

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

SEPTEMBER 2018

TECHNICAL SCIENCES P2

MARKS: 150

TIME: 3 hours



This question paper consists of 17 pages, including 4 data sheets.

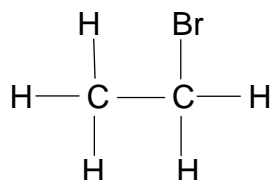
INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWERBOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number your answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
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 et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for eg. 1.11 E.

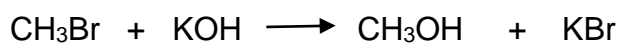
1.1 Study the structural formula of an organic compound below.



The homologous series to which the compound belongs is ...

- A alkanes.
- B ketones.
- C aldehydes.
- D haloalkanes. (2)

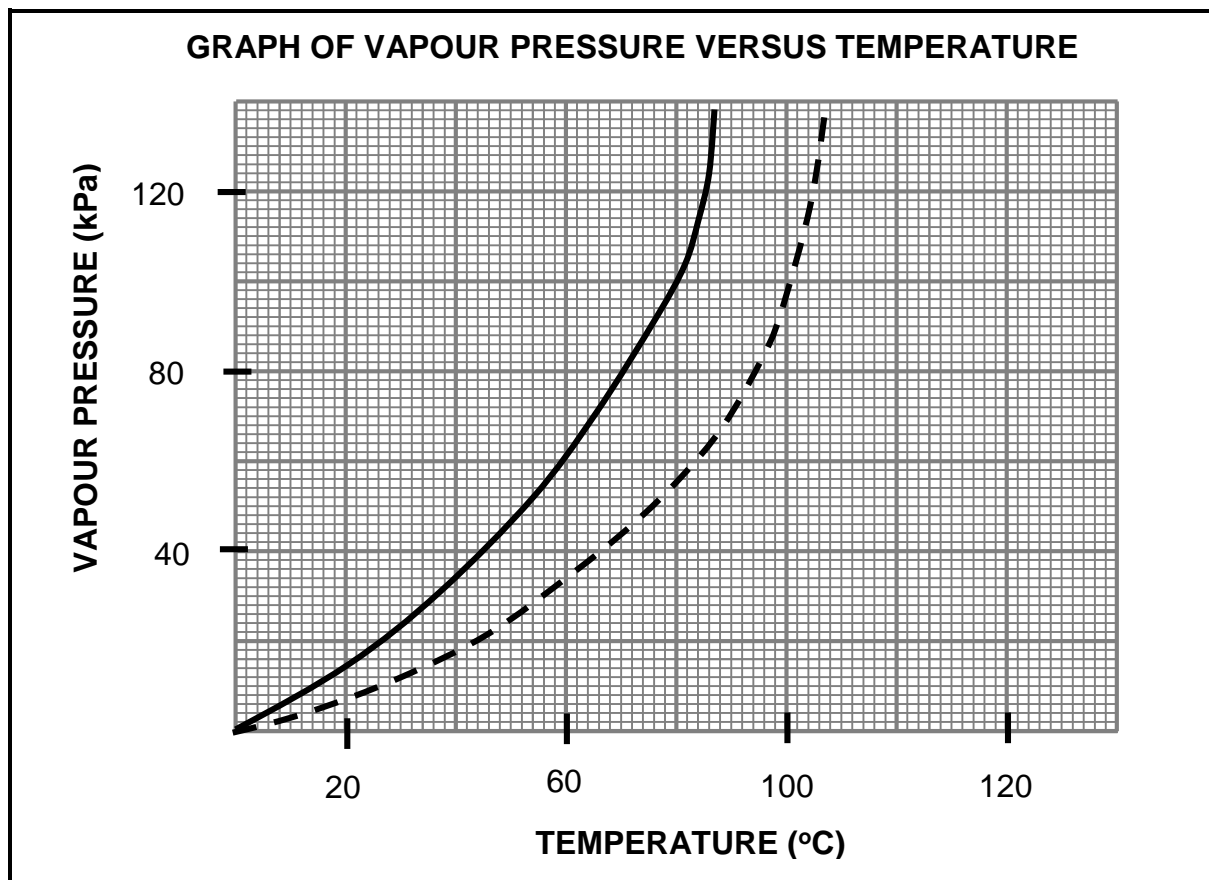
1.2 Consider the reaction:



The type of reaction taking place is ...

- A addition.
- B hydration.
- C substitution.
- D combustion. (2)

- 1.3 Study the vapour pressure versus temperature graphs for a secondary and a tertiary alcohol. Both compounds have the molecular formula $C_4H_{10}O$. The atmospheric pressure is 100 kPa.



Which ONE of the following is the boiling point of the TERTIARY alcohol?

