M17/4/CHEMI/SP2/ENG/TZ1/XX/M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

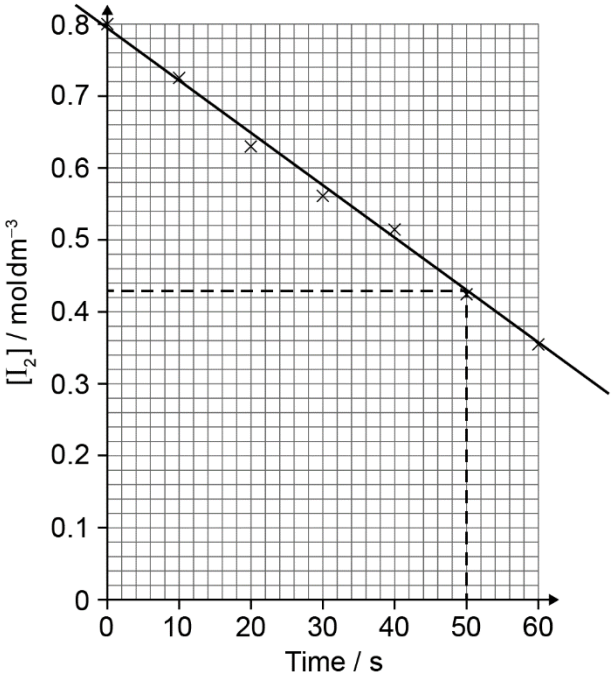
May 2017

Chemistry

Standard level

Paper 2

9 pages

Question			Answers	Notes	Total
1.	a	i	use a colorimeter/monitor the change in colour ***OR*** take samples ***AND*** quench ***AND*** titrate «with thiosulfate» ✓	*Accept change in pH.* *Accept change in conductivity.* *Accept other suitable methods.* *Method must imply "change".*	**1**
1.	a	ii	 best fit line ✓ relative rate of reaction = « $\frac{-\Delta y}{\Delta x} = \frac{-(0.43 - 0.80)}{50}$ = » 0.0074/7.4 x 10^{-3} ✓	*Best fit line required for M1.* *M2 is independent of M1.* *Accept range from 0.0070 to 0.0080.*	**2**
1.	b		*Relationship:* rate of reaction is «directly» proportional to $[H^+]$ ***OR*** rate of reaction α $[H^+]$ ✓ *Explanation:* more frequent collisions/more collisions per unit of time «at greater concentration» ✓	*Accept "doubling the concentration doubles the rate".* *Do **not** accept "rate increases as concentration increases".* *Do **not** accept collisions more likely.*	**2**

Question			Answers	Notes	Total
2.	a		electrostatic attraction ✓ between «a lattice of» metal/positive ions/cations ***AND*** «a sea of» delocalized electrons ✓	*Accept mobile electrons.* *Do **not** accept "metal atoms/nuclei".*	**2**
2.	b		$\frac{(46 \times 7.98) + (47 \times 7.32) + (48 \times 73.99) + (49 \times 5.46) + (50 \times 5.25)}{100}$ ✓ $= 47.93$ ✓	*Answer must have two decimal places with a value from 47.90 to 48.00.* *Award [2] for correct final answer.* *Award [0] for 47.87 (data booklet value).*	**2**
2.	c		*Protons:* 22 ***AND*** *Neutrons:* 26 ***AND*** *Electrons:* 22 ✓		**1**
2.	d	i	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$ ✓		**1**
2.	d	ii	titanium atoms/ions distort the regular arrangement of atoms/ions ***OR*** titanium atoms/ions are a different size to aluminium «atoms/ions» ✓ prevent layers sliding over each other ✓	*Accept diagram showing different sizes of atoms/ions.*	**2**
2.	e	i	ionic ***OR*** «electrostatic» attraction between oppositely charged ions ✓		**1**
2.	e	ii	«simple» molecular structure ***OR*** weak«er» intermolecular bonds ***OR*** weak«er» bonds between molecules ✓	*Accept specific examples of weak bonds such as London/dispersion and van der Waals.* *Do **not** accept "covalent".*	**1**
2.	f	i	$TiCl_4\ (l) + 2H_2O\ (l) \rightarrow TiO_2\ (s) + 4HCl\ (aq)$ correct products ✓ correct balancing ✓	*Accept ionic equation.* *Award M2 if products are HCl and a compound of Ti and O.*	**2**

