



RIVER VALLEY HIGH SCHOOL

YEAR 6 Preliminary Examination II

CANDIDATE NAME

CLASS

6	
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CENTRE NUMBER

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INDEX NUMBER

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H1 CHEMISTRY

8872/02

Paper 2

13 Sept 2016

2 hours

Candidates answer Section A on the Question Paper.

Additional Materials: Data Booklet, graph paper, writing papers

READ THESE INSTRUCTIONS FIRST

Write your name, class, Centre number and index number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer all the questions.

Section B

Answer two questions on separate answer paper.

The number of marks is given in brackets [] at the end of each question or part question.

At the end of the examination, fasten all your work securely together.

For Examiner's Use										
Paper 2										
Section A	1	2	3	4	5	Section B	Q6	Q7	Q8	Total (Paper 2)
	10	7	6	7	10		20	20	20	80
Paper 1	30					Total	110	Grade		

This paper consists of **17** printed pages and **3** blank pages

Section A (40 marks)

Answer all the questions in the space provided.

1	The oxidation number of vanadium in a complex ion was determined as follows. 0.015 mol of the complex was dissolved in water and the solution was made up to 250 cm ³ . A 25.0 cm ³ portion of this solution required 11.60 cm ³ of 0.050 mol dm ⁻³ KMnO ₄ to oxidise all the V ³⁺ ions.		
	(a)	Using V ⁿ⁺ to represent the final product of V and in terms of n, write an equation to show the oxidation of V ³⁺	[1]
		V ³⁺ → V ⁿ⁺ + (n-3) e	
	(b)	Hence or otherwise, use these data to calculate the final oxidation number of the vanadium ions.	[3]
		<p>Amount of MnO₄⁻ in 11.60 cm³ = 0.050 × $\frac{11.60}{1000}$</p> <p style="text-align: center;">= 5.80 × 10⁻⁴ mol</p> <p>MnO₄⁻ + 8H⁺ + 5e⁻ → Mn²⁺ + 4H₂O</p> <p>MnO₄⁻ ≡ 5e⁻</p> <p>Amount of electrons gained by 5.80 × 10⁻⁴ mol of MnO₄⁻ = 5.80 × 10⁻⁴ × 5</p> <p style="text-align: center;">= 2.90 × 10⁻³ mol</p> <p>Amount of electrons lost by 0.013 mol of vanadium = 2.90 × 10⁻³ × $\frac{250}{25}$</p> <p style="text-align: center;">= 2.90 × 10⁻² mol</p> <p>Amount of electrons lost by 1 mol of vanadium = (2.90 × 10⁻²) ÷ 0.015</p> <p style="text-align: center;">= 1.9333 mol</p> <p style="text-align: center;">≈ 2 mol (integer value)</p> <p>n-3 = 2</p> <p>n=5</p>	

2	<p>The graph below shows the first ionisation energy of the elements beryllium to magnesium.</p> <table border="1"><caption>First Ionisation Energy Data (kJ mol⁻¹)</caption><thead><tr><th>Element</th><th>1st Ionisation Energy (kJ mol⁻¹)</th></tr></thead><tbody><tr><td>Be</td><td>900</td></tr><tr><td>B</td><td>800</td></tr><tr><td>C</td><td>1100</td></tr><tr><td>N</td><td>1400</td></tr><tr><td>O</td><td>1300</td></tr><tr><td>F</td><td>1700</td></tr><tr><td>Ne</td><td>2100</td></tr><tr><td>Na</td><td>500</td></tr><tr><td>Mg</td><td>750</td></tr></tbody></table>	Element	1st Ionisation Energy (kJ mol ⁻¹)	Be	900	B	800	C	1100	N	1400	O	1300	F	1700	Ne	2100	Na	500	Mg	750	
Element	1st Ionisation Energy (kJ mol ⁻¹)																					
Be	900																					
B	800																					
C	1100																					
N	1400																					
O	1300																					
F	1700																					
Ne	2100																					
Na	500																					
Mg	750																					
	(a) Define the term <i>first ionisation energy</i> .	[1]																				
	First ionisation energy is the energy required to remove first mole of electrons from one mole of gaseous atoms or ions.																					
	(b) Explain why the first ionisation energy from beryllium to neon is increasing.	[2]																				
	<p>Elements from Be to Ne are in the same period. Across the period, <u>nuclear charge increases</u>, while there is <u>negligible increase in screening effect</u> as electrons are removed from the same shell. Hence, the <u>effective nuclear charge increases</u>. The <u>atomic radius also decreases</u>.</p> <p>Therefore, valence electrons are increasingly more attracted by the positive nucleus and more energy is required to remove the valence electrons.</p>																					
	(c) Explain why the first ionisation energy decreases from beryllium to boron and nitrogen to oxygen.	[2]																				
	<p>The <u>2p electron to be removed from B has a higher energy than the 2s electron to be removed from Be</u>. The 2p electron of B requires less energy to be removed. Therefore, the 1st IE of B is smaller than the 1st IE of Be.</p> <p>(Coulombic) <u>repulsion between the paired 2p electrons in O makes it easier to remove one of the paired 2p electrons</u> than an unpaired 2p electron from N. As a result, less energy is required. Hence, the 1st IE of O is smaller than the 1st IE of N.</p>																					
	(d) Explain why the sharp decrease from neon to sodium.	[1]																				

