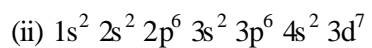
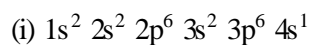


1. (5 marks) Complete the following table:

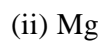
FORMULA	SYSTEMATIC NAME
	aluminium oxide
$K_2Cr_2O_7$	
	calcium acetate
$[Fe(H_2O)_6]^{3+}$	
	sodium tetrahydroxoplumbate(II)
$Na[Ag(CN)_2]$	
	tetraamminecopper(II) sulfate
$NH_3$	
	iron(II) phosphate
$(NH_4)_2SO_4$	

2. (8 marks) (a) For which atom does each of the following ground state electron configuration apply:



(b) Give three ways in which typical compounds of d-block elements differ from compounds of s-block elements.

(c) Give full structures in terms of subshells for each of the following **species**:



(d) Give an equation to define the first ionization energy of lithium.

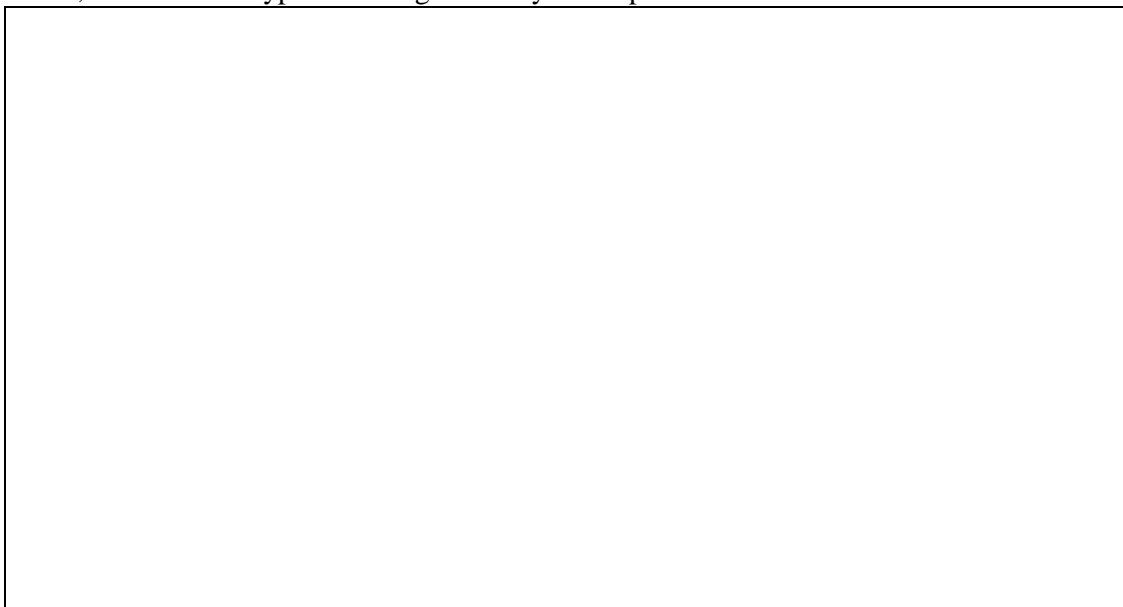
3. (2 marks) Why are the noble gases so unreactive?

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4. (4½ marks) Complete the following table.

MOLECULE	LEWIS DIAGRAM	GEOMETRIC ARRANGEMENT OF ELECTRON PAIRS around the underlined atom	SHAPE OF MOLECULE
<u>Si</u> Cl <sub>4</sub>			
<u>B</u> F <sub>3</sub>			
Xe <u>F</u> <sub>4</sub>			

5. (1½ marks) Consider the water molecule, H<sub>2</sub>O. Use the valence bond model to detail the occupancy of atomic orbitals by the valence shell electrons (**bonding and lone pairs**) for all atoms, and the bond types resulting from any overlap of atomic orbitals.



6. (1½ marks) Dropwise addition of 16 M ammonia, NH<sub>3</sub>, to a solution of a salt containing the Cu<sup>2+</sup> ion at first produces a blue precipitate, but when excess of the ammonia solution has been added, the blue precipitate dissolves to form a purple solution. Account for these observations.



7. (1½ marks) Why is the first ionization energy of an element which is higher up in a given group of the periodic table always greater than the first ionization energy for an element which is lower down in the same group?

8. (1½ marks) Explain why benzene which contains pi-bonds is much less reactive than expected when compared with cyclohexene which also has pi-bonding.

9. (1½ marks) In order to prepare the most effective buffer at a given pH, what if possible, would one do?

10. (6½ marks) Relevant  $pK_a$  data is on the separate data sheet.

(a) Calculate the pH of the following solutions in water. Give your answer to 2 decimal places.

(i) Benzoic acid (0.10 M)

(ii) Sodium acetate (0.10 M)

(b) A buffer of  $pH = 5.00$  is required, using  $CH_3COOH$  as the weak acid and its conjugate,  $CH_3CO_2^-$ , as the weak base. If the concentration of  $CH_3COOH$  used is 1.00 M, calculate the concentration of  $CH_3CO_2^-$  that would be needed in the buffer to give the desired pH. Give your answer to 2 significant figures.

11. (1½ marks) Explain why the statement "weak acids have strong conjugate bases" is incorrect.

## 12. (2 marks)

(a) It is usually only for titrations between a strong acid and a strong base that the  $\text{pH} = 7$  at the equivalence point. Explain why the equivalence point is not at  $\text{pH} = 7$  in titrations involving a weak acid or a weak base.

(b) From the list of indicators on the data sheet, select a suitable indicator for a titration between acetic acid and sodium hydroxide solutions.

13. (1½ marks) Distinguish between the terms "end point" and "equivalence point" in reference to a titration.

14. (1 mark) Use the  $\text{p}K_a$  data on the data page where relevant to rank the following acids in order of **increasing** strength:

ammonium ion, hydrogen chloride, hydrogen cyanide, carbonic acid

weakest acid

strongest acid

15. (1½ marks) Explain why a solution of sodium carbonate has a  $\text{pH}$  of about 11. Include an equation in your answer.

THIS PAGE FOR ROUGH WORKING ONLY

**CHEMISTRY 1002 SEMESTER 2 EXAMINATION****DATA PAGE, PART A**

Acid dissociation constants,  $pK_a$ , at 298 K

benzoic acid, $C_6H_5COOH$	4.20
acetic acid, $CH_3COOH$	4.76
carbonic acid, $H_2CO_3^1$	6.35
hydrogen cyanide, $HCN$	9.22
ammonium ion, $NH_4^+$	9.24

Acid/base indicator  $pK_a$  values

methyl yellow	3.1
methyl red	5.1
phenolphthalein	9.6
alizarin yellow	11.1

Periodic Table: