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.

CAMBRIDGE
International Examinations

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

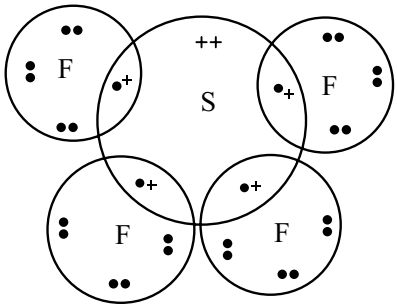
sulfur: $1s^2 2s^2 2p^6 3s^2 3p^4$

(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]

© Cambridge International Examinations 2015

2 **(a)** A_r = 204 × 0.019 + 206 × 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. $SnO + 2HCl \longrightarrow SnCl_2 + H2O$(*or* ionic *or* with H_2SO_4) **[2]**
$SnO_2 + 2NaOH \longrightarrow Na_2SnO_3 + H_2O$ (*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)

$PbO_2 \longrightarrow PbO + \frac{1}{2} O_2$ *or* $3PbO_2 \longrightarrow Pb_3O_4 + O_2$

[Total: 8]

© Cambridge International Examinations 2015

3 (a) $^{33}P^{-}$ **[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 $Ca^{2+}(aq) + SO4^{2-}(aq) \rightleftharpoons CaSO_4(s)$

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

$n(e^-)$ = 4320 / 96500 (= 4.477×10^{-2} mol) ecf

n(Cr) = 0.776 / 52 (= 1.492×10^{-2} mol) ecf

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

[Total: 12]

© Cambridge International Examinations 2015

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) HCO_3^- reacts with H^+ ions as follows: **[2]**

$$HCO3^- + H^+ \longrightarrow H_2CO_3 \text{ (}or\text{ } H_2O + CO_2\text{)}$$

and with OH^- ions thus:

$$HCO_3^- + OH^- \longrightarrow CO_3^{2-} + H_2O$$

(the equation arrows can be equilibrium arrows, as long as HCO_3^- is on the left)

(iii) ($pK_a = -\log(K_a) = 7.21$) **[2]**

$pH = pK_a + \log([\text{base}]/[\text{acid}]$ $= 7.21 + \log(0.5/0.3)$
$= \mathbf{7.43\ (7.4)}$

(b) (i) $K_{sp} = [Ag^+]^3[PO_4^{3-}]$ **and** units: mol^4dm^{-12} **[1]**

(ii) call $[PO_4^{3-}] = x$, then $[Ag^+] = 3x$, and $K_{sp} = 27x^4$ **[3]**

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

$[Ag^+] = 3x = \mathbf{1.39 \times 10^{-5}}$ (mol dm^{-3}) (allow $\mathbf{1.4} \times 10^{-5}$)

(c) $H_3PO_3 + 2Fe^{3+} + H_2O \longrightarrow H_3PO_4 + 2Fe^{2+} + 2H^+$ **[2]**

$E\ominus_{cell} = 0.77 - (-0.28) = (+)\mathbf{1.05}$ V

or $3H_3PO_3 + 3H_2O + 2Fe^{3+} \longrightarrow 3H_3PO_4 + 6H^+ + 2Fe$

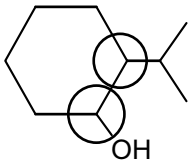
$E\ominus_{cell} = -0.04 - (-0.28) = (+)\mathbf{0.24}$ V

[Total: 12]

© Cambridge International Examinations 2015

5 (a) (i) H_2 + Pt *or* H_2 + Ni / Pd + heat / warm *or* 50° < T < 500 °C **[1]**

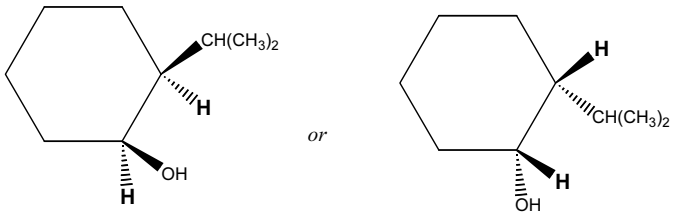
(ii)



[1]

