Section A: Multiple Choice: (1 mark each)
Write your answers on the multiple choice grid on page 2

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 ○

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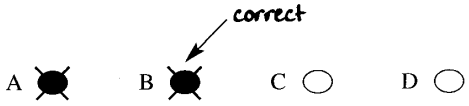

1.Which substance would not be classified as an acid according to Lavoisier?

(A) CH_3COOH
(B) HCl
(C) H_2SO_4
(D) H_2CO_3

2. Which equation shows the ionisation of sulfuric acid in water?

(A) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow 2H_2O_{(l)} + SO_{3\,(aq)}$

(B) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)} + SO_{3\,(aq)}$

(C) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_2SO_{3\,(aq)} + H_2O_{2\,(aq)}$

(D) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + HSO_4^-{}_{(aq)}$

3.The table shows data about four different acid solutions …

Solution	*Data*
A	pH 3.50
B	$[H^+] = 2.0 \times 10^{-4}$ mol L^{-1}
C	0.00025 mol L^{-1} CH_3COOH
D	0.00025 mol L^{-1} HCl

Which solution will have the lowest pH?

(A) A
(B) B
(C) C
(D) D

4. Rosa Canina wanted to see if a certain potting mix is suitable for cultivating a special type of grass seed requiring a soil pH of 4.5. Given the following indicator properties:

Indicator	*Transition pH*
Methyl orange (MO)	3.1 – 4.4
Bromothymol blue (BTB)	6.0 – 7.6
Phenolphthalein (Ph)	8.0 – 9.6

Which indicator or combination of indicators will she need to ascertain the pH most accurately.

(A) BTB and MO
(B) BTB and Ph
(C) BTB only
(D) MO only

5. Which of the following is the best description for a 0.01 mol L^{-1} solution of citric acid?

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

6. Which of the following is an acidic oxide?

(A) CoO
(B) CaO
(C) MgO
(D) NO_2

Section A

Multiple Choice Answer Grid

1.	A O	B O	C O	D O
2.	A O	B O	C O	D O
3.	A O	B O	C O	D O
4.	A O	B O	C O	D O
5.	A O	B O	C O	D O
6.	A O	B O	C O	D O

Section B: Questions requiring short answers

Question 7 (3 marks)

Concentrated sulfuric acid is shipped around Australia in large steel tanks by road and rail transport. Accidents have occurred where the acid tanks have ruptured and the concentrated acid has spilled out into the surrounding environment.

Assess the use of neutralisation reactions as a safety measure to minimise damage in such accidents. **(3 marks)**

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Question 8 (1 mark)

Compare the relative strengths of 0.10 mol L^{-1} solutions of acetic, citric and hydrochloric acids.

(1 mark)

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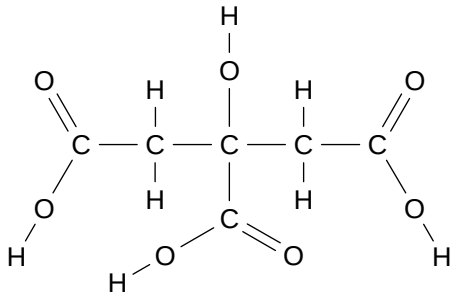
Question 9

Calculate the mass of citric acid crystals required to prepare 500 mL of 0.10 mol L^{-1} solution.
(1 mark)



Citric acid

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Question 10

Identify the need for collaboration between chemists as they collect and analyse data. **(2 marks)**

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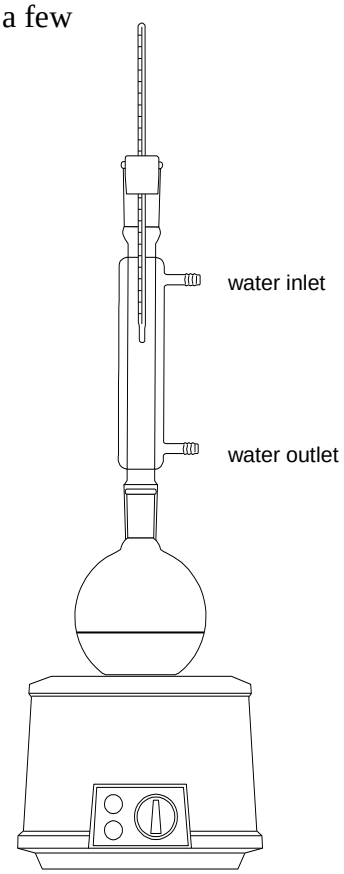
Question 11

