Year 12 Semester One Examination, 2007

Question/Answer Booklet

CHEMISTRY

Name:	

Part	Mark
1	/50
2	/60
3	/42
4	/18
Total	/170
	%

Time allowed for this paper

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Materials required/recommended for this paper

To be provided by the supervisor
This Question/Answer Paper
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet

To be provided by the candidate

Standard Items: *Pens, pencils, eraser or correction fluid and ruler*

Special Items: A 2B, B or HB pencil for the separate Multiple Choice Answer Sheet and Calculators satisfying the conditions set by the Curriculum Council for this subject.

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Part		Number of questions available	Number of questions to be attempted	Suggested working time	Marks available
1	Multiple choice	25	ALL	45	50 (%)
2	Short answer		ALL	65	60 (%)
3	Calculations	4	ALL	40	42 (%)
4	Extended answers	1	1	20	18 (%)
				Total marks	170 (100%)

Instructions to candidates

1. Answer the questions according to the following instructions:

   Part 1 *Answer **all** questions, using a 2B, B or HB pencil on the separate Multiple Choice Answer Sheet.*

   If you consider that two or more of the alternative responses are correct, choose the one you think is best. If you think you know an answer, mark it even if you are not certain you are correct. Marks will **not** be deducted for incorrect answers.

   Feel free to write or do working on the question paper; many students who score high marks on the Multiple Choice Section do this.

   Parts 2, 3 and 4 *Write your answers in the spaces provided in this Question/Answer Booklet. A blue or black ball point or ink pen should be used.*

   Questions containing specific instructions to show working should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; correct answers which do not show working will not be awarded full marks.

2. It is recommended that you spend your reading time mainly reading the Instructions to Candidates and Parts 2, 3 and 4.

3. At the end of the examination make sure that your name is on your Question/Answer Booklet and on your separate Multiple Choice Answer Sheet.

4. **Chemical Equations**
   For full marks, chemical equations should refer only to those specific species consumed in the reaction and the new species produced. These species may be **ions** [for example $Ag^{+}_{(aq)}$], **molecules** [for example $NH_{3(g)}$, $CH_3COOH_{(l)}$, $CH_3COOH_{(aq)}$] or **solids** [for example $BaSO_{4(s)}$, $Cu_{(s)}$, $Na_2CO_{3(s)}$].

PART 1 (50 marks = % of paper)

Answer ALL questions in Part 1 on the separate Multiple Choice Answer Sheet provided, using a 2B, B or HB pencil. Each question in this part is worth 2 marks.

1.

1. Element X has the outer shell electron configuration s^2p^1. Element Y has the outer shell electron configuration s^2p^3. The most likely formula of the compound formed by X and Y is which of the following?

   (a) XY

   (b) XY_2

   (c) X_2Y

   (d) X_2Y_3

2. Which of the following rows contains three correct formulae for the named ions?

	dichromate ion	dihydrogenphosphate ion	oxalate ion
(a)	CrO_2^-	$H(PO_4)_2^-$	O_2^-
(b)	$Cr_2O_7^{2-}$	$H_2PO_4^-$	$C_2O_4^{2-}$
(c)	$Cr_2O_3^{2-}$	HPO_4^{2-}	O_2^{2-}
(d)	CrO_2^{2-}	HPO_3^{2-}	$HCOO^-$

3. An element has the electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$.
   In which group and period of the Periodic Table is the element located?

   (a) Group III, period 4

   (b) Group V, period 4

   (c) Group IV, period 1

   (d) Group VII, period 3

4. Which one of the following has only dispersion forces between its molecules in the liquid phase?

   (a) CO_2

   (b) NH_3

   (c) C_2H_5OH

   (d) H_2O

5. Which of the following molecules has a double bond?

   (a) $BeCl_2$

   (b) $CH_3(CH_2)_3CH_3$

   (c) HCOOH

(d) $CH_3CHBrCH_3$

6. The unusual electrical conductivity of graphite (a form of pure carbon) is best explained by which of the following?

(a) Carbon atoms are free to move between the layers in graphite, carrying their charge with them.

