



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2023

MARKS: 150

TIME: 3 hours

Stanmorephysics

This question paper consists of 16 pages and 3 data sheets.



INSTRUCTION QUESTION 4 (Start on a new page.)

1. Write on the Trolley **A** of mass 7,2 kg moves to the right at $0,4 \text{ m}\cdot\text{s}^{-1}$ in a straight line on a horizontal floor. It collides with a stationary trolley **B** of mass 5,3 kg.
2. This After the collision, the trolleys lock together and move to the right, as shown in the diagram below.
3. Start Ignore any frictional effects.

4. Numl
quesl

5. Leavl
QUE.

6. You I

7. You I

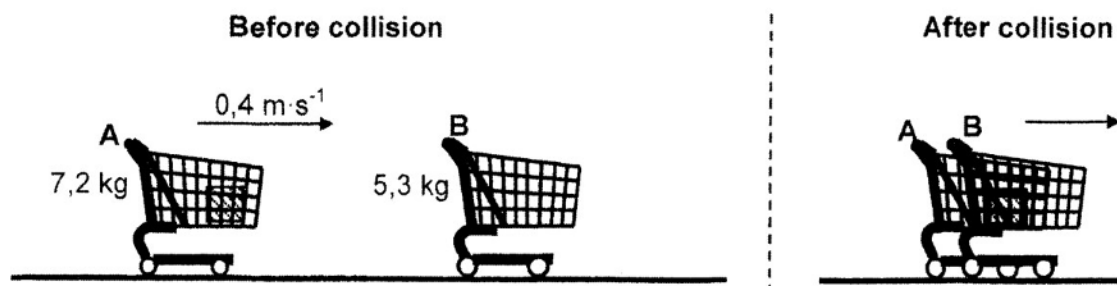
8. Shov

9. Rour
place

10. Give

11. You

12. Write



4.1 State the *principle of conservation of linear momentum* in words.

4.2 Calculate the magnitude of the:

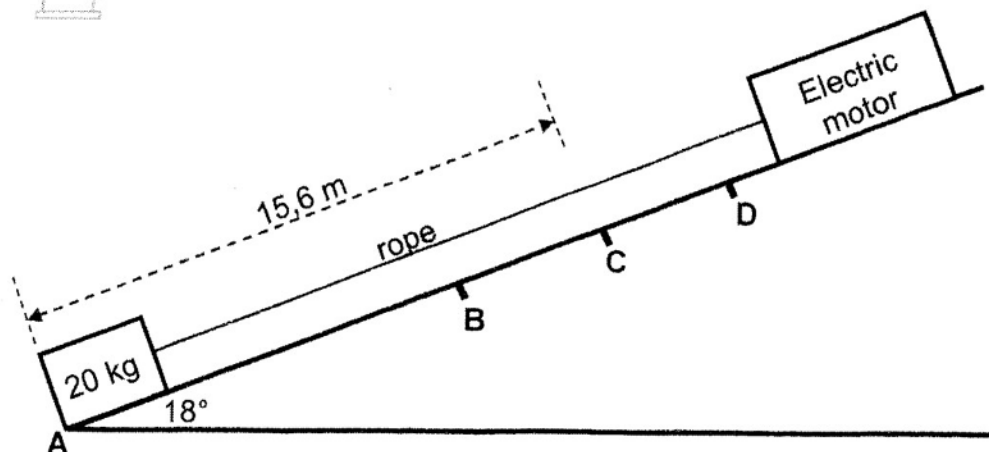
4.2.1 Velocity of the trolleys immediately after the collision

4.2.2 Average net force exerted by trolley **A** on trolley **B** during the collision, if the collision time is 0,02 s



QUESTION 5 (Start on a new page.)

An electric motor pulls a 20 kg crate from rest at point **A** up an inclined plane by means of a light inextensible rope. The inclined plane makes an angle of 18° with the horizontal. **B**, **C** and **D** are points on the inclined plane and the distance between points **A** and **C** is 15,6 m, as shown in the diagram below.



The motor exerts a constant force of 96,8 N parallel to the inclined plane on the rope.

A constant frictional force of 13,5 N acts on the crate as it moves on the inclined plane.

