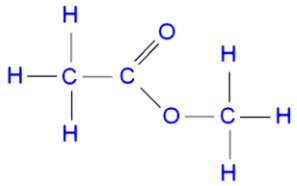
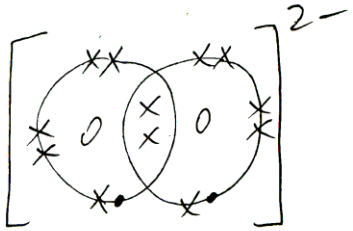
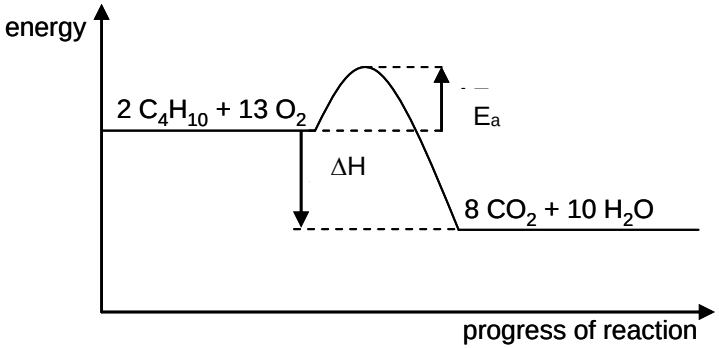
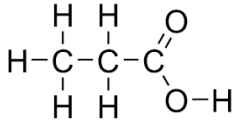
Marker's Report and Answers to 2024 Preliminary Examination 6092/2:

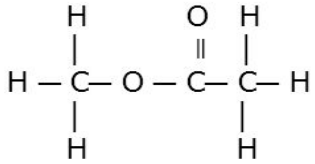
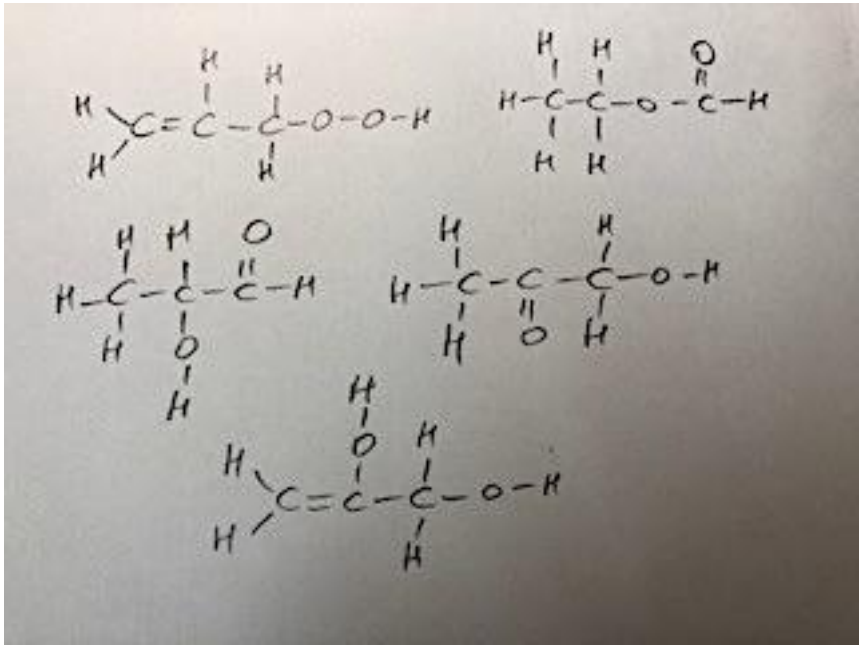
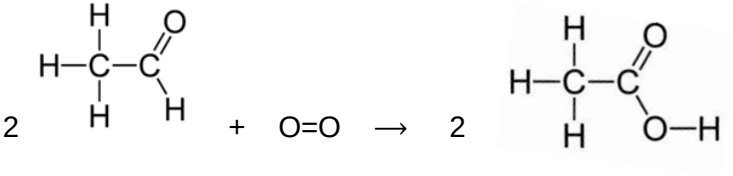
No.	Answers	Marks
A1ai	Li^+ Some candidates carelessly did not put the charge.	**[1]**
A1aii	Ca^{2+} and Cl^- Some candidates only wrote one ion and did not consider the rest.	**[1]**
A1aiii	Ca^{2+} and O^{2-} Many candidates did not realise about comparing the other possible ionic compound other than NaCl.	**[1]**
A1b	Solution remains reddish-brown; ACCEPT no observable change OR solution turns reddish-brown (since aqueous bromine is added) Bromine is less reactive than chlori**ne** hence bromine cannot displace chlori**de** ions from its solution (recall the ionic equation!); Similar question to 2023 TYS A1. Common mistake is the usual one in bold above.	**[2]**
A2a	 methyl ethanoate This whole question is also from TYS. Some candidates could not spell the name of the ester.	**[2]**
A2b	H_2O ; HCl ; Some candidates did not read the bolded word in the question and gave the molecular formulae of the ester instead.	**[2]**
A3ai	To slow down the reaction/decomposition of hydrogen peroxide; OWTTE REJECT prevent decomposition Many candidates mistakenly thought by putting substances at a lower temperature will stop decomposition entirely rather than slow the process down.	**[1]**