- A 80 °C
- B 70 °C
- C 100 °C
- D 110 °C

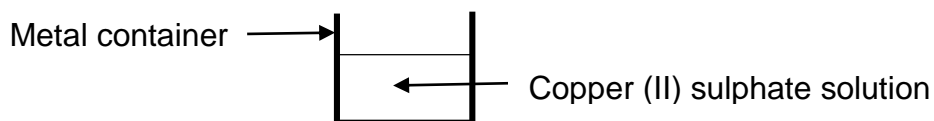
(2)

- 1.4 In a redox reaction a reducing agent always:

- A Loses electrons
- B Gains electrons
- C Undergoes reduction
- D Undergoes a decrease in oxidation number

(2)

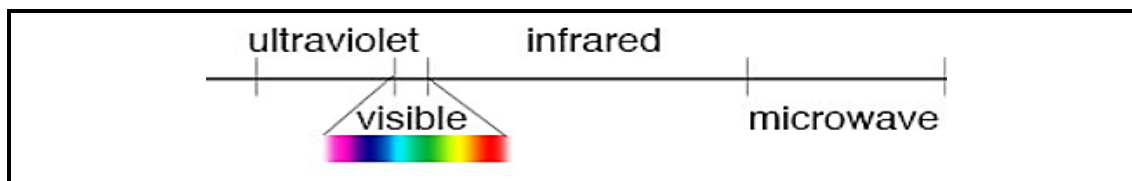
- 1.5 A Technical science learner wants to store copper (II) sulphate solution CuSO_4 in a metal container. The container must not develop a leak due to a chemical reaction between the metal and the solution.



Which ONE of the following metals must the learner use as the container?

- A Al
 - B Ni
 - C Ag
 - D Sn (2)
- 1.6 Which ONE of the following CORRECTLY describes the energy change in an electrolytic cell?
- A Electrical energy changes to chemical energy.
 - B Electrical energy changes to mechanical energy.
 - C Chemical energy changes to electrical energy.
 - D Chemical energy to mechanical energy. (2)
- 1.7 The image of a candle is found to be 5 cm behind a flat mirror.
- The distance between the candle and the mirror is ...
- A 0 cm.
 - B 5 cm.
 - C longer than 5 cm.
 - D shorter than 5 cm. (2)
- 1.8 The bending of light as it moves from one medium to another called:
- A Dispersion
 - B Diffraction
 - C Refraction
 - D Reflection (2)

1.9 Consider the section of the electromagnetic spectrum below.

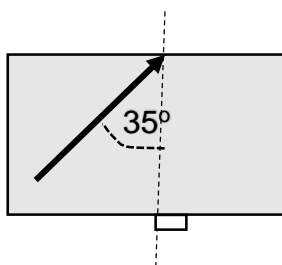


Which ONE of the electromagnetic radiations shown in the diagram above has the longest wavelength?

- A Infrared
- B Ultraviolet
- C Microwave
- D Visible light

(2)

1.10 A ray of light passes from glass to air as shown in the diagram below.



The critical angle for glass is 38° .

The light ray will undergo the following:

- A Reflection
- B Total internal reflection
- C Refraction towards the normal
- D Refraction away from the normal

(2)
[20]

QUESTION 2 (Start on a NEW page.)

The letters **A** to **F** represent six organic compounds.

A	$\text{HC} \equiv \text{C}-\text{CH}_2-\text{CH}_3$	B	Polythene
C	2-chloro-2-methylpropane	D	$\text{CH}_3\text{CH}_2-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2\text{CH}_3$
E	$\begin{array}{ccccc} & \text{H} & & \text{O} & & \text{H} \\ & & & & & \\ \text{H} & -\text{C} & - & \text{C} & - & \text{C} & -\text{H} \\ & & & & & \\ & \text{H} & & & & \text{H} \end{array}$	F	$\begin{array}{ccccccc} & & & & & \text{CH}_3 & & \text{O} & & \text{H} \\ & & & & & & & & & / \\ \text{CH}_3 & \text{CH} & \text{CH} & - & \text{CH} & - & \text{C} & - & \text{H} \\ & & & & & & & & \\ & \text{CH}_2\text{CH}_3 & & & & & \text{H} & & \end{array}$

2.1 Write down the LETTER that represents the following:

2.1.1 A hydrocarbon (1)

2.1.2 A ketone (1)

2.1.3 A compound with the general formula $\text{C}_n\text{H}_{2n-2}$ (1)

2.2 Write down the NAME of the homologous series to which EACH of the following belong:

2.2.1 Compound **A** (1)

2.2.2 Compound **D** (1)

2.2.3 Compound **F** (1)

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

2.4 Write down the IUPAC name of each of the following:

2.4.1 Compound **E** (2)

2.4.2 Compound **F** (3)

2.5 Write down the condensed structural formula of a positional isomer of compound **A**. (2)

- 2.6 Compound **D** is prepared from a carboxylic acid and an alcohol in the presence of concentrated sulphuric acid.

