

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 series

9701 CHEMISTRY

9701/42

Paper 4 (Structured Questions), maximum raw mark 100

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the May/June 2015 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Page 4
	Cambridge International A Level – May/June 2015	9701	42

1 (a) fluorine: $1s^2 2s^2 2p^5$ [1]

sulfur: $1s^2 2s^2 2p^6 3s^2 3p^4$

(b) (i) $2HCl \longrightarrow H_2 + Cl_2$ [1]

(ii) bond energies: HF (562) is **stronger** than HCl (431) [1]
or F_2 (158) is **weaker** than Cl_2 (244)

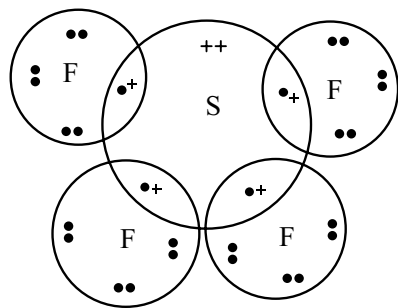
(c) *electronegativity*: [2]

The attraction by an atom / nucleus / element of the electrons in a bond *or* a shared pair *or* a molecule

bond polarity:

..is due to atoms / elements of **different** electronegativities at each end of a bond

(d) (i)



(ii) Yes, it will have a dipole moment, [3]
either because it has an uneven distribution of electrons *or* because it contains a lone pair

or the S–F dipoles don't cancel *or* molecule is not symmetrical *or* diagram of see-saw shape.

(allow an ecf for "no dipole" if their structure in (d)(i) has **no** lone pair)

(e) Sulfur can use its d-orbitals *or* has low-lying / accessible / available d-orbitals *or* can expand its octet. [1]

(allow reverse argument for oxygen; do NOT allow just "sulfur has d-orbitals")

(f) (i) Burning of **fossil** fuels *or* coal / oil / petrol / natural gas (NOT methane *or* hydrocarbons) *or* volcanoes *or* roasting / burning sulfide ores

(ii) Acid rain [2]

[Total: 11]

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – May/June 2015	9701	42

2 (a) $A_r = 204 \times 0.019 + 206 \times 0.248 + 207$ [2]

$= 207.21$

(correct ans = [2])

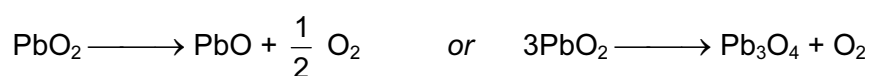
The **last** answer written by the candidate needs to be written with 2 d.p. to get the last mark.

(b) (i) Tin(II) oxide is more basic than tin(IV) oxide [1]
or tin(II) oxide is less acidic than tin (IV) oxide

(ii) e.g. $\text{SnO} + 2\text{HCl} \longrightarrow \text{SnCl}_2 + \text{H}_2\text{O}$ (or ionic or with H_2SO_4) [2]
 $\text{SnO}_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$ (or ionic or with KOH etc.)

(iii) SnO_2 stays the same (white) or is stable or no reaction [3]

PbO_2 changes colour (from brown/black to yellow/orange/red)



[Total: 8]

Page 4	Mark Scheme	Syllabus	Page 4
	Cambridge International A Level – May/June 2015	9701	42

3 (a) $^{33}\text{P}^-$ [2]

(b) Solubility decreases (from Mg to Ba or down the group) [4]

Both lattice energy / ΔH_{latt} and enthalpy change of hydration / ΔH_{hyd} are involved

enthalpy change of hydration **decreases more** than lattice energy

So enthalpy change of solution / ΔH_{sol} becomes more endothermic or more positive or less exothermic or less negative (NOT ΔH_{sol} decreases, or increases)

(c) precipitate/solid CaSO_4 would form [2]
 due to the **common ion effect** or K_{sp} is exceeded or the following equilibrium shifted over to the right $\text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightleftharpoons \text{CaSO}_4(\text{s})$

