Australian International School Singapore

2007

Half Yearly Examination

HSC Chemistry

General Instructions

• Reading time – 5 minutes
• Working time – 2 hours
• Write using black or blue pen
• Draw diagrams using pencil
• Board-approved calculators may be used
• A data sheet and a Periodic Table are provided at the back of this paper

Total marks – 82

Part A – 20 marks

• Attempt Questions 1 – 20
• Allow about 40 minutes for this part

Part B – 62 marks

• Attempt Questions 21 - 30
• Allow about 1 hour and 20 minutes for this part

Part A – 20 marks

Attempt Questions 1 – 20

Allow about 40 minutes for this part

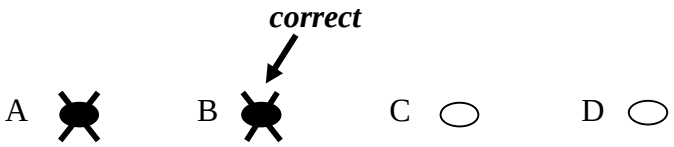
Use the multiple-choice answer sheet.

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

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

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



1. Why is catalytic cracking an important process associated with the petrochemical industry?

a) it increases the amount of larger fractions such as bitumen
b) it increases the amount of useful fractions such as petrol and ethene
c) it breaks the double bonds found in many of the fractions
d) it decreases the amount of smaller fractions such as methane

2. The radiation which would penetrate the greatest distance in metallic sheets would be:

a) alpha particles b) beta particles
c) gamma rays d) positrons

3. Red cabbage can be boiled and the juice used to test for acidity. The red cabbage juice would be an example of a(n):

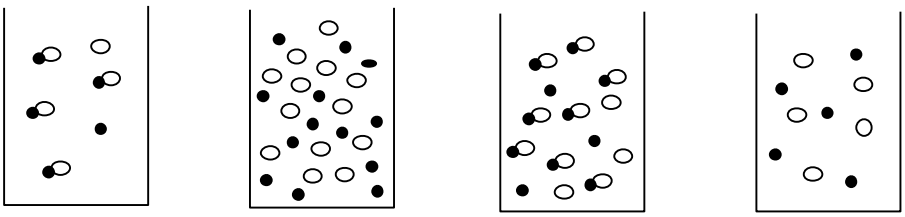
a) buffer b) ester c) neutralizer d) indicator

4. The reaction which shows the alpha decay of cadmium-114 is:

a) $^{114}_{48}Cd + {}^{4}_{2}He \rightarrow {}^{118}_{50}Sn$ b) $^{114}_{48}Cd \rightarrow {}^{110}_{46}Pd + {}^{4}_{2}He$
c) $^{114}_{48}Cd + {}^{4}_{2}He \rightarrow {}^{114}_{49}In$ d) $^{114}_{48}Cd \rightarrow {}^{114}_{47}Ag + {}^{4}_{2}He$

5. The following diagrams represent samples of 4 acids dissolved in water. ***Identify*** the diagram representing a <u>concentrated</u> solution of a <u>weak</u> acid.

A B C D



Key: Ions are shown as ○ and ●. Molecules are shown as ○●

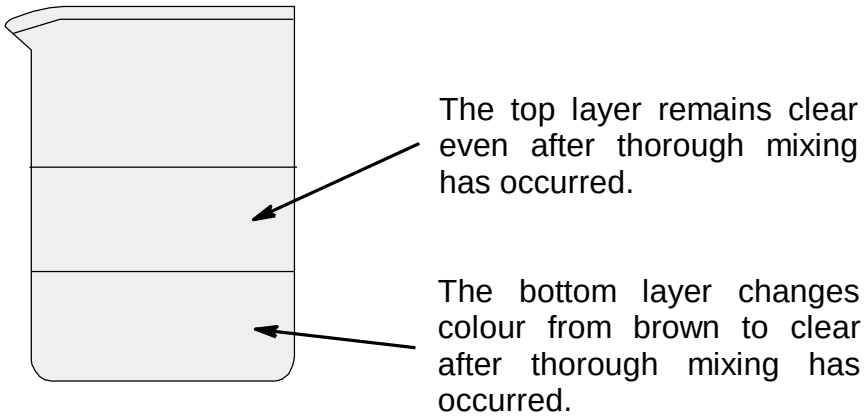
6. The use of biological polymers such as biopol has increased over the past decade. The main reason for the increase in interest in biopolymers is:

a) the ease at which biological polymers are created
b) the decrease in the cost and energy use associated with biopolymers compared with the more traditional polymers
c) the monomers used in the production of biopolymers tend to be biodegradable
d) the monomers used in the production of biopolymers tend to be renewable resources

7. A student prepares to ferment sugars to produce alcohol. The correct reaction conditions he must use to ensure that he gains the maximum yield of ethanol are:

a) 20-25^{o}C, yeast and adequate oxygen
b) 20-25^{o}C, yeast and adequate carbon dioxide
c) 20-25^{o}C, yeast and limited oxygen
d) 20-25^{o}C, yeast and limited carbon dioxide

8. A student tests an unknown hydrocarbon with bromine water. Her results are shown in the diagram below.



From the observations she is able to conclude that:

a) the hydrocarbon was saturated because the top layer remains clear even after mixing
b) the hydrocarbon was unsaturated because the top layer remains clear even after mixing
c) the hydrocarbon contained double bonds because the bottom layer changes colour from brown to clear after thorough mixing has occurred
d) the hydrocarbon contained single bonds only because the bottom layer changes colour from brown to clear after thorough mixing has occurred

9. Identify the common chemical which would have the lowest pH value.

a) Orange juice
b) Blood
c) Bathroom cleaner
d) Vinegar

10. When a solution changes from pH = 5 to pH = 3, the hydrogen (or hydronium) ion concentration changes:

a) Twice as much as the original
b) 10x as much as the original
c) 100x as much as the original
d) No difference as they are both acids

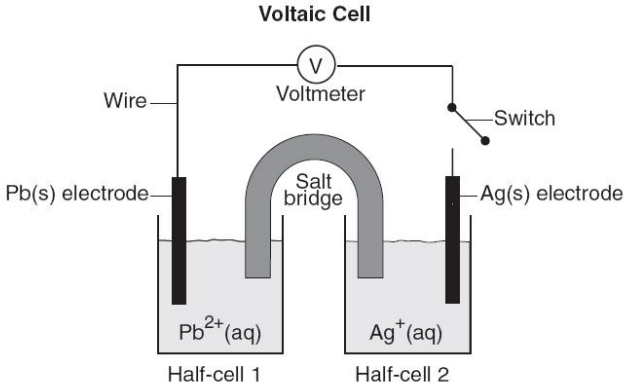
11. Identify the reaction representing a neutralization reaction is:

a) $Na_2CO_{3(aq)} + CaCl_{2(aq)} \rightarrow 2\ NaCl_{(aq)} + CaCO_{3(aq)}$
b) $Ni(NO_3)_{2(aq)} + H_2S_{(aq)} \rightarrow NiS_{(aq)} + 2\ HNO_{3(aq)}$
c) $NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$
d) $H_2SO_{4(aq)} + Mg(OH)_{2(aq)} \rightarrow MgSO_{4(aq)} + 2\ H_2O_{(l)}$

12. The main gas responsible for the problem of acid rain is:

a) Methane
b) Carbon dioxide
c) Oxides of sulfur
d) Ozone

13. A student set up the electrochemical cell shown.



The equation occurring at the anode in the cell is shown by the equation:

a) $Pb_{(s)} \longleftrightarrow Pb^{2+}_{(aq)} + 2e^-$
b) $Pb^{2+}_{(aq)} + 2e^- \longleftrightarrow Pb_{(s)}$
c) $Ag_{(s)} \longleftrightarrow Ag^{+}_{(aq)} + 1e^-$
d) $Ag^{+}_{(aq)} + 1e^- \longleftrightarrow Ag_{(s)}$