(b) Carbon atoms form three covalent bonds with neighbouring atoms in graphite, leaving one valence electron for conductivity.

(c) Carbon atoms in graphite form charged molecules which move under the influence of an applied electrical field.

(d) Carbon has only dispersion forces between atoms in graphite, so the four valence electrons are free to move throughout the structure.

7. Which of the following substances have both covalent and ionic bonding within them?

(a) CsF (s)

(b) C_2H_5Cl (l)

(c) $Ca_3(PO_4)_2$ (s)

(d) HF (g)

14. Which of the following best describes the shape and polarity of a molecule whose formula is CF_4 ?

(a) tetrahedral, non polar

(b) pyramidal, polar

(c) pyramidal, non polar

(d) tetrahedral, polar

15. Silicon dioxide has a much higher melting point than carbon dioxide. Which of the following best explains this difference?

(a) Silicon dioxide is a larger molecule than carbon dioxide, so the dispersion forces between its molecules are greater than those between carbon dioxide molecules.

(b) The double bonds within silicon dioxide molecules are stronger than the double bonds within carbon dioxide molecules.

(c) Silicon atoms in silicon dioxide are each bonded to four oxygen atoms to produce an extended covalent bonding arrangement, whereas carbon dioxide forms discrete molecules.

(d) Silicon dioxide molecules are polar and have stronger dipole - dipole interactions, whereas carbon dioxide molecules are non-polar and have only weak dispersion forces between them.

1. Which one of the following **electron configurations** represents a neutral atom in an **excited** state?

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$
B $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

C $1s^2 2s^2 2p^4 3s^2$
D $1s^2 2s^2 2p^6 3s^2 3p^4$

2. An atom has the ground state electron configuration $1s^2 2s^2 2p^6 3s^2$.
The electron configuration of the **next atom** in the same group on the Periodic Table would be -

A $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$
C $1s^2 2s^2 2p^6 3s^2 3p^2$
D $1s^2 2s^2 2p^6 3s^2 3p^1$

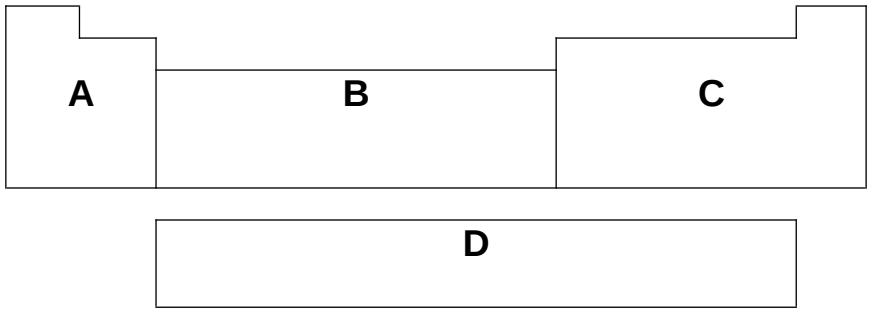
3. The successive **ionisation energies** for an element, E, are shown below.

Reaction	**Energy (kJ mol^{-1})**
To form E^+ from E	1012
To form E^{2+} from E^+	1903
To form E^{3+} from E^{2+}	2914
To form E^{4+} from E^{3+}	4958
To form E^{5+} from E^{4+}	6276
To form E^{6+} from E^{5+}	21270
To form E^{7+} from E^{6+}	25400
To form E^{8+} from E^{7+}	29860

Element E is most probably:

A aluminium
B phosphorus
C nitrogen
D chlorine

4. Four sections of the periodic table have been labelled A, B, C and D.



The section that has progressive filling of ***f* orbitals** is -

A **A**
B **B**
C **C**
D **D**

5. Which one of the following statements **best explains** why sodium hydroxide has a higher melting point than ammonia?

A The bonding in sodium hydroxide is stronger than the bonding in ammonia.

B Sodium hydroxide has ionic and covalent bonds whereas ammonia only has covalent bonds.