(d) charge passed = $1.8 \times 40 \times 60$ (= 4320 C) [4]

$$n(\text{e}^-) = 4320/96500 \quad (= 4.477 \times 10^{-2} \text{ mol}) \text{ ecf}$$

$$n(\text{Cr}) = 0.776/52 \quad (= 1.492 \times 10^{-2} \text{ mol}) \text{ ecf}$$

$$n = 4.477 \times 10^{-2} / 1.492 \times 10^{-2} = 3.00 \quad (=3)$$

[Total: 12]

Page 5	Mark Scheme	Syllabus	Page
	Cambridge International A Level – May/June 2015	9701	42

- 4 (a) (i) a solution that resists / minimises a change in its pH or **helps** maintain its pH..... [2]
 (NOT any of: "maintains pH"; "keeps pH constant"; "no change in pH")
when small amounts of acid/H⁺ or base/OH⁻ are added (**both** acid and base are needed)
- (ii) HCO₃⁻ reacts with H⁺ ions as follows: [2]

$$\text{HCO}_3^- + \text{H}^+ \longrightarrow \text{H}_2\text{CO}_3 \text{ (or } \text{H}_2\text{O} + \text{CO}_2\text{)}$$
 and with OH⁻ ions thus:

$$\text{HCO}_3^- + \text{OH}^- \longrightarrow \text{CO}_3^{2-} + \text{H}_2\text{O}$$
 (the equation arrows can be equilibrium arrows, as long as HCO₃⁻ is on the left)
- (iii) (pK_a = -log(K_a) = 7.21) [2]

$$\text{pH} = \text{pK}_a + \log\left(\frac{[\text{base}]}{[\text{acid}]}\right) = 7.21 + \log(0.5/0.3)$$

$$= \mathbf{7.43 \text{ (7.4)}}$$
- (b) (i) K_{sp} = [Ag⁺]³[PO₄³⁻] and units: mol⁴dm⁻¹² [1]
- (ii) call [PO₄³⁻] = x, then [Ag⁺] = 3x, and K_{sp} = 27x⁴ [3]

$$x = (\text{K}_{\text{sp}}/27)^{1/4} = (1.25 \times 10^{-20}/27)^{1/4} = 4.64 \times 10^{-6} \text{ mol dm}^{-3}$$

$$[\text{Ag}^+] = 3x = \mathbf{1.39 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}} \quad (\text{allow } \mathbf{1.4 \times 10^{-5}})$$
- (c) H₃PO₃ + 2Fe³⁺ + H₂O \longrightarrow H₃PO₄ + 2Fe²⁺ + 2H⁺ [2]

$$E_{\text{cell}} = 0.77 - (-0.28) = (+)\mathbf{1.05 \text{ V}}$$
 or 3H₃PO₃ + 3H₂O + 2Fe³⁺ \longrightarrow 3H₃PO₄ + 6H⁺ + 2Fe

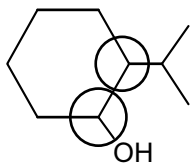
$$E_{\text{cell}} = -0.04 - (-0.28) = (+)\mathbf{0.24 \text{ V}}$$

[Total: 12]

Page 6	Mark Scheme	Syllabus	Page 4
	Cambridge International A Level – May/June 2015	9701	DailyBased.com

5 (a) (i) $\text{H}_2 + \text{Pt}$ or $\text{H}_2 + \text{Ni/Pd} + \text{heat/warm}$ or $50^\circ < T < 500^\circ\text{C}$ [1]

(ii)

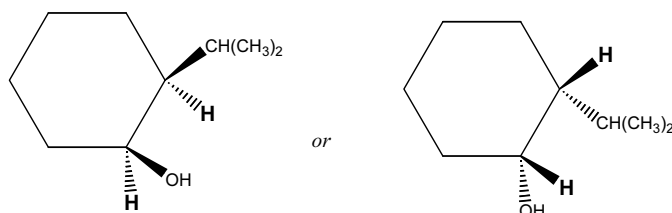


[1]

(iii) $2^2 = 4$

[1]