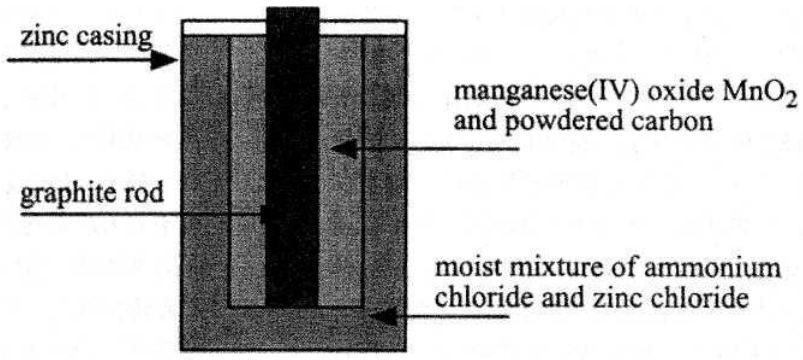
14. The hydrogen ion concentration in a hydrochloric acid solution with a pH = 2.3 is:

a) 0.05M
b) 0.005M
c) 0.0005M
d) 5.0×10^{-2}M

15. A student neutralized 16.4 mL of HCl by adding 12.7 mL of 0.620 M KOH. The molarity of the HCl is:

a) 0.168M
b) 0.480M
c) 0.620M
d) 0.801M

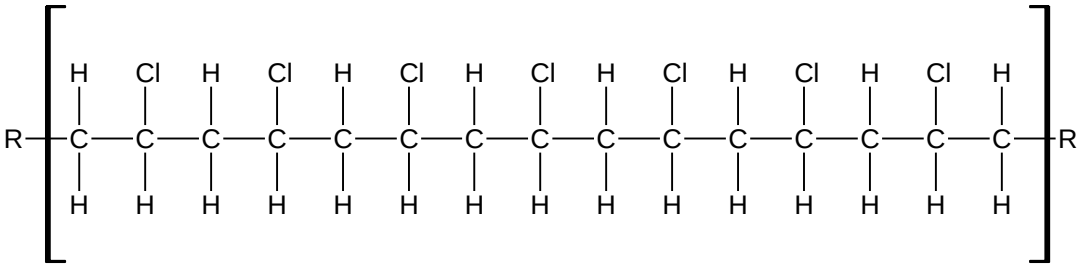
16. The diagram shows a cross section of a typical dry cell.



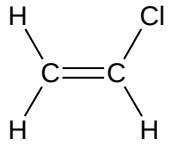
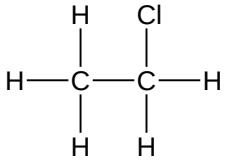
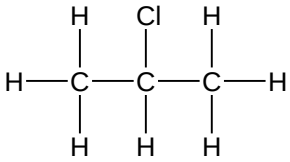
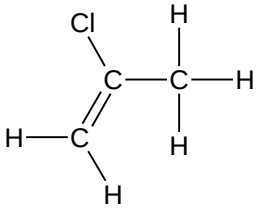
Identify the correct statement about the cell.

a) The manganese (IV) oxide is the electrolyte
b) The graphite rod is the anode
c) Graphite is reduced at the cathode
d) Zinc is oxidised to zinc (II) at the anode

17. The structure below shows a small sample of a polymer.



Identify the structure and name of the monomer used in producing the polymer

	Monomer structure	Monomer name
a)		Chloro ethene
b)		1 chloro ethane
c)		2 chloro propane
d)		2 chloro prop-1-ene