- 5.1 Define a *non-conservative force*. (2)
- 5.2 Use ENERGY PRINCIPLES to calculate the speed of the crate when it reaches point **C**. (5)
- 5.3 Calculate the minimum average power dissipated by the electric motor to pull the crate from point **A** to point **C**. (3)

When the crate reaches point **C**, the rope breaks. The crate continues moving up the inclined plane, comes to a stop at point **D**, and then slides down the plane past point **B**.

- 5.4 Draw a labelled free-body diagram for the crate as it slides down the plane past point **B**. (3)
- 5.5 Draw a velocity-time graph for the entire motion of the crate starting from point **A** until it passes point **B** again on its motion down the inclined plane. (4)

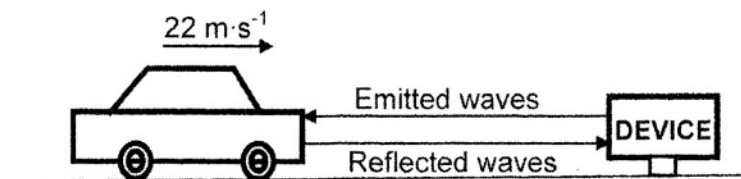
[17]



QUESTION 6 (Start on a new page.)

- 6.1 A car moves at a constant velocity of $22 \text{ m}\cdot\text{s}^{-1}$ on a straight horizontal road TOWARDS a stationary device, which can both emit and detect sound waves.

The device emits sound waves with a frequency of $24\,000 \text{ Hz}$. These sound waves are reflected off the car and the reflected sound waves are then detected by the device, as shown in the diagram below.

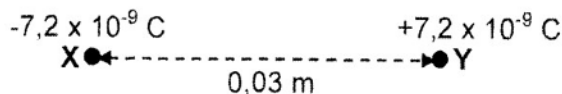


- 6.1.1 State the *Doppler effect* in words. (2)
- 6.1.2 If the speed of sound in air is $340 \text{ m}\cdot\text{s}^{-1}$, calculate the frequency of the reflected sound waves detected by the device. (6)
- 6.2 The spectral lines observed for a distant star show that the star is moving away from Earth. Explain, by referring to frequency, how one can deduce that the star is moving away from Earth. (2)
- [10]**



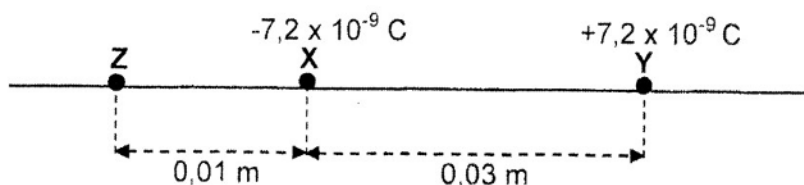
QUESTION 7 (Start on a new page.)

Two point charges, **X** and **Y**, are held 0,03 m apart, as shown in the diagram below. The charge of **X** is $-7,2 \times 10^{-9} \text{ C}$, while the charge of **Y** is $+7,2 \times 10^{-9} \text{ C}$.



- 7.1 State Coulomb's law in words. (2)
- 7.2 Draw the net electric field pattern due to the two point charges. (3)
- 7.3 Calculate the magnitude of the electrostatic force that **Y** exerts on **X**. (3)

A third point charge, **Z**, of unknown positive charge, is positioned 0,01 m to the left of point charge **X** on the line joining point charges **X** and **Y**, as shown in the diagram below.



- 7.4 Draw a labelled vector diagram to show the directions of the electric fields at the point where **X** is positioned. (2)
- 7.5 The magnitude of the resultant electric field at the point where **X** is positioned is $4,91 \times 10^5 \text{ N} \cdot \text{C}^{-1}$.

