Section A Multiple Choice (1 mark each)

.1. A prac test requires students to devise a method to distinguish 0.1 mol L $^{-1}$ nitric and acetic acids. A student thinks about the following possibilities…

> (i) *Titrate equal volumes of each acid with a strong base using appropriate indicators.*
> (ii) *Test the pH of the solutions.*
> (iii) *Test the electrical conductivity of the solutions.*

Which method(s) is/are invalid*?*

(A) (i) only
(B) (ii) only
(C) (iii) only
(D) (i) and (iii) only

2. 100 mL of a 2.5 x 10^{-3} mol L $^{-1}$ sample of a strong monoprotic acid is diluted by the addition of 500 mL of water. What is the change in pH*?*

(A) decreases by 0.70 pH units
(B) increases to pH 3.30
(C) decreases by 0.78 pH units
(D) increases to pH 3.38

3. When a student conducts a titration, the burette should be:

(A) rinsed with distilled water only
(B) only used when completely dry
(C) rinsed with the solution to be delivered
(D) rinsed with a trace of an indicator

4. The compound $CH_3CH_2CH_2COOCH_3$ is a component of pineapple fragrance. The name of the compound is

(A) propyl ethanoate
(B) butyl methanoate
(C) methyl propanoate
(D) methyl butanoate

Answer Booklet for Sections A and B Student No......................................

INSTRUCTIONS

Use the multiple choice answer sheet below.

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

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

A ⃝   B ζ   C ⃝   D ⃝

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

A ζ   B⃠   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:

correct

A⃠   B⃠   C ⃝   D ⃝

Section A

Multiple Choice Answer Sheet

1.   A ⃝   B ⃝   C ⃝   D ⃝

2.   A ⃝   B ⃝   C ⃝   D ⃝

3.   A ⃝   B ⃝   C ⃝   D ⃝

4.   A ⃝   B ⃝   C ⃝   D ⃝

Section B. Short Answer Questions (Nos 5-11)

Question 5 (1 mark)
Describe the purpose of using acid as a catalyst for esterification .   **1**

....

....

....

Question 6 (2 marks)
Name an acidic salt and give an equation to show the reaction of this acidic salt
in water   .   **2**

....

....

Question 7. (3 marks)

 In a titration, 25.00mL of barium hydroxide solution is neutralised by
24.95 mL of a 0.0500 mol L^{-1} solution of hydrochloric acid. What is the
concentration of the barium hydroxide solution?   **3**

....

....

....

....

....

....

Question 8 (5 marks)

(a) Ammonia ranks second to sulfuric acid in terms of annual worldwide
   production.. Identify *one* industrial use of ammonia.   **1**

....

(b) Describe the conditions under which Haber developed the industrial synthesis
   of ammonia and evaluate its significance at that time in world history.

....

....

....

....

....

....

....

....

....

....

....

Question 9 (4 marks)   **MARK(S)**

Last year, the Japanese-owned PKC copper smelter located in Port Kembla was prosecuted by the EPA for air pollution. The company was fined $150,000 and forced to fit $6,000,000 of anti-pollution gear to the smelter.

Copper smelting involves extraction of copper metal from sulfide ores…

$$Cu_2S \ (s) \ + \ O_2 \ (g) \ \rightleftarrows \ 2Cu \ (s) \ + \ SO_2 \ (g)$$
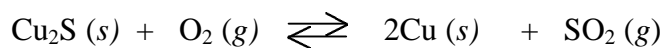
(a) Calculate the volume of sulfur dioxide produced
     (at 25 °C and 100 kPa) when one tonne of copper is extracted.   **2**

....

....

....

....

....

....

(b) Write an equation to show how sulfur dioxide emissions produce s
     acid rain and name the acid produced.   **2**

....

....

(c) Describe a harmful effect of rain polluted by the smelter's
     operation.   **1**

....

....

....

.
Question 10 (6 marks)

(a)   Explain why chemists classify acetic acid as a weak acid, while
        hydrochloric acid is regarded as a strong acid. Include equations
        to support your answer.   **2**

....

