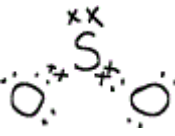
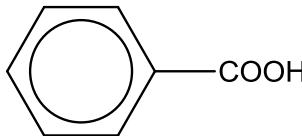



2016 H1 Chemistry PRELIMS Paper 2 Answers

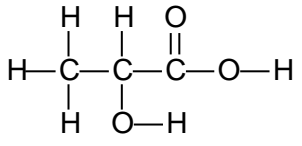
1.	(a)(i)		[1m]
		Shape: <u>Bent</u>	[1m]
	(a)(ii)	Both SO ₂ and H ₂ O have simple molecular structures. <u>Less energy</u> is needed to overcome the <u>weaker pd-pd</u> interactions <u>between SO₂</u> molecules, compared to the <u>stronger hydrogen bonds</u> <u>between water</u> molecules.	[1m]
	(b)	Sulfur has <u>energetically accessible vacant 3d orbitals/subshell</u> to expand its octet.	[1m]
	(c)(i)	Equilibrium position would shift to the <u>right</u> to <u>favour</u> the <u>exothermic</u> reaction / to <u>produce</u> some <u>heat</u> . <u>K_c increases.</u>	[1m] [1m] [1m]
	(c)(ii)	Equilibrium position would shift to the <u>right</u> to favour the side with <u>fewer gas molecules/particles</u> in order to reduce total pressure. <u>K_c is unchanged / no effect.</u>	[1m] [1m] [1m]

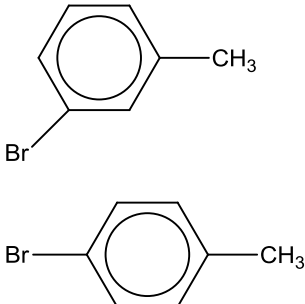
2.	(a)(i)		[1m]
	(a)(ii)	Conditions: Ammonia in <u>ethanol</u> , <u>heat in sealed tube</u> Type of reaction: <u>Nucleophilic substitution</u> Class of organic compound: <u>Amine</u>	[1m] [1m] [1m]
	(b)(i)	Structure of K: 	[1m]
	(b)(ii)	Step I: <u>Excess concentrated H₂SO₄, 170°C</u> Step II: <u>Br₂ (accept liquid/aqueous), absence of UV light</u>	[1m] [1m]
	(b)(iii)	<u>BrCH₂CH₂CH₃</u> / <u>Bromopropane</u> Nucleophilic <u>substitution</u>	[1m] [1m]

3.	(a)(i)	<p>pH of chloride</p> <p>Na Mg Al Si P</p>	[1m]								
	(a)(ii)	<p><u>$\text{SiCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HCl}$</u></p> <p><u>$\text{PCl}_5 + 4\text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 + 5\text{HCl}$</u></p>	[1m] [1m]								
	(b)(i)	<table border="1"> <tr> <td>BeO</td><td>Na_2O</td><td>Al_2O_3</td><td>SO_2</td></tr> <tr> <td><u>1.87</u></td><td>2.52</td><td><u>1.83</u></td><td><u>0.86</u></td></tr> </table>	BeO	Na_2O	Al_2O_3	SO_2	<u>1.87</u>	2.52	<u>1.83</u>	<u>0.86</u>	[1m]
BeO	Na_2O	Al_2O_3	SO_2								
<u>1.87</u>	2.52	<u>1.83</u>	<u>0.86</u>								
	(b)(ii)	<p><u>Giant ionic structure</u> with high degree of covalent character.</p> <p><u>Amphoteric</u></p>	[1m] [1m]								
	(b)(iii)	<p><u>$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$</u></p> <p><u>$\text{Al}_2\text{O}_3 + 2\text{NaOH} + 3\text{H}_2\text{O} \rightarrow 2\text{NaAl(OH)}_4$</u></p>	[1m] [1m]								
4.	(a)(i)	<p><u>Ethyl-2-methyl butanoate</u>,</p> <p>as it has a <u>lower odour detection threshold</u> than methyl hexanoate / a <u>lower amount of it is needed to be detected</u>.</p>	[1m] [1m]								
	(a)(ii)	<p>OAV of methyl hexanoate = <u>$(3.74 / \frac{150}{1000}) / 70 = 0.356$</u></p> <p>OAV of ethyl-2-methyl butanoate</p> <p>= <u>$(1.52 / \frac{150}{1000}) / 0.006 = 1690$</u></p> <p><u>Ethyl-2-methyl butanoate</u> contributes more to the overall aroma.</p>	[1m] [1m] [1m]								
	(b)(i)	<p><u>Condensation</u></p>	[1m]								

