CRANBROOK SCHOOL

YEAR 12

TERM 3, 2001

TRIAL HSC COURSE EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper

Section I Pages 2 - 10

Total marks (93)
This section has two parts, Part A and Part B

Part A
Total marks (15)
- Attempt Questions 1 - 15
- Allow about 30 minutes for this part

Part B
Total marks (78)
- Attempt Questions 16 - 30
- Allow about 2 hours and 15 minutes for this part

Section II Pages 11 - 12

Total marks (7)
- Attempt question 31
- Allow about 15 minutes for this section.

Section 1
Total marks (93)

Part A
Total marks (15)
Attempt Questions 1 - 15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

A ⬭ B ⬭ C ⬭ D ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ⬭ B ⬭ C ⬭ D ⬭

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A ⬭ B ⬭ C ⬭ D ⬭

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1. Which of the following statements is correct?

(A) Ethane has a higher MP than ethene due to weaker dispersion forces between ethane molecules

(B) Ethane is less reactive than ethene and ethane undergoes addition reactions

(C) Ethane and ethene are both polar molecules

(D) Ethane is less reactive than ethene and ethane undergoes substitution reactions

2. Polystyrene is best suited for:

(A) carry bags due to its rigidity

(B) tool handles due to its large side group

(C) garden hoses due to its high melting point

(D) carpets due to its ability to stretch and return to its original position

3. Which underlined species is being oxidised in the following equations?

(A) $4Fe_{(s)} + 3\ \underline{O_{2(g)}} \rightarrow 2Fe_2O_{3(s)}$

(B) $H_2SO_{4(aq)} + 2\underline{NaOH}_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

(C) $\underline{Zn}_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

(D) $H_{2(g)} + \underline{Cl_{2(g)}} \rightarrow 2HCl_{(g)}$

4. When refining a metal such as copper by electrolysis the:

(A) impure copper is at the cathode

(B) impure copper is the electrolyte

(C) pure (refined) copper is the oxidant

(D) pure (refined) copper undergoes oxidation

5. The stability of isotopes is related to the ratio of neutrons to protons in the nucleus. Unstable nuclei of elements with:

(A) a low atomic number mainly produce β-particles

(B) an atomic number greater than 83 produce α-particles only

(C) an atomic number less than 83 produce α-particles and δ-radiation only

(D) a neutron to proton ratio between 1 and 1.1 produce δ-radiation only

6. Acid strength is a measure of the:

(A) concentration of an acid in solution

(B) extent to which an acid neutralises a base

(C) extent to which an acid ionises in water

(D) number of acidic protons present in the acid molecule

7. The preparation of phosgene, $COCl_{2(g)}$, is exothermic and can be represented by the equation:

$$CO_{(g)} + Cl_{2(g)} \leftrightarrow COCl_{2(g)}$$

The formation of phosgene would be most favoured by:

(A) high temperature, high pressure and removal of phosgene

(B) low temperature, low pressure and removal of chlorine

(C) low temperature, high pressure and removal of phosgene

(D) high temperature, low pressure and addition of carbon monoxide

8. To indicate that a substance is slightly acidic and not highly acidic a scientist would best use a combination of which two indicators:

(A) methyl orange and bromothymol blue

(B) litmus and bromothymol blue

(C) litmus and phenolphthalein

(D) methyl orange and phenolphthalein

9. The structure below represents:

$CH_3CH_2CH_2COOCH_2CH_2CH_3$

(A) propyl propanoate

(B) propyl butanoate

(C) butyl propanoate

(D) butyl butanoate

10. In a titration of a strong base with a weak acid the solution at the equivalence point is:

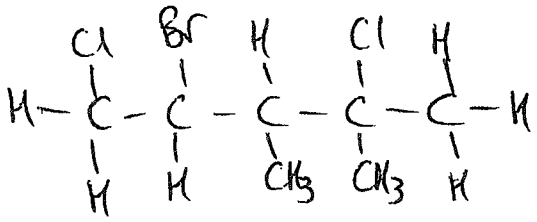
(A) acidic

(B) basic

(C) neutral

(D) dependent on the concentrations of the acid and base used

11. The systematic name for the compound shown below is:



(A) 2-bromo –1, 4 –dichloro –3, 4-dimethylpentane

(B) 4-bromo-2, 5-dichloro-2, 3-dimethylpentane

(C) 3, 4-dimethyl-4-bromo-2, 5-dichloropentane

(D) 1, 3, 4-trichloro-bromo-hexane

12. A particular chemical is found to exhibit the following properties:

- A brick-red flame colour
- A white precipitate with F^- ions
- A yellow precipitate with Pb^{2+} ions

