

# Markscheme

May 2019

Chemistry

Standard level

Paper 2

10 pages

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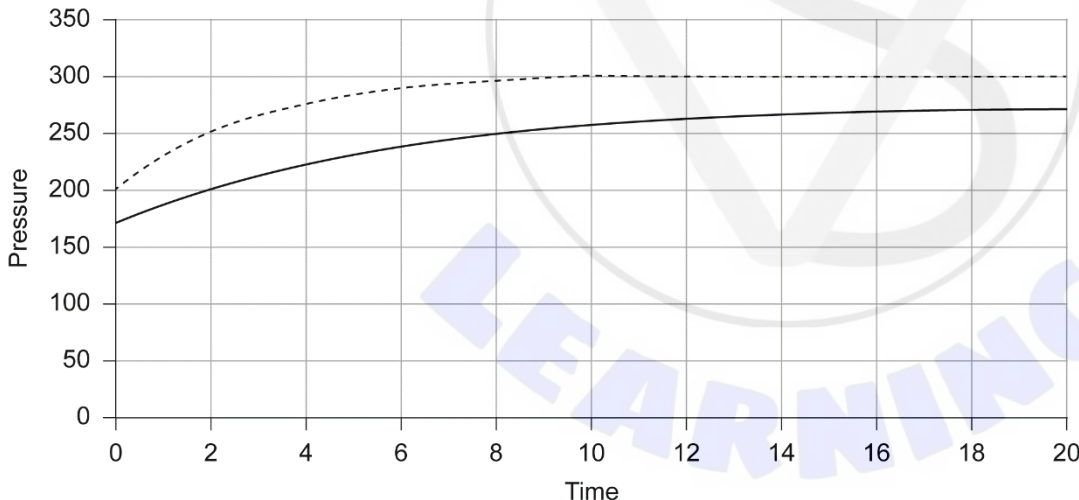
Question			Answers	Notes	Total
1.	a		$C_2H_2(g) + 2.5O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$ <b>OR</b> $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l) \checkmark$		1
1.	b	i	$H:C::C:H / H-C\equiv C-H \checkmark$	Accept any valid combination of lines, dots and crosses.	1
1.	b	ii	«ethyne» shorter <b>AND</b> a greater number of shared/bonding electrons <b>OR</b> «ethyne» shorter <b>AND</b> stronger bond $\checkmark$		1
1.	b	iii	London/dispersion/instantaneous dipole-induced dipole forces $\checkmark$	Do <b>not</b> accept just “intermolecular forces” or “van der Waals’ forces”.	1
1.	c	i	«electrophilic» addition/A <sub>«E»</sub> $\checkmark$	Accept “polymerization”.	1
1.	c	ii	ethanal $\checkmark$		1
1.	c	iii	«sum of bond enthalpies of reactants $\Rightarrow$ $2(C-H) + C\equiv C + 2(O-H)$ <b>OR</b> $2 \times 414 \text{ «kJ mol}^{-1}\text{»} + 839 \text{ «kJ mol}^{-1}\text{»} + 2 \times 463 \text{ «kJ mol}^{-1}\text{»}$ <b>OR</b> $2593 \text{ «kJ»} \checkmark$  «sum of bond enthalpies of A $\Rightarrow$ $3(C-H) + C=C + C-O + O-H$ <b>OR</b> $3 \times 414 \text{ «kJ mol}^{-1}\text{»} + 614 \text{ «kJ mol}^{-1}\text{»} + 358 \text{ «kJ mol}^{-1}\text{»} + 463 \text{ «kJ mol}^{-1}\text{»}$ <b>OR</b> $2677 \text{ «kJ»} \checkmark$  «enthalpy of reaction = $2593 \text{ kJ} - 2677 \text{ kJ} = -84 \text{ «kJ»} \checkmark$	Award <b>[3]</b> for correct final answer.	3