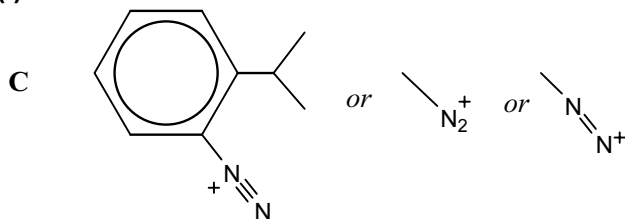
(iv)



2 Hs have to be on the **same side** of the ring. Allow $-\text{C}_3\text{H}_7$ or $-\text{R}$ for $-\text{CH}(\text{CH}_3)_2$ [1]

(b) (i)

[1]



(ii) step 1: **conc** $\text{HNO}_3 + \text{H}_2\text{SO}_4$ (@ $25^\circ\text{C} < T < 60^\circ\text{C}$ – see below) ("aq" negates) [4]

step 2: $\text{Sn/Fe} + \text{HCl}$

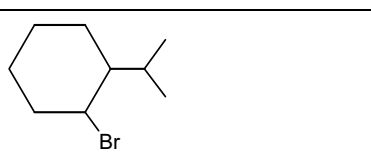
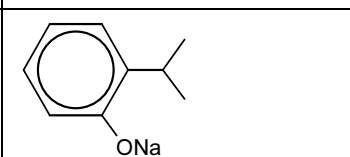
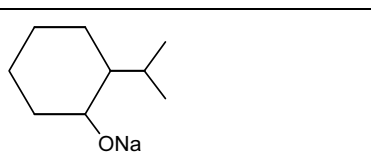
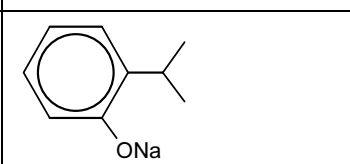
step 3: HNO_2 or $\text{NaNO}_2 + \text{HCl}$ (@ $T < 10^\circ\text{C}$ – see below)

both temperatures correct for steps 1 + 3 (temperature not required for step 2)

(inclusion of the word "heat" or "reflux" in step 3 negates the temperature mark)

(c)

[5]

HBr	no reaction	
Na		
NaOH(aq)		no reaction

[Total: 14]

Page 7	Mark Scheme	Syllabus	Page 4
	Cambridge International A Level – May/June 2015	9701	42

6 (a) There are three acceptable alternatives – follow each column down vertically:

(i) D is	RCOCl	$\text{RCOOCH}_2\text{CH}_3$	$\text{RCO}_2^- \text{NH}_4^+$
(ii) step 1	SOCl_2 (or PCl_3 or PCl_5)	ethanol (e.g.) + conc H_2SO_4	NH_3
(ii) step 2	NH_3 (NaOH negates this mark)	heat	
(ii) step 3	LiAlH_4 (aq) negates (NOT NaBH_4 ; $\text{Sn} + \text{HCl}$ etc.)		

(b) (i) amine (other groups negate) [1]

(ii) phenol **and** carboxylic acid (**both** needed) [1]

(iii) [4]

compound	first functional group	second functional group
E	amide	alcohol
F	amine	carboxylic acid
G	amine	ester
H	amide	phenol

(iv) Mark this in the following way. For each structure of **E**, **F**, **G** and **H**: [4]

- check whether the structure fits the molecular formula $\text{C}_8\text{H}_9\text{NO}_2$, i.e. that it has: **one** nitrogen, **two** oxygens and **eight** carbons.
- check that it contains the two groups that the candidate's answers to part (ii) says it contains.

[Total: 13]

Page 8	Mark Scheme	Syllabus	Page
	Cambridge International A Level – May/June 2015	9701	42

