CAMBRIDGE

Study & Master

Support Pack | Grade 12

CAPS

Physical Sciences

Chemistry exemplar examination

This support pack for the **Chemistry exemplar examination paper** for the **Physical Sciences Grade 12 CAPS curriculum** provides valuable practice in writing the examinations. An answer memo is provided separately for you to check learners' answers. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

Cambridge University Press Africa is a proudly South African publisher – we are providing this material in response to the need to support teachers and learners during the school shutdown and for the remainder of the 2020 school year.

For more information on our *Study & Master* CAPS-approved textbooks and valuable resource materials, visit ***www.cambridge.org***

We are all in this together!

Chemistry exemplar examination paper

SECTION A

Question 1

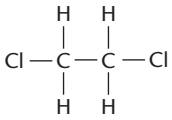
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number in the ANSWER BOOK.

1.1 Which ONE of the following homologous series does NOT contain a CARBONYL group (=C=O)?

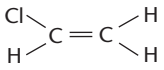
A Aldehydes
B Alcohols
C Carboxylic acids
D Esters (2)

1.2 The likely product of an addition reaction involving chlorine and an organic compound is:

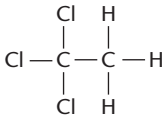
A



B



C



D Cl–C≡C–Cl (2)

1.3 A simple reaction scheme is shown below.

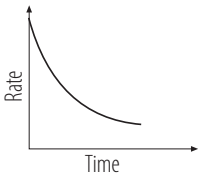
$$CH_3–CH=CH_2 \xrightarrow{HBr(g)} X \xrightarrow{NaOH(aq)} Y + NaBr$$

The formula for Y is:

A $CH_3–CH_2–COOH$
B $CH_3–CHBr–CH_2–OH$
C $CH–_3CHOH–CH_3$
D $CH_3–CHOH–CH_2–Br$ (2)

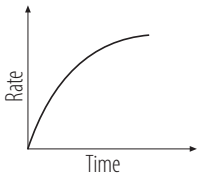
1.4 Magnesium ribbon reacts with dilute hydrochloric acid. Which one of the following graphs best describes the relationship between the rate of reaction and time as the reaction proceeds?

A



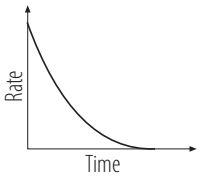
A

B



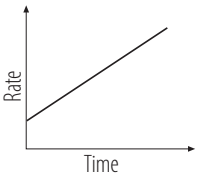
B

C



C

D



D

(2)

1.5 Methanol (CH_3OH) can be produced by the following reaction:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) + \text{energy}$$

The conditions necessary to maximise the yield of CH_3OH are:

A high temperature and low pressure
B high temperature and high pressure
C low temperature and low pressure
D low temperature and high pressure. (2)

1.6 An acid solution exactly neutralises a base solution according to the equation:

$$\text{acid} + \text{base} \rightarrow \text{salt} + \text{water}$$

If the neutralised mixture contains the salt NaCl, the pH of the aqueous mixture will be closest to:

A 9
B 3
C 7
D 11 (2)

1.7 A solution that is formed by combining 200 cm^3 of 0,15 $mol \cdot dm^{-3}$ HCl with 300 cm^3 of 0,9 $mol \cdot dm^{-3}$ NaOH has a $[OH^-]$ of:

A 0,24 $mol \cdot dm^{-3}$
B 0,27 $mol \cdot dm^{-3}$
C 0,8 $mol \cdot dm^{-3}$
D 0,48 $mol \cdot dm^{-3}$ (2)

1.8 Which ONE of the following half-reactions occurs at the CATHODE during the electrolysis of a solution of $CuCl_2$?

A $Cu^{2+} + 2e^- \rightarrow Cu$
B $Cu \rightarrow Cu^{2+} + 2e^-$
C $2Cl^- \rightarrow Cl_2 + 2e^-$
D $Cl_2 + 2e^- \rightarrow 2Cl^-$ (2)

1.9 You are supplied with the following half-cell: $Fe(s)/Fe^{3+}(1\ mol \cdot dm^{-3})$.
This half-cell is to be used to produce a highest possible potential difference.
The most suitable half-cell combination for this purpose is:

A Pt, $SO_2(g)/SO_4^{2-}(1\ mol \cdot dm^{-3})$

B $Mg(s)/Mg^{2+}(1\ mol{\cdot}dm^{-3})$
C $Pt, Br_2(g)/Br^-(1\ mol{\cdot}dm^{-3})$
D $Co(s)/Co^{2+}(1\ mol{\cdot}dm^{-3})$ (2)

1.10 Choose the correct combination of plant nutrients according to the headings in the table:

	Non-mineral nutrients	Primary mineral nutrients
A	C, H, O	N, P, K
B	C, H, N	Ca, P, K
C	N, H, O	S, P, Ca
D	N, P, K	C, H, O

