

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.

The content and format of this paper do not necessarily reflect the content and format of the HSC examination paper.

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 ☒ *correct* C ☐ D ☐

- Which of the following statements is correct?
 - Ethane has a higher MP than ethene due to weaker dispersion forces between ethane molecules
 - Ethane is less reactive than ethene and ethane undergoes addition reactions
 - Ethane and ethene are both polar molecules
 - Ethane is less reactive than ethene and ethane undergoes substitution reactions
- Polystyrene is best suited for:
 - carry bags due to its rigidity
 - tool handles due to its large side group
 - garden hoses due to its high melting point
 - carpets due to its ability to stretch and return to its original position
- Which underlined species is being oxidised in the following equations?
 - $4\text{Fe}_{(s)} + 3 \text{O}_{2(g)} \rightarrow 2\text{Fe}_2\text{O}_{3(s)}$
 - $\text{H}_2\text{SO}_{4(aq)} + 2\text{NaOH}_{(aq)} \rightarrow \text{Na}_2\text{SO}_{4(aq)} + 2\text{H}_2\text{O}_{(l)}$
 - $\text{Zn}_{(s)} + 2\text{HCl}_{(aq)} \rightarrow \text{ZnCl}_{2(aq)} + \text{H}_{2(g)}$
 - $\text{H}_{2(g)} + \text{Cl}_{2(g)} \rightarrow 2\text{HCl}_{(g)}$
- When refining a metal such as copper by electrolysis the:
 - impure copper is at the cathode
 - impure copper is the electrolyte
 - pure (refined) copper is the oxidant
 - pure (refined) copper undergoes oxidation
- The stability of isotopes is related to the ratio of neutrons to protons in the nucleus. Unstable nuclei of elements with:
 - a low atomic number mainly produce β -particles
 - an atomic number greater than 83 produce α -particles only
 - an atomic number less than 83 produce α -particles and δ -radiation only
 - a neutron to proton ratio between 1 and 1.1 produce δ -radiation only
- Acid strength is a measure of the:
 - concentration of an acid in solution
 - extent to which an acid neutralises a base
 - extent to which an acid ionises in water
 - number of acidic protons present in the acid molecule
- The preparation of phosgene, $\text{COCl}_{2(g)}$, is exothermic and can be represented by the equation:

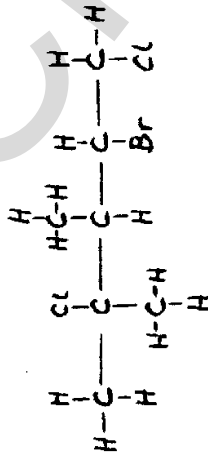
$$\text{CO}_{(g)} + \text{Cl}_{2(g)} \leftrightarrow \text{COCl}_{2(g)} + \Delta$$
 The formation of phosgene would be most favoured by:
 - high temperature, high pressure and removal of phosgene
 - low temperature, low pressure and removal of chlorine
 - low temperature, high pressure and removal of phosgene
 - high temperature, low pressure and addition of carbon monoxide
- To indicate that a substance is slightly acidic and not highly acidic a scientist would best use a combination of which two indicators:
 - methyl orange and bromothymol blue
 - litmus and bromothymol blue
 - litmus and phenolphthalein
 - methyl orange and phenolphthalein
- The structure below represents:

$$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_2\text{CH}_3$$
 - propyl propanoate
 - propyl butanoate
 - butyl propanoate
 - 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) 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.
- (b) Write an equation for one of the oxides acting as a base and one acting as an acid.

1

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 alkanolic 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 Brønsted and Lowry.

4

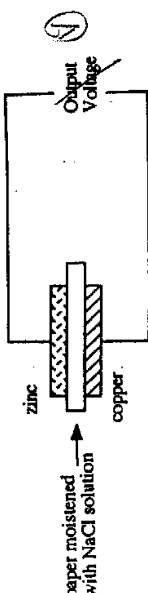
- (b) Explain how both theories in part (a) increased our understanding of acids and bases.

