Chemistry
Year 12
2002

Name: .....

Teacher: .....

TIME ALLOWED FOR THIS PAPER

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

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer Booklet
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet

TO BE PROVIDED BY THE CANDIDATE

Standard Items: Pens, pencils, eraser or corrector fluid, ruler

Special Items: Calculators satisfying the conditions set by the Curriculum Council and a 2B pencil for the Separate Multiple Choice Answer Sheet.

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 THE PAPER

Part	Format	No. of Questions Set	No. of Questions to be Attempted	Marks allocated	Recommended Time (Approx) /Minutes
1	Multiple choice	30	ALL	60	55
2	Short answers	9	ALL	70	60
3	Calculations	5	ALL	50	45
4	Extended answers	2	1	20	20

INSTRUCTIONS TO CANDIDATES

Reading Time: The examiners recommend that candidates spend the reading time mainly reading the Instructions to Candidates and Parts 2, 3 and 4.

Part 1 - Multiple Choice

Use a "2B" pencil to answer on the separate Multiple Choice Answer Sheet. **Do not** use a ballpoint or ink pen.

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 in the Multiple Choice Section do this.

Parts 2, 3 and 4

Use a ballpoint or ink pen. **Do not** answer in pencil. Write your answers in this Question/Answer Booklet.

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

CHEMICAL EQUATIONS

For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced.
These species may be **ions** [for example $Ag^+(aq)$], **molecules** [for example $NH_3(g)$, $NH_3(aq)$, $CH_3COOH(l)$, $CH_3COOH(aq)$] or **solids** [for example $BaSO_4(s)$, $Cu(s)$, $Na_2CO_3(s)$].

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PART 1: Answer **ALL** questions in Part 1 on the Separate Multiple Choice Answer Sheet provided. This part carries 60 marks out of 200.

1. A molecule of a gaseous substance at room temperature has one double bond, one single bond and six lone pairs of electrons. Which of the following could it be?

   (a) Carbon dioxide.

   (b) Sulfur dioxide.

   (c) Phosphorus pentoxide.

   (d) Carbon tetrachloride.

2. A student added 20.0 mL of concentrated sulfuric acid to 100.0 mL of 0.100 mol L^{-1} barium hydroxide 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 barium hydroxide is precipitated.

   (b) A rise in the 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 is lowered.

3. An element has the electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^1$.
   In which group and period of the periodic table is the element located?

   (a) Group III, period 4

   (b) Group I, period 4

   (c) Group IV, period 1

   (d) Group V, period 3

4. Consider the following substances in the molten (liquid) state:

   I $C_{10}H_{22}$

   II NH_3

   III CH_3Cl

   IV N_2

   Which of the above substances have only dispersion forces between their molecules?

   (a) None of the above
   (b) II and IV only
   (c) II and III only
   (d) I and IV only

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5. Which of the following pairs of approximately 0.1 mol L^{-1} solutions can be distinguished on the basis of colour alone?

   (a) $NaMnO_4(aq)$ and $KMnO_4(aq)$

   (b) $CuCl_2(aq)$ and $[Cu(NH_3)_4^{2+}](aq)$

   (c) $BaCl_2(aq)$ and $Ba(NO_3)_2(aq)$

   (d) $Hg_2(NO_3)_2(aq)$ and $HgCl_2(aq)$

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

   (a) Carbon atoms form ionic bonds in graphite, so there are four valence electrons per atom available for conduction of electricity.

   (b) Carbon atoms form three covalent bonds with neighboring atoms in graphite, leaving one valence electron free to move through the solid lattice.

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

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

7. A sea water sample was collected near the waste outlet from a metal refinery. 1.00 kg of the sea water occupied 970 mL and was found to contain 2.00 mg of lead present as $Pb^{2+}(aq)$.

   Which of the following is the **incorrect** expression for the concentration of lead in the sea water sample?

   (a) 9.65 ppm (parts per million)

   (b) 2.06 mg L^{-1}

   (c) 2.00×10^{-4} g per 100 g

   (d) 9.95×10^{-6} mol L^{-1}

8. 20.0 mL of a 0.100 mol L^{-1} barium hydroxide solution is added to 80.0 mL of a 0.0500 mol L^{-1} sodium sulfate solution .