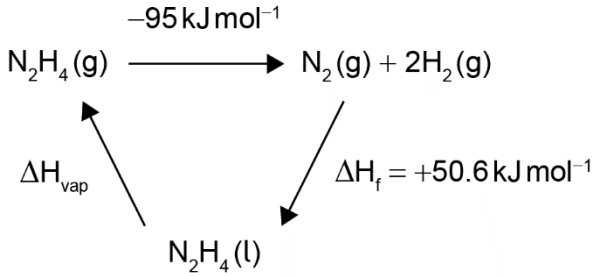
continued…

(Question 2f continued)

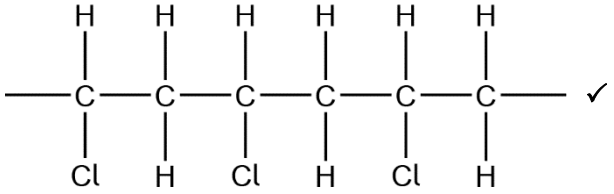
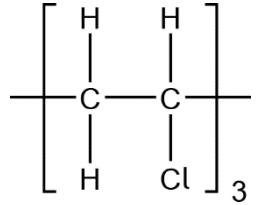
Question			Answers	Notes	Total
2.	**f**	**ii**	HCl causes breathing/respiratory problems ***OR*** HCl is an irritant ***OR*** HCl is toxic ***OR*** HCl has acidic vapour ***OR*** HCl is corrosive ✓	*Accept "TiO_2 causes breathing problems/is an irritant".* *Accept "harmful" for both HCl and TiO_2.* *Accept "smoke is asphyxiant".*	**1**

Question			Answers	Notes	Total
3.	**a**		V_2O_5: +5 ✓ VO^{2+}: +4 ✓	*Do **not** penalize incorrect notation twice.*	**2**
3.	**b**		VO^{2+} (aq) + V^{2+} (aq) + $2H^+$ (aq) → $2V^{3+}$ (aq) + H_2O (l) ✓	*Accept equilibrium sign.*	**1**

Question			Answers	Notes	Total
4.	a		107° ✓	*Accept 100° to <109.5°.* *Literature value = 105.8°*	1
4.	b		removes/reacts with OH^- ✓ moves to the right/products «to replace OH^- ions» ✓	*Accept ionic equation for M1.*	2
4.	c		N_2H_4 (aq) + H_2O (l) ⇌ $N_2H_5^+$ (aq) + OH^- (aq) ✓	*Accept N_2H_4 (aq) + $2H_2O$ (l) ⇌ $N_2H_6^{2+}$ (aq) + $2OH^-$ (aq).* *Equilibrium sign must be present.*	1
4.	d		bubbles ***OR*** gas ***OR*** magnesium disappears ✓ $2NH_4^+$ (aq) + Mg (s) → Mg^{2+} (aq) + $2NH_3$ (aq) + H_2 (g) ✓	*Do **not** accept "hydrogen" without reference to observed changes.* *Accept "smell of ammonia".* *Accept $2H^+$ (aq) + Mg (s) → Mg^{2+} (aq) + H_2 (g)* *Equation must be ionic.*	2
4.	e		no oxygen required ✓		1
4.	f		*bonds broken*: E(N–N) + 4E(N–H) ***OR*** 158 «kJ mol^{-1}» + 4 × 391 «kJ mol^{-1}» / 1722 «kJ» ✓ *bonds formed*: E(N≡N) + 2E(H–H) ***OR*** 945 «kJ mol^{-1}» + 2 × 436 «kJ mol^{-1}» / 1817 «kJ» ✓ «ΔH = bonds broken − bonds formed = 1722 − 1817 =» –95 «kJ» ✓	*Award [3] for correct final answer.* *Award [2 max] for +95 «kJ».*	3

