Hillcrest High School

PHYSICAL SCIENCE

June 2024

Grade 10

MARKS : 150
TIME : 2,5 Hours

EXAMINER : Mrs M. Smith
MODERATORS : Mrs J. Knox-Whitehead
Ms N. Badenhorst

Instructions:

1 Answer ALL the questions.

2 This question paper consists of **TWO** sections:
SECTION A : CHEMISTRY (90 marks) **SECTION B : PHYSICS (60 marks)**

3 Answer SECTIONS A and SECTION B in the ANSWER BOOK.

4 Non-programmable calculators may be used.

5 Appropriate mathematical instruments may be used.

6 Number the answers correctly according to the numbering system used in this question paper.

7 Data sheets are attached for your use.

8 Give brief motivations, discussions, et cetera where required.

9 Numbers must be rounded off to <u>two decimal</u> places.

SECTION A : CHEMISTRY (90)

MULTIPLE CHOICE : QUESTION 1: (2 x 6 = 12)

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 (1.1 – 1.6) in the answer book.

1.1 Liquids which form a homogeneous mixture are …..

A immiscible

B oil and water

C emulsions

D water and alcohol

1.2 Metal X forms a carbonate with the formula $X_2(CO_3)_3$.
Which one of the following is the correct formula for the nitrate of X?

A $X(NO_3)_3$

B $X_2(NO_3)_3$

C XNO_2

D X_3NO_3

1.3 Paulis Exclusion Principle states that

A an orbital can hold a maximum of two electrons provided that they have opposite spin

B no pairing of electrons in p orbitals until each of the three orbitals contains one electron

C an energy level can contain a maximum of 8 electron

D lower energy levels will fill completely before higher energy level start filling up

1.4 The process of separating the components of a liquid mixture, based on their difference in densities is called

A distillation

B chromatography

C decantation

D filtration

1.5 Which molecule shows a triple covalent bond?

A H_2

B N_2

C O_2

D CO_2

1.6 In which ONE of the following compounds do BOTH ions have the same electron structure as Argon?

A calcium sulfide

B magnesium oxide

C sodium sulfide

D calcium bromide

QUESTION 2 (9)

Read the following extract and answer the questions that follow.

In South Africa, uranium metal is a by-product of gold and copper metal production and is found in rocks in the form of uranium (IV) oxide . Like many elements uranium has two isotopes, mostly U-238.
Only 0,70% is the U-235 isotope, which is used in the reactors of nuclear power stations.

2.1 State one property of metals. (1)

2.2 Write down the formula for uranium (IV) oxide. (2)

2.3 Mention one way in which these uranium isotopes are similar. (1)

2.4 What percentage of any given sample will contain the U-238 isotope? Show your working. (2)

2.5 Calculate the relative atomic mass of uranium. (3)

QUESTION 3 (7)

Grade 10 learners placed an unknown solid compound in a pan on a stove and heated the pan at a uniform rate, with a lid on. The table below shows the temperatures of the compound at different times during the experiment.

Time (minutes)	0	2	4	6	8	10	12	14	16	18	20	22
Temperature (^{o}C)	16	25	34	34	34	43	52	61	61	61	65	68

3.1 Suggest a suitable investigative question for this experiment. (2)

3.2 What would have been observed to be happening in the pot at 34^{o}C ? (1)

3.3 Define the term 'temperature'. (2)

3.4 In what phase was the compound at t = 10 minutes ? (1)

3.5 At what temperature did the compound boil? (1)

QUESTION 4 (10)

The table below shows the first ionisation energy and the atomic radii of some elements.