The chemical is most probably:

(A) $BaCl_2$

(B) BaI_2

(C) $CaCl_2$

(D) CaI_2

13. The rate of the following exothermic reaction can be increased by:

$A_{(g)} + 2B_{(g)} \leftrightarrow 2C_{(g)}$

(A) decreasing the temperature

(B) increasing the pressure

(C) removing the product

(D) adding a catalyst

14. AAS (Atomic Absorption Spectroscopy) could not be used to monitor:

(A) excessive chlorination of drinking water

(B) micro-nutrients in soil

(C) trace elements in living cells

(D) the mercury content in fish

15. A gas is found to have the following properties:

- Colourless
- Condenses to a distinct blue liquid
- Strong odour
- Poisonous in very small proportions
- Used to sterilise water

The gas is most probably:

(A) CO_2

(B) O_2

(C) O_3

(D) H_2S

Section I

Part B
Total marks (78)
Attempt Questions 16 - 30
Allow about 2 hours and 15 minutes for this part

Answer Questions 16 - 21 in the Part B1 Answer Booklet.
Answer Questions 22 – 30 in the Part B2 Answer Booklet

Show all relevant working in questions involving calculations.

Question 16 (5 marks) **Marks**

Name a propellant that has been used as an alternative to CFC's (chlorofluorocarbons). Discuss why this propellant is favourable to chlorofluorocarbons. 5

Question 17 (3 marks)

(a) Describe how the acidity/basicity of the oxides varies across period 3. 1

(b) Write an equation for one of the oxides acting as a base and one acting as an acid. 2

Question 18 (4 marks)

Ozone and oxygen are allotropes. Account for the difference in their properties on the basis of their molecular structure and bonding. 4

Question 19 (6 marks)

You are given a sample of water to analyse for its drinking quality. List three tests that need to be carried out to determine the drinking quality of the sample and explain the importance of each test for this purpose. 6

Question 20 (4 marks)

Outline and describe the role of a particular chemist employed in a named industry. 4

Question 21 (6 marks) **Marks**

Chemical reactions in industry need to be monitored continuously so that yields are maximised and costs are kept low. **6**

Discuss this statement with reference to the Haber process.

Question 22 (7 marks)

Oxides of sulfur are readily released into the atmosphere with detrimental effects.

(a) (i) Identify natural and industrial sources of the oxides of sulfur. **4**

(ii) Use equations to show how the two common oxides of sulfur are formed.

(b) Explain why the oxides of sulfur are causing concern when released into the atmosphere. Use equations to support your explanation. **3**

Question 23 (2 marks)

Outline the differences between the alkanol and alkanoic acid functional groups in carbon compounds. **2**

Question 24 (8 marks)

(a) Outline the differences between the definition of acids and bases proposed by Lewis and those of Brönsted and Lowry. **4**

(b) Explain how both theories in part (a) increased our understanding of acids and bases. **4**

Question 25 (4 marks)

Discuss the advantages and disadvantages of using ethanol as an alternative fuel. **4**

Question 26 (4 marks) **Marks**

Ethene is an important industrial chemical.

(a) Ethene is obtained from oil as a by-product of catalytic cracking. Name a commonly used catalyst in this industrial process and state if it is classed as a homogeneous or heterogenous catalyst. 2

(b) Ethene can also be obtained from ethanol. 2

(i) Write the equation for the production of ethene from ethanol.

(ii) Identify the catalyst used in this reaction and describe how it works.

Question 27 (6 marks)

The radioactive isotope sodium-24 is a β- and δ-emitter

(a) Write the equation for the decay of sodium-24. 1

(b) Describe two types of instruments or processes that can be used to detect radiation. 2

(c) (i) What feature(s) would sodium-24 exhibit that make it suitable as a leak detector in water and oil pipelines? 3

(ii) Describe how sodium-24 can be used as a leak detector in water or oil pipelines.