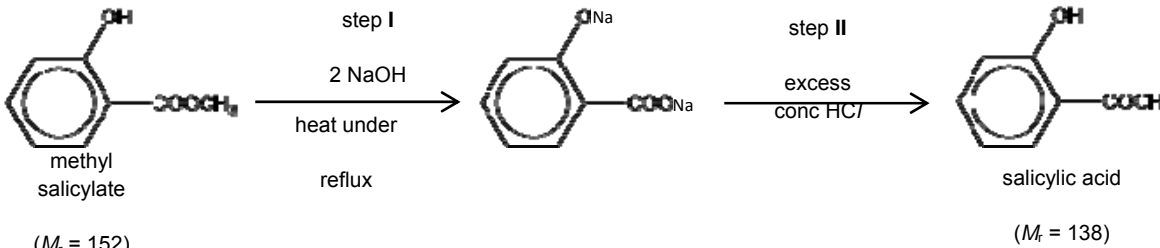
		Sodium (Na) is in period 3 while neon (Ne) is in period 2. There is an additional inner shell of electrons which increases the shielding effect. Hence there is a sharp drop in the first ionisation energy.	
		[Total: 6]	

3	Gallium oxide is an important material in the production of catalysts, one of which is $\text{Ga}_2\text{O}_3\text{-Al}_2\text{O}_3$ catalyst. The production of this catalyst involves the reaction between aqueous gallium nitrate and aluminium oxide.										
	(a)	With reference to Ga_2O_3 , explain what is meant by the following terms:		[2]							
		(i)	standard enthalpy change of formation								
			Enthalpy change when one mole of Ga_2O_3 is formed from its constituent elements $\text{Ga}(\text{s})$ and $\text{O}_2(\text{g})$ in their standard states under standard conditions.								
		(ii)	lattice energy								
			Enthalpy change when one mole of solid Ga_2O_3 is formed from its gaseous ions $\text{Ga}^{3+}(\text{g})$ and $\text{O}^{2-}(\text{g})$ under standard conditions.								
	(b)	Given the following information, as well as that from the <i>Data Booklet</i> , calculate the lattice energy of Ga_2O_3 :									
		<table><tr><td>Enthalpy change of atomisation of Ga</td><td>+277 kJ mol⁻¹</td></tr><tr><td>Sum of first two electron affinities of O</td><td>+752 kJ mol⁻¹</td></tr><tr><td>Enthalpy change of formation of Ga_2O_3</td><td>-1089 kJ mol⁻¹</td></tr></table>			Enthalpy change of atomisation of Ga	+277 kJ mol ⁻¹	Sum of first two electron affinities of O	+752 kJ mol ⁻¹	Enthalpy change of formation of Ga_2O_3	-1089 kJ mol ⁻¹	
Enthalpy change of atomisation of Ga	+277 kJ mol ⁻¹										
Sum of first two electron affinities of O	+752 kJ mol ⁻¹										
Enthalpy change of formation of Ga_2O_3	-1089 kJ mol ⁻¹										
					[2]						