18. The hydrogen sulfate ion (HSO_4^-) is amphiprotic. According to the Bronsted-Lowry theory of acids:

a) HSO_4^- is the conjugate base of SO_4^{2-}

b) H_2SO_4 is the conjugate acid of SO_4^{2-}

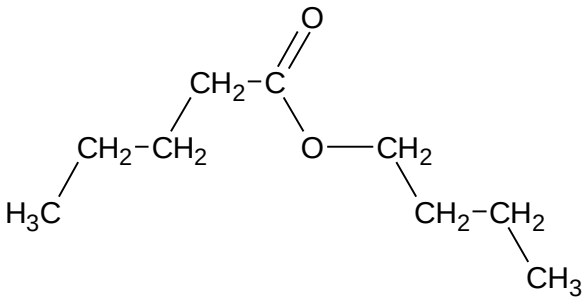
c) SO_4^{2-} is the conjugate base of H_2SO_4

d) H_2SO_4 is the conjugate acid of HSO_4^-

19. A student constructed a galvanic cell using two different metals in electrolytes of the nitrate of the metals (1 mol L^{-1} solution). The combination of metals which would give the greatest potential difference is:

a) magnesium and zinc
b) zinc and nickel
c) manganese and silver
d) nickel and silver

20. Esters are carbon based compounds used in the food industry as flavourings. The structure shown is an ester.



Identify the reactants which would be required to produce this ester

a) pentanol and pentanoic acid
b) butanol and butanoic acid
c) pentanol and butanoic acid
d) butanol and pentanoic acid

Part B

Written Responses

Attempt all questions in the space provided. Show all appropriate working for calculations.

Marks

21. Fermentation is a process used in the production of ethanol from natural sources. The ethanol can be used as a chemical feedstock for industrial processes or as a solvent.

a) *Describe* the reaction conditions required for the fermentation of ethanol from biomass.

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b) Ethanol is a chemical feedstock that could be used in the production of chemicals such as ethene.
Use an appropriate equation to show the conversion of ethanol into ethene – *include all appropriate reaction conditions required for the reaction.*

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c) *Evaluate* the importance of ethanol as a solvent, making reference to the structure and bonding present within the molecule.

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22. A sodium hydroxide solution was standardized against a 0.0100 mole L^{-1} solution of hydrochloric acid. It was then available for use in another titration.

a) *Explain* why it is necessary to standardize sodium hydroxide against the acid prior to use.

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b) An acid-base titration experiment can be used to determine the concentration of an organic acid solution. *Briefly outline* the steps that you would follow.

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23. A chemistry class conducted an experiment to investigate the voltages of several electrochemical cells.
A half cell consisting of a strip of lead in a 1.00 mol L^{-1} solution of lead nitrate ($Pb(NO_3)_2$) was joined to a half cell consisting of a strip of magnesium in a 1.00 mol L^{-1} solution of magnesium nitrate ($Mg(NO_3)_2$). A salt bridge containing sodium nitrate ($NaNO_3$) was used to join the two half cells. In the external circuit, a galvanometer was included in the external circuit attached to the cell.

a) *Identify* the anode, and *write* a half equation representing the reaction occurring there.

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b) *Identify* the cathode, and *write* a half equation representing the reaction occurring there.

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c) *Write* an equation representing the overall cell reaction, and *calculate* the maximum voltage obtainable from this cell.

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d) Draw a labelled diagram of the *original cell*. Clearly label the anode and cathode, and the charge on each. Indicate on the diagram the direction of electron flow in the external circuit, and the direction of ion flow through the salt bridge.

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e) The magnesium half cell was replaced by a copper half cell (a strip of copper in a 1.00 mol L^{-1} solution of copper II nitrate ($Cu(NO_3)_2$). *Compare* the current flow in the new cell with that occurring in the original cell.

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24. The ionisation constant for water, K_w, is 1.0×10^{-14} at 25°C and approximately 5×10^{-13} at 90°C.
Write an equation for the ionisation of water and *explain* how the electrical conductivity of water would change as it is heated.

