NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

TECHNICAL SCIENCES: PAPER II

Time: 3 hours 150 marks

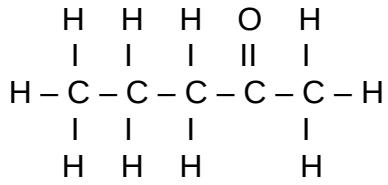
PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 10 pages and a Data Sheet of 4 pages (i–iv). Please check that your question paper is complete.
2. This paper consists of 11 questions. Answer ALL the questions in the Answer Book.
3. Please start each question on a new page in your Answer Book.
4. Number your answers exactly as the questions are numbered in the question paper.
5. Leave ONE line open between sub-questions, e.g. between QUESTION 2.2 and QUESTION 2.3.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEET.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a MINIMUM of TWO decimal places.
11. Give brief motivations, discussions, etc. where required.
12. Read the questions carefully.
13. Do not write in the margin.
14. It is in your own interest to write legibly and to present your work neatly.

QUESTION 1

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Choose the correct answer and write only A, B, C or D next to the question number (1.1–1.10) in your Answer Book.

1.1 To which homologous series does the following compound belong?



A Aldehyde
B Ketone
C Ester
D Carboxylic Acid (2)

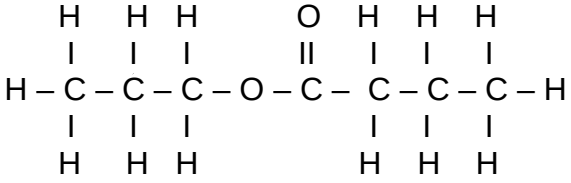
1.2 Which one of the following compounds will definitely be an alcohol?

A $C_2H_4O_2$
B $C_3H_6O_2$
C C_3H_7O
D C_3H_8O (2)

1.3 The following intermolecular forces are found between carboxylic acids:

A Dipole-Dipole bonds
B Hydrogen bonds
C Dispersion forces
D London Forces (2)

1.4 What is the IUPAC name of the following ester?



A Propyl butanoate
B Butyl propanoate
C Butanoic acid
D Propene butanoate (2)

1.5 When will there be no deviation of the light ray when it moves from one medium to another?

A When the ray does not enter the new medium perpendicularly.
B When the ray enters the new medium at an angle of incidence of 40°.
C When the second medium is denser than the first medium.
D When the incident ray is perpendicular to the boundary between the two mediums. (2)

1.6 Dispersion of white light is caused by:

A Total internal reflection of white light.
B The differences in speed in white light.
C The angle of incidence of the white light.
D The type of medium the white light is moving through. (2)

1.7 Which of the following statements on electromagnetic waves is not true?

A Electromagnetic rays are produced when charged particles accelerate.
B Electromagnetic rays need a medium for propagation.
C Electromagnetic rays have a dual nature.
D Electromagnetic waves can be polarized. (2)

1.8 A student places a copper wire into a silver nitrate solution. After about 10 minutes, silver crystals form on the copper wire. Which statement is correct?

A The Ag^+ ion is oxidized.
B Reduction takes place and Ag is formed.
C Ag^+ ion acts as the reducing agent and Ag is formed.
D Cu is reduced, loses $2e^-$ and Cu^{2+} ions are formed. (2)

1.9 A student sets up a silver/iron electrochemical cell. The solution that would be suitable for the salt bridge would be:

A $Mg(OH)_2$
B NaCl
C KNO_3
D $MgCO_2$ (2)

1.10 A certain standard electrochemical cell can be represented as follows:

$Pt, I^- / I_2 // Fe^{3+} / Fe^{2+}, Pt$

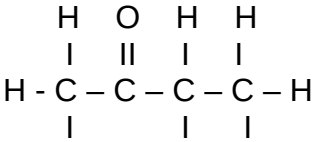
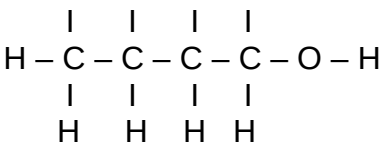
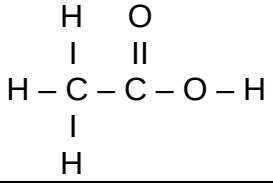
The oxidizing agent is

A I_2
B I^-
C Fe^{3+}
D Fe^{2+} (2)

[20]

QUESTION 2 (Start on a new page.)

