INTERNATIONAL BACCALAURÉAT BACHILLERATO
BACCALAUREATE INTERNATIONAL - INTERNACIONAL

M99/420/S(2)M

MARKSCHEME

May 1999

CHEMISTRY

Standard Level

Paper 2

10 pages

SECTION A

Students to answer all questions in this Section. Total marks for Section A: 20.

1. (a) (i) Increases *[1 mark]*

the volume/number of moles decreases during the reaction, so increasing the pressure shifts equilibrium to the right. *[1 mark]*

(ii) Exothermic *[1 mark]*

because the yield decreases as the temperature increases *[1 mark]*

must have exothermic to score second mark

(b) low temperature, high pressure *[1 mark]*

Do not award credit for specific numerical values

(c) $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ product (as numerator) *[1 mark]*

for powers *[1 mark]*

(d) Decreased *[1 mark]*

equilibrium moves (shifts) to left/less NH_3 produced *[1 mark]*

(e) (i) increased *[1 mark]*

(ii) unchanged *[1 mark]*

2. (a) **energy** needed to **break** *[1 mark]*

(a mole of covalent bonds)

in the **gaseous** state *[1 mark]*

(b) -698 ($kJ\,mol^{-1}$) *value [1 mark]*

sign [1 mark]

+698 scores *[1 mark]*

3. (a) Increase in boiling point (with increasing number of carbons). *[1 mark]*

relative molecular mass increases or molecular size gets bigger;

Intermolecular forces/temporary dipole increases/more energy needed to *[1 mark]*

separate molecules/overcome forces. *[1 mark]*

(b) methanol is polar (or polarity implied) *[1 mark]*

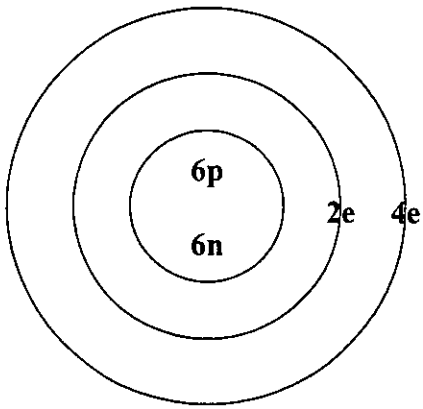
hydrogen bonding occurs (between molecules) *[1 mark]*

[Total 20 marks]

SECTION B

Students to answer only ONE of the questions in the Section. Total mark for each question: 20.

4. (a) mass number: number of protons and neutrons (in the nucleus) *[1 mark]*
atomic number: number of protons/number of electrons in the atom *[1 mark]*



nucleus *[1 mark]*

electron distribution must be 2, 4 to score the mark *[1 mark]*

(b) $^{23}_{11}Na$ 11p, 11e$^-$, 12n *[1 mark]*
2, 8, 1 *[1 mark]*

$^{39}_{17}K^+$ 19p, 18e$^-$, 20n *[1 mark]*
2, 8, 8 *[1 mark]*

$^{35}_{17}Cl^-$ 17p, 18e$^-$, 18n *[1 mark]*
2, 8, 8

Allow s, p notation if correct *[1 mark]*

(c) Same group: Na, K *[1 mark]*
Each has 1e$^-$/same number of valence e$^-$s in outer orbital *[1 mark]*

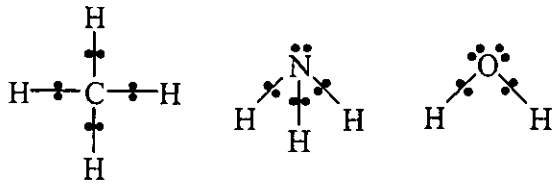
Same period: Na, Cl *[1 mark]*
same number (3) of orbitals containing electrons *[1 mark]*

(d) ^{35}Cl is the more abundant *[1 mark]*
35.5 is nearer to 35 (than to 37)/35.5 means 75 % ^{35}Cl *[1 mark]*

(e) (i) The lines become **closer together/converge** *[1 mark]*
then converge/form a (thick) **band/cease** *[1 mark]*

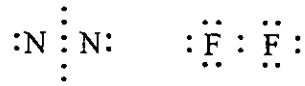
(ii) electrons/electronic changes *[1 mark]*
change energy (levels) *[1 mark]*

[Total 20 marks]

5. 

