KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

PROVINCIAL STANDARDISED ASSESSMENT

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

JUNE 2026

MARKS: 150

TIME: 3 Hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the 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 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Provide brief motivations, discussions, etc., where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE CHOICE QUESTIONS

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

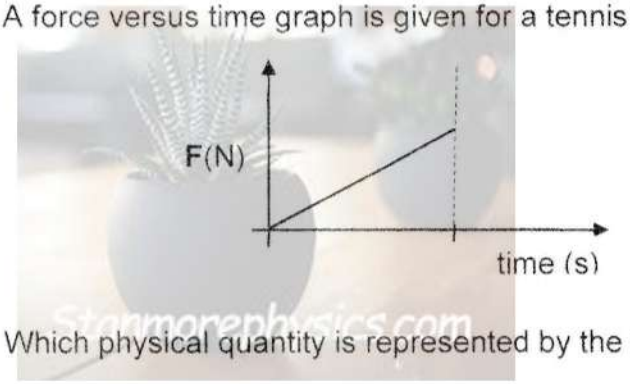
1.1 Which ONE of the following quantities is the tendency of an object to resist a change to its state of motion?

A Weight
B Inertia
C Momentum
D Impulse (2)

1.2 Two spherical objects with masses m_1 and m_2 are placed a distance **d** apart. The two objects exert a gravitational force F on each other.
What will be the gravitational force exerted by the objects on each other if the distance between their centers is doubled?

A $\frac{1}{4}F$
B $\frac{1}{2}F$
C F
D 2F (2)

1.3 A force versus time graph is given for a tennis ball struck by a cricket bat.



Which physical quantity is represented by the **area under the graph**?

A Acceleration.
B Kinetic energy
C Impulse.
D Velocity (2)

1.4 An object is thrown vertically upwards. Which ONE of the following regarding the object's velocity and acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

	VELOCITY	ACCELERATION
A	Zero	Zero
B	Zero	9, 8 $m.s^{-2}$ Upward
C	9, 8 $m.s^{-1}$	Zero
D	Zero	9, 8 $m.s^{-2}$ downward

(2)

1.5 An object is dropped from the top of a tall building, and strikes the ground below after **t** seconds. Which expression gives the distance travelled by the object in the LAST second of its motion?

A $\Delta y = \frac{a(t-1)^2}{2}$

B $\Delta y = \frac{a(2t-1)}{2}$

C $\Delta y = a(2t-1)$

D $\Delta y = \frac{at^2}{2}$

(2)

1.6 The net work done by a constant force **F** that acts on an object to increase its velocity from **0** to **v** is **W**. The net work done by the same force on the object to increase its velocity from **v** to **2v** is ...

