2012

HSC Half-Yearly Examination

Chemistry

General Instructions
Reading time – 5 minutes
Working time – 1.5 hours

Write using blue or black pen
Draw diagrams using pencil
Approved calculators may be used
Write your student number on each section of this booklet

Total marks 60
This examination has two parts, Part A and Part B.
Part A – 10 marks
Attempt Questions 1 – 10.
Allow about 15 minutes for this part.

Part B – 50 marks
Attempt Questions 11 – 17.
Allow about 1 hour and 15 minutes for this part.

Teachers-in-charge: Mrs Davis, Mr Geerling, Ms Jackson

Task Weighting: 20%

Part A.

10 marks
Attempt questions 1 - 10.
Allow about 15 minutes for this part.
Record your answers on the separate multiple-choice answer sheet. Ensure your student number is written on it.

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 the correct answer by writing the word *correct* and drawing an arrow as follows.

correct ↙

A ⊗ B ⊗ C ○ D ○

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1. Why does the addition of a suitable catalyst to a chemical reaction speed up the rate of reaction?

(A) it lowers the potential energy of the products
(B) it lowers the potential energy of the reactants
(C) it lowers the activation energy of the reaction
(D) it lowers the amount of heat absorbed or released by the reaction

2. Despite the similar properties between ethane and ethylene, why is ethylene used more readily in industry?

(A) the –C-C- bond is much more reactive than the –C=C- bond
(B) the –C-C- bond is much less reactive than the –C=C- bond
(C) ethane has stronger dispersion forces than ethene
(D) ethane is less soluble in water than ethene

3. Which one of the following statements correctly describes a chemical system that has reached equilibrium?

(A) the rate of the forward reaction is equal to the rate of the reverse reaction
(B) the rate of the forward reaction and the rate of the reverse reaction are both zero
(C) the number of moles of product is equal to the number of moles of starting material
(D) the number of moles of products is greater than the number of moles of starting material

4. Which of the following chemical species acts as a Bronsted-Lowry base when hydrofluoric acid is added to an aqueous solution of sodium chloride?

(A) Na^+
(B) Cl^-
(C) H_2O
(D) NaCl

5. Bromothymol blue is an indicator, changing in colour from yellow to blue over the pH range of 6.0 – 7.6.
Bromothymol blue is added to a variety of different solutions. The solutions were made by dissolving samples of the compounds shown below in water.

Which alternative matches the solutions tested with the correct colour of the added bromothymol blue?

	NO_2	CaO	NaCl	$NaCH_3COO$
(A)	yellow	blue	green	blue
(B)	blue	yellow	blue	yellow
(C)	green	blue	yellow	green
(D)	yellow	blue	green	yellow

6. Consider the following reaction between marble chips (calcium carbonate) and dilute hydrochloric acid:

$$CaCO_{3(s)} + 2H^+_{(aq)} \rightarrow Ca^{2+}_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

What volume of carbon dioxide will be released at 25°C and 100 kPa when 50.00 g of powdered marble chips are added to 750 mL of 0.525 $mol.L^{-1}$ hydrochloric acid?

(A) 4.88 L
(B) 9.76 L
(C) 11.3 L
(D) 12.4 L

7. 50 mL of 0.080 $mol.L^{-1}$ potassium hydroxide is mixed with 25 mL of 0.040 $mol.L^{-1}$ phosphoric acid.

What will be the final pH of this mixture?

(A) 7.00
(B) 11.00
(C) 11.30
(D) 11.48

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8. Several theories of acids have been proposed by scientists. One theory is that "acids are substances that contain positive hydrogen ions in aqueous solution".

Who was the proposer of this theory?

(A) Arrhenius
(B) Bronsted-Lowry
(C) Davy
(D) Lavoisier

9. What is the systematic name given to the monomer used to make the polymer PVC?

(A) chloroethene
(B) vinyl chloride
(C) 1,2-dichloroethene
(D) 1,1-dichloroethene

10. The pH of a 0.001 $mol.L^{-1}$ solution of an acid is 2.7. What can we conclude about this acid?

(A) it is a weak acid
(B) it is amphiprotic
(C) it is a concentrated acid
(D) it cannot be monoprotic

Part B.

50 marks
Attempt questions 11 – 17.
Read the whole of each question before commencing it.
Answer the questions in the spaces provided.
Show full working for questions requiring calculations.
Allow about 1 hour and 15 minutes for this part.

11. Polystyrene is a commercially significant polymer produced from ethylene.

(a) Cracking is one of the processes involved in the production of ethylene from crude oil.

Construct a balanced equation to show the cracking of $C_{15}H_{34}$ to form an alkane and two molecules of ethylene. 1M

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(b) Draw the structural formula for the monomer from which polystyrene is made. 1M

(c) Describe TWO uses of polystyrene in terms of its properties. 3M

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12. Outline TWO uses of acids as food additives. 2M

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13.

(a) Identify one element that can form an acidic oxide. 1M

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(b) Write an equation to show the oxide of the element identified in (a) forming an aqueous acidic solution. 1M

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(c) Outline TWO impacts that increased acidity will have on the natural environment. 2M

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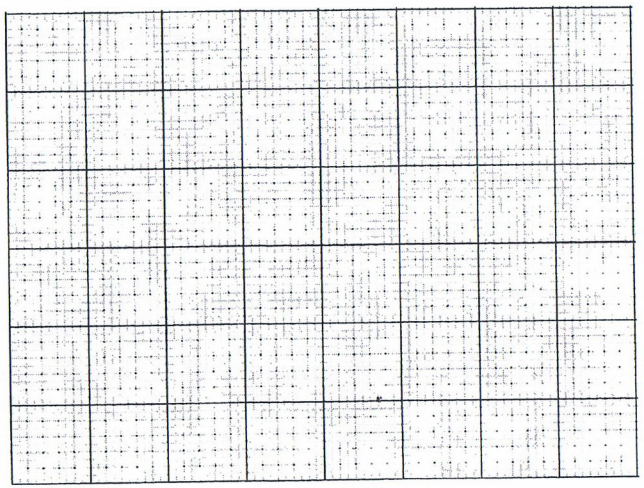
14. A student used a calibrated pH probe to measure the pH of the contents of a can of soft drink, immediately after it is opened, then at 15 minute intervals. The table below shows the data obtained.

Time (min)	0	15	30	45	60	75	90	105	120
pH	4.5	5.9	6.5	6.7	7.1	7.3	7.4	7.5	7.5

(a) Graph the data on the grid below. 3M



(b) Quantitatively compare the initial hydrogen ion concentration with that after 120 minutes. 1M

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(c) Outline the procedure used in our laboratory sessions to calibrate the pH probe prior to use. 2M

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(d) Explain the changing pH of the soft drink with reference to Le Chatelier's principle, and the properties of carbon dioxide. 4M

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15. Justify the procedure you used to prepare an ester in a school laboratory. Identify the ester that you produced and include a relevant chemical equation in your answer. 7M

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16. Describe the effects of buffers by referring to a specific example in a natural system that you have studied. Include an equation in your description. 3M

17. A manufacturer makes orange cordial by mixing flavouring, sugar syrup and citric acid.

The concentration of the citric acid in the orange cordial is determined by titration with a solution of sodium hydroxide of known concentration.

The sodium hydroxide solution is prepared by dissolving 5.500 g of sodium hydroxide pellets in distilled water to give exactly 1.000 L of solution. This solution is standardised by titrating exactly 25.00 mL of it with a 0.1215 mol L^{-1} standardised solution of hydrochloric acid. The average volume of hydrochloric acid used is 24.00 mL.

To analyse the orange cordial, exactly 50.00 mL of the cordial is measured out using a prepared pipette and then diluted to exactly 500.0 mL. Then a 25.00 mL aliquot of the diluted cordial solution is titrated with the sodium hydroxide solution to the phenolphthalein endpoint.

The following data is collected during one of the analysis runs of the orange cordial.