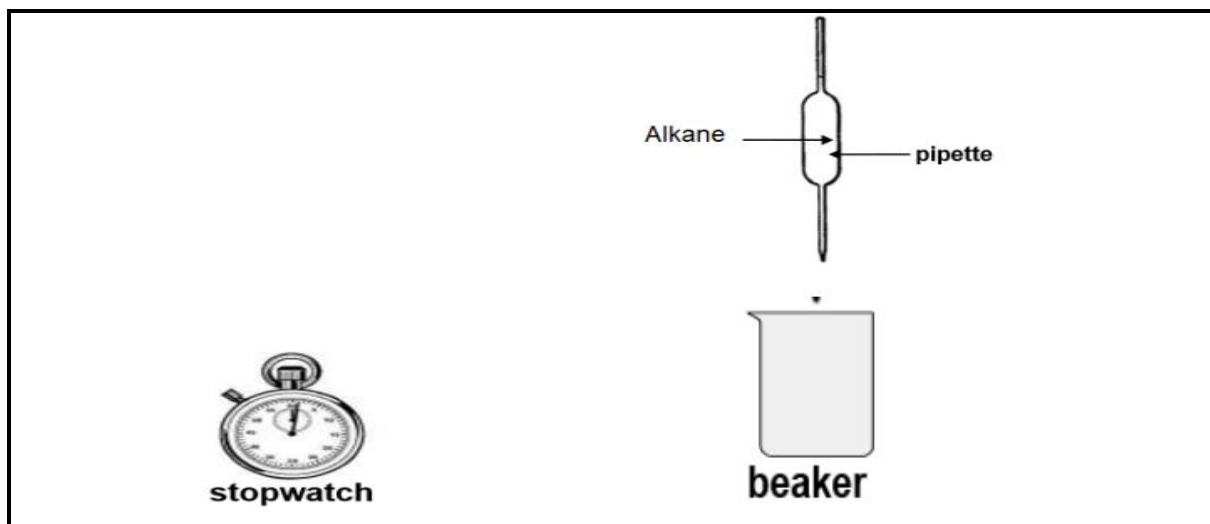
Write down the:

- 2.6.1 Structural formula of the carboxylic acid used (2)
- 2.6.2 IUPAC name of compound **D** (2)
- 2.7 Compound **B** is a macromolecule from which synthetic materials derived from organic compounds are produced.
- 2.7.1 Define the term *macromolecule*. (2)
- 2.7.2 Write down single term for the underlined phrase. (1)
- 2.7.3 Write down the structural formula of polythene. (2)

[24]

QUESTION 3 (Start on a NEW page)

During an investigation to compare the viscosity of alkanes, learners used a stopwatch to measure the time it takes a FIXED volume of each alkane to flow from a pipette as shown below.



The learners' results are recorded in the table below.

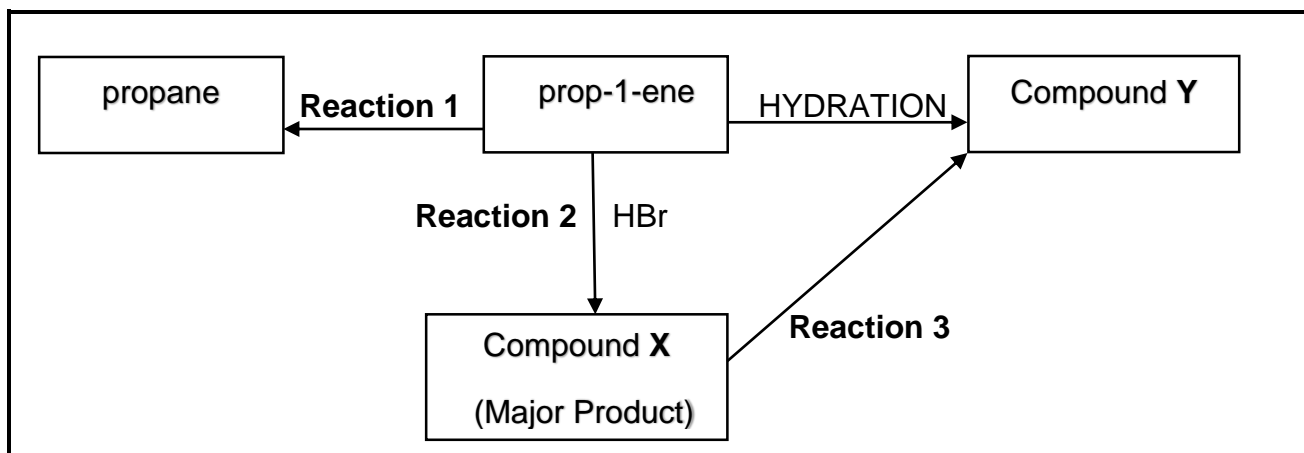
COMPOUND	ALKANE	TIME OF FLOW (minutes)
A	2,2 – dimethylpropane	0,214
B	2 – methylbutane	0,297
C	pentane	0,350

- 3.1 Define the term *viscosity*. (2)
- 3.2 Which alkane (**A**, **B** or **C**) has the HIGHEST viscosity? (1)
- 3.3 Explain fully the answer to QUESTION 3.2. (3)
- 3.4 Which alkane (**A**, **B** or **C**) has the HIGHEST vapour pressure? (1)
- 3.5 Compounds **A** and **B** have LOWER boiling points than compound **C**.
Write down a definition of *boiling point*. (2)
- 3.6 Compound **C** is a component of petrol.
Write down a balanced equation for the reaction of compound **C** with excess oxygen. (3)

[12]

QUESTION 4

The flow diagram given below shows how prop-1-ene can be converted to other organic compounds.