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25. Esters are the basis of many naturally occurring odours and are therefore widely used in the creation of artificial flavours. Methyl butanoate is a component of the smell of pineapple. A manufacturer decides to test the use of some of this compound in an ice-cream mix.

a) *Sketch* the structure of the ester methyl butanoate.

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b) Using butanoic acid and methanol as starting materials *outline* the steps in the preparation of methyl butanoate from the reactants. *Identify* the name of any catalyst used in the reaction.

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26. a) The Earth's oceans contain significant amounts of dissolved carbon dioxide. The dissolving process can be described by the following chemical equilibria.

$$CO_{2(g)} \longleftrightarrow CO_{2(aq)}$$
$$CO_{2(aq)} + H_2O_{(l)} \longleftrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$$

Use this information to *explain* the likely effect of the increasing concentration of atmospheric CO_2 on the pH of seawater at the ocean surface.

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b) Several different acid-base systems contribute to the hydrogen ion concentration in blood. One of these systems is represented by the equilibrium

$$CO_{2(aq)} + H_2O_{(l)} \longleftrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$$

The equilibrium constant for the reaction (K) is 7.9×10^{-7} @ normal body temperature.

The concentration of $CO_{2(aq)}$ in freshly oxygenated blood is approximately 1.3×10^{-5} M and the pH of blood is 7.4.
Calculate the concentration of the hydrogen ion, H^+, in fresh blood – *show all necessary working*

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27. The physical properties of polymers are influenced by chemical factors such as chain length. In industry, the manufacturers use the different factors to produce polymers to suit a particular function.
a) A factory specialises in producing products made of high density and low density polythene. *Describe* the different structures that are present in the two types of polythene

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b) The factory manager and owners decide that they will investigate the use of biopolymers in their production process. They hire you to investigate current biopolymer usage and report back to them.
Assess the advantages and disadvantages associated with the current production and use of biopolymers.

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28. An ecologist wishes to trace the movement of water carrying fertilizers and pesticides through the sub-soil on a farm. He is concerned that fertilizer and pesticides are moving through the subsoil of the farm before entering the surrounding natural ecosystem. He uses a radioactive isotope to label water molecules entering the irrigation system.
a) He decides that an alpha emitting source would be most suitable for his study. Do you agree? *Explain*.

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b) *Assess* the factors which must be considered when choosing the source to use in his particular study.

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29. A student uses a spirit burner to assess the heat released by the combustion of ethanol. She sets up a 400mL beaker on a tripod over the burner and adds exactly 250mL of deionised water to it. She allows the burner to be ignited for 2 minutes before extinguishing the flame. She determines the mass of the burner before and after the experiment. All of her results are shown.

Initial water temperature = 23^{o}C

Highest temperature = 47^{o}C

Initial burner mass = 217.9g

Final burner mass = 216.3g

The theoretical value for the enthalpy of combustion of ethanol is 1364 kJ mol^{-1}.

a) Use the student's results to *calculate* the enthalpy of combustion of ethanol in (kJmol^{-1}) – *show all necessary working*

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b) After completing her calculations, she noted that her experimental results differ from the theoretical value found in the data book. *Suggest* why this difference occurred.

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30. Lactic acid is a weak acid. It forms naturally when milk sours.
25mL of lactic acid is pipetted into a beaker and the pH is measured initially and after adding volumes of 0.05M sodium hydroxide. The results of the titration are shown in the table.

pH	Volume of sodium hydroxide added (mL)
2.43	0
3.26	5.0
3.68	10.0
4.04	15.0
4.46	20.0
5.24	24.0
5.26	24.9
8.43	25.0
10.31	25.1
11.29	26.0
11.96	30.0

a) ***On the grid provided at the end of the paper***, plot the curve for the titration of the acid — 3

b) *Determine* the pH of the equivalence point – *clearly marking its position on your line graph* — 1

c) Calculate the concentration of the lactic acid – *showing all necessary working*

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