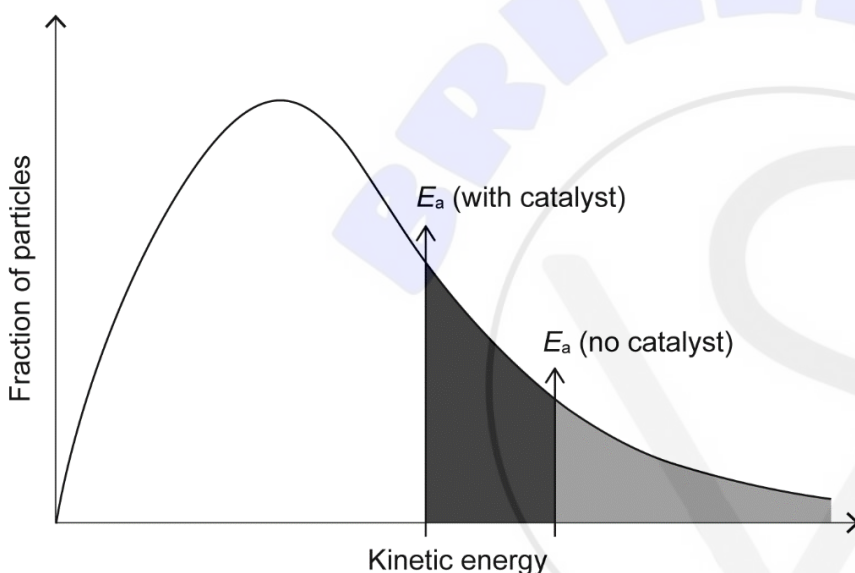
(continued...)

(Question 1c continued)

Question			Answers	Notes	Total
1.	c	iv	B <b>AND</b> it has a more negative/lower enthalpy/«potential» energy <b>OR</b> B <b>AND</b> more exothermic «enthalpy of reaction from same starting point» ✓		1
1.	c	v	<i>Identity of product: «B»</i> <i>IR spectrum:</i> 1700–1750 «cm <sup>-1</sup> band» <b>AND</b> carbonyl/CO group present <b>OR</b> no «band at» 1620–1680 «cm <sup>-1</sup> » <b>AND</b> absence of double bond/C=C <b>OR</b> no «broad band at» 3200–3600 «cm <sup>-1</sup> » <b>AND</b> absence of hydroxyl/OH group ✓  <i><sup>1</sup>H NMR spectrum:</i> «only» two signals <b>AND</b> A would have three <b>OR</b> «signal at» 9.4–10.0 «ppm» <b>AND</b> «H atom/proton of» aldehyde/–CHO present <b>OR</b> «signal at» 2.2–2.7 «ppm» <b>AND</b> «H atom/proton of alkyl/CH next to» aldehyde/CHO present <b>OR</b> «signal at» 2.2–2.7 «ppm» <b>AND</b> «H atom/proton of» RCOCH <sub>2</sub> - present <b>OR</b> no «signal at» 4.5–6.0 «ppm» <b>AND</b> absence of «H-atom/proton next to» double bond/C=C ✓	<i>Accept a specific value or range of wavenumbers and chemical shifts.</i>  <i>Accept “two signals with areas 1:3”.</i>	2

Question			Answers	Notes	Total
1.	d	i	<p><i>Reagents:</i> acidified/H<sup>+</sup> <b>AND</b> «potassium» dichromate«(VI)»/K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>/Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> ✓</p> <p><i>Conditions:</i> distil «the product before further oxidation» ✓</p>	<p>Accept “«acidified potassium» manganate(VII)/KMnO<sub>4</sub>/MnO<sub>4</sub><sup>-</sup>/permanganate”.</p> <p>Accept “H<sub>2</sub>SO<sub>4</sub>” or “H<sub>3</sub>PO<sub>4</sub>” for “H<sup>+</sup>”.</p> <p>Accept “more dilute dichromate(VI)/manganate(VII)” or “excess ethanol”.</p> <p>Award M1 if correct reagents given under “Conditions”.</p>	2
1.	d	ii	-1 ✓		1
1.	d	iii	<p><i>Any three of:</i> has an oxygen/O atom with a lone pair ✓ that can form hydrogen bonds/H-bonds «with water molecules» ✓ hydrocarbon chain is short «so does not disrupt many H-bonds with water molecules» ✓ «large permanent» dipole-dipole interactions with water ✓</p>		3 max

Question		Answers	Notes	Total
2.	a	increase in the amount/number of moles/molecules «of gas» ✓ from 2 to 3/by 50 % ✓		2
2.	b	«rate of reaction decreases» concentration/number of molecules in a given volume decreases <b>OR</b> more space between molecules ✓  collision rate/frequency decreases <b>OR</b> fewer collisions per second/unit time ✓	Do not accept just "larger space/volume" for M1.	2
2.	c	 <p>smaller initial gradient ✓                      initial pressure is lower <b>AND</b> final pressure of gas lower «by similar factor» ✓</p>		2

