

Trinity Grammar School



Year 12 HSC Chemistry Semester 1 Examination (April, 2010)

This examination contributes 15% towards your final assessment
Time Allowed: 3 hours (plus 5 minutes reading time)

Student Number: _____

Format of paper

Part A: 20 multiple choice questions (worth 1 mark each). All answers must be entered in the special multiple choice Answer sheet provided.

Part B: Free response questions worth 80 marks in total. All answers must be written in the space provided.

-A data sheet and Periodic table are provided at the back of this paper. Please detach for use.

Part A- 20 Multiple choice. (Worth one mark each)

Allow about 45 minutes for this part.

Answer questions on the Answer Sheet provided.

1. A polymer has the following properties and uses:

- low melting point
- transparent
- oil and water resistant
- uses include food packaging

Which one of the following polymers is consistent with the above description?

- (A) high density polyethene
- (B) low density polyethene
- (C) polychloroethene
- (D) polyphenylethylene

2. A student was shown a demonstration in which a sample of an element was heated strongly in air, and the powder produced by the reaction was added to water. When tested with a pH probe connected to a data logger, the resulting solution had a pH of 9. Which one of the following elements could have been used?

- (A) S
- (B) C
- (C) Si
- (D) Ca

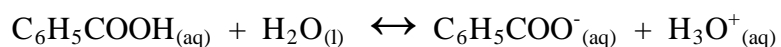
3. A few drops of bromine water are added to an unknown colourless hydrocarbon. No chemical change was observed after allowing the mixture to stand for 5 minutes under ordinary laboratory lighting.

Which one of the following is the most appropriate conclusion?

- (A) The hydrocarbon must be unsaturated.
- (B) The hydrocarbon contains single bonds only.
- (C) The hydrocarbon must contain a double bond.
- (D) The hydrocarbon must contain a triple bond.

4. A student diluted a solution of a strong acid by mixing 10 mL with 90 mL of water. If the original solution had a pH of 2.1, what will the final pH of the solution be?
- (A) 1.1
(B) 2.1
(C) 3.1
(D) 4.1

5. Consider the equilibrium reaction:



Which one of the following would decrease the $\text{C}_6\text{H}_5\text{COO}^-$ ion concentration in solution?

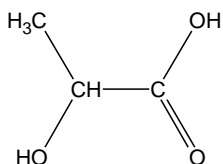
- (A) adding H_2
(B) adding HCl
(C) adding NaOH
(D) adding $\text{C}_6\text{H}_5\text{COOH}$
6. Which one of the following is an acid/base conjugate pair?
- (A) HCl/NaOH
(B) $\text{H}_2\text{SO}_4/\text{SO}_4^{2-}$
(C) $\text{H}_3\text{O}^+/\text{H}_2\text{O}$
(D) $\text{NH}_2^+/\text{NH}_3$

7. A piece of zinc is placed into copper(II) nitrate solution in a test tube.

Which one of the following changes would occur?

- (A) The concentration of nitrate ions would decrease.
(B) The colour of the solution would darken.
(C) The concentration of nitrate ions would increase.
(D) The colour of the solution would fade.

8. The following monomer undergoes condensation polymerisation.



What is the small molecule eliminated in this reaction?

- (A) H₂O
(B) CH₄
(C) H₂O₂
(D) CH₃OH
9. Which of the following correctly identifies the low pH colour of each indicator?

	phenolphthalein	methyl orange	bromothymol blue
(A)	pink	red	yellow
(B)	pink	yellow	blue
(C)	colourless	red	yellow
(D)	colourless	red	blue

