Exam Choice

Student Number

2020

TRIAL EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes.
- Working time – 3 hours.
- Write using black pen.
- Draw diagrams using pencil.
- For questions in Section II, show all relevant working in questions involving calculations.
- NESA approved calculators may be used.

Total marks: 100

Section I – 20 marks (pages 3 – 12)

- Attempt questions 1 – 20.
- Allow about 35 minutes for this section.

Section II – 80 marks (pages 13 – 30)

- Attempt questions 21 – 35
- Allow about 2 hours and 25 minutes for this section.

Section I – 20 marks

Attempt Questions 1-20

Allow about 35 minutes for this section

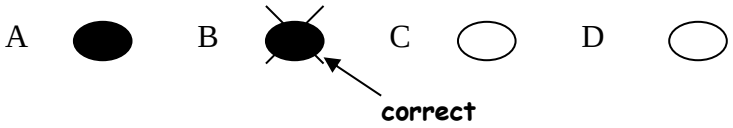
Use the multiple-choice answer sheet.

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

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

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.



1. Consider the reaction:

$$2NO_{2(g)} \longleftrightarrow N_2O_{4(g)}$$

(brown) (colourless)

$NO_{2(g)}$ was introduced into a closed syringe which was then capped and left for several minutes. The plunger was then pulled out so as to increase the volume in the syringe.

Which observation and explanation is correct?

	Observation	**Explanation**
(A)	Colour fades	Equilibrium shifts to side with more moles of gas
(B)	Colour increases	Equilibrium shifts to side with more moles of gas
(C)	Colour increases	Equilibrium shifts to side with fewer moles of gas
(D)	Colour fades	Equilibrium shifts to side with fewer moles of gas

2. Which alternative is an example of a closed dynamic equilibrium?

(A) Two groups of students lining up opposite each other across a basketball court swapping sides one at a time.

(B) Water evaporating from a tree being replaced by water from the ground through the tree's roots.

(C) Marbles rolling down a slope into a bucket.

(D) Water evaporating from a swimming pool being replaced with water from a hose.

3. The correct equilibrium expression for K_{eq} for the following reaction is:

$$2H_2S_{(g)} + 3O_{2(g)} \longleftrightarrow 2H_2O_{(g)} + 2SO_{2(g)}$$

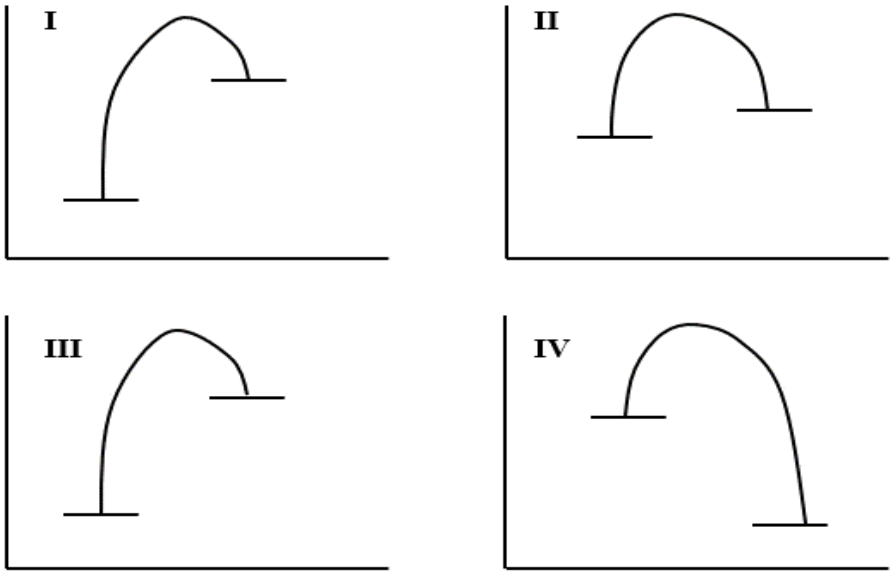
(A) $\left[H_2O_{(g)}\right]\left[SO_{2(g)}\right]$

(B) $\dfrac{\left[H_2O_{(g)}\right]\left[SO_{2(g)}\right]}{\left[H_2S_{(g)}\right]\left[O_{2(g)}\right]}$

(C) $\dfrac{\left[H_2S_{(g)}\right]^2\left[O_{2(g)}\right]^3}{\left[H_2O_{(g)}\right]^2\left[SO_{2(g)}\right]^2}$

(D) $\dfrac{\left[H_2O_{(g)}\right]^2\left[SO_{2(g)}\right]^2}{\left[H_2S_{(g)}\right]^2\left[O_{2(g)}\right]^3}$

4. Four different reaction profiles, **I**, **II**, **III and IV**, are shown.



The pair of reactions that would undergo the same changes to their equilibrium positions if the temperature was changed is:

(A) **I** and **II**

(B) **II** and **III**

(C) **I** and **III**

(D) **III** and **IV**

5. Which alternative is the best explanation of the action of detergents?

(A) The intermolecular bonding capabilities of a detergent molecule are due to the hydrogen atoms within the molecule.

(B) The length of a detergent molecule enables its overall polarity.

(C) The hydrophilic nature of a detergent molecule allows it to break up grease and fats.

(D) One end of the detergent molecule is polar while the other end is non-polar.

6. What are the correct names for the acids given?

I $HClO_2$
II $HClO$
III $HClO_3$
IV $HClO_4$

	I	**II**	**III**	**IV**
(A)	Hypochlorous acid	Chlorous acid	Chloric acid	Perchloric acid
(B)	Chlorous acid	Hypochlorous acid	Chloric acid	Perchloric acid
(C)	Chlorous acid	Hypochlorous acid	Perchloric acid	Chloric acid
(D)	Chloric acid	Perchloric acid	Chlorous acid	Hypochlorous acid

7. Arrhenius' theory of acids does not explain the acid-base behaviour of which reaction?

(A) $HCl_{(g)} + NH_{3(g)} \rightarrow NH_4Cl_{(s)}$

(B) $CH_3COOH_{(aq)} \rightarrow CH_3COO^-_{(aq)} + H^+_{(aq)}$

(C) $2HCl_{(aq)} + CaCO_{3(s)} \rightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

(D) $HF_{(aq)} + H_2O_{(l)} \rightarrow F^-_{(aq)} + H_3O^+_{(aq)}$

8. How many isomers exist for C_5H_{12}?

(A) 1

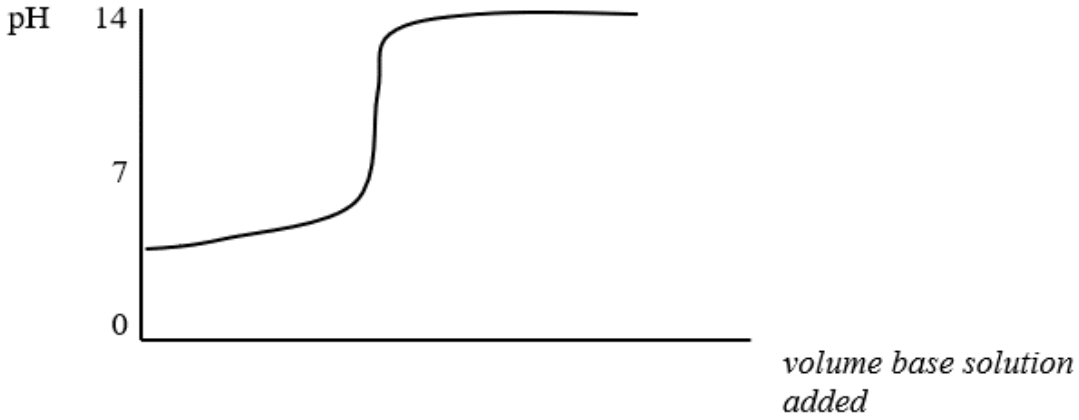
(B) 2

(C) 3

(D) 4

9. A titration was performed by adding a solution of a base to a solution of an acid with the same concentration.

The titration curve is shown.



Which acid and base combination could have been used in this titration?

(A) CH_3COOH; KOH

(B) CH_3COOH; NH_4Cl

(C) HCl; NaOH

(D) H_3PO_4; KOH

10. How many peaks would be observed in a C-13 NMR analysis of ethyl propanoate?

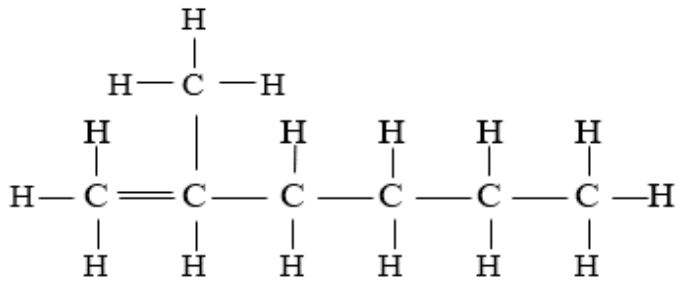
(A) 3

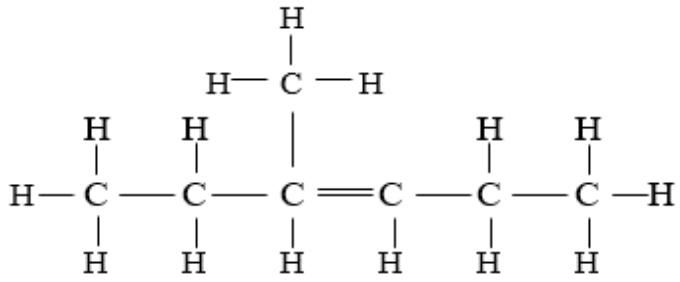
(B) 4

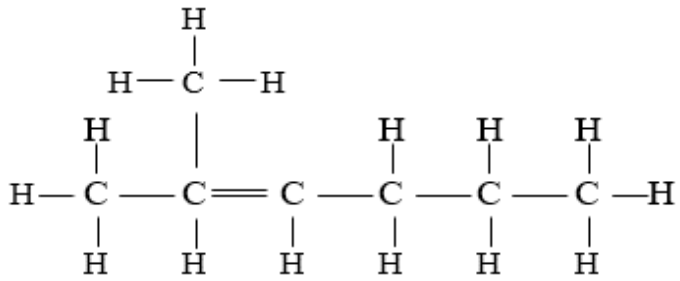
(C) 5

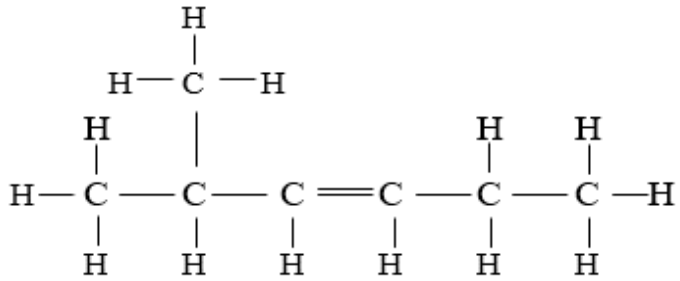
(D) 6

11. The structural formula representing 2-methyl-3-hexene is:

(A) 

(B) 

(C) 

(D) 

12. Which concentration of an HCl solution would have the same pH as a solution of 0.50 mol L^{-1} acetic acid?

The K_a of acetic acid is 1.8×10^{-5}.

(A) 0.090 mol L^{-1}

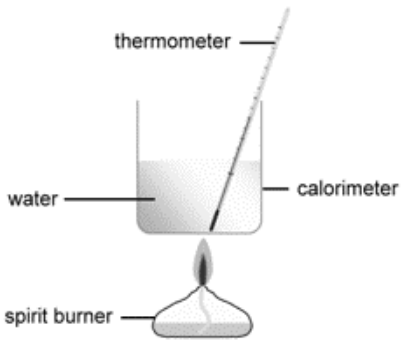
(B) 0.030 mol L-^{1}

(C) 0.0090 mol L^{-1}

(D) 0.0030 mol L^{-1}

13. A student conducted an investigation to find the enthalpy of combustion of propanol.

Apparatus was set up as shown, and relevant data collected and recorded.



Data table

Volume of water used	300 mL
Initial temperature of water	18.9 °C
Initial mass of spirit burner with propanol	187.5 g
Final temperature of water	28.5 °C
Final mass of spirit burner with propanol left	183.4 g

The student made the assumption that 50% of the heat of the combusting propanol was absorbed by the water.

