Student number

PEM

Chemistry

2020 TRIAL EXAMINATION

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- NESA approved calculators may be used
- A formulae sheet, data sheet and Periodic Table are provided at the back of this paper
- For questions in Section II, show all relevant working in questions involving calculations

Total marks: 100

Section I – 20 marks (pages 3–9)

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

Section II – 80 marks (pages 11–28)

- Attempt Questions 21–37
- Allow about 2 hours and 25 minutes for this section

Section I
20 marks

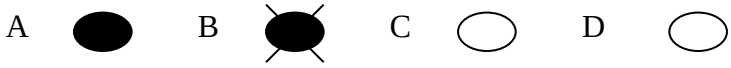
Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet.

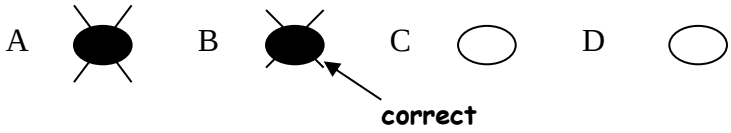
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

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.



Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

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1. The following equilibrium is set up in a sealed reaction vessel.

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$; $\Delta H = +54.8$ kJ mol^{-1}

Which of the following would INCREASE the yield of nitrogen dioxide?

A. Adding a catalyst to the reaction vessel.
B. Decreasing the volume of the reaction vessel.
C. Raising the temperature of the reaction vessel.
D. Increasing the pressure by adding argon to the reaction vessel.

2. The reaction below demonstrates the equilibrium between hydrated cobalt (pink) and the cobalt (II) chloride ion (blue)

$$\underset{\text{Pink}}{Co(H_2O)_6^{2+}(aq)} + 4Cl^-(aq) \rightleftharpoons \underset{\text{blue}}{CoCl_4^{2-}(aq)} + 6H_2O(l)$$

At equilibrium, what would occur if water was added to the reaction mixture?

A. The Cl^- concentration decreases.
B. The reaction moves towards the product increase the Cl^- concentration.
C. The resulting colour changes from pink to blue.
D. The temperature increases.

3. Arrange the following reactions in order of their increasing ability to reach completion.

I.	$Ag^+(aq) + 2NH_3(aq) \rightleftharpoons Ag(NH_3)^{2+}$	$K_{eq} = 1.6 \times 10^7$
II.	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	$K_{eq} = 1.6 \times 10^{-3}$
III.	$Br_2(aq) + Br^-(aq) \rightleftharpoons Br_3^-(aq)$	$K_{eq} = 18$
IV.	$I_2(g) \rightleftharpoons 2I(g)$	$K_{eq} = 4 \times 10^{-5}$

(Note: Assume that each equilibrium constant was determined under their optimum conditions)

A. IV, II, III, I
B. I, III, II IV
C. III, II, IV, I
D. I, IV, II, III

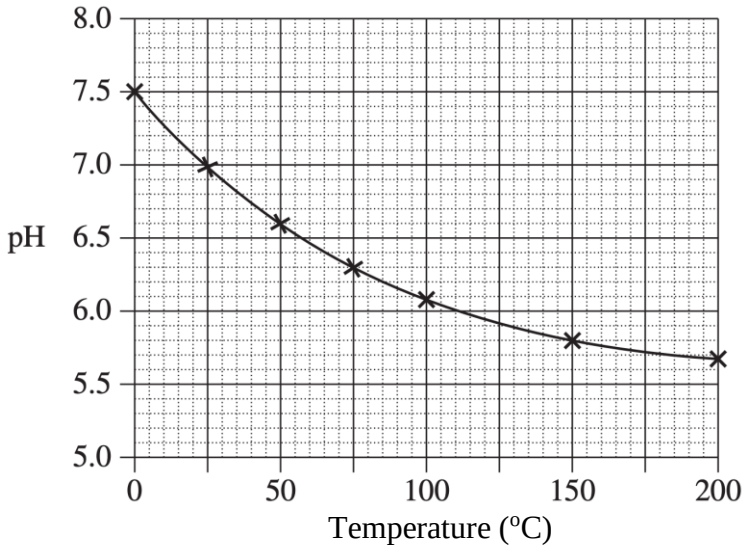
4. There are two unlabelled solutions. One is barium nitrate and the other lead nitrate. Which of the following could be added to the two unlabelled solutions to distinguish between them?

A. Potassium carbonate.
B. Potassium chloride.
C. Potassium nitrate.
D. Potassium sulfate.

5. A student tested 4 household substances using phenolphthalein and methyl oranfe indicators. Which of the following results is recorded correctly?

	Substance	**Colour with phenolphthalein**	**Colour with methyl orange**
A.	Wine	Pink	Red
B.	Ammonia Cleaner	Pink	Yellow
C.	Vinegar	Red	Blue
D.	Baking Soda	Clear	Blue

6. The graph shows the pH of a solution of a weak acid, HA, as a function of temperature.



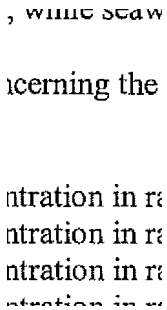
What happens as the temperature decreases?

A. HA becomes less ionised and the H^+ concentration increases.
B. HA becomes less ionised and the H^+ concentration decreases.
C. HA becomes more ionised and the H^+ concentration increases.
D. HA becomes more ionised and the H^+ concentration decreases.

7. The conjugate acid of HS^- is

A. H^+
B. S^{2-}
C. H_2S
D. $HS(OH)^{2-}$

8. The diagram below shows hydrochloric acid solution in a burette, at the end-point of a titration with an ammonia solution. The starting level of the acid was 0.0 mL.



Which statement about the *end-point* of the titration is the most correct?

A. The acid volume used was 17.7 mL at pH= 7.
B. The acid volume used was 17.8 mL at pH <7.
C. The acid volume used was 18.2 mL at pH >7.
D. The acid volume used was 18.25 mL at pH =7.

9. Rainwater has a pH of about 5, while seawater has a pH of about 8.

Which statement is correct concerning the *hydrogen ion concentrations* of rainwater and seawater?

A. The hydrogen ion concentration in rainwater is less by a factor of 5/8.
B. The hydrogen ion concentration in rainwater is less by a factor of 1000.
C. The hydrogen ion concentration in rainwater is greater by a factor of 3.
D. The hydrogen ion concentration in rainwater is greater by a factor of 1000.

10. Which of the following is an isomer of 1,4 dichloro-4-fluoro-2-butene?

A. 1–bromopropane
B. 1,2–dichloro-2-fluoropropane
C. 1,1–dichloro-3-fluoro-2-butane
D. 1,1 –dichloro-3-fluoro-2-butene

11. Which of the following hydrocarbons has a higher boiling point than pentane?

i. 1-pentene
ii. 1-hexene
iii. 2-pentyne
iv. 2-methylbutane

A. II only
B. IV only
C. I only
D. II and III

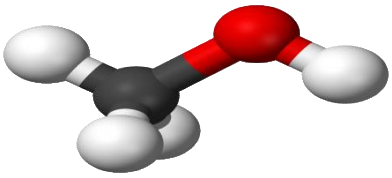
12. In a first-hand investigation in a school laboratory, students were asked to distinguish between alkanes and alkenes, by reaction with bromine water.