4.1 Is propane a SATURATED or UNSATURATED compound? (1)

4.2 Write down the TYPE of ADDITION reaction represented by:

4.2.1 **Reaction 1** (1)

4.2.2 **Reaction 2** (1)

4.3 For **Reaction 1** write down the:

4.3.1 Name of the catalyst used (1)

4.3.2 Name or Formula of the inorganic reagent used (1)

4.4 For **Reaction 3** write down:

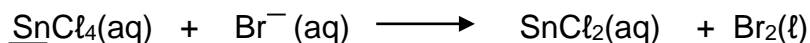
4.4.1 ONE reaction condition (1)

4.4.2 Balanced equation using structural formulae for organic reagents (6)

[12]

QUESTION 5 (Start on a NEW page)

5.1 Consider the reaction represented by the balanced equation.



5.1.1 Define *oxidation* in terms of electron transfer. (2)

5.1.2 Write down the oxidation number of the underlined substance in the equation. (1)

5.1.3 Determine by calculation whether the reaction is spontaneous. (5)

5.2 The following reactions occur spontaneously in galvanic cells **P**, **Q**, **R** and **S**.

CELL	NET CELL REACTION
P	$\text{Ni} + \text{Au}^{3+} \longrightarrow \text{Ni}^{2+} + \text{Au}$
Q	$\text{Mn} + \text{Ni}^{2+} \longrightarrow \text{Mn}^{2+} + \text{Ni}$
R	$\text{Al} + \text{Mn}^{2+} \longrightarrow \text{Al}^{3+} + \text{Mn}$
S	$\text{Al} + \text{Au}^{3+} \longrightarrow \text{Au} + \text{Al}^{3+}$

Which cell (**P**, **Q**, **R** or **S**) will produce the HIGHEST EMF?

Explain the answer without performing any calculation. (3)

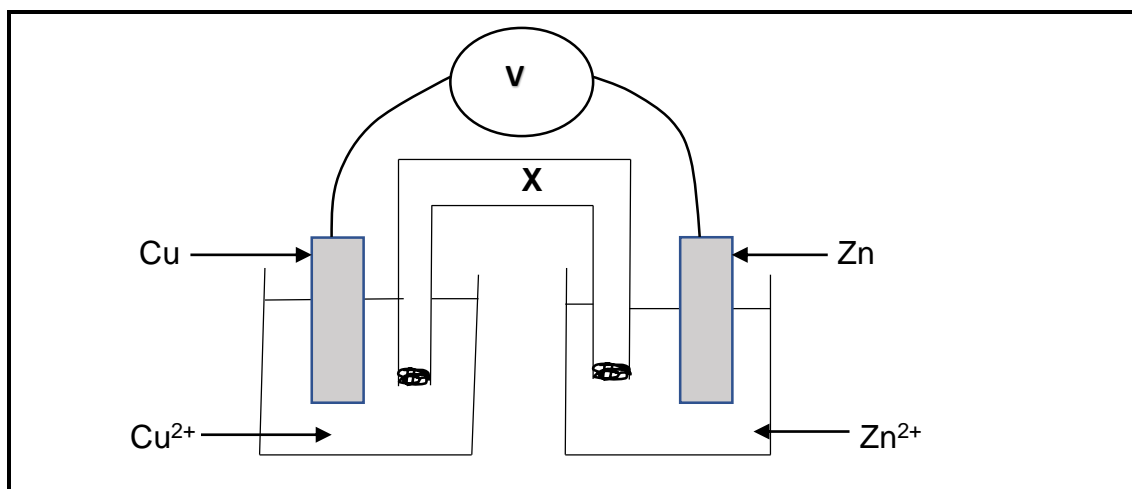
5.3 Another galvanic cell, **T**, is constructed using Ni/ Ni²⁺ and Al/ Al³⁺ half-cells.

For cell **T**.

5.3.1 Which electrode is the anode (Ni or Al)? (1)

5.3.2 Write down the balanced overall ionic equation for the reaction that takes place. (3)

- 5.4 The diagram given below shows a galvanic cell constructed under standard conditions.



Write down the:

- 5.4.1 Energy change taking place when the cell is in operation (2)
- 5.4.2 TWO standard conditions for this cell (2)
- 5.4.3 TWO functions of component X (2)
- 5.4.4 Cell notation (3)
- 5.5 Fuel cells and biodiesel can be used as alternative energy sources to petrol or petroleum diesel.

Write down ONE:

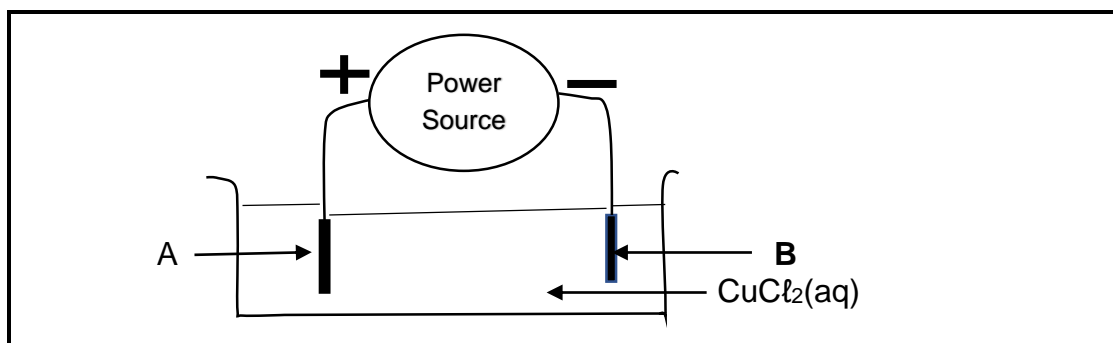
- 5.5.1 Advantage of using biodiesel in place of petrol (1)
- 5.5.2 Disadvantage of using biodiesel in cars (1)

[26]

QUESTION 6 (Start on a NEW page)

Consider the electrochemical cell used for the electrolysis of copper (II) chloride solution below.