Question			Answers	Notes	Total
4.	g		 ***OR*** ΔH_{vap} = –50.6 kJ mol^{-1} – (–95 kJ mol^{-1}) ✓ «ΔH_{vap} =» +44 «kJ mol^{-1}» ✓	*Award [2] for correct final answer.* *Award [1 max] for –44 «kJ mol^{-1}».* *Award [2] for:* *ΔH_{vap} = –50.6 kJ mol^{-1} –(– 85 kJ mol^{-1})* *+ =34 «kJ mol^{-1}».* *Award [1 max] for –34 «kJ mol^{-1}».*	**2**
4.	h	i	total mass of oxygen «= 8.0 × 10^{-3} g dm^{-3} × 1000 dm^3» = 8.0 «g» ✓ n(O_2) «= $\frac{8.0\text{ g}}{32.00\text{ g mol}^{-1}}$ =» 0.25 «mol» ***OR*** n(N_2H_4) = n(O_2) ✓ «mass of hydrazine = 0.25 mol × 32.06 g mol^{-1} =» 8.0 «g» ✓	*Award [3] for correct final answer.*	**3**
4.	h	ii	«n(N_2H_4) = n(O_2) = $\frac{8.0\text{ g}}{32.00\text{ g mol}^{-1}}$ =» 0.25 «mol» «volume of nitrogen = 0.25 mol × 24.8 dm^3 mol^{-1}» = 6.2 «dm^3» ✓	*Award [1] for correct final answer.*	**1**

Question			Answers	Notes	Total
5.	a		substitution ***AND*** «free-»radical ***OR*** substitution ***AND*** chain ✓	*Award [1] for "«free-»radical substitution" or "S_R" written anywhere in the answer.*	1
5.	b		*Two propagation steps:* $C_2H_6 + \bullet Cl \rightarrow C_2H_5\bullet + HCl$ ✓ $C_2H_5\bullet + Cl_2 \rightarrow C_2H_5Cl + \bullet Cl$ ✓ *One termination step:* $C_2H_5\bullet + C_2H_5\bullet \rightarrow C_4H_{10}$ ***OR*** $C_2H_5\bullet + \bullet Cl \rightarrow C_2H_5Cl$ ***OR*** $\bullet Cl + \bullet Cl \rightarrow Cl_2$ ✓	*Accept radical without • if consistent throughout.* *Allow ECF from incorrect radicals produced in propagation step for M3.*	3
5.	c	i	$C = \frac{24.27}{12.01} = 2.021$ ***AND*** $H = \frac{4.08}{1.01} = 4.04$ ***AND*** $Cl = \frac{71.65}{35.45} = 2.021$ ✓ «hence» CH_2Cl ✓	*Accept* $\frac{24.27}{12.01} : \frac{4.08}{1.01} : \frac{71.65}{35.45}$. *Do **not** accept $C_2H_4Cl_2$.* *Award [2] for correct final answer.*	2
5.	c	ii	molecular ion peak(s) «about» *m/z* 100 ***AND*** «so» $C_2H_4Cl_2$ «isotopes of Cl» ✓ two signals «in ^{1}H NMR spectrum» ***AND*** «so» CH_3CHCl_2 ***OR*** «signals in» 3:1 ratio «in ^{1}H NMR spectrum» ***AND*** «so» CH_3CHCl_2 ***OR*** one doublet and one quartet «in ^{1}H NMR spectrum» ***AND*** «so» CH_3CHCl_2 ✓ 1,1-dichloroethane ✓	*Accept "peaks" for "signals".* *Allow ECF for a correct name for M3 if an incorrect chlorohydrocarbon is identified*	3

Question			Answers	Notes	Total
5.	d		 ✓	*Continuation bonds must be shown. Ignore square brackets and "n".* *Accept*  . *Accept other versions of the polymer, such as head to head and head to tail. Accept condensed structure provided all C to C bonds are shown (as single).*	**1**

6.	a		*Any two of:* planar «X-ray» ✓ C to C bond lengths all equal ***OR*** C to C bonds intermediate in length between C–C and C=C ✓ all C–C–C bond angles equal ✓	*Accept all C to C bonds have same bond strength/bond energy.*	**2 max**
6.	b		*benzene:* «electrophilic» substitution/S_E ***AND*** *cyclohexene:* «electrophilic» addition/A_E ✓	*Accept correct equations.*	**1**