The most suitable pair of chemicals to use in this experiment would be:

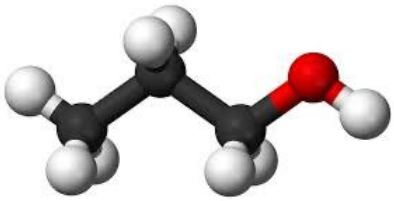
A. propane and ethane.
B. cyclohexene and hex-1-ene.
C. cyclohexene and cyclohexane.
D. hex-1-ene and hex-2-ene.

13. The models below show examples of alkanols.

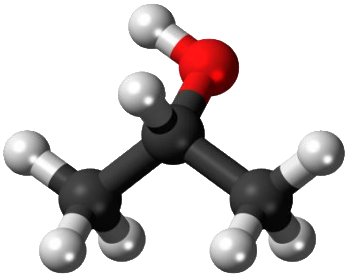
Alkanol 1



Alkanol 2



Alkanol 3



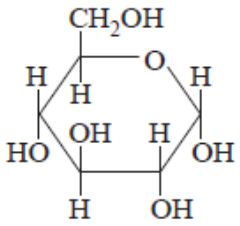
Alkanol 4

The <u>INCORRECT</u> statement is:

A. Alkanols 1 and 2 are described as homologues.
B. Alkanols 2 and 3 have the same molecular formula.
C. Alkanols 3 and 4 are classified as isomers.
D. Alkanol 4 would have the lowest solubility in water.

14. Which of the following chemicals is the product of a condensation polymerisation reaction?

A.



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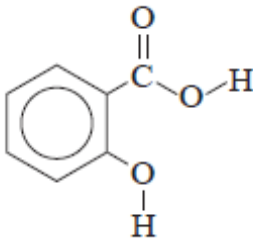

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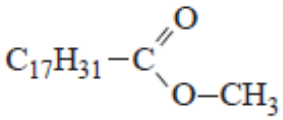
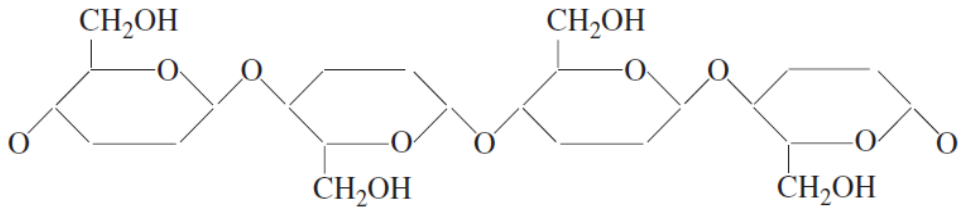


D.



15. Which of the following is the principle of atomic absorption spectroscopy?

A. Radiation is absorbed by non-excited atoms in vapour state and are excited to higher states of energy.
B. Medium absorbs radiation and transmitted radiation is measured.
C. Colour is measured.
D. Colour is simply observed.

16. An unknown solid was analysed by a number of tests, the results of which are described below.

- The solid did not react when $HNO_3(aq)$ was added to a sample.
- When $Ba(NO_3)_2(aq)$ was added to a solution of the solid, no observable change occurred.
- When $AgNO_3(aq)$ was added to a solution of the solid, a cream precipitate formed.
- The precipitate dissolved in excess nitric acid.
- When a small sample of the solid was placed into a Bunsen flame, a flash of red colour was observed.

Which one of the following chemicals would behave in a similar way when analysed with the same set of tests?

A. barium chloride
B. barium phosphate
C. calcium chloride
D. calcium phosphate

17. A lawn fertiliser lists the sulfate content as 38.5% (w/w).

What mass of barium sulfate precipitate would be expected to form if a 1.50 g sample of the fertiliser were analysed by reacting the sample with excess barium nitrate solution?

A. 0.238 g
B. 0.578 g
C. 1.40 g
D. 3.64 g

18. The increase in atmospheric carbon dioxide has been linked to the burning of fossil fuels.

The combustion of octane produces 1.554×10^7 kJ of energy per tonne of carbon dioxide produced.

Ethanol has been proposed as a more environmentally sound source of energy. The heat of combustion for ethanol is 1367 kJ mol^{-1}. The energy produced per tonne of carbon dioxide from the combustion of ethanol is

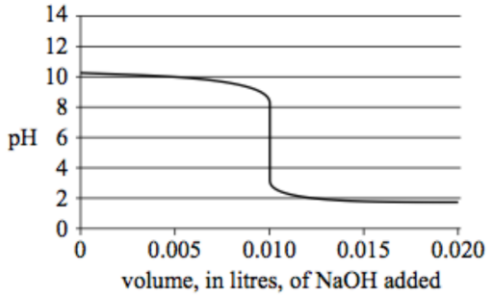
A. 8.311 kJ
B. 2.272×10^4 kJ
C. 1.553×10^7 kJ
D. 3.106×10^7 kJ

19. Select the statement that is TRUE about C-13 NMR Spectroscopy

A. The standard used is dimethylpropane.
B. The chemical shift of the NMR peaks is affected strongly by electronegative atoms in functional groups.
C. The C-13 NMR spectrum of methane contains five peaks.
D. Carbon-carbon double bonds have chemical shifts between 5-40 ppm.

20. Which titration curve best represents the change in pH as 0.100 M NaOH solution is added to a 10.0 mL aliquot of 0.100 M HCl solution?

A.



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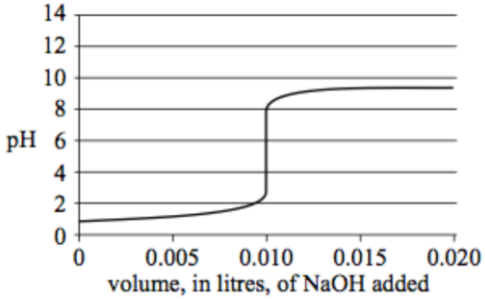
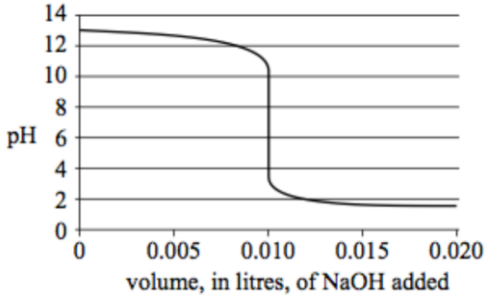


C.



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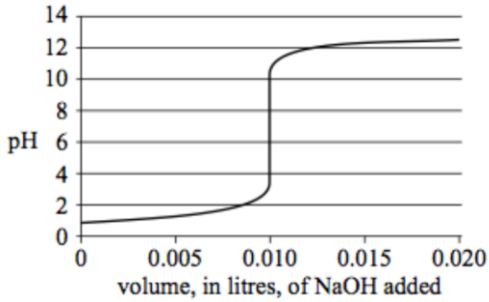

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Student number

Chemistry

2020 TRIAL EXAMINATION

Section II
80 marks

Attempt Questions 21- 37
Allow about 2 hour and 25 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Question 21 (2 marks)

Iron(III) ions and thiocyanate ions exist in equilibrium with iron(III) thiocyanate as shown in the equation below.

$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons FeSCN^{2-}(aq)$

The iron (III) ion is a pale yellow colour and iron (III) thiocyanate is a much deeper red colour.

When silver nitrate is added, it reacts with the thiocyanate ions forming a precipitate. Explain the colour change that occurs if silver nitrate is added to this equilibrium.