The letters A to F in the table below represent six organic compounds. Use these compounds to answer the questions that follow.

A		**B**	C_3H_7Cl
C	C_4H_8	**D**	
E	Propanal	**F**	

2.1 Write the IUPAC name of:

2.1.1 F (2)

2.1.2 D (2)

2.2 2.2.1 Define the term *functional isomer.* (2)

2.2.2 Write down the letters of the two compounds that have the same functional group. (2)

2.2.3 Name the two homologous series that are formed when this functional group changes position on the chain. (2)

2.3 Name the type of addition reaction when **compound C** reacts with an excess of water (H_2O) in the presence of an acidic catalyst to form **compound D**. (1)

2.4 Draw the structural formula of:

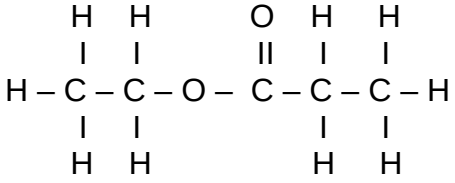
2.4.1 B (2)

2.4.2 E (2)

2.5 Define an *unsaturated hydrocarbon.* (2)

2.6 Write down the letter of an unsaturated hydrocarbon in the table. (1)

2.7 Name the following ester:

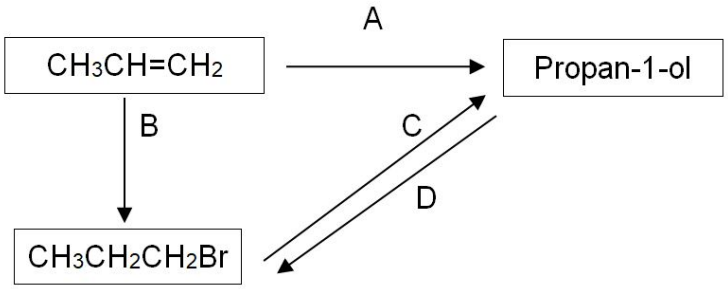


(2)

[20]

QUESTION 3 (Start on a new page.)

When doing some experiments, John found that there were two or three methods to prepare a certain haloalkane. Study the flow chart below and use it to answer the following questions.



3.1 Would the reaction taking place in reaction B be substitution halogenation or addition halogenation? Give a reason for your answer. (2)

3.2 Name the anorganic substance used in reaction B. (1)

3.3 Give the name of the base used in reaction C to form propan-1-ol. (1)

3.4 Use structural formulae to write a balanced equation for reaction D. (3)

3.5 What type of substitution reaction takes place at D? (1)

3.6 When reaction A takes place there are two reaction conditions. Name one of them. (1)
[9]

QUESTION 4 (Start on a new page.)

Study the table below that compares different homologous series and their melting points and use it to answer the following questions.

Organic compound	**Melting point (°C)**
Pentane	–129,8
Pentanol	50
Pentene	–106

4.1 Define the term *melting point.* (2)

4.2 Which substance in the table above has the lowest melting point? Give an explanation for your answer with reference to intermolecular forces. (3)

4.3 Explain the term *vapour pressure.* (2)

4.4 Referring to the table above, which compound will have the lowest vapour pressure? Give a reason for your answer. (3)

4.5 When comparing molecules from the same homologous series, for example alkanes, what factors will influence the boiling point? Name two factors and explain how the factors will influence the boiling point. (3)

[13]

QUESTION 5 (Start on a new page.)