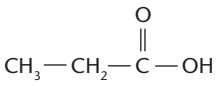
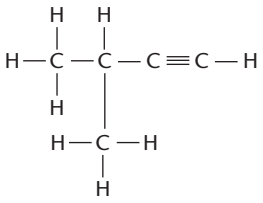
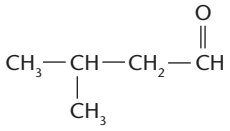
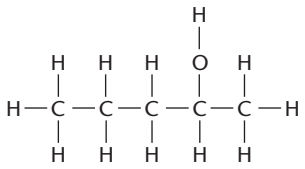
(2)

[20]

SECTION B

Question 2

The letters A to F in the table below represent six organic compounds.

A		D	Ethyl methanoate
B	Pent-2-ene	E	
C		F	

2.1 From the list in the table, write down the letter(s) (a compound may be used more than once) representing:

2.1.1 two compounds that can react to form an ester (2)

2.1.2 two compounds that are isomers (2)

2.1.3 two compounds that are unsaturated hydrocarbons (2)

2.1.4 a compound that has the general formula C_nH_{2n-2} (1)

2.1.5 an aldehyde. (1)

2.2 Write down:

2.2.1 the IUPAC name of compound F (2)

2.2.2 the name of the homologous series of compound A. (1)

2.3 Write down the structural formula of compound D. (2)

[13]

Question 3

The table below shows the boiling points of four organic compounds of comparable molecular mass, represented by the letters A to D.

	Compound	Molecular mass ($g \cdot mol^{-1}$)	Boiling point (°C)
A	Pentane	72	36
B	Butanal	72	75
C	Butan-1-ol	74	117
D	Propanoic acid	74	141

3.1 Compound A can be found in fuel.

3.1.1 Is compound A in the gas, liquid or solid phase at 25 °C? (1)

3.1.2 How will the boiling point of an isomer of compound A compare to that of compound A? Write down HIGHER THAN, LOWER THAN or EQUAL TO. Explain your answer by referring to molecular structure, intermolecular forces and the energy needed. (4)

3.1.3 Using molecular formulae, write down the balanced equation for the combustion of compound A in excess oxygen. (3)

3.1.4 Compound A has a lower boiling point than compound B. Give reasons for this difference in boiling points by referring to the following:

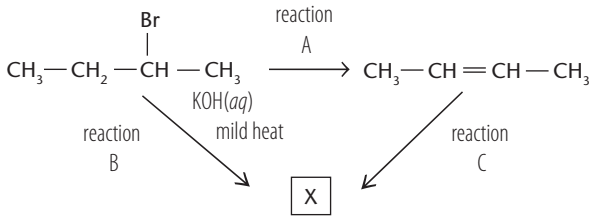
- structural differences between the two compounds
- polarity. (2)

3.2 Consider the boiling points of compounds C and D. Give a reason for this difference in boiling points by referring to the intermolecular forces present in each of these compounds. (2)

[12]

Question 4

4.1 In the flow diagram below, A, B and C represent three different types of organic reactions. X represents an organic compound.



4.1.1 Name the type of reaction represented by A. (1)

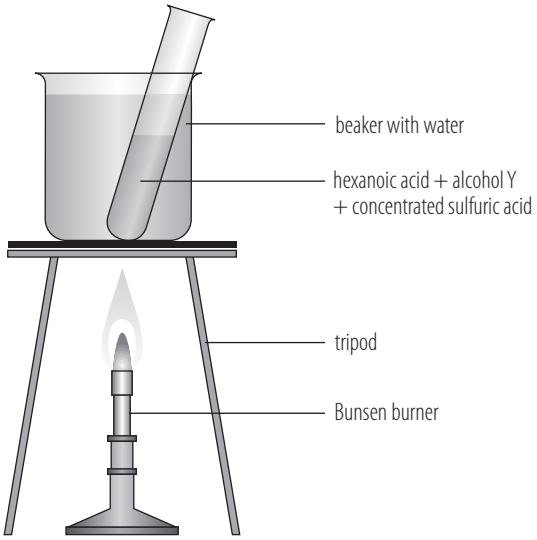
4.1.2 State two reaction conditions needed for reaction A. (2)

4.1.3 Reaction B represents a substitution reaction. Write down the structural formula of compound X formed in this reaction. (2)

4.1.4 Apart from the organic reactant, write down the name of the other reactant needed in reaction C. (1)

4.1.5 Name the type of reaction represented by C. (1)

4.2 Hexanoic acid is responsible for the unique odour associated with goats. When hexanoic acid reacts with alcohol Y, propyl hexanoate is formed, which is used commercially as a fruit flavour. Learners set up the apparatus shown below to prepare propyl hexanoate in a laboratory.