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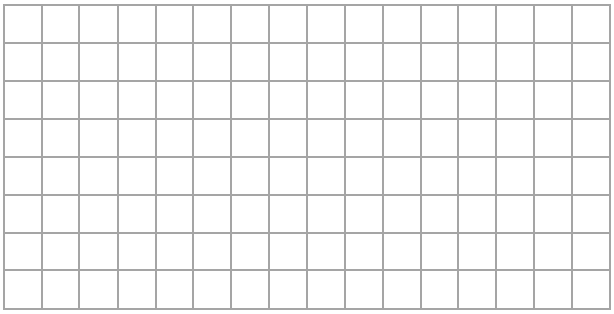
Question 22 (3 marks)

(a) Draw a simple energy profile diagram for an endothermic reaction in which 50 kJ mol^{-1} is absorbed with an activation energy of 100 kJ mol^{-1}. **2**



(b) On the same energy profile, demonstrate how a catalyst affects the activation energy of the reaction. **1**

Question 23 (5 marks)

The following table provides equilibrium data on the effect of temperature on the concentration of gases in the ammonia equilibrium at 300 atm pressure.
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

T (ºC)	**P (atm)**	**[NH_3]**	**[H_2]**	**[N_2]**
400	300	2.580	2.139	0.713
500	300	1.239	2.618	0.873
600	300	0.557	2.723	0.908

(a) Identify whether this reaction equilibrium is endothermic or exothermic. Justify your response. **3**

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Question 23 continues on page 13

Question 23 (continued)

(b) Explain why moderate temperatures (~400^{o}C) are used in the industrial manufacture of ammonia.

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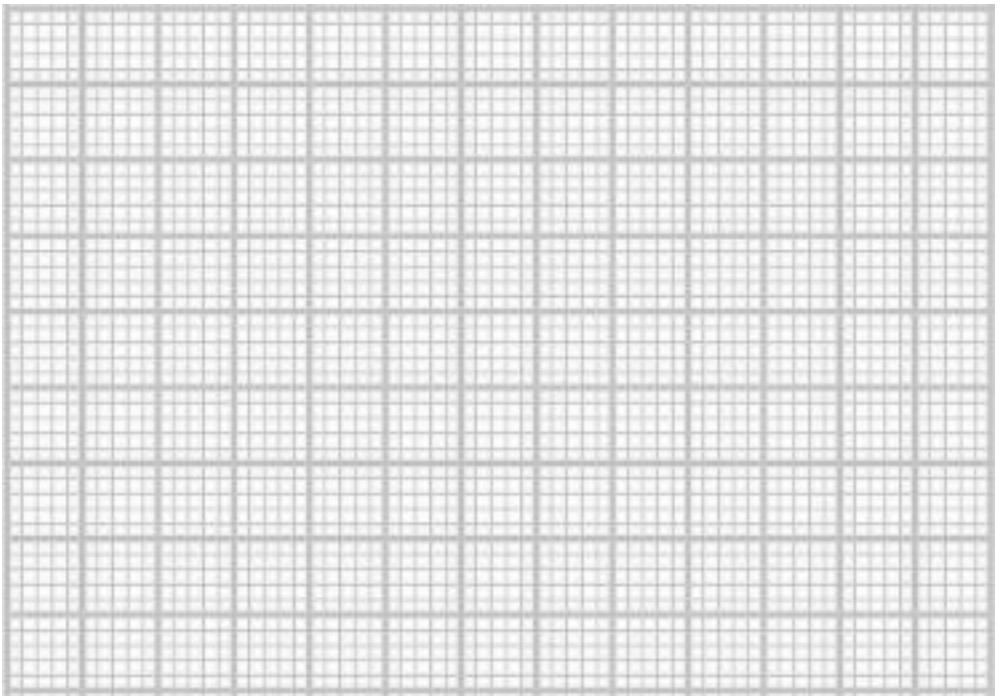
Question 24 (7 marks)

The information in the table shows how the solubility of barium hydroxide is affected by temperature. The amount of solvent (water) was kept constant at 100 g.

Temperature of water (^oC)	0	20	40	60	80	100
Mass of solute	1.25	1.35	1.55	1.9	2.75	4.2

(a) Plot the solubility of barium hydroxide in water and hence, calculate the K_{sp} of barium hydroxide at 70^oC. **6**



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Question 24 continues on page 15

Question 24 (continued)

(b) What is the minimum mass of water at 50°C needed to dissolve 1 g of $Ba(OH)_2$? **1**

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Question 25 (3 marks)

Investigations by various scientist over time have improved our knowledge and depth of understanding about acids and bases. **3**

Compare the Arrhenius Theory of acids and bases with that of Bronsted-Lowry, describing how the limitations of Arrhenius theory were improved upon.

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Question 26 (5 marks)

(a) SO_2, K_2O, N_2O_5, CaO **1**

From the list of oxides above, identify:

(i) Acidic oxide ……

(ii) Basic oxide ……..

(b) Write a balanced equation for a reaction which illustrates the acidic or basic nature of one of the oxides you identified in part (a) **1**

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(c) Aluminium oxide is classified as amphoteric. Define the term amphoteric **1**

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Question 27 (5 marks)

H_2SO_4 is a polyprotic acid and dissociates according to the following processes:

$H_2SO_4(aq) + H_2O(l) \rightleftharpoons HSO_4^-(aq) + H_2O(l)$
$HSO_4^-(aq) + H_2O(l) \rightleftharpoons SO_4^{2-}(aq) + H_2O(l)$

The deprotonation of HSO_4^- has a K_a of 0.011.

What is the pH of a $0.089 mol L^{-1}$ solution of sulfuric acid (H_2SO_4)? **5**

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Questions 28 (4 marks)

25.0 mL of 0.12 mol L^{-1} standard barium hydroxide solution was titrated with nitric acid. The results were recorded in the table.

Titration	Volume of nitric acid used (mL)
1	20.4
2	18.1
3	18.2
4	18.1

Calculate the concentration of the nitric acid solution. **4**

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Question 29 (4 marks)

Buffer solutions are important in natural systems.

(a) Explain why a mixture of sodium chloride and hydrochloric acid cannot form a buffer solution. **2**

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(b) Demonstrate the effect of adding hydrochloric acid to solution of CH_3COO^- / CH_3COOH. **2**

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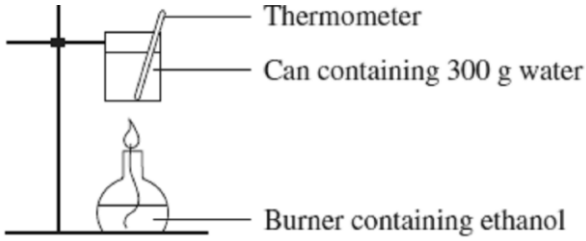
Question 30 (6 marks)

A student used the set up below to determine the molar enthalpy of the combustion of ethanol.



The following results were obtained.

Initial mass of burner	133.20 g
Final mass of burner	132.05 g
Initial temperature of water	25.0°C
Final temperature of water	45.5°C

(a) Calculate the molar enthalpy of combustion using the data above. **4**

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(b) Calculate the mass of ethanol that must be burnt to increase the students' temperature of 300g of water by 65°C, if exactly half of the heat released is lost to the surroundings. ($\Delta H_{ethanol}$ = 1360 kJ mol^{-1}) **2**

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Question 31 (8 marks)

To perform an esterification reaction in the laboratory a student was provided with methanol and propanoic acid, which she heated together under reflux with a catalyst.