		$ \begin{array}{ccc} 2\text{Ga(s)} & + & \frac{3}{2}\text{O}_2\text{(g)} & \xrightarrow{-1089} & \text{Ga}_2\text{O}_3\text{(s)} \\ \downarrow 2(277) & & \downarrow \frac{3}{2}(+496) & & \nearrow \text{LE(Ga}_2\text{O}_3\text{)} \\ 2\text{Ga(g)} & + & 3\text{O(g)} & & \\ \downarrow 2(577+1980+2960) & & \downarrow 3(+752) & & \\ 2\text{Ga}^{3+}\text{(g)} & + & 3\text{O}^{2-}\text{(g)} & & \end{array} $ $ \begin{aligned} \text{LE(Ga}_2\text{O}_3) &= -1089 - [2(+277) + 2(+5517) + \frac{3}{2}(+496) + 3(+752)] \\ &= -15677 \text{ kJ mol}^{-1} \\ &= \underline{-1.57 \times 10^4 \text{ kJ mol}^{-1}} \text{ (3 s.f)} \end{aligned} $	
	(c)	How would you expect the magnitude of lattice energy of Ga_2O_3 to compare with that of Al_2O_3 ? Explain your answer.	
		$ \text{LE} \propto \frac{q_+ q_-}{r_+ + r_-}$ <p> Ga^{3+} is <u>larger</u> than Al^{3+}, the <u>electrostatic attraction between Ga^{3+} and O^{2-} is weaker</u> than that between Al^{3+} and O^{2-}, hence the magnitude of lattice energy of Ga_2O_3 is <u>smaller</u> than that of Al_2O_3. </p>	[2]
		[Total: 6]	

4	In a reaction between nitric oxide (NO) and oxygen (O ₂), the order of reaction with respect to nitric oxide is two, and the order of reaction with respect to oxygen is one.																		
	(a)	Write a rate equation for the reaction and give the units for the rate constant.																	
		Rate = k[NO] ² [O ₂] Units: mol ⁻² dm ⁶ s ⁻¹		[2]															
	<p>Two experiments are conducted to study the effect of temperature on the rate of reaction between nitric oxide and oxygen.</p> <p>Experiment 1 is carried out at T₁ °C, and the numerical value of the rate constant is found to be 3.60 × 10⁻⁴.</p> <p>Experiment 2 is carried out at T₂ °C.</p> <p>The following table shows the initial concentrations of nitric oxide and oxygen, and the initial rates for Experiment 1 and 2 performed at T₁ and T₂ respectively.</p> <table><tr><th>Experiment</th><th>Temperature / °C</th><th>Initial [O₂] / mol dm⁻³</th><th>Initial [NO] / mol dm⁻³</th><th>Initial rate / mol dm⁻³ s⁻¹</th></tr><tr><td>1</td><td>T₁</td><td>0.12</td><td>0.64</td><td>x</td></tr><tr><td>2</td><td>T₂</td><td>0.48</td><td>0.64</td><td>7.80 × 10⁻⁵</td></tr></table>			Experiment	Temperature / °C	Initial [O ₂] / mol dm ⁻³	Initial [NO] / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹	1	T ₁	0.12	0.64	x	2	T ₂	0.48	0.64	7.80 × 10 ⁻⁵	
Experiment	Temperature / °C	Initial [O ₂] / mol dm ⁻³	Initial [NO] / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹															
1	T ₁	0.12	0.64	x															
2	T ₂	0.48	0.64	7.80 × 10 ⁻⁵															
	(b)	(i)	Calculate the value of the initial rate of reaction of Experiment 1, x.																
			x = (3.60 × 10 ⁻⁴)(0.64) ² (0.12) = <u>1.77 × 10⁻⁵</u>																
		(ii)	Calculate the value of the rate constant at T ₂ . Hence, deduce whether T ₁ or T ₂ is higher. Explain your answer.																
		Rate constant = $\frac{7.80 \times 10^{-5}}{(0.64)^2(0.48)} = \underline{3.97 \times 10^{-4}} \text{ mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$ <u>T₂ is higher</u> as the rate constant for Experiment 2 is <u>larger</u> than that of Experiment 1. Increasing the temperature increases the value of the rate constant.		[4]															
		[Total: 6]																	