Question		Answers	Notes	Total
2.	d	no <b>AND</b> it is a systematic error/not a random error <b>OR</b> no <b>AND</b> «a similar magnitude» error would occur every time ✓		1
2.	e	 <p>catalysed and uncatalysed <math>E_a</math> marked on graph <b>AND</b> with the catalysed being at lower energy ✓</p> <p>«for catalysed reaction» greater proportion of/more molecules have <math>E \geq E_a</math> / <math>E &gt; E_a</math> <b>OR</b> «for catalysed reaction» greater area under curve to the right of the <math>E_a</math> ✓</p>	Accept "more molecules have the activation energy".	2

Question			Answers	Notes	Total
3.	a		absorbs <u>UV/ultraviolet</u> light «of longer wavelength than absorbed by O <sub>2</sub> » ✓		1
3.	b	i	mass spectrometry/MS ✓		1
3.	b	ii	$\left\langle \frac{(98 \times 14) + (2 \times 15)}{100} \Rightarrow 14.02 \right\rangle \checkmark$ $\left\langle M_r = (14.02 \times 2) + 16.00 \Rightarrow 44.04 \right\rangle \checkmark$		2
3.	b	iii	<p>Any two:</p> <p>same <b>AND</b> have same nuclear charge/number of protons/<math>Z_{\text{eff}}</math> ✓</p> <p>same <b>AND</b> neutrons do not affect attraction/ionization energy/<math>Z_{\text{eff}}</math></p> <p><b>OR</b></p> <p>same <b>AND</b> neutrons have no charge ✓</p> <p>same <b>AND</b> same attraction for «outer» electrons ✓</p> <p>same <b>AND</b> have same electronic configuration/shielding ✓</p>	<p>Accept “almost the same”.</p> <p>“same” only needs to be stated once.</p>	2 max
3.	c		oxides of nitrogen/non-metals are «usually» acidic ✓		1

Question			Answers	Notes	Total
4.	a		gap in the periodic table <b>OR</b> element with atomic number «75» unknown <b>OR</b> break/irregularity in periodic trends ✓ «periodic table shows» regular/periodic trends «in properties» ✓		2
4.	b		place «pieces of» Re into each solution ✓ if Re reacts/is coated with metal, that metal is less reactive «than Re» ✓	Accept other valid observations such as “colour of solution fades” or “solid/metal appears” for “reacts”.	2
4.	c	i	rhenium(III) chloride <b>OR</b> rhenium trichloride ✓		1
4.	c	ii	« $M_r \text{ReCl}_3 = 186.21 + (3 \times 35.45) \Rightarrow 292.56$ ✓ « $100 \times \frac{186.21}{292.56} \Rightarrow 63.648$ «%» ✓		2

Question			Answers	Notes	Total
5.	a	i	<p><i>Weak acid:</i> partially dissociated/ionized «in solution/water»  <b>AND</b>  <i>Strong acid:</i> «assumed to be almost» completely/100 % dissociated/ionized                      «in solution/water» ✓</p>		1
5.	a	ii	CO <sub>3</sub> <sup>2-</sup> ✓		1
5.	a	iii	shifts to left/reactants <b>AND</b> to increase amount/number of moles/molecules of gas/CO <sub>2</sub> (g) ✓	Accept “shifts to left/reactants <b>AND</b> to increase pressure”.	1
5.	b	i	«additional HCO <sub>3</sub> <sup>-</sup> » shifts position of equilibrium to left ✓ pH increases ✓	Do <b>not</b> award M2 without any justification in terms of equilibrium shift in M1.	2
5.	b	ii	<p>«molar mass of NaHCO<sub>3</sub> =&gt; 84.01 «g mol<sup>-1</sup>» ✓</p> <p>«concentration = <math>\frac{3.0 \times 10^{-2} \text{g}}{84.01 \text{g mol}^{-1}} \times \frac{1}{0.100 \text{dm}^3} \Rightarrow 3.6 \times 10^{-3} \text{«mol dm}^{-3}\text{»} \checkmark</math></p>	Award [2] for correct final answer.	2
5.	b	iii	<p>Between sodium and hydrogencarbonate:                      ionic ✓</p> <p>Between hydrogen and oxygen in hydrogencarbonate:                      «polar» covalent ✓</p>		2