Titration run #1	27.85 mL
Titration run #2	26.75 mL
Titration run #3	26.65 mL
Titration run #4	29.35 mL
Titration run #5	26.80 mL

(a) Identify the IUPAC name for citric acid and draw its extended structural formula. 2M

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(b) In this titration, a pipette was used to transfer 25.00 mL of sodium hydroxide solution into the reaction vessel. The pipette was initially rinsed with distilled water and had a final rinse with the sodium hydroxide solution. The rinsings were discarded. 2M
Justify the rinsing procedure used.

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(c) Name an acid that is suitable for use as a primary standard to standardise a sodium hydroxide solution. 1M

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(d) Calculate the concentration of the standardised solution of sodium hydroxide. 1M

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(e) Why is the calculated concentration of the standardised sodium hydroxide solution different from the concentration calculated using the mass given, assuming no human error occurred? 2M

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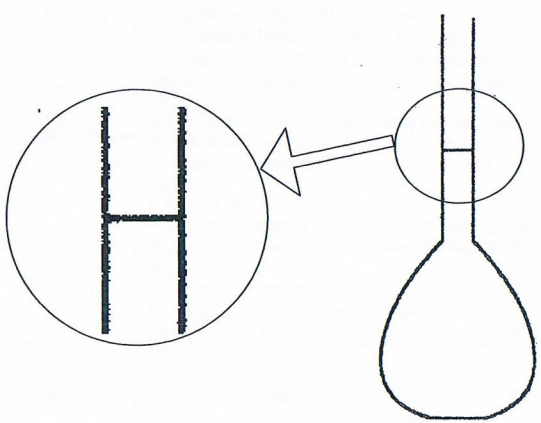
(f) Explain how the conical flask used in the titration between hydrochloric acid and sodium hydroxide would have been prepared prior to use. 2M

(g) Determine the concentration of the citric acid in the orange cordial.
Express the concentration in g/L. 4M

(h) Explain why phenolphthalein is an ideal indicator to use when titrating the diluted cordial solution with the sodium hydroxide solution. Include relevant equations in your answer. 4M

(i) The diagrams show a 500.00 mL volumetric flask (and an enlargement of the etched mark that appears on the flask), used for preparing solutions in volumetric analysis.

On the diagrams, show clearly the flask containing 500.00 mL of solution. 1M



Marking Guidelines HY Exam - 2012
Year 12 CHEMISTRY

Part A – multiple choice.

1.	C	4.	C	7.	B	10.	D
2.	B	5.	A	8.	A		
3.	A	6.	A	9.	A		

Part B.

11 a.

Marking criteria	Marks
$C_{15}H_{34} \rightarrow 2C_2H_4 + C_{11}H_{26}$ OR $C_{15}H_{34} \rightarrow 2C_2H_4 + C_{11}H_{24} + H_2$	1

11 b.

Marking criteria	Marks
Draws the structural formula for styrene	1

11 c.

Marking criteria	Marks
Identifies TWO uses of PS and provides a different property for each use (must be relevant to the use)	3
Identifies ONE use of PS and provides TWO different properties that are relevant to the use OR Identifies TWO use of PS and provides the same property for both (must be relevant to each use) OR Identifies TWO use of PS and provides a different, relevant property for each (BUT one of the properties is "good insulator" without specifying whether it is thermal or electrical insulation)	2
Identifies ONE use of PS and provides a property that is relevant to that use	1

12.

Marking criteria	Marks
Outlines two uses of acids as food additives	2
Outlines one use of an acid as a food additive	1

13 a.

Marking criteria	Marks
Identifies one element that can form an acidic oxide e.g. sulfur, carbon, nitrogen	1

13 b.

Marking criteria	Marks
Writes an equation for an acidic oxide (of the element identified in 13a) forming an acid e.g. $SO_2 + H_2O \rightarrow H_2SO_3$	1

13 c.

Marking criteria	Marks
Outlines two impacts on the natural environment that will be caused by increased acidity	2
Outlines one impact on the natural environment that will be caused by increased acidity	1

14 a.