5	(a)	<p>Magnesium, phosphorus and sulfur are elements in Period 3 in the Periodic Table.</p> <p>Describe what you would observe when these three elements are separately burned in oxygen.</p> <p>Write equations for the reactions that occur.</p>	[4]
		<p>Magnesium burns with an <u>intense white flame</u> in a very vigorous reaction to form <u>white solid</u> of magnesium oxide.</p> $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ <p>Phosphorus burns with a <u>white flame</u> in a vigorous reaction to form <u>white solid</u> of P_4O_6 in limited oxygen and white solid of P_4O_{10} in excess oxygen.</p> $\text{P}_4 + 3\text{O}_2 \rightarrow \text{P}_4\text{O}_6 \text{ or}$ $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10}$ <p>Sulfur burns with a <u>pale blue flame</u> in a vigorous reaction to form SO_2.</p> $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$	
	(b)	<p>The oxides of phosphorus and sulfur resulting from the reactions in (a) both react with water.</p> <p>Write equations for these two reactions and state the colour of litmus indicator in the resulting solutions.</p>	[3]
		<p>Oxide of phosphorus</p> $\text{P}_4\text{O}_6 + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_3 \text{ or}$ $\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$ <p>Litmus indicator is <u>red</u>.</p> <p>Oxide of sulfur</p> $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3 \text{ or}$ $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$ <p>Litmus is <u>red</u>.</p>	
	[Total: 7]		

6	<p>Salicylic acid is known for its ability to ease aches and pains as well as reduce fevers. Its analgesic and anti-inflammatory properties makes it one of the most important medications needed in a basic health system, placing it on the World Health Organisation Model List of Essential Medicines.</p> <p>It is synthesised from a precursor known as methyl salicylate shown in the reaction scheme below:</p>			
<div><div><p>methyl salicylate ($M_r = 152$)</p><p>step I 2 NaOH heat under reflux</p><p>sodium salicylate</p><p>step II excess conc HCl</p><p>salicylic acid ($M_r = 138$)</p></div></div>				
	(a)	(i)	Name a functional group present in methyl salicylate.	
			Ester (accept: phenol)	
		(ii)	State the two types of reaction that occurred in step I.	
			Alkaline hydrolysis Acid-base reaction	[3]
<p>Methyl salicylate is a liquid with a density of 1.174 g cm^{-3}.</p> <p>Aqueous sodium hydroxide has a concentration of 6.0 mol dm^{-3}.</p> <p>The yield of most organic reactions is less than 100%. A typical yield of pure salicylic acid using the above method is 60%.</p>				
	(b)	Calculate the volumes of methyl salicylate and aqueous sodium hydroxide you would use to prepare 10 g of salicylic acid.		

		<p>Amount of salicylic acid in 10 g = $\frac{10}{138} = 0.0725 \text{ mol}$</p> <p>Theoretical amount of salicylic acid = $\frac{0.0725}{60} \times 100 = 0.121 \text{ mol}$</p> <p>Amount of methyl salicylate required = 0.121 mol</p> <p>Mass of methyl salicylate required = $0.121 \times 152 = 18.4 \text{ g}$</p> <p>Volume of methyl salicylate required = $\frac{18.4}{1.174} = \underline{15.7 \text{ cm}^3}$</p> <p>Amount of sodium hydroxide required = $0.121 \times 2 = 0.242 \text{ mol}$</p> <p>Volume of sodium hydroxide required = $\frac{0.242}{6.0} \times 1000$ $= \underline{40.3 \text{ cm}^3}$</p>	[3]	
	<p>Suitable quantities of methyl salicylate and aqueous sodium hydroxide are added into a round bottom flask, and the mixture is heated under reflux for 30 minutes.</p> <p>Once the reaction is completed, the reaction mixture is cooled down before the addition of concentrated hydrochloric acid. During the addition of acid, the round bottom flask is placed in an ice bath.</p>			
	(c)	(i)	Explain why there is a need to heat the mixture under reflux.	
			To <u>minimise the loss of volatile organic compounds</u> so as to <u>increase the yield</u> of the reaction.	[2]
		(ii)	Taking into consideration the need to place the round bottom flask in an ice bath, suggest the nature of the acidification process.	
			Exothermic	[1]
	(d)	Describe a simple chemical test to distinguish between methyl salicylate and salicylic acid. Write the expected observations for both compounds.		
		Add a few drops of <u>aqueous sodium carbonate</u> . Methyl salicylate: no gas evolved. Salicylic acid: colourless, odourless gas evolved that formed white ppt with limewater.		[2]
		[Total: 11]		

Section B (40 marks)

Answer all the questions in this section on separate answer paper.

