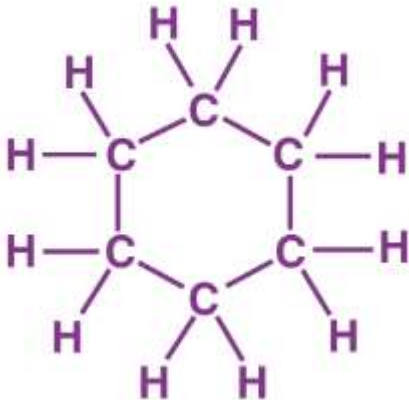
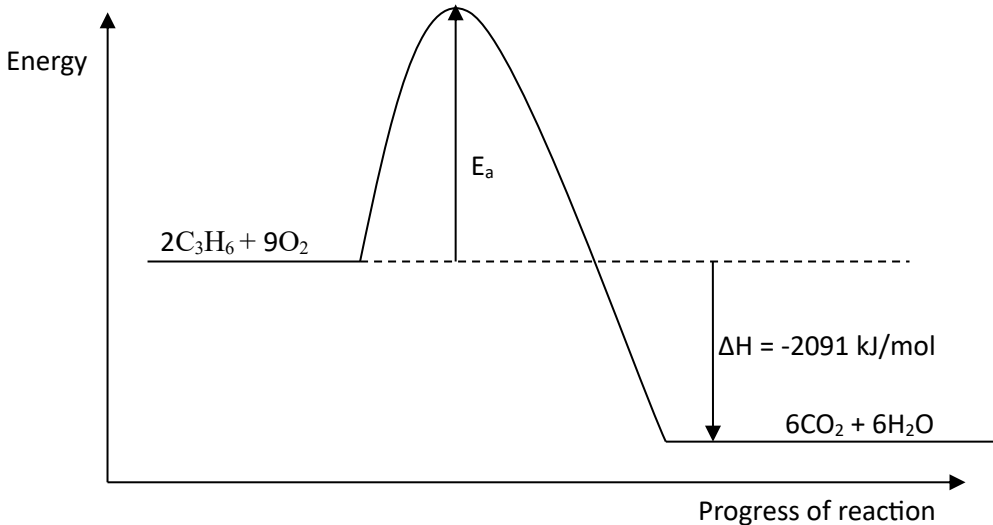


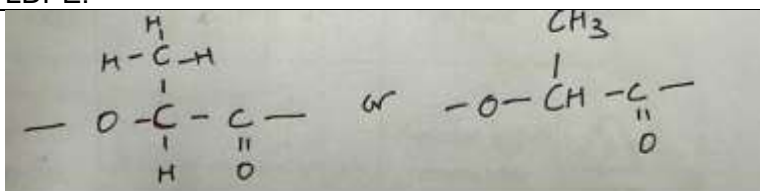
2026 ZHSS 4E Pure Chem (6092) Preliminary Examination

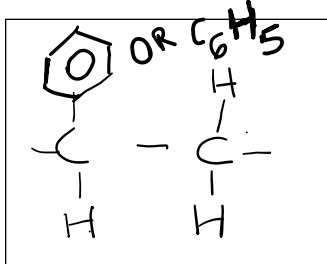
Section A (70 m)			
1	(a)	H	1
	(b)	C	1
	(c)	F	1
	(d)	A	1
	(e)	D	1
			[Total:5]
2	(a)	Carbon allotrope A (diamond): It has <u>a giant molecular / covalent structure</u> in which each carbon atom is covalently bonded to four other carbon atoms by <u>strong covalent bonds</u>. [1] <u>A large amount of energy</u> is needed to break these bonds, making diamond very hard and suitable for use as a drill bit.[1] Carbon allotrope B (graphite):It has <u>a giant molecular / covalent structure made up of layers of carbon atoms</u>. [1] The <u>weak forces of attraction</u> between the layers allow them to slide over one another easily lubricant [1], making graphite slippery and suitable for use as a lubricant.	4
	(b)	The property is <u>electrical conductivity</u>. [1] The diagram only shows the arrangement of atoms and covalent bonds. It does not show the <u>mobile electrons (or charge carriers)</u> [1] for electrical conductivity.	2
	(c)(i)	[1] – number of shared electrons [1] – number of valence electrons on C & H	2
	(ii)	In methane, each <u>carbon atom shares one electron with each hydrogen atom</u> to form four single covalent bond.[1] Both carbon and hydrogen atom achieve a stable (noble gas) electronic configuration.	1
			[Total:9]