(a) Name and draw the structural formula of the ester that could be synthesised **2**

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(b) Name a suitable catalyst for this reaction **1**

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(c) Justify the use heating under reflux for this experiment **2**

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(d) The ester formed in the above reaction has a molar mass of 88 g and boils at 78°C. Two other substances with the same molar mass are: **3**

- 1-pentanol BP 138°C
- butanoic acid BP 163°C

Explain the differences in boiling point between the ester produced and the other two substances mentioned above.

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Question 32 (4 marks)

Compare the uses, structures and properties of soap and anionic synthetic detergents. **4**

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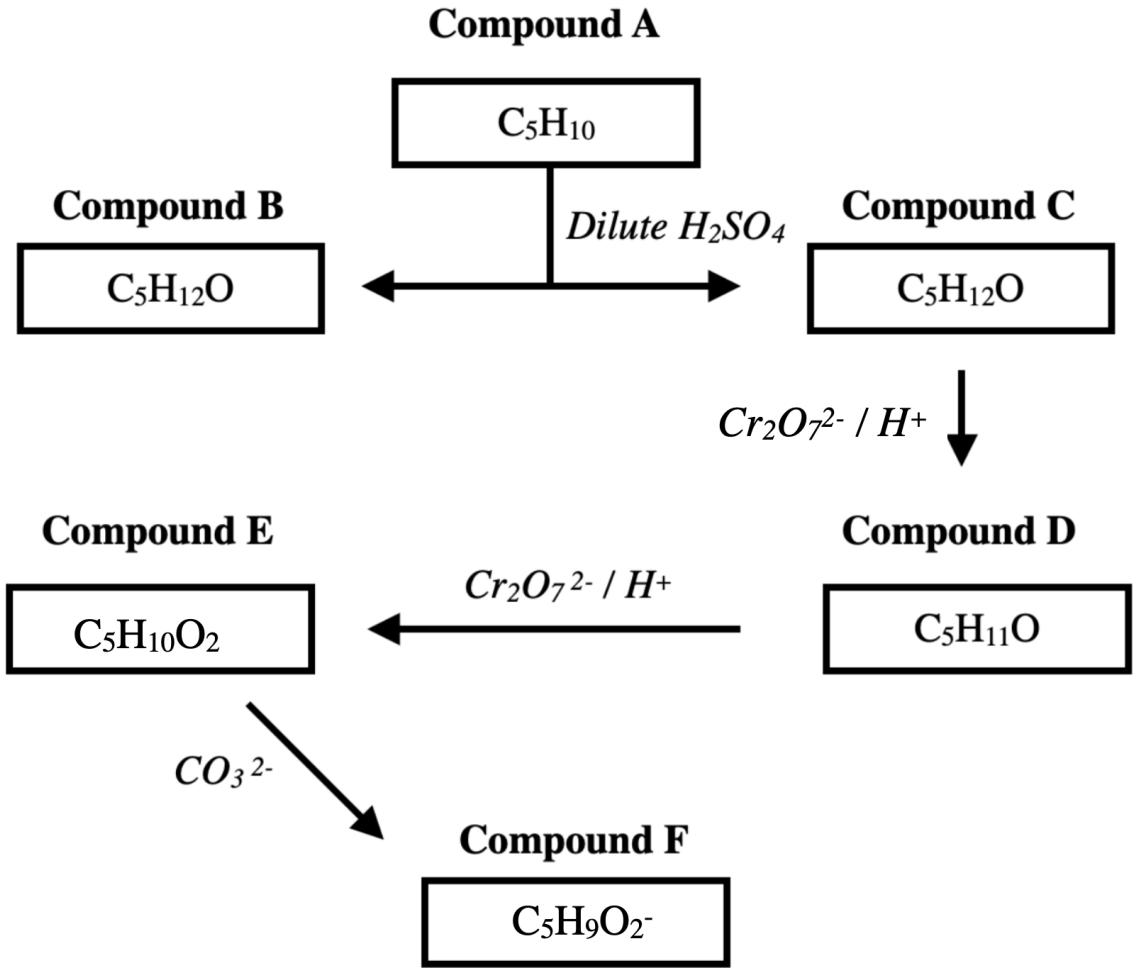
Question 33 (6 marks)

The flowchart below illustrates the processes involved in six different organic compounds.



Question 33 continues on page 24

Question 33 (continued)

Complete the table by drawing the structural formulae for the compounds and justifying your answers with reference to the information provided.

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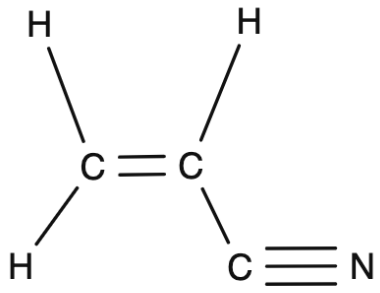
Compound	Structural	Justification
Compound A C_5H_{10}		
Compound B $C_5H_{12}O$		
Compound C $C_5H_{12}O$		
Compound D $C_5H_{11}O$		
Compound E $C_5H_{10}O_2$		
Compound F $C_5H9O_2^-$		

Question 34 (4 marks)

Polyacrylonitrile (PAN) is used to make "Orlon" fibres, which are used to make rugs, blankets and clothing. The monomer is shown below:



(a) Draw the structure of the polymer PAN **1**

(b) The properties of polymers are very important in determining their uses. Discuss the properties expected for polyacrylamide **3**

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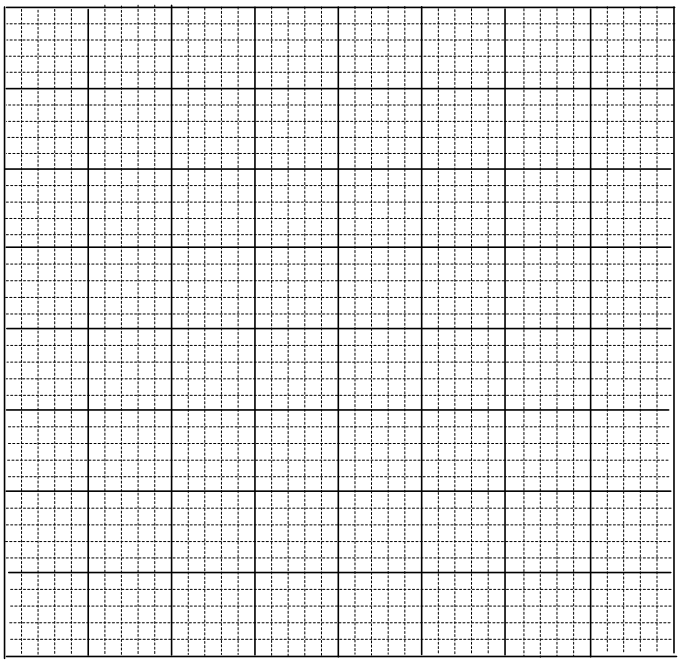
Question 35 (7 marks)

The content of lead in lip balm is regularly monitored. In one study, the technician was given four standard solutions containing different concentrations of lead ions and asked to measure their absorbance at 400 nm. The results are shown in the table:

Maximum absorbance obtained at 400nm				
Lead Concentration (ppm)	5	15	25	35
Lead Concentration (ppm) Absorbance	0.2	0.6	1.1	1.4

(a) Draw a calibration curve for the above data. **4**



(b) Studies suggest that the average user consumes 1.8 kilograms of lip balm during their lifetime while consuming food and drinks and licking their lips. The US Food and Drug Administration limits lead in lip balm to 20 parts per million. **2**

Assuming all lip balm comply with this regulation, calculate the maximum mass of lead an average user would consume over their lifetime. (***Hint:*** Assume all of the lip balm contain 20 ppm of lead.)

