GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Chemistry
(Subject Code CHM1)

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CHM1 Atomic Structure, Bonding and Periodicity

SECTION A

Question 1

(a) Proton mass = 1 charge = +1 1
Electron mass ≤ 1/1800 **or** ≤ 5.6×10^{-4} charge = –1 1
(Do not accept +1 for proton mass or 'g' units)

(b) (i) 13 1

(ii) Si 1
Mass number = 28 **and** atomic number = 14 1
(Do not accept 28.1 or 28.0 or 'Silicon')

(c) Mean (average) mass of an atom / all the isotopes 1
$1/12^{th}$ mass of atom of ^{12}C 1

or Mass of 1 mole of atoms of an element (1)
$1/12^{th}$ mass of 1 mole of ^{12}C (1)

or Average mass of an atom / all the isotopes (1)
Relative to the mass of a ^{12}C atom taken as exactly 12 / 12.000 (1)
(Penalise 'weight' once only) (Ignore 'average' mass of ^{12}C)
(Do not allow 'mass of average atom')

(d) A_r = (24 × 0.735) + (25 × 0.101) + (26 × 0.164) 1
= 24.4 1
(mark M2 conseq on transcription error or incorrect addition of %)

(e) M_r = highest m/z value 1
(NOT 'highest/largest/right-hand' peak)

Total 10

Question 2

(a) (i) 4.86×10^{-3} 1

(ii) 2.43×10^{-3} *(mark consequential on (a)(i))* 1

(iii) 2.43×10^{-2} *(mark consequential on (a)(ii))* 1

(iv) $3.01/2.43 \times 10^{-2}$ *(mark consequential on (a)(iii))* 1
124 1
(Do not allow 124 without evidence of appropriate calculation in (a)(iii))

(b) $M_r(Na_2CO_3) = 106$ 1
$M_r\ (xH_2O) = 250 - 106 = 144$ *(mark consequential on M1)* 1
$x = 8$ *(mark consequential on M2)* 1
(*Penalise sf errors once only)*

(c) (i) $PV = nRT$ 1

(ii) Moles Ar = 325/39.9 = 8.15 (*accept M_r = 40)* 1

$P = nRT/V = (8.15 \times 8.31 \times 298)/5.00 \times 10^{-3}$ 1
$= 4.03 \times 10^6$ Pa or $= 4.03 \times 10^3$ kPa 1
Range = 4.02 ×10^6 Pa to 4.04 ×10^6 Pa

(If equation incorrectly rearranged, M3 & M4 = 0 If n =325, lose M2)

(Allow M1 if gas law in (ii) if not given in (i))

Total 12

Question 3

(a) Enthalpy change/required when an electron is removed/knocked out/displaced (*Ignore 'minimum' energy*) 1

From a gaseous atom (*could get this mark from equation*) 1

(b) $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ Equation 1
Or $Mg^+(g) + e^- \rightarrow Mg^{2+}(g) + 2e^-$ State symbols (*Tied to M1*) 1

(c) Increased/stronger nuclear charge **or** more protons 1
Smaller atom **or** electrons enter the same shell **or** same/similar shielding 1

(d) Electron removed from a shell of lower energy **or** smaller atom **or** e^- 1
nearer nucleus **or** e^- removed from 2p rather than from 3s
Less shielding 1
(Do not accept 'e$^-$ from inner shell')

Total 8

Question 4

(a) **4**LiH + $AlCl_3$ → $LiAlH_4$ + **3**LiCl 1

(b) H^- = $1s^2$ **or** $1s_2$ 1

(c) Tetrahedral **or** diagram *(Not distorted tetrahedral)* 1

(Equal) repulsion 1

between four bonding pairs / bonds 1
(*Not repulsion between H atoms loses M2 and M3*)
(*Not 'separate as far as possible'*)
('*4' may be inferred from a correct diagram*)