3	(a)	volume of gas/ dm³ experiment 1 experiment 2 time/s [1]: volume of gas must be lower (no values needed) [1]: initial gradient must be steeper	2
	(b) (i)	$3\text{CaCO}_3 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 3\text{H}_2\text{O} + 3\text{CO}_2$	1
	(ii)	No. of moles of $\text{CaCO}_3 = 6/100 = 0.06 \text{ mol}$ No. of moles of $\text{H}_3\text{PO}_4 = (40/1000) \times 2 = 0.08 \text{ mol}$ [1] Mole ratio of $\text{CaCO}_3:\text{H}_3\text{PO}_4 = 3:2$ 0.08 mol of H_3PO_4 requires 0.12 mol of CaCO_3, but only 0.06 mol of CaCO_3 is available. CaCO_3 is limiting reagent. [1] * No e.c.f.	2
	(c)	There is a lower concentration of H^+ ions in weak acid as it <u>partially dissociates</u>. [1] The decrease in concentration of H^+ ions would <u>decrease the number of H^+ ions per unit volume</u> [1], leading to decrease frequency of collision between leading to an <u>decrease in the frequency of effective collision</u>. This lower/decrease the rate of reaction. <i>both</i> [1]	3
[Total:8]			
4	(a)	Cobalt oxide (CoO) and Bismuth oxide (Bi_2O_3) [1] <u>Both metal oxides form grey solids after heating, which are the metals formed.</u> [1] And the liquid was also observed on the side of the glass tube, showing that water was produced. The metal oxides have been reduced by hydrogen to form metals.	2

	(b)	Gallium, Cobalt, Lead and Bismuth	1
	(c)	$\text{Co(s)} + \text{Pb}^{2+}(\text{aq}) \rightarrow \text{Co}^{2+}(\text{aq}) + \text{Pb(s)}$ [1]: Correct ionic equation [1]: Correct state symbols	2
	(d) (i)	Cl_2 : 0; Cl^- : -1, ClO^- : +1; ClO_3^- : +5 2 correct – [1]	2
	(d) (ii)	In the chlorate(I) ion, chlorine in ClO^- has an oxidation number of +1. Some ClO^- ions are reduced, where <u>the oxidation number of chlorine decreases from +1 in ClO^- to –1 in Cl^-</u> . Therefore, ClO^- acts as an oxidising agent. [1] Other ClO^- ions are oxidised, <u>where the oxidation number of chlorine increases from +1 in ClO^- to +5 in ClO_3^-</u> . Therefore, ClO^- acts as a reducing agent. [1]	2
		[Total:9]	
5	(a)	$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ [1] Since 1 mole of gas occupies the same volume of gas at room temperature. From the equation: 1 mole of nitrogen reacts with 3 moles of hydrogen, hence a ratio of 1: 3 is most efficient. [1]	2
	(b)	At a lower pressure, the particles are further apart. There are <u>less particles per unit volume</u> . [1] Therefore, there is a lower frequency of collisions, leading to a <u>lower frequency of effective collisions between reacting particles</u> . [1] resulting in a lower rate of reaction.	2
	(c)	<u>Lower pressure would reduce the percentage yield of ammonia</u> . [1] Hence, <u>less ammonia</u> leaves [1] the reactor and <u>more nitrogen and hydrogen</u> would be left unreacted and leave the reactor. [1]	3
	(d)	- To allow the unreacted hydrogen and nitrogen to react again <u>to produce more ammonia</u> . - To reduce the wastage of nitrogen & hydrogen / <u>reduce the cost of production</u> / improve efficiency of the process.	2
		[Total:9]	