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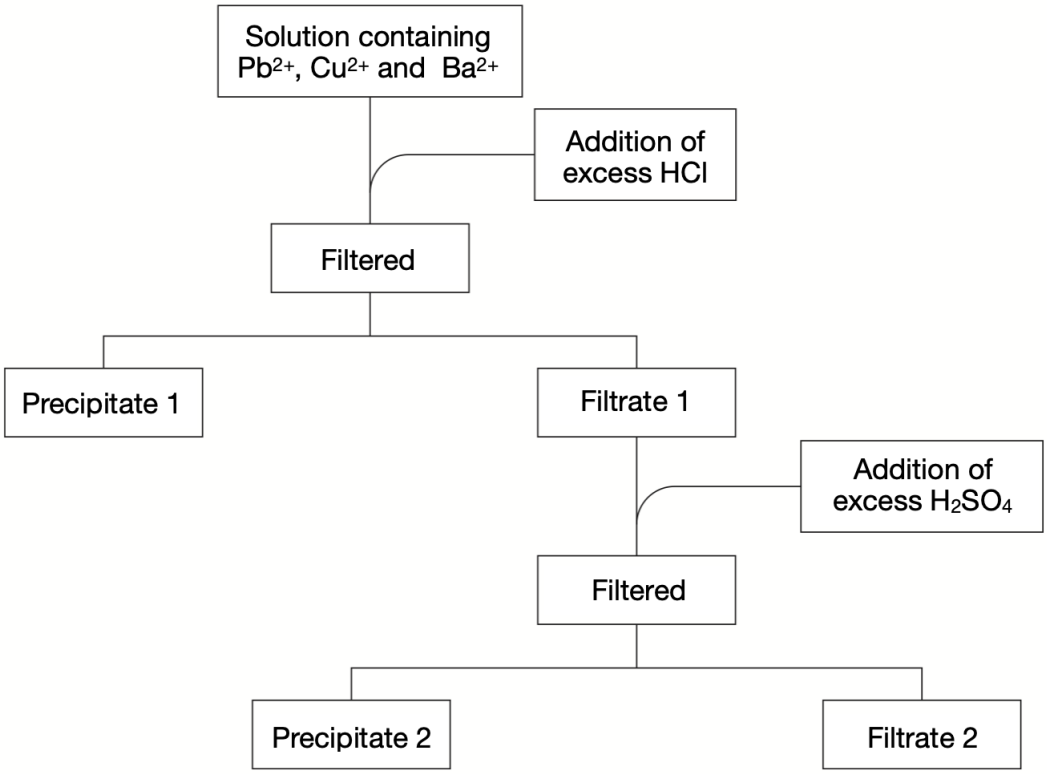
Question 36 (4 marks)

A mystery solution contains three ions Pb^{2+}, Cu^{2+} and Ba^{2+}. The flow chart below represents the process required to confirm the identity of these ions.



(a) Write a balanced ionic equation representing the formation of Precipitate 1. **2**

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(b) Suggest a test and the expected result that would confirm the identity of the metal cations remaining in Precipitate 2 and Filtrate 2. **2**

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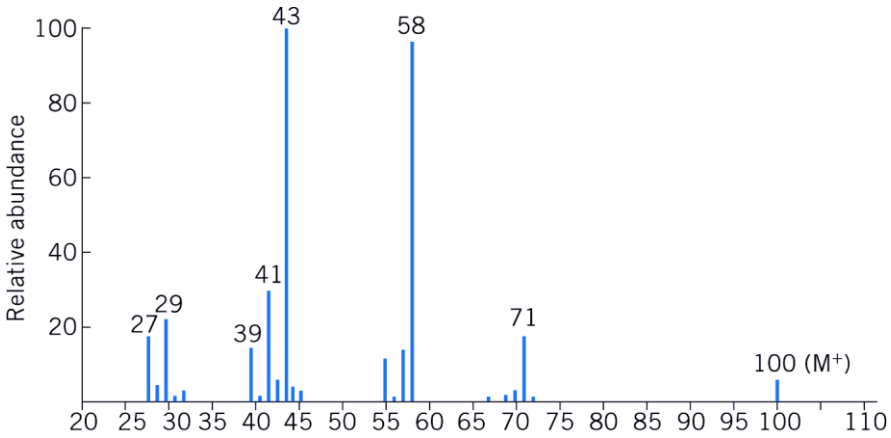
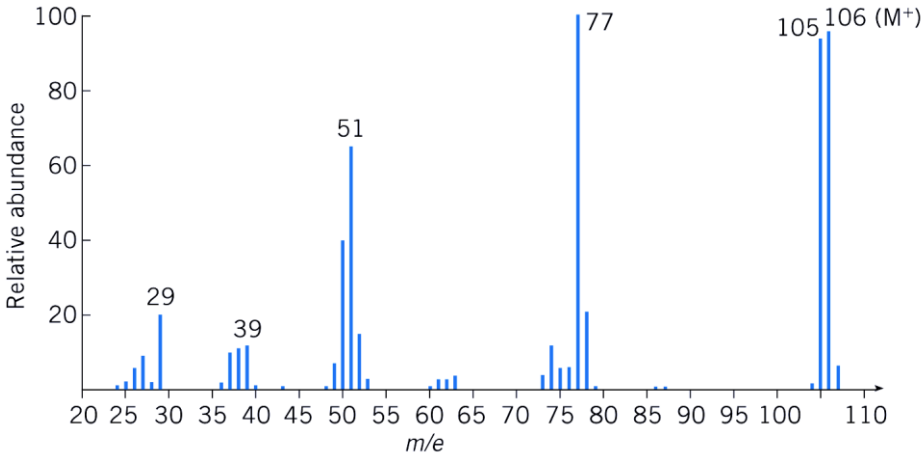
Question 37 (5 marks)

The mass spectra of 2-methylpentanal and benzaldehyde are provided below.

Spectrum X



Spectrum Y



(a) Identify the spectrum belonging to each compound. **1**

……

……

(b) Identify the fragments responsible for some of the main peaks. **4**

……

……

……

……

End of paper

2020 Year 12 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
C	A	A	B	B	B	C	B	D	D	D	C	C	D	A	D	C	C	B	D

Section II

Question 21

Marking guidelines	Marks
• Gives the correct answer. • Gives an appropriate explanation.	2
• Gives an appropriate explanation.	1

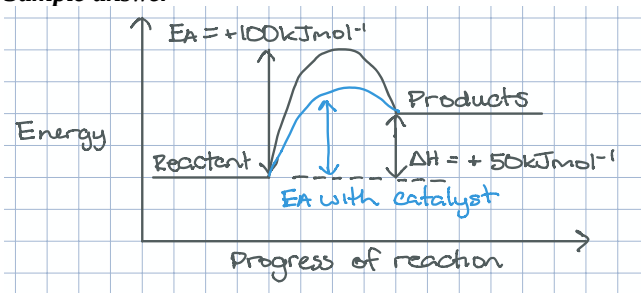
Sample answer

The colour of the mixture will become lighter. Silver nitrate will remove the thiocyanate ions. The system will react in such a way as to minimise these changes (Le Châtelier). Therefore, the reaction will generate more thiocyanate ions, causing the position of equilibrium to shift to the left and having fewer iron(III) thiocyanate (coloured) ions.

Question 22 (a)

Marking guidelines	Marks
• Gives general pattern of an endothermic reaction including labels • Demonstrates differences in energy using appropriate values and scale	2
• Draws the energy profile of an endothermic reaction	1

Sample answer



Question 22 (b)

Marking guidelines	Marks
• Shows a lower activation energy	1

Sample answer

See above in blue

Question 23 (a)

Marking guidelines	Marks
• Identifies exothermic reaction • Explains the effect of temperature on exothermic reactions • Refers to data from the table referencing LCP	3
• Addresses TWO of the above	2
• Addresses ONE of the above	1

Sample answer

The reaction equilibrium is exothermic. The data shows that as the temperature increases, the concentration of ammonia decreases, and the concentration of reactants increases. This is consistent with an exothermic equilibrium in which heat is a product. Le Chatelier's principle predicts that the addition of more heat will force the equilibrium towards the reactant side of the equilibrium to use up some of the added heat.

Question 23 (b)

Marking guidelines	Marks
• Explains optimum temperature referencing greater yield • Refers to activation energy	2
• Any relevant information	1

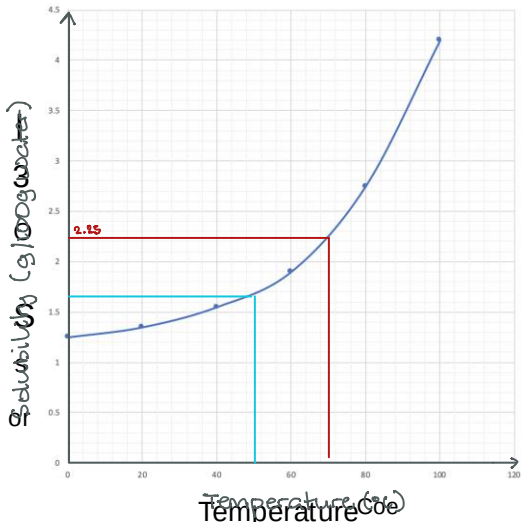
Sample answer

The data shows that lower temperatures favour higher yields of ammonia. If the temperature is too low, however, the rate of reaction will be too low and insufficient reactant molecules will have the energy needed to overcome the activation energy barrier. Thus, a moderate temperature is used as a compromise between these opposing factors.

Question 24 (a)

Marking guidelines	Marks
• Correctly calculates K_{sp} • Provides a fully labelled graph showing correct scale and line of best fit • Includes a relevant chemical equation	6
• Applies correct process to calculate K_{sp} • Provides a fully labelled graph showing correct scale and line of best fit • Includes a relevant chemical equation	5
• Provides some steps to calculate K_{sp} • Provides a labelled graph showing scale and line of best fit • Includes a relevant chemical equation	4
• Provides a substantially correct graph showing scale and line of best fit OR Plots some correct points and includes a relevant chemical equation	2-3
• Provides some basic features of the graph	1

Sample answer



$Ba(OH)_2(s) \rightarrow Ba^{2+}(aq) + 2OH^-(aq)$

Solubility is 2.25g/100mL or 22.5g/1L at 70°C

$n(Ba(OH)_2) = \frac{m}{mm}$

$= \frac{22.5}{137.3 + 16 + 1.008) \times 2}$

$= 0.131 mol$

$\therefore c = 0.131 mol/L$

$K_{sp} = [Ba^{2+}][OH^-]^2$

$= s \times (2s)^2$

$= 4s^3$

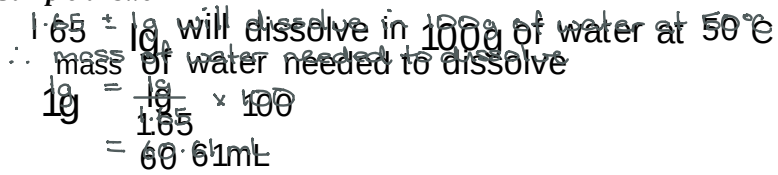
$= 4 \times (0.131)^3$

$= 0.0090$ or 6.90×10^{-2}

Question 24 (b)

Marking guidelines	Marks
• Correctly calculates minimum mass of water	1

Sample answer



Question 25

Marking guidelines	Marks
• Provides a detailed description of both theories • Considers an advantage AND a limitation for each theory • Includes a supporting equation for each theory	3
• Provides a general description of both theories • Considers an advantage or a limitation for each theory • Includes at least ONE relevant equation OR • Outlines an advantage and a limitation for each theory • Includes a supporting equation for each theory	2
• Provides some relevant information	1

Sample answer

Arrhenius noticed that the electrolysis of acids gave hydrogen at the cathode. He suggested that when dissolved in water, all acids ionise to form hydrogen ions.
For example: $H_2SO_4(aq) + H_2O(l) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$

Also, according to Arrhenius, strong acids were completely ionised in water whereas weak acids were only partially ionised. He suggested that when a base dissolved in water, hydroxide ions were formed. Acid base reactions involved hydrogen ions reacting with hydroxide ions to form neutral water. However Arrhenius could not explain why carbonates and some metal oxides were basic as they neutralised ions acids
For example: $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

The Bronsted-Lowry definition defines acids as proton (H^+) donors and bases as proton acceptors. Acids gave up a proton and become a conjugate base.
For example: $H_2SO_4(aq) + H_2O(l) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$
Acid Base conjugate acid conjugate base

This theory also more clearly defined the role of the solvent and explained why salts can be neutral, acidic, or basic

Question 26 (a)

Marking guidelines	Marks
• Correctly identifies an acidic AND basic oxide	1

Sample answer

CaO and SO_2

Question 26 (b)

Marking guidelines	Marks
• Writes a correct, balanced equation	1

Sample answer

$SO_2(g) + H_2O(g) \rightleftharpoons H_2SO_3(aq)$

Question 26 (c)

Marking guidelines	Marks
• Defines the term Amphoteric	1

Sample answer

Substances that act like an acid or base. Reacts with an acid or base. It does not accept or donate Hydrogen ions. (There is none to donate).

Question 27

Marking guidelines	Marks
• Correctly calculates pH • Correctly calculates total $[H_3O^+]$ or $[H^+]$ • Calculates $[H_3O^+]$ or $[H^+]$ for second dissociation • Correct Ka expression • Negligible value ignored	5
• Addresses FOUR of the criteria	4
• Addresses THREE of the criteria	3
• Addresses TWO of the criteria	2
• Addresses ONE of the criteria correctly	1

Sample answer

$[H_3O^+] = 0.089$ molL^{-1} (1:1 ratio)

$$K_a = \frac{[SO_4^{2-}][H_3O^+]}{[HSO_4^-]}$$

$$0.011 = \frac{x^2}{[HSO_4^-]} \quad x \leftarrow \text{negligible}$$

$$x^2 = 0.011 \times [HSO_4^-]$$
$$x^2 = 0.011 \times 0.089$$
$$x^2 = 0.000979$$
$$= 3.13 \times 10^{-2}$$

$$\therefore [H_3O^+] = 3.13 \times 10^{-2} + 0.089$$
$$= 0.120 \text{ mol}L^{-1}$$

$$\therefore pH = -\log[H^+]$$
$$= -\log(0.120)$$
$$= 0.91977$$
$$= 0.92$$

Question 28

Marking guidelines	Marks
• Balanced chemical equation • Uses correct volume of nitric acid • Calculates moles of barium hydroxide • Calculates correct concentration of nitric acid	4
• Addresses THREE of the criteria	3
• Addresses TWO of the criteria	2
• Provides any relevant calculations	1