Ken Chemiski attempts to prepare propyl butanoate by setting up the apparatus diagrammed.
► *For clarity, supporting clamps are not shown on the diagram.*

He mixes 25mL of the alkanoic acid and 25mL of the alkanol in the flask and adds a few boiling chips. The reaction mixture is heated using a hot plate set on low heat.



(a) Identify two errors Ken has made in his procedure/equipment. **(2 marks)**

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(b) Using structural formulae write the balanced equation for the esterification reaction. **(1 mark)**

_____

Question 12 (3 marks)

The mass of a sealed 300mL soft drink was found to be 400.02g. The soft drink was then decarbonated by shaking, opening gently to release the gas and recapping, the series of processes being done several times. When no visible sign of gas was being evolved, the capped soft drink weighed 397.08g.

What volume of carbon dioxide gas was released at 25^{o}C and 100 kPa? Show your working **(3 marks)**

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Question 13 (3 marks)

Describe an experiment which will allow you to decide which of two acids, HX and HZ is the stronger. Justify your answer. **(3 marks)**

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Question 14 (2 marks)

Describe the way in which a medical radioisotope is used and explain its use in terms of its chemical property.

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Question 15 (3 marks)

(a) Write a net ionic equation to explain the acidity of a solution of carbon dioxide in water. **(1 mark)**

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(b) What will happen to the pH of carbonated water if the temperature of the solution is increased? Explain your answer **(1 mark)**

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(c) What happens to the pH of the carbonated water if the pressure of the gas above the solution is reduced? Explain your answer. **(1 mark)**

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……

A END of TEST

Section A: Multiple Choice: (1 mark each)
Write your answers on the multiple choice grid on page 2

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

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

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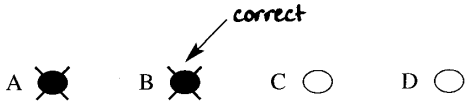


1.Which substance would not be classified as an acid according to Lavoisier?

(A) CH_3COOH
(B) HCl
(C) H_2SO_4
(D) H_2CO_3

Answer: B

Outcome: H1

2. Which equation shows the ionisation of sulfuric acid in water?

(A) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow 2H_2O_{(l)} + SO_{3\,(aq)}$

(B) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + OH^-_{(aq)} + SO_{3\,(aq)}$

(C) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_2SO_{3\,(aq)} + H_2O_{2\,(aq)}$

(D) $H_2SO_{4\,(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + HSO_4^-{}_{(aq)}$

Answer: D

Outcome: H8

3.The table shows data about four different acid solutions …

Solution	*Data*
A	pH 3.50
B	$[H^+] = 2.0 \times 10^{-4}$ mol L^{-1}
C	0.00025 mol L^{-1} CH_3COOH
D	0.00025 mol L^{-1} HCl

Which solution will have the lowest pH?

(A) A
(B) B
(C) C
(D) D

Answer: A

Outcome: H10

4. Rosa Canina wanted to see if a certain potting mix is suitable for cultivating a special type of grass seed requiring a soil pH of 4.5. Given the following indicator properties:

Indicator	*Transition pH*
Methyl orange (MO)	3.1 – 4.4
Bromothymol blue (BTB)	6.0 – 7.6
Phenolphthalein (Ph)	8.0 – 9.6

Which indicator or combination of indicators will she need to ascertain the pH most accurately.