Marking criteria	Marks
Draws a graph including the following; → correctly labeled axes (horiz..= time; vert. = pH) → heading/title for graph → points plotted correctly → line of best fit	3
Three of the above points	2
Two of the above points	1

14 b.

Marking criteria	Marks
Outlines the initial $[H^+]$ is 1000 times stronger than the final $[H^+]$.(must use a comparative word in statement)	1

14 c.

Marking criteria	Marks
Outlines the procedure for the calibration of the pH probe including the use of at least two buffers of differing pH e.g pH 4 and pH 10	2
Outlines the procedure for the calibration of the pH probe including the use of one buffer of known pH	1

14 d.

Marking criteria	Marks
States and uses Le Chatelier's principle to explain the changing pH due to the following; (students use appropriate equations to support the following) → decrease in pressure when can is opened → release of $CO_{2(g)}$ which in turn shifts the position of equilibrium to favour the production of more $CO_{2(g)}$ from $CO_{2(aq)}$ → which leads to a loss in the $[H+]$ due to the shift in equilibrium favouring the production of H_2CO_3 AND → uses the property of solubility to indicate why carbon dioxide is released when pressure is decreased.	4
States and uses Le Chatelier's principle to explain the changing pH due to three of the above points using appropriate equations	3
States and uses Le Chatelier's principle to explain the changing pH due to two of the above points using appropriate equations.	2
States and uses Le Chatelier's principle to explain the changing pH due to one the above points using appropriate equations.	1

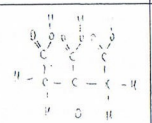
15.

Marking criteria	Marks
Includes a thorough procedure based on heating under refluxing AND justifies FOUR or THREE of the crucial steps AND names the ester produced AND includes the chemical equation (including an equilibrium arrow) for the production of the named ester. *(An alternative for a 6 mark allocation could be as above , with 4 steps justified with an error in the equation)*	7-6
Includes a procedure based on heating under refluxing AND justifies TWO or ONE of the crucial steps AND names the ester produced AND includes the chemical equation (including an equilibrium arrow) for the production of the named ester. OR Includes a thorough procedure based on heating under refluxing AND justifies FOUR of the crucial steps (4 marks) *(An alternative for a 5 or 4 mark allocation could be as above , with 3 or 2 steps justified with an error in the equation)*	5-4
Includes a procedure for esterification AND/OR the name of an ester AND/OR a chemical equation.(1 mk for each)	3-1

16.

Marking criteria	Marks
Includes:- →A description of the effects of buffers (maintaining pH even with the addition of small amounts of acid or base) →The effects of buffers are related to a specific example of a buffer as part of a natural system →A correct chemical equation related to the example	3
Includes:- →A description of the effects of buffers (maintaining pH even with the addition of small amounts of acid or base) →The effects of buffers are related to a specific example of a buffer as part of a natural system	2
Identifies a natural system OR demonstrates an understanding of buffers	1

17 a.

Marking criteria	Marks
Identifies the IUPAC name for citric acid as: 2-hydroxypropane-1,2,3-tricarboxylic acid  AND Draws its full structural formula	2
Identifies the IUPAC name for citric acid OR Draws its full structural formula	1

17 b.

Marking criteria	Marks
Gives a reason for each of the TWO steps in the rinsing process → water = to dissolve and discard any impurities from its previous use → NaOH = to coat the inside of the pipette so that the 25.00 mL aliquot measured out retains its original concentration	2
Gives a reason for ONE of the steps in the rinsing process	1

17 c.

Marking criteria	Marks
Names (not a formula) a suitable chemical (eg. oxalic acid; benzoic acid)	1

17 d.

Marking criteria	Marks
Calculates the [NaOH] as 0.11664 mol/L	1

17 e.

Marking criteria	Marks
Identifies that NaOH is hygroscopic AND Outlines that the consequence of this will be that when 5.5 g of the NaOH pellets are weighed out, there will actually be less than 5.5 g of pure NaOH and hence the real [NaOH] will be lower than the calculated [NaOH].	2
Identifies that NaOH is hygroscopic	1

17 f.