Graphite rods are used as electrodes.



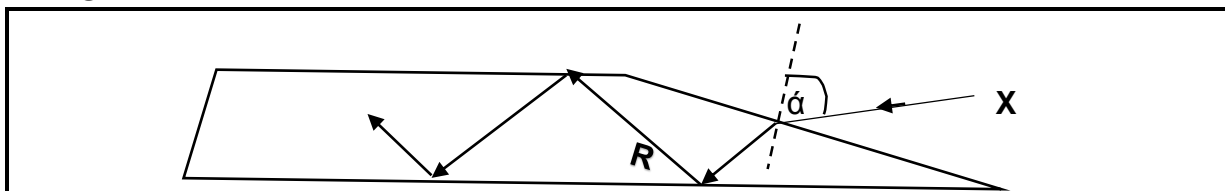
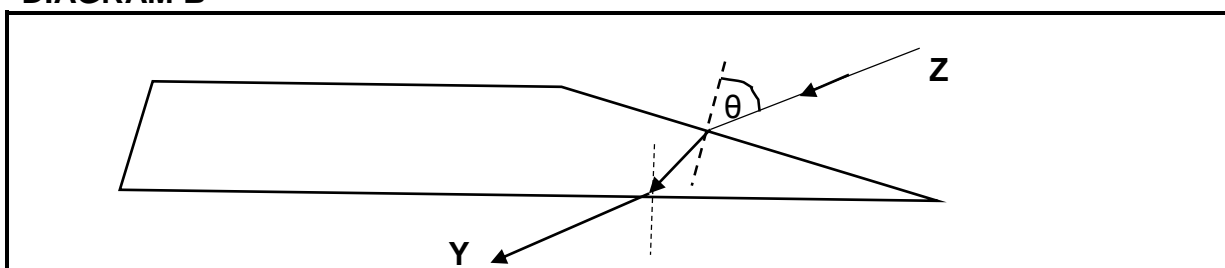
- 6.1 Define the term *electrolysis*. (2)
- 6.2 Is the power source AC or DC? (1)
- 6.3 In which direction will Cu^{2+} ions move in the solution?
Write down only TOWARDS **A** or TOWARDS **B**. (1)
- 6.4 Give a reason why copper (II) chloride crystals must be dissolved into the solution before electrolysis. (2)
- 6.5 Write down:
- 6.5.1 ONE observable change at electrode **A** (1)
- 6.5.2 The NAME or FORMULA of the oxidising agent (1)
- 6.6 Write down the half reaction taking place at electrode **B**. (2)

[10]

QUESTION 7 (Start on a NEW page)

The diagrams given below (**A** and **B**) show TWO phenomena that can take place when a ray of light strikes a glass prism.

Study the ray diagrams and answer the questions that follow.

DIAGRAM A**DIAGRAM B**

- 7.1 Define the term *reflection*. (2)
- 7.2 Write down the NAME of:
- 7.2.1 Ray X (1)
 - 7.2.2 Ray R (1)
 - 7.2.3 Ray Y (1)
 - 7.2.4 Angle labelled θ in diagram B (1)
 - 7.2.5 The phenomenon taking place inside the prism in **diagram A** (1)
 - 7.2.6 The phenomenon shown in **diagram B** (1)
- 7.3 State TWO requirements for the phenomenon taking place inside the prism in **diagram A**. (2)
- 7.4 Is ray Z refracted AWAY or TOWARDS the normal as it travels inside the prism?
Give a reason. (3)
- 7.5 How does the angle θ in **diagram B** compare in size to the angle α in **diagram A**?

