

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

**ANSWERS**

1. A prac test requires students to devise a method to distinguish  $0.1 \text{ mol L}^{-1}$  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  $2.5 \times 10^{-3} \text{ mol L}^{-1}$  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  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_3$  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 $\zeta$    | B $\bigcirc$ | C $\bigcirc$ | D $\bigcirc$ |
| 2. | A $\bigcirc$ | B $\bigcirc$ | C $\bigcirc$ | D $\zeta$    |
| 3. | A $\bigcirc$ | B $\bigcirc$ | C $\zeta$    | D $\bigcirc$ |
| 4. | A $\bigcirc$ | B $\bigcirc$ | C $\bigcirc$ | D $\zeta$    |

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

**Question 5** (1 mark)

Describe the purpose of using acid in esterification for catalysis.

**1**

*H<sub>2</sub>SO<sub>4</sub> for catalysis in esterification*

*-adding acid absorbs the product H<sub>2</sub>O and so forces the equilibrium to the right (Smith)*

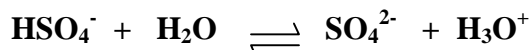
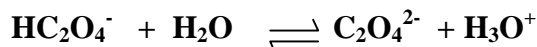
*-sulfuric acid acts as a catalyst as well as a dehydrating agent. The removal of water from the ester equilibrium will cause a shift to the right and increase the yield of ester (Thickett)*

**Question 6** (2 marks)

Identify an acidic salt and give an equation to show its reaction in water.

**2**

e.g. NaHSO<sub>4</sub>, KHC<sub>2</sub>O<sub>4</sub>, NH<sub>4</sub>NO<sub>3</sub>



**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<sup>-1</sup> solution of hydrochloric acid. What is the concentration of the barium hydroxide solution?

**3**

Sample Answer	Mark
$\text{Ba}(\text{OH})_2 + 2 \text{HCl} \rightarrow \text{BaCl}_2 + 2 \text{H}_2\text{O}$ $\text{mol HCl} = M \times V = 0.05 \times 0.02495 = \mathbf{0.0012475}$ $\therefore \text{mol Ba}(\text{OH})_2 = 1/2 \times 0.0012475 = 0.00062375$ $[\text{Ba}(\text{OH})_2] = \text{mol}/V = 0.00062375/0.02500 = 0.02495 \text{ mol L}^{-1}$ $= \mathbf{2.495 \times 10^{-2} \text{ mol L}^{-1}}$	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) <sub>2</sub> ] from incorrect origins or correct [HCl] or correct mol Ba(OH) <sub>2</sub>	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.  $\text{NH}_4\text{NO}_3$  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 - Evaluate significance pros <b>1</b> , cons <b>1</b> (Determine the value of, make a judgement, very significant because....	2 marks
increasing agricultural demand for fertilizer	1
production of more explosives for <b>WWI</b>	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

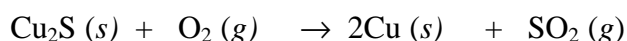
*Very significant as it insulated German agriculture from any harm caused by interrupted supplies of saltpetre from S. America and it facilitated the production of nitric acid and hence of explosives allowing Germany to prolong their war efforts in WWI.*

**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...



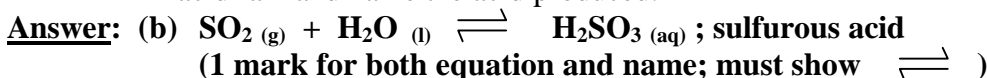
- (a) Calculate the volume of sulfur dioxide produced  
(at 25 °C and 100 kPa) when one tonne of copper is extracted. 2

**Answer:** (a)  $\text{moles Cu} = (1 \text{ t})(1000 \text{ kg/t})(1000 \text{ g/kg}) \div 63.55 \text{ g/mol}$   
 $= 15735.6 = 1.6 \times 10^4 \text{ moles}$

$$\begin{aligned} \text{moles SO}_2 &= \text{moles Cu} \div 2 \\ &= 7.8678 \times 10^3 = \underline{7.9 \times 10^3 \text{ moles}} \quad (1 \text{ mark}) \\ \text{volume of SO}_2 &= (7.8678 \times 10^3 \text{ moles})(24.47 \text{ L/mol}) \\ &= 1.925 \times 10^5 = \underline{1.9 \times 10^5 \text{ L}} \quad (1 \text{ mark}) \end{aligned}$$

**Outcome:** H10

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



**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  $[\text{H}^+]$  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

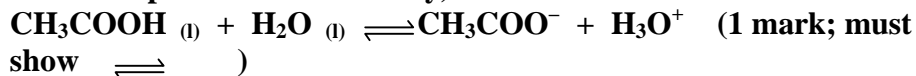
**Question 10**

**MARK(S)**

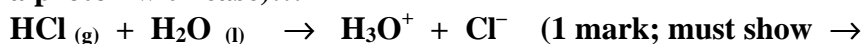
- (a) Explain why chemists classify acetic acid as a weak acid, while hydrochloric acid is regarded as a strong acid. Include equations to support your answer.

**2**

**Answer:** (a) Acetic acid is a weak acid because it ionizes poorly in water (or donates a proton with difficulty)...



HCl is a strong acid because it ionizes completely in water (or donates a proton with ease)...



**Outcomes:** H2, 8

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

**1**

**Answer:** (b)  $\text{pH} = -\log [\text{H}^+] = -\log 0.020 \text{ M} = 1.69897 = \underline{1.7}$  (1 mark)

**Outcome:** H10

- (c) Select the indicator in the table which could be used to distinguish  $0.020 \text{ mol L}^{-1}$  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 CH<sub>3</sub>COOH solutions after the indicator was added.

**Answer:** (d) **Norphen: HCl (green) and CH<sub>3</sub>COOH (blue)**  
**Orsin: HCl (yellow) and CH<sub>3</sub>COOH (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**