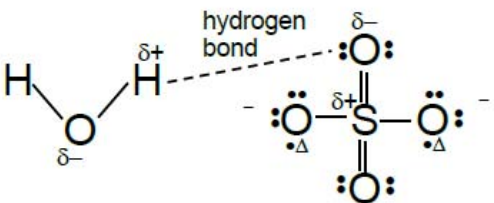
7	(a)	Nitrous oxide or dinitrogen oxide, N ₂ O, is commonly known as "laughing gas" due to the euphoric effects of inhaling it. It is used in surgery and dentistry for its anesthetic and analgesic effects. To produce N ₂ O, ammonium nitrate is decomposed at 170 °C. Water is produced in this reaction too.																		
		(i)	Write an equation for the production of dinitrogen oxide from ammonium nitrate	[1]																
			NH ₄ NO ₃ (s) → 2 H ₂ O (g) + N ₂ O (g)																	
		(ii)	In the manufacturing of N ₂ O gas, 1kg of N ₂ O gas is produced for every 2.1kg of ammonium nitrate used. Determine the percentage yield of the production of dinitrogen oxide.	[2]																
			Amount of NH ₄ NO ₃ used = $\frac{2.1 \times 1000}{14 \times 2 + 4 + 16 \times 3} = 26.3 \text{ mol}$ Theoretical amt of N ₂ O produced = 26.3 mol Theoretical mass of N ₂ O produced = 26.3 x (14x 2+16) = 1157g % yield = $\frac{1000}{1157} \times 100\% = 86.4\%$																	
	(b)	At 1200K, in the presence of gold wire, dinitrogen oxide decomposes as shown: 2N ₂ O(g) → 2N ₂ (g) + O ₂ (g). To follow the rate of reaction, the change in concentration of a sample of N ₂ O is measure against time. The results are shown below: <table><tr><th>Time, t/ s</th><th>Concentration of N₂O / × 10⁻³ mol dm⁻³</th></tr><tr><td>0</td><td>2.50</td></tr><tr><td>1000</td><td>2.01</td></tr><tr><td>2000</td><td>1.62</td></tr><tr><td>3000</td><td>1.31</td></tr><tr><td>4000</td><td>1.05</td></tr><tr><td>5000</td><td>0.85</td></tr><tr><td>6000</td><td>0.68</td></tr></table>			Time, t/ s	Concentration of N ₂ O / × 10 ⁻³ mol dm ⁻³	0	2.50	1000	2.01	2000	1.62	3000	1.31	4000	1.05	5000	0.85	6000	0.68
Time, t/ s	Concentration of N ₂ O / × 10 ⁻³ mol dm ⁻³																			
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4000	1.05																			
5000	0.85																			
6000	0.68																			

			7000	0.55																			
		(i)	With reference to the reaction, define half-life		[1]																		
			Half-life is time taken for the concentration of a N_2O to be halved.																				
		(ii)	Using the data above, draw a concentration against time graph on a suitable axis.		[2]																		
			<table><caption>Data points from the concentration vs. time graph</caption><thead><tr><th>Time/s</th><th>Concentration of $\text{N}_2\text{O} / \times 10^{-3} \text{ mol dm}^{-3}$</th></tr></thead><tbody><tr><td>0</td><td>2.5</td></tr><tr><td>1000</td><td>2.0</td></tr><tr><td>2000</td><td>1.6</td></tr><tr><td>3000</td><td>1.3</td></tr><tr><td>4000</td><td>1.05</td></tr><tr><td>5000</td><td>0.85</td></tr><tr><td>6000</td><td>0.7</td></tr><tr><td>7000</td><td>0.55</td></tr></tbody></table>		Time/s	Concentration of $\text{N}_2\text{O} / \times 10^{-3} \text{ mol dm}^{-3}$	0	2.5	1000	2.0	2000	1.6	3000	1.3	4000	1.05	5000	0.85	6000	0.7	7000	0.55	
Time/s	Concentration of $\text{N}_2\text{O} / \times 10^{-3} \text{ mol dm}^{-3}$																						
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5000	0.85																						
6000	0.7																						
7000	0.55																						
		(iii)	From your graph, deduce the order of the reaction with respect to N_2O .		[2]																		
			<p>When concentration decreases from 2.5×10^{-3} to 1.25×10^{-3}, time taken is 3000s.</p> <p>When concentration decreases from 1.25×10^{-3} to 0.7×10^{-3}, time taken is 3000s. (to be shown on the graph)</p> <p>Since half-life is constant, the <u>order of reaction with respect to N_2O is 1.</u></p> <ul style="list-style-type: none">Show on graph that half time constant																				
		(iv)	Calculate the rate constant for the reaction and state its units.		[2]																		
			$\text{Rate constant} = \frac{\ln 2}{t_{1/2}} = 2.31 \times 10^{-4} \text{ s}^{-1}$																				
		(v)	Define catalyst		[1]																		
			A catalyst is a substance that increases the rate of a chemical reaction but remains chemically unchanged at the end of the reaction.																				
		(vi)	With reference to Maxwell-Boltzmann distribution curve, explain how the presence of catalyst increases the rate of reaction.		[2]																		

