KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

PHYSICAL SCIENCES P1

COMMON TEST

JUNE 2023

MARKS: 75

DURATION: 1,5 hours

This question paper consists of 9 pages and a data sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.5) in the ANSWER BOOK, for example 1.11 E.

1.1 Which of the following indicates a wave in which the particles of the medium vibrate parallel to the direction of motion of the wave?

A Water waves

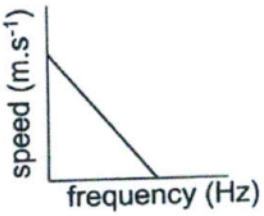
B Transverse waves

C Light waves

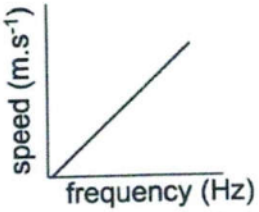
D Sound waves (2)

1.2 Which graph represents the relationship between the frequency and the speed of LIGHT waves in a vacuum?

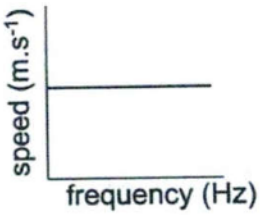
A



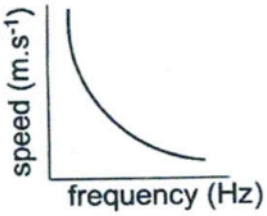
B



C

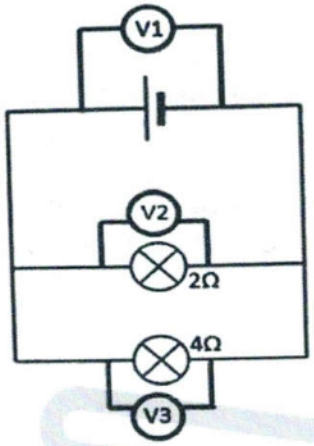


D



(2)

1.3 Consider the circuit diagram below. Which is the correct relationship between the voltmeter readings?



A $V_2 = V_3$

B $V_3 = 0,5V_2$

C $V_2 = 0.5V_3$

D $V_1 = V_2 + V_3$ (2)

1.4 Which ONE of the following is equivalent to 1 Volt?

A $1J \cdot C$

B $1A \cdot s$

C $1J \cdot C^{-1}$

D $1A \cdot s^{-1}$ (2)

1.5 A perspex rod is rubbed on a woollen cloth, and becomes negatively charged. Which ONE of the following explains why the perspex rod becomes negatively charged?

A It loses electrons.

B It gains electrons.

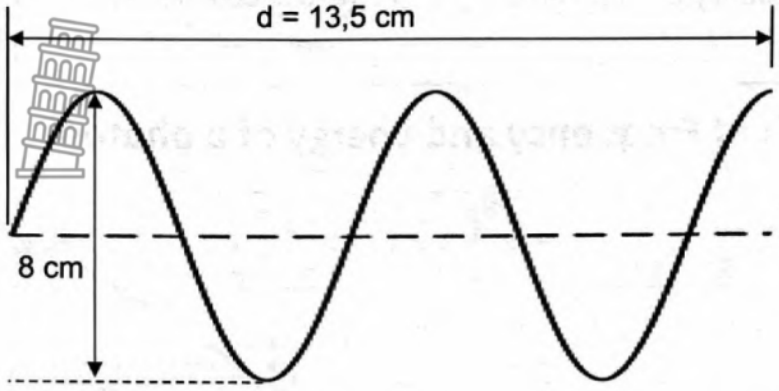
C It gains protons.

D It loses protons. (2)

2 X 5 = **10**

QUESTION 2 (Start on a new page.)

The diagram below represents a transverse wave moving from left to right.



The time taken for <u>3 consecutive crests</u> to pass a given point is 2,5 seconds.