(iii) 2^2 = **4** **[1]**

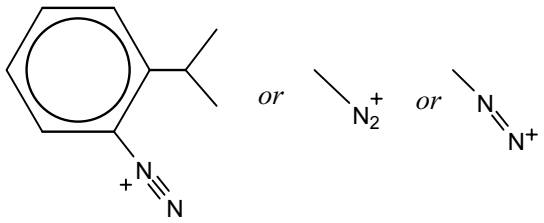
(iv)



2 Hs have to be on the **same side** of the ring. Allow $–C_3H_7$ *or* –R for $–CH(CH_3)_2$ **[1]**

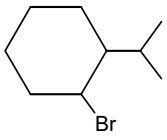
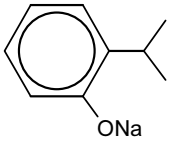
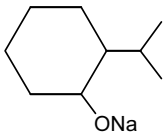
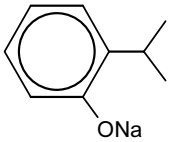
(b) (i) **[1]**

C



(ii) step 1: **conc** HNO_3 + H_2SO_4 (@ 25 °C < T < 60 °C – see below) ("aq" negates) **[4]**
step 2: Sn / Fe + HC*l*
step 3: HNO_2 *or* $NaNO_2$ + HC*l* (@ T< 10 °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]

© Cambridge International Examinations 2015

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

(i) D is	RCO*Cl*	$RCOOCH_2CH_3$	$RCO_2^-\ NH_4^+$
(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 $NaBH_4$; Sn + HC*l* 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 $C_8H_9NO_2$, 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]

© Cambridge International Examinations 2015

7 (a) **L** – it is the only compound that is an amino acid *or* can **form** (NOT *contain*) –NH–CO– / amide / peptide linkages / bonds **[1]**
or
it contains an N atom / NH_2 group / CO_2H 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]

© Cambridge International Examinations 2015

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)
The D in D_2O **exchanges** with the H in –OH *or* H is **replaced** by D
or "–OH $\rightarrow$ –OD", **[2]**

(iii) The adjacent carbon atom has no hydrogen atoms bonded to it **[1]**

(iv) Methyl / CH_3 group **[1]**

(v) P is $(CH_3)_3C–CH_2OH$ **[1]**

(c) (i) $n = \frac{100 \times (M+1)}{1.1 \times M} = \frac{100 \times 0.5}{1.1 \times 9.3} = 50/10.23$
= 4.89 hence **5** carbons **[1]**

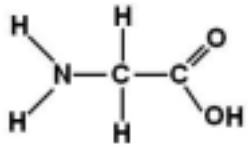
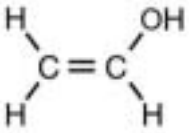
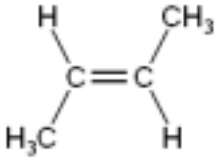
(ii) (Ratio of ^{79}Br:^{81}Br is 1 : 1),
hence ratio of M : M+2 : M+4 is **1 : 2 : 1** **[1]**

(iii) Molecular formula of **R** is $C_5H_{10}Br_2$ **[1]**

[Total: 12]

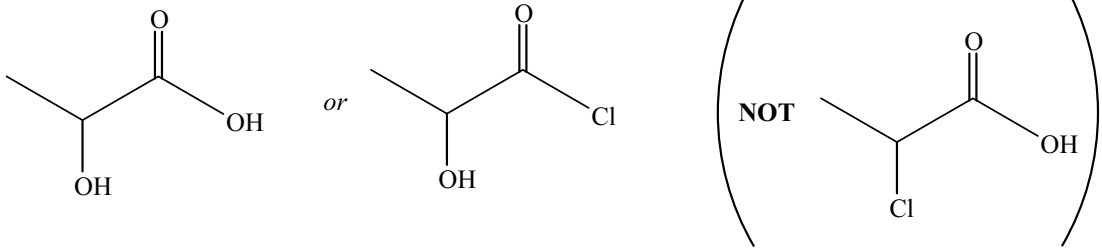
© Cambridge International Examinations 2015

9 (a) **[3]**

monomer	addition	condensation	both
		✓	
	✓		
	✓		

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

(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]

© Cambridge International Examinations 2015