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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Chemistry 5421

CHM1 Atomic Structure, Bonding and Periodicity

Mark Scheme

2007 examination - June series

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Dr Michael Cresswell Director General

CHM1

Question 1

(a) Decreasing (1)
[If wrong trend = 0] [If trend missing mark on]

Increase in protons / nuclear charge / nucleus more +ve (1)
[Not increased atomic number]

Similar/same shielding / shells (1)
Or increased attraction between nucleus and (outer) e^- [tied to increase in number of protons]
[Not similar orbitals/sub-shells]

(b) (i) $Mg(g) \rightarrow Mg^+(g) + e^-$ *[state symbols required]* (1)
$Mg(g) + e^- \rightarrow Mg^+(g) + 2e^-$
$Mg(g) - e^- \rightarrow Mg^+(g)$

(ii) e^- removed from a shell of lower energy/smaller size (1)
or e^- closer to nucleus
or harder to remove an e^- from +2 ion than from +1 ion / more highly charged ion

Less shielding / clear description of difference in shielding (1)
[Accept converse arguments]
[Not just unexplained identification of orbitals involved]
[Not just 'increased attraction']
[Not increased nuclear charge]

(iii) Decreasing (1)
[If wrong trend = 0] [If trend missing mark on]

e^- further from nucleus / increased atomic radius / bigger atoms (1)
[Not references to ionic radius / bonding e^-]
[Not higher energy levels /electronic energy levels further from nucleus]

More shells / shielding / energy levels *[Not more sub-shells]* (1)
or decreased attraction between nucleus and outer e^- (tied to e^- further from nucleus)

Accept 'e^- to be removed /valance e^- as alternative to 'outer e^-']
[Accept converse arguments]
[NOT references to charge/size ratio / charge density / delocalised e^-/bonding e^-]

(c) Mg Steam/high temperature/gaseous water (1)
[Not heat / hot water]

$Mg + H_2O \rightarrow MgO + H_2$ (1)

Ca Cold/water / RT (1)
[Not hot/warm water/'none'/standard conditions/just 'liquid']

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ (1)

[Don't transfer condition mark to M1/M3, from state symbol in equation]
[Ignore state symbols – even if wrong – for equation marks]
[Treat incorrect state symbols as contradictions of correct conditions]

Question 2

(a)

	C	O	N	H	
	15.38	41.03	35.90	7.69	
	12	16	14	1	(1)

[Incorrect A_r used = 0]

	1.28	2.56	2.56	7.69	
and	1	2	2	6	(1)

So, $CH_6N_2O_2$

(b) (i) M_r of ammonium carbamate = 78.0 (1)

Moles ammonium carbamate = $\frac{7.50}{78.0}$ = 9.62×10^{-2} (1)
[range = $9.6 - 9.62 \times 10^{-2}$]

[Mark consequentially on their M_r]

Moles gas = $3 \times 9.62 \times 10^{-2}$ = 0.288 (1)
[range = 0.288 – 0.29]

[Mark consequentially on their moles of ammonium carbamate]

(ii) pV = nRT (1)
[In lieu of this, accept correctly rearranged version of expression]

$V = \frac{nRT}{P} = \frac{0.288 \times 8.31 \times 473}{98.7 \times 10^3}$ (populating expression) (1)
(pressure conversion) (1)

[If expression wrongly rearranged or if n/R etc. missing, lose M2/M4]

= 1.15×10^{-2} m^3 [range = $1.1 - 1.2 \times 10^{-2}$ m^3] (1)

[Using 0.253 gives $1.0 - 1.01 \times 10^{-2}$ m^3]

[If 'n' ≠ 0.253 or their moles of gas lose M2 but mark consequentially for M4]
[If no pressure conversion and correct answer in dm^3, allow M3/M4]
[If no pressure conversion and consequentially answer in m^3, allow M4]
[Check that moles shown in equation = moles used in calculation]

Question 3

(a) $\mathbf{3}N_2O_4 + \mathbf{2}H_2O \rightarrow \mathbf{4}HNO_3 + \mathbf{2}NO$ (1)

(b) (i) Moles HNO_3 = $150 \times 10^{-3} \times 1.65$ (1)

= 0.2475/0.248 [range = 0.247 – 0.25] (1)

(ii) Moles Cu = ⅜ × 0.2475 [if mole ratio wrong, lose M3/4 (1)

= 0.0928 [range = 0.0926 – 0.094] (1)
[consequentially on their moles]