6	(a)	C_nH_{2n}	1
	(b)		1
	(c)	The boiling points increase down the homologous series, because the <u>forces of attraction between the molecules increase as their size increases</u>. [1] <u>More energy is required to overcome the forces of attraction</u>. [1]	2
	(d) (i)	The <u>energy absorbed to break the bonds in cyclopropane and oxygen is less than the energy released when bonds are formed in carbon dioxide and water</u>. [1] Therefore, the <u>reaction is exothermic</u> [1] and the enthalpy change is negative.	2
	(d) (ii)	 [1]: general curve with reactants and products [1]: E_a and enthalpy	2

	(d) (iii)	$n(\text{cyclopropane}) = \frac{24}{24000} = 0.001 \text{ mol}$ $\text{C}_3\text{H}_6:\text{CO}_2$ $1 : 3$ $n(\text{CO}_2) = 0.001 \times 3 = 0.003 \text{ mol [1]}$ $v(\text{CO}_2) = 0.003 \times 24\,000 = 72 \text{ cm}^3 \text{ [1]}$	2												
			[Total:10]												
		Data-based question (12m)													
7	(a)(i)	Similarity: Both HDPE and LDPE contain carbon and hydrogen only ./hydrocarbons/ contain carbon-carbon single bonds, carbon - hydrogen single bonds/ contains monomer ethene. [1] Difference: LDPE contains side chains with different number of carbon atoms while HDPE does not contain any side chain / LDPE is branched but HDPE is a straight chain. [1] <i>Reject:</i> Different number of C atoms between LDPE and HDPE.	2												
	(ii)	HDPE does not have any side chains resulting in a closer arrangement . [1] This leads to higher mass/molecules per unit volume / can pack closely <u>within the same volume</u> . [1] Therefore, HDPE has a higher density than LDPE.	2												
	(b)(i)		1												
	(ii)	Poly(lactic acid) is a homopolymer.	1												
	(c)(i)	M_r of ONE repeat unit = $100000 / 962 = 103.95$	1												
	(ii)	<table border="1"><thead><tr><th></th><th>C</th><th>H</th></tr></thead><tbody><tr><td>percentage / %</td><td>92.3</td><td>7.7</td></tr><tr><td>no. of moles</td><td>$\frac{92.3}{12} = 7.691$</td><td>$\frac{7.7}{1} = 7.7$</td></tr><tr><td>ratio</td><td>$\frac{7.691}{7.691} = 1$</td><td>$\frac{7.7}{7.691} = 1.0011$</td></tr></tbody></table> Empirical formula = CH		C	H	percentage / %	92.3	7.7	no. of moles	$\frac{92.3}{12} = 7.691$	$\frac{7.7}{1} = 7.7$	ratio	$\frac{7.691}{7.691} = 1$	$\frac{7.7}{7.691} = 1.0011$	1
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	(iii)	M_r of CH = $12 + 1 = 13$ Let the molecular formula of one repeat unit of poly(styrene) be $(\text{CH})_n$. $n = (\text{relative molecular mass})/(\text{M}_r \text{ of empirical formula})$ $= 103.95/13 = 7.99$ $= 8$ (round off to whole no.)	1												
	(iv)	Molecular formula of one repeat unit = C_8H_8 From the Table 7.1.	1												