   The concentrations of barium ions, sulfate ions and hydroxide ions in the **final 100.0 mL** of solution is correctly shown by which of the following?

	$[Ba^{2+}(aq)]$	$[SO_4^{2-}(aq)]$	$[OH^-(aq)]$
(a)	1.00×10^{-2} mol L^{-1}	2.00×10^{-2} mol L^{-1}	zero moles per litre
(b)	zero moles per litre	2.00×10^{-2} mol L^{-1}	4.00×10^{-2} mol L^{-1}
(c)	2.00×10^{-2} mol L^{-1}	1.00×10^{-2} mol L^{-1}	zero moles per litre
(d)	1.00×10^{-2} mol L^{-1}	zero moles per litre	2.00×10^{-2} mol L^{-1}

SEE NEXT PAGE

9. Which one of the following substances dissolved in pure water will not raise or lower the pH?

   (a) Na(s)

   (b) $C_2H_5OH(l)$

   (c) $NH_4Cl(s)$

   (d) $Cl_2(g)$

10. Which of the following substances is an amine?

   (a) $CH_3CH_2NO_2$

   (b) $HCOONH_4$

   (c) $CH_3CH_2CH_2CONH_2$

   (d) CH_3NH_2

11. Balance the unbalanced equation below:

   $...Cu(s) + ...NO_3^-(aq) + ...H^+(aq) \rightarrow ....Cu^{2+}(aq) + ...NO(g) + ...H_2O(1)$

   Which of the following gives the correct coefficients, reading from left to right in the balanced equation?

   (a) 2, 3, 2, 2, 3 and 1

   (b) 3, 2, 8, 3, 2 and 4

   (c) 2, 2, 4, 2, 1 and 2

   (d) 3, 1, 4, 3, 1 and 2

12. The reaction between sulfur dioxide gas and oxygen gas to form sulfur trioxide gas is part of the synthesis of sulfuric acid by the Contact Process. It is catalysed by vanadium (V) oxide and after a certain time, equilibrium in the closed system is reached. Consider the following statements about this reaction.

   I The catalyst allows the reaction to reach equilibrium sooner by increasing the rate of both the forward and reverse reactions.

   II The catalyst lowers the activation energy barrier for both forward reaction and reverse reaction.

   III The catalyst increases the mass of products compared to the mass of reactants when equilibrium is reached.

   Which of the following statements is correct?

   (a) Only statement I above is true

   (b) All the above statements are true

   (c) None of the above statements is true

   (d) Only statements I and II above are true.

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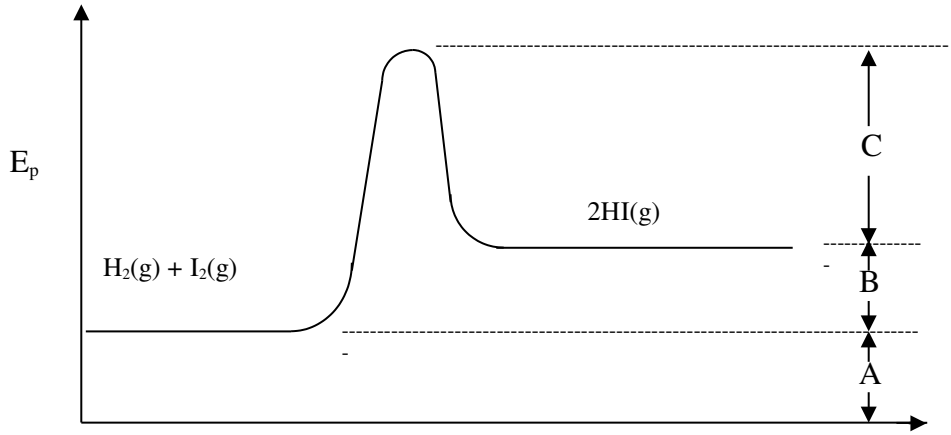
Questions 13 and 14 refer to the energy profile diagram for the reaction between hydrogen gas and iodine vapour producing hydrogen iodide gas.