(A) BTB and MO
(B) BTB and Ph
(C) BTB only
(D) MO only

ANS A
Outcome: H9

5. Which of the following is the best description for a 0.01 mol L^{-1} solution of citric acid?

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

ANS B
Outcome:H13

6. Which of the following is an acidic oxide?

(A) CoO
(B) CaO
(C) MgO
(D) NO_2

ANS D
Outcome: H9

Section A

Multiple Choice Answer Grid

1.	A O	B●	C O	D O
2.	A O	B O	C O	D ●
3.	A ●	B O	C O	D O
4.	A ●	B O	C O	D O
5.	A O	B ●	C O	D O
6.	A O	B O	C O	D ●

Section B: Questions requiring short answers

Question 7 (3 marks)

Concentrated sulfuric acid is shipped around Australia in large steel tanks by road and rail transport. Accidents have occurred where the acid tanks have ruptured and the concentrated acid has spilled out into the surrounding environment.

Assess the use of neutralisation reactions as a safety measure to minimise damage in such accidents. **(3 marks)**

Model Answer

A spill of concentrated sulfuric acid is of serious concern due to its highly corrosive nature. It can cause severe damage to a wide variety of materials and organisms near the spill site. The accident damage is best minimised by neutralising the acid.

A neutralisation reaction locks up the acid's corrosive H^+ ions in the form of safe, stable water… $H^+ + OH^- \rightarrow H_2O$. The neutralising agent should be a safe, weak base such as $NaHCO_3$. Use of a strong base (e.g. NaOH) is not suitable as its caustic nature can cause collateral damage at the accident site. The use of water to dilute the acid is not recommended as the dilution reaction produces considerable damaging heat and the acid remains effectively corrosive when diluted.

✓ Stating that a neutralisation reaction involves a base.	1 mark
✓ Citing a suitable base, e.g. $NaHCO_3$, Na_2CO_3, $Ca(OH)_2$	1 mark

Question 8 (1 mark)

Compare the relative strengths of 0.10 mol L^{-1} solutions of acetic, citric and hydrochloric acids.

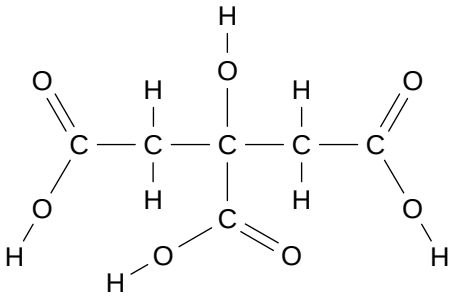
(1 mark)

Outcome: **H8**

Answer: Acetic < Citric < Hydrochloric

Question 9

Calculate the mass of citric acid crystals required to prepare 500 mL of 0.10 mol L^{-1} solution.
(1 mark)



Citric acid

Outcome: H10

Answer: **m = c × V × M = 0.10 mol L^{-1} × 0.500 L × 192.124 g mol^{-1}**

Question 10

Identify the need for collaboration between chemists as they collect and analyse data. **(2 marks)**

Outcome: H2, 12, 13, 14, 15

Model Answer:

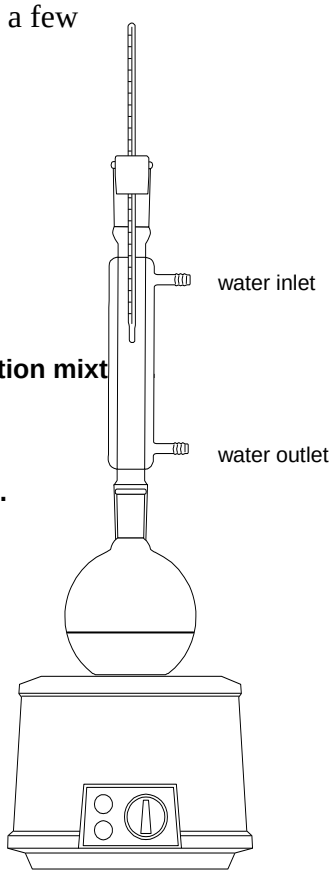
The foundations of modern science are based on the tenets of the scientific method. Hypotheses are formulated and tested by collecting and analysing data. Enlarging the data set increases reliability. If the data is collected and/or reviewed by independent groups of chemists, reliability is further enhanced as methodical human error is reduced.