C The intermolecular dispersion forces and hydrogen bonding in ammonia are weaker than the ionic bonds in sodium hydroxide.

D The molar mass of sodium hydroxide (39.998) is much higher than the molar mass of ammonia (17.034)

6. Which one of the following substances contain **four lone pairs of electrons** (i.e. unshared or non-bonded pairs) in its valence shells?

A Water
B Carbon dioxide
C Ammonium ion
D Chloroethane

1. Calculate the mass of solute dissolved in 250 mL of 0.2 mol L^{-1} sodium hydroxide solution.

a) 0.1 g b) 0.2g
c) 2.0 g d) 8.0g

2. 100 mL of 2.00 mol L^{-1} sodium hydroxide is mixed with 50.0 mL of 2.50 mol L^{-1} sodium hydroxide, then 50.0 mL of distilled water is added to the solution.

What is the concentration of the final sodium hydroxide solution produced?

a) 1.62 mol L^{-1} b) 2.17 mol L^{-1}
c) 2.25 mol L^{-1} d) 2.40 mol L^{-1}

3. Calculate the concentration of chloride ions in 20 mL of a 0.5 mol L^{-1} solution of aluminium chloride.

a) 0.5 mol L^{-1} b) 1.0 mol L^{-1}
c) 1.5 mol L^{-1} d) 2.0 mol L^{-1}

4. Consider the following two solutions:

Solution 1 consists of 1 mol L^{-1} iron (III) sulfate and Solution 2 consists of 1 mol L^{-1} sodium sulfate.

Which of the following statements is TRUE?

a) The $[SO_4^{2-}]$ in Solution 1 is 1.5 times the $[SO_4^{2-}]$ in Solution 2.
b) The $[Na^+]$ is Solution 2 is equal to the $[Fe^{3+}]$ in Solution 1.
c) The $[Na^+]$ in Solution 2 is half the $[SO_4^{2-}]$ in Solution 1.
d) The $[Fe^{3+}]$ in Solution 1 is equal to the $[SO_4^{2-}]$ in Solution 2.

5. Identify which ONE of the following pairs of *solutions* would produce a precipitate when mixed together.

a) $Fe(NO_3)_3$ and K_3PO_4.
b) NH_4NO_3 and Na_2CO_3.
c) $Ca(NO_3)_2$ and NaCl.
d) $MgCl_2$ and NaBr.

. Which one of the equations below is NOT balanced?

a) $2KClO_3 \Rightarrow 2KCl + 2O_2$
b) $Fe_2O_3(s) + 3CO(g) \Rightarrow 2Fe(l) + 3CO_2(g)$
c) $Zn(s) + 2HCl(aq) \Rightarrow ZnCl_2(aq) + H_2(g)$
d) $2HgO \Rightarrow 2Hg + O_2$

The next two questions refer to the equation below which shows the decomposition of zinc carbonate upon heating.

$$ZnCO_3(s) \xRightarrow{heat} ZnO(s) + CO_2(g)$$

8. If 2.5 g of zinc carbonate is heated, what mass of zinc oxide would be produced?

a) 0.02 g b) 0.8 g
c) 1.6 g d) 3.2 g

9. If the carbon dioxide produced in the above reaction was collected and conditions set to STP, what volume would the carbon dioxide gas occupy?

a) 88.0 mL b) 100.0 mL
c) 22.4 mL d) 448 mL

13. Which of the following is used as a primary standard in acid-base titrations?

a) Hydrochloric acid.

b) Sodium carbonate.
c) Sodium hydroxide.
d) Sulfuric acid.

14. Which one of the following acids is diprotic?

a) Nitric acid.
b) Phosphoric acid.
c) Ethanoic acid.
d) Sulfuric acid.

