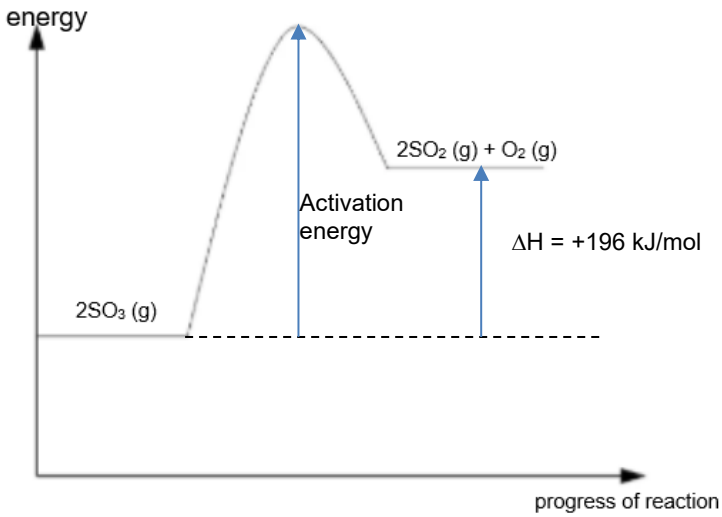
FUHUA SECONDARY SCHOOL
Sec 4E Chemistry 6092
Preliminary Examinations 2025 – Mark Scheme

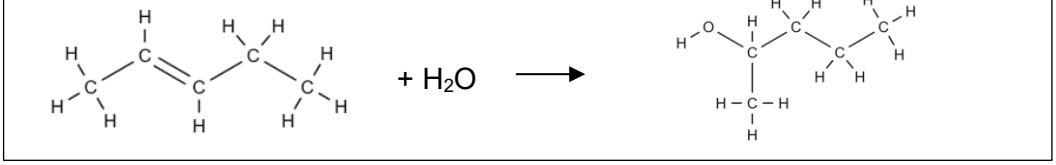
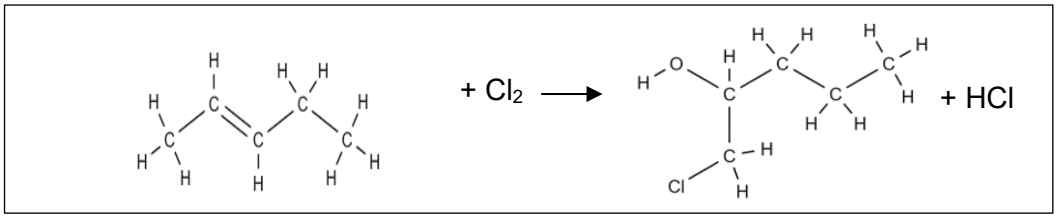
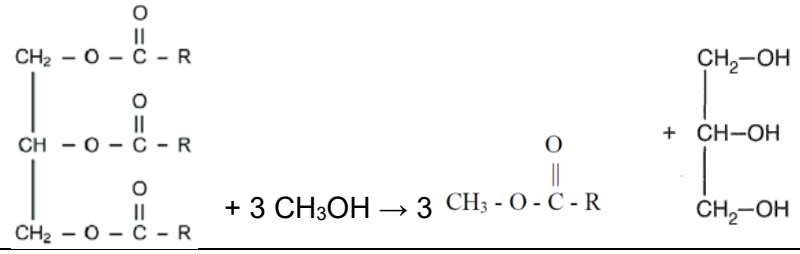
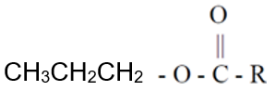
PAPER 1

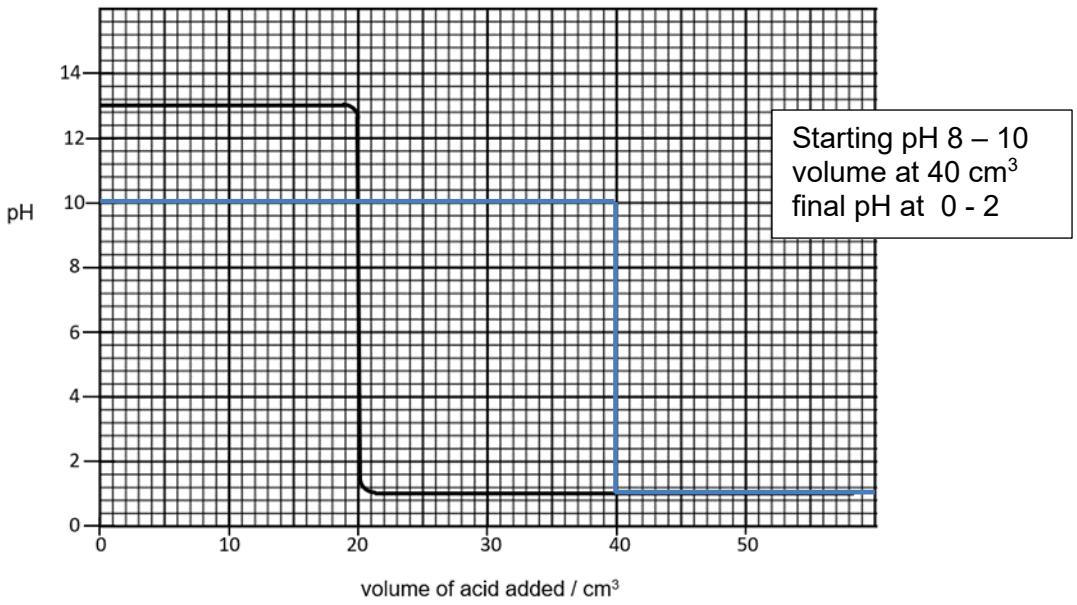
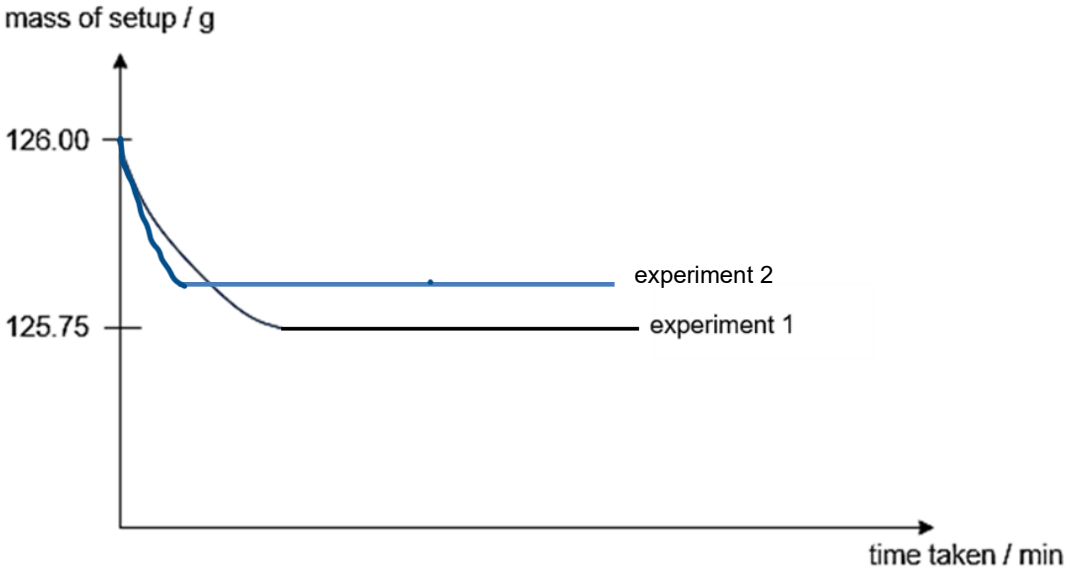
1	2	3	4	5	6	7	8	9	10
C	A	B	A	D	A	A	B	A	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	C	C	B	B	A	D	D	C	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	A	D	B	A	A	C	C	B	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	B	D	B	C	C	B	C	D	C

