); which corrodes/erodes (buildings)/damages (qualified)/harmful to life/ toxic(1)  Two from greenhouse gas(1); causes global warming (1);/changes climate/affects agriculture/causes floods(1)  Two from forms ozone(1); which causes smog: (1) which causes respiratory problems/ toxic(1)  Destroys ozone (1); which keeps out harmful/high energy u.v./ sun’s rays (ora)/ causes skin cancer/cataracts(1)  Toxic (AW) alone (1)	2
1 b ii	Either one set  Harmful to us/life(1); hinders oxygen absorption (AW) (1)  Causes smog(1) which causes respiratory problems/ toxic(1) NOT greenhouse	2
1 c	Any one set Unburnt hydrocarbons (1); smog/greenhouse gas/toxic(1) Allow correct name or formula of hydrocarbon > C <sub>3</sub>  SO <sub>x</sub> (1); acid rain/ toxic/smog (1) ( SO causes acid rain scores (1))  CO <sub>2</sub> (1); Greenhouse gas / global warming (1)  Particulates (1); cause smog/ harmful to us(1)  Water(1); greenhouse gas/ global warming (1)  Lead/ lead compounds (1); toxic(1)  Other nitrogen oxides (1); as above (1)	2
1 d i	It is in different state (from the reactants)(1); It speeds up a chemical reaction (1); But is unchanged (chemically at the end/not used up / by lowering activation enthalpy/energy providing alternative route (1) NOT “does not take part”	3
1 D ii	$2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$ (2) any balanced equation scores (2) Correct species unbalanced/ balanced with ‘N’ scores (1)	2

2a	<p>Proton 11 1 +1</p> <p>Neutron 12 1 0/neutral/non (NOT a dash)</p> <p>Electron 11 very small -1</p> <p>Two marks for four correct; One mark for two or three correct NB Only one tick per mark</p>	2
2 b I	<p>Arrow upwards from lower to higher level labeled 'absorbs'/ excited (AW) (1); Arrow downwards from higher to lower, labeled 'emits (light)'/loses energy AW (1);</p> <p>Arrows alone score (1) if down arrow starts at finishing height or below up arrow</p>	2
2 b ii	<p>Electrons (only exist in these ) levels/ shells (1) any correct mention of electrons and level/shells at any stage</p> <p>Dropping/ moving down levels releases energy (1);</p> <p>Frequency related to energy/ <math>E=h\nu</math> (1);</p> <p>Which is the energy difference between levels (1)</p> <p><math>E = h\nu</math> scores both last two marks.</p> <p>Mark points independently if they make sense</p> <p>Can look back to 2b(i) for any marks</p>	4
2 c i	<p>2.8.1 (1); 2.8.8.1 (1)</p> <p>Allow commas; allow <math>1s^2, 2s^2, 2p^6, 3s^1</math> and <math>1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^1</math> (or using noble gas convention)</p>	2
2 c ii	<p>Both metals react by losing one/outermost electron/ form 1+ ions (1) NOT just "have one electron in out shell (unless referred to later)</p> <p>(In potassium) this electron is further from the nucleus/ more shells/ larger atom/ more shielding (1); Thus held less tightly/ more easily lost/ good rid of (1) NOT Just "reacts faster"</p>	3

3 a i	$  \begin{array}{ccccccc}  & \text{H} & \text{H} & & \text{H} & \text{H} & \\  &   &   & &   &   & \\  \text{H} & -\text{C} & -\text{C} & -\text{O} & -\text{C} & -\text{C} & -\text{H} \\  &   &   & &   &   & \\  & \text{H} & \text{H} & & \text{H} & \text{H} &   \end{array}  $	1
3 a ii	Ether (alkoxyalkane)	1
3 a iii	<p>Two bonding pairs/bonds (1); and two lone pairs round the oxygen (1);  These can be shown in a diagram with or without labels  Repel each other (1); get as far away from each other as possible (1)  (1) of first two for “four pairs of electrons/ Four areas of electron density/ charge clouds/ groups of electrons”</p> <p>Second two marks can be scored if distribution round carbon considered  Ignore references to lone pair- lone pair repulsions &gt; bond-pair – bond pair</p>	4
3 b i	<p>Butan-1-ol (2)</p> <p>Butanol, butane-1-ol, but-1-ol, 1-butanol, omission of dashes score (1)</p> <p>NOT propan-1-ol</p>	2
3 b ii	 <p>(2)</p>  <p>Or “blobs” score (1)</p>	2
3 b iii	<p>Same molecular formula/ same number of C’s, H’s Os (2);  “same formula/chemical formula”/ scores (1)</p> <p>Different structure/ structural formula/ arrangement of atoms (1)</p>	2
3 c i	<p><math>\text{C}_4\text{H}_{10}\text{O} + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}</math></p> <p>Balancing right hand side (1); balancing oxygen(1)  (1) if multiple</p>	2
3 c ii	<p>6.0dm<sup>3</sup> of oxygen (1) (ecf);</p> <p>(6.0 x 5) = 30dm<sup>3</sup> of air (1) (ecf).</p> <p>Allow 28-32 dm<sup>3</sup> without calculation (19-21% on ecf)</p>	2