4

Question 25 (4 marks)

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

4

Question 26 (4 marks) 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 heterogeneous catalyst. (b) Ethene can also be obtained from ethanol. (i) Write the equation for the production of ethene from ethanol. (ii) Identify the catalyst used in this reaction and describe how it works.	2	2
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. (b) Describe two types of instruments or processes that can be used to detect radiation. (c) (i) What feature(s) would sodium-24 exhibit that make it suitable as a leak detector in water and oil pipelines? (ii) Describe how sodium-24 can be used as a leak detector in water or oil pipelines.	1	2
Question 28 (6 marks) Aminoethane, $\text{C}_2\text{H}_5\text{NH}_2$ 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? (ii) Using equations clearly show $\text{C}_2\text{H}_5\text{NH}_2$ 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 $\text{C}_2\text{H}_5\text{NH}_2$ acts as a <u>weak</u> base in water.	4	2
Question 29 (2 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. (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 <i>standard conditions</i>, calculate the voltage of the cell. (v) Are the conditions, as described above, <i>standard conditions</i>? Explain. (vi) Describe the direction of electron flow in the cell. (b) Which metal would be the anode of the cell? Explain. (c) The cell did not operate when the paper was moistened with pure water. Why? (d) Explain why this cell is classed as a galvanic cell and not an electrolytic cell. (e) Discuss how this cell has impacted (benefitted) on modern society.	6	2

Section II – Option

Total marks (7)

Attempt Question 31

Allow about 15 minutes for this section

Answer the question in a writing booklet. Extra Writing booklets are available.

Show all relevant working in questions involving calculations.

Question 31 – Shipwrecks and Salvage (7 marks)			Marks
(a)	Identify the two major sources (origins) of the minerals in oceans.		2
(b)	Identify each of the parts of the shorthand notation for the electrochemical cell: $\text{Fe} \mid \text{Fe}^{2+} \parallel \text{Fe}^{3+}, \text{Fe}^{2+} \mid \text{Pt}$		5
and calculate the voltage produced by the cell (assuming standard conditions)			

CHEMISTRY DATA SHEET

Values of several numerical constants

$$6.022 \times 10^{23} \text{ mol}^{-1}$$

Avogadro's constant, N_A

Volume of 1 mole ideal gas:

at 101.3 kPa (1.00 atm) and

at 273 K (0°C)

at 298 K (25°C)

Ionisation constant for water

at 298 K (25°C), K_w

Specific heat capacity of water

Some useful formulae

$$\Delta H = m \Delta T$$

$$\text{pH} = -\log_{10} [\text{H}^+]$$

Some standard potentials

$\text{K}^+ + \text{e}^-$	K(s)	-2.94 V
$\text{Ba}^{2+} + 2\text{e}^-$	Ba(s)	-2.91 V
$\text{Ca}^{2+} + 2\text{e}^-$	Ca(s)	-2.87 V
$\text{Na}^+ + \text{e}^-$	Na(s)	-2.71 V
$\text{Mg}^{2+} + 2\text{e}^-$	Mg(s)	-2.36 V
$\text{Al}^{3+} + 3\text{e}^-$	Al(s)	-1.68 V
$\text{Mn}^{2+} + 2\text{e}^-$	Mn(s)	-1.18 V
$\text{Zn}^{2+} + 2\text{e}^-$	Zn(s)	-0.76 V
$\text{Fe}^{2+} + 2\text{e}^-$	Fe(s)	-0.44 V
$\text{Ni}^{2+} + 2\text{e}^-$	Ni(s)	-0.25 V
$\text{Sn}^{2+} + 2\text{e}^-$	Sn(s)	-0.14 V
$\text{Pb}^{2+} + 2\text{e}^-$	Pb(s)	-0.13 V
$\text{H}^+ + \text{e}^-$	$\text{H}^+(\text{aq})$	0.00 V
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	$\text{SO}_4^{2-}(\text{aq}) + 2\text{H}^+(\text{aq})$	0.16 V
$\text{Cu}^{2+} + 2\text{e}^-$	Cu(s)	0.34 V
$\text{Fe}^{3+} + \text{e}^-$	$\text{Fe}^{3+}(\text{aq})$	0.77 V
$\text{Fe}^{2+} + 2\text{e}^-$	Fe(s)	0.63 V
$\text{Ag}^+ + \text{e}^-$	Ag(s)	0.80 V
$\text{Br}_2(\text{l}) + 2\text{e}^-$	$\text{Br}_2(\text{l})$	1.08 V
$\text{I}_2(\text{s}) + 2\text{e}^-$	$\text{I}_2(\text{s})$	1.10 V
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$	$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq})$	1.23 V
$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^-$	$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	1.36 V
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	$\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq})$	1.36 V
$\text{Cl}_2(\text{g}) + 2\text{e}^-$	$\text{Cl}_2(\text{g})$	1.40 V
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^-$	$\text{Mn}^{2+} + 4\text{H}^+(\text{aq})$	1.51 V
$\text{F}_2(\text{g}) + 2\text{e}^-$	$\text{F}_2(\text{g})$	2.89 V

Aylward and Findlay, SI Chemical Data (4th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

This sheet should be REMOVED for your convenience.