Reaction coordinate

13. For the reaction $H_2(g) + I_2(g) \rightarrow 2HI(g)$, which of the following is true?

(a) It is an endothermic reaction with ΔH = **B**

(b) It is an exothermic reaction with ΔH = **(C - A)**

(c) It is an exothermic reaction with ΔH = **(A - B)**

(d) It is an endothermic reaction with ΔH = **(B - A)**

14. The activation energy for the reaction $2HI(g) \rightarrow H_2(g) + I_2(g)$ is indicated on the graph by which of the following?

(a) **(A + B)**

(b) **C**

(c) **(C – B)**

(d) **(A + B – C)**

15. Which of the following best describes the molecular shape and molecular polarity of a phosphine molecule whose formula is PH_3?

(a) Triangular planar, non polar

(b) Pyramidal, polar

(c) Tetrahedral, non polar

(d) Pyramidal, non polar

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16. Ethanoic acid is classified as a weak acid. Which of the following best accounts for this?

(a) It is only sparingly soluble in water, resulting in a low concentration of molecules.

(b) Its molecules hydrolyse in water solution to produce hydroxide ions.

(c) Its molecules have only a slight tendency to ionise in water solution.

(d) In aqueous solution it forms complex ions which do not react with any known indicator.

17. In which of the following species is the oxidation number of manganese equal to +6?

(a) K_2MnO_4

(b) Mn_2O_3

(c) $NaMnO_4$

(d) $Mn(ClO_3)_2$

18. An electrolytic cell contains a dilute cobalt chloride solution. When electrolysed with inert electrodes, which of the following occurs?

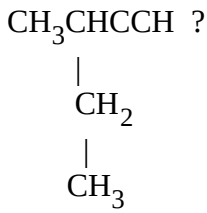
(a) Cobalt metal is deposited at the cathode and oxygen gas is evolved at the anode.

(b) Hydrogen gas is evolved at the cathode and chlorine gas is evolved at the anode.

(c) Chlorine gas is evolved at the cathode and cobalt metal deposits at the anode.

(d) Cobalt metal deposits at the cathode and chlorine gas is evolved at the anode.

19. What is the IUPAC name for the compound



(a) 3-methyl-1-pentyne

(b) 2-ethylbutane

(c) 3-ethyl-1-butyne

(d) cis-3-ethylhexene

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20. Which of the following molecules contain(s) no double bond?

1 $(CH_3)_2CHCH_3$
2 $(CH_3)_3CCHCH_2$
3 $CHCl_2(CH_2)_3COOH$
4 $(CH_3)_2CHCHO$
5 CH_3CH_2CHO

(a) 1 only
(b) 3 only
(c) 3 and 4 only
(d) 3, 4 and 5 only

21. An acid-base indicator is made by mixing a few drops of phenolphthalein indicator with the same amount of methyl orange. Assuming that the two indicators do not react chemically with each other, which of the following indicates **progressive** colour changes when this indicator mixture is used in a hydrochloric acid – ammonia solution titration? (The indicator mixture is placed in the ammonia solution whose pH is 10, and the acid is added dropwise from a burette until the final pH is 2.)

(a) The solution will turn from red to colourless to pink.
(b) The solution will change from yellow to pink to colourless after the end point is reached.
(c) The solution will change from pink/yellow to yellow to red after the end point is reached.
(d) The solution will turn from colourless to pink/yellow to colourless again after the end point is reached.

22. A standardised 0.0250 mol L^{-1} potassium permanganate solution is acidified and is then used to determine the concentration of an iron(II) nitrate solution. It is found that equal volumes of these solutions, when mixed, produce the required end point (a faint remaining pink colour of permanganate ion). Which of the following gives the concentration of iron(II) ions in the original iron(II) nitrate solution?

(a) 0.025 mol L^{-1}
(b) 0.050 mol L^{-1}
(c) 0.125 mol L^{-1}
(d) 0.150 mol L^{-1}

23. Which of the following contains the greatest number of discrete molecules?

(a) 30.0 g of ammonia gas
(b) 25.0 g of ethyne gas
(c) 4.0 g of fluorine gas
(d) 12.0 g of dinitrogen monoxide gas

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24. Which of the following is a list of progressively more oxidised substances?

