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:

(i) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

(ii) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^7$

(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**:

(i) $S^{2!}$

(ii) Mg

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

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

4. **(4½ marks)** Complete the following table.

MOLECULE	LEWIS DIAGRAM	GEOMETRIC ARRANGEMENT OF ELECTRON PAIRS around the underlined atom	SHAPE OF MOLECULE
$\underline{Si}Cl_4$			
$\underline{B}F_3$			
XeF_4			

5. **(1½ marks)** Consider the water molecule, H_2O. 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_3, to a solution of a salt containing the Cu^{2+} 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 pH = 7 at the equivalence point. Explain why the equivalence point is not at 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 pK_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 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 !	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: