Student Number	
Mark / 44	

Chemistry

HSC Course

Acidic Environment + Industrial Chemistry

Theory Test • 2007

General Instructions

- Reading time – 5 minutes
- Working time – 45 minutes
- 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
- Write your Student Number at the top of this page

Total Marks – 44

Part A – 12 marks

- Attempt Questions 1 – 12
- Allow about 10 minutes for this part

Part B – 32 marks

- Attempt Questions 13 – 20
- Allow about 40 minutes for this part

Part A – 12 marks
Attempt Questions 1 – 12
Allow about 10 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

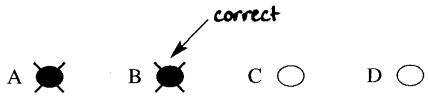
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.



Answer Box for Questions 1 – 12

1	**A** ○	**B** ○	**C** ○	**D** ○
2	**A** ○	**B** ○	**C** ○	**D** ○
3	**A** ○	**B** ○	**C** ○	**D** ○
4	**A** ○	**B** ○	**C** ○	**D** ○
5	**A** ○	**B** ○	**C** ○	**D** ○
6	**A** ○	**B** ○	**C** ○	**D** ○
7	**A** ○	**B** ○	**C** ○	**D** ○
8	**A** ○	**B** ○	**C** ○	**D** ○
9	**A** ○	**B** ○	**C** ○	**D** ○
10	**A** ○	**B** ○	**C** ○	**D** ○
11	**A** ○	**B** ○	**C** ○	**D** ○
12	**A** ○	**B** ○	**C** ○	**D** ○

► ***Mark your answers for Questions 1 – 12 in the Answer Box on page 2.***

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1 Which of the following substances is a natural source of atmospheric NO_2?

(A) combustion of coal
(B) combustion of unleaded petrol
(C) lightning storm
(D) volcanoes

2 Which of the following is the correct IUPAC name for citric acid?

(A) 2–hydroxypropanoic acid
(B) 1,2,3–tripropanoic acid
(C) hydroxypropane carboxylic acid
(D) 2–hydroxypropane–1,2,3–tricarboxylic acid

3 Which of the following would be the most appropriate chemical to neutralise a small amount of acid spilt on a lab benchtop.

(A) CH_3COOH
(B) H_2O
(C) NaOH
(D) $NaHCO_3$

4 A pigment from violet flowers is purple in acidic solutions, yellow in alkaline solutions and colourless in neutral solutions. In which of the following would you expect the pigment to show no colour?

(A) a solution of sodium chloride
(B) white vinegar
(C) household ammonia (cleaning agent)
(D) lemonade (colourless lemonade)

5 Which of the following substance will have the lowest boiling point?

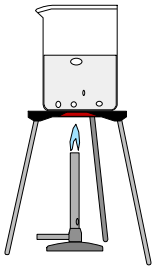
(A) HCOOH
(B) CH_3OH
(C) H_2O
(D) CH_4

6 Identify the main product of the reaction between $CH_3(CH_2)_4COOH$ and CH_3CH_2OH.

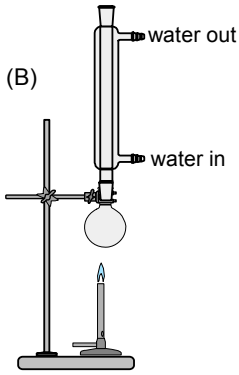
(A) pentyl ethanoate
(B) ethyl butanoate
(C) hexyl ethanoate
(D) ethyl hexanoate

7 Which of the set–ups below is most appropriate to produce esters in the laboratory?

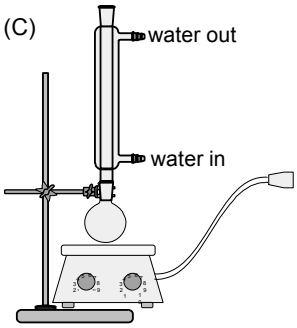
(A)



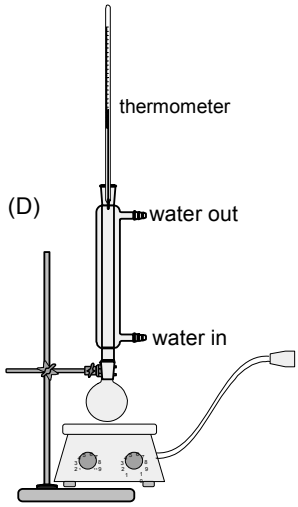
(B)



(C)



(D)



8 Which of the following best describes a 2.0 mol L^{-1} solution of acetic acid?

(A) a concentrated solution of a weak acid
(B) a weak solution of a dilute acid
(C) a strong solution of a concentrated acid
(D) a dilute solution of a strong acid

9 Which of the following chemists proposed that all acids contain hydrogen?

(A) Arrhenius
(B) Brønsted
(C) Davy
(D) Lavoisier

10 What is the pH of 3.6×10^{-3} mol L^{-1} HNO_3 ?

(A) 0.0036
(B) 2.44
(C) 3.60
(D) 5.63

11 The table shows the colour ranges of several indicators.

Indicator	*low range colour*	*pH of transition range*	*high range colour*
thymol blue	red	1.2 – 2.8	yellow
bromophenol blue	yellow	3.0 – 4.6	blue
methyl orange	red	3.1 – 4.4	yellow
methyl red	red	4.8 – 6.0	yellow
litmus	red	4.7 – 8.2	blue
thymol blue	yellow	8.0 – 9.6	blue
phenolphthalein	colourless	8.3 – 10.0	red

The results of testing a substance with three of the indicators are shown in the table.

Indicator added to substance	*Result (final colour of indicator)*
methyl orange	red
thymol blue	yellow
phenolphthalein	colourless

Which is a possible pH of the substance?

(A) 1
(B) 3
(C) 4.5
(D) 8

12 What is the purpose of concentrated sulfuric acid in the esterification reaction?

(A) To speed up the attainment of equilibrium
(B) To shift the equilibrium to the left
(C) To increase the yield of ester
(D) To increase the activation energy of the reaction

Part B – 32 marks
Attempt Questions 13 – 20
Allow about 40 minutes for this part

► ***Show all relevant working in questions involving calculations.***

Question 13 (5 marks)

Cloudy ammonia (a household cleansing product) is a solution of ammonia in water which is excellent for cleaning glass. The Amalgamated Ammonia Company regularly tests the concentration of its manufactured cloudy ammonia by a simple acid–base titration using standardised sulfuric acid.

(a) Write the balanced chemical equation for the neutralisation of cloudy ammonia by sulfuric acid. **(1 mark)**

(b) Suggest a suitable indicator for this acid–base titration and justify your answer. **(2 marks)**

(c) A lab technician analyses a sample of cloudy ammonia from the production line.
The table shows the titration data.

Concentration of standardised H_2SO_4	0.155 mol L^{-1}
Average titre of standardised H_2SO_4	47.4 mL
Aliquot of cloudy ammonia	5.00 mL

Calculate the concentration of cloudy ammonia. **(2 marks)**

Question 14 (3 marks)

The reaction of hydrogen chloride gas with ammonia gas,

$$HCl\,(g) + NH_3\,(g) \rightarrow NH_4Cl\,(s)$$

is classified as an acid /base reaction according to Brønsted/Lowry theory, but not according to Arrhenius' theory of acids and bases.

Justify this statement.

Question 15 (5 marks)

(a) Identify the following salts as acidic, basic or neutral. **(2 marks)**

Salt	*Acidic, basic or neutral solution*
NaCl	
NH_4Cl	
$NaHCO_3$	
KCH_3COO	

(b) Write an equation to show the action of an acidic salt in (a), in water. **(1 mark)**

(c) Identify one conjugate acid/base pair in the reaction given in (b) above. **(1 mark)**

(d) Identify an amphiprotic ion present in one of the salts listed in the table. **(1 mark)**

Question 16 (7 marks)

Atmospheric oxides of sulfur have been increasing over the last 150 years.

(a) Assess the impact of this trend and include relevant balanced equations in your answer. **(5 marks)**
► *Do not reproduce the reaction from part (b) below.*

(b) Copper may be extracted from copper(II) sulfide ore by roasting it in oxygen.
Copper(II) oxide and sulfur dioxide are produced.

What volume of sulfur dioxide is produced when 191 g of copper(II) sulfide is roasted?
(Volume measured at 25°C and 100 kPa). **(2 marks)**

Question 17 (3 marks)

A primary standard solution was prepared by dissolving 0.316 g of hydrated oxalic acid, $(COOH)_2 \bullet 2H_2O$ in water and making the solution up to 250.0 mL.

(a) Calculate the concentration of the solution. **(2 marks)**

(b) Identify the piece of accurate glassware in which this solution is prepared. **(1 mark)**

Question 18 (2 marks)

An organic acid and an alcohol were allowed to react using the appropriate apparatus, producing an ester and water.

$$\text{organic acid} + \text{alkanol} \underset{\longleftarrow}{\xrightarrow{\text{conc. } H_2SO_4}} \text{ester} + \text{water} \qquad \Delta H = -58 \text{ kJ mol}^{-1}$$

Certain changes are then made to this mixture. Considering each separately, state the effect that the change has on the equilibrium position by completing the table.

Change/Stress	*Effect on the equilibrium position*
(a) raising the temperature	
(b) increasing the pressure above the solution	
(c) adding alkanol to the mixture	
(d) adding a base	

Question 19 (3 marks)

Selected students from Hiuai High School were assigned to plan and perform an experiment to decarbonate a cola drink. Detailed below are the steps they took to address the problem.

- *Placed a pre-weighed 400 mL beaker on a warm hot plate.*
- *Unscrewed a 375 mL bottle of JR cola and carefully transferred the contents to the beaker.*
- *The beaker was weighed immediately after transfer and weighed every 2 minutes thereafter.*
- *At intervals between weighings, the beaker was kept on the hot plate and stirred with a thermometer to monitor the temperature which was kept at 60°C for 10 minutes.*

Assess the validity of the procedure.

Question 20 (4 marks)

Identify a non-fossil fuel natural product and the issues associated with the need to replace this natural product. Assess the viability of a possible replacement with respect to the issues.