A $\frac{1}{3}\mathbf{W}$

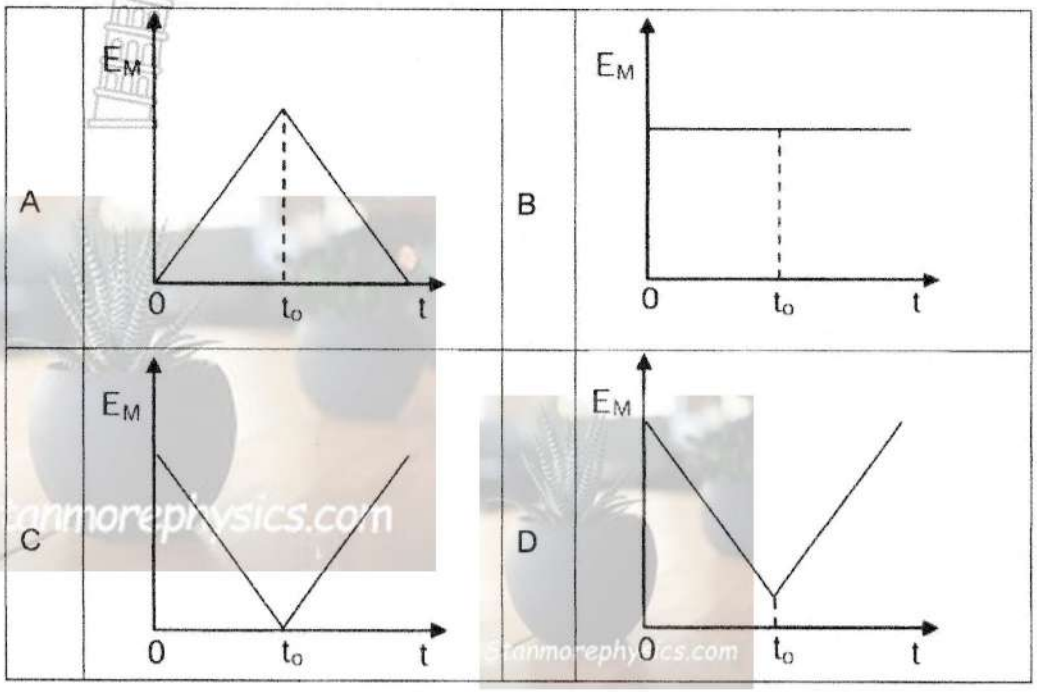
B $\frac{1}{2}\mathbf{W}$

C $2\,\mathbf{W}$

D $3\,\mathbf{W}$

(2)

1.7 A ball is dropped from a height above a floor. The ball makes an elastic collision with the floor at time t_o and bounces vertically upwards. Ignore air resistance. Which ONE of the following graphs shows how the total mechanical energy (E_M) of the ball changes with time?



(2)

1.8 A stationary passenger at a railway station listens to a train approaching at constant speed. Which ONE of the following is CORRECT for the sound of the approaching train heard by the stationary passenger?

A Higher pitch, lower frequency

B Lower pitch, higher frequency

C Higher pitch, higher frequency

D Lower pitch, lower frequency (2)

1.9 A positively charged sphere creates an electric field pointing outward. What happens to an electron placed near the sphere?

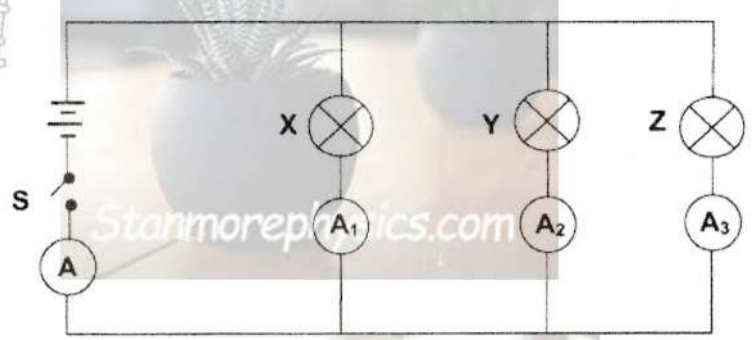
A The electron will move towards the sphere at a constant speed.

B The electron will move away from the sphere at a constant speed.

C The electron will accelerate towards the sphere.

D The electron will accelerate away from the sphere. (2)

1.10 Three light bulbs, **X**, **Y**, and **Z**, are connected in parallel as shown in the circuit diagram below. **X** and **Y** have EQUAL resistance, and **Z**'s resistance is double that of **X**. The battery has negligible internal resistance.
When switch S is closed, all the bulbs light up, and the reading on ammeter **A** is 3 A.



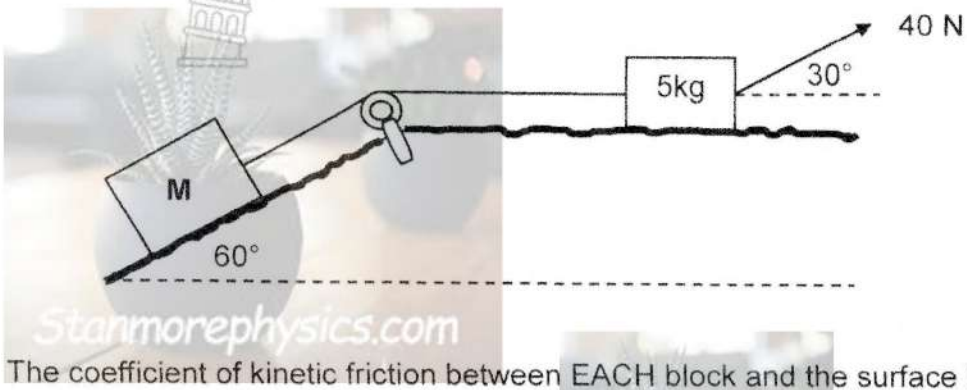
Which ONE of the following correctly describes the ammeter readings (in Amperes) when bulb **X** burns out?