			[1m]
(b)(ii)	[ethyl-2-methyl butanoate] = $\underline{1.52 \times 10^{-6} / 130 / 0.126}$ $= \underline{9.28 \times 10^{-8} \text{ mol dm}^{-3}}$		[1m] [1m]
(b)(iii)	$K_c = \frac{[\text{C}_7\text{H}_{14}\text{O}_2][\text{H}_2\text{O}]}{[\text{C}_2\text{H}_6\text{O}][\text{C}_5\text{H}_{10}\text{O}_2]}$		[1m]
(b)(iv)	$4 = \frac{[9.28 \times 10^{-8}]^2}{[\text{C}_2\text{H}_6\text{O}]^2}$ <p>At eqm, $[\text{C}_2\text{H}_6\text{O}] = [\text{C}_5\text{H}_{10}\text{O}_2] = 4.64 \times 10^{-8} \text{ mol dm}^{-3}$</p> <p>Hence, the $[\text{C}_2\text{H}_6\text{O}]$ and $[\text{C}_5\text{H}_{10}\text{O}_2]$ used</p> $= 4.64 \times 10^{-8} + 9.28 \times 10^{-8} = \underline{1.38 \times 10^{-7} \text{ mol dm}^{-3}}$		[1m] [1m]
(b)(v)	Concentrated sulfuric acid removes water thus concentration of H_2O decreases . This causes the equilibrium position of $\text{C}_2\text{H}_6\text{O} + \text{C}_5\text{H}_{10}\text{O}_2 = \text{C}_7\text{H}_{14}\text{O}_2 + \text{H}_2\text{O}$ to shift to the right .		[1m]

5.	(a)	Acids are proton / H⁺ donors . Bases are proton / H⁺ acceptors .	[1m] [1m]												
	(b)(i)	Weak acid. $[H^+] = 10^{-2.43} = 3.72 \times 10^{-3} \text{ mol dm}^{-3}$ [H⁺] < [lactic acid] / explanation in words	[1m] [1m]												
	(b)(ii)	$K_a = [H^+]^2 / [HA]_{\text{initial}}$ $= \underline{(3.72 \times 10^{-3})^2 / (0.1)}$ $= \underline{1.38 \times 10^{-4} \text{ mol dm}^{-3}}$	[1m] [1m] [1m]												
	(b)(iii)	Phenolphthalein	[1m]												
	(b)(iv)	Amount of Ca(OH) ₂ reacted = <u>0.250 x 22.3/1000</u> $= 5.575 \times 10^{-3} \text{ mol}$ Amount of lactic acid = <u>2 x 5.575 x 10⁻³</u> $= 0.01115 \text{ mol}$ M_r of lactic acid = $1 / 0.01115 = \underline{89.7}$	[1m] [1m] [1m]												
	(b)(v)	<table><tr><td></td><td>C</td><td>H</td><td>O</td></tr><tr><td>Mass /g</td><td>40.0</td><td>6.7</td><td>53.3</td></tr><tr><td>No. of moles</td><td>40.0/12 = 3.3</td><td>6.7</td><td>53.3/16 = 3.3</td></tr></table>		C	H	O	Mass /g	40.0	6.7	53.3	No. of moles	40.0/12 = 3.3	6.7	53.3/16 = 3.3	[1m]
	C	H	O												
Mass /g	40.0	6.7	53.3												
No. of moles	40.0/12 = 3.3	6.7	53.3/16 = 3.3												