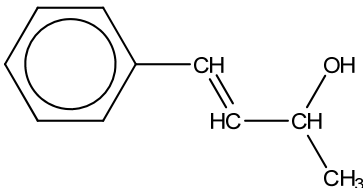
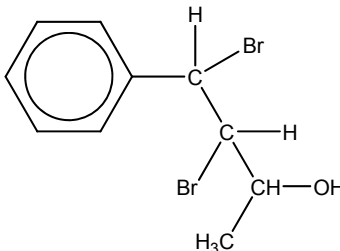
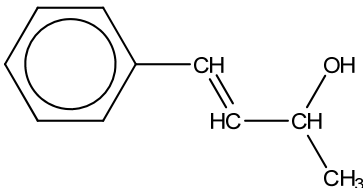
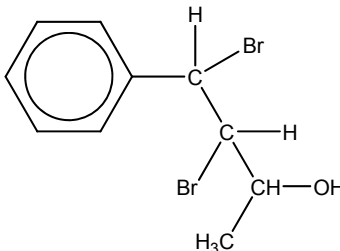
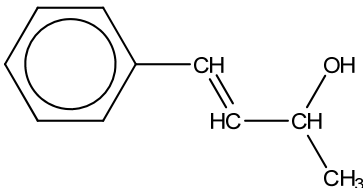
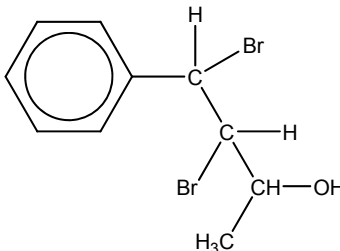
		<div></div> <p>A catalyst <u>lowers the activation energy of the reaction</u>. The <u>number of particles with energy equal to or greater than the activation energy decreases</u>. This leads to <u>an increase in the number of effective collisions</u>, hence <u>rate of reaction increase</u>.</p>											
	(c)	<p>The water-gas reaction plays a central role in the chemical method for obtaining cleaner fuels from coal.</p> $\text{CO (g)} + \text{H}_2\text{O (g)} \rightleftharpoons \text{CO}_2\text{(g)} + \text{H}_2\text{(g)} \quad \Delta H > 0$ <p>A mixture of carbon monoxide and steam was heated at 500 K and a pressure of 10 atm. The equilibrium mixture was found to contain the following amount of of gases in 2 dm³ flask.</p> <table><tr><th>Amount /mol</th><th>CO</th><th>H₂O</th><th>CO₂</th><th>H₂</th></tr><tr><td></td><td>0.260</td><td>1.12</td><td>1.24</td><td>0.86</td></tr></table>	Amount /mol	CO	H ₂ O	CO ₂	H ₂		0.260	1.12	1.24	0.86	
Amount /mol	CO	H ₂ O	CO ₂	H ₂									
	0.260	1.12	1.24	0.86									
	(i)	Calculate the equilibrium constant, K_c , at 500 K.	[2]										
		$K_c = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$ $K_c = \frac{[0.620][0.430]}{[0.130][0.560]} = 3.66 \text{ (no units)}$											
	(ii)	Define <i>Le Chatelier's Principle</i>	[1]										
		Le Chatelier's Principle states that if a system at equilibrium is subjected to a change which disturbs the equilibrium, the system responds in such a way to counteract the effect of the change.											
	(iii)	Describe and explain what will happen to the equilibrium position and	[5]										

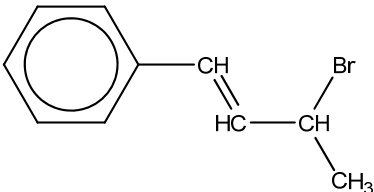
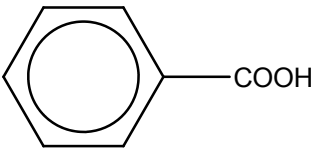
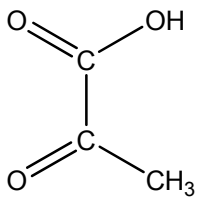
			the value of K_C if	
			1. the temperature is increased;	
			2. the pressure is increased.	
			1. When temperature is increased, <u>the forward reaction will favoured to absorb the extra heat added. The equilibrium position will shift to the right</u> to favour the forward reaction. Kc will increase.	
			2. When pressure is increased,	
			When pressure is increased, the equilibrium position will shift to the right to reduce the number of gaseous particles. Kc remain the same	
			[Total: 20]	