The student calculated that the actual enthalpy of combustion of propanol is:

(A) 353 kJ mol^{-1}

(B) 176 kJ mol^{-1}

(C) 120 kJ mol^{-1}

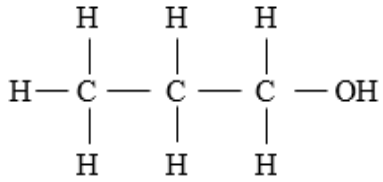
(D) 88 kJ mol^{-1}

14. An organic substance was oxidised using potassium dichromate solution with heating:

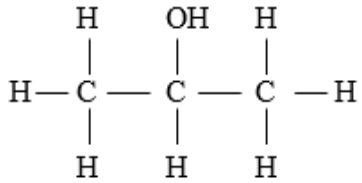
$$\text{organic substance} \xrightarrow{[O]} C_3H_6O$$

What was the organic substance?

(A)



(B)



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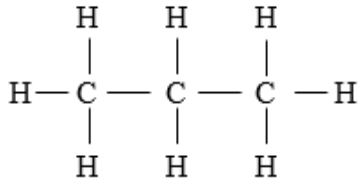
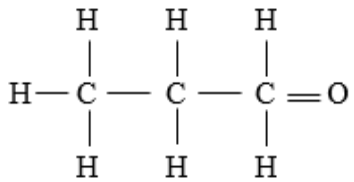
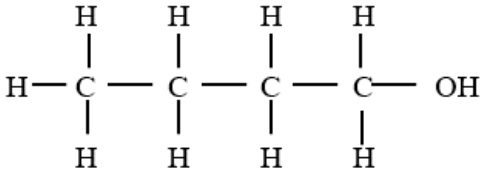
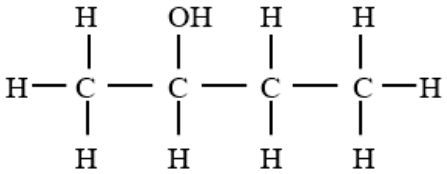


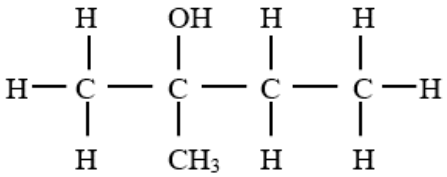
(D)

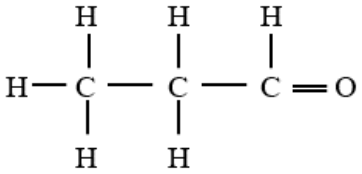


15. The solution of which compound would show no colour change after the addition of a few drops of acidified potassium dichromate?

(A) 

(B) 

(C) 

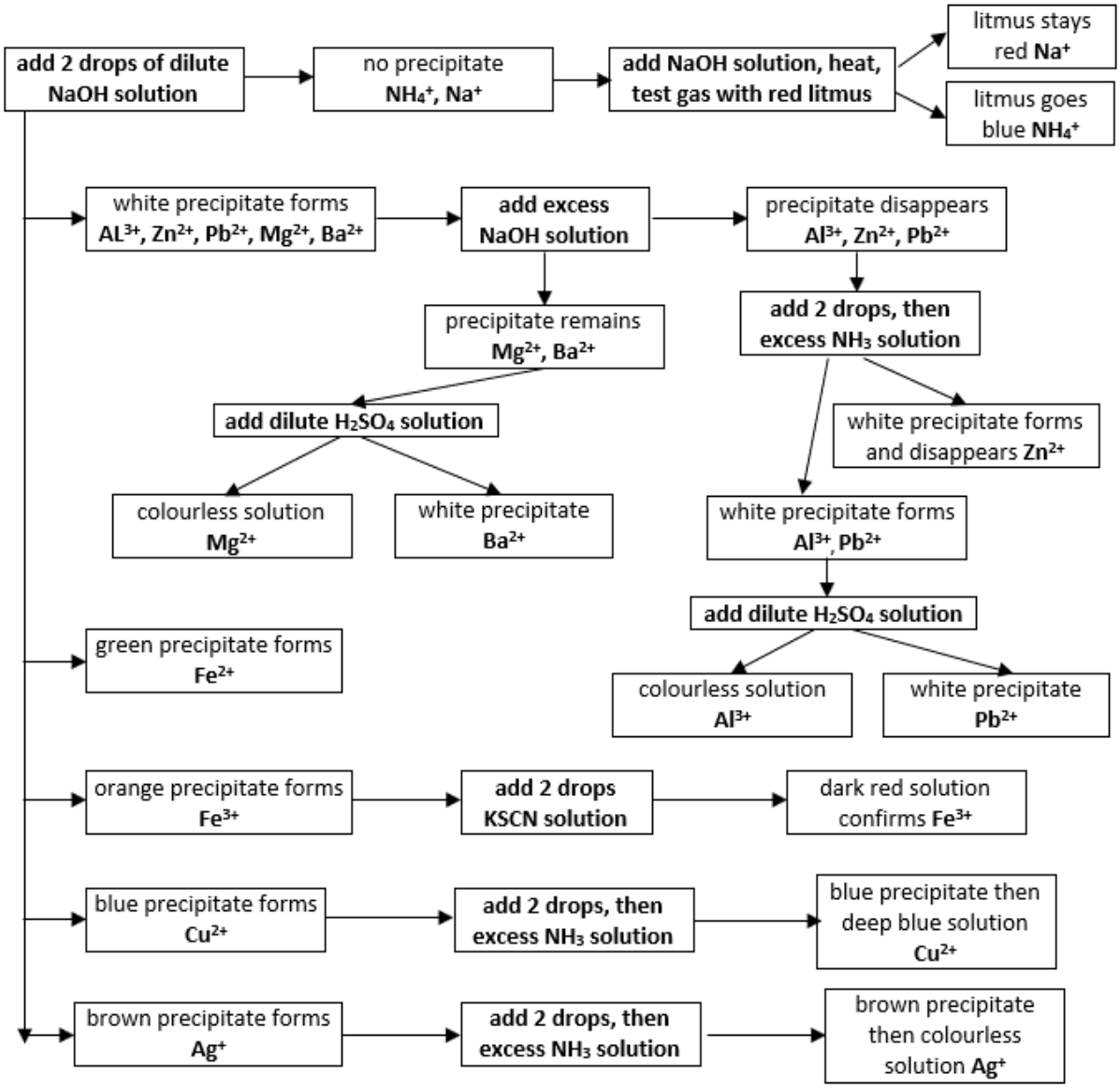
(D) 

16. In which case will a precipitate form, given the following information?

$$Pb^{2+}_{(aq)} + 2I^-_{(aq)} \longleftrightarrow PbI_{2(s)} \qquad K_{sp} = 9.8 \times 10^{-9}$$

	$[Pb^{2+}]$	**$[I^-]$**
(A)	4.5×10^{-6}	4.4×10^{-2}
(B)	4.5×10^{-6}	4.9×10^{-2}
(C)	2.8×10^{-5}	3.7×10^{-4}
(D)	2.8×10^{-5}	4.2×10^{-4}

17. Consider the flowchart and the following information:



I When 2 drops of NaOH solution was added to a sample, a white precipitate was formed.

II After excess NaOH solution was added the precipitate disappeared.

III When 2 drops, then excess NH_3 solution was added, a white precipitate appeared.

IV After dilute H_2SO_4 solution was added, the result was a colourless solution.

The ion present in the solution is:

(A) Pb^{2+}

(B) Al^{3+}

(C) Mg^{2+}

(D) Zn^{2+}

18. A sample of Teflon, polytetrafluorethene, was found to have a molecular mass of 1.9×10^4 g mol^{-1}.

On average, how many monomer units are there in the polymer?

(A) 190

(B) 186

(C) 258

(D) 212

19. What is the pH of a 0.0150 mol L^{-1} solution of a weak monoprotic acid that has a $pK_a = 5.5$?

(A) 5.5

(B) 3.7

(C) 0.000218

(D) $10^{-5.5}$

20. 3.50 g of ethanol was refluxed with 5.75 g of methanoic acid. The product was extracted and found to weigh 4.23 g.

The percentage yield in this process is closest to:

(A) 34%

(B) 46%

(C) 74%

(D) 75%

2020 | TRIAL EXAMINATION

Chemistry

Section II
Answer Booklet

80 marks

Attempt Questions 21 – 35

Allow about 2 hours and 25 minutes for this part

Instructions

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which questions you are answering.

Marks

Question 21 (6 marks)

Describe the relationship between collision theory and reaction rate, and how equilibrium reactions are affected by these concepts. **6**

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Marks

Question 22 (3 marks)

Given that for the reaction:

$$2SO_{2(g)} + O_{2(g)} \longleftrightarrow 2SO_{3(g)}$$

the value of $K_{eq} = 6.5$ at a certain temperature T.

In a sealed container, initial concentrations were as follows:

$[SO_2] = 0.47 \text{ mol } L^{-1}$

$[O_2] = 0.62 \text{ mol } L^{-1}$

$[SO_3] = 0.21 \text{ mol } L^{-1}$

By performing appropriate calculations, explain how the reaction will proceed to equilibrium. **3**

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Marks

Question 23 (6 marks)

(a) Outline the procedure for an investigation that determines the value of K_{sp} of a chemical equilibrium system involving an ionic compound. **4**

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(b) Explain why the temperature of the system investigated may influence the value of K_{sp} found. **2**

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Question 24 (3 marks)

Given the K_{sp} of $Mn(OH)_2$ = 2.0 x 10^{-13} , calculate the pH of a saturated solution of manganese hydroxide. **3**

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Marks

Question 25 (6 marks)

50.0 mL of a solution of 0.300 mol L^{-1} NaOH was added to a 50.0 mL solution of 0.250 mol L^{-1} HNO_3 in an insulated cup.

The initial temperature of both solutions was 21.0 °C. The final temperature of the resulting solution was 22.5 °C.

(a) Calculate the experimental heat of neutralisation from these results. **3**

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(b) Given that the generally accepted value for the molar heat of neutralisation is 58 kJ mol^{-1}, determine the percentage error in the above calculation. **2**

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(c) Suggest ONE change to the experimental design used above that would improve the accuracy of the investigation. **1**

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Marks

Question 26 (5 marks)

(a) With the use of chemical equations, show the amphiprotic nature of the hydrogen carbonate ion. **2**

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(b) State the definition of conjugate pairs and identify ONE conjugate pair in your response in part (a).
Describe the acidic/basic nature of each species in the pair. **3**

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Marks

Question 27 (10 marks)

3.20 g of pure anhydrous solid Na_2CO_3 was weighed, dissolved and transferred to a 500 mL volumetric flask which was then filled to the mark with distilled water.

25 mL of this solution was then transferred to a conical flask.

10.0 mL of a solution of HCl was transferred to a 250 mL volumetric flask and filled to the mark with distilled water.

A burette was filled with the diluted HCl solution and a titration performed against the Na_2CO_3 in the conical flask, with the following titre volumes obtained:

12.70 mL
11.40 mL
11.50 mL
11.45 mL

(a) What apparatus would be used to transfer the 25 mL of Na_2CO_3 solution into the conical flask, and how would it have been prepared before use? **2**

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(b) Calculate the concentration of the Na_2CO_3 solution used in the titration. **2**

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(c) Suggest a suitable indicator for this titration. Justify your choice. **2**

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Question 27 continues on page 20.

Marks

Question 27 (continued)

(d) Calculate the concentration of the diluted HCl solution. **3**

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(e) Find the concentration of the original undiluted HCl solution. **1**

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Marks

Question 28 (4 marks)

In an addition reaction, hydrogen chloride is reacted with cyclohexene.

(a) Name the product formed and draw its structural formula. **2**

(b) Name and draw the structural formula for all possible products of the reaction between chlorine gas and propene. **2**

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Marks

Question 29 (6 marks)

"The use of organic substances underpins our modern society."

Assess the need to handle and dispose of organic substances following strict safety procedures. Refer to specific examples in your response. **6**

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Marks

Question 30 (8 marks)

Yeast was added to a 150 mL solution of glucose and water in a conical flask and the apparatus weighed.

(a) Describe the optimal conditions required for fermentation. **2**

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(b) Write a balanced chemical equation for the fermentation of glucose. **1**

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(c) The mixture was left under these optimal conditions for 24 hours. When weighed again, the mass of the mixture had reduced by 2.38 g.

What was the mass of ethanol produced? **2**

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(d) Discuss the benefits and limitations of using ethanol obtained by the fermentation of sugars as an alternative liquid fuel. **3**

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Marks

Question 31 (6 marks)

Polymers are important substances and are found in many applications in our society.

(a) Explain what is meant by the term "condensation" polymer, using an example to illustrate your answer. **2**

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(b) Polyhydroxybutyrate is a polymer formed from the polymerisation of 3-hydroxy butanoic acid.