Sample answer

$2HNO_{3(aq)} + Ba(OH)_{2(aq)} \rightarrow Ba(NO_3)_{2(aq)} + 2H_2O_{(l)}$

$v(HNO_3) = 18.13mL$ (Discard titration 1)

$n(Ba(OH)_2) = CV$
$= 0.12 molL^{-1} \times 0.025L$
$= 0.0030 mol$

$\therefore n(HNO_3) = 0.0030 mol \times 2$
$= 0.0060 mol$ (2:1 ratio)

$c(HNO_3) = \frac{n}{V}$
$= \frac{0.0060 mol}{0.01813 L}$
$= 0.0381 molL^{-1}$
$= 0.033 molL^{-1}$ (2sf)

Question 29 (a)

Marking guidelines	Marks
• Correctly explains using examples	2
• Correctly explains	1

Sample answer

Buffers are a mixture of a weak acid and its conjugate in equal concentrations which resists changes. HCl and NaCl are no conjugates. NaCl is a neutral substance and is too weak to interact with water to accept Hydrogen ion. Furthermore, HCl is a strong acid which completely ionises, therefore does not buffer.

Question 29 (b) Buffers

Marking guidelines	Marks
• Demonstrates with use of equations	2
• Explains without the use of equations	1

Sample answer

$CH_3COO^-(aq) + H_3O(aq) \rightleftharpoons CH_3COOH(aq) + H_2O(l)$
An increase in hydronium ions will result in a decrease in a decrease in the ethanoate ion. This results in the solution resisting a change in pH in according to Le Chatelier.

Question 30 (a)

Marking guidelines	Marks
• Correctly calculates ΔH with units • Uses correct significant figures	4
• Provides substantially correct working	3
• Provides some relevant steps	2
• Provides some relevant information	1

Sample answer

$Q = mC\Delta T$
$= 300g \times 4.18 Jg^{-1}°C^{-1} \times 20.5°C$
$= 25\,707 J$
$= 25.7 kJ$ per 1.15g ethanol

$\Delta H = \frac{25.7}{1.15} \times [(12.01 \times 2) + (1.008 \times 6) + 16]$
$= 1029.52 kJmol^{-1}$
$= 1.03 \times 10^3 kJmol^{-1}$

Question 30 (b)

Marking guidelines	Marks
• Correctly calculates Q • Correctly calculates mass used	2
• Provides some relevant information	1

Sample answer

$Q = mC\Delta T$
$= 300g \times 4.18 Jg^{-1}°C^{-1} \times 65°C$
$= 81510\ J$
$= 81.51\ kJ$ assuming no heat loss

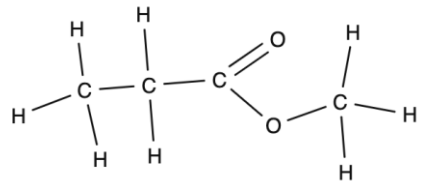
1360 kJ is released per 46.068 g (1 mol) ethanol

$m = \frac{81.51}{1360} \times 46.068$
$= 2.76g$ (if there is no heat loss
$\therefore m = 2.76g \times 2$
$= 5.52g$

Question 31 (a)

Marking guidelines	Marks
• Correctly names and draws the correct structure of the ester	2
• Names OR • Draws the structural formula	1

Sample answer



Methyl Propanoate

Question 31 (b)

Marking guidelines	Marks
• Any strong acid	1

Sample answer

Conc. Sulfuric acid or phosphorus pentoxide etc.

Question 31 (c)

Marking guidelines	Marks
• Correct justification	1

Sample answer

Heating under reflux increases the reaction rate (higher temperature) while preventing loss of reactants or products by vaporisation to outside.

Question 31 (d)

Marking guidelines	Marks
• Explains in terms of intermolecular forces and referring to H-bonds AND • Refers polarity AND • Relates back to strength of bonds	3
• Addresses TWO of the criteria	2
• Provides some relevant information	1

Sample answer
The ester has low polarity resulting in much weaker intermolecular forces than in pentanol and butanoic acid which both have polar OH groups. With an additional O atom butanoic acid is still more polar
Pentanol and butanoic acid also form hydrogen bonds.
The boiling points reflect the strengths of these intermolecular forces.

Question 32

Marking guidelines	Marks
• Compares thoroughly the uses, structures and properties of soap and • anionic synthetic detergents	4
• Compares soundly the uses, structures and properties of soap and anionic synthetic detergents	3
• Outlines correctly some similarities and/or differences between soap AND anionic detergents	2
• Outlines a property of a soap OR • Outlines a property of an anionic detergent	1

Sample answer
Soaps and anionic synthetic detergents are both classified as surfactants. In water, surfactants allow oil or dirt to form droplets (micelles), with the head of the surfactant on the outer surface of the micelle, attracted to the water, and the tail embedded in the grease or oil in the middle of the micelle. Because all surfactants have similar structures (hydrocarbon tail and polar or ionic head), all soaps and detergents are able to clean objects.

Soaps and anionic detergents both have similar structures (hydrocarbon tail and an anionic head). Soaps are made from natural fats and oils and have a carboxylate head, while anionic detergents are made synthetically and have anionic groups other than carboxylate groups as their heads.

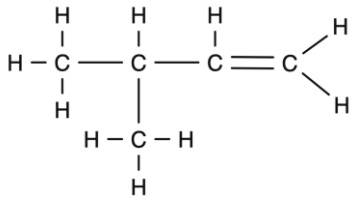
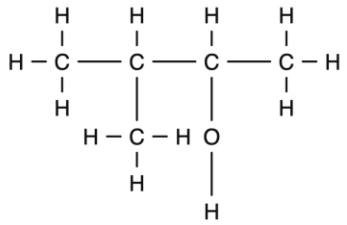
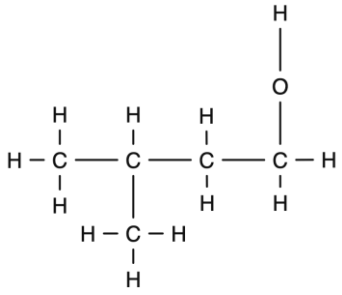
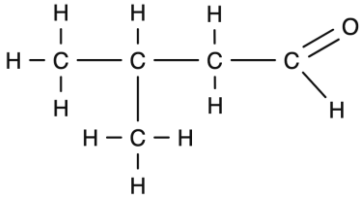
Soaps are biodegradable and useful in soft water for personal hygiene. However, soaps can form insoluble scum in hard water. For example, the carboxylate ion of soap can form precipitates with calcium ions according to the following equation:

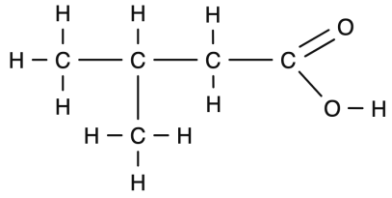
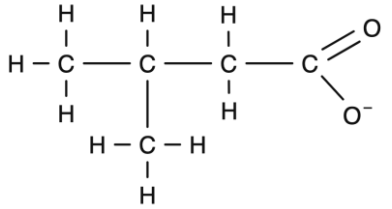
$2RCOO^-(aq) + Ca^{2+}(aq) \rightarrow (RCOO)2Ca(s)$

Detergents are more soluble than soaps. This makes them more useful as laundry detergents. The differences in structure of different surfactants determine their specific uses.