8	(a)	(i)	$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$	[1]
		(ii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{H}_2\text{O}$	[1]
		(iii)	<p>Amount of 1-bromopentane in 15.0 g = $\frac{15.0}{150.9} = 0.0994 \text{ mol}$</p> <p>Amount of pentan-1-ol = 0.0994 mol</p> <p>Mass of pure pentan-1-ol = $0.0994 \times 88.0 \text{ mol} = \underline{8.75 \text{ g}}$</p> <p>Percentage purity of pentan-1-ol = $\frac{8.75}{10.3} \times 100\% = \underline{84.9\%}$</p>	[2]
	(b)	<p>Elimination</p> <p>Excess concentrated H_2SO_4, heat at 170°C</p>		[2]
	(c)	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>$\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$</p> <p>↓ HBr(g), heat</p> <p>$\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{Br}$</p> <p>↓ Ethanolic KCN, heat under reflux</p> <p>$\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{CN}$</p> <p>↓ Dilute HCl, heat under reflux</p> <p>A: $\text{CH}_3(\text{CH}_2)_4\text{COOH}$</p> </div> <div style="text-align: center;"> <p>$\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$</p> <p>↓ CH_3COOH, a few drops of conc H_2SO_4, heat under reflux</p> <p>B: $\text{CH}_3\text{CO}_2(\text{CH}_2)_4\text{CH}_3$</p> </div> </div>		[3]
	(d)	(i)	Acts as a catalyst / dehydrating agent.	[1]
		(ii)	The reaction is <u>reversible</u> and does not go to completion.	[1]
		(iii)	Pentan-1-ol may be <u>dehydrated</u> by concentrated sulfuric acid, adding excess can increase the amount for condensation to form the ester.	[1]
		(iv)	Displayed formula of <u>pent-1-ene</u>	[1]
		(v)	To remove concentrated sulfuric acid / unreacted ethanoic acid	[1]

(e)	(i)	$\left[\text{Mg} \right]^{2+} \quad \left(\begin{array}{c} \text{:}\ddot{\text{O}}\text{:} \\ \text{xx} \\ \text{:}\ddot{\text{O}}\text{:} \times \text{S} \times \text{:}\ddot{\text{O}}\text{:} \\ \text{xx} \\ \text{:}\ddot{\text{O}}\text{:} \end{array} \right)^{2-}$	[1]
	(ii)	Tetrahedral	[1]
	(iii)		[2]
	(iv)	<p>In solid magnesium sulfate, the ions are <u>held in fixed positions</u> in the giant ionic lattice, hence are <u>not mobile</u> to carry charges.</p> <p>In molten magnesium sulfate, the ions are <u>free to move about</u> to carry charges.</p>	[2]
		[Total: 20]	

9	(a)	In a titration experiment, 25.0 cm ³ of 1.0 mol dm ⁻³ NH ₃ (aq) requires 25.0 cm ³ of 0.5 mol dm ⁻³ H ₂ SO ₄ solution for complete neutralisation.										
		(i)	Explain what is meant by a <i>Bronsted–Lowry acid</i> and a <i>Bronsted–Lowry base</i> .	[2]								
			An bronsted-lowry acid is a substance that can donate a proton to another substance, or proton donor. A bronsted-lowry base is a substance that can accept a proton from another substance, or proton acceptor.									
		(ii)	Use these <i>Bronsted–Lowry</i> definitions to describe how H ₂ SO ₄ behaves as an acid. Include equations where appropriate.	[2]								
			H ₂ SO ₄ is able to donate H ⁺ to water to form SO ₄ ²⁻ . H ₂ O accepts the H ⁺ to for H ₃ O ⁺ H ₂ SO ₄ (aq) + 2H ₂ O(l) → 2H ₃ O ⁺ (aq) + SO ₄ ²⁻ (aq) or H ₂ SO ₄ (aq) + NH ₃ (aq)→ (NH ₄) ₂ SO ₄ (s)									
		(iii)	Calculate the initial pH of the H ₂ SO ₄ solution.	[1]								
			Amt of H ⁺ = 2 × 0.5 = 1.0 mol dm ⁻³ Initial pH = 10 ⁻¹ = 0.1									
		(iv)	<table border="1"><thead><tr><th>Indicator</th><th>Working pH range</th></tr></thead><tbody><tr><td>Bromocresol green</td><td>3.5-5.4</td></tr><tr><td>Bromothylmol blue</td><td>6.0-7.6</td></tr><tr><td>Phenol red</td><td>6.8-8.4</td></tr></tbody></table> Suggest a suitable indicator, with reasoning, for the titration reaction. State the change in colour when end-point is reached.	Indicator	Working pH range	Bromocresol green	3.5-5.4	Bromothylmol blue	6.0-7.6	Phenol red	6.8-8.4	[2]
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			Bromocresol green as the pH of the working range coincides with the vertical range of the graph.									
		(v)	NH ₃ (aq) and its salt can act as a alkaline buffer. Explain how such a buffer solution can resist changes in pH when small amount of acid or base is added to it. Write equations when needed.	[2]								
			<ul style="list-style-type: none">When a small amount of H⁺ is added, NH₃ + H⁺ → NH₄⁺ H⁺ added is removed by NH₃ to form NH₄⁺When a small amount of OH⁻ is added,									