	A	**A_1**	**A_2**	**A_3**
A	3	0	2	1
B	1, 8	0	1, 2	0, 6
C	3	0	1	2
D	1, 8	0	0, 6	1, 2

[20]

QUESTION 2 (Start on a new page).

The diagram below shows a 5 kg block on a horizontal surface, connected by a light, inextensible string passing over a frictionless pulley to a second block, **M**. A 40 N force applied to the 5 kg block at an angle of 30° causes the 5 kg block to move to the LEFT and block M DOWN the inclined surface, which makes an angle of 60° with the horizontal. Both blocks move at CONSTANT VELOCITY.



The coefficient of kinetic friction between EACH block and the surface is 0,7.

2.1 State *Newton's first law* in words. (2)

2.2 Draw a labeled free-body diagram showing ALL the forces acting on the 5 kg block. (5)

2.3 Calculate:

2.3.1 The magnitude of the kinetic frictional force between the 5 kg block and the surface. (3)

2.3.2 The mass of block **M**. (5)

2.4 The angle of the 40 N force on the 5 kg block has now DECREASED, while the blocks continue to move in the original direction.
How will this change affect the following: Choose from INCREASES, DECREASES, or REMAINS THE SAME.

2.4.1 The coefficient of kinetic friction between the blocks and the surface. (1)

2.4.2 The acceleration of the system. (1)

2.4.3 Explain how you arrived at your answer to Question 2.4.2. (3)

2.5 The mass of planet Jupiter is 1, 92 x 10^{27} kg. The average distance between the SURFACE of planet Earth and the center of Jupiter is $6,27 \times 10^{11}$ m.

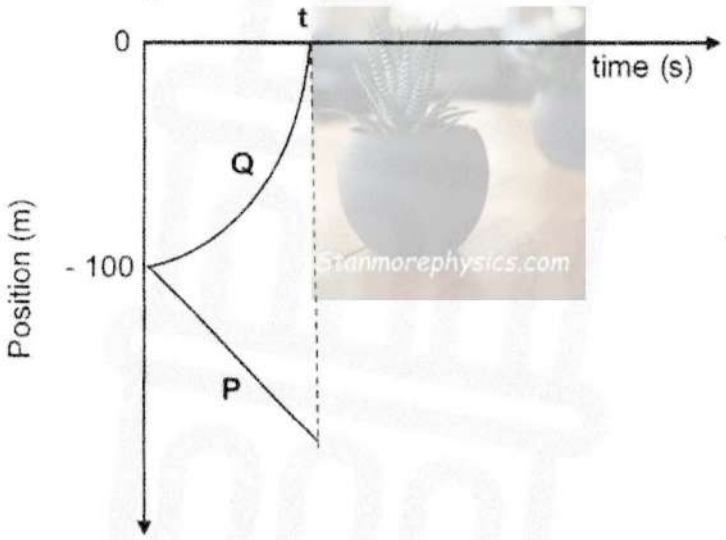
2.5.1 State Newton's law of Universal Gravitation in words. (2)

2.5.2 Calculate the magnitude of the gravitational force that the Earth exerts on Jupiter. (4)

[26]

QUESTION 3 (Start on the new page).

A hot-air balloon is moving vertically upward at a CONSTANT velocity. When the balloon is 100 m above the ground, a ball is thrown vertically downward from the balloon with a velocity EQUAL TO the velocity of the balloon. The position-time graphs below, where **downward is taken as positive**, represent the motion of the hot-air balloon and the ball. Take the ground as the zero position.