10. Which one of the following is least likely to be a stable isotope?

- (A) hydrogen-3
(B) boron-11
(C) chlorine-35
(D) potassium-39

11. What is the catalyst used to hydrate ethylene?
- (A) zeolite
 - (B) yeast
 - (C) iron/iron oxide
 - (D) dilute sulfuric acid
12. Which of the following is true about current research into biopolymers?
- (A) It has resulted in polymers which biodegrade when disposed of.
 - (B) It has resulted in the widespread adoption of biopolymers by industry.
 - (C) It has resulted in polymers less expensive than those from petrochemicals.
 - (D) It has resulted in polymers with exactly the same properties as those from petrochemicals.
13. Polyethene (polyethylene) is an extremely important polymer, available in two general forms-high density polyethene (HDPE) and low density polyethene (LDPE). Which of the following statements about polyethene is correct?
- (A) HDPE is branched and has a lower melting point than LDPE.
 - (B) HDPE is unbranched and has a lower melting point than LDPE.
 - (C) LDPE is branched and has a lower melting point than HDPE.
 - (D) LDPE is unbranched and has a higher melting point than HDPE.
14. Phosphorus-30 is produced by bombarding aluminium-27 with alpha particles. Which of the following nuclear equations correctly represents this?
- (A) ${}_{13}^{27}\text{Al} + {}_2^4\text{He} \rightarrow {}_{15}^{30}\text{P} + {}_0^1\text{n}$
 - (B) ${}_{13}^{27}\text{Al} + {}_2^4\text{He} \rightarrow {}_{15}^{31}\text{P}$
 - (C) ${}_{27}^{13}\text{Al} + {}_4^2\text{He} \rightarrow {}_{30}^{15}\text{P} + {}_1^0\text{n}$
 - (D) ${}_{13}^{27}\text{Al} + {}_2^3\text{He} \rightarrow {}_{15}^{30}\text{P}$

15. Which of the following reactions is a redox reaction?

- (A) $\text{KOH(aq)} + \text{HCl(aq)} \rightarrow \text{KCl(aq)} + \text{H}_2\text{O(l)}$
- (B) $\text{Cu(s)} + 2\text{AgNO}_3\text{(aq)} \rightarrow \text{Cu(NO}_3)_2\text{(aq)} + 2\text{Ag(s)}$
- (C) $2\text{NaCl(aq)} + \text{Pb(NO}_3)_2\text{(aq)} \rightarrow \text{PbCl}_2\text{(s)} + 2\text{NaNO}_3\text{(aq)}$
- (D) $\text{H}_2\text{SO}_4\text{(aq)} + \text{K}_2\text{CO}_3\text{(s)} \rightarrow \text{K}_2\text{SO}_4\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$

16. Which of the following substances are in order of increasing boiling points?

- (A) ethanol, ethene, ethane
- (B) methanol, ethane, propanol
- (C) propanol, ethanol, methanol
- (D) methane, methanol, methanoic acid

17. The pH of a sulfuric acid solution is measured at 2.0 by a pH meter.

Which of the following alternatives shows the correct concentrations of hydrogen and sulfate ions in this solution?

	Concentration of hydrogen ions in solution (M)	Concentration of sulfate ions in solution (M)
A	1.0×10^{-1}	2.0×10^{-1}
B	1.0×10^{-2}	2.0×10^{-2}
C	1.0×10^{-1}	5.0×10^{-2}
D	1.0×10^{-2}	5.0×10^{-3}

18. Which of following may lead to increased levels of both sulfur dioxide and nitrogen dioxide in the atmosphere?

- (A) Production of photochemical smog
- (B) Lightning strikes during thunderstorms
- (C) Production of radioisotopes at a nuclear reactor
- (D) Production of electricity at a coal-fired power station

19. The table below shows the pH and colour ranges of some common acid-base indicators.

Indicator	low pH colour	pH range	high pH colour
bromothymol blue	Yellow	6.0-7.6	blue
phenolphthalein	Colourless	8.3-10	pink

A student carries out the following procedure:

Step 1. Add a few drops of phenolphthalein to 50mL of 0.1M NH_3 solution.

Step 2. Add 50mL of 0.1M HNO_3 (aq) to the NH_3 solution formed in step 1.

Step 3. Add a few drops of a bromothymol blue to the mixture formed in steps 1 and 2.

Which of the following is the best prediction of the colour of the mixture at the end of each step of the procedure?