Draw a monomer of polyhydroxybutyrate. **1**

(c) Use a diagram to show how two of these monomers can join to begin to form the polymer. **2**

(d) Name another kind of polymer other than condensation polymers and outline how they differ from condensation polymers. **1**

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Marks

Question 32 (5 marks)

To determine the sulfate content of a sample of fertiliser by gravimetric analysis requires the sample to be dissolved and the sulfate ions precipitated with an appropriate cation before being filtered, dried and then weighed.

Several assumptions have to be made at particular steps in the process.

(a) Identify any *two* assumptions made in this process and outline how these assumptions may affect the final result. **2**

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(b) From an initial sample of fertiliser weighing 4.27 g, a dried precipitate of $BaSO_{4(s)}$ weighed 3.12 g. **3**

Calculate the percentage sulfate content of this fertiliser sample.

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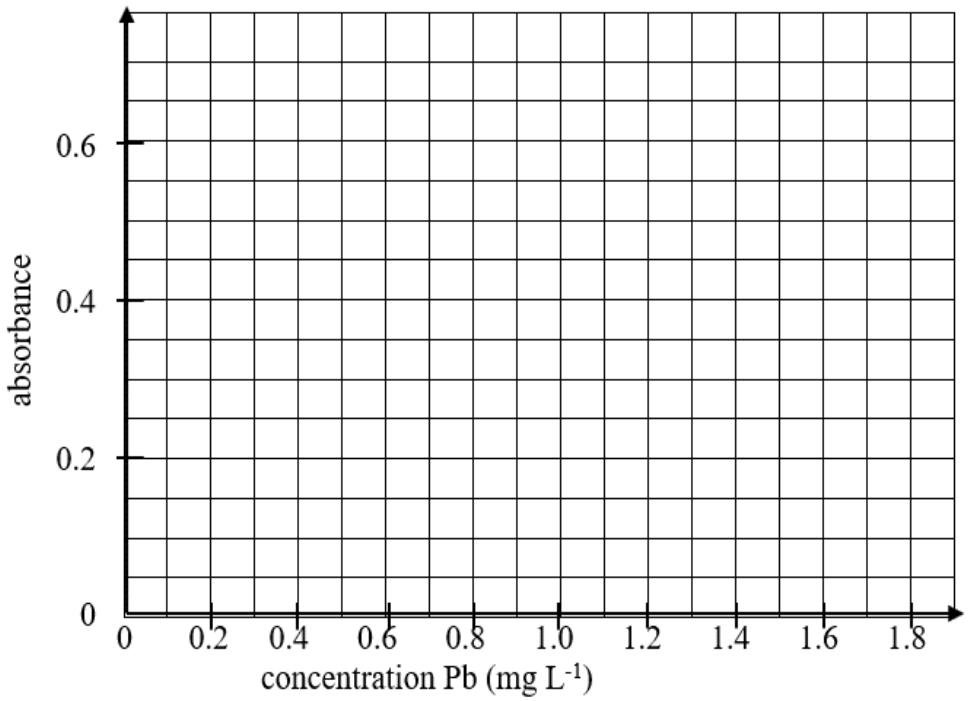
Marks

Question 33 (5 marks)

A sample of waste water from a coal mine is being analysed for heavy metals.

The absorbance calibration data shown in the table below was obtained using AAS at a wavelength of 218 nm with Pb being analysed.

[Pb] ($mg\ L^{-1}$)	absorbance
0.25	0.12
0.63	0.28
1.08	0.40
1.42	0.57
1.73	0.64



Waste water was taken from the mine and a 10 mL sample was diluted with distilled water to make a total volume of 1000 mL.

A sample of the diluted waste water produced an absorbance of 0.51.

Question 33 continues on page 27.

Marks

Question 33 (continued)

(a) By using the grid provided and other appropriate procedures, calculate the mass of lead in mg in one litre of waste water. **3**

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(b) Suggest one advantage and one disadvantage of using AAS to make a full analysis of the heavy metal contaminants in the waste water. **2**

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Marks

Question 34 (3 marks)

(a) When a small piece of sodium is added to an alcohol, a reaction occurs that liberates hydrogen gas and forms the alkoxide ion.

Write the molecular equation for this reaction using propan-1-ol as the alcohol. **1**

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(b) Outline how propan-1-ol could be identified from propan-2-ol or 2-methylpropan-2-ol. **2**

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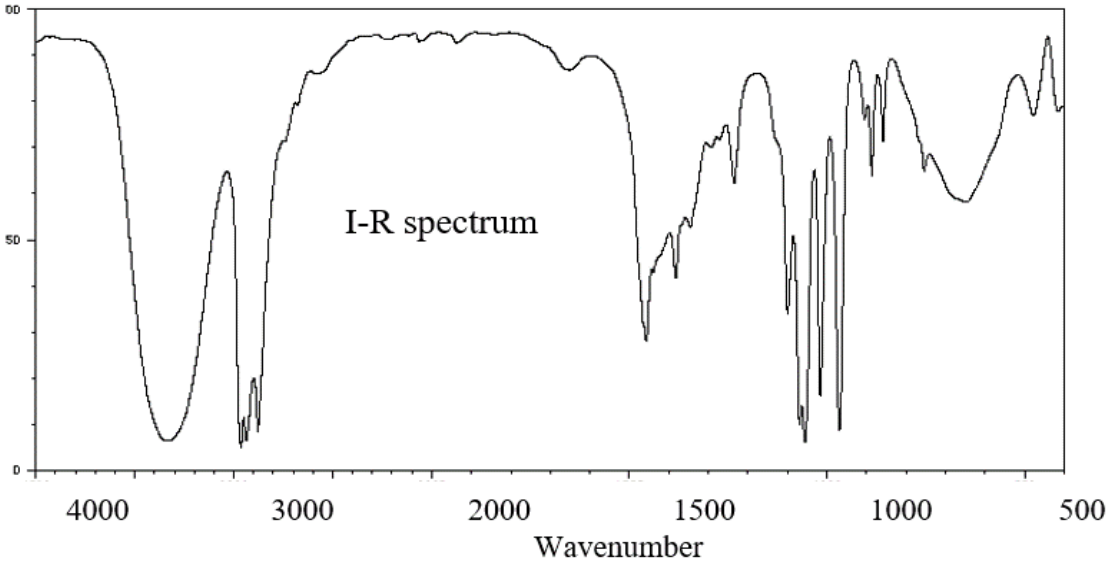
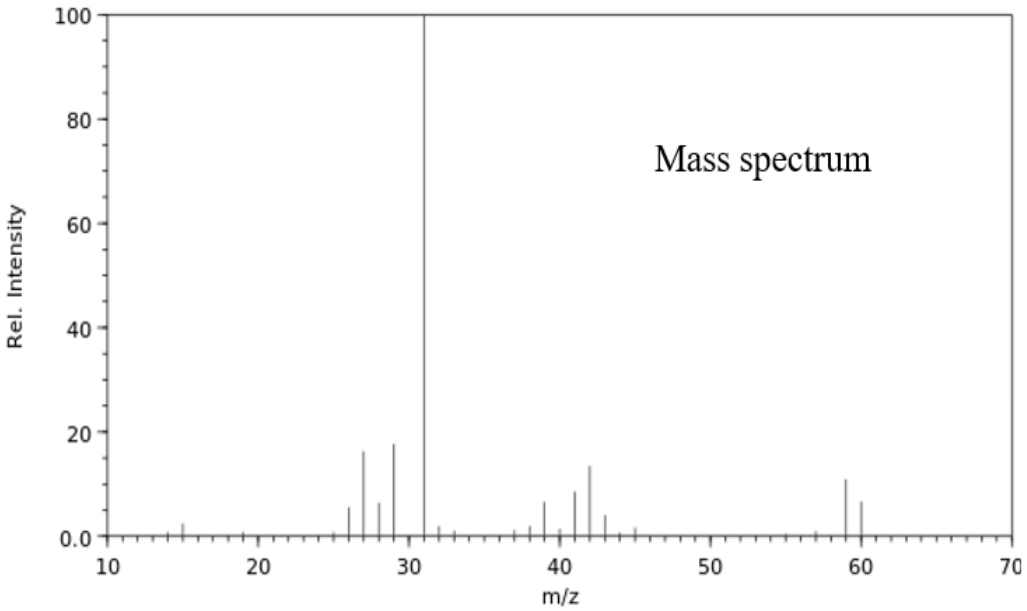
Marks