3.1 Define the term *free fall*. (2)

3.2 Which one of the graphs above, **P** or **Q**, represents the motion of:

3.2.1 The hot-air balloon? (1)

3.2.2 The ball? (1)

3.3 Write down the magnitude of the ball's velocity immediately after it is thrown from the hot-air balloon. (1)

3.4 Calculate:

3.4.1 The value of **t**, shown on the graph. (4)

3.4.2 The magnitude of the velocity with which the ball hits the ground. (3)

3.5 Three seconds after the ball was thrown, the distance between the hot-air balloon and the ball was 62.1 m.
Calculate the velocity of the hot-air balloon. (5)

3.6 Draw a velocity- time graph for the motion of the ball from the moment it is thrown until it strikes the ground. Indicate the following:

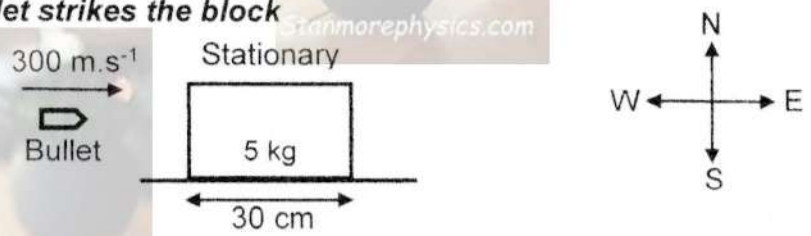
- Initial and final velocity of the ball.
- Time taken by the ball to strike the ground.

(4)
[21]

QUESTION 4 (Start on the new page).

A 5 kg wooden block, 30 cm long, is at rest on a frictionless horizontal surface. A bullet of mass 0, 02 kg is fired horizontally, at a velocity of 300 $m.s^{-1}$, toward the wooden block, as shown in the diagram below.

Just before the bullet strikes the block

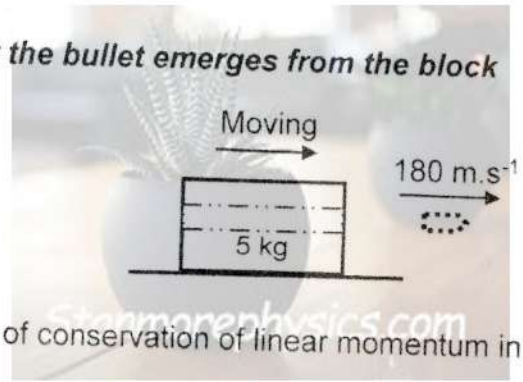


4.1 Define the term momentum in words. (2)

4.2 Calculate the momentum of the bullet just before it strikes the wooden block. (3)

The bullet strikes the block, passes straight through, and emerges with a velocity of 180 $m.s^{-1}$. Assume the bullet's acceleration is constant and that no mass is lost as it moves through the block.

Immediately after the bullet emerges from the block



4.3 State the law of conservation of linear momentum in words. (2)

4.4 Calculate:

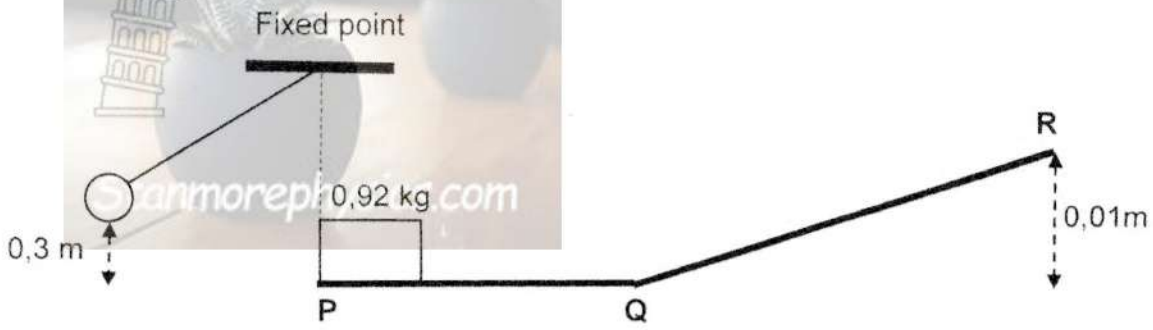
4.4.1 The magnitude of the velocity of the wooden block immediately after the bullet emerges from it. (4)

