Version 1.0

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 5421

CHM1 Atomic Structure, Binding and Periodicity

Mark Scheme

2005 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.

SECTION A

Question 1

(a)	(i)	(atoms with the) same number of protons / same atomic number /atoms of the same element;	1
		(molecules = contradiction)	
		But different number of neutrons / different mass number;	1
		(not different atomic mass or A_r)	
	(ii)	detected by: +ve ions collide with / are directed or deflected to / are collected at the detector;	1
		causing current to flow / detected electrically / idea of electricity or voltage generated;	1
		(not 'charge produced' or 'detected electronically')	
		abundance measured: idea that current depends on abundance/number of ions hitting detector;	1
(b)	(i)	<u>mean /average</u> <u>mass of an atom / all the isotopes;</u>	1
		1/12th mass of atom of ^{12}C ;	1
		(mark independently)	
		OR	
		<u>mass of 1 mole of atoms (of an element)</u> ;	1
		1/12th mass of 1 mole of ^{12}C ;	1
		OR	
		average mass of a molecule/entity;	1
		relative to the mass of a ^{12}C atom taken as 12 / 12.000;	1
		(penalise 'weight' once only)	
		(ignore 'average' mass of ^{12}C)	
		(do not allow 'mass of average atom')	
	(ii)	$\frac{(54 \times 5.8) + (56 \times 91.6) + (57 \times 2.6)}{100}$;	1
		= 55.9;	1

(c) (i) $1s^2\ 2s^2 2p^6 3s^2 3p^6 3d^6$; 1
(accept subscripts or caps; ignore $4s^0$)
(penalise missing shell numbers)

(ii) highest energy level / last sub-shell to be filled / is (3)d;

OR

outermost electrons in the d sub-shell/orbital; 1
(*not incomplete d sub-shell)*
(not valance electron in d sub-shell)

(iii) no difference; 1
same e^- arrangement / same number of e^- / same valence e^-;

OR

same chemical properties;

OR

chemical properties determined by electrons; 1
(M2 tied to correct answer for M1)

Question 2

(a)	moles HNO_3	=	$175 \times 10^{-3} \times 1.5$ = (0.2625 mol);	1
	moles $Pb(NO_3)_2$	=	½ × 0.2625 = (0.131 mol);	1
	M_r $Pb(NO_3)_2$	=	331(.2);	1
	mass $Pb(NO_3)_2$ *(accept 43.2 – 43.8)*	=	331.2 × 0.131 = 43.5 g;	1

(M1 & M2 are process marks. If error in M1, or in M2, do not mark M4 consequentially, i.e. do not award M4)

(if atomic numbers used in M3, do not award M4)

(b) (i) pV = nRT; 1

$$n = \frac{pV}{RT} = \frac{100000 \times 1.5 \times 10^{-4}}{8.31 \times 500};$$ 1

		= 3.61×10^{-3} ;	1
		(If pressure not converted to Pa, max 2)	
		(If $n = \frac{RT}{pV}$ used = CE; M2 = M3 = 0)	
	(ii)	moles NO_2 = 4/5 × 3.61×10^{-3}; *[mark is for use of 4/5]*	1
		= 2.89×10^{-3} *OR* 1.78×10^{-3};	1
		M_r NO_2 = 46;	1
		mass NO_2 = 46 × 2.89×10^{-3} = 0.1.33(g) *OR* 0.0821(g);	1
		(if atomic numbers used, M3 = M4 = 0)	

Question 3

(a)		$2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3Cu$;	1
		(accept multiples/fractions)	
		OR	
		$2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$;	
(b)	(i)	increases;	1
	(ii)	lower than expected / lower than Mg / less energy needed to ionise;	1
		e^- removed from (3)p sub-level; *('e^- removed' may be implied)*	1
		of higher energy / further away from nucleus / shielded by <u>3s</u> e^-s;	1
(c)		$Al^+(g) \rightarrow Al^{2+}(g) + e^-$;	1
(d)		trend: increases;	1
		more protons / higher charge on cation / more delocalised e^- / smaller atomic/ionic radius;	1

stronger attraction between (cat)ions and delocalised/free/mobile e^-

OR

stronger metallic bonding; 1

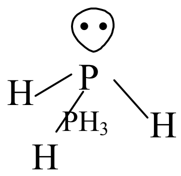
Question 4

(a) dative / coordinate (covalent) bond; 1

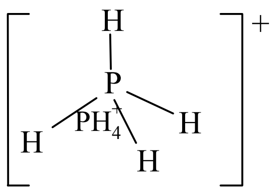
Lone/non-bonding pair / both electrons; 1

(donated) <u>from P</u> to H^+; 1

(b)



(1)



(1)

pyramidal *OR* trigonal pyramid 109(½)°; 2

(accept tetrahedral)

Question 5

(a) Oxygen more/very/highly electronegative (than hydrogen)

OR oxygen has stronger attraction for <u>bonding</u> electrons / <u>bonding</u> electrons drawn towards oxygen; 1

causes higher e^- density round oxygen atom / causes $H^{\delta+}$ & $O^{\delta-}$; 1

(b) van der Waals' forces between oxygen <u>molecules;</u> 1

Hydrogen bonding between methanol molecules; 1

H-B stronger than van der Waals' *OR* stronger IMF in methanol; 1

(if dipole-dipole forces in O_2 or methanol, allow comparison, hence max 2)

(if ionic/covalent etc. max 1)

(mention of bond break = CE = 0)

SECTION B

Question 6

Structure and hardness

M1	QoL	both macromolecular/giant atomic/giant covalent/giant molecular;	1
M2		C atoms in diamond joined to 4 other C atoms / diagram with min 5 C atoms i.e. shows tetrahedral shape / coordination number = 4;	1
M3		C atoms in graphite joined to 3 other C atoms diagram with clear extended hexagonal plane/pattern i.e. shows trigonal planar shape / coordination number = 3;	1
M4		diamond hard / crystal strong; *(not diamond stronger than graphite)*	1
M5		because of 3-D structure / rigid structure / not layered;	1
M6		graphite (soft) as layer can slide over each other;	1
M7	QoL	as only (weak) van der Waals' forces between layers;	1

Melting point (for either allotrope)

M8	covalent bonds must be broken / overcome;	1
M9	which are strong / many / hard to break; *(M9 tied to M8)*	1

Other difference

M10	diamond is non-conductor of electricity, graphite is conductor *OR* appropriate difference in appearance;	1

9 max

Question 7

X = Mg;		1
(accept Be, Ca)		
Y = Ba;		1
(accept Sr)		
$MgCl_2(aq) + 2NaOH(aq) \rightarrow Mg(OH)_2(s) + 2NaCl(aq)$		
	Species;	1
	State symbols & balance;	1
$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$;		
	Species;	1
	State symbols & balance;	1