....

....

....

(b)   The pH of 0.020 mol L $^{-1}$ acetic acid is 3.32.
        Calculate the pH of 0.020 mol L $^{-1}$ HCl.   **1**

....

....

(c)   Select the indicator from the table which could be used to identify
        0.020 mol L $^{-1}$ solutions of the two acids. (Hydrochloric and acetic acids) **1**

Indicator	pH range	Colour (low pH – high pH)
Manzate	1.6 – 3.3	red – yellow
Norphen	1.2 – 2.8	yellow-blue
Orsin	2.4 – 4.0	yellow – red
Phentanyl	3.3 – 5.2	green – violet

....

Question 10 continues next page

(d)   State the resultant colours (**use single words**)
      of the HCl and CH$_3$COOH solutions after the indicator
      was added.

1

Acid	Colour
Hydrochloric acid	
Acetic acid	

Question 11

Radioisotopes are of immense importance for diverse uses in
medicine and industry.

(a)   Describe how commercial radioisotopes are produced.   **1**

....

....

....

....

....

(b)   Identify one named radioisotope and describe its use
      in medicine **or** industry   **2**

....

....

....

....

END of TEST

Section A Multiple Choice (1 mark each)   **ANSWERS**

.1. A prac test requires students to devise a method to distinguish 0.1 mol L^{-1} nitric and acetic acids. A student thinks about the following possibilities…

(i)   *Titrate equal volumes of each acid with a strong base using appropriate indicators.*
(ii)   *Test the pH of the solutions.*
(iii)   *Test the electrical conductivity of the solutions.*

Which method is invalid*?*

(A)   (i)
(B)   (ii)
(C)   (iii)
(D)   (i) and (iii)
Answer: (A)
Outcomes: H2, 8, 11

2. 100 mL of a 2.5 x 10^{-3} mol L^{-1} sample of a strong monoprotic acid is diluted by the addition of 500 mL of water. What is the change in pH*?*

(A)   decreases by 0.70 pH units
(B)   increases to pH 3.3
(C)   decreases by 0.78 pH units
(D)   increases to pH 3.4
Answer: (D)
Outcome: H10

3. When a student conducts a titration, the burette should be:

(A) rinsed with distilled water only
(B) only used when completely dry
(C) rinsed with the solution to be delivered
(D) rinsed with a trace of an indicator
Answer: (C)
Outcome: H12

4. The compound $CH_3CH_2CH_2COOCH_3$ is a component of pineapple fragrance. The name of the compound is

(A) propyl ethanoate
(B) butyl methanoate
(C) methyl propanoate
(D) methyl butanoate

Answer: (D)
Outcome: H9

Section A
Multiple Choice Answer Sheet

1. A ζ   B ○   C ○   D ○

2. A ○   B ○   C ○   D ζ

3. A ○   B ○   C ζ   D ○

4. A ○   B ○   C ○   D ζ

Section B. Short Answer Questions (Nos. 5-12)

Question 5 (1 mark)
Describe the purpose of using acid in esterification for catalysis.   **1**
H_2SO_4 for catalysis in esterification
-adding acid absorbs the product H_2O and so forces the equilibrium to the right (Smith)
-sulfuric acid acts as a catalyst as well as a dehydrating agent. The removal of water from the ester equilibrium will cause a shift to the right and increase the yield of ester (Thickett)

Question 6 (2 marks)
Identify an acidic salt and give an equation to show its reaction in water.   **2**
.e.g. **$NaHSO_4$, KHC_2O_4, NH_4NO_3**

e.g.   **$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$**

          $HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{2-} + H_3O^+$

          $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$
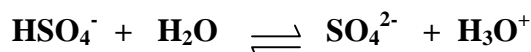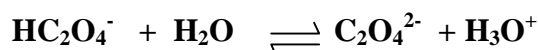
Question 7 (3 marks)
 In a titration 25.00mL of barium hydroxide solution is neutralised with 24.95 mL of a 0.0500 mol L^{-1} solution of hydrochloric acid. What is the concentration of the barium hydroxide solution?   **3**