15. If a solution has a pH of 10, then the hydroxide ion concentration of the solution is

a) 10 mol L^{-1}
b) 0.1 mol L^{-1}
c) 0.04 mol L^{-1}
d) 0.0001 mol L^{-1}

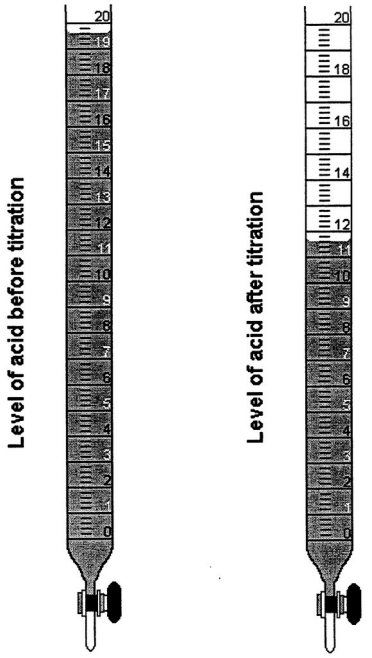
16. In volumetric analysis work, the following items of glassware are used:

I. Pipette
II. Volumetric flask
III. Conical flask
IV. Burette

Which of these items must be rinsed with a *sample* of the solution they will contain *prior* to them being filled with this solution for a titration?

a) All of them
b) I and IV.
c) I, II and IV.
d) III only.

17. The diagram below shows the level of hydrochloric acid in the burette immediately before and after a titration.



What volume of acid has been used in this titration?

a) 7.0 mL
b) 8.0 mL
c) 8.2 mL
d) 11.6 mL

18. What instrument should be used to accurately measure and deliver exactly 20 mL of the primary standard?

a) A graduated cylinder.
b) An eyedropper.
c) A burette.
d) A pipette.

9. 20.0 mL of 0.100 mol L^{-1} calcium chloride solution is added to 80.0 mL of 0.0500 mol L^{-1} silver nitrate solution.
The concentrations of ions in the **final 100.0 mL** of solution is correctly shown by which of the following?

$[Ca^{2+}(aq)]$	$[NO_3^-(aq)]$	$[Ag^+(aq)]$

(a)	1.00×10^{-2} mol L^{-1}	2.00×10^{-2} mol L^{-1}	2.00×10^{-2} mol L^{-1}
(b)	2.00×10^{-2} mol L^{-1}	4.00×10^{-2} mol L^{-1}	zero moles per litre
(c)	2.00×10^{-2} mol L^{-1}	8.00×10^{-2} mol L^{-1}	1.00×10^{-2} mol L^{-1}
(d)	4.00×10^{-2} mol L^{-1}	8.00×10^{-2} mol L^{-1}	zero moles per litre

10. A chemist added 20.0 mL of concentrated sulfuric acid to 100.0 mL of 0.100 mol L^{-1} lead nitrate solution in a 500 mL beaker. Which one of the following does **not** occur in the beaker as a result of the mixing of the two liquids?

(a) Solid lead(II) sulfate is precipitated.

(b) A rise in temperature of the liquid contents of the beaker is observed.

(c) The reaction: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ occurs.

(d) The pH of the solution in the 500 mL beaker is lowered.

12. Solutions of lithium carbonate, sodium chloride and ammonium sulfate have their pH tested. Which of the following is the correct classification from the test?

	$Li_2CO_3(aq)$	$NaCl(aq)$	$(NH_4)_2SO_4(aq)$
(a)	acidic	neutral	basic
(b)	basic	neutral	acidic
(c)	neutral	acidic	basic
(d)	neutral	acidic	neutral

13. When 1.0 mol L^{-1} solutions of the following are mixed, which combinations will result in the formation of precipitates?