	Step 1	Step 2	Step 3
A	colourless	pink	yellow
B	colourless	pink	green
C	pink	colourless	yellow
D	pink	colourless	blue

20. Which of the following observations can be explained in terms of the Bronsted-Lowry theory of acids but not the Arrhenius theory?
- (A) A solution of hydrochloric acid is a good conductor of electricity.
 - (B) Magnesium will displace hydrogen from a solution of sulfuric acid.
 - (C) Hydrogen chloride gas and ammonia gas react to produce solid ammonium chloride.
 - (D) When passed through water, carbon dioxide gas decreases the pH of the water.

End of Part A

Part B

Total Marks (80)

Attempt all questions 21-35

Allow about 2 Hours 15 minutes for this part

Answer the questions in the spaces provided

Marks

Question 21 (4 marks)

Polystyrene is an industrially important polymer.

(a) Draw the structure of polystyrene showing three (3) repeating units.

2

(b) Explain ONE use of this polymer with reference to its properties.

2

.....
.....
.....
.....

Question 22 (7 marks)

A student wanted to compare the heat of combustion of 1-pentanol with that of ethanol. To do this, he burned 1.55 g of 1-pentanol to heat 250.0 mL of water from 10.0°C to 38.0°C.

(a) Draw the structural formula of 1-pentanol.

1

(b) Using the student's data, calculate the heat of combustion of 1-pentanol.

3

.....
.....
.....
.....
.....
.....

(c) Identify how you would expect the student's value to compare with the experimental value for ethanol determined under the same conditions.

1

.....

(d) Identify how you would expect the student's value for 1-pentanol to compare with the literature value (eg in the SI Data Book) for 1-pentanol. Explain your answer.

2

.....
.....
.....
.....

Question 23 (3 marks)

A student was provided with two colourless solutions, each in a separate beaker, labelled X and Y. They were informed that one solution was 0.10M hydrochloric acid, the other 0.10M ethanoic acid.

The student performed two tests on the solutions:

Test 1: The pH was determined by inserting a pH probe into each solution.

Test 2: The volume of 0.10M sodium hydroxide solution needed to reach end-point with the acids was determined with a suitable indicator.

Compare the effectiveness of the two tests in determining the identity of each acid.

Justify your answer.

.....

.....

.....

.....

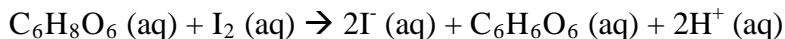
.....

.....

3

Question 24 (4 marks)

The daily recommended intake for Vitamin C (ascorbic acid) is 60 mg. The label on a brand of orange juice claims the juice contains over half the daily requirement of Vitamin C (ascorbic acid) in every 100 mL of the juice. The concentration of ascorbic acid in juice can be determined by titration method. A sample of juice is titrated against a standard solution of iodine using starch as an indicator. The following redox reaction takes place as the iodine is added to the juice sample:



The starch remains colourless as the iodine is added until all of the ascorbic acid present has reacted with the iodine. As soon any excess iodine is present, a blue-black colour is observed, as the starch reacts with the iodine. This is the end-point of the titration.

In an experiment to determine the vitamin C content in the above juice, a 25.0 mL sample of juice was added to a conical flask, along with 5 drops of starch solution. This sample was titrated with 5.00×10^{-3} mol/L iodine solution. An average of 9.15 mL of iodine was needed to reach end-point.

- (a) Identify the piece of glassware which would be used to accurately deliver 25.0 mL of orange juice into conical flask.

..... **1**

- (b) Calculate the mass (in mg) of ascorbic acid present in the 25 mL sample of orange juice. Show your working

..... **2**

- (c) Determine if the claim made on the label of the juice is valid. Show your working.

..... **1**

Question 25 (5 marks)

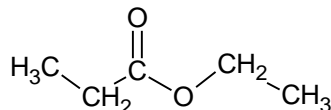
5

Explain the conditions that affect the solubility of carbon dioxide in carbonated beverages. Include at least one balanced equation in your answer.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

Question 26 (5 marks)

The structural formula of an organic compound (X) is shown in the following diagram.



- (a) Identify the family of organic compounds to which the above chemical belongs. 1

.....

- (b) Draw the structural formula and give the IUPAC name for one isomer of this compound. 2

.....