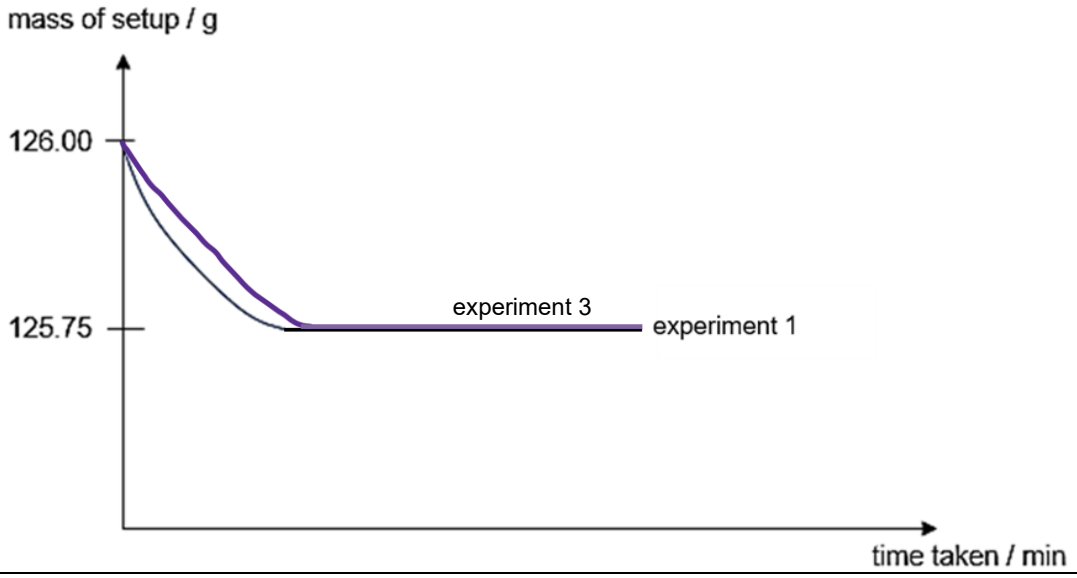
FUHUA SECONDARY SCHOOL
Sec 4E Chemistry 6092
Preliminary Examinations 2025 – Mark Scheme
PAPER 2
Section A [70 marks]

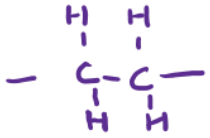
Q	Answer	Ma	Remarks
1a	B and E	1	
b	A, D and F	1	
c	A	1	
d	Two B^{3+} ions Three D^{2-} ions	1 1	
	Total	5 marks	
2a	No. I disagree with the student. A catalyst provides <u>an alternative pathway with lower activation energy</u> for the reaction to proceed but the enthalpy change remains unchanged as the <u>energy levels of reactant and product remain the same</u>. Accept both not accepted be catalyst.	1 1	
b	Stage 1: S is oxidised as the oxidation state of sulfur increases from 0 in S to +4 in SO_2 . O_2 is reduced as the oxidation state of oxygen decreases from 0 in O_2 to -2 in SO_2 . Stage 2: SO_2 is oxidised as the oxidation state of sulfur increases from +4 in SO_2 to +6 in SO_3 and O_2 is reduced as its oxidation state decreases from 0 in O_2 to -2 in SO_3.	; ; ; ;	4; [3]
c	Stage 2 is a reversible reaction AND some of the sulfur trioxide formed decompose to form sulfur dioxide and oxygen.	1	
di	Shape of graph Label axes with units and include correct reactant and product Enthalpy change and activation energy, arrow must be correct  	; ; ;	3; [2]
ii	Moles of SO_3 = $\frac{500000}{(32+3\times16)} = 625$ Moles of SO_2 = SO_3 = 625 Total amount of heat released = 625/2 × 196 = 61 300 kJ	1 1	
	Total	10 marks	

3ai	$2H^+(aq) + 2e \rightarrow H_2(g)$	1	
ii	Solution turned from colourless to reddish-brown. Chlorine is produced at electrode Q as chloride ions are selectively oxidised. Chlorine is more reactive than bromine [;] and displaces bromine from its halide solution.[;] Aqueous bromine formed is reddish-brown.	1 1 1	2; [1]
iii	No gas collected in the gas syringe / reading on syringe is 0 cm^3 [;] as Cu^{2+} ions are selectively reduced at electrode P to form Cu. [;] No visible change / solution remained colourless [;] Oxygen gas, instead of chlorine gas is produced at electrode Q.[;] as OH^- ions are selected oxidised at electrode Q to form oxygen gas. [;]	3	5; [3] 3-4;[2] 1-2; [1]
bi	Electrons flow from Mg to Pb.	1	
ii	Electrode 3 [;] as Ag^+ ions are selectively reduced by gaining electrons at electrode 3 to form Ag deposited on toy car. [;] $Ag^+(aq) + e \rightarrow Ag(s)$ [;]		3 ; [2]
iii	pH decreases to below 7. As Ag^+ ions and OH^- ions are selectively reduced and oxidised at electrode 3 and 4 respectively [;], H^+ and NO_3^- ions are left in the electrolyte / concentration of H^+ ions in electrolyte increases / electrolyte becomes increasingly acidic.[;]	1 1	2; [1]
	Total	12 marks	
4a	38 and 71	1	
b	$F_2(g) + 2I^-(aq) \rightarrow 2F^-(aq) + I_2(aq)$	1	
c	Rate of diffusion of gases is directly proportional to 1/time taken AND for Rate to be directly proportional to 1/t and 1/t has to be directly proportional to M_r of the gas, the product of M_r × time taken must be equal. Data Processing For F_2, $M_r \times t = 38 \times 16 = 608$ s For Cl_2, Mr × t = 71 × 29 = 2059 s Since the products are different, the measurements do not support the data. OR Rate of diffusion of gases is indirectly proportional to time taken AND for M_r of the gas to be indirectly proportional to time taken, the product of M_r × time taken must be equal.	1 1	
	Total	4 marks	