(1) $Ba(NO_3)_2$ and HCl

(2) $Ca(NO_3)_2$ and Na_2CO_3

(3) $Cu(NO_3)_2$ and KOH

(4) $Zn(NO_3)_2$ and **limited** $NH_3(aq)$

(a) 1, 2 and 3 only

(b) 2 and 3 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

21. In which of the following examples is the underlined substance acting as a base?

(a) $\underline{NH_3}$ (aq) + H_2O (l) → NH_4^+ (aq) + OH^- (aq)

(b) $\underline{H_2O}$ (l) + O^{2-} (aq) → $2OH^-$ (aq)

(c) $\underline{2K}$(s) + $2H_2O$ (l) → $2K^+$ (aq) + $2OH^-$ (aq) + H_2 (g)

(d) $\underline{H_2O}$ (l) + CO_3^{2-} (aq) → OH^- (aq) + HCO_3^- (aq)

23. For the titration between dilute ethanoic acid (in a burette) and standardised sodium hydroxide in a conical flask, which of the following procedures is incorrect?

(a) Prior to adding the acid to the burette, rinse the burette with distilled water and then a small portion of the acid solution.

(b) Pipette out 20.00 mL aliquots of the sodium hydroxide solution into three separate conical flasks which have each been rinsed with distilled water.

(c) Rinse the pipette with the standardised sodium hydroxide solution before transferring the first aliquot to the conical flask.

(d) Add a few drops of methyl orange indicator to the acid in the burette

26. A student requires a solution of pH = 4 for an experiment.
Which of the following procedures will yield such a solution?

(a) Add 50 mL of a solution of pH = 2 to 50 mL of a solution of pH = 6.

(b) Add 95 mL of distilled water to 5 mL of 0.1 mol L^{-1} HCl(aq).

(c) Add 50 mL of 0.1 mol L^{-1} NaOH to 25 mL of 0.1 mol L^{-1} HCl(aq).

(d) Add 1.0 mL of 0.01 mol L^{-1} HCl(aq) to 99 mL of distilled water.

7. The amount of arsenic in a poison can be determined by precipitation of the arsenic as its sulphide, As_2S_3. If 0.246 g of As_2S_3 is obtained from 1.50 g of poison, then the **percentage by mass of arsenic** in the poison is -

A 1.50%
B 1.00%
C 4.99%
D 10.0%

8. The waste water produced by a paper mill contains NaOH at a concentration of 2.0 mol L^{-1}. What is the **volume** of HCl(aq) of pH = 1 that you would have to add to 500 L of waste water to raise its pH to 7?

A 1.0×10^4 L
B 1.0×10^3 L
C 7.0×10^3 L
D 5.0×10^2 L

9. 0.380 mol of an organic compound has a mass of 44.8 g. Its empirical formula is $C_2H_3O_2$. What is its **molecular formula**?

A $C_2H_3O_2$
B $C_4H_6O_4$
C $C_3H_4O_3$
D $C_4(H_2O)_3$

10. Which one of the following is a **conjugate acid-base pair**?

A HNO_3 and H_2O
B HNO_3 and NO_3^-
C NH_3 and OH^-
D H_3O^+ and OH^-

11. If the hydroxide ion concentration in an egg white is $10^{-6.48}$ mol L^{-1}, the **pH** of the egg white is

A 2.16
B 6.48
C 7.52
D 11.8

12. Which one of the following species acts as an **acid** when ammonia gas is bubbled through an aqueous solution of potassium chloride?

A H_2O
B Cl^-
C NH_3
D None of the above because it is not an acid-base reaction.

13. Which list of chemicals contains **all amphoteric** substances?

A	Zn	$Cu(NH_3)_4^{2+}$	$Al(OH)_3$
B	Cr_2O_3	Zn	Al_2O_3
C	NiO	CuO	$Zn(NH_3)_4^{2+}$
D	$Cu(NH_3)_4^{2+}$	$Zn(NH_3)_4^{2+}$	$Al(OH)_4^-$

14. Which one of the following substances will have a **pH greater than 7** when dissolved in water?

A Calcium nitrate
B Potassium ethanoate
C Ammonium bromide
D Magnesium hydrogensulfate

17. Which of the following statements about oxidising and reducing agents is false?

(a) Hydrogen peroxide solution is capable of spontaneous self oxidation - reduction.

(b) Group I metals are good reducing agents.

(c) Acidified potassium permanganate solution can oxidise oxalic acid solution to carbon dioxide and water.