A3aii	 Correct number of bonded and unbonded outer electrons with different symbols labelled with oxygen; Correct brackets and charge; Exactly same question as 2023 TYS A4. Many candidates could not obtain full marks as some drew hydrogen peroxide instead or did not notice the charges on the ion or complete the shells with gaining two electrons.	**[2]**
A3b	$S_2O_8^{2-}$ Some candidates forgot to include the charge while others could not do this typical exam question on formula writing.	**[1]**
A3ci	$Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O_2$ Many candidates obtained credit for this question except those who did not read the question and wrote sodium oxide instead. Some candidates did not balance the equation.	**[1]**
A3cii	The reaction of sodium peroxide with water produces an <u>alkaline</u> solution of <u>sodium hydroxide</u> and hence Paul thought the indicator solution will turn <u>blue</u>; However <u>hydrogen peroxide</u>, which is also produced in the reaction, is a <u>bleach</u> and hence the solution will turn colourless; hence this does not support Paul's statement. REJECT 'basic' as this includes insoluble oxides. Any contradiction results in no mark at all. Similar question to 2023 TYS A4. Many candidates did not read the entire question and hence only answered partially.	**[2]**
A3di	$C + 2O \longrightarrow CO_2$ Many candidates either did not notice the bolded word and wrote oxygen gas instead of oxygen atom. Some also did not prepare for this exam to realise the greenhouse gas in the question is not CO.	**[1]**
A3dii	increased levels of greenhouse gases cause <u>global warming</u> which will <u>cause extreme weather events</u> / <u>melting of polar ice</u> OWTTE; Many candidates did not write the final effects of the global warming and just stopped at writing temperature increases. This answer above is straight from the syllabus and notes.	**[1]**

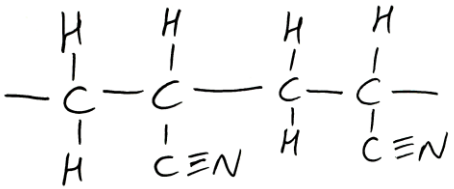
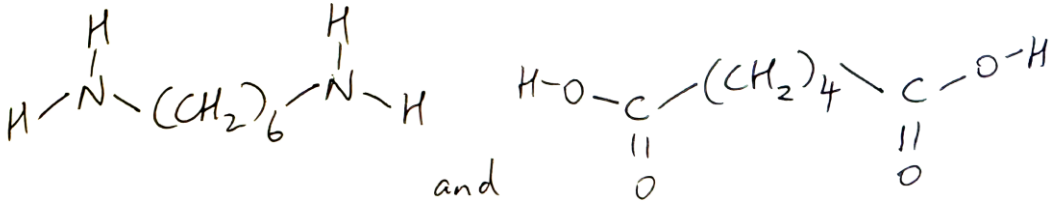
A4a	 correct chemical equation on the correct lines; correct balanced chemical equation; Once shape of graph is correct, check for correctly labelled activation energy; and enthalpy change; REJECT enthalpy change and/or activation energy if no dotted lines are drawn or obviously drawn without a ruler. REJECT -ΔH (based on O level markers report) If Endothermic graph is drawn, mark only for the balanced chemical equation (max 2 marks) Many candidates either did not balance the equation or got the formula of butane wrong. Most candidates remembered to use a **ruler** to draw the **single-headed arrow** and **dotted line** as they were advised during WA. Only a few candidates wrongly drew an endothermic graph for a combustion reaction.	**[4]**
A4b	energy released per dm^3 of gas = 120 kJ energy released per 24 dm^3 of gas = 120 x 24 = 2880 kJ/mol or kJ. REJECT if wrong units are written (e.g. in small 'j' instead of J) Some candidates did not read that butane is a gas at r.t.p. and hence they need to use 24 dm^3.	**[1]**
A4c	Requires compression/liquification for storage/transportation OR butane (from crude oil) is non-renewable; REJECT flammable as all fuels are flammable. REJECT higher temperature or incomplete combustion Many candidates correctly wrote 'non-renewable' answer as they recalled butane is from crude oil.	**[1]**
A4d	At a lower pressure, there are <u>fewer molecules/particles per unit volume;</u> hence <u>butane and oxygen molecules/particles</u> collide less often with <u>lower frequency of effective collisions;</u> Therefore rate of reaction decreases. REJECT if no 'particles' is mentioned (no mark for entire question) Many candidates did not study their 'collision theory' key phrases in the notes thoroughly to obtain full credit.	**[2]**