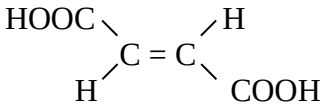
(a) Methane, ethane, propane, butane

(b) Propane, propanol, propanal, propanoic acid

(c) Ethane, ethene, ethyne, ethanamine

(d) 1-butanol, 2-butanol, 2-methyl-1-propanol, 2-methyl-2-propanol

25. Which of the following is an isomer of fumaric acid whose structure is shown below?



(a) $CH_3CH_2CH_2COOH$

(b) $HO(CH_2)_3\ COOH$

(c) $HOOCCH_2CHOHCOOH$

(d) $HOOC(CH)_2COOH$

26. A solution was able to oxidise copper(I) ions to copper(II) ions, but was not able to oxidise iodide ions to iodine. Which of the following could it have been?

(a) $Pb^{2+}(aq)$

(b) $O_2(g) + H_2O(l)$

(c) $Fe^{3+}(aq)$

(d) $HOOCCOOH(aq)$

27. A current of 2.00 A was passed for one minute through each of the following 1.0 mol L^{-1} solutions using inert electrodes:

$Ni^{2+}(aq)$, $Pb^{2+}(aq)$, $Ag^{+}(aq)$, $Au^{3+}(aq)$.

In which one did the greatest mass of metal deposit at the cathode?

(a) $Ni^{2+}(aq)$

(b) $Pb^{2+}(aq)$

(c) $Ag^{+}(aq)$

(d) $Au^{3+}(aq)$

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28. The following represents the repeating sequence of a condensation polymer:

$$-OCCH_2COO(CH_2)_2O-$$

Which of the following represents the pairs of monomers which produced the above polymer?

(a) CH_2OH and $HOOC(CH_2)_2COOH$

(b) $HOOCCH_2COOH$ and $HO(CH_2)_2OH$

(c) $HOCH_2OH$ and $HOOC(CH_2)OH$

(d) $(HO)_2CCH(OH)_2$ and $(HOOC)_2CH_2(COOH)_2$

29. A compound has the empirical formula CH_2O. If 3.50 g of the gaseous compound occupied 436 mL at STP, which of the following is the molecular formula of the compound?

(a) CH_2O

(b) $C_3H_6O_3$

(c) $C_4H_8O_4$

(d) $C_6H_{12}O_6$

30. Which of the following compounds is most soluble in petrol whose formula may be represented as $C_8H_{18}(l)$:

(a) $CH_3(CH_2)_7OH(l)$

(b) $C_7H_{16}(l)$

(c) $HCl(g)$

(d) $CH_3COOH(l)$

END OF PART 1.

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PART 2

Answer **ALL** questions in Part 2 in the spaces provided below.

This part carries 70 marks out of 200.

Give fully balanced equations for the reactions which occur (if at all) in the following experiments. Use **ionic equations** where appropriate. In each case describe observations such as colour changes, precipitate formation (give the colour), or gas evolution (give the colour or describe as colourless) resulting from the chemical reaction.

1. a) Propanal is shaken vigorously with a dilute solution of acidified potassium permanganate.

Oxidation_____

Reduction_____

Overall equation_____

Observation_____

_____

[4 marks]

(b) Concentrated ammonia solution is added to solid zinc hydroxide.

Equation_____

Observation_____

_____

[3 marks]

(c) Magnesium metal is placed in a solution of lead(II) nitrate.

Equation_____

Observation_____

_____

[3 marks]

(d) A solution of ammonium carbonate is added to a solution of potassium hydroxide and the mixture is then gently warmed.

Equation_____

_____

Observation_____

_____

[3 marks]

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2. For each of the species listed in the table below;

(a) Draw the structural formula,
including **all** valence shell electron pairs and representing each either as **:** or as **-**

[for example, water $H:\ddot{O}:H$ or $H-O-H$ or $H-\ddot{O}-H$ and so on].

(b) Indicate the shape of each species by either a sketch or a name.

(c) Indicate the polarity of each species. Write either 'non-polar' or 'polar'.