ELEMENT	**FIRST IONIZATION ENERGY (kJ.mol $^{-1}$)**	**ATOMIC RADII (nm)**
sodium	496	0,191
magnesium	738	0,160
aluminium	578	0,130
silicon	786	0,118
phosphorus	1022	0,110
sulphur	998	0,102
chlorine	1251	0.099

4.1 Describe the trend in the ionization energy from sodium to chlorine.
(Choose from increase / decrease / stays the same) (1)

4.2 Explain why the atomic radius decreases from sodium to chlorine. (2)

4.3 The element to the right of chlorine on the Periodic table is Ar.
Explain why this element does not have an electronegativity value assigned to it. (2)

4.4 Define the term 'ionisation energy. (2)

4.5 Predict whether the ionization energy for potassium will be greater or less than that of sodium, and explain how you arrived at your answer. (3)

QUESTION 5 (22)

5.1 Write down the chemical formulae for the following substances.

5.1.1 ammonium sulphate (2)

5.1.2 aluminium carbonate (2)

5.1.3 dinitrogen trioxide (2)

5.2 Write down the names of the following compounds, using Stock Notation where necessary.

5.2.1 Fe_2O_3 (2)

5.2.2 $KMnO_4$ (2)

5.2.3 $Ca_3(PO_4)_2$ (2)

5.3 Rewrite and balance the following equations:

5.3.1 $NH_3 \rightarrow H_2 + N_2$ (2)

5.3.2 $KClO_3 \rightarrow KCl + O_2$ (2)

5.4 Butane (C_4H_{10}) burns in oxygen gas to produce carbon dioxide and water.

5.4.1 Write a balanced equation for the reaction. (4)

5.4.2 Laboratory gas is a mixture of butane and propane gas.
Both gases are organic compounds called alkanes and follow the general formula $C_nH_{2n} + 2$ (where n is any whole number).

If the prefix 'but -' means four and the prefix 'prop -' means three, write down the chemical formula for propane gas. (2)

QUESTION 6 (10)

Refer to the substances A to E in the table below and answer the questions that follow.

6.1 Write down only the letters (A to E) that

	MATERIAL
A	sodium chloride
B	magnesium metal
C	hydrogen gas
D	ammonia
E	solid carbon dioxide

6.1.1 forms a crystal lattice with positive kernels in a 'sea' of delocalized electrons. (1)

6.1.2 sublimes at room temperature (1)

6.1.3 forms an ionic bond held together by strong electrostatic forces of attraction (1)

6.1.4 forms a pure covalent bond (1)

6.2 Draw a Lewis – dot diagram to show a molecule of E (3)

6.3 Draw an Aufbau / Energy Level diagram for an atom of B (3)

QUESTION 7 (9)

The table below shows the electron structures and mass numbers of elements found on the Periodic Table. The elements are represented by the **letters A to G.**

	MASS NUMBER	ELECTRON STRUCTURE
A	27	$1s^2\,2s^2\,2p^6\,3s^2\,3p^1$
B	19	$1s^2\,2s^2\,2p^5$
C	28	$[Ne]\,3s^2\,3p^1$
D	24	$1s^2\,2s^2\,2p^6\,3s^2$
E	16	$1s^2\,2s^2\,2p^4$
F	23	$1s^2\,2s^2\,2p^6\,3s^1$
G	7	$[He]\,2s^1$

7.1 Which letter **(A to G)**

7.1.1 is an element with ten neutrons in each atom (1)

7.1.2 is an isotope of A (1)

7.1.3 is an alkaline - Earth metal (1)

7.2 Write down the formula **(using the letters A to G)** of the compound formed when

7.2.1 A combines with B (2)

7.2.2 E combines with F (2)

7.3 What type of bonding takes place between atoms of

7.3.1 E (1)

7.3.2 D and E (1)

QUESTION 8 **(11)**

Grade 10s investigated the temperature changes that occurred when calcium chloride ($CaCl_2$) powder was added to a sodium bicarbonate ($NaHCO_3$) solution. They mixed the two reactants in a beaker with some water and observed that bubbles of gas were formed. They recorded the temperature changes of the mixture every 30 seconds for the next 2 and a half minutes.