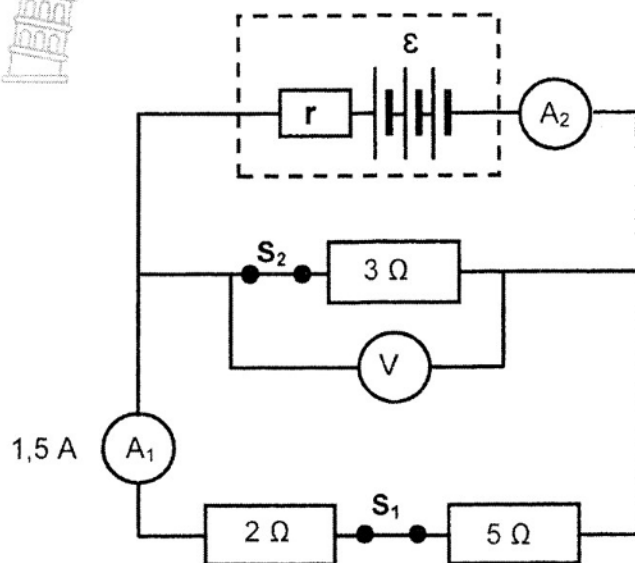
Calculate the magnitude of charge **Z**.

(5)
[15]



QUESTION 8 (Start on a new page.)

A battery with unknown emf ($\mathcal{E}$) and unknown internal resistance (r) is connected to three resistors, a high-resistance voltmeter, two switches and two ammeters of negligible resistance, as shown below.



8.1 State Ohm's law in words. (2)

Both switch S_1 and switch S_2 are CLOSED. The reading on ammeter A_1 is 1,5 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

8.2.2 Reading on ammeter A_2 (4)

8.2.3 Power dissipated in the 3Ω resistor (3)

Switch S_1 is now OPENED, while switch S_2 remains CLOSED. The reading on ammeter A_2 is now 3,64 A.

8.3 Calculate the emf of the battery. (5)

Switch S_2 is now OPENED, while switch S_1 is CLOSED.

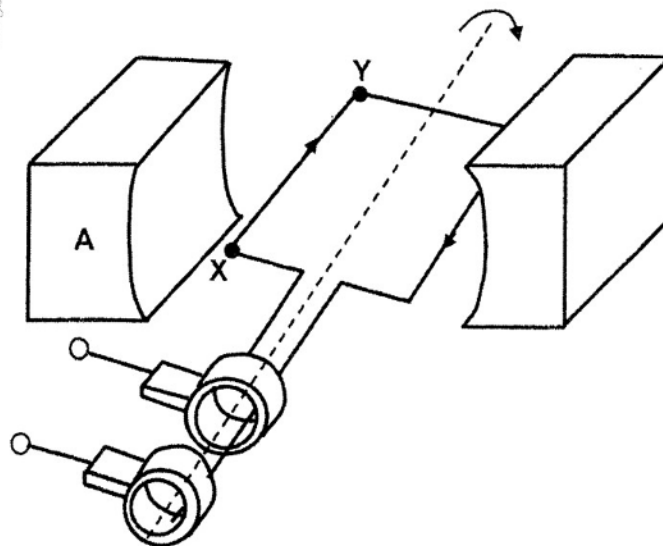
8.4 How does the voltmeter reading change? Choose from INCREASES, DECREASES or REMAINS THE SAME. (4)

Explain the answer. [21]



QUESTION 9 (Start on a new page.)

- 9.1 The simplified sketch below represents an AC generator with the coil initially horizontal between the poles of a magnet. **X** and **Y** are two points on the coil, while **A** is one of the poles of the magnet.



When the coil of the generator rotates clockwise between the two poles of the magnet, the direction of the induced current is from **X** to **Y**, as shown above.

- 9.1.1 Is **A** the NORTH POLE or the SOUTH POLE of the magnet? (1)
- 9.1.2 The coil is now rotated through 180° .
Will the direction of the current be from **X** to **Y** or from **Y** to **X**? (1)
- 9.1.3 Sketch an emf-time graph for TWO complete rotations of the coil, starting from the position of the coil as shown in the diagram above. (3)
- 9.2 An electrical device is connected to an AC generator. The rms potential difference across the device is 200 V and the maximum current passing through the device is 6 A.

