



Markscheme

May 2019

Chemistry

Standard level

Paper 2

10 pages

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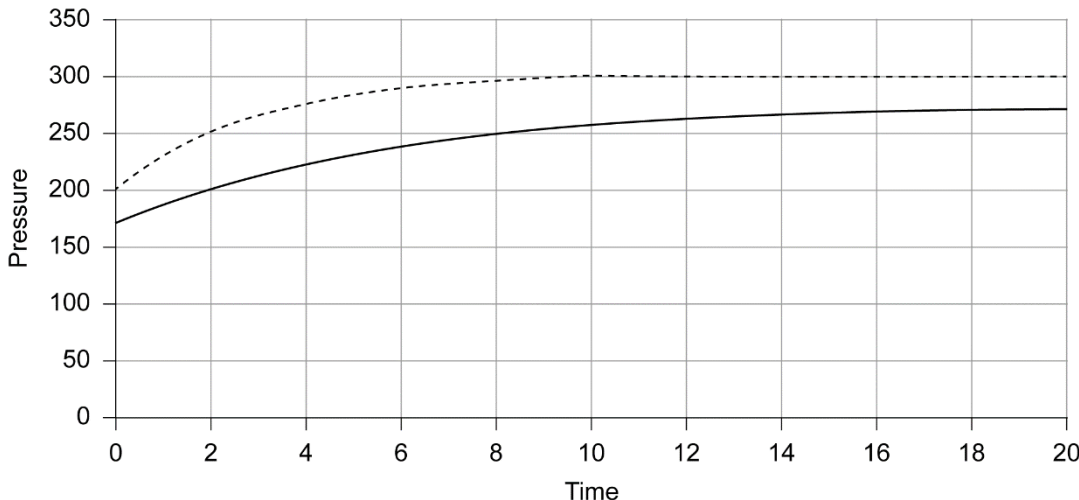
Question			Answers	Notes	Total
1.	a		$C_2H_2(g) + 2.5O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$ OR $2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l) \checkmark$		1
1.	b	i	$H:C::C:H / H-C\equiv C-H \checkmark$	Accept any valid combination of lines, dots and crosses.	1
1.	b	ii	«ethyne» shorter AND a greater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

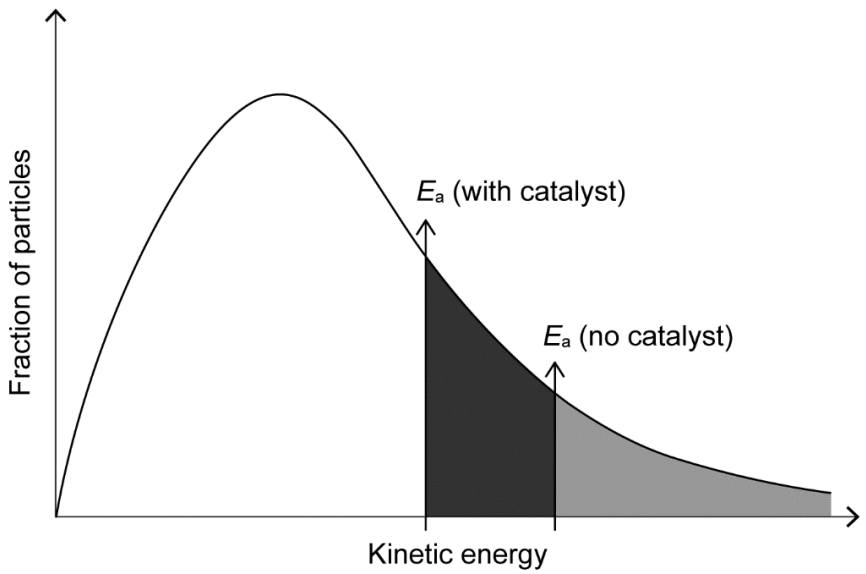
(continued...)

(Question 1c continued)

Question			Answers	Notes	Total
1.	c	iv	B AND it has a more negative/lower enthalpy/«potential» energy OR B AND 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 ⁻¹ band» AND carbonyl/CO group present OR no «band at» 1620–1680 «cm ⁻¹ » AND absence of double bond/C=C OR no «broad band at» 3200–3600 «cm ⁻¹ » AND absence of hydroxyl/OH group ✓ <i>¹H NMR spectrum:</i> «only» two signals AND A would have three OR «signal at» 9.4–10.0 «ppm» AND «H atom/proton of» aldehyde/–CHO present OR «signal at» 2.2–2.7 «ppm» AND «H atom/proton of alkyl/CH next to» aldehyde/CHO present OR «signal at» 2.2–2.7 «ppm» AND «H atom/proton of» RCOCH ₂ - present OR no «signal at» 4.5–6.0 «ppm» AND 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⁺ AND «potassium» dichromate«(VI)»/K₂Cr₂O₇/Cr₂O₇²⁻ ✓</p> <p><i>Conditions:</i> distil «the product before further oxidation» ✓</p>	<p>Accept “«acidified potassium» manganate(VII)/KMnO₄/MnO₄⁻/permanganate”.</p> <p>Accept “H₂SO₄” or “H₃PO₄” for “H⁺”.</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 OR more space between molecules ✓ collision rate/frequency decreases OR fewer collisions per second/unit time ✓	<i>Do not accept just "larger space/volume" for M1.</i>	2
2.	c	 <p>smaller initial gradient ✓ initial pressure is lower AND final pressure of gas lower «by similar factor» ✓</p>		2

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

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

Question			Answers	Notes	Total
4.	a		gap in the periodic table OR element with atomic number «75» unknown OR 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» ✓	<i>Accept other valid observations such as “colour of solution fades” or “solid/metal appears” for “reacts”.</i>	2
4.	c	i	rhenium(III) chloride OR rhenium trichloride ✓		1
4.	c	ii	$\ll M_r \text{ReCl}_3 = 186.21 + (3 \times 35.45) \Rightarrow 292.56 \checkmark$ $\ll 100 \times \frac{186.21}{292.56} \Rightarrow 63.648 \text{ «\%» } \checkmark$		2

Question			Answers	Notes	Total
5.	a	i	<p><i>Weak acid:</i> partially dissociated/ionized «in solution/water» AND <i>Strong acid:</i> «assumed to be almost» completely/100 % dissociated/ionized «in solution/water» ✓</p>		1
5.	a	ii	CO ₃ ²⁻ ✓		1
5.	a	iii	shifts to left/reactants AND to increase amount/number of moles/molecules of gas/CO ₂ (g) ✓	Accept “shifts to left/reactants AND to increase pressure”.	1
5.	b	i	«additional HCO ₃ ⁻ » shifts position of equilibrium to left ✓ pH increases ✓	Do not award M2 without any justification in terms of equilibrium shift in M1.	2
5.	b	ii	<p>«molar mass of NaHCO₃ => 84.01 «g mol⁻¹» ✓</p> <p>«concentration = $\frac{3.0 \times 10^{-2} \text{g}}{84.01 \text{g mol}^{-1}} \times \frac{1}{0.100 \text{dm}^3} \Rightarrow 3.6 \times 10^{-3} \text{«mol dm}^{-3}\text{»} \checkmark$</p>	Award [2] for correct final answer.	2
5.	b	iii	<p><i>Between sodium and hydrogencarbonate:</i> ionic ✓</p> <p><i>Between hydrogen and oxygen in hydrogencarbonate:</i> «polar» covalent ✓</p>		2