Mass Cu = 0.0928 × 63.5
= 5.89 – 5.91 g [range = 5.88 – 6.0] (1)
[consequentially on their moles]

[Using 0.172 gives: Moles Cu = 0.0645 – 0.065
Mass Cu = 4.09 – 4.13 g]

Question 4

(a) **QoL** Covalent bond Two atoms share a pair of/2 e^- / shared pair/2 of e^- (1)
[Allow multiple pairs of e^-s]
[NOT ions / molecules / elements/metal] [Not donated]
[Not just one e^- from each atom; must have idea of shared pair(s)]

Polar bond; a covalent bond in which the e^- distribution is not (1)
symmetrical / a bond with unequal/unfair sharing of e^- /
bond with δ^+ and δ^- on the ends /
bonding e^-s spend more time near one end of bond
[Allow e^- pair closer to one atom]
[Not just a diagram] [Not distorted e^-/cloud]

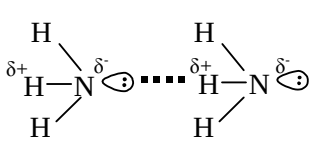
(b) (i) Difference in electronegativity / (1)
F more electronegative that H / F is very electronegative /
clear description of electronegativity difference in terms of bonding e^-
[Not diagram]
Bonding e^-s drawn towards F (1)
[Not bonding e^-s spend more time near one end of bond]

(ii) NH_3 *[if wrong compound score 0 for (b)(iii)]* (1)

(iii) N has smallest electronegativity of N, O and F/ (1)
NH_3 has smallest electronegativity difference
[Not 'more bonds']

(c) (i) Hydrogen bonding / H bonding (1)

[If only 1 NH_3 molecule shown = 0]



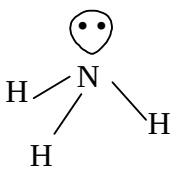
1 pair of charges shown on both molecules (1)
lone pair on both molecules (1)
hydrogen bond between lone pair and H atom (1)

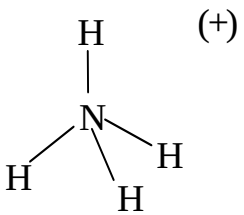
[Allow dimeric structure]
[H-bonded N-H-N does NOT need to be linear]
[if full structure of NH_3 molecules not shown, treat as a contradiction; lose 1st mark earned]

(d) (i) Dative/coordinate *[ignore 'covalent' but ionic/hydrogen etc, = 0]* (1)

Both bonding e^- come from the same atom (1)
Correct direction of electron pair donation (i.e. from N/NH_3) (1)
[So, 'both e^- come from NH_3 to form bond' scores 2]

(ii)





(1)

(1)

[Not H-N-H linear] *[penalise missing 'H' once]*

(iii) Pyramidal / (distorted)tetrahedral / (trigonal) pyramid (1)

(iv) 109°/109.5° (1)

Question 5

(a) Both have 7 protons (1)

^{14}N has 7n **and** ^{15}N has 8n (1)
[allow 1 mark for traditional 'same protons; different neutrons /^{15}N has an extra neutron style of answer]

Chemical properties identical *[Not similar]* (1)

as chemistry determined by electrons / electron arrangement / (1)
they have same electron arrangement / number of electrons / same e^-
[Not just 'same p and e^-' – there needs to be a focus on the number of e^-]

(b) 'p' block (1)

QoL Highest energy/outermost electron(s)/last e^- in p sub-shell/orbital/ level/sub-level (1)
[Answer must be in words] *[Not 'p shell']*

$1s^2 2s^2 2p^6$ [accept upper case letters & subscripted numbers] (1)
[Not [He] $2p^6$*]*

Question 6

(a) Ionisation (1)

By an electron gun/clear description of electron gun – tied to 'ionisation' (1)
[Ignore descriptions of the ionisation process]
[Not ionisation chamber]

Deflection (1)

By a magnetic field / electromagnet/magnetic plate - tied to 'deflection' (1)
[Not negative plate etc.]

Ignore 'vaporisation' explanations]

(b) $\frac{(188 \times 1.5) + (189 \times 2.5) + (190 \times 3.0) + (192 \times 4.5)}{11.5}$ (1) (1)

[If not divided by 11.5 (or thereabouts) then:
if an arithmetic error; allow consequentially on M3
if 'silly value' e.g. 100 or 759 = 0 for M3]

= 190.3 *[Allow consequentially to an arithmetic error or 'almost' 11.5 totals]* (1)

Z = Os [accept whenever seen] (1)
[Consequentially on M_r but must be a metal]