2.1 Write down the amplitude of the wave. (1)

2.2 Define the term wavelength in words. (2)

2.3 For the above wave, calculate:

2.3.1 The wavelength. (2)

2.3.2 The period of the wave. (2)

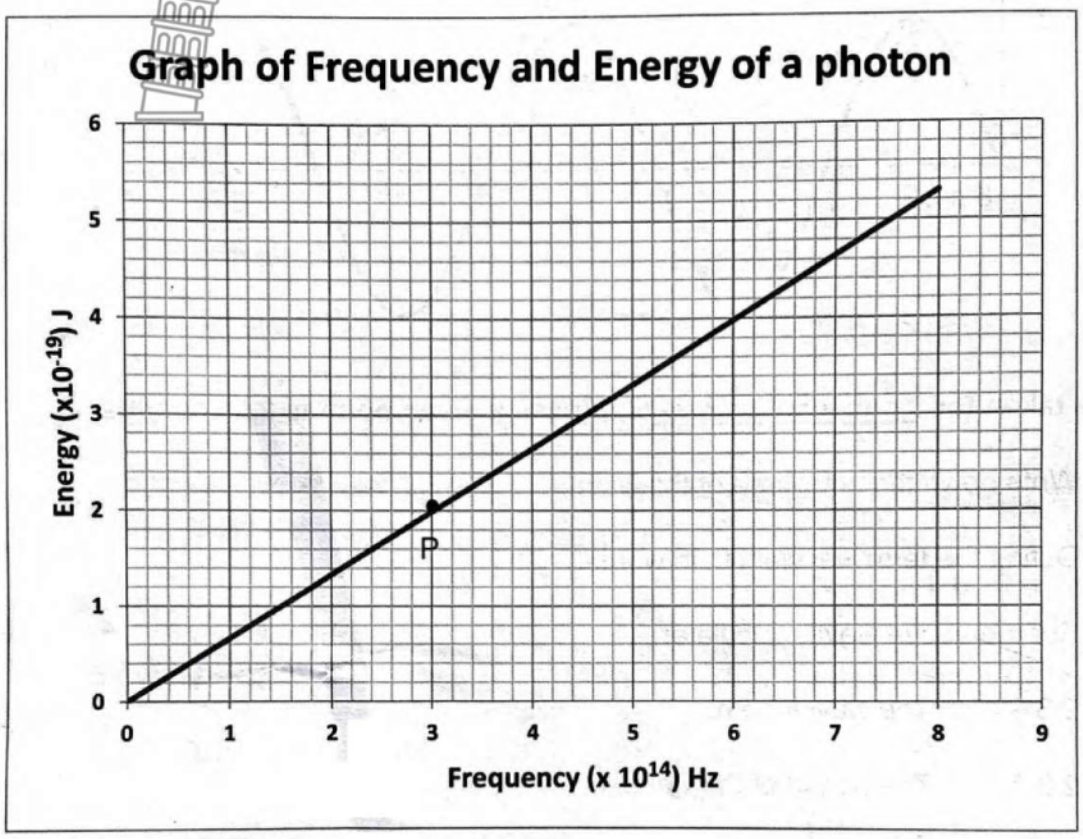
2.3.3 The wave speed. (3)

2.4 Determine the distance between six consecutive crests in this wave pattern. (3)

[13]

QUESTION 3 (Start on a new page.)

3.1 An investigation was conducted to determine the relationship between the energy and frequency of a photon of light. The results obtained are shown in the graph below.



3.1.1 Write a suitable investigative question. (2)

3.1.2 What is the mathematical relationship between the energy of a photon and its frequency? (1)

3.1.3 Explain your answer to Question 3.1.2 by referring to the shape of the graph. (2)

3.1.4 Determine the wavelength of the photon associated with point P on the graph. (3)

3.2 The table below displays data for different types of electromagnetic radiation in order of increasing energy.

TYPE OF RADIATION	Energy (J)
Radio waves	$2,65 \times 10^{-27}$
Microwaves	$1,99 \times 10^{-23}$
Infrared (IR)	$3,99 \times 10^{-22}$
Visible light	$1,33 \times 10^{-19}$
Ultraviolet (UV) light	$4,64 \times 10^{-18}$
X-rays	$9,95 \times 10^{-17}$
Radiation Y	$2,32 \times 10^{-14}$