Sample Answer	Mark
$Ba(OH)_2 + 2 HCl \rightarrow BaCl_2 + 2 H_2O$ mol HCl = M xV = 0.05 x 0.02495 = **0.0012475** $\therefore$ mol $Ba(OH)_2$ = 1/2 x 0.0012475 = 0.00062375 $[Ba(OH)_2]$ = mol/V = 0.00062375/0.02500 = 0.02495 molL^{-1} = **2.495 x 10^{-2} mol L^{-1}**	1 1 1
Criteria	Mark(s)
correct answer with shown working including calculations	3
a maximum of 2 for any combination of marks given below	2
equation or correct $[Ba(OH)_2]$ from incorrect origins or correct [HCl] or correct mol $Ba(OH)_2$	1

Question 8(5 marks))

(a) Ammonia ranks second to sulfuric acid in terms of quantity produced
worldwide per year. Identify *one* industrial use of ammonia.   **1**

**fertilizers, fibres and plastics, nitric acid to make fertilizers, explosives
e.g. NH_4NO_3 or TNT or nitroglycerine, household cleaners, non-ionic
detergents**

(b) Describe the conditions under which Haber developed the industrial synthesis
of ammonia and evaluate its significance at that time in world history.   **4**

Criteria	Mark(s)
Describe -	2 marks
Evaluate significance pros **1,** cons **1**(Determine the value of, make a judgement, very significant because....	
increasing agricultural demand for fertilizer	1
production of more explosives for **WWI**	1
very significant	1
allowed German agriculture to continue.....	1
any 3 of the above	3
any 2 of the above	2
only 1 of the above	1

Sample Answer:

Describe the conditions

In the beginning of the twentieth century, increasing world population meant a growing need for nitrogenous fertilizer for agriculture. At that time, saltpetre from Chile was the main source. An increase in militancy in Germany was also calling for the production of more explosives, and for this, ammonia was needed.

Evaluate the significance

Very significant as it insulated German agriculture from any harm caused by interrupted supplies of saltpetre from S. America and it facilitated the production of nitric acid and hence of explosives allowing Germany to prolong their war efforts in WWI.

Question 9 (4 marks)   **MARK(S)**

Last year, the Japanese-owned PKC copper smelter located in Port Kembla
was prosecuted by the EPA for air pollution. The company was fined
$150,000 and forced to fit $6,000,000 of anti-pollution gear to the smelter.

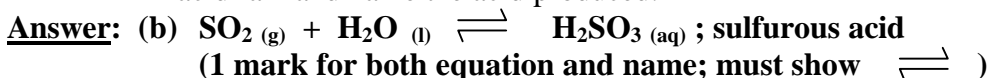Copper smelting involves extraction of copper metal from sulfide ores…

$$Cu_2S \ (s) \ + \ O_2 \ (g) \quad \rightarrow \ 2Cu \ (s) \quad + \ SO_2 \ (g)$$
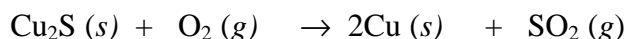
(a)   Calculate the volume of sulfur dioxide produced
        (at 25 °C and 100 kPa) when one tonne of copper is extracted.   **2**

Answer: (a) moles Cu = (1 t)(1000 kg/t)(1000 g/kg) ÷ 63.55 g/mol
                       = 15735.6 = 1.6 x 10^4 moles

          moles SO_2 = moles Cu ÷ 2
                        = 7.8678 x 10^3 = 7.9 x 10^3 moles   (1 mark)
          volume of SO_2 = (7.8678 x 10^3 moles)(24.47 L/mol)
                         = 1.925 x 10^5 = 1.9 x 10^5 L   (1 mark)

Outcome: H10

(b)   Write an equation to show how sulfur dioxide emissions produce
        acid rain and name the acid produced.   **1**

Answer: (b) $SO_{2 \ (g)}$ + $H_2O_{(l)}$ $\rightleftharpoons$ $H_2SO_{3 \ (aq)}$; sulfurous acid
                (1 mark for both equation and name; must show $\rightleftharpoons$)

Outcome: H4

(c)   Describe a deleterious effect of rain polluted by the smelter's
        operation.   **1**

Answer: (c) Acid rain causes damage to exterior building materials and surfaces.
                (e.g. metal, paint, stone, mortar).