Question 35 (4 marks)

The I-R spectrum and the mass spectrum of an organic compound are shown below:





(a) Explain the presence of a small signal at 59 m/z on the mass spectrum. **1**

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Question 35 continues on page 30.

Marks

Question 35 (continued)

(b) Suggest which organic compound has produced these spectra, giving your reasons. **3**

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Exam Choice

2020 Chemistry Trial Examination.

Marking Guidelines and Model Answers.

Section I Multiple Choice

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
B	A	D	C	D	B	C	C	A	C	D	D	A	B	C	A	B	A	B	D

Section II

21.

Marking Criteria	Marks
• Collision theory related to reaction rate clearly, succinctly and thoroughly • How equilibrium reactions are affected by these concepts is related clearly, succinctly with evidence of deep understanding	**6**
• Collision theory related to reaction rate • How equilibrium reactions are affected by these concepts is related showing some understanding	**4-5**
• Collision theory related to reaction rate OR • How equilibrium reactions are affected by these concepts is related	**2-3**
• Response contains one correct, relevant statement.	**1**

Collision theory states that when reactant particles collide, collisions that occur with sufficient energy (activation energy) and favourable orientation will result in a reaction to produce products. The rate of reactions is a function of a number of variables, including: concentration (pressure), particle size, agitation/stirring. Temperature rise increases both the speed of reactant particles so more collisions occur and the energy of the particles, increasing the probability of a reaction resulting. The presence of a catalyst lowers the required activation energy, again increasing the probability of a reaction when a collision occurs. A faster reaction rate will allow an equilibrium system to reach equilibrium faster, as both forward and reverse reaction rates are increased, decreasing as equilibrium is reached and then equalling each other's rates when equilibrium is attained.

22

Marking Criteria	Marks
• Q calculation performed correctly • Q compared to K_{eq} and subsequent explanation given is clear and correct	**3**
• As above but with one error or mistake made	**2**
• One correct and appropriate calculation step or statement is evident	**1**

$$Q = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$
$$= \frac{0.21^2}{0.47^2 \times 0.62}$$
$$= 0.32 \quad \text{i.e. } Q < K_{eq}$$

So, the forward reaction rate will be greater than the reverse rate until equilibrium is attained, at which time the forward and reverse rates will be equal, and Q = K_{eq}.

23 a.

Marking Criteria	Marks
• A comprehensive outline of an appropriate procedure is provided in a clear, logical manner	**4**
• A complete outline of an appropriate procedure is provided	**3**
• An outline of an appropriate procedure is provided with some omissions	**2**
• An aspect of an appropriate procedure is provided	**1**

e.g. (exact concentrations not needed)
1. Solutions of 0.010M $Pb(NO_3)$ and KI were made up.
2. 10 test tubes were labelled and placed in a test tube rack
3. To tube #1 was added 5 mL of each solution.
4. To each successive test tube, one less mL of one solution was added and distilled water added to make the total volume 10 mL.
5. The tubes were allowed to stand for 15 minutes.
6. For the last test tube that does have a precipitate present, the ionic product Q was calculated.
7. For the first test tube that does not have a precipitate present, the ionic product Q was calculated.
8. The K_{sp} for the precipitate, PbI_2, lies between these two values.

23 b.

Marking Criteria	Marks
• A thorough explanation is provided	**2**
• An incomplete explanation is provided	**1**

The solubility of most salts is affected by the temperature. Higher temperatures may result in higher solubility as the solid particles have greater vibrational energy and may remain in solution at higher concentrations than at lower temperatures, thus affecting the value of the K_{sp} calculated in part (a).

24.

Marking Criteria	Marks
• Writes the correct dissociation equation for $Mn(OH)_2$ • Calculates the correct $[OH^-]$ • Calculates the correct pOH and subsequently the correct pH OR directly finds the correct pH	**3**
• Writes the correct dissociation equation for $Mn(OH)_2$ • Calculates the correct $[OH^-]$ OR • uses the incorrect value of $[OH^-]$ to subsequently find the pH	**2**
• Writes the correct dissociation equation for $Mn(OH)_2$	**1**

$Mn(OH)_2(s) \leftrightarrows Mn^{2+}(aq) + 2OH^-(aq)$

$K_{sp} = x \times (2x)^2$

$4x^3 = 2.0 \times 10^{-13}$

$x = 3.7 \times 10^{-5}$

$[OH^-] = 2 \times 3.7 \times 10^{-5}$

$= 7.4 \times 10^{-5}$

pOH = 4.1

pH = 14 – 4.1

= 9.9

25 a.