- (c) In an experiment to produce a sample of the organic compound X, a chemist refluxed a suitable reaction mixture for 1 hour. At this point, 5.00×10^{-3} moles of H^+ ions remained in the reaction flask along with compound X. The chemist added excess sodium carbonate solution to remove the unwanted H^+ ions. 2

Calculate the volume of carbon dioxide gas which would theoretically be produced from the addition of the sodium carbonate at 25°C and 100kPa pressure. Show all working.

.....

.....

.....

.....

.....

Marks

Question 27 (3 marks)

Coal fired power stations can contribute to the problem of acid rain if the coal burnt contains sulfur impurities.

3

A recent media report quoted a politician who said that converting from coal to methane in electricity generation would eliminate the production of acid rain.

Assess the accuracy of this statement, including an appropriate chemical equation.

.....

.....

.....

.....

.....

.....

Question 28 (5 marks)

Sodium hydrogencarbonate, NaHCO_3 , is a common laboratory chemical.

5

Explain why the Arrhenius acid/base definition is unable to account for the acid/base properties of this species, whereas the Lowry-Bronsted theory can.

Include chemical equations to illustrate your explanation.

.....

.....

.....

.....

.....

.....

.....

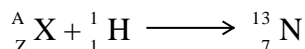
.....

.....

Question 29 (5 marks)

Two radioisotopes produced by scientists are nitrogen-13 and neptunium-239.

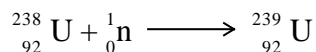
- (a) The equation to describe the production of nitrogen-13 is shown below: **1**



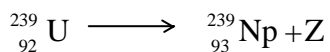
Identify X in the equation above. Include the symbol of the element, its atomic number (Z) and mass number (A).

.....

- (b) Np-239 can be produced from the bombardment of U-238 with a neutron. This forms U-239 as shown. **1**



The U-239 then decays into Np-239 via the equation:



Identify Z in the equation above.

.....

- (c) A student researching the production of the above radioisotopes reported that both could be produced in a nuclear reactor such as the one located in Lucas Heights, NSW. **3**

Assess the accuracy of this statement.

.....

.....

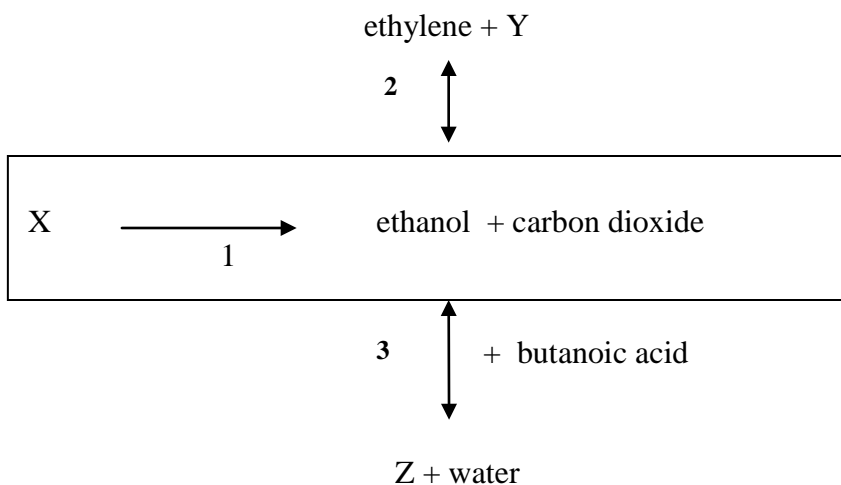
.....

.....

Question 30 (9 marks)

Marks

The flow chart below represents a series of reactions (1, 2 and 3), starting with substance X in reaction 1.



- (a) Write balanced chemical equations to represent reactions 1 and 2 above. 2

.....
.....

- (b) Using structural formulae, write a balanced equation to represent reaction 3 above. 2

- (c) Outline the conditions under which ethylene is converted to HDPE. 2

.....
.....
.....
.....

Question 30 continues on next page.

Question 30 (continued)

- (d) Assess the significance of the reaction conditions in reaction (1) in the above diagram. **3**

.....

