INTERNATIONAL A-LEVEL CHEMISTRY

(9620)

PAPER 3
Mark Scheme

Specimen 2018

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Part	Marking guidance	Total marks
01	1	enthalpy / energy to break / dissociate a bond	1
		averaged over different molecules	1

Question	Part	Marking guidance	Total marks
01	1	$\Delta H = \Sigma$ bonds broken – Σ bonds formed **or** ΔH / – 379 = [(1 x C≡C) + (2 x C-H) + (2 x Cl-Cl)] – [(1 x C-C) + (2 x C-H) + (4 x C–Cl)]	1
		– 379 = [(1 x 837) + (2 x 412) + (2 x 242)] – [(1 x 348) + (2 x 412) + (4 x C–Cl)] **or** – 379 = [2145] – [1172 + (4 x C–Cl)] **or** (4 x C–Cl) = 1352	1
		(C–Cl) = (+) 338 (kJ mol^{-1})	1

Question	Part	Marking guidance	Total marks
02	1	$F(g) + e^- \rightarrow F^-(g)$	1
02	2	There is an attraction between the nucleus / protons and (the added) electron(s) Energy is released (when the electron is gained)	2
02	3	Top line: + e– + F(g) Second line from top : + e– + ½ F2(g) Bottom two lines: + ½ F2(g)	3
02	4	½ E(F–F) + 732 + 289 + +203 = 348 + 955 ½ E(F–F) = 79 E(F–F) = 158 (kJ mol^{-1})	2
02	5	$\Delta_{sol}H = \Delta_{LE}H + \Delta_{hyd}H$ (Ag^+ ions) + $\Delta_{hyd}H$ (F^- ions) **or** = (+) 955 + (– 464) + (– 506) = – 15 (kJ mol^{-1})	1 1
02	6	fluoride ion is smaller so the electrostatic attraction between the fluoride ions and water is greater allow chloride ion is larger	1 1

Question	Part	Marking guidance	Total marks
03	1	Not feasible / unfeasible / not spontaneous	1
03	2	*(-) $\Delta S = m$ or (-)ΔS = gradient*	1
03	3	Because the entropy change / ΔS is positive / $T\Delta S$ gets bigger	1
03	4	+ 44.5 J K^{-1} mol^{-1}	1
03	5	At 5440 ΔH = TΔS = 5440 × 44.5 = 242 080 ΔH = 242 kJ mol−1	2
03	6	C	1

Question	Part	Marking guidance	Total marks
04	1	**M1** $[H^+] = 10^{-1.25}$ OR 0.05623 **M2** mol HCl = $(25 \times 10^{-3}) \times 0.0850$ $(= 2.125 \times 10^{-3})$ **M3** vol $\left(= \frac{2.125 \times 10^{-3}}{0.05623}\right)$ = 0.0378 dm^3 or 37.8 cm^3	3
04	2	$K_a = \frac{[H^+][X^-]}{[HX]}$	1
04	3	**M1** $K_a = \frac{[H^+]^2}{[HX]}$ or with numbers **M2** $[H^+] = (\sqrt{(3.01 \times 10^{-5} \times 0.174)} = \sqrt{(5.24 \times 10^{-6})})$ $= 2.29 \times 10^{-3}$ - 2.3×10^{-3} **M3** pH = 2.64 (allow more than 2dp but not fewer)	3
04	4	M1 mol OH^- = $(10.0 \times 10^{-3}) \times 0.125 = 1.25 \times 10^{-3}$ M2 orig mol HX = $(15.0 \times 10^{-3}) \times 0.174 = 2.61 \times 10^{-3}$ M3 mol HX in buffer = orig mol HX – mol OH^- $= 2.61 \times 10^{-3} - 1.25 \times 10^{-3} = 1.36 \times 10^{-3}$ M4 mol X^- in buffer = mol OH^- = 1.25×10^{-3} ($[X^-] = 1.25 \times 10^{-3}/25 \times 10^{-3} = 0.05$) May be scored in M5 expression	6

		M5 $[H^+]$ $\left(= \frac{Ka \times [HX]}{[X^-]}\right)$ $= \frac{3.01 \times 10^{-5} \times 1.36 \times 10^{-3}}{1.25 \times 10^{-3}}$ OR $\frac{3.01 \times 10^{-5} \times 0.0544}{0.05}$ $(= 3.27 \times 10^{-5})$ M6 pH = 4.48 or 4.49 (allow more than 2dp but not fewer)	

Question	Part	Marking guidance	Total marks
05	1	Na2O ionic Strong forces between ions/strong ionic bonding SiO2 macromolecular Strong covalent bonds (between atoms) Allow lots of energy to break covalent bonds Molecular Covalent bonds (between P and O)	6
05	2	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$	1

Question	Part	Marking guidance	Total marks
06	1	Q is iron (II) iodide R is aluminium Sulphate S is iron(III) chloride	6
06	2	Ag + + Cl- --------- AgCl [Fe(H2O)6] 3+ + 3OH Fe(H2O)3(OH)3 + 3H2O 2[Fe(H2O)6] 3+ + 3CO3 2– 2Fe(H2O)3(OH)3 + 3H2O + 3CO2 [Fe(H2O)6] 3+ + 4Cl- [FeCl4] – + 6H2O	4

Question	Part	Marking guidance	Total marks
07	1	ΔE = hv v = ΔE / h = 2.84 × 10−19 / 6.63 × 10−34 = 4.28 × 1014 s−1 / Hz	2
07	2	(One colour of) light is absorbed (to excite the electron) The remaining colour / frequency / wavelength / energy is transmitted (through the solution)	2
07	3	Bigger Blue light would be absorbed OR light that has greater energy than red light would be absorbed OR higher frequency (of light absorbed / blue light) leads to higher ΔE Can only score M2 if M1 is correct.	2
07	4	Any three from: (Identity of the) metal Charge (on the metal) / oxidation state / charge on complex (Identity of the) ligands Co-ordination number / number of ligands Shape	3

Question	Part	Marking guidance	Total marks
08	1	Diagram of an Fe^{3+} / Fe^{2+} electrode that includes the following parts labelled: Solution containing Fe^{2+} and Fe^{3+} ions Platinum electrode connected to one terminal of a voltmeter Salt bridge 298 K and 100 kPa / 1 bar all solutions unit / 1 mol dm^{-3} concentration	5
08	2	$Cu^{2+} + Fe \rightarrow Cu + Fe^{2+}$ $Fe\|Fe^{2+}\|\|Cu^{2+}\|Cu$ correct order Phase boundaries and salt bridge correct, no Pt Copper electrode	4
08	3	$E^\ominus$ Au^+(/ Au) > $E^\ominus$ O_2 (/ H_2O) So Au^+ ions will oxidise water / water reduces Au^+	3

		$2Au^+ + H_2O \rightarrow 2Au + \frac{1}{2}O_2 + 2H^+$	

09	1	Any 2 from: Electrons round P • P has 5 electrons in the outside shell • With 3 electrons from 3 fluorine, there are a total of 8 electrons in outside shell • so 3 bond pairs, 1 non-bond pair Any 2 from: Electron pair repulsion theory • Electron pairs repel as far as possible • Lone pair repels more than bonding pairs Any 1 from: Conclusions • Therefore, tetrahedral / trigonal pyramidal shape • With angle of 109(.5)° decreased to 107°	5