Marking Criteria	Marks
• Heat energy produced in reaction is calculated • Number of moles H_2O produced is calculated • Heat of neutralisation subsequently calculated correctly	**3**
• Two of the above steps correct	**2**
• One step correct	**1**

$q = mc\Delta T$
$= 100 \times 4.18 \times (22.5 - 21.0)$
$= 627$ J
$= 0.627$ kJ

No. moles H_2O produced = c x v for HNO_3 (limiting reagent)
$= 0.250 \times 0.0500$
$= 1.25 \times 10^{-2}$ mol

Heat of neutralisation $= 0.627 \text{ kJ} / 1.25 \times 10^{-2}$
$= 50.2$ kJ

25 b.

Marking Criteria	Marks
• Percentage error calculates correctly from data in part (a)	**2**
• An error or omission made using data from part (a)	**1**

$$\% \text{ error} = \frac{\text{accepted value - experimental value}}{\text{accepted value}} \times 100\%$$
$$= \frac{58 - 50.2}{58} \times 100\%$$
$$= 13.4\%$$

25 c.

Marking Criteria	Marks
• A change suggested that would improve the accuracy	**1**

e.g. Use larger quantities; use a calorimeter with closed lid; etc

26 a.

Marking Criteria	Marks
• Amphiprotic nature of HCO_3^- ion shown fully	**2**
• Amphiprotic nature of HCO_3^- ion shown partially	**1**

$HCO_3^-(aq) + H_2O(l) \rightarrow CO_3^{2-}(aq) + H_3O^+(aq)$ shows acting as an acid
$HCO_3^-(aq) + H_2O(l) \rightarrow H_2CO_3(aq) + OH^-(aq)$ shows acting as a base

26 b.

Marking Criteria	Marks
• One conjugate pair identified correctly • Conjugate pair definition stated • Acidic and basic nature of both species in the pair described	**3**
• One conjugate pair identified correctly • Conjugate pair definition stated • Acidic or basic nature of one species in the pair described	**2**
• One conjugate pair identified correctly OR • Conjugate pair definition stated	**1**

e.g. conjugate pair: H_2O and H_3O^+ . A conjugate pair differ by a proton only.

Here, the H_2O is acting as a very weak base and the H_3O^+ ion is a very strong acid.

27 a.

Marking Criteria	Marks
• Pipette identified • AND • Correct rinsing given, i.e. with solution	**2**
• One of the above	**1**

25 mL pipette, rinsed with the solution to be used

27 b.

Marking Criteria	Marks
• Correct concentration calculated	**2**
• Concentration calculation attempted with an error or omission	**1**

$$n(Na_2CO_3) = \frac{3.20}{22.99\times2 + 12.01 + 3\times16.00}$$
$$= 0.03019$$
$$[Na_2CO_3] = \frac{0.03019}{0.500}$$
$$= 0.0604 \text{ mol L}^{-1}$$

27 c.

Marking Criteria	Marks
• Suitable indicator suggested AND • Correct reason given including pH of equivalence pt	**2**
• One of the above	**1**

e.g. methyl orange, as the pH range for colour change is <7 and the equivalence point pH of the strong acid vs weak base is also <7.

27 d.

Marking Criteria	Marks
• Correct concentration found using correct calculations	**3**
• Most calculations correct – error made	**2**
• A correct step towards the answer is shown	**1**

Average titre = 11.45 mL = 0.01145 L: $Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$

$n(Na_2CO_3) = C \times V = 0.0604 \times 0.025 = 1.5095 \times 10^{-3}$ mol

$n(HCl) = n(Na_2CO_3) \times 2 = 3.019 \times 10^{-3}$ mol

$[HCl] = 3.019 \times 10^{-3}/0.01145 = 0.2636$ mol L^{-1}

27 e.

Marking Criteria	Marks
• Correct answer supplied	**1**

[HCl](undiluted) = [HCl](diluted) x 250/10

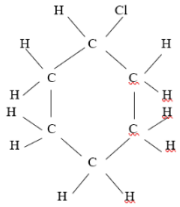
= 0.2636 x 250/10 = 6.59 mol L^{-1}

28 a.

Marking Criteria	Marks
• Correct name supplied • Correct structural formula drawn	**2**

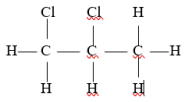
• One of the above	**1**

chlorocylcohexane



28 b.

	Marks
• Correct name and structur h no incorrect additional products or duplication	**2**
• Either correct name OR structural formula provided OR • Correct answer but with extra incorrect additional products	**1**



1,2 dichloropropane

29

Marking Criteria	Marks
• Response is thorough and addresses at least three separate aspects of the question • Response is made in a logical and clear manner	**6**
• Response addresses three separate aspects of the question	**4-5**
• Response identifies three aspect of the question • OR • Response discusses two aspects of the question	**2-3**
• A relevant aspect addressing the question is provided	**1**

The safe handling and disposal of organic substances is important for a variety of reasons, including: many are toxic; they can be bio-accumulating; they can be flammable; they may take many years to break down in the environment if released; they are volatile and thus, if released, may evaporate into the atmosphere and be breathed in; they may be absorbed through contact with skin, etc.

One example is biphenyls, of which 40 000 tonnes are produced each year. Being mildly toxic, they are used to make other materials including plastics (PCBs) as well as a food preservative in many countries. In the school laboratory, organic substances such as methanol are toxic, flammable and therefore should be stored safely and away from any ignition source in a flammable liquid cabinet, ventilated to ensure any fumes or vapour do not build up if a spill or leak occurs. When handling, gloves and safety glasses should be used, and hands should be washed afterwards.

The disposal of unwanted organic substances must be performed safely to ensure that they do not enter into the food chain or waterways. High temperature incinerators can be used to break the molecules down into safer, less toxic compounds which are released into the atmosphere, or by being safely stored long term in appropriate spill-proof containers.

30 a.

Marking Criteria	Marks
• Three conditions identified	**2**
• Two conditions identified	**1**

anaerobic (stop air getting in); warm (around 25-35°C); sugar dissolved in water;

30 b.

Marking Criteria	Marks

• Appropriate balanced equation written.	**1**

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH(l) + 2CO_2(g)$

30 c.