.....

.....

.....

.....

.....

Question 31 (5 marks)

In order to determine the concentration of a solution of acetic (ethanoic) acid, a student prepared a solution of NaOH, which then had to be standardised.

The acetic acid concentration was calculated to be 0.1155 M.

- (a) Identify one property of NaOH which makes it unsuitable for use as a primary standard. **1**

.....

.....

- (b) Calculate the pH of the acetic acid solution, assuming that 1% of the acetic acid molecules are ionised in solution. **1**

.....

.....

Question 31 continues on next page.

Question 31 (continued)

- (c) The student chose phenolphthalein as the indicator for this titration. 3

Explain, using equations to illustrate your answer, why this was an appropriate choice.

.....

.....

.....

.....

.....

Question 32 (6 marks)

A student wanted to construct a galvanic cell using a piece of silver metal, a strip of magnesium metal, and suitable other reagents.

- (a) In the space below, draw and label the galvanic cell the student constructed. 3

- (b) Write the two half equations for the reactions occurring in the cell. 2

.....

.....

- (c) Calculate the expected voltage produced by the student's cell. 1

.....

.....

Question 33 (9 marks)

To determine the mass of CO₂(g) dissolved in a 250 mL bottle of soft drink, a student carried out the following steps:

1. Weigh the unopened bottle of soft drink (with the cap on).
2. Carefully remove the cap, wait for 20 seconds, then reweigh the bottle and cap.
3. Place the *open* bottle on an electronic balance connected to a data logger and record the mass of the bottle over the course of 12 hours.

They obtained the following data.

Initial mass of bottle and lid: 335.8 g

Mass of bottle and lid after opening: 335.2 g

time (hr)	mass of bottle (g)
0.0	332.1
0.5	330.2
1.0	329.1
1.5	328.5

time (hr)	mass of bottle (g)
2.0	328.2
4.0	327.7
8.0	327.4
12.0	327.2

- (a) Calculate the total volume of CO₂ dissolved in the soft drink (at 25 °C and 100 kPa). **3**

.....

.....

.....

.....

- (b) Explain how the pH of the soft drink would have changed over the course of the student's experiment, including an appropriate chemical equation. **3**

.....

.....

.....

.....

Question 33 continues on the next page.

Question 33 (continued)

- (c) In another experiment, a student decides to determine the H_2CO_3 concentration in the soft drink by titration with NaOH , and to use this data to calculate the mass, and hence volume, of $\text{CO}_2(\text{g})$ dissolved. **3**

They:

1. Take a 250 mL bottle of soft drink, open it, and pour the contents into a 500 mL conical flask.
2. Add two drops of a suitable indicator.
3. Titrate the carbonic acid in the soft drink using standardised $\text{NaOH}(\text{aq})$.

Explain, making reference to each method, why a combination of the two methods would give the most accurate result.

.....

.....

.....

.....

.....

.....

Question 34(6 marks)

Marks

A student carried out a first-hand investigation to distinguish between saturated and unsaturated liquid hydrocarbons.

- (a) Outline the method of the investigation, identifying the chemicals used. **2**

.....

.....

.....

.....

.....

.....

.....

.....

.....

- (b) Explain the risks involved and the safety precautions needed during this investigation. **2**

.....

.....

.....

.....

.....

.....

.....

- (c) Write a balanced equation for an “addition reaction” which has occurred and name the organic product(s) formed. **2**

.....

.....

Question 35(4 marks)

Marks

Many natural systems contain buffer solutions.

Sodium hydrogen carbonate and carbonate ion can be used to make a buffer solution.

- (a) Explain why buffers are important in natural systems. **1**

.....

.....

.....

.....

- (b) Write an equilibrium equation to represent the hydrogen carbonate ion/carbonate ion buffer system and use this equation and Le Chatelier's Principle to explain how the buffer system works. **2**

.....

.....

.....

.....

.....

.....

.....

- (c) Explain why a combination of hydrochloric acid and sodium chloride solution cannot act as a buffer solution. **1**

.....

.....

.....

End of Exam