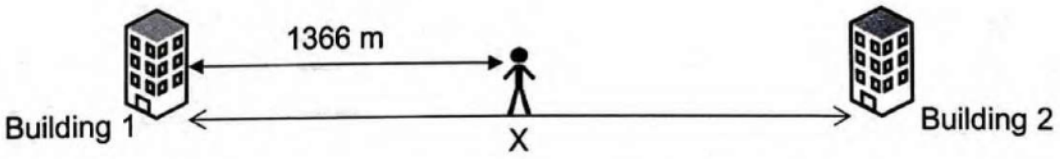
3.2.1 Identify the type of radiation represented by Radiation Y. (1)

3.2.2 Write down the energy value for the type of radiation with the highest wavelength. (1)

3.2.3 Determine the frequency of ultraviolet light. (3)
[13]

QUESTION 4 (Start on a new page.)

A man standing between 2 buildings, as shown in the diagram below, sounds a siren. He hears the echo of the sound produced by the siren from building 1 after 8 seconds, and the echo from building 2 after 6 seconds.



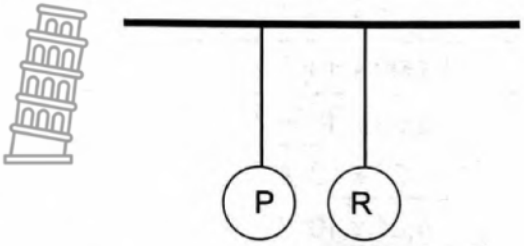
The distance between the man and building 1 is 1366 m. The man and both buildings are on the same plane and in a straight line.

4.1 Calculate the speed of sound in air. (3)

4.2 Determine the distance "X" between both buildings. (4)
[7]

QUESTION 5 (Start on a new page.)

Two small identical spheres, P and R, are suspended on long silk threads, as shown in the sketch below. Sphere P is initially **neutral** and the initial charge of R is unknown



Sphere P is rubbed with a cloth and gains $2x10^{13}$ electrons.

5.1 Determine the new charge of sphere P. (3)

5.2 State the principle of conservation of charge in words. (2)

5.3 Sphere P, is now brought into contact with Sphere R and the two spheres are then separated. Both spheres have a charge of 6,4 µC after they are separated.

Calculate:

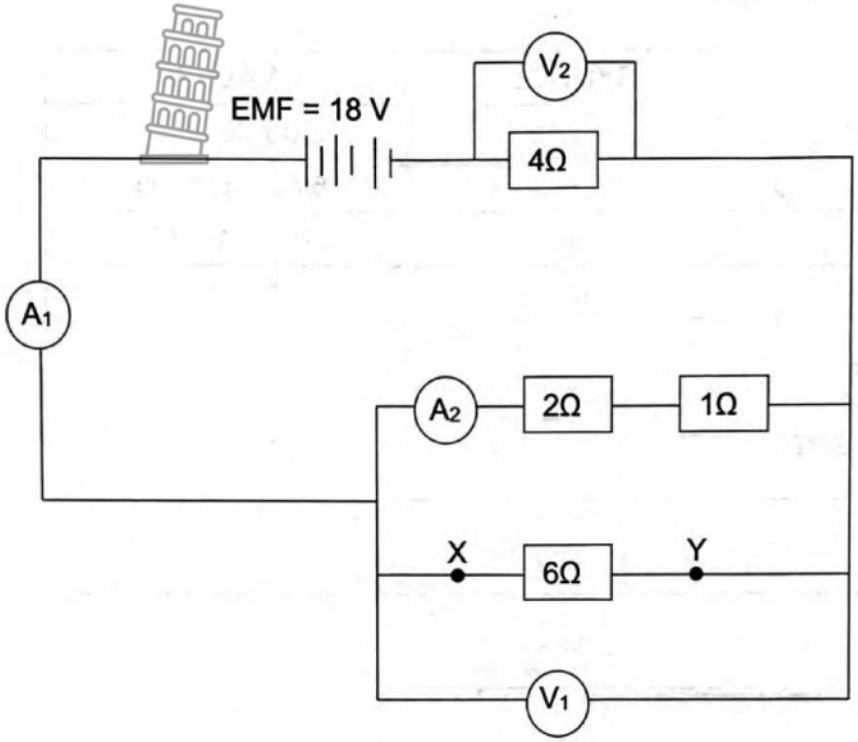
5.3.1 The initial charge on Sphere R. (4)