5.1 What is the difference between a monomer and a polymer? (2)

5.2 Are reusable bottles made from high-density polythene or low-density polythene? (1)

5.3 When (an) organic molecule(s) react(s) in an abundant amount of oxygen, we call it … (1)

5.4 Use molecular formulae and write a balanced reaction for when butane gas is used in camping stoves to heat or cook food. (2)

[6]

QUESTION 6 (Start on a new page.)

Optical fibres are thin plastic tubes with polished plastic pieces inside that are used to transmit light over distances. They make use of a phenomenon called total internal reflection.

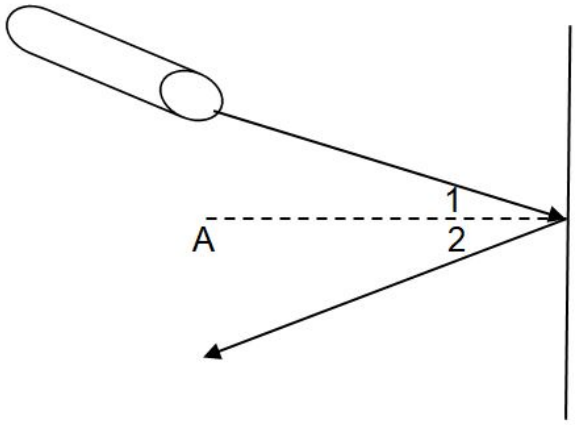
6.1 6.1.1 Give the definition of *total internal reflection*. (2)

6.1.2 What are the conditions for total internal reflection? (2)

6.1.3 Give one other optical instrument that makes use of total internal reflection. (1)

6.2 When an object is reflected in a mirror the image has certain properties. Name two of these properties. (2)

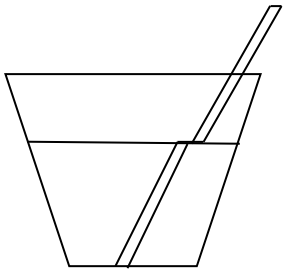
6.3 Consider the following figure of a ray of torch light that is shone onto a mirror and answer the following questions.



6.3.1 If angle 1 = 45°, what would the size of angle 2 be? (1)

6.3.2 What is the line at A called? (2)

6.4 The figure below shows a straw in a glass of water. Use it to answer the following questions.



6.4.1 What do we call the phenomenon of light illustrated in the sketch above? (2)

6.4.2 For this phenomenon of light to take place, must the light move from a dense to more dense medium or from a dense to a less dense medium? (2)

6.4.3 Does the speed of the light change in this phenomenon or does the frequency of the light change? (2)

[16]

QUESTION 7 (Start on a new page.)

7.1 Give the name of the phenomenon when white light breaks up into the different component colours. (2)

7.2 Name the seven different colours that make up white light. (3)

7.3 Red light has a wavelength of 700 nm in a vacuum. If the speed of light is 3×10^8 m·s^{-1}, calculate the frequency of red light in a vacuum. (3)

7.4 Explain by referring to frequency and wavelength why violet light is bent more than red light when light moves through a prism and breaks up into its different component colours. (3)

7.5 What type of lens will a short-sighted person use in their spectacles? (2)

7.6 Draw a ray diagram to show the path of a light ray through a concave lens. (3)

[16]

QUESTION 8 (Start on a new page.)

8.1 Define an electromagnetic wave. (2)

8.2

satellite communications	night-vision devices
sunburn	detect hidden weapons
treatment of cancer	

Use the words in the table above to complete the following sentences. Write only the number and the words from the table in your Answer Book.