Question 28 (6 marks)

Aminoethane, $C_2H_5NH_2$ is soluble in water. It can act as either an acid or base (at the NH_2 end).

(a) (i) What is the name given to a species that can act as an acid or base? 4

(ii) Using equations clearly show $C_2H_5NH_2$ acting as an acid and then a base.

(iii) Underline one conjugate acid-base pair in either of the equations above.

(b) Describe a simple test that could be carried out in the school laboratory that would verify that $C_2H_5NH_2$ acts as a weak base in water. 2

Question 29 (2 marks)

Marks

Describe using an equation how and where a named transuranic element can be produced. 2

Question 30 (11 marks)

In 1794, Alessandro Volta constructed the first electrochemical cell. He used a zinc plate and a copper plate separated by a sheet of paper moistened with sodium chloride solution.

Volta observed that the zinc plate was gradually eaten away as the cell operated, but the copper was not. Small bubbles of gas (which proved to be hydrogen) formed continuously at the surface of the copper nearer the paper.

(a) (i) Write a balanced half-equation to explain the change in the zinc plate. 6

(ii) Write a balanced half-equation to explain the formation of bubbles on the copper plate.

(iii) Write the fully balanced equation for the reaction.

(iv) Assuming *standard conditions*, calculate the voltage of the cell.

(v) Are the conditions, as described above, *standard conditions*? Explain.

(vi) Describe the direction of electron flow in the cell.

(b) Which metal would be the anode of the cell? Explain. 1

(c) The cell did not operate when the paper was moistened with pure water. Why? 1

(d) Explain why this cell is classed as a galvanic cell and not an electrolytic cell. 1

(e) Discuss how this cell has impacted (benefitted) on modern society. 2

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Student Number

CRANBROOK SCHOOL

YEAR 12

TERM 3, 2001

TRIAL HSC COURSE EXAMINATION

Chemistry
Part A Answer Booklet

General Instructions

- Write your Student Number at the top of this page
- Answer Questions 1 - 15 in this answer booklet
- Write using blue or black pen
- Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

1. (A) (B) (C) ●
2. (A) ● (C) (D)
3. (A) (B) ● (D)
4. (A) (B) ● (D)
5. ● (B) (C) (D)
6. (A) (B) ● (D)
7. (A) (B) ● (D)
8. ● (B) (C) (D)
9. (A) ● (C) (D)
10. (A) ● (C) (D)
11. ● (B) (C) (D)
12. (A) (B) (C) ●
13. (A) (B) (C) ●
14. ● (B) (C) (D)
15. (A) (B) ● (D)

Write your answers on the lines or in the spaces provided for each question.

Marker's use only

Question 16 (5marks)

Hydrofluorocarbons - contain C-H bonds - susceptible to attack by reactive radicals in troposphere thus decomposed before most get to stratosphere. CFC's dont break down in troposphere (read stratosphere where uv breaks Cl off which reacts with O_3 to form O_2 - reduces ozone layer)

Question 17 (3 marks)

(a) basic to acidic (GIII amphoteric, GVIII neutral) not required

(b) $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$

$SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3(aq)}$

Question 18 (4 marks)

Marker's use only

O_2  double bond, linear shape

needs high energy to break bond for O_2 to react. Non-Polar molecule v. low BP (lower than O_2), not very soluble in H_2O, stable

O_3 bent shape, polar molecule 2 bonds - single bond easily broken - lower energy than double bond thus forms O_2. Higher BP than O_2, more soluble in H_2O (polar), reactive

Question 19 (6 marks)

Three tests to be explained - importance to test for drinking (any from p255 of text) "Conquering chemistry"

Marker's use only

Question 20 (4 marks)

Student response must thoroughly describe the role of a named chemist in industry

Question 21 (6 marks)

Student's response must thoroughly discuss the reasons for monitoring the Haber process so to maximise yield and keep costs low and
- give the chemical reactions for the process and
- briefly explain the equilibrium compromise required to keep cost low but yield high

Write your answers on the lines or in the spaces provided for each question.