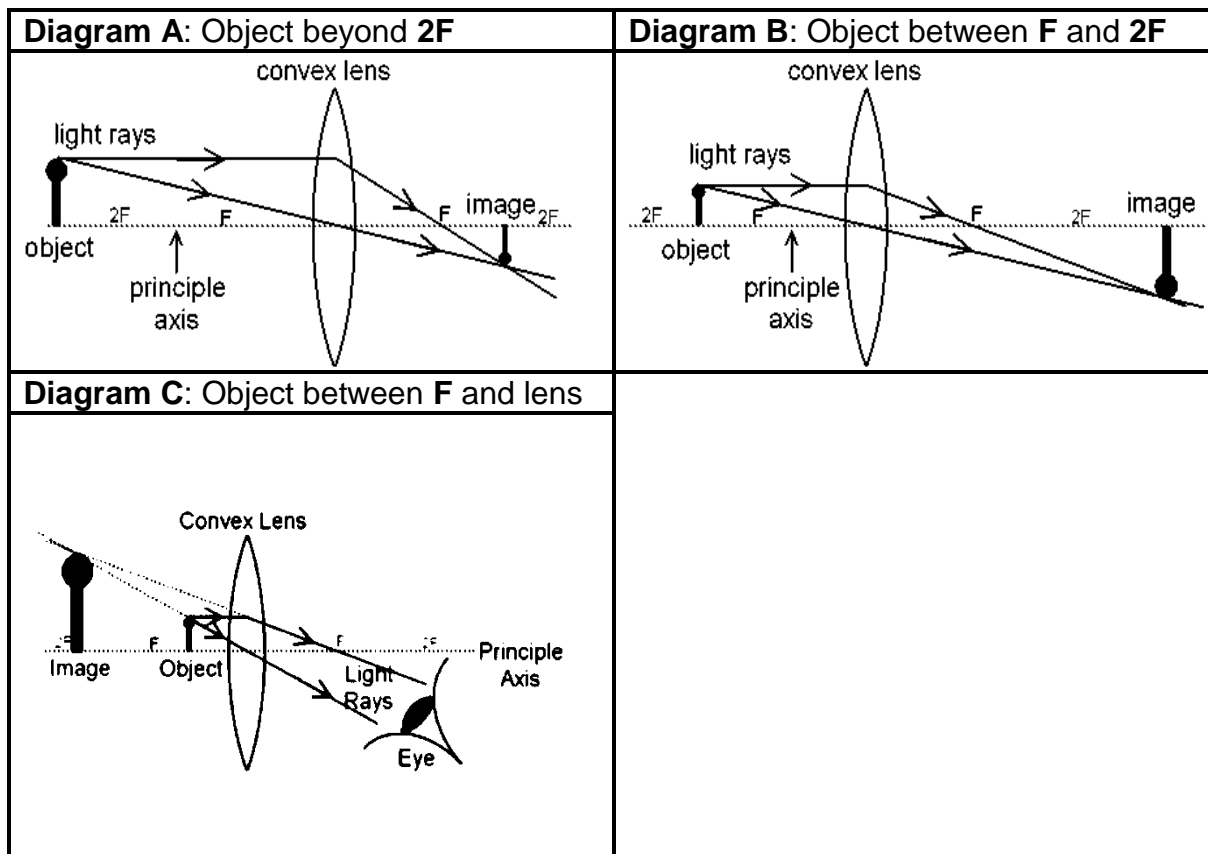
Write only LARGER THAN, SMALLER THAN or EQUAL TO.

Explain the answer.

(3)
[16]

QUESTION 8 (Start on a NEW page)

A group of learners investigate the effect of decreasing the distance between an object and a convex lens on the height of the image formed. They place the object at different positions from the lens as shown in the diagrams below and measure the height of the image formed at each position.



8.1 Besides the larger height of the image formed in diagram **C**, write down TWO other properties of the image formed in diagram **C**. (2)

8.2 For this investigation write down:

8.2.1 The independent variable (2)

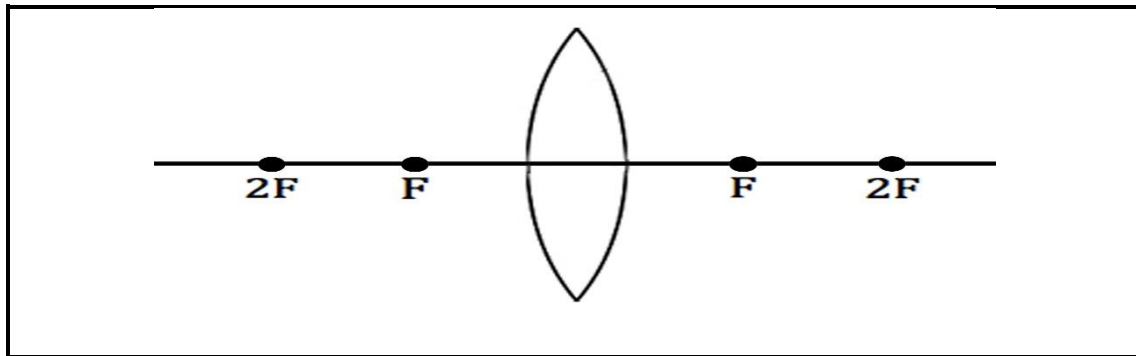
8.2.2 TWO precautions that the learners must take to ensure a fair test (2)

The learners conclude that: "As the distance between the lens and the object decreases the height of the image increases."

8.3 Is the learners' conclusion generally TRUE? (YES or NO)

Explain the answer. (2)

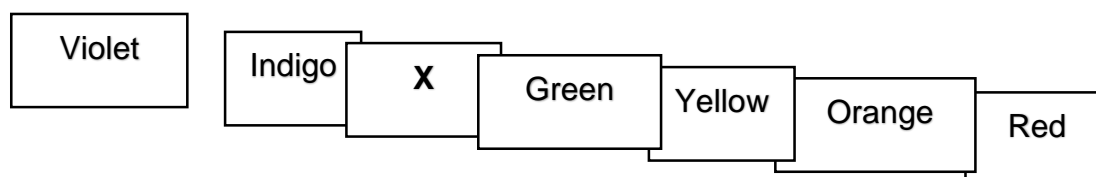
- 8.4 In the diagram below the focal length (F) of the lens is 30 mm. Draw a ray diagram to determine the position of the image formed when an object of height 20 mm is placed at $2F$.