- 7 (a) L – it is the only compound that is an amino acid *or* can **form** (NOT *contain*) [1]
 –NH–CO– / amide / peptide linkages / bonds
or
 it contains an N atom / NH₂ group / CO₂H group
- (b) mark both parts of this together – max [4] from the following six points [4]
 M1 mRNA is complementary to *or* a copy of (a portion of) DNA
 M2 mRNA encodes the sequence of amino acids in proteins *or* each of its codons (base triplets) codes for one amino acid
 M3 mRNA binds to / associates with the ribosome
 M4 tRNAs are **specific** to their amino acids
 M5 tRNA contains an **anticodon** *or* bonds to the codon / mRNA through base pairing *or* **translates** the RNA code into the amino acid sequence
 M6 tRNA carries the amino acid to the ribosome / mRNA
- (c) max [3] from the following six points. [3]
 M1 the pH of that area of the protein would change
 M2 protein becomes less hydrophilic / soluble *or* more hydrophobic
 M3 fewer hydrogen bonds *or* more van der Waals' (id–id) forces
 M4 fewer ionic bonds form
 M5 the tertiary structure / folding / (3D) shape (of the protein) would change
 M6 the active site would be different / less efficient

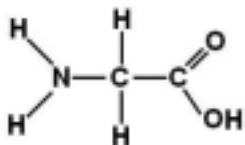
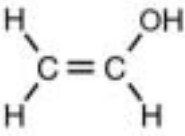
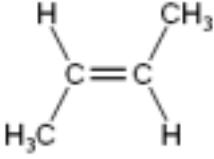
[Total: 8]

Page 9	Mark Scheme	Syllabus	Paper 4
	Cambridge International A Level – May/June 2015	9701	42

- 8 (a) (i) The **nucleus/proton** of a hydrogen atom has **spin** [1]
- (ii) Hydrogen doesn't have enough electrons/electron density [1]
- (iii) S/sulfur – it has the greatest number of electrons *or* highest electron density [1]
- (b) (i) 12 protons (=9+2+1) [1]
- (ii) The group responsible for this peak is –OH (allow NH) [2]
The D in D₂O **exchanges** with the H in –OH *or* H is **replaced** by D *or* "–OH → –OD",
- (iii) The adjacent carbon atom has no hydrogen atoms bonded to it [1]
- (iv) Methyl/CH₃ group [1]
- (v) P is (CH₃)₃C–CH₂OH [1]
- (c) (i) $n = \frac{100 \times (M+1)}{1.1 \times M} = \frac{100 \times 0.5}{1.1 \times 9.3} = 50/10.23$ [1]
= 4.89 hence **5** carbons
- (ii) (Ratio of ⁷⁹Br:⁸¹Br is 1 : 1), [1]
hence ratio of M : M+2 : M+4 is **1 : 2 : 1**
- (iii) Molecular formula of **R** is C₅H₁₀Br₂ [1]

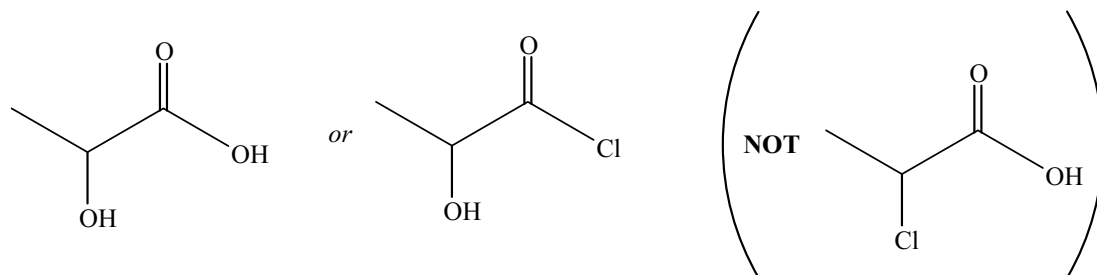
[Total: 12]

9 (a) [3]

monomer	addition	condensation	both
		✓	
	✓		
	✓		

(b) polythene is non-polar *or* its bonds are non-polar
so not (easily) **hydrolysed** [2]

(c) (i) [1]



(Allow displayed, skeletal, part-skeletal, structural etc.)

(ii) The **ester** (or –COO–) linkage/bond is hydrolysed *or* reacts with water [1]

(d) Polythene has (weak) van der Waals' (*or* id–id) forces [3]
PVC has **stronger** van der Waals' forces *or* additional dipole forces
Nylon has (strong) hydrogen bonding

[Total: 10]