Calculate the:

- 9.2.1 Resistance of the device (4)
- 9.2.2 Energy consumed by the device in two hours (4)



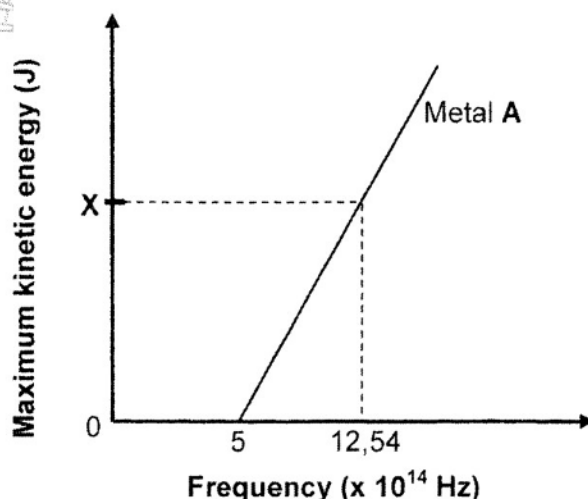
[13]



QUESTION 10 (Start on a new page.)

In a photoelectric investigation, light of different frequencies was radiated on each of two metals, **A** and **B**. The graph of maximum kinetic energy of the ejected electrons from metal **A** and the frequency of the incident photons is shown below.

Point **X** on the graph represents an unknown maximum kinetic energy.



- 10.1 Write down the numerical value of the gradient of the graph. (1)
- 10.2 Define the term *work function*. (2)
- 10.3 Calculate the:
- 10.3.1 Work function of metal **A** (3)
- 10.3.2 Value of **X** shown on the graph (4)
- 10.4 How will EACH of the following be affected if light of frequency $12,54 \times 10^{14}$ Hz, but of higher intensity, is used?
Choose from INCREASES, DECREASES or NO EFFECT.
- 10.4.1 The value of **X** (1)
- 10.4.2 The number of photoelectrons emitted per unit time (1)

Metal **B** has a larger work function than metal **A**.

- 10.5 Redraw the graph above in your ANSWER BOOK. (Do NOT include values on the axes.) Label this graph as **A**.

On the SAME set of axes, sketch the graph for metal **B**. Label this graph as **B**.

(2)
[14]

TOTAL: 150



DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	$9,8 \text{ m} \cdot \text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N} \cdot \text{m}^2 \cdot \text{kg}^{-2}$
Radius of the Earth <i>Radius van die Aarde</i>	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth <i>Massa van die Aarde</i>	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m} \cdot \text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J} \cdot \text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	m_e	$9,11 \times 10^{-31} \text{ kg}$



TABLE 2: FORMULAE/TABEL 2: FORMULES

MOTION/BEWEGING

$v_f = v_i + a \Delta t$	$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or/of $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ or/of $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t$

FORCE/KRAG

$F_{\text{net}} = ma$	$p = mv$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ or/of $F = G \frac{m_1 m_2}{r^2}$	$g = G \frac{M}{d^2}$ or/of $g = G \frac{M}{r^2}$

WORK, ENERGY AND POWER/ARBEID, ENERGIE EN DRYWING

$W = F \Delta x \cos \theta$	$U = mgh$ or/of $E_p = mgh$
$K = \frac{1}{2} mv^2$ or/of $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$ / $P_{\text{gemid}} = F v_{\text{gemid}}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(\text{max})}$ or/of $E = W_0 + K_{\text{max}}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(\text{max})} = \frac{1}{2} mv_{\text{max}}^2$ or $K_{\text{max}} = \frac{1}{2} mv_{\text{max}}^2$	
$E = W_0 + E_{k(\text{maks})}$ of $E = W_0 + K_{\text{maks}}$ waar $E = hf$ en $W_0 = hf_0$ en $E_{k(\text{maks})} = \frac{1}{2} mv_{\text{maks}}^2$ of $K_{\text{maks}} = \frac{1}{2} mv_{\text{maks}}^2$	



ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	emf ($\mathcal{E}$) = $I(R + r)$ emk ($\mathcal{E}$) = $I(R + r)$
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$ / $I_{\text{wgk}} = \frac{I_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = V_{\text{rms}} I_{\text{rms}}$ / $P_{\text{gemiddeld}} = V_{\text{wgk}} I_{\text{wgk}}$
$V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$ / $V_{\text{wgk}} = \frac{V_{\text{maks}}}{\sqrt{2}}$	$P_{\text{ave}} = I_{\text{rms}}^2 R$ / $P_{\text{gemiddeld}} = I_{\text{wgk}}^2 R$
	$P_{\text{ave}} = \frac{V_{\text{rms}}^2}{R}$ / $P_{\text{gemiddeld}} = \frac{V_{\text{wgk}}^2}{R}$