The results of the temperature changes were as follows :

Temperature (^oC)	21	34	42	45	46	46
Time (s)	0	30	60	90	120	150

8.1 State the dependent variable in this experiment. (1)

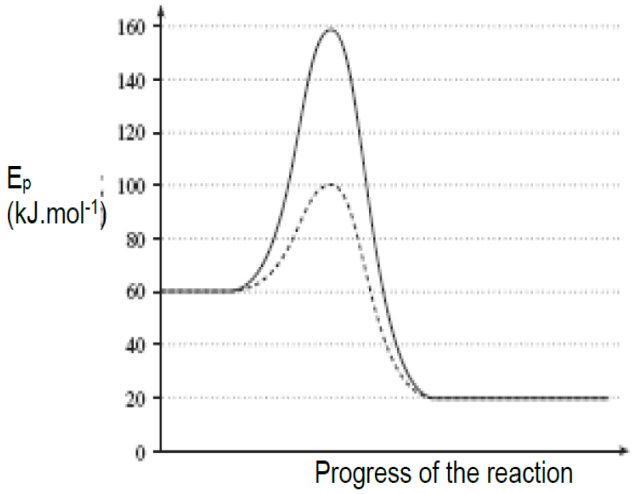
8.2 Was this experiment an example of a physical or a chemical change? Explain your answer. (2)

8.3 The equation for the reaction was as follows :

$$\mathbf{CaCl_2 + 2\,NaHCO_3 \rightarrow 2\,NaCl + CaCO_3 + H_2O + CO_2}$$

Show that the Law of Conservation of Mass applied in this experiment. (3)

8.4 The potential energy graph for the experiment is shown below.



8.4.1 Was the forward reaction exothermic or endothermic? (1)

8.4.2 What did the addition of a catalyst do to the value of the activation energy in this experiment? (State **increase** / **decrease** / **remains the same**) (1)

8.4.3 Calculate the heat of the reaction for the forward reaction. (3)

SECTION B : PHYSICS (60)

QUESTION 9 (4 X 2 = 8)

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 (9.1 – 9.4) in the answer book.

9.1 The angle between the direction of a disturbance and direction of motion of a transverse wave is:

A 0^o

B 45^o

C 60^o

D 90^o

9.2 The energy of an electromagnetic wave is directly proportional to its

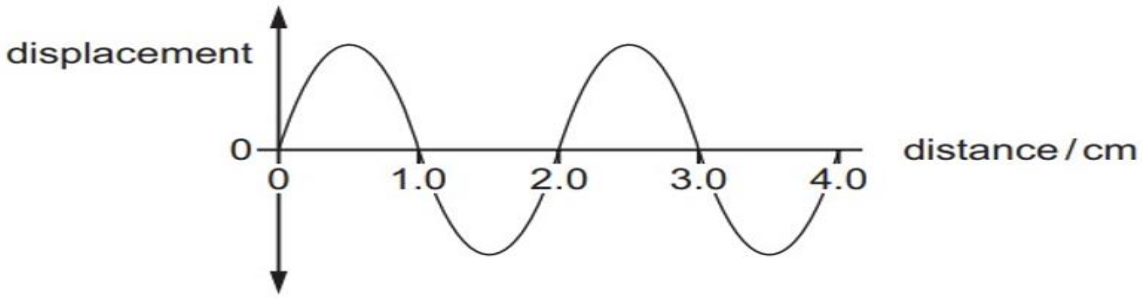
A speed

B frequency

C wavelength

D amplitude

9.3 The diagram represents a wave travelling at 20 $cm.s^{-1}$.



What is the frequency of the wave?