4.2.1 Write down the IUPAC name of alcohol Y. (2)

4.2.2 What is the role of the sulfuric acid in the above reaction? (1)

4.2.3 Use structural formulae to write down a balanced equation for the preparation of propyl hexanoate. (5)

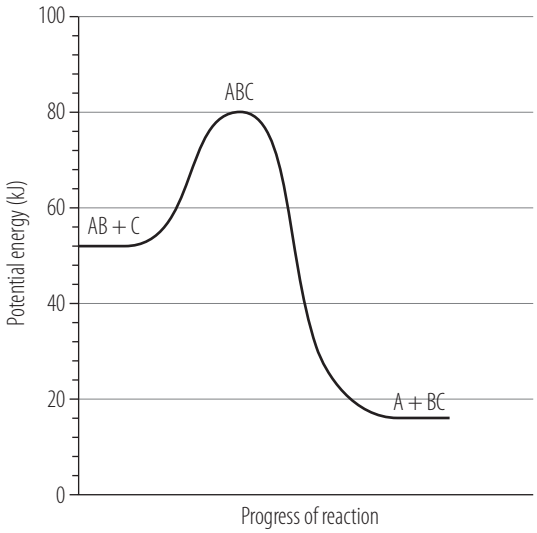
4.2.4 Give a reason why the test tube and its contents are heated in a water bath and not directly over the flame. (1)

4.2.5 Write down ONE use of esters in the food manufacturing industry. (1)

[17]

Question 5

Use the following potential energy diagram to answer the questions below.



5.1 Determine the activation energy for the forward reaction. (1)

5.2 What is the enthalpy change for the:

5.2.1 forward reaction (1)

5.2.2 reverse reaction? (1)

5.3 Which bond is stronger, A–B or B–C? (1)

5.4 Is the reaction A + BC → AB + C exothermic or endothermic? (1)

5.5 Suppose compound AB is a gas and element C is a solid. What effect would grinding C into a fine powder have on the graph shown here? (1)

5.6 To speed up the reaction a catalyst is added to the reaction mixture. The catalyst changes the activation energy by providing a different route for the reaction. Redraw the potential energy graph and indicate the activation energy with a catalyst. (2)

5.7 What is the influence of the catalyst on the enthalpy change of the reverse reaction? (1)

5.8 Describe what happens with two reactant particles that collide with less energy than the activation energy. (1)

5.9 Give a possible reason why two reactant particles that collide with more energy than the activation energy do not react. (1)

[11]

Question 6

Sulfuric acid is produced industrially using the Contact process. A crucial stage in the production is the reversible reaction between sulfur dioxide and oxygen to form sulfur trioxide:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197\ \text{kJ·mol}^{-1}$$

This reaction is carried out at 450 °C and at approximately 1–2 atm pressure. Excess air (oxygen) is mixed with sulfur dioxide and the gases are passed through a catalyst bed. The catalyst used is vanadium(V) oxide, which is formed into hollow cylinders. Having passed through the catalyst bed, the equilibrium mixture of gases enters a heat exchanger, which cools the gases down. The gases then pass through another catalyst bed, followed by another heat exchanger. This process is repeated several times.

6.1 Which conditions of temperature and pressure would produce the highest yield of sulfur trioxide? (2)

6.2 The temperature used, 450 °C, is not low. Why is such a temperature used, despite its effect on the position of equilibrium? (2)

6.3 Suggest reasons why a pressure higher than 1–2 atm is not maintained during this reaction. (2)

6.4 Why should the reacting gas mixture contain an excess of air (which contains oxygen)? (2)

6.5 A vanadium-based catalyst, vanadium(V) oxide, is used.

6.5.1 Give the formula of the catalyst that is used. (1)

6.5.2 Why do you think hollow cylinders of the catalyst are used? (1)

6.5.3 What effect does the catalyst have on the equilibrium reaction? (1)

6.6 When the gases pass through the catalyst bed and form sulfur trioxide, the temperature increases to greater than 450 °C. Heat exchangers are used to cool the gases back down to 450 °C, before passing them through the catalyst again.

