Version 1.0: 1006

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 5421

CHM1 Atomic Structure, Bonding and Periodicity

Mark Scheme

2006 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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.

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CHM1

SECTION A

Question 1

(a) Atoms/isotopes/particles/species with the same (number of) <u>protons</u> and different (number of) <u>neutrons</u> (1)
[Not atomic number/mass number/molecules/same element/diff electrons]

(b) $^{37}_{17}Cl$ Mass number (1)
17 & Cl (1)
[Not 37.0] *[Mark independently]* *[ignore charges]*

(c) (i) $2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$ (1)
[allow reversed $4s^2\ 3d^{10}$] *[allow capitals/subscripts]*

(ii) $A_r = \dfrac{(70 \times 24.4) + (72 \times 32.4) + (74 \times 43.2)}{100}$ (1)
[Wrong approach or not dividing by 100 = CE = 0]
= <u>72.4</u> (1)
[Answer to 1 d.p.] *[Mark conseq on transcription error]*

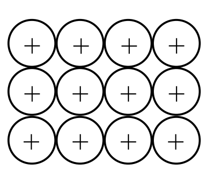
(iii) Magnet/electromagnet/magnetic field / electric field/charge on negative/accelerator plate (1)
Correct link between deflection and *<u>m/z</u>* (1)
Correct link between deflection and field (1)
[Penalise 'reflected'/'diffracted' once only]
[Ignore references to molecules/atoms/particles]
[Consolation mark: allow correct link between mass and deflection for 1 mark out of the 2]

(iv) $^{72}Ge^{2+}$ <u>only</u> (1)
<u>Same</u> m/z as $^{36}S^{+}$ *[Mark independently]* (1)

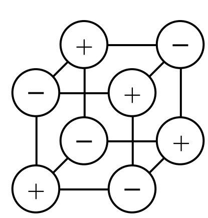
Total 11

Question 2

(a)



(1)



(1)

[Diagrams must be complete and accurate]

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(b) (i) Attraction /electrostatic forces/bonds/attractions between (positive) ions/lattice and delocalised/free electrons/sea of electrons. (1)
[Not metallic bonding] *[Not just 'forces']*

(ii) Electrostatic attractions/forces between ions or attractions between (oppositely charged) ions/ Na^+ & Cl^- (1)

[Not ionic bonding]

(iii) (Here) the ionic bonding in NaCl is stronger/requires more energy to break than the metallic bonding in Na (1)
QoL Accept 'bonding/forces of attraction in NaCl is stronger than in Na'
[If IMF/molecules/van der Waals'/dipole-dipole mentioned in parts(i) or (ii), then CE = 0 for parts (i) and/or(ii) and CE = 0 for part(iii)]

(c) Comparison:
Sodium conducts **and** sodium chloride does NOT conduct (1)
Allow 'only Na conducts'
Accept 'Na conducts, NaCl only conducts when molten'
[Do not accept sodium conducts better than sodium chloride etc.]
Explanation:
(Delocalised) electrons flow though the metal (1)
Allow e^- move/carry current/are charge carriers/transfer charge.
[Not 'electrons carry electricity']
[Not 'NaCl has no free charged particles']
Ions can't move in solid salt (1)

(d) Layers can slide over each other – idea that ions/atoms/particles move (1)
[Not molecules] *[Not layers separate]*

(e) (i)

	Na	Cl	O	
	$\frac{21.6}{23}$	$\frac{33.3}{35.5}$	$\frac{45.1}{16}$	(1)
	0.9(39)	0.9(38)	2.8(2)	
Hence:	1	1	3	(1)

Accept backwards calculation, i.e. from formula to % composition, and also accept route via M_r to 23; 35.5; 48, and then to 1:1:3
[If % values incorrectly copied, allow M1 only]
[If any wrong A_r values/atomic numbers used = CE = 0}

(ii) $3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$ (1)

Total 12

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Question 3

(a) (i) Avogadro's number/constant of molecules/particles/species / 6×10^{23} (1)
[Not 'atoms']
Or same number of particles as (there are atoms) *[Not molecules]* in 12.(00)g of ^{12}C

(ii) *Moles* $O_2 = \frac{0.350}{32}$ *(= 1.09×10^{-2} mol)* (1)
$= 29 (\times 1.09 \times 10^{-2})$ (1)
[Accept answers via 4 separate mole calculations]
= 0.316 - 0.317 mol [answer to 3+ sf] (1)
[Mark conseq on errors in M1/M2]

(iii) Moles of nitroglycerine = $4 \times 1.09 \times 10^{-2}$ (= 0.0438 mol) (1)
[Mark conseq on their moles of O_2]
M_r of nitroglycerine = 227 or number string (1)
Moles of nitroglycerine = 227×0.0438 = 9.90 - 9.93(g) *[answer to 3+ sf]*
[If string OK but final answer wrong then allow M6 but AE for M7]
[Mark conseq on error in M_r] *[Penalise wrong units]*
[Penalise sig. fig. errors once only in whole question]