Marking Criteria	Marks
• Correct answer given	**2**
• An appropriate calculation performed but error or omission made	**1**

Assume mass loss = $CO_2(g)$ liberated.
n (CO_2) = 2.38 g/44.01 g mol^{-1} = 0.05408 mol
n (CO_2) = n (C_2H_5OH)
mass (C_2H_5OH) = 0.05408 x 46.068 = 2.49 g

30 d.

Marking Criteria	Marks
• At least one benefit and one limitation of the use of ethanol as an alternative fuel discussed • Response shows evidence of good understanding of the issue	**3**
• A benefit and a limitation of the use of ethanol as an alternative fuel discussed	**2**
• A benefit or a limitation is described	**1**

Sugars for fermentation to produce ethanol are obtained from plant material or biomass. In many cases, the plant material is sourced from a crop that would otherwise be used as a food (e.g. rice or corn), thus increasing the price of the food, having a detrimental effect for poor populations. The distillation of the fermentation mixture to obtain pure ethanol is energy intensive, however burning waste biomass is often used for this. The biomass grown for ethanol consumes CO_2 from the atmosphere, recycling that CO_2 released upon the combustion of the ethanol, making it less carbon emitting overall than fossil fuel liquids such as petrol or diesel.

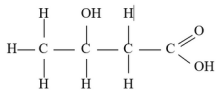
31 a.

Marking Criteria	Marks
• Explanation of condensation polymer is clear and accurate • Suitable example is provided and used to illustrate response	**2**
• Explanation is provided OR • Example provided with no explanation	**1**

A condensation polymer is one where a molecule of water (or other small molecule) is produced whenever two monomers react and join.
e.g. cellulose is a condensation polymer made from monomers of glucose – an -OH from one monomer combines with an -H from another to produce and H_2O molecule and a bridging O atom joins the two monmers.

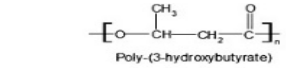
31 b.

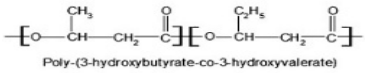
Marking Criteria	Marks
• Correct structural formula drawn	**1**

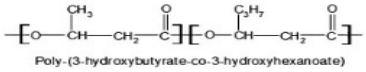


31 c.

Marking Criteria	Marks
• Diagram is clear and shows how monomers join accurately	**2**
• Diagram drawn but with an error or is not clear	**1**







31 d.

Marking Criteria	Marks
• Polymer kind named and difference outlined	**1**

Addition polymers – monomers join by the opening of a C=C bond.

32 a.

Marking Criteria	Marks
• Two assumptions identified • For each assumption, how the final result is affected is outlined correctly	**2**
• At least one assumption identified • For one assumption, how the result is affect is outlined correctly	**1**

e.g. Assumption 1: All the SO_4^{2-} ions are precipitated out of the solution. This has the effect of obtaining a result lower than the actual result for the % of SO_4^{2-} in the fertiliser.
Assumption 2: All the precipitate is filtered out of the solution. In effect, some precipitate may pass through the filter paper used, so the assumption again has the effect of causing the result to be lower than the actual content of SO_4^{2-} in the fertiliser.

32 b.

Marking Criteria	Marks
• Correct answer calculated	**3**
• Answer calculated but with an error made or an omission	**2**
• A correct step or steps made towards solving the question	**1**

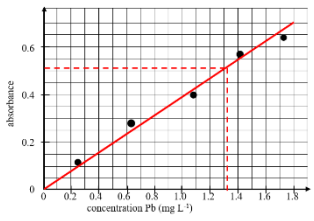
$$n\ BaSO_4 = \frac{3.12}{137.3 + 32.06 + 4 \times 16.00} = 0.01337\ mol$$

Therefore mass SO_4^{2-} = 0.01337 x (32.06 + 4 x 16.00)
= 1.284 g

% SO_4^{2-} = (1.284/4.27) x 100%
= 30.1 % (3 sig figs)

33 a.

Marking Criteria	Marks
• Data points correct • Line of best fit drawn correctly • Interpolation of line of best fit correct to find conc. of diluted solution • Undiluted concentration found with correct mass of Pb stated	**3**
• Line of best fit used with plotted data points • Interpolation attempted to find mass of mg	**2**
• One correct step towards answer is clearly evident	**1**



The diluted concentration = 1.32 mg L^{-1}

The undiluted concentration = 1.32 x 1000/10
= 132 mg L^{-1}

Therefore the mass of lead in 1 L of waste water = 132 mg

33 b.

Marking Criteria	Marks
• An advantage and a disadvantage stated clearly	**2**
• Either an advantage or a disadvantage stated	**1**

Advantages: suitable for low concentrations of metals; not affected by presence of other metals;
Disadvantages: can only measure one metal at a time; not particularly transportable – samples need to be taken back to the lab

34 a.

Marking Criteria	Marks
• Correct equation given (molecular or expanded molecular form)	**1**

$2CH_3CH_2CH_2OH(l) + 2Na(s) \rightarrow 2CH_3CH_2CH_2O^-Na^+(aq) + H_2(g)$

34 b.

Marking Criteria	Marks
• An appropriate procedure is outlined that would differentiate 1-propanol	**2**
• A key part of an appropriate procedure is identified, e.g. oxidation	**1**

By oxidation of the alcohol with a suitable oxidising agent, e.g. $KMnO_4(aq)$ and testing the product formed. Propan-1-ol will oxidise to proanoic acid which will turn blue litmus red. Propan-2-ol will oxidise to propanone, while 2-methylpropan-2-one will not oxidise.

35 a.

Marking Criteria	Marks
• Correct explanation given	**1**

This signal, being 1 less m/z than the highest at 60 is due to the single ion of the compound, where an H^+ ion has been released from the compound.

35 b.

Marking Criteria	Marks
• Correct compound identified • At least 3 correct supporting reasons used	**3**
• A compound identified based on valid reasons	**2**
• One piece of relevant and correct reasoning provided	**1**

Propanol: From mass spectrum: mol. mass = 60; fragment at 31 is $-CH_2-OH$
From IR – large OH signal near 3500; C-O signal at 1050-1100; all typical of an alcohol
So, use the molecular formula $C_nH_{2n+2}O$ to calculate the number of carbon atoms which will yield the molecular formula of the alcohol:
Given atomic mass of C = 12, H = 1, O = 16:
Molar mass, MM = (12 x n) + 1 x (2n+2) +16 = 60
$14n + 18 = 60$
$n = 3$
therefore the formula of the alcohol is C_3H_8O