(d) Copper metal will not react with a dilute silver nitrate solution.

22. In which one of the following species is the oxidation number of manganese lower than it is in the other three compounds?

(a) K_2MnO_4

(b) Mn_2O_3

(c) $NaMnO_4$

(d) MnO_2

20. Which of the following reactions represent disproportionation (self oxidation - reduction)?

I $2CrO_4^{2-}(aq) + H^+(aq) \rightarrow Cr_2O_7^{2-}(aq) + OH^-(aq)$

II $3I_2(s) + 6OH^-(aq) \rightarrow 5I^-(aq) + IO_3^-(aq) + 3H_2O(l)$

III $Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

IV $2Cu^+(aq) \rightarrow Cu(s) + Cu^{2+}(aq)$

(a) I only

(b) II and IV only

(c) III only

(d) IV only

27. According to the Standard Reduction Potential Table, which of the following partially completed half reactions is able to oxidise $Cu^+(aq)$ to $Cu^{2+}(aq)$, but is not able to oxidise aqueous iodide ions to solid iodine?

(a) $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$

(b) $O_2(g) + 2H_2O(l) + 4e^-$

(c) $S(s) + 2H^+(aq) + 2e^-$

(d) $H_2(g) + 2OH^-(aq)$

15. Which one of the following reactions would **not go in the forward direction** to any appreciable extent?

A $3Sn^{4+}(aq) + 2Cr(s) \rightarrow 3Sn^{2+}(aq) + 2Cr^{3+}(aq)$
B $2Ag^{+}(aq) + Cu(s) \rightarrow 2Ag(aq) + Cu^{2+}(aq)$
C $Sn^{4+}(aq) + 2Fe^{2+}(aq) \rightarrow Sn^{2+}(aq) + 2Fe^{3+}(aq)$
D $2Cu^{+}(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$

16. The **emf (cell voltage)** of an electrochemical cell constructed using standard Ni^{2+}/Ni and Sn^{4+}/Sn^{2+} half cells would be

A 0.41 V, with the Ni electrode positive
B 0.41 V, with the Pt electrode positive
C 0.11 V, with the Ni electrode positive
D 0.11 V, with the Pt electrode positive

The following information refers to the next three questions.

The reactions taking place when a lead-acid accumulator delivers electricity are described by the equations:

Negative electrode: $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$
Positive electrode: $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

17. As the accumulator **produces electricity**,

A the concentration of H_2SO_4 decreases.
B the number of ions in the solution increases.
C Pb is deposited at the negative electrode
D PbO_2 is precipitated

18. While the accumulator is being **recharged**,

A PbO_2 is formed at the positive electrode.
B Pb is oxidised to PbO_2.
C Pb is oxidised to $PbSO_4$.
D SO_4^{2-} is reduced to H_2SO_4.

19. As the accumulator is being **recharged**, a gas is also evolved at the positive electrode. The equation which best describes the process most likely to produce the gas is

A $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$
B $2H^+(aq) + 2e^- \rightarrow H_2(g)$
C $SO_4^{2-}(aq) \rightarrow SO_2(g) + O_2(g) + 2e^-$
D $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

20. The equation below represents a reaction in the extraction of chromium from its ore.

$$2Fe_2O_3.Cr_2O_3 + 4Na_2CO_3 + 3O_2 \rightarrow 2Fe_2O_3 + 4Na_2CrO_4 + 4CO_2$$

Which one of the following statements about the **oxidation states (numbers)** of the substances is correct?

A The carbon has been oxidised from a +2 state to a +4 state.
B The iron has been reduced from a +3 state to a +2 state.
C The chromium has been oxidised from a +3 to a + 6 state.
D There is no change in the oxidation state of any of the substances in the reaction.

21. Which one of the following is **least** important in making potassium dichromate a good **primary standard** for oxidation-reduction titrations?

A The coloured solution makes the meniscus easy to see in the burette.
B It is stable and available in very high purity.
C It will oxidise a wide variety of chemical compounds
D The reduced form of the reagent is readily distinguished by its green colour.