5.3.2 The number of electrons transferred from sphere P to sphere R. (4)

5.4 Your hand feels a small sharp electric shock when you touch a metal doorknob, after walking on carpet on a dry day.
Explain this phenomenon. (3)
[16]

QUESTION 6 (Start on a new page)

A battery with an emf of 18V is connected to four resistors as shown.



180 C of charge passes through the 2Ω resistor in 1,5 minutes.

6.1 Define *current* in words. (2)

6.2 Calculate the reading on ammeter A_2. (3)

6.3 Determine the:

6.3.1 Effective resistance of the parallel combination (2)

6.3.2 The reading on voltmeter V_1 (2)

6.3.3 Energy transferred to the 2Ω resistor in 1,5 minutes (4)

6.4 A wire of negligible resistance is connected from point X to point Y. Will the reading on A_1 INCREASE, DECREASE OR REMAIN THE SAME? Explain the answer. (3)

[16]

TOTAL: 75

DATA FOR PHYSICAL SCIENCES GRADE 10
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Speed of light in a vacuum	c	$3,0 \times 10^{8}$ m·s^{-1}
Planck's constant	h	$6,63 \times 10^{-34}$ J·s
Charge on electron	q_e	$-1,6 \times 10^{-19}$ C
Electron mass	m_e	$9,11 \times 10^{-31}$ kg

TABLE 2: FORMULAE

WAVES, SOUND AND LIGHT

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

ELECTROSTATICS

$Q = n \times q_e$	$Q = \frac{Q1 + Q2}{2}$

ELECTRIC CIRCUITS

$Q = I \times \Delta t$	$\frac{1}{Rp} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots.$
$R_s = R_1 + R_2 + \cdots$	$V = \frac{W}{Q}$

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QUESTION 1

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 A ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B ✓✓ (2)

[10]

QUESTION 2

2.1 4 cm or 0,04 m ✓ (1)

2.2 The distance between two successive/consecutive points in phase. ✓✓ (2)

2.3 **POSITIVE MARKING FOR QUESTION 2.3**

2.3.1 $\lambda = \frac{13,5}{2,25}$ ✓

= 6 cm or 0,06 m ✓ (2)

2.3.2 $T = \frac{2,5}{2}$ ✓

= 1,25 s ✓ (2)

2.3.3

OPTION 1	**OPTION 2**
$f = \frac{1}{T}$	Speed = $\frac{distance}{time}$ ✓
$= \frac{1}{1.25}$	$= \frac{0.12}{2,5}$ ✓
= 0.8 Hz	= 0,048 m.s^{-1} ✓
v = f × λ ✓	
= 0,8 × 0,06 ✓	
= 0,048 m.s^{-1} ✓	

(3)

2.4 Distance = 5 x 6 ✓ ✓

= 30 cm or 0,3 m ✓ (3)

[13]

QUESTION 3

3.1

3.1.1 What is the relationship between the frequency and energy of a photon? ✓✓ (2)

3.1.2 The energy of a photon is directly proportional to the frequency ✓

Or (1)

Direct proportion ✓

3.1.3 The graph is a straight line ✓ starting from the origin ✓. (2)

Or

As the frequency increases the energy increases ✓ proportionally ✓.

3.1.4 $c = f \times \lambda$ ✓.