		$\text{NH}_4^+ + \text{H}^+ \rightarrow \text{NH}_3 + \text{H}_2\text{O}$ <p>OH^- added is removed by NH_4^+. NH_3 and H_2O is produced</p>														
(b)	<p>Compound A has a molecular formula of $\text{C}_{10}\text{H}_{12}\text{O}$. It can react with Br_2 in CCl_4 to form compound B of molecular formula $\text{C}_{10}\text{H}_{12}\text{OBr}_2$. Reacting compound A with HBr will yield compound C. Heating compound C under reflux with NaOH(aq), acidification and addition of AgNO_3 will yield a cream precipitate. Reaction of compound A with acidified KMnO_4 will yield 2 products D and E of molecular formula $\text{C}_7\text{H}_6\text{O}_2$ and $\text{C}_3\text{H}_4\text{O}_3$ respectively. E reacts with 2,4 dinitrophenylhydrazine to form an orange precipitate. E and F reacts with Na_2CO_3 to produce CO_2 gas.</p> <p>Deduce the structures of A - F. Explain your answers.</p>	[11]														
	<table><tr><td>C:H ratio in A \approx 1:1</td><td><u>Benzene ring</u> present in A</td></tr><tr><td>A undergoes <u>electrophillic addition</u> with Br_2 in CCl_4</td><td>A has a C=C bond</td></tr><tr><td>A undergoes <u>substitution</u> with HBr</td><td>A is a <u>hydroxyl group</u></td></tr><tr><td>C undergoes <u>nucleophilic substitution</u> with NaOH(aq)</td><td>C is an <u>alkyl bromide</u>.</td></tr><tr><td>A undergoes <u>oxidation</u> with acidified KMnO_4 to form 2 products.</td><td></td></tr><tr><td>E undergoes <u>condensation</u> with 2,4DNPH</td><td>E contains a <u>ketone or aldehyde</u> Since E is formed from the oxidation of A, E should contain a ketone. A is a <u>2° alcohol</u></td></tr><tr><td>E and F undergoes an <u>acid-carbonate reaction</u></td><td>E & F has COOH group</td></tr></table>	C:H ratio in A \approx 1:1	<u>Benzene ring</u> present in A	A undergoes <u>electrophillic addition</u> with Br_2 in CCl_4	A has a C=C bond	A undergoes <u>substitution</u> with HBr	A is a <u>hydroxyl group</u>	C undergoes <u>nucleophilic substitution</u> with NaOH(aq)	C is an <u>alkyl bromide</u> .	A undergoes <u>oxidation</u> with acidified KMnO_4 to form 2 products.		E undergoes <u>condensation</u> with 2,4DNPH	E contains a <u>ketone or aldehyde</u> Since E is formed from the oxidation of A , E should contain a ketone. A is a <u>2° alcohol</u>	E and F undergoes an <u>acid-carbonate reaction</u>	E & F has COOH group	
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		 <chem>BrC(=O)C=Cc1ccccc1</chem>	 <chem>OC(=O)c1ccccc1</chem>	
		C	D	
		 <chem>CC(=O)C(=O)O</chem>		
		E		

~ END OF PAPER~