3 c iii	<p>Bonds broken: Bond made ecf from 3ci</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">2 C-C 694</td> <td style="width: 33%;">8 C=O 6440</td> <td style="width: 33%;"></td> </tr> <tr> <td>2 C-O 716</td> <td>10 O-H 4640</td> <td></td> </tr> <tr> <td>10 C-H 4130</td> <td>Total 11080</td> <td style="text-align: right;">(1)</td> </tr> <tr> <td>6 O=O 2988</td> <td></td> <td></td> </tr> <tr> <td>Total 8528</td> <td></td> <td style="text-align: right;">(1)</td> </tr> </table> <p>Answer = -2552 KJ mol<sup>-1</sup>  Difference of broken and made (1) (i.e subtraction suml if not shown can award on total)  Calculation, unit and sign (allow ecf, though a “+” sign must be shown if necessary) (1)</p> <p>Correct answer with no (or incorrect) working scores full marks</p>	2 C-C 694	8 C=O 6440		2 C-O 716	10 O-H 4640		10 C-H 4130	Total 11080	(1)	6 O=O 2988			Total 8528		(1)	4
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3 c iv	<p>One set of</p> <p>Bond enthalpies are only average values/ Ora: enthalpy changes are specific(1); so they will not be exact for these bonds(1)or</p> <p>Reactants and products are not in their standard states/ they are measured under different conditions (1) eg water ( or ethoxyethane) not liquid/ i.e states at 1 atm and 298K(1)</p> <p>There are i.m.f (1); which are also broken/made (1)</p>	2															
3 c v	<p>C=O short than C-O (ora) (1)  C=O greater bond enthalpy (ora; AW) (1)  2<sup>nd</sup> mark depends on first correct</p>	2															
3 d	<p>Catch fire/explode (1) ignore source of ignition</p>	1															

3e	<p>One mark each for three properties identified, followed by a second mark for each for a discussion( either description of the effects or (where appropriate) the possible property of ethoxyethane). (max 6) (4<sup>th</sup>-6<sup>th</sup> marks must be paired and normally depend on the first being scored)</p> <p>Volatility/ evaporates easily/ low bpt (AW)(1); similar to petrol/ rather high hence lost as vapour/ causes air locks (1); NOT extension to auto-ignition.</p> <p>Octane ratings/ number(1); might be too low as explodes easily/ high since molecule contains oxygen/ is oxygenate/ is small mol./short chain/ low since unbranched/meaning in terms of auto-ignition*/pre-ignition/knocking/ use in high compression engine (1)</p> <p>Low flash point (1); dangerous in use/ tendency to auto-ignite*/ low engine temp (1)</p> <p>Energy density (1); needs to be as high as possible (1) (max (1) if density not mentioned i.e discussed in terms of enthalpy change of combustion)</p> <p>Complete combustion (1); more efficient/ oxygenate(1)</p> <p>Reacts with/absorbs with water (1); could corrode tank/ because has oxygen (1) Stoichiometric ratio (AW) (1); engine efficiency (1) Anaesthetic (1); causes driver drowsiness (1) NOT storage gas/liquid or points (eg flammability) would would apply almost equally to petrol.</p> <p>Plus one mark if candidate has “ organized relevant information clearly and coherently using specialist vocabulary (italicized words) as appropriate”</p> <p>Check if in sentences (2min) – if logical – if net two correctly used italicized words</p> <p>QWC mark : tick (with Q) in body (by [7]) “0Q” or “1Q” in margin to right</p> <p>*only award once</p>	6+1
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4 a i	Aluminum (1) Accept 'Al'	1
4 a ii	Filter/ centrifuge (1)	1
4 a iii	H <sub>2</sub> O (1)	1
4 a iv	Insoluble(1); The solubility of the hydroxide decreases up the group (AW) (1) Can score second mark if 'fairly soluble' given for first	2
4 b I	$\begin{array}{c} \cdot\cdot & & \cdot\cdot \\ \cdot & \times & \cdot \\ \cdot & \times & \cdot \\ \cdot\cdot & & \cdot\cdot \end{array}$ <p style="text-align: center;">Ignore rings and inner shells</p> <p>(1) for seven electrons on chlorine and two electrons on beryllium (1) for covalent bonds shown Zero if clearly ionic Award separately</p>	2
4 b ii	Linear/ described as such (eg straight/ angle 180) Ecf from structure in (b)	1
4 c I	$M+(g) \rightarrow M^{2+}(g) + e^{-}$ (1) state symbols vital: Allow $M^{+}$ - $E^{-}$ . Allow Mg Second(1); ionisation (enthalpy/energy)(1)	3
4 c ii	Beryllium as it does not form ions/ shares electron(AW;ora)/ above Mg, therefore smaller and holds on to electron (AW) Answer must be based on evidence from ©	1
4 d i	Same number of protons/ atomic number/ proton number(1) Different mass number/different neutrons(1) NOT atomic mass Magnesium has 12 protons but the isotopes have 12,13,14 neutrons/ mass numbers 24,25,26/ ' has one more neutron' (1) Only two isotopes need be mentioned to score	3
4 d ii	$(70 \times 24) + (19 \times 25) + (11 \times 26) (=2441)$ (1); /100 (1) Answer 24.4 (correct decimal place no units (1); 3 marks with no working  Other answers with no working score zero, except 24.41 (2)	3

4 e	Moles of Be – $12.9/9.0 = 1.43$ Moles of C = $17.3/12.0 = 1.44$ Moles of O = $69.8/16.0 = 4.36$ (1) for these calculations Ration 1:1:3 (1) gives BeCO <sub>3</sub> (1) Correct answer with wrong or no working scores(1)	3
4 f	$ \begin{array}{ccccccc} 9 & \textcircled{4} & & 12 & \textcircled{1} & & \\ \text{Be} & \text{He} & \rightarrow & \text{C} & \text{n} & & \\ \textcircled{4} & \textcircled{2} & & \textcircled{6} & \textcircled{0} & &  \end{array} $	4
4 g i	Radioactive (1)	1
4 g ii	$ \begin{array}{ccc} 226 & 222 & 4 \\ \text{Ra} & \text{Rn} & \text{He/Alpha (accept numbers on other side)} \\ 88 & 86 & 2 \end{array} $ (1)for each reactant and product	3