6.6.1 Why does the temperature increase when sulfur trioxide is formed? (1)

6.6.2 Why are heat exchangers used to cool the gases back to 450 °C? (1)

6.6.3 Why are the gases cycled several times through the catalyst and heat exchangers? (1)

6.7 In an experiment, a mixture of 1,5 mole of sulfur dioxide and 0,9 mole of oxygen is introduced to a 10 dm^3 container at 500 °C. When equilibrium is reached, it is found that 80% of sulfur dioxide is converted to sulfur trioxide. Calculate the equilibrium constant, K_c, at 500 °C. (6)

[20]

Question 7

A solution containing 0,7 g of sodium hydroxide in a 35 cm^3 solution is mixed with 15 cm^3 of a 0,5 $mol \cdot dm^{-3}$ HCl solution. The balanced equation for the reaction is:

$$HCl + NaOH \rightarrow NaCl + H_2O$$

7.1 Determine the amount of mole present in the solutions of:

7.1.1 NaOH (2)

7.1.2 HCl. (2)

7.2 Did this reaction reach the equivalence point? Explain. (2)

7.3 Calculate the pH of the final solution. (5)

[11]

Question 8

Perchloric acid ($HClO_4$) is a strong acid. 20 cm^3 of this acid with concentration 0,06 $mol \cdot dm^{-3}$ (in a conical flask) is titrated with 0,04 $mol \cdot dm^{-3}$ KOH in a burette.

8.1 Explain what is meant by a strong acid. (1)

8.2 Write down the overall reaction that occurs during the titration. (2)

8.3 What volume of NaOH solution must be added to reach the equivalence point of the titration? (4)

8.4 Which substance(s) (except for water) are present in the flask after some NaOH has been added but before the equivalence point has been reached? (2)

8.5 Which substance(s) (except for water) are present in the flask at the equivalence point of the titration? (1)

8.6 What is the pH of the solution in the flask at the equivalence point of the titration? (1)

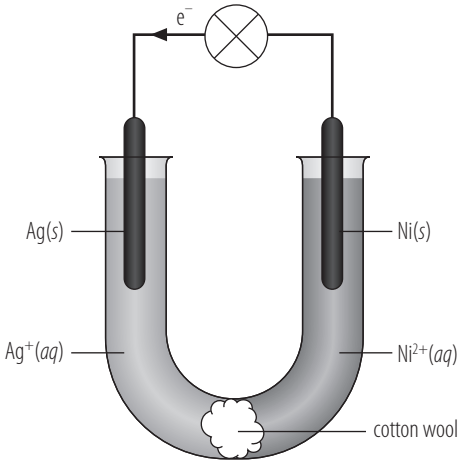
8.7 The following label is found on the bottle containing the potassium hydroxide. What does this label tell you about the base?

(1)

[12

Question 9

The following diagram is a representation of an electrochemical cell under standard conditions. A suitable bulb in the external circuit glows brightly and the electron flow is indicated.



9.1 State the standard conditions applicable to this cell. (2)

9.2 Write down the symbolic notation for this cell. (3)

9.3 After some time it is noted that the brightness of the bulb decreases. State possible reasons why the cell goes 'flat'. (2)

9.4 Which electrode will show a loss in mass? Give a half-reaction to prove your choice. (2)

9.5 Calculate the emf of this cell. (3)

[12]

Question 10

Explain the following scenarios by using chemistry principles.

10.1 Cavities in teeth are filled with gold or silver/mercury amalgam rather than with iron or zinc. (2)

10.2 If a person has an amalgam teeth filling, why might that person experience pain when biting onto a piece of aluminium foil left on a chocolate? (3)

[5]

Question 11

Different processes used in the preparation of fertilisers are represented in the flow diagram on the next page.

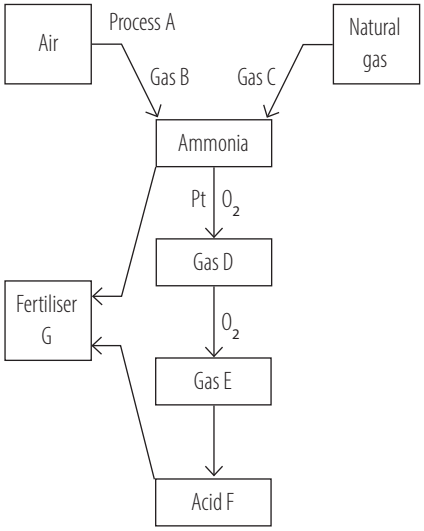
11.1 Write down the name of process A. (2)

11.2 Write down the formula of:

11.2.1 gas B (1)

11.2.2 gas C (1)

11.2.3 acid F. (1)



11.3 Gases D and E are prepared during the Ostwald process. Write down:

11.3.1 the name given to the preparation of gas D from ammonia (1)

11.3.2 the balanced equation for the preparation of gas D (3)

11.3.3 the formula of gas E. (1)

11.4 Fertiliser G is prepared by reacting ammonia with acid F.

11.4.1 Write down the name of fertiliser G. (1)

11.4.2 Write down two properties of fertiliser G that makes it suitable for use as a fertiliser. (2)

11.5 The rapidly increasing human population is resulting in an ever-increasing demand for food. To meet the demand, farmers apply fertiliser to the same cultivated land each year.

11.5.1 Explain why farmers have to apply fertilisers to their land each year. (2)

11.5.2 Write down one negative impact that over-fertilisation can have on humans. (2)

[17]

TOTAL:150