(d) Dative (covalent) or coordinate 1

Lone pair **or** non-bonding pair of electron **or** both e^- 1

QoL Donated from H^- to Al **or** shared between H and Al 1
(tied to M2)
(Not 'from H atom') (*Not 'to Al ion'*) (*Not 'e^-s transferred'*)

Total 8

Question 5

(a) Increases 1
Heat or steam or gas phase or H temp (>100º) (*NOT 'hot'*) 1
$Mg + H_2O \rightarrow MgO + H_2$ 1
(*Ignore state symbols – even if they are wrong*)

(b) White precipitate/solid/suspension (*Not 'cloudy / milky'*) 1

$BeCl_2 + 2NaOH \rightarrow Be(OH)_2 + 2NaCl$ 1
or $Be^{2+} + 2OH^- \rightarrow Be(OH)_2$
(*Accept $BeCl_2 + 2OH^- \rightarrow Be(OH)_2 + 2Cl^-$*)

Ppt (re)dissolves or solution goes clear (*Allow 'ppt disappears'*) 1
(NOT 'solution forms')

$Be(OH)_2 + 2OH^- \rightarrow Be(OH)_4^{2-}$ [*NOT* $Be(OH)_6^{4-}$] 1
or $Be(OH)_2 + 2NaOH \rightarrow Na_2Be(OH)_4$

Total 7

SECTION B

Question 6

(a) Tendency **or** strength **or** ability **or** power of an atom/element/nucleus to attract/withdraw electrons / e^- density / bonding pair / shared pair 1

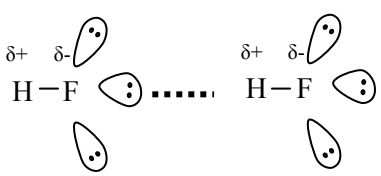
In a covalent bond *(tied to M1 – unless silly slip in M1)* 1
(If molecule/ion then = CE = 0) (*NOT electron (singular) for M1*)
Mark as 2 + 2

Increase in size **or** number of shells **or** increased shielding **or** bonding electrons further from nucleus [*NOT 'increase in number of electrons'*] 1

Decreased attraction for (bonding) electrons ***(tied to M3)*** 1
(If 'ion' here, lose M3 and M4) (*NOT 'attraction of covalent bond'*)
(Ignore reference to proton number or effective nuclear charge)

(b) Hydrogen bonding *(full name)* 1
Diagram shows at least one $^{\delta+}$H **and** at least one $^{\delta-}$F 1
(If full charges shown, M2 = 0)

3 lone pairs shown on at least one fluorine atom 1
H-bond indicated, between H and a lone pair on F 1



(If atoms not identified, zero for diag) (*'Fl' for fluorine - mark to Max 2*)
(Max 1 if only one HF molecule shown, ***or*** *HCl shown*)

Dipole results from electronegativity difference **or** values quoted 1
('*difference' may be inferred*)
(Allow explanation – e.g. F attracts bonding electrons more strongly than H)

QoL Fluorine more/very electronegative **or** iodine less electronegative 1
or electronegativity difference too small in HI
Comparison required, may be implied.

HI dipole weaker or bonding e^- more equally shared - wtte 1

(c) NaCl is <u>ionic</u> (lattice) (*Treat atoms/molecules as a contradiction*) 1
(*Accept 'cubic lattice'*)

Diamond is macromolecular/giant covalent/giant atomic/giant molecular 1
(*NOT molecular or tetrahedral*) *(Ionic/van der Waals' = CE = 0)*

(Many) covalent/C-C bonds need to be broken / overcome 1
(*NOT just 'weakened' etc.*) (*'Covalent' may be inferred from diagram*)
(Treat diagram of graphite (without one of diamond) as a contradiction – lose M2 but allow M3/M4])

Which takes much energy **or** covalent bonds are strong 1
(References to van Der Waals' bonds breaking lose M3/M4)

Total 15