Marker's use only

Question 22 (7marks)

(a) (i) natural: geothermal hot springs, volcanoes
industrial: burning processing fossil fuels + extracting metals from sulfide ores

(ii) $S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$ or
$MS_{(s)} + 3/2\ O_{2(g)} \longrightarrow MO_{(s)} + SO_{2(g)}$

(b) $SO_{2(g)} + \frac{1}{2} O_{2(g)} \longrightarrow SO_{3(g)}$
SO_2 - irritates respiratory system in humans
- causes breathing difficulties
- forms acid rain; increase acidity in lakes damage to pine trees, erosion of marble, limestone
or SO_3 $SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(aq)}$
or $H_2SO_{3(aq)} + \frac{1}{2} O_{2(g)} \longrightarrow H_2SO_{4(aq)}$
or $SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$

Question 23 (2 marks)

alkanol - contains an OH group (not hydroxide) attached to C which has C or H only attached to it
alkanol - contains an OH group and =O, attached to C which has C or H only attached to it

Marker's use only

Question 24 (8 marks)

(a) Lewis - broader than L-B, electron pair movement
- base has lone pair e' donates lone pr
- acid is electron pr acceptor
Bronsted-Lowry - more limited
- acid donates a proton to form conjugate base
- base accepts a proton to form a conjugate acid

(b) L-B increased knowledge by showing acidity depends on structure of substance plus its properties relative to solvent or reactant in solution
- source basis for quantitative treatment
- idea of conjugates
weak + strong acids, amphiprotic species

Question 25 (4 marks)

Marker's use only

Advantages: renewable resource (reduce oil dependence)
reduce greenhouse gas

Disadvantages: - large area of Ag land needed
- disposal of large amounts of fermentation liquors
- low yield by fermentation

Question 26 (4 marks)

(a) zeolite - heterogeneous

(b) (i) $CH_3CH_2OH \xrightarrow[H_2SO_4]{\text{conc}} CH_2CH_2 + H_2O$

(ii) H_2SO_4 is catalyst - removes H_2O causing dehydration; reaction →

Marker's use only

Question 27 (6 marks)

(a) ${}^{24}_{11}Na \longrightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e + \gamma$

(b) Photographic film : film darkens ; darker = more radiation
Cloud Chamber : radiation ionises air, H_2O particles condense on ionised air : leaving trail
α = dense trail, β = less dense, longer, γ = thin v long.
GM tube - ionises gas in tube, electrical impulse picked up by detector

(c) (i) short lived half life, so Al foil can be used shortly after (15 hours)
low range of β allows them only to pass out via cracks

(ii) add Na24 to liquid and scan along pipe with Geiger counter - no leaks = no detection

Marker's use only

Question 28 (6 marks)

(a) (i) amphiprotic

(ii)/(iii) acid: $C_2H_5NH_2 + H_2O \rightarrow C_2H_5NH^- + H_3O^+$

base $C_2H_5NH_2 + H_2O \rightarrow C_2H_5NH_3^+ + OH^-$

(b) make 0.1 mol/L solution, check pH using meter

Question 29 (2 marks)

Nuclear reactors or accelerators

eg. bombard U238 with high speed neutrons

$^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e$

Question 30 (11 marks)

(a) (i) $Zn \rightarrow Zn^{2+} + 2e^-$

(ii) $H^+ + e^- \rightarrow \frac{1}{2} H_{2(g)}$

(iii) $Zn + 2H^+ \rightarrow Zn^{2+} + H_{2(g)}$

(iv) $0.76\,V + 0.0\,V = 0.76\,V$

(Question 30 continues on next page)

Marker's use only

(v) no - not 1 mol/L NaCl

not at 25°C / 101·3 kPa

(vi) from Anode (Zn plate) to Cathode (Cu plate)

(b) Zinc plate - oxidation occurs or e^- produced

(c) Na^+ ions flow (or salt bridge electrolyte Cl^-)

(d) It produces electric current (not conserves)

(e) basic of batteries, electricity, electrolysis

- any discussion of batteries, cells, electrical energy etc

Option

31. (a) leaching by rain + /or groundwater
hydrothermal vents in mid ocean ridges

(b) single line denotes phase change
double line " salt bridge
LHS anode compartment (oxidation)
RHS cathode compartment (reduction)

LHS iron metal immersed in solution containing Fe^{2+} ions
RHS inert metal (Pt) immersed in solution containing Fe^{2+}, Fe^{3+} ions

$EMF^{\circ}_{cell} = 0.44\,V + 0.77\,V = 1.21\,V$