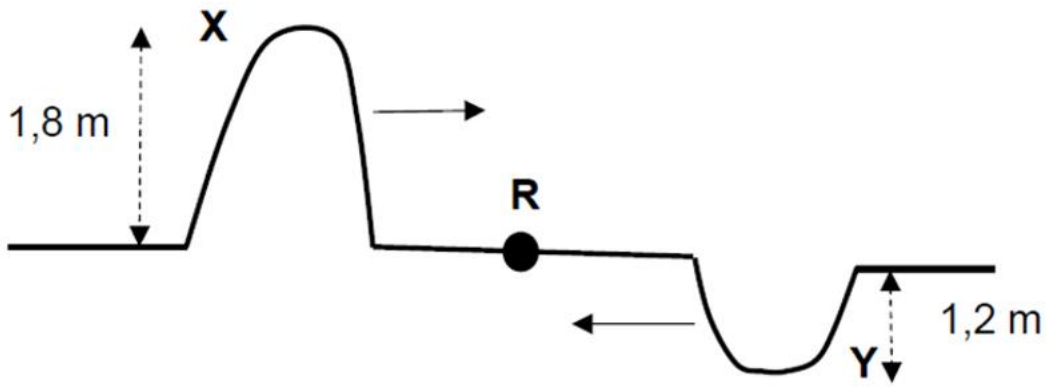
A 5HZ

B 10 Hz

C 40 Hz

D 80 Hz

9.4 Two pulses X and Y move towards each other at the same speed. The amplitude of the pulses is shown in the diagram below.



The resultant amplitude when the two pulses meet at point R is

A 0,6m destructive interference

B 3m destructive interference

C 0,6m constructive interference

D 3m constructive interference

QUESTION 10 (5)

Convert the following :

10.1 30 ml → litres

10.2 6×10^4 mm^3 → m^3

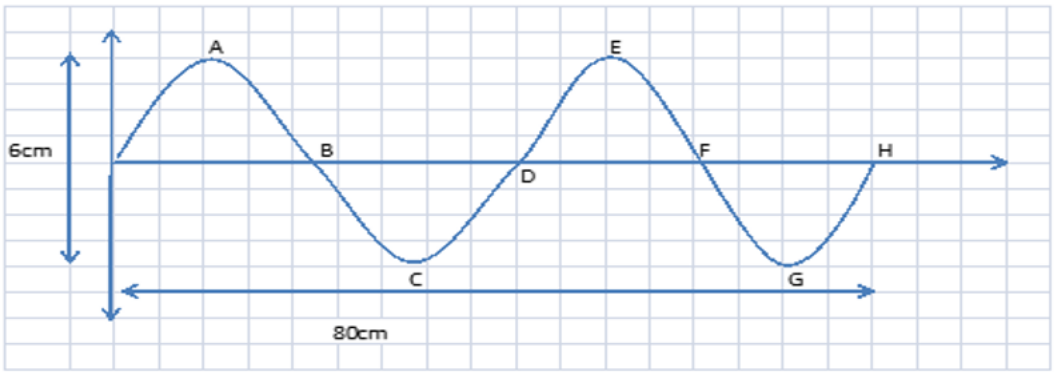
10.3 100 $km.h^{-1}$ → $m.s^{-1}$

10.4 300 nHz → Hz

10.5 20 cm^3 → dm^3

QUESTION 11 (13)

The diagram below represents a water wave where two wavelengths pass a point in 0,5 seconds.



11.1 Use the letter/s to identify:

11.1.1 a trough (1)

11.1.2 a wavelength (1)

11.1.3 any point at equilibrium (1)

11.1.4 any two points in phase (1)

11.2 Define the term **amplitude**, and hence determine the amplitude of the wave. (3)

11.3 Calculate the

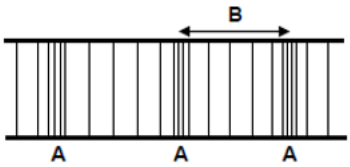
11.3.1 frequency (2)

11.3.2 the speed of the wave (4)

QUESTION 12 (6)

The sound wave produced by a vibrating string on a piano is represented in **DIAGRAM 1** below.

DIAGRAM 1



12.1 What type of wave is a sound wave? (1)

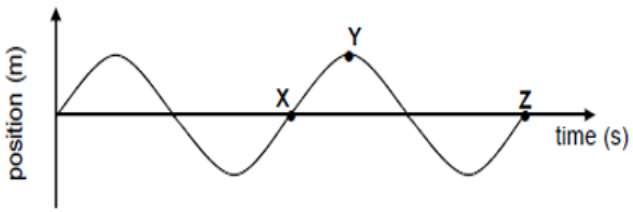
12.2 Provide labels for the sections marked

12.2.1 A (1)

12.2.2 B (1)

12.3 The position – time graph in **DIAGRAM 2** below represents the same sound wave produced by the piano string above.

DIAGRAM 2



12.3.1 Which one of the points X, Y or Z in DIAGRAM 2 corresponds to the section labelled A in **DIAGRAM 1**? (1)

Copy the above graph onto your booklet and label it **a**.