4.4.2 Calculate the time it takes the bullet to pass through the block. (5)

[16]

QUESTION 5 (Start on the new page).

The diagram below shows a 0,1 kg metal bob held stationary at a height of 0,3 m above the ground and a 0,92 kg block resting on a FRICTIONLESS surface **PQ**. After the bob is released from rest, it collides with the block, causing the block to move to the right.



5.1 State the principle of conservation of mechanical energy. (2)

5.2 Use ENERGY PRINCIPLES to calculate the velocity of the bob just before it collides with the block. (4)

The collision between the bob and the block is ELASTIC.

5.3 Define the term *Elastic collision*. (2)

5.4 Calculate the velocity of the block immediately after the collision. (7)

The block slides past point **Q** and goes up a ROUGH inclined surface **QR**, then stops at point **R**, which is 0, 01 m above the ground.

5.5 Write down the name of ONE non-conservative force acting on the block as it moves from **Q** to **R**. (1)

5.6 Calculate the work done by the non-conservative force identified in Question 5.5. (4)
[20]

QUESTION 6 (Start on the new page).

A traffic police officer places a sound-frequency detector next to the road to monitor the speed of cars passing through a 120 $km.h^{-1}$ speed limit zone. The frequency of sound emitted by a car traveling toward the traffic officer at a constant speed is 228,26 Hz. The detector records a frequency of 250 Hz. Take the speed of sound in air as 340 $m.s^{-1}$.

6.1 Define the term *Doppler Effect*. (2)

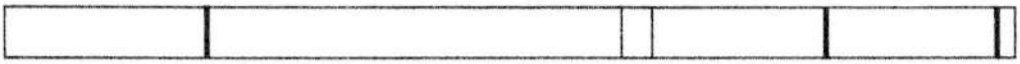
6.2 Use calculations to determine whether the car exceeds the speed limit. (6)

6.3 Calculate the frequency recorded by the detector immediately after the car passes and moves away from the traffic officer. (3)

6.4 A study of spectral lines from various stars can provide valuable information about their motion. The two diagrams below represent different spectral lines of an element:
Diagram 1 represents the spectrum of the element in a laboratory on Earth.
Diagram 2 represents the spectrum of the same element from a distant star.

Diagram 1

Diagram 2

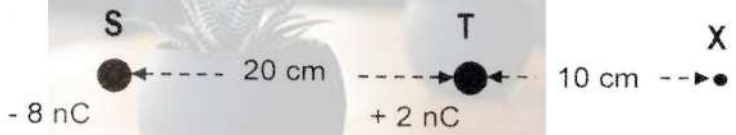


6.4.1 Is the star moving TOWARDS or AWAY FROM the Earth? (1)

6.4.2 Explain your answer in Question 6.4.1. (2)
[14]

QUESTION 7 (Start on the new page).

The diagram below shows two identical spheres, **S** and **T**, each carrying a charge of -8 nC and +2 nC, respectively, placed 20 cm apart in a vacuum. X is a point in space situated 10 cm to the right of sphere T such that it makes a straight line with spheres S and T.



7.1 State *Coulomb's law* in words. (2)

7.2 Calculate the magnitude of the electrostatic force that sphere **S** exerts on sphere **T**. (4)

The spheres are now brought into contact, then separated, and returned to their original positions.