Question 33

Marking guidelines	Marks
• Correctly draws all structural formulas AND • Names and correctly justifies their response	6
• Correctly draws most structural formulas AND • Names and correctly justifies most of their response	4 - 5
• Correctly draws some structural formulas AND • Names and correctly justifies some of their response	3
• Identifies some characteristics (functional groups) of some structures	2
• Provides some relevant information	1

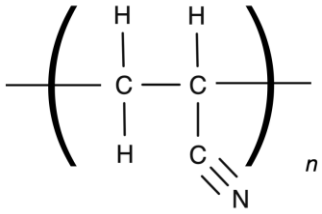
Compound	Structural	Justification
Compound A C_5H_{10}		Compound A is 3-methylbutene and undergoes a hydration reaction across the double bond to produce a primary and secondary alcohol
Compound B $C_5H_{12}O$		Compound B is 3-methylbutan-2-ol. The hydrogen is applied according to Markovnikov's Rule.
Compound C $C_5H_{12}O$		Compound C is 3-methylbutan-1-ol. This is the only other option and is oxidised by acidified chromate ions forming an aldehyde
Compound D $C_5H_{10}O$		Compound D is 3-methylbutanal, produced from the oxidation of acidified chromate.

Compound E $C_5H_{11}O_2$		Compound E is 3-methylbutanoic acid as aldehydes are easily oxidised further from acidified chromate ions
Compound F $C_5H_{11}O_2$		F is the 3-methylbutanoate ion. This is a result of a carboxylic acid (compound E) reacting with a carbonate to produce this salt, water, and CO_2.

Question 34 (a)

Marking guidelines	Marks
• Correctly shows structure (either repeating units OR within brackets)	1

Sample answer



Question 34 (b) Polymers 3-6

Marking guidelines	Marks
• Provides at least 3 properties AND • Reasons for those 3 properties in relation to its untended use.	3
• Provides at least 3 properties OR • Reasons for some properties in relation to its untended use.	2
• Identifies at least two properties required for its intended use	1

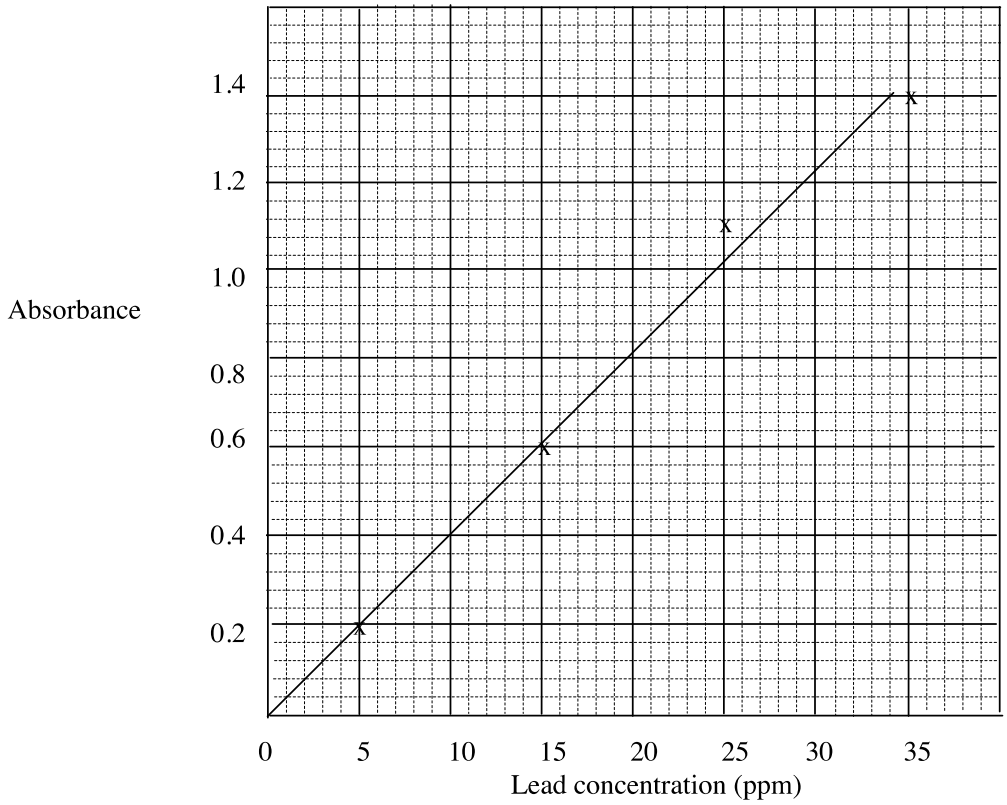
Sample answer

Polyacrylonitrile must be able to be drawn into long filaments, which can be knitted together to make the material for rugs blankets and clothes. It should have a high tensile strength, be lightweight and feel soft and warm. It. Should be possible to colour the polymer and the material must be able to be washed. The polymer should be resistant to attack from chemicals and should not deteriorate under sunlight

Question 35 (a)

Marking guidelines	Marks
• Correct units and labels X axis • Correct units and labels Y axis • Correct placements of points on graph • Correct drawing of line on graph	4

Sample answer



Question 35 (b)

Marking guidelines	Marks
• Calculates the maximum mass of lead that would be consumed, including units	2
• Calculates the maximum mass of lead that would be consumed but makes a simple error	1

Sample answer

$\text{Mass} = 1.8 \times 10^3 \times \frac{20}{10^6}$

$= 3.6 \times 10^{-2}\ g$

Question 36 (a)

Marking guidelines	Marks
• Provides a correct, balanced net ionic equation	2
• Provides a partially correct net ionic equation	1

Sample answer

$Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s)$

Question 36 (b)

Marking guidelines	Marks
• Suggests a suitable test for one of the ions AND • Provides the observation expected	2
• Suggests a suitable test OR • Provides the observation expected	1

Sample answer
The remaining metal ion in solution is Cu^{2+} which can be tested by a flame test. When present Cu^{2+} copper will turn the flame blue-green.

Question 37 (a)

Marking guidelines	Marks
• Correctly identifies both spectra	1

Sample answer
Spectra X = 2-methylhexanal
Spectra Y = benzaldahyde

Question 37 (b)

Marking guidelines	Marks
• Identifies THREE or more possible fragments for 2-methylhexanal AND identifies THREE or more possible fragments for benzaldehyde	4
• Identifies TWO possible fragments for 2-methylhexanal AND identifies TWO possible fragments for benzaldehyde	3
• Identifies TWO possible fragments for 2-methylhexanal AND a possible fragment for benzaldehyde OR • Identifies TWO possible fragments for benzaldehyde AND a possible fragment for 2-methylhexanal	2
• ONE possible fragment for each spectrum	1

Sample answer
- *2-methylhexanal: 29 = CHO, 43 = $CH_3CH_2CH_2$, + 100 = $CH_3CH_2CH_2CH(CH_3)CHO^+$.*
- *Benzaldehyde: 29 = CHO, 77 = C_6H_5, 106 = $C_6H_5CHO^+$*