Species	Structural formula (showing all valence shell electrons)	Shape (sketch or name)	Polarity ('non-polar' or 'polar')
Carbonate ion			
Chlorite ion (ClO_2^-)			
Ethyne			

[12 marks]

3. (a) Write the name of an addition polymer .

_____

[1 mark]

(b) Write the name and draw the structure of the monomer used to produce (a)

Name _____ Structure:

[3 marks]

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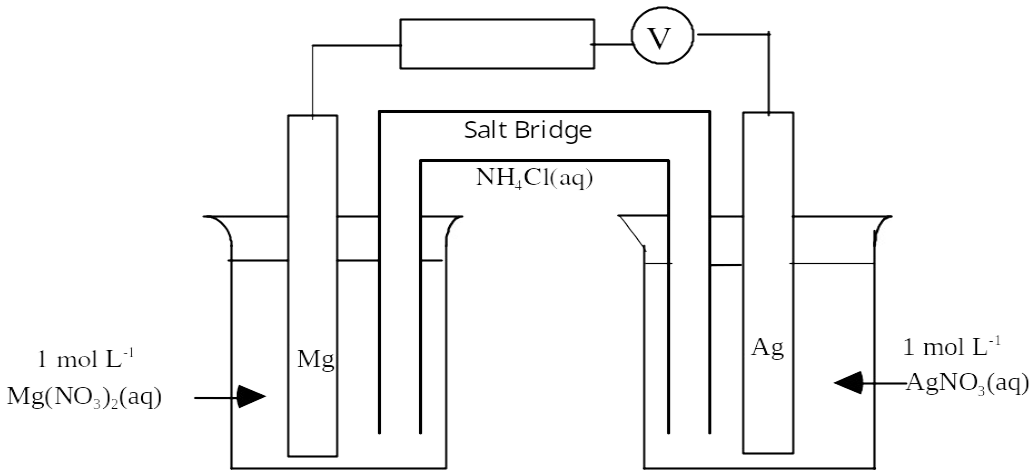
4. Below is a diagram of an electrochemical cell.



(a) Write a half equation to show the reaction at the anode of the cell.

_____

[2 marks]

(b) Draw an arrow in the box provided on the diagram to indicate the flow of electrons in the external circuit. [1 mark]

(c) Give the formula of one ion that will move from the Mg/Mg^{2+} half cell towards the Ag/Ag^{+} half cell through the salt bridge.

_____

[1 mark]

5. Complete the following table.

I.U.P.A.C. NAME	SEMI-STRUCTURAL FORMULA
(a) 2-iodo-3-methyl-2-pentanol	
(b) 5,6-difluoro-5-methyl-3-heptanone	
(c).....	$CH_3CH_2CH_2CH_2ONa$
(d).....	$HCOOCH_2CH_2CH_2CH_2CH_3$

[4 marks]

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6. When carbon dioxide and chlorine gas are mixed a slow reaction takes place.

$$2CO_2(g) + 2Cl_2(g) \rightleftharpoons 2COCl_2(g) + O_2(g) \qquad \Delta H = -52 \text{ kJ mol}^{-1}$$

"The above mixture of gases will eventually reach chemical equilibrium in a closed system".

(a) With reference to the above, explain what is meant by:

i) Chemical equilibrium _____

_____

_____[2 marks]

ii) ΔH _____

_____

_____[2 marks]

(b) If each of the following changes is imposed separately on the system at equilibrium, state what will happen to the **amount** of products and reactants once equilibrium is re-established. Use the words "increase", "decrease" or "remain constant". Give a reason for your answer in each case.

(i) **Pressure is increased by reducing the volume of the container**:

Amount of products will_____

Amount of reactants will _____

Reason: _____

_____

[4 marks]

(ii) **Temperature is decreased:**

Amount of products will _____

Amount of reactants will _____

Reason: _____

_____

[4 marks]

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7. Consider the following list of substances:

sulfur trioxide gas, ammonia gas, ethanol, butanoic acid, carbon disulfide, propanone.

From the above, choose the substance(s) relevant to each of the following descriptions.
Note: The same substance may appear more than once in your answers to this question.