(4)
[12]

QUESTION 9 (Start on a NEW page)

- 9.1 The diagram below shows the spectrum obtained during the dispersion of white light.



9.1.1 Define the term *dispersion* (2)

9.1.2 Write down the name of the colour of light represented by **X**. (1)

9.1.3 Which colour of visible light has the highest frequency? (1)

A photon of a light wave has $7,0 \times 10^{-19}$ J of energy.

9.1.4 Define the term *photon*. (2)

9.1.5 Calculate the wavelength of the wave. (5)

- 9.2 An electromagnetic wave is defined below. Write down the missing word.

An electromagnetic wave is a *changing ... field and a changing magnetic field mutually perpendicular to each other and the direction of propagation of the wave.* (1)

- 9.3 Four of the seven electromagnetic radiations are listed below.

Ultraviolet rays	Microwaves	Visible light	Infra-red rays
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Write down the NAME of electromagnetic radiation from the list given above that:

9.3.1 Is used in night-vision devices (1)

9.3.2 Leads to skin damage when one is over exposed to sunlight. (1)

9.3.3 Has photons with lowest energy (1)

- 9.4 Name THREE electromagnetic radiations NOT shown in the list given in QUESTION 9.3 above. (3)

[18]

TOTAL: 150

4.3 INFORMATION SHEETS – PAPER 2

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Standard pressure	p^θ	$1,01 \times 10^5 \text{ Pa}$
Standard temperature	T^θ	273 K
Speed of light in a vacuum	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$

TABLE 2: WAVES, SOUND AND LIGHT

$v = f \lambda$	$T = \frac{1}{f}$
$E = hf$ or $E = h \frac{c}{\lambda}$	

TABLE 2: FORMULAE

$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$
$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta$
$E_{\text{cell}}^\theta = E_{\text{oxidisingagent}}^\theta - E_{\text{reducingagent}}^\theta$

5
6
KEY/SLEUTEL

1 (I)	2 (II)	3	4	5 KEY/SLEUTEL	6	7	8 Atomic number Atoomgetal	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)	
2,1 1 H 1	1,0 3 Li 7	1,5 4 Be 9					29 Cu 63,5					5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20	
0,9 11 Na 23	1,2 12 Mg 24											13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35,5	18 Ar 40	
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1,5 25 Mn 55	1,8 26 Fe 56	1,8 27 Co 59	1,8 28 Ni 59	1,9 29 Cu 63,5	1,6 30 Zn 65	1,6 31 Ga 70	1,8 32 Ge 73	2,0 33 As 75	2,4 34 Se 79	2,8 35 Br 80	36 Kr 84	
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91		41 Nb 92	42 Mo 96	43 Tc 96	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137		57 La 139	1,6 72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Tl 204	82 Pb 207	83 Bi 209	84 Po	85 At	86 Rn
0,7 87 Fr	0,9 88 Ra 226	89 Ac																
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175	
				90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

TABLE 4A: STANDARD REDUCTION POTENTIALS

Half-reactions			E° (V)
$F_2(g) + 2e^-$	\rightleftharpoons	$2F^-$	+ 2,87
$Co^{3+} + e^-$	\rightleftharpoons	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	\rightleftharpoons	$2H_2O$	+ 1,77
$MnO_4^- + 8H^+ + 5e^-$	\rightleftharpoons	$Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^-$	\rightleftharpoons	$2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	\rightleftharpoons	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	\rightleftharpoons	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	\rightleftharpoons	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	\rightleftharpoons	Pt	+ 1,20
$Br_2(l) + 2e^-$	\rightleftharpoons	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	\rightleftharpoons	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	\rightleftharpoons	$Hg(l)$	+ 0,85
$Ag^+ + e^-$	\rightleftharpoons	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	\rightleftharpoons	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	\rightleftharpoons	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	\rightleftharpoons	H_2O_2	+ 0,68
$I_2 + 2e^-$	\rightleftharpoons	$2I^-$	+ 0,54
$Cu^+ + e^-$	\rightleftharpoons	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	\rightleftharpoons	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	\rightleftharpoons	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	\rightleftharpoons	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	\rightleftharpoons	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	\rightleftharpoons	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	\rightleftharpoons	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	\rightleftharpoons	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	\rightleftharpoons	$H_2(g)$	0,00
$Fe^{3+} + 3e^-$	\rightleftharpoons	Fe	- 0,06
$Pb^{2+} + 2e^-$	\rightleftharpoons	Pb	- 0,13
$Sn^{2+} + 2e^-$	\rightleftharpoons	Sn	- 0,14
$Ni^{2+} + 2e^-$	\rightleftharpoons	Ni	- 0,27
$Co^{2+} + 2e^-$	\rightleftharpoons	Co	- 0,28
$Cd^{2+} + 2e^-$	\rightleftharpoons	Cd	- 0,40
$Cr^{3+} + e^-$	\rightleftharpoons	Cr^{2+}	- 0,41
$Fe^{2+} + 2e^-$	\rightleftharpoons	Fe	- 0,44
$Cr^{3+} + 3e^-$	\rightleftharpoons	Cr	- 0,74
$Zn^{2+} + 2e^-$	\rightleftharpoons	Zn	- 0,76
$2H_2O + 2e^-$	\rightleftharpoons	$H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^-$	\rightleftharpoons	Cr	- 0,91
$Mn^{2+} + 2e^-$	\rightleftharpoons	Mn	- 1,18
$Al^{3+} + 3e^-$	\rightleftharpoons	Al	- 1,66
$Mg^{2+} + 2e^-$	\rightleftharpoons	Mg	- 2,36
$Na^+ + e^-$	\rightleftharpoons	Na	- 2,71
$Ca^{2+} + 2e^-$	\rightleftharpoons	Ca	- 2,87
$Sr^{2+} + 2e^-$	\rightleftharpoons	Sr	- 2,89
$Ba^{2+} + 2e^-$	\rightleftharpoons	Ba	- 2,90
$Cs^+ + e^-$	\rightleftharpoons	Cs	- 2,92
$K^+ + e^-$	\rightleftharpoons	K	- 2,93
$Li^+ + e^-$	\rightleftharpoons	Li	- 3,05