✓ Citing one valid point.	1 mark
✓ Citing two valid points.	2 marks

Question 11

Ken Chemiski attempts to prepare propyl butanoate by setting up the apparatus diagrammed.
► *For clarity, supporting clamps are not shown on the diagram.*

He mixes 25 mL of the alkanoic acid and 25 mL of the alkanol in the flask and adds a few boiling chips. The reaction mixture is heated using a hot plate set on low heat.



(a) Identify two errors Ken has made in his procedure/equipment. **(2 marks)**

Answers:

(a) Ken made three errors in his esterification experiment…

(1) He did not add a small amount of concentrated H_2SO_4 catalyst to the reaction mixt

(2) He should have connected the water inlet to the bottom of the condenser.

(3) He should not have a thermometer connected to the top of the condenser.

✓ Citing one error.	1 mark
✓ Citing two errors.	2 marks

(b) Using structural formula write the balanced equation for the esterification reaction. **(1 mark)**

ANSWER

(b) $CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xleftrightarrow{H_2SO_4 + \text{Refluxing}} CH_3CH_2CH_2COOCH_2CH_2CH_3 + H_2O$

► No marks deducted for lack of conditions.

Question 12 (3 marks)

The mass of a sealed 300 mL soft drink was found to be 400.02 g. The soft drink was then decarbonated by shaking, opening gently to release the gas and recapping, the series of processes being done several times. When no visible sign of gas was being evolved, the capped soft drink weighed 397.08 g.

What volume of carbon dioxide gas was released at 25^{o}C and 100 kPa? Show your working **(3 marks)**

Answer:
Outcome: H10, H9
mass of CO_2 = 400.02 – 397.08 = 2.94 g 1 mark

moles CO_2 = mass CO_2/MM_{CO2} $= \dfrac{400.02 - 397.08}{12.01 + 2(16.00)}$ *= 0.0668* 1 mark

Volume CO_2 = # moles x molar volume
= 0.0668 moles x 24.79 L/mole
= 1.66L 1 mark

Criteria	*Mark*
Mass of CO_2	1
Calculation of # of moles	1
Volume of CO_2	1

Question 13 (3 marks)

Describe an experiment which will allow you to decide which of two acids, HX and HZ is the stronger. Justify your experimental technique. **(3 marks)**

Answer:

Using a pH probe, the pH of equal concentrations of acids HX and HZ is determined. The pH measures the free [H^+] hence, the stronger acid which releases a greater [H^+] will record a lower pH.

Criteria	Mark
brief description of technique (must include equal concentrations of acids and pH measurement)	2
justification of technique	1

Question 14 (2 marks)

Describe the way in which a medical radioisotope is used and explain its use in terms of its property.

Possible answer:

Iodine-131 is a radioisotope used in medicine. . Because of its structure and reactivity iodine –131 is selectively incorporated in the thyroid gland, when injected into the body. Iodine-131 is a β-emitter and a γ-emitter and hence able to destroy cancerous tissues in the thyroid gland.

Criteria	*Mark*
Use	1
Property (nuclear or chemical)	1

Question 15 (3 marks)

(a) Write a net ionic equation to explain the acidity of a solution of carbon dioxide in water. **(1 mark)**

Ans:

$CO_2\,(g) \quad + \quad 2\,H_2O\,(l) \rightleftharpoons HCO_3^-\,(aq) \quad + \quad H_3O^+\,(aq)$

The equation must be *ionic*

(b) Explain what will happen to the pH of carbonated water if the temperature of the solution is increased? **(1 mark)**

Ans:

When the temperature is increased, the solubility of gaseous carbon dioxide in water decreases. This pushes the equilibrium to the left. More of the hydrogen carbonate ion (HCO_3^-) reacts with the hydronium to produce more CO_2. This decreases the[H_3O^+] and hence increases the pH.

(c) What happens to the pH of the carbonated water if the pressure of the CO_2 gas above the solution is reduced? Explain your answer. **(1 mark)**

Ans:

If the pressure above the solution is decreased, then the solubility of the gas(CO_2) in the solution is decreased. This pushes the equilibrium to the left to maintain equilibrium with the CO_2 above the solution, resulting in an increase in the pH because of the escape of carbon dioxide gas from the solution (carbonated drink).

A END of TEST