(a) The substance whose molecules are linear and non-polar

_____

(b) The substance which when dissolved in water produces a strong acid

_____

(c) The **two** substances required to make an ester

_____ and _____

(d) The substance least soluble in water

_____

(e) the **three** substances which are non-electrolytes

_____ and _____ and _____

[8 marks]

8. Write a chemical equation(s) which is consistent with the observations in the following experiments:

What is done	Observation	Equation(s)
A colourless liquid is added dropwise to a colourless liquid.	A brown precipitate is formed at first, but the precipitate dissolves to become colourless with further addition of the first liquid.	
A colourless liquid is added to a green solid.	Bubbles of a colourless odourless gas are evolved and the green solid dissolves to form a clear green liquid.	
A colourless liquid is added to a pink/red shiny solid.	A brown gas is evolved and a clear blue liquid is formed.	

[6 marks]

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9. In the table below, draw structural diagrams for the indicated substances:

A tertiary alcohol whose formula is $C_5H_{12}O$	
The cis- isomer of $C_4H_6Cl_2$	
The organic product formed when sodium metal is added to methanol	

[7 marks]

END OF PART 2

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PART 3

Answer ALL the questions in Part 3. The calculations are to be set out in detail in this Question/Answer Booklet. Marks will be allocated for correct equations and clear setting out of your answer, even if you cannot complete the problem. When questions are divided into sections labelled (a), (b), etc you MUST answer in sections labelled (a), (b), etc. Use the four figure atomic masses from the Periodic Table supplied. Round final numerical answers to three (3) significant figures. Appropriate units must be shown. Information which may be necessary for the solution of the problem is on the standard Chemistry Data Sheet.

This part carries 50 marks out of 200.

1. A sample of 3.230 g of an unsaturated chlorofluorocarbon (a compound containing carbon, fluorine and chlorine only) was analysed as follows:

   All the carbon in the sample was converted into carbon dioxide gas, which was then bubbled through excess limewater. Highly insoluble calcium carbonate weighing 4.864 g was produced.

   A further sample of the chlorofluorocarbon weighing 3.230 g was vaporised in the absence of air and produced 545 mL of vapour at STP.

   A third sample of the compound was analysed and was found to contain 28.6% by mass fluorine.

   a) Determine the empirical formula of the compound. [6]

   b) Determine the molecular formula of the compound. [2]

   c) Name and draw a possible structure of the compound. [2]

   [10 marks]

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2. An analytical chemist was contracted by a mining company to determine the percentage of nickel in an ore which was known to be mainly hydrated nickel(II) carbonate of formula $NiCO_3.xH_2O$. [Assume that the impurities in the ore are inert and do not react chemically in any testing procedure.]

The chemist took a 5.750 g sample of the ore and heated it strongly to drive off all the water of crystallisation. The dry anhydrous powder (nickel carbonate + impurities) remaining weighed 4.164 g. This powder was then dissolved in excess nitric acid. The resulting solution was then diluted to 1.00 L by the addition of distilled water, and was then electrolysed with inert electrodes until the mass of the cathode finally remained constant, indicating that all the nickel in the solution had been deposited at the cathode. The gain in mass of the cathode was 1.707 g. From the above information, calculate:

(a) the value of x (ie determine the formula of the hydrated nickel carbonate).

(b) the percentage of hydrated nickel carbonate in the ore.

[10 marks]

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3. One method of measuring the blood alcohol content (BAC) of a human is the Kozelka and Hine procedure. In this method, protein, aldehydes and ketones are first removed from a blood sample and the purified sample is then reacted with an acidified dichromate solution. A 25.0 mL sample of blood taken from a driver involved in an accident yielded sufficient alcohol (ethanol) to consume 3.00×10^{-5} moles of $Cr_2O_7^{2-}(aq)$ according to the equation:

$$2Cr_2O_7^{2-}(aq) + 3CH_3CH_2OH(aq) + 16H^+(aq) \rightarrow 4Cr^{3+}(aq) + 3CH_3COOH(aq) + 11H_2O(l).$$