5ai	  displayed formula for organic compounds	1 1 1	
ii	butanol and methanoic acid	1	
iii	Add aqueous bromine to a sample of each solution. If reddish brown aqueous bromine decolourise rapidly, the solution is A. Add magnesium/sodium carbonate to remaining three solutions, if effervescence is observed, the solution is D. Add acidified potassium manganate (VII) to a sample of remaining two solutions and warm them. If purple potassium manganate (VII) turns colourless, the solution is B. The remaining unidentified solution is C.	; ; ; ;	Sequence to be correct to be awarded full credit. 4; [3]
bi	correct formula for all the structures [1] balanced chemical equation [1] 	2	
ii	A glycerol molecule contains 3 hydroxyl/-OH functional groups.	1	
iii		1	
	Total	11 marks	
6a	Ethylamine acts as a base as it accepts a proton from water.	1	
bi	Moles of sulfuric acid = 20/1000 ×0.25 = 0.005 Moles of sodium hydroxide = 0.01 Concentration of sodium hydroxide = 0.01 / (25/1000) = 0.400 mol/dm^3	1 1	

ii	 ethylamine is a weak base that ionises partially to give a lower concentration of OH^- ions and hence a lower initial pH. Hydrochloric acid is a monobasic acid and hence one acid unit gives half the no. of moles of H^+ ions and hence double the volume of acid required to neutralise the ethylamine.	1 1 1	
		Total	6 marks
7a	Mass of CO_2 given off = 0.25 g Moles of $PbCO_3$ = Moles of CO_2 = 0.25 / 44 = <u>0.0056818</u> Mass of $PbCO_3$= 0.0056818 × (207 + 12 + 3 × 16) = 1.5170 g % purity of $PbCO_3$ sample = 1.517 / 2.00 × 100% = <u>75.9%</u>	1 1	Ignore if no 'g' Ignore if > 3sg but reject if no '%'
bi	steeper gradient but yield lower, final mass above 125.75 	1	
ii	Lead (II) carbonate reacts with sulfuric acid to form <u>insoluble lead(II) sulfate which coats</u> around lead(II) carbonate <u>prevents it from further reaction</u> with acid, giving a low yield of carbon dioxide gas Sulfuric acid is a <u>dibasic acid</u> which will give <u>twice the concentration of H^+ ions</u> leading to a faster rate of reaction.	1 1	

ci	gentler gradient and yield same at 125.75.  	1	
ii	Ethanoic acid <u>dissociate partially in aqueous solution</u> to produce H^+ ions [;] Ethanoic acid produces a <u>lower initial concentration of H^+ ions</u> [;] in aqueous solution than hydrochloric acid. Hence produces a slower initial rate of reaction. However, <u>same mass/moles of the limiting reactant $PbCO_3$</u> is used and hence gives the same yield of gas.	1 1	2;[1]
d	Add <u>aqueous</u> lead(II) nitrate to a fixed volume of <u>aqueous</u> sodium carbonate till no precipitate is formed. Filter the mixture to remove lead(II) carbonate as residue. AND Wash the residue with distilled water and leave the precipitate to dry.	1 1	
	Total	10 marks	

8ai	PET:  HDPE: 	1 1	
bi	PET: 0.03 kg × 1.9 = 57 g CO_2 HDPE: 0.04 kg × 1.8 = 72 g CO_2 Tritan: 0.15 kg × 4.5 = 675 g CO_2	; ; ;	3; [2] 1-2; [1]
ii	copolyester per use = 675 ÷ 50 = 13.5 g CO_2/use	1	