		Repeat unit of poly(styrene) with the deduced R formula:		
	(d)	Based on the information provided, both mechanical recycling and depolymerisation can be used to recycle RIC 1- PET which is a co polymer. Thus, the statement is not true.	1	
	(e)	Any one of the following: - Recycling plastics reduces the amount of built-up waste in landfills. - Recycling plastics conserves natural resources. - Recycling plastics reduces the amount of plastics required to be incinerated, which releases poisonous gases.	1	
			[Total:12]	
8	(a)(i)	Carbon monoxide: toxic, combines/binds with haemoglobin in blood, reduces the ability of haemoglobin to /prevent transport oxygen to the rest of the body. [1] Oxides of nitrogen: react with water/rain water to form acid rain which corrodes buildings and harms aquatic life and plants OR cause lung/eye irritations [1]	2	
	(ii)	$2\text{NO} + 2\text{CO} \rightarrow 2\text{CO}_2 + \text{N}_2$	1	
	(iii)	Carbon dioxide [1] is a greenhouse gas and it contributes to global warming/trap heat within the atmosphere/. [1] Reject: Carbon dioxide degrades the ozone layer and leads to global warming. Reject: sulfur dioxide/ oxides of nitrogen	2	
	(b)	The NO molecules reacted/removed in step 1 (after reacting with ozone) are regenerated in step 2 (in reaction with more ozone). Accept: reproduced/ form back Reject if describe the step 1 and 2 as it is listing information without thinking Reject NO is a catalyst	1	
	(c)	The carbon dioxide released during combustion /burning of biofuel is removed from air by photosynthesis carried out by sugarcane plant [1]. Thus, there is no net gain or loss of /offset/balance off carbon dioxide [1] Accept: remove and produce at the same rate	2	
			[Total:8]	

Section B (10 m)			
9	(a)(i)	A	1
	(ii)	D	1
	(b)(i)	$\text{Cu(s)} \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ <i>No deduction of mark if missing state symbols</i>	1
	(ii)	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$ <i>No deduction of mark if missing state symbols</i>	1
	(c)(i)	No of moles of copper deposited = $2.56 / 64 = 0.0400 \text{ mol}$ [1] For the deposition of copper: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ Thus 0.04000 moles of Cu is discharged by 0.0800 moles of electrons $\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$ 0.0800 moles of electrons will discharge $0.0800 \text{ moles of Ag}$ no. of moles of Ag [1] Mass of Ag = $0.0800 \times 108 = 8.64 \text{ g}$ [1]	3
	(ii)	Number of moles of Cr deposited = $1.04 / 52 = 0.0200$ [1] 0.0200 moles of Cr is discharged by 0.0800 moles of electrons (<i>e.c.f from (c)</i>) 1 mole of Cr will be discharged by 4 moles of electrons Thus the charge of ion $\text{Cr is } +4$ [1] $\text{Cr}^{4+}(\text{aq}) + 4\text{e}^- \rightarrow \text{Cr(s)}$ [1] (<i>follow through</i>)	3
			[Total:10]

10	(a)	The electrodes and copper wires have <u>free moving electrons</u> [1] to conduct electricity whereas the electrolyte has <u>free moving ions</u> to conduct electricity. [1]			2
	(b)	cell	electrode	half-equation with state symbols for the electrode reaction	4
		cell A	zinc electrode	$\text{Zn(s)} \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{e}^-$	
			silver electrode	$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	
		cell B	graphite electrode 1	$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$	
			graphite electrode 2	$4\text{OH}^-(\text{aq}) \rightarrow \text{O}_2(\text{g}) + 2\text{H}_2\text{O(l)} + 4\text{e}^-$	
	(c)	The <u>pH</u> of the electrolyte <u>decreases</u> . [1] <u>OH⁻ is selectively discharged</u> at graphite electrode 2 and resulting in a <u>lower OH⁻ concentration</u> or concentration of OH ⁻ becomes lower than concentration of H ⁺ . [1]			2
	(d)	Oxide ions are <u>discharged to give oxygen</u> gas at graphite electrode 2. [1] After a long period of time, the <u>oxygen gas produced reacts / oxidises graphite electrode 2</u> to become carbon dioxide gas. [1] ACCEPT equations written for the reactions at the electrode At graphite electrode 2: $2\text{O}^{2-}(\text{l}) \rightarrow \text{O}_2(\text{g}) + 2\text{e}^-$ $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$			2
					[Total: 10]