(a) calculate the BAC of the driver expressed in millimoles of ethanol per 100 mL of blood. [Note: 1 millimole = 10^{-3} mole.] [6 marks]

(b) Assuming that 1.00 mL of blood weighs 1.00 g, calculate the percentage by mass of ethanol in the driver's blood. [4 marks]

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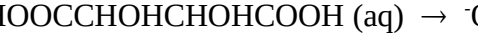
4. The acidity of wine is due to the grape acid tartaric acid HOOCCHOHCHOHCOOH(aq). A wine producer wishes to determine the percentage of tartaric acid in a sample of wine. Tartaric acid is a weak diprotic acid which ionizes according to the following equation:



$$HOOCCHOHCHOHCOOH\ (aq) \rightarrow {}^{-}OOCCHOHCHOHCOO^{-}(aq) + 2H^{+}(aq).$$

She takes a 20.0 mL sample of the wine and dilutes it to 250 mL in a volumetric flask. The diluted wine is then placed in a burette and is titrated against 20.0 mL samples of a standardized 0.0125 mol L^{-1} sodium hydroxide solution in a conical flask to which a suitable indicator has been added.
The results of four titrations of the diluted wine are shown in the following table:

	Titration 1	Titration 2	Titration 3	Titration 4
Initial volume (mL)	0.0	0.5	1.2	0.0
Final volume (mL)	13.5	12.5	13.1	12.1
Titre volume (mL)				

(a) Determine the appropriate average titre of diluted wine in this experiment. [2 marks]

(b) Calculate the concentration of tartaric acid in the undiluted wine in mol L^{-1}. [6 marks]

(c) Calculate the percentage by mass of tartaric acid in the wine given that 1.00 mL of the wine weighs 1.00 g. [2 marks]

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5. The explosive TNT [2,4,6 trinitrotoluene (2,4,6 trinitro-1-methylbenzene)] is made by treating methyl benzene (toluene, $C_6H_5CH_3$) with nitric acid. Three alternate H atoms on the toluene ring are replaced by NO_2 groups producing TNT whose overall molecular formula may be written $C_7H_5N_3O_6$.

(a) Sketch the structure of TNT. [2 marks]

(b) Calculate the masses of methyl benzene and nitric acid required to manufacture 1.00 tonne of TNT. [Note: 1 tonne = 10^6 g.] [8 marks]

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END OF PART 3

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PART 4

Answer **ONE** of the following extended answer questions. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing. Marks are awarded principally for the **relevant chemical content** of your essay, but some marks can also be gained for **clarity** in arranging a reasonable amount of material in essay form. Your answer should be presented in about 1.5 - 2 pages.

This part carries 20 marks out of 200.

1. Ammonia is one of the most widely used chemicals in the world. It is synthesized from its elements nitrogen and hydrogen. Ammonia is used in making ammonium nitrate fertilizer when $NH_3(aq)$ is neutralized by nitric acid. Ammonia forms only a weak base when dissolved in water even though it is highly soluble in water – one volume of water at 25°C is able to dissolve about 700 volumes of ammonia gas at the same temperature and at 1.00 atmospheres pressure.
   Compare and contrast this information about the manufacture, solubility and uses of ammonia with the manufacture and uses of hydrogen chloride gas.
   Include in your answer an explanation of the difference in the strength of aqueous solutions of ammonia to behave as a base and the strength of aqueous solutions of hydrogen chloride to act as an acid. [20 marks]

OR

2. A number of pure substances (elements and compounds) were subjected to several chemical and physical tests. The results of the tests are summarized in the following table.

Substance	Boiling Point (°C)	Solubility in water	Conductivity when solid	Conductivity when molten	Nature of aqueous solution	Other properties
A	650	"soluble"	nil	nil	Non-electrolyte	brittle white solid
B	100	"insoluble"	nil	nil	-	colourless non-polar liquid
C	1100	"soluble"	nil	excellent	Strong electrolyte	brittle white solid
D	1800	"insoluble"	excellent	excellent	-	silvery solid

Discuss the properties of each substance, relating each to a likely structure for the substance. Suggest the type of bonding likely to be found in each one and give reasons. Suggest a possible name for each substance.

[20 marks]

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