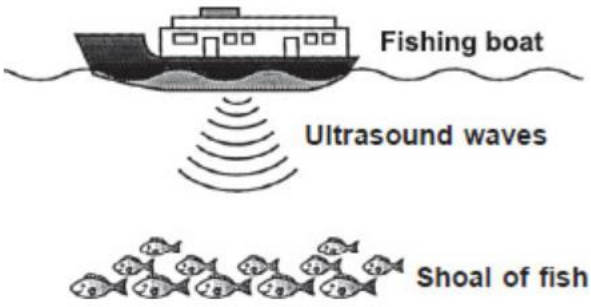
Then draw the following onto the **same axes**.

12.3.2 The same note played on the piano, but much louder than before.
Label this graph as **b**. (1)

12.3.3 A note of higher frequency but the same original loudness played on the piano.
Label this graph as **c**. (1)

QUESTION 13 (10)

Fishermen use echo - location to locate fish. They use a sonar devise attached to their boat that emits *ultrasonic* sound waves, which locates the depth of the shoal.



13.1 What are 'ultrasonic' waves? (2)

13.2 The ultrasonic waves transmitted by the boat have a frequency of 100 kHz.

13.2.1 Convert 100 kHz to Hz. (1)

13.2.2 Calculate the wavelength of these waves, if the speed of sound in water is given as 1500 $m.s^{-1}$. (3)

13.3 If it takes 0,75 s for the sound waves to be transmitted and received back at the boat, calculate how far the boat is away from the shoal of fish. (4)

QUESTION 14 (18)

The following table shows some properties and uses of wave from certain parts of the electromagnetic spectrum.

14.1 Complete the table by providing only the missing information for **14.1.1 – 14.1.6**
The first one has been done for you. (Do **NOT** copy out the table.) (6)

EM SOURCE/ APPLICATION	TYPE OF EM	USE
	visible light	to enable us to see the world around us.
 	14.1.1	14.1.2
	14.1.3	14.1.4
	14.1.5	14.1.6

14.2 List 1 property common to all of the electromagnetic waves above in Q 14.1. (1)

14.3 A beam of ultra-violet light from the sun has a wavelength of $4,6 \times 10^{-7}$ m.

Calculate

14.3.1 the frequency (3)

14.3.2 and the energy of a single photon of this ultra-violet light. (3)

14.4 Consider the following three types of electromagnetic waves that are emitted by the Sun.

ultra-violet rays	gamma rays	infra red rays

14.4.1 How are all electromagnetic waves generated? (2)

Which rays have

14.4.2 the longest wavelength? (1)

14.4.3 the highest frequency? (1)

14.4.4 the highest penetrating ability? (1)

SUB TOTAL (60)

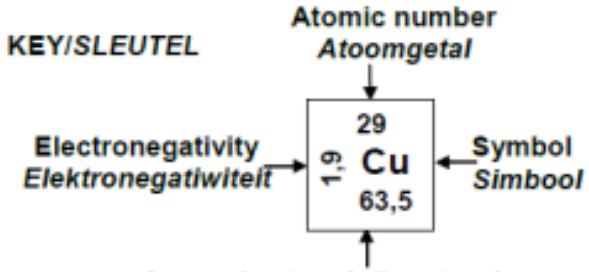
TOTAL (150)

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**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**

KEY/*SLEUTEL*



DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 10
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vacuum*	c	$3,0 \times 10^{8}\ m{\cdot}s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J{\cdot}s$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$v = \frac{\Delta x}{\Delta t}$	$E = hf$
$c = f\lambda$	$E = h\frac{c}{\lambda}$