A4e	(Propane and butane exist as simple covalent molecules) Propane consists of smaller molecular size than butane; and hence has **weaker** intermolecular forces of attraction which require less energy to overcome; REJECT "smaller molecular mass", weak intermolecular forces, 'break forces' Many candidates did not study the key phrases in the notes thoroughly to obtain full credit. Some mistakenly thought bonds are the same as forces of attraction. Some mistakenly thought one had a giant molecular structure.	**[2]**
A5a	The percentage of ammonia present at equilibrium decreases with increasing temperature but percentage of ammonia present at equilibrium increases with increasing pressure. (Quote examples from table) Most candidates obtained full credit.	**[1]**
A5bi	100 °C and 1000 atm REJECT wrong units Most candidates obtained full credit except those who forgot the units.	**[1]**
A5bii	At 100 °C, temperature is low causing the reaction to be too slow to proceed; At 1000 atm, the high pressure makes it costly to maintain at such a pressure OR costly using thick containers to withstand the high pressure of the reaction; OWTTE (**reason** for high cost must be mentioned) Some candidates did not read the entire data to notice 100 °C is a relatively low temperature whereas 1000 atm is a relatively high pressure. Generally the high pressure part was well explained.	**[2]**
A5c	Moles of nitrogen = 1000 000 / 28 = 35714.29 Mole ratio of nitrogen: ammonia = 1:2 Moles of ammonia = 2 × 35714.29 = **71428.57;** (OR 71429) Mass of ammonia = 71428.57 × 17 × 38.8% = 471 143 g = **471 000 g (to 3 sf);** OR **0.471 tonnes (to 3 sf)** Many candidates obtained full credit for this typical mole question except those who overlooked the mole ratio or miscalculated the Mr. Some carelessly rounded off wrongly or did not include units.	**[2]**
A5di	Oxidation state of N increases from -3 in NH_3 to 0 in N_2; hence ammonia is oxidised; REJECT 3- which is the charge Many candidates obtained full credit except those who could not phrase this typical Redox answer straight from the notes. Many miscalculated the oxidation states.	**[2]**
A5dii	There will be (unreacted or more or excess) nitrogen monoxide released into the atmosphere together with (less) nitrogen (and water vapour/steam) produced; REJECT not all NO reacted (with no mention of it in the gases released) Many candidates did not read to understand the question of 'composition of gases' from the equation. Some candidates who obtained credit carefully wrote about all the substances in the equation.	**[1]**

A5diii	NO will react with air/oxygen to form NO_2 which reacts with moisture and air (or water and oxygen) to form nitric acid which reacts/dissolves in water; to form acid rain which corrodes limestone buildings/kills aquatic life OWTTE; REJECT oxides of nitrogen REJECT NO is a greenhouse gas (because only nitrous oxides (N_2O) are) Some candidates mistakenly thought NO was acidic and went straight into writing about NO causing acid rain effects. Good answers included writing about how NO becomes nitric acid before describing acid rain effects.	**[2]**
A6a	Members • have same general formula of $C_nH_{2n+1}CHO$, n is more than or equal to 0 [REJECT $C_nH_{2n+2}O$ as functional group CHO must be shown] OR $C_{n-1}H_{2n-1}CHO$, n is more than or equal to 1; • have same functional group of CHO • each successive member increases by CH_2; REJECT 'down the group' as this is not Periodic table group Many candidates obtained partial credit. Some did not include the general formula and simply stated 'same general formula' without processing data. Many candidates could not correctly write the CH_2 phrase and used words like 'next row/next one/they increase by/next one'.	**[3]**
A6b	butanal; C_4H_9COOH; Similar question to 2016 TYS A6. Most candidates obtained full credit.	**[2]**
A6c	name: acidified potassium manganate(VII) / potassium dichromate(VI); ALLOW chemical formulae observation: purple solution turns colourless / orange solution turns green; Many candidates who studied obtained full credit except those who forgot to write 'acidified'.	**[2]**
A6di	 Most candidates obtained full credit.	**[1]**