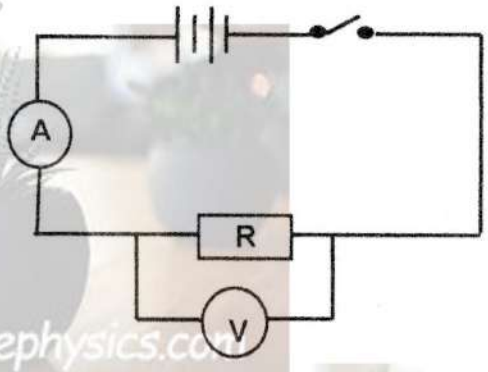
7.3 During contact, were electrons transferred from **S** to **T** or from **T** to **S**? (1)

7.4 Define the term *Electric field at a point*. (2)

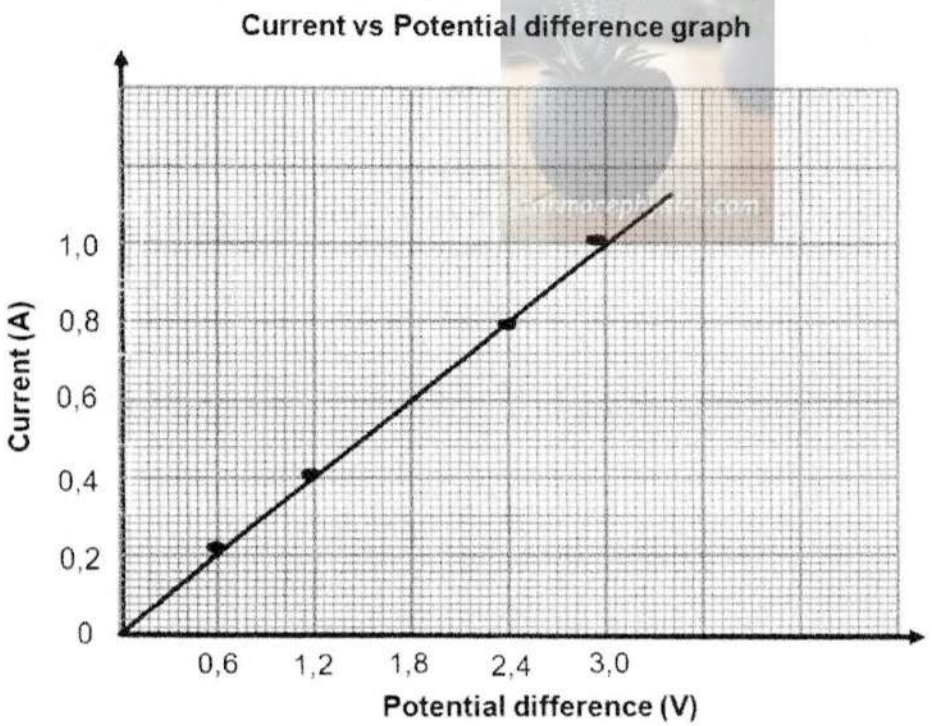
7.5 Calculate the net electric field at point **X**, after separation. (6)
[15]

QUESTION 8 (Start on the new page).

8.1 The circuit diagram below shows a setup used to investigate the relationship between current and potential difference across the ends of a conductor. The Ammeter and Voltmeter readings are taken each time the number of cells in the battery is increased.



The recorded results were used to plot the following graph.

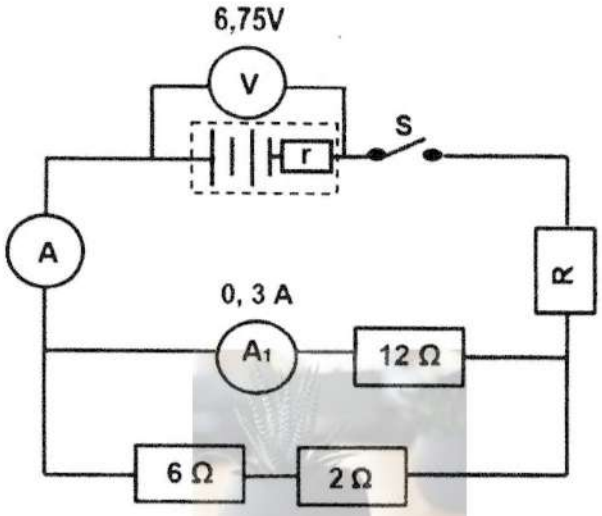


8.1.1 Name and state the law that has been investigated during this experiment. (3)

8.1.2 Use the graph to calculate the value of the resistance R used in this experiment. (3)

8.1.3 How will the gradient of this graph be affected if a resistance of a greater value was used? Write down INCREASES, DECREASES, or REMAINS THE SAME. (1)