		<table border="1"> <tr> <td>Ratio</td><td>1</td><td>2</td><td>1</td></tr> </table> <p>Empirical formula is <u>CH₂O</u>. Let the molecular formula be (CH₂O)_n</p> <p>$n[12.0 + 2(1.0) + 16.0] = 89.7$</p> <p>$n = 3$</p> <p>Molecular formula is <u>C₃H₆O₃</u></p>	Ratio	1	2	1	[1m]
Ratio	1	2	1				
			[1m]				
(b)(vi)			[1m]				
(c)	A buffer solution is a <u>solution that resists changes in pH when small amounts of acid or base are added to it.</u>		[1m]				
(d)(i)	<p>H⁺ is removed by reaction with lactate ions:</p> <p><u>H⁺ + C₃H₅O₃⁻ → C₃H₆O₃</u> or <u>H⁺ + A⁻ → HA</u></p>		[1m] reject =				
(d)(ii)	<p>OH⁻ is removed by reaction with lactic acid:</p> <p><u>OH⁻ + C₃H₆O₃ → C₃H₅O₃⁻ + H₂O</u> or <u>HA + OH⁻ → A⁻ + H₂O</u></p>		[1m] reject =				
(e)	<p>[A⁻] = [HA] = 0.1 mol dm⁻³</p> <p>Amount of lactate ions = <u>0.1 x 500/1000 = 0.05</u></p> <p>Mass of sodium lactate needed = 0.05 x 112.0 = <u>5.60 g</u></p>		[1m] [1m]				
6.	(a)	<p>The <u>atomic radius</u> of elements <u>decreases across the period</u>. Across the period, <u>nuclear charge increases</u> due to increase in the number of protons in the nucleus while <u>shielding effect by inner shell electrons remains relatively constant</u>.</p> <p><u>First ionisation energy</u> of elements <u>increases across the period</u>. Across the period, nuclear charge increases and shielding effect by inner shell electrons remains relatively constant. <u>More energy is required*</u> to remove an electron.</p> <p>There is a <u>decrease</u> in first I.E. <u>between Mg and Al</u> as the <u>3p electron of Al is further away from the nucleus</u> and has a higher energy.</p> <p>There is a <u>decrease</u> in first I.E. <u>between P and S</u> as there is <u>mutual repulsion between the paired 3p electrons in S</u>, but not in P.</p>	[1m] [1m] [1m] [1m] [1m]				
	(b)(i)	reaction <u>I</u> (Must state rxn)					

		<p><u>Acidified KMnO_4 (aq), heat</u></p> <p>[1m]</p> <p><u>Oxidation</u></p> <p>[1m]</p> <p>reaction <u>II</u></p> <p><u>Br_2, UV light</u></p> <p>[1m]</p> <p><u>Free radical substitution</u></p> <p>[1m]</p> <p>reaction <u>III</u></p> <p><u>Br_2, anhydrous $\text{FeBr}_3/\text{AlBr}_3/\text{Fe}$ absence of light</u></p> <p>[1m]</p> <p><u>Electrophilic substitution</u></p> <p>[1m]</p>	
	(b)(ii)	 <p>[1m]</p> <p>[1m]</p>	
	(b)(iii)	<p>Graph:</p> <ul style="list-style-type: none"> - Points correctly plotted. - Best fit straight line drawn through plotted points. 	<p>[1m]</p> <p>[1m]</p>

	(b)(iv)	<p>Order of reaction with respect to a reactant is the power to which the concentration of that reactant is raised in the experimentally determined rate equation.</p> <p>or</p> <p>In an experimentally determined rate equation:</p> $\text{Rate} = k[A]^m[B]^n$ <p>the order of reaction with respect to A is m and the order of reaction with respect to B is n.</p> <p><i>From the graph, gradient is constant, which means rate is constant and independent of concentration of methylbenzene.</i></p> <p>Thus, it is zero order with respect to methylbenzene.</p>	<p>[1m]</p> <p>[1m]</p>
	(b)(v)	<p>The graph will be shifted upwards</p> <p>but gradient remains the same because the rate of reaction (represented by gradient) is independent of the concentration of methylbenzene.</p>	<p>[1m]</p> <p>[1m]</p>