          Acid rain causes damage and death to plantlife.
          (e.g. the release of aluminium ions by elevated [H^+] in the soil is toxic
          to plants).

          Acid rain lowers the pH of waterways affecting marine life adversely.
          (e.g. disrupts reproduction in fish and invertebrates; destruction of
          fish eggs).

          (1 mark for any one reasonable description.)
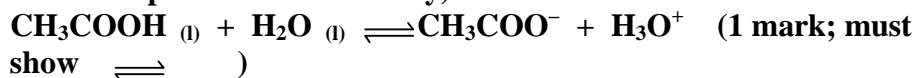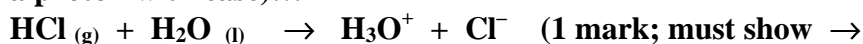**Outcome: H4**
          .

Question 10

(a)   Explain why chemists classify acetic acid as a weak acid, while
        hydrochloric acid is regarded as a strong acid. Include equations to
        support your answer.   **2**

   **Answer: (a)   Acetic acid is a weak acid because it ionizes poorly in water (or
              donates a proton with difficulty)…**
   $$CH_3COOH_{(l)} + H_2O_{(l)} \rightleftharpoons CH_3COO^- + H_3O^+ \quad \text{(1 mark; must}$$
   show $\rightleftharpoons$)
   **HCl is a strong acid because it ionizes completely in water (or donates
   a proton with ease)…**
   $$HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+ + Cl^- \quad \text{(1 mark; must show } \rightarrow$$
   Outcomes: H2, 8

(b)   The pH of 0.020 mol L^{-1} CH$_3$COOH is 3.22..
        Calculate the pH of 0.020 mol L^{-1} HCl.   **1**

Answer: (b) pH = $- \log [H^+]$ = $- \log 0.020\,M$ = 1.69897 = 1.7   (1 mark)
Outcome: H10

(c)   Select the indicator in the table which could be used to distinguish
        0.020 mol L^{-1} solutions of the two acids.   **1**

Answer: (c)   Norphen or Orsin   (1 mark)
Outcome: H14

Indicator	pH range	Colour (low pH – high pH)
Manzate	1.6 – 3.3	red – yellow
Norphen	1.2 – 2.8	yellow – blue
Orsin	2.4 – 4.0	yellow – red
Phentanyl	3.3 – 5.2	green – violet

(d) State the resultant colours (**use single words**)
        of the HCl and CH3COOH solutions after the indicator was added.

Answer: (d) Norphen: HCl (green) and CH₃COOH (blue)
              Orsin: HCl (yellow) and CH₃COOH (orange)   (1 mark for either
              pair of colours)

Outcome: H10

Question 11

Radioisotopes are of immense importance for diverse uses in
medicine and industry.

(a)   Describe how commercial radioisotopes are produced.   **1**

Answer: (a) Commercial radioisotopes are made by the process of neutron
              bombardment.
              A fission reactor supplies the neutrons which are aimed at a target
              element which absorbs the neutrons and becomes activated
              (radioactive).

              Particle accelerators are also used. Light ions, protons, or alpha
              particles are accelerated and beamed at a target element causing a
              transmutation to the desired radioisotope.
              (1 mark)

Outcome: H3

(b)   Identify one named radioisotope and describe how it is used
        in medicine or industry   **2**

Answer: (b) Cobalt–60 has many uses. As a strong gamma emitter it is employed
              in medicine for radiotherapy to kill cancerous tumours. It is also used
              to sterilise medical supplies.

              In industry, it is used to take radiographs of large metallic objects
              (e.g. jet engines) to detect flaws.

              (1 mark for naming a viable radioisotope and 1 mark for a description
              of its use)

Outcome: H3