A6dii	Any one:   Some candidates who did not obtain credit either drew the same as d(i) or did not check their structure is not complete with the correct bonding rules.	**[1]**
A6e	 1 mark for both correct structural formulae; 1 mark for balancing equation; REJECT second mark if have extra brackets. Similar question to 2016 TYS A6. Many candidates who obtained partial credit did not balance the equation.	**[2]**

A7ai	Hydrogen sulfide has a pungent smell (while the other gases in biogas are odourless); Most candidates obtained full credit.	**[1]**
A7aii	When hydrogen sulfide is combusted, it produces sulfur dioxide and sulfuric acid; which will corrode the metal machinery parts. Hydrogen sulfide is toxic; REJECT sulfuric acid or sulfur dioxide is toxic Many candidates did not obtain full credit as they missed out the 'toxic' part of the data.	**[2]**
A7b	**Environmental:** - If cow dung is not used, the cow dung will also degrade naturally to release methane which is a greenhouse gas; - Converting cow dung into biomethane to be used as biofuel instead of letting it degrade naturally cuts down greenhouse gases by 4%. This is because methane has a much greater global-warming power than carbon dioxide; (**any one**) - Conserves use of the limited/non-renewable fossil fuels/crude oil OR - the fertiliser made on the farm can reduce the synthetic fertilisers made from fossil fuels/ crude oil; **Economical:** (**any two**) - Cow dung is produced and/or collected directly on the farm or on-site and biodigester is on-site so farmers save on transportation costs and/or time; (REJECT easy to use) - Also cuts costs on using fossil fuels/crude oil for electricity; - Biomethane is a biofuel with high performance and high purity; - The fertiliser produced from the biodigester can be readily used by farmers, saving costs from purchasing synthetic fertilisers; Most candidates read this easy data and obtained either partial or full credit. Some candidates who left blank gave up so easily without using their basic English comprehension skills to gain many possible marks here.	**[5]**
A7ci	carbon or hydrogen; ACCEPT chemical formula Many candidates who studied obtained credit.	**[1]**
A7cii	Iron(III) oxide is a solid product which can be collected more easily for recycling than the gaseous (or escaped) product, carbon dioxide, produced from the burning fossil fuels, which easily escapes into the atmosphere. Many candidates did not complete their answer mentioning what the solid product is. Some did not compare solid vs gaseous products.	**[1]**

A8ai	type of polymerisation: <u>addition</u> reason: the polymerisation involves <u>unsaturated</u> monomers like acrylonitrile OR acrylonitrile monomer has <u>carbon to carbon or C=C double bond</u>. Many candidates who studied obtained full credit. Some did not know how to write the reason using proper terms.	**[1]**
A8aii	 REJECT if drawn as -CN Most candidates obtained full credit.	**[1]**
A8bi	 ACCEPT acyl chloride -COCl Many candidates could not obtain full credit as they either did not revise this concept or did not check their bonding rules and missed out some bonds.	**[2]**
A8bii	M_r of repeating unit of nylon-6,6 ($C_{12}H_{22}N_2O_2$) = **226** ; Let n be the number of repeating units. For M_r of 12 000, n = 12 000 / 226 = 53.1 For M_r of 20 000, n = 20 000 / 226 = 88.5 1 mark for both values above; Hence the range is **53 < n ≤ 88** OR **54 to 88**; (must be written on dotted line as final answer) Similar question to 2016 TYS B7. Some candidates either miscalculated Mr or did not round off to 54 and 88 correctly.	**[2]**