7.	(a)(i)	<p>L.E. of $\text{NaCl} = -(\Delta H_4 + \Delta H_5 + \Delta H_2 + \Delta H_3) + \Delta H_1$</p> <p>$= -(+494 - 364 + 109 + 244) - 776$</p> <p>$= -1259 \text{ kJ mol}^{-1}$ or $-1260 \text{ kJ mol}^{-1}$</p>	<p>[1m]</p> <p>[1m]</p>
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	(a)(ii)	<p>ΔH_1 is the <u>enthalpy change of formation of solid NaCl</u></p> <p>ΔH_4 is the <u>first ionisation energy of Na(g)</u></p>	<p>[1m]</p> <p>[1m]</p>
	(a)(iii)	<p>L.E. $\propto \frac{q_+ q_-}{r_+ + r_-}$ (✓)</p> <p>Mg^{2+} has a <u>higher charge and smaller ionic radius</u> (✓) than Na^+.</p> <p>$MgCl_2$ would have a <u>higher magnitude / value / more exothermic lattice energy</u> compared to NaCl.</p>	<p>2(✓) : [1m]</p> <p>[1m]</p>
	(b)	<p>P undergoes <u>nucleophilic substitution</u> to give Q. (✓)</p> <p>Q is an <u>alcohol</u>. (✓)</p> <p>Q undergoes <u>oxidation</u> to form R. (✓)</p> <p>R undergoes <u>condensation</u> with 2,4-DNPH. (✓)</p> <p>R is an <u>aldehyde or ketone</u>. (✓)</p> <p>Q is a <u>primary or secondary alcohol</u>. (✓)</p> <p>Q and R undergo <u>positive iodoform test</u>. (✓)</p> <div style="text-align: center;"> $\begin{array}{c} OH \\ \\ \text{---}C\text{---}CH_3 \\ \\ H \end{array}$ </div> <p>Q contains <u> </u> (✓)</p> <div style="text-align: center;"> $\begin{array}{c} O \\ \\ \text{---}C\text{---}CH_3 \end{array}$ </div> <p>R contains <u> </u> (✓)</p> <p>P undergoes <u>elimination</u> (✓) to form V, W and X which are <u>alkenes</u>. (✓)</p> <p>V, W and X can undergo <u>electrophilic addition</u> to form P. (✓)</p>	<p>12(✓): [4m]</p> <p>9-11(✓): [3m]</p> <p>6-8(✓): [2m]</p> <p>3-5(✓): [1m]</p>
		<p>P: <u>$CH_3CH_2CH(Br)CH_3$</u></p> <p>Q: <u>$CH_3CH_2CH(OH)CH_3$</u></p> <p>R: <u>$CH_3CH_2COCH_3$</u></p> <p>V / W / X:</p> <p><u>$CH_3CH=CHCH_3$ (cis) / $CH_3CH=CHCH_3$ (trans) / $CH_3CH_2CH=CH_2$</u></p>	<p>[1m]</p> <p>[1m]</p> <p>[1m]</p> <p>[3m]</p>
	(c)(i)	<p><u>Add Na_2CO_3 to separate samples of propanoic acid and propanol. Pass any gas evolved through limewater.</u></p> <p><u>Propanoic acid would produce a gas that forms white ppt. in</u></p>	<p>[1m] test</p> <p>[1m]</p>

		<p><u>limewater, while propanol would not.</u></p> <p>OR</p> <p><u>Add acidified $K_2Cr_2O_7(aq)$ to</u> separate samples of <u>propanoic acid and propanol</u> and <u>heat</u>.</p> <p><u>Propanol would turn $K_2Cr_2O_7$ from orange to green while propanoic acid would not.</u></p> <p>(can also use $KMnO_4$)</p>	observation
	(c)(ii)	<p>To separate samples of chloroethane and bromoethane,</p> <p>Step 1: Add <u>$NaOH(aq)$</u> to the alkyl halide in a test-tube and <u>heat</u> using a hot water bath.</p> <p>Step 2: <u>Acidify</u> the resulting mixture with <u>excess $HNO_3(aq)$</u>.</p> <p>Step 3: Then add dilute <u>$AgNO_3(aq)$</u> to the mixture.</p> <p><u>Chloroethane</u> would give a <u>white ppt. of $AgCl$</u> while <u>bromoethane</u> would give a <u>cream ppt. of $AgBr$</u>.</p>	<p>[1m] test</p> <p>[1m] observation</p>