$3 \times 10^{8} = 3 \times 10^{14} \times \lambda$ ✓.

$\lambda = 1 \times 10^{-6}$ m ✓. (3)

3.2

3.2.1 Gamma rays ✓. (1)

3.2.2 $2{,}65 \times 10^{-27}$ J ✓. (1)

3.2.3 $E = h \times f$ ✓.

$4{,}64 \times 10^{-18} = 6{,}63 \times 10^{-34} \times f$ ✓.

$f = 7 \times 10^{15}$ Hz ✓. (3)

[13]

QUESTION 4

4.1 $\text{speed} = \frac{\text{distance}}{\text{time}}$ ✓

$= \frac{1366}{4}$ ✓

$= 341{,}5 \text{ m.s}^{-1}$ ✓ (3)

4.2 $\text{speed} = \frac{\text{distance}}{\text{time}}$

✓ $341{,}5 = \frac{\text{distance}}{3}$ ✓

Distance = 1024,5 m

X = 1024,5 + 1366 ✓

= 2390 m ✓ (4)

[7]

QUESTION 5

5.1 $Q = n \times q_e$ ✓

$= 2 \times 10^{13} \times (1,6 \times 10^{-19})$ ✓

$= 3,2 \times 10^{-6}$ C ✓

Therefore charge on sphere P is $-3,2 \times 10^{-6}$ C. (3)

5.2 The net charge of an isolated system remains constant during any physical process ✓✓ (2)

5.3 **POSITIVE MARKING FROM QUESTION 5.1**

5.3.1 $Q = \frac{Q1 + Q2}{2}$ ✓

✓ $6,4 \times 10^{-6} = \frac{-3,2 \times 10^{-6} + Q_R}{2}$ ✓

$Q_R = 1,6 \times 10^{-5}$ C ✓ (4)

5.3.2 $n = \frac{\Delta Q}{q_e}$ ✓

$= \frac{6,4 \times 10^{-6} - 1,6 \times 10^{-5}}{1,6 \times 10^{-19}}$ OR $= \frac{6,4 \times 10^{-6} - (-3.2 \times 10^{-6})}{-1,6 \times 10^{-19}}$ ✓ ✓

$= 6 \times 10^{13}$ electrons ✓ (4)

5.4 Whilst walking on the carpet, electrons are transferred to you. ✓
You pick up a negative charge, ✓ due to the excess electrons.
When you touch the doorknob (a conductor) , the quick movement of electrons ✓ from you to the doorknob results in the sudden shock. (3)

[16]

QUESTION 6

6.1 The rate of flow of charge ✓✓ (2)

6.2 $I = \frac{Q}{\Delta t}$ ✓

$= \frac{180}{90}$ ✓

$= 2A$ ✓ (3)

6.3

6.3.1 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$

$= \frac{1}{3} + \frac{1}{6}$ ✓

$R_p = 2\ \Omega$ ✓ (2)

6.3.2 **POSITIVE MARKING FROM QUESTION 6.3.1**

Using Ratios

$V_1 = \frac{2}{6} \times 18$ ✓

$= 6\ V$ ✓

OR

Using Ohms Law

$V_1 = I \times R$

$= 2 \times 3$ ✓

$= 6\ V$ ✓ (2)

6.3.2 **POSITIVE MARKING FROM QUESTION 6.3.2**

6.3.3 Using Ratios

$V_{2\Omega} = \frac{2}{3} \times 6$ ✓

$= 4\ V$

$W = V \times Q$ ✓

$= 4 \times 180$ ✓

$= 720\ J$ ✓

Using Ohms Law

$V_{2\Omega} = I \times R$

$= 2 \times 2$ ✓

$= 4\ V$

$W = V \times Q$ ✓

$= 4 \times 180$ ✓

$= 720\ J$ ✓ (4)

6.4 Increase. ✓
The total resistance decreases. ✓ (3)
Current is inversely proportional to resistance. ✓

[16]

TOTAL: 75