

SECOND PUBLIC EXAMINATION  
Honour School of Chemistry

**CHEMISTRY PART IB**

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**INORGANIC CHEMISTRY II  
SAMPLE PAPER**

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TRINITY TERM 2012

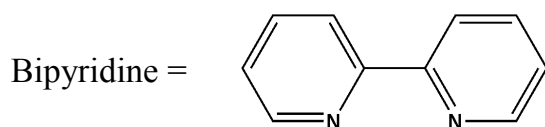
XXXXX, XX 2:30 p.m. – 5:00 p.m. (2.5 hrs)

Candidates should answer **FOUR** questions.

**Please start each question in a new booklet.**

The numbers in square brackets indicate the approximate marks that the examiners intend to assign to each part of the question.

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1. Compare and contrast the chemistry of the elements in **ONE** of following pairs:

N and P      Cr and W      Ti and Ni      Zr and Sn      [25]

2. Answer **EITHER** part **A** or part **B**

**A** Discuss critically the significant differences between the chemistries of the elements Li to F in the first row of the periodic table and the chemistries of the elements Na to Cl in the second row of the periodic table.

**B** Compare the main features of the chemistry of the elements of the lanthanide series with those of the actinide series. [25]

3. Comment on the points of interest associated with **FIVE** of the following. Note that some may be depicted as an empirical formula only.

Ferritin	$K_2Re_2Cl_8$	$Li_3N$	$Rb_9O_2$	$GaCl_2$
$C_{60}$	$Fe_3O_4$	$HSO_3F$	$Si_2H_6$	$TlI_3$
GaS	$AsH_3$	$Rb_2XeF_8$		

[5 x 5]

4. Discuss **FOUR** of the following topics, citing appropriate experimental evidence. [4 x 25/4]

- (i) Relativistic effects in post transition metal chemistry.
- (ii) The agostic effect
- (iii) The trans effect
- (iv) The macrocyclic effect
- (v) The nephelauxetic effect
- (vi) The lanthanide contraction
- (vii) Electronic and formation in solids

5. Discuss **THREE** of the following sets of observations. In each case provide further examples to indicate the extent to which exemplify the chemistry of the *p*-block elements. [3 x 25/3]

- (i) The N-N bond lengths (in pm) in the following nitrogen compounds:

N <sub>2</sub>	110;	N <sub>2</sub> O	113;	H <sub>2</sub> NNO <sub>2</sub>	143;
N <sub>2</sub> H <sub>4</sub>	145;	N <sub>2</sub> O <sub>4</sub>	175;	N <sub>2</sub> O <sub>3</sub>	186

- (ii) The mean bond enthalpies (in kJmol<sup>-1</sup>) in some group 15 hydrides and chlorides

	N	P	As	Sb
EH <sub>3</sub>	391	321	297	254
ECl <sub>3</sub>	193	322	309	314

- (iii) PCl<sub>5</sub> is thermally stable at 200°C, AsCl<sub>5</sub> decomposes above -50°C, SbCl<sub>5</sub> is stable up to ~140° C while BiCl<sub>5</sub> is unknown. The reduction potentials of some Group 15 elements at pH = 0 are:

Couple	E <sup>0</sup> /V
H <sub>3</sub> PO <sub>4</sub> /H <sub>3</sub> PO <sub>3</sub>	-0.28
H <sub>3</sub> AsO <sub>4</sub> /H <sub>3</sub> AsO <sub>3</sub>	-0.56
Bi <sub>2</sub> O <sub>5</sub> /BiO <sup>+</sup>	+2.00

- (iv) The N(III), P(III) and As(III) oxides are acidic, Sb(III) oxide is amphoteric while Bi(III) oxide is basic.

4. Answer ***EITHER*** part **A** or part **B**

**A** For **THREE** of the following series (i) to (iv) of anions or compounds in the states specified describe the structures and indicate how they reflect the positions of the element in bold in the periodic table. The formulae may be empirical. [3 x 25/3]

(i)	<b>La</b> Cl <sub>3</sub> (s)	<b>Au</b> Cl <sub>3</sub> (s)	<b>Re</b> Cl <sub>3</sub> (s)
(ii)	<b>Sn</b> Cl <sub>2</sub> (s)	<b>Hg</b> Cl <sub>2</sub> (s)	<b>Ga</b> Cl <sub>2</sub> (s)
(iii)	[ <b>Ni</b> Cl <sub>4</sub> ] <sup>2-</sup>	[ <b>Pt</b> Cl <sub>4</sub> ] <sup>2-</sup>	[ <b>Mo</b> Cl <sub>4</sub> ] <sup>-</sup>
(iv)	<b>CO</b> <sub>2</sub> (g)	<b>Si</b> O <sub>2</sub> (s)	<b>Pb</b> O <sub>2</sub> (s)
(v)	<b>S</b> <sub>4</sub> <b>N</b> <sub>4</sub> (s)	<b>B</b> N(s)	<b>Li</b> <sub>3</sub> <b>N</b> (s)

**B** Discuss the occurrence of isomerism in inorganic chemistry with reference to some or all of the following species and, if you wish, examples of your own choosing. [25]

[CoCl <sub>2</sub> (NH <sub>3</sub> ) <sub>4</sub> ] <sup>+</sup>	Co(NH <sub>3</sub> ) <sub>3</sub> (NO <sub>2</sub> ) <sub>3</sub>
[Co(NH <sub>3</sub> ) <sub>5</sub> (NO <sub>2</sub> )] <sup>2+</sup>	[Ru( <i>bipy</i> ) <sub>3</sub> ] <sup>2+</sup>
[Cr(en) <sub>2</sub> Br <sub>2</sub> ] <sup>+</sup>	Co(NH <sub>3</sub> ) <sub>5</sub> (NO <sub>3</sub> )(SO <sub>4</sub> )
CrCl <sub>3</sub> .6H <sub>2</sub> O	Fe(η <sup>5</sup> -C <sub>5</sub> H <sub>5</sub> )(CO)(PPh <sub>3</sub> )COCH <sub>3</sub>
N <sub>2</sub> F <sub>2</sub>	[Ni(CN) <sub>5</sub> ] <sup>3-</sup>

*End of paper*