Marking criteria	Marks
Outlines the cause and effect relationship: CAUSE →Identifies that the conical flask should be rinsed with distilled water ONLY EFFECT →distilled water remaining in the flask will not affect the number of moles of reactant in the 25.00 mL aliquot of diluted cordial solution that is added to the flask (and hence the integrity of the titration is not compromised)	2
Outlines that the conical flask should be rinsed with distilled water ONLY	1

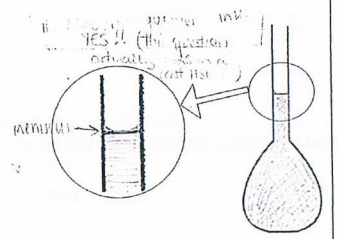
17 g.

Marking criteria	Marks
Correctly presents all SEVEN of the following steps of calculations: 1. average volume of NaOH used as 26.733 mL 2. moles of NaOH used as 3.118... X 10^{-3} mol 3. moles of citric acid reacted as 1.039... X 10^{-3} mol 4. [diluted citric acid] as 4.157... X 10^{-2} mol/L 5. [original citric acid] as 0.4175... mol/L 6. molar mass of citric acid as 192.124 g/mol 7. conc. of citric acid as 79.88 g/L NOTE: answer should be to 4 significant figures to match the data provided in the question NOTE: do NOT do any rounding off until the final answer	4
Correctly presents FIVE or SIX of the steps of calculations as shown above	3
Correctly presents THREE or FOUR of the steps of calculations as shown above	2
Correctly presents ONE or TWO of the steps of calculations as shown above	1

17 h.

Marking criteria	Marks
Outlines that the equivalence point of this reaction will be at a pH of approximately 9 since the salt produced by the neutralisation reaction will be basic AND Outlines that phenolphthalein will indicate the endpoint for neutralisation reaction at a pH of between 8.3 and 10.0 (ie. when it changes colour) AND States that since the endpoint and equivalence point coincide, phenolphthalein is highly suitable (the terms endpoint and equivalence points must be explicitly used) AND Uses relevant, correct equations to explain why the salt produced by this neutralisation reaction will produce a basic solution (3 equations should be presented) $3NaOH + C_6H_8O_7 \rightarrow Na_3C_6H_5O_7 + 3H_2O$ $Na_3C_6H_5O_{7(aq)} \rightarrow 3Na^+_{(aq)} + C_6H_5O_7^{3-}{}_{(aq)}$ $C_6H_5O_7^{3-}{}_{(aq)} + H_2O \leftrightarrow C_6H_6O_7^{2-}{}_{(aq)} + OH^-{}_{(aq)}$	4
Outlines that the equivalence point of this reaction will be at a pH of approximately 9 since the salt produced by the neutralisation reaction will be basic AND Outlines that phenolphthalein will indicate the endpoint for neutralisation reaction at a pH of between 8.3 and 10.0 (ie. when it changes colour) AND States that since the endpoint and equivalence point coincide, phenolphthalein is highly suitable (the terms endpoint and equivalence points must be explicitly used)	3
Identifies that NaOH is a strong base and $C_6H_8O_7$ is a weak acid (OR that salt produced is a basic salt) AND Outlines that phenolphthalein changes colour when the pH of the acid/base mixture it is in is between 8.3 and 10.0	2
Outlines that phenolphthalein changes colour when the pH of the acid/base mixture it is in is between 8.3 and 10.0 OR Outlines that phenolphthalein is ideal because it shows a sharp colour change from colourless to magenta OR Identifies that NaOH is a strong base and $C_6H_8O_7$ is a weak acid OR Identifies that salt produced by the reaction of NaOH and $C_6H_8O_7$ is a basic salt	1

17 i. Many students really answered the question – "On one of the diagrams draw a line which represents the meniscus to show the flask containing 500.00mL of solution".

Marking criteria	Marks
Draws a curved line that has the bottom of the curve on the line on the left-hand diagram NOTE – this line should have been drawn on both diagrams AND then both diagrams should have been shaded to show the liquid contents of the flask. 	1