All valence ēs should be shown for ***[3 marks]*** . Award ***[1 mark]*** if only lone pairs shown in $NH_3$and H_20 ***[3 marks]***

(a) electrons initially arranged **tetrahedrally**/methane is **tetrahedral** ***[1 mark]***
lone pairs repel more than bonded pairs ***[1 mark]***
NH_3 has **1 lone pair** so angle < 109.5 (tetrahedral) (≏107°) ***[1 mark]***
H_2O has **2 lone pairs** so angle < NH_3 (≏105°) ***[1 mark]***

(b)  ***[2 marks]***

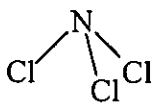
all valence ēs should be shown for ***[2 marks]*** .

Triple bond is stronger/more difficult to break ***[1 mark]***

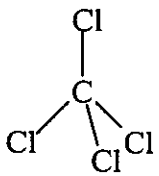
(c) Na, Mg, Al (ignore Si if included) have free/sea of electrons
and show metallic properties/holding the ions together
Na has 1, Mg 2, Al 3 ('free' electrons)
So strength of bonding increases
Si has a giant covalent/macromolecular structure
which is very difficult to break down with so many bonds

any five ***[1 mark]*** *each* ***[5 marks]***

(d) C–Cl is more polar than N–Cl ***[1 mark]***
N is more electronegative than C ***[1 mark]***



is polar



is non-polar ***[1 mark]*** *each* ***[2 marks]***

The NCl_3 molecule is not symmetrical/CCl_4 is symmetrical ***[1 mark]***

[Total 20 marks]

6. (a) **three** correctly-balanced equations from:
appropriate metal/acid $\rightarrow H_2$;
MO and acid;
MOH and acid;
M-carbonate and acid;

one each ***[3 marks]***
if H–X used, maximum ***[2 marks]***
Accept any reasonable chemical reaction for acid

(b) H^+ donor (acid) **and** H^+ acceptor (base) ***[1 mark]***
$NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
*(NH_3 accepting proton **[1 mark]**; balanced correctly **[1 mark]**)* ***[2 mark]***
pH paper will turn blue/pH value of 10–12 ***[1 mark]***

(c)

	acid	**conjugate base**	**base**	**conjugate acid**
(i)	H_2SO_4	HSO_4^-	HNO_3	$H_2NO_3^+$
(ii)	H_2O	OH^-	$CH_3CH_2NH_2$	$CH_3CH_2NH_3^+$

acid/conjugate base **and** base/conjugate acid ***[1 mark] each*** ***[2 marks]***

(d) H_2SO_4 is stronger than HNO_3 ***[1 mark]***
Some evidence of reasoning *e.g.* H_2SO_4 gives proton to HNO_3 in equation (i) ***[1 mark]***

(e) Strong acid is completely dissociated/ionised, weak acid only partially dissociated/ionised. ***[2 marks]***

Test solutions of equal concentration/equimolar solutions ***[1 mark]***
Strong acid gives lower pH value/higher conductivity ***[1 mark]***

OR

Weak acid gives higher pH value/lower conductivity

OR

Strong acid gives faster reaction with carbonate/suitable metal

(f) (i) A is stronger acid ***[1 mark]***
Difference of 1 pH unit= 10 fold difference in acidity ***[1 mark]***
Therefore A is $10\times10\times10\times10 = 10000$ times more acidic ***[1 mark]***

award BOTH marks if correct value given

(ii) add a base/alkali, add water/dilute

[1 mark] *each*

[2 marks]

[Total 20 marks]