Increasing oxidising ability

Increasing reducing ability/

TABLE 4B: STANDARD REDUCTION POTENTIALS

Half-reactions			E^{θ} (V)
$\text{Li}^{+} + \text{e}^{-}$	\rightleftharpoons	Li	- 3,05
$\text{K}^{+} + \text{e}^{-}$	\rightleftharpoons	K	- 2,93
$\text{Cs}^{+} + \text{e}^{-}$	\rightleftharpoons	Cs	- 2,92
$\text{Ba}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ba	- 2,90
$\text{Sr}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Sr	- 2,89
$\text{Ca}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ca	- 2,87
$\text{Na}^{+} + \text{e}^{-}$	\rightleftharpoons	Na	- 2,71
$\text{Mg}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Mg	- 2,36
$\text{Al}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Al	- 1,66
$\text{Mn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Mn	- 1,18
$\text{Cr}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cr	- 0,91
$2\text{H}_2\text{O} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2(\text{g}) + 2\text{OH}^{-}$	- 0,83
$\text{Zn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Zn	- 0,76
$\text{Cr}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Cr	- 0,74
$\text{Fe}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Fe	- 0,44
$\text{Cr}^{3+} + \text{e}^{-}$	\rightleftharpoons	Cr^{2+}	- 0,41
$\text{Cd}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cd	- 0,40
$\text{Co}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Co	- 0,28
$\text{Ni}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Ni	- 0,27
$\text{Sn}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Sn	- 0,14
$\text{Pb}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Pb	- 0,13
$\text{Fe}^{3+} + 3\text{e}^{-}$	\rightleftharpoons	Fe	- 0,06
$2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{H}_2\text{S}(\text{g})$	+ 0,14
$\text{Sn}^{4+} + 2\text{e}^{-}$	\rightleftharpoons	Sn^{2+}	+ 0,15
$\text{Cu}^{2+} + \text{e}^{-}$	\rightleftharpoons	Cu^{+}	+ 0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+ 0,17
$\text{Cu}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Cu	+ 0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-}$	\rightleftharpoons	4OH^{-}	+ 0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-}$	\rightleftharpoons	$\text{S} + 2\text{H}_2\text{O}$	+ 0,45
$\text{Cu}^{+} + \text{e}^{-}$	\rightleftharpoons	Cu	+ 0,52
$\text{I}_2 + 2\text{e}^{-}$	\rightleftharpoons	2I^{-}	+ 0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	H_2O_2	+ 0,68
$\text{Fe}^{3+} + \text{e}^{-}$	\rightleftharpoons	Fe^{2+}	+ 0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-}$	\rightleftharpoons	$\text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+ 0,80
$\text{Ag}^{+} + \text{e}^{-}$	\rightleftharpoons	Ag	+ 0,80
$\text{Hg}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{Hg}(\text{l})$	+ 0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-}$	\rightleftharpoons	$\text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+ 0,96
$\text{Br}_2(\text{l}) + 2\text{e}^{-}$	\rightleftharpoons	2Br^{-}	+ 1,07
$\text{Pt}^{2+} + 2\text{e}^{-}$	\rightleftharpoons	Pt	+ 1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$\text{Mn}^{2+} + 2\text{H}_2\text{O}$	+ 1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-}$	\rightleftharpoons	$2\text{H}_2\text{O}$	+ 1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^{+} + 6\text{e}^{-}$	\rightleftharpoons	$2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+ 1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^{-}$	\rightleftharpoons	2Cl^{-}	+ 1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-}$	\rightleftharpoons	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	+ 1,51
$\text{H}_2\text{O}_2 + 2\text{H}^{+} + 2\text{e}^{-}$	\rightleftharpoons	$2\text{H}_2\text{O}$	+ 1,77
$\text{Co}^{3+} + \text{e}^{-}$	\rightleftharpoons	Co^{2+}	+ 1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-}$	\rightleftharpoons	2F^{-}	+ 2,87

Increasing oxidising ability
↓↑
Increasing reducing ability/