8.2.1 Ultraviolet rays are responsible for …

8.2.2 Gamma rays are used for the …

8.2.3 Infrared rays are used in …

8.2.4 Microwaves are used for … (4)

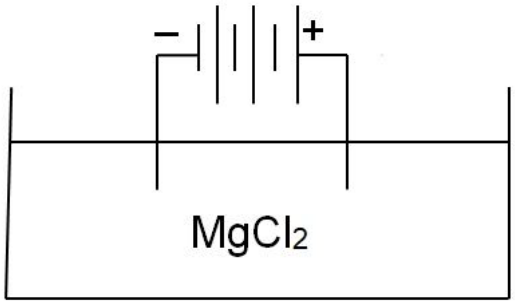
8.3 8.3.1 A gamma ray photon has a wavelength of 1,2 pm. Calculate the energy of that photon. (3)

8.3.2 Why are gamma rays considered dangerous? (2)

[11]

QUESTION 9 (Start on a new page.)

In the process of refining titanium, an electrolytic cell with a solution of magnesium chloride is used. The cell is set up as follows:



9.1 What is a redox reaction? (2)

9.2 Is the positive pole of the cells connected to the anode or the cathode? Motivate your answer by referring to oxidation reduction and electron transfer. (3)

9.3 What would be observed at the negative electrode? Explain your observation. (2)

9.4 What type of energy transfer takes place in this electrolytic cell? (2)

9.5 Write down a balanced equation for the reaction that takes place in this cell. (3)
[12]

QUESTION 10 (Start on a new page.)

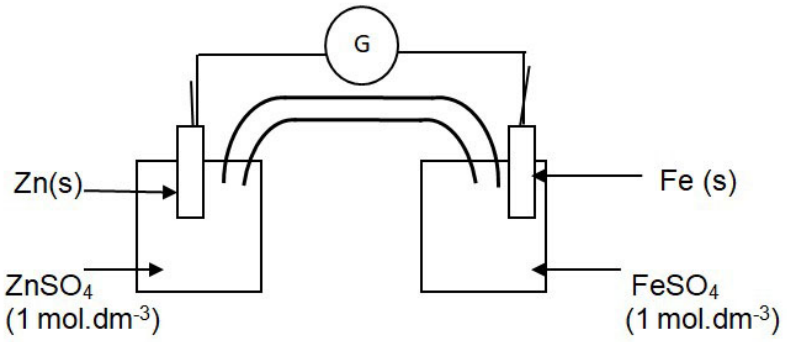
10.1 Define a *galvanic cell.* (2)

10.2 In an electrolytic cell the reacting components are in one glass container. In a galvanic cell the reacting components are placed in separate containers that are called half-cells. These half-cells are connected by a salt bridge.

10.2.1 Give an example of a substance that may be used in the salt bridge. Explain why you would use this substance. (2)

10.2.2 Give a function of the salt bridge in a galvanic cell. (2)

10.3 Zinzi sets up an experiment as shown. She uses a zinc plate with a Zn solution in one half cell and an iron plate in the Fe solution in the other half cell.



10.3.1 For accurate results standard conditions are required for the cell. What is the standard temperature for this cell? (1)

10.3.2 Write a balanced half reaction for the reaction at the anode. (2)

10.3.3 Is this a reduction half-reaction or an oxidation half-reaction? (1)

10.3.4 Use the Table of Standard Electrode Potentials to determine whether the redox reaction for this cell will take place spontaneously or not. Make use of a calculation to prove your answer. (4)

10.3.5 Explain your answer to Question 10.3.4. (2)

10.4 A standard voltaic cell is set up with magnesium in $Mg(NO_3)_2$ and silver in $AgNO_3$. Use the Table of Standard Electrode Potentials to answer the following questions.

10.4.1 Identify the strongest reducing agent. (1)

10.4.2 Which substance is reduced? (1)

10.4.3 Write the standard cell notation for this cell. (3)

[21]

QUESTION 11 (Start on a new page.)

Due to the energy crisis in South Africa and over the world, alternative sources of energy must be found.

11.1 Explain what is meant by renewable energy. (2)

11.2 What is a photovoltaic cell? (2)

11.3 Name two advantages of the photovoltaic cell. (2)

[6]

Total: 150 marks