Where the atomic weights of Mn and Tc are given for the isotopes ^{55}Mn and ^{98}Tc .
The relative atomic mass of the most common radioactive isotope is shown in brackets.

Atomic Number	Symbol of element	Atomic Weight	Name of element
1	H	1.008	Hydrogen
2	He	4.003	Helium
3	Li	6.941	Lithium
4	Be	9.012	Beryllium
5	B	10.81	Boron
6	C	12.01	Carbon
7	N	14.01	Nitrogen
8	O	16.00	Oxygen
9	F	19.00	Fluorine
10	Ne	20.18	Neon
11	Na	22.99	Sodium
12	Mg	24.31	Magnesium
13	Al	26.98	Aluminium
14	Si	28.09	Silicon
15	P	30.97	Phosphorus
16	S	32.07	Sulphur
17	Cl	35.45	Chlorine
18	Ar	39.95	Argon
19	K	39.10	Potassium
20	Ca	40.08	Calcium
21	Sc	44.96	Scandium
22	Ti	47.87	Titanium
23	V	50.94	Vanadium
24	Cr	52.00	Chromium
25	Mn	54.94	Manganese
26	Fe	55.85	Iron
27	Co	58.93	Cobalt
28	Ni	58.69	Nickel
29	Cu	63.55	Copper
30	Zn	65.39	Zinc
31	Ga	69.72	Gallium
32	Ge	72.61	Germanium
33	As	74.92	Arsenic
34	Se	78.96	Selenium
35	Br	79.90	Bromine
36	Kr	83.80	Krypton
37	Rb	85.47	Rubidium
38	Sr	87.62	Strontium
39	Y	88.91	Yttrium
40	Zr	91.22	Zirconium
41	Nb	92.91	Niobium
42	Mo	95.94	Molybdenum
43	Tc	[98.91]	Technetium
44	Ru	101.1	Ruthenium
45	Rh	102.9	Rhodium
46	Pd	106.4	Palladium
47	Ag	107.9	Silver
48	Cd	112.4	Cadmium
49	In	114.8	Indium
50	Sn	118.7	Tin
51	Sb	121.8	Antimony
52	Te	127.6	Tellurium
53	I	126.9	Iodine
54	Xe	131.3	Xenon
55	Ba	137.3	Barium
56	La	[138.9]	Lanthanum
57	Ce	140.1	Cerium
58	Pr	140.9	Praseodymium
59	Nd	144.2	Neodymium
60	Pm	[146.9]	Promethium
61	Sm	150.4	Samarium
62	Eu	152.0	Europium
63	Gd	157.3	Gadolinium
64	Tb	158.9	Terbium
65	Dy	162.5	Dysprosium
66	Ho	164.9	Holmium
67	Er	167.3	Erbium
68	Tm	168.9	Thulium
69	Yb	173.0	Ytterbium
70	Lu	175.0	Lutetium
71	La	[175.0]	Lanthanum
72	Hf	178.5	Hafnium
73	Ta	180.9	Tantalum
74	W	183.8	Tungsten
75	Re	186.2	Rhenium
76	Os	190.2	Osmium
77	Ir	192.2	Iridium
78	Pt	195.1	Platinum
79	Au	197.0	Gold
80	Hg	200.6	Mercury
81	Tl	204.4	Thallium
82	Pb	207.2	Lead
83	Bi	209.0	Bismuth
84	Po	[209.0]	Polonium
85	At	[210.0]	Astatine
86	Rn	[222.0]	Radon
87	Fr	[223.0]	Francium
88	Ra	[226.0]	Radium
89	Ac	[227.0]	Actinium
90	Th	232.0	Thorium
91	Pa	231.0	Protactinium
92	U	238.0	Uranium
93	Np	[237.0]	Neptunium
94	Pu	[239.1]	Plutonium
95	Am	[241.1]	Americium
96	Cm	[244.1]	Curium
97	Bk	[247.1]	Berkelium
98	Cf	[251.1]	Californium
99	Es	[252.1]	Einsteinium
100	Fm	[257.1]	Fermium
101	Md	[258.1]	Mendelevium
102	No	[259.1]	Nobelium
103	Lr	[262.1]	Lutetium