(b) $pV = nRT$ ***or*** $pV = \frac{mRT}{M_r}$ ***or*** $p = \frac{nRT}{V}$ (1)

$p = \frac{nRT}{V} = \frac{0.873 \times 8.31 \times 1100}{1.00 \times 10^{-3}}$ (1)

= 7980093 **or** 7980 **or** 7.98 *[ignore s.f.]* (1)

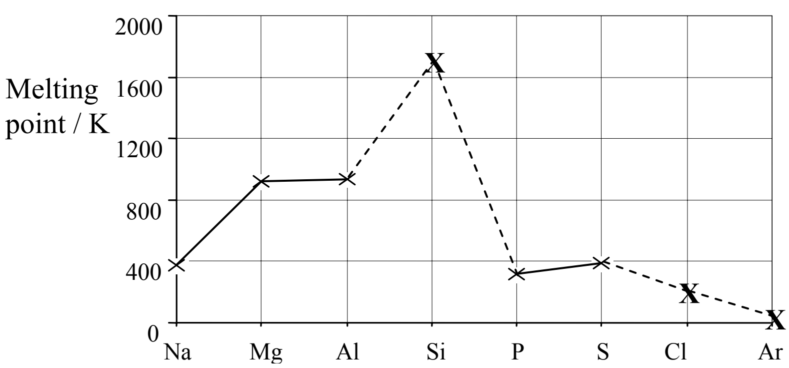
units = Pa **or** kPa **or** MPa (as appropriate) (1)

[If error in conversion from Pa, treat as a contradiction of the units mark]
[If transfer error, mark conseq but penalise M2]
[If data from outside of question 3(b) used, penalise M2 and M3]
[If pV expression incorrectly rearranged, penalise M2 and M3]
[if T = 1373 K used, penalise M2]

Total 11

Question 4

(a) (i)



M1 Si: cross ≥ 1200 (1)
M2 Cl: cross below S (1)
M3 Ar: cross below Cl *[allow, even if M2 wrong)* (1)
[If Cl cross missing and Ar below S, allow M3]

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(ii) Si is macromolecular/giant molecular/giant covalent/ giant atomic (1)
Covalent bonds need to be broken/accept 'overcome' (1)
[Not loosened/weakened]
Covalent bonds are strong / many covalent bonds involved/requires much energy/hard to break (1)
[Tied to 'break' or near miss in M2] *[Not 'structure' is broken]*
[Must mention 'covalent' somewhere in part (a)(ii) to earn M2/M3]
[If van der Waals'/IMF mentioned M2/M3 = CE = 0.
[If ions mentioned M1/M2/M3 = CE = 0]

(iii) Intermolecular force = van der Waals'/induced dipole-dipole/dispersion forces (1)
QoL Sulphur has greater M_r / size / surface area/more electrons/more atoms **so** stronger intermolecular forces (comparison) (1)
[Mark separately] *[Not 'more shells']*

(b) Trend: Decreases *[If trend wrong = CE = 0]* (1)
Increase in size of ion/atom / more shells / decrease in charge density / decrease in charge size ratio (1)
Weaker attraction for delocalised/free/sea of electrons / weaker metallic bonding (1)
[Ignore shielding] *[van der Waals' etc. = CE = 0 for M2 and M3]*

Total 11

SECTION B

Question 5

(a) (1)

Hydroxide: ***solubility increases*** (1)

Sulphate: ***solubility decreases*** ***[BOTH inc/dec allow ½]***
[Allow correct solubilities of top (Mg) and bottom (Ba) cpds]

(1)

Add: ***$BaCl_2(aq)$ / $Ba(NO_3)_2(aq)$ / $Ba(OH)_2(aq)$*** ***[Not solid added]***
[Not Ba^{2+} / Ba / Ba + HCl / $Pb(NO_3)_2(aq)$]

[If $BaSO_4$ / H_2SO_4 used, M3 to M6 = CE = 0]
[Allow any sensible nitrate test as an alternative to the sulphate test]

[Note: If M3 not awarded but test would work, allow correct observations and equations]

(1)

Na_2SO_4 ***white precipitate / solid / suspension*** **[not cloudy/milky]**

(1)

$NaNO_3$ ***no change***

$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$ (1)

Accept ionic equation

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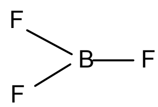
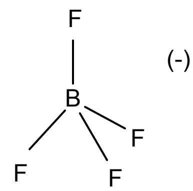
(b) (i)





(1) (1)

[Do not allow shapes which show a lone pair]

BF_3 Trigonal planar/planar triangular *[Not plane triangle]* (1)

BF_4^- Tetrahedral *[Not distorted tetrahedral]* (1)

Equal repulsion between (4) bonding pairs/bonds/bonding electrons (1)

109(½) ° (1)

(ii) Lone pair donated / both electrons supplied by one atom (1)

from F^- (to B) [ignore missing charge or fluorine or 'atom'] (1)

dative/dative covalent/coordinate bonding (1)

Total 15