<table>
<tr><td>c</td><td>
<table>
<tr><td></td><td>PET</td><td>HDPE</td><td>copolyester</td></tr>
<tr><td>Factor 1: atom economy</td><td>PET = (238-36)/238 × 100% = 84.2%</td><td>HDPE = highest (100%), no by-products</td><td>copolyester = (310-36)/310 × 100% = 88.4%</td></tr>
<tr><td></td><td colspan="3">HDPE is most sustainable as it has 100% economy, no wastage of raw material and is widely recycled. [1]</td></tr>
<tr><td>Factor 2: carbon footprint</td><td>PET = 57 g CO_2 per use</td><td>HDPE = 36 g CO_2 per use</td><td>copolyester = lowest per use, 13.5 g</td></tr>
<tr><td></td><td colspan="3">Copolyester yields the lowest carbon footprint per use. [1]</td></tr>
<tr><td>Factor 3 recyclability</td><td>widely recycled</td><td>widely recycled</td><td>not recycled</td></tr>
</table>
</td><td>1

1

1</td><td>[1] for calculated data on atom economy
[1] for comparison</td></tr>
<tr><td>d</td><td>Mr of repeat unit = [$C_8H_6O_4$- 2OH] + [$C_8H_{16}O_2$- 2H] = 132 + 142 = 274

When M_r = 42 000, number of repeating units
= 42 000/274
= 153.28 [;] = 154 [round up]

When Mr = 50 400, number of repeating units
= 50 000/274
= 183.94 = 183 [round down] [;]

Therefore, the range of the average number of repeating units is between 154 and 183 inclusive.</td><td>1

1</td><td></td></tr>
<tr><td></td><td>Total</td><td>12 marks</td><td></td></tr>
</table>

Section B [10 marks]

Q	Answer	M	Remarks
9ai	manganese (II) nitrate solution: no observed change copper(II) nitrate solution: blue solution turned green and nickel coated with a pink solid. nickel is **<u>less reactive</u>** than manganese, hence nickel is unable to displace manganese from manganese nitrate solution / no reaction take place between manganese and nickel (II) nitrate solution. Nickel is **<u>more reactive</u>** than copper, hence nickel displaces pink copper metal from blue copper(II) nitrate solution, forming a solution of green nickel(II) nitrate solution.	1 1 1 1	
ii	Mass of solution decreases. [no mark] In the displacement reaction, the nickel (II) ions in solution are replaced with manganese (II) ions. As the relative atomic mass of manganese (55) is smaller than that of nickel (59), the mass of solution will decrease.	1 1	
bi	Strontium is more reactive than calcium	1 1	

	As initial gradient of graph steeper for graph for strontium/ a greater volume of gas produced in a fixed time [1]		
ii	$Sr + 2\ H_2O \rightarrow Sr(OH)_2 + H_2$ Solution turns purple/violet/from green to violet AND Sr reacts with water to produce strontium hydroxide which is an alkali / alkaline / base / contains OH^-	1 1	
	Total	10 marks	
10a	The melting point increases for the first four elements from Li to C and decreases sharply for N then remains constant from N to Ne. Li and Be are metals and the melting points increase as the strength of the electrostatic forces of attraction between the increasing charge of cations and increased number of delocalised electrons increases. C has the highest melting point because of its giant molecular structure with strong covalent bonds between the C atoms. N, O, F and Ne have low melting point as they form simple covalent structures with weak intermolecular forces of attraction between the molecules/atoms Largest amount of energy required to break the covalent bonds in C and lowest amount of energy required to overcome weak intermolecular forces of attraction in N, O, F and Ne.	; ; 1 1 1 1	2; [1]
b	Li and Be have giant lattices of cations in a sea of delocalised electrons. The delocalised electrons move freely within the lattice C has giant covalent structure. Each carbon atom uses 3 out 4 valence electrons to form covalent bonds, leaving one unused. These delocalised electrons conduct electricity. N, O, F and Ne are covalent molecules / monoatomic and possess no mobile charged carriers.	1 1 1	
c	The element has good electrical conductivity and hence a metal. Most metals have high melting points except for Group 1 metals. Hence metal is sodium.	; ; ;	3; [2] 1-2;[1]
	Total	10 marks	