A8biii	Nylon-6,10 contains more C and H atoms (OR 4 more carbon atoms and 8 more hydrogen atoms) / has a longer molecular chain / is a larger molecule. REJECT if merely states one has 'this' and other has 'that' without COMPARING the difference. REJECT larger than nylon-6,6 since question is asking about structures. REJECT size since question is asking about structures. Many candidates obtained full credit except those who did not compare the structures. Some gave very superficial differences eg. it consists of carbon.	**[1]**
A8ci	melted; fuels; Candidates who studied this new syllabus fact obtained full credit.	**[2]**
A8cii	diamine and dicarboxylic acid Candidates who studied the correct terms obtained full credit.	**[1]**
B9ai	$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ Most candidates obtained full credit except those who did not balance the equation.	**[1]**
B9aii	Hydrogen (is a more efficient fuel) as it produces more energy per unit mass (or per 1g since question has given this data units kJ/g) as compared to methanol [1]. Hydrogen is a gas while methanol is a liquid at room temperature. (For the same volume of fuel, there is more molecules of methanol present as compared to hydrogen) **OR** less space is required to transport OR store methanol in the car (OR easier to transport OR easier to store) [1]. OWTTE REJECT the fuels requires energy (this is not endothermic!) Most candidates did not obtain full credit as they did not phrase their answer using the units shown in the table 'energy per gram'.	**[2]**
B9bi	Zinc / Zn (accept either chemical name or chemical formula) Candidates who studied obtained credit.	**[1]**
B9bii	$Zn\ (s) + Cu^{2+}\ (aq) \rightarrow Zn^{2+}\ (aq) + Cu\ (s)$ [1] Zinc is more reactive than copper [1], therefore Zn displaced Cu^{2+} in solution **Y** to form reddish-brown copper metal and the blue-green colour solution was decolourised [1]. REJECT all if mentioned other metals. Candidates who studied wrote about reactivity comparison. According to marker's report, candidates are advised not to write 'zinc is higher up the reactivity series than copper' without writing which metal is more reactive. Most candidates did not answer the OBSERVATION part of the question thoroughly and stopped answering after writing about the displacement reaction. Some candidates mistakenly thought of the Cu^{2+} solution as the Cu metal.	**[3]**

B9biii	As the reaction proceeds, sodium decreases in size OR sparks are observed OR burns with a yellow-orange flame [1], and vigorous effervescence of a colourless and odourless gas is observed [1]. For Metal **X**/Zinc, no observable change. [1]. Candidates who studied this new syllabus fact obtained full credit.	**[3]**
B10a	When zinc brushes are used, the zinc electrode is oxidised [1] (to form zinc ions), resulting in the wearing away of the brushes and will need regular replacement. However, platinum is an inert/unreactive electrode (so it will not react) [1] and the platinum brushes will not wear away. Most candidates chose B10 and obtained more marks than those who chose B9. Most could obtain full credit except those who did not do a comparison between Zn and Pt.	**[2]**
B10bi	Poly(ethene) consists of macromolecules, hence there is an absence of mobile charge carriers (ions or electrons)[1], hence it is unable to be conduct electricity (OR insulator) [1] and is a suitable material for the handle of the brush. Candidates who studied obtained full credit. Candidates are advised to remember POLYMERS as a class of MACROMOLECULES, not giant molecular or simple molecular structures.	**[2]**
B10bii	Bubble ethane and ethene to two separate test-tubes containing aqueous bromine [1]. If the gas is ethene/monomer, reddish-brown solution will turn colourless/decolourise, while the reddish-brown solution remains if the gas is ethane/product of addition reaction [1]. [1] for mention of ethene **AND** ethane Most candidates knew about aqueous bromine but did not outline the test to state how to use it. They need to learn to 'BUBBLE the gaseous ethane and ethene into aqueous bromine', just like how they bubble CO_2 into limewater. Some did not know bromine is reddish-brown in colour from their notes. Many candidates also did not know the monomer of polyethene or the product in the question.	**[3]**
B10c	The layer of zinc protects/prevents/shields the iron support from coming into contact with oxygen and water [1], and even if the layer of zinc is scratched and exposes the iron beneath, the iron will not rust. This is because zinc is more reactive than iron and will corrode/oxidise/react in place of iron [1]. REJECT "zinc rusts" Most candidates obtained only partial credit as they did not answer BOTH **barrier protection** as well as **sacrificial protection** parts of the question.	**[2]**
B10d	(Heat) energy is taken in at the anode for oxidation to occur, so that electrons can be gained at the cathode for reduction to occur [1]. REJECT if have contradiction to this point. Most candidates did not obtain credit.	**[1]**

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