8.2 The internal resistance r of the battery in the circuit below is 0,2 Ω. When switch S is open, the voltmeter reads 6, 75 V. The resistance of resistor R is unknown.



8.2.1 Calculate the equivalent resistance of the parallel branch. (3)

When the switch is closed, the ammeter A_1 reads 0, 3 A.

Calculate:

8.2.2 The current in the Ammeter A. (4)

8.2.3 The resistance of resistor R. (4)
[18]

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

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ 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* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or/*of* $E = W_0 + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or $K_{max} = \frac{1}{2}mv_{max}^2$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

FINAL

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PROVINCIAL STANDARDISED ASSESSMENT

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

MARKING GUIDELINES

JUNE 2026

Marks: 150

This marking guidelines consists of 6 pages.

QUESTION 1

1.1 B ✓✓ (2)

1.2 A ✓✓ (2)

1.3 C ✓✓ (2)

1.4 D ✓✓ (2)

1.5 B ✓✓ (2)

1.6 D ✓✓ (2)

1.7 B ✓✓ (2)

1.8 C ✓✓ (2)

1.9 C ✓✓ (2)

1.10 B ✓✓ (2)

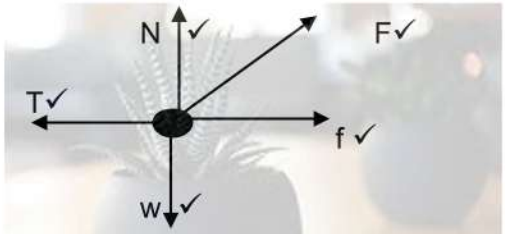
[20]

QUESTION 2

2.1 A body will remain in its state of rest or motion at constant velocity unless a (non-zero) resultant/net force acts on it. ✓✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. (2)

2.2



Accept	
F_N	Normal force
F_A	Applied force
F_T	Tension force
F_g	Weight

(5)

2.3.1 $F_k = \mu_k N$ ✓
$F_k = \mu_k(mg - F\sin\theta)$ } Any of the TWO
$=0,7[(5\times9.8) - (40\sin30°)]$ ✓
$= 20,30N$ ✓ (3)

2.3.2 **POSITIVE MARKING FROM 2.3.1**
5 kg block
$F_{net} = ma$ ✓
$T - F\cos\theta - f_k = ma$ } Any of the TWO
$T - 40\cos30° - 20,30$ ✓ $= 0$ ✓
$T = 54,94$ N
Block M
$F_{net} = ma$
$mg\sin\theta - \mu_k mg\cos\theta - T = ma$
$m(9,8)\sin60° - (0,7)m(9,8)\cos60° - 54,94$ ✓ $= 0$
$m = 10,86kg$ ✓ (5)

2.4.1 Remains the same. ✓ (1)

2.4.2 Decreases. (Accept increases - the acceleration changes from zero) (1)

2.4.3 By decreasing the angle:
- The horizontal component of the applied force (F_x) increases. ✓
- The kinetic friction experienced by the 5 kg block increases. ✓
- The net force decreases. ✓ (3)

2.5.1 Each body in the universe attracts every other body with a force that is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres. ✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. (2)

2.5.2 $F = \frac{Gm_1m_2}{r^2}$ ✓
$= \frac{6,67\times10^{-11}\times5,98\times10^{24}\times1,92\times10^{27}}{(6,38\times10^{6}+6,27\times10^{11})^2}$ ✓ ✓
$F = 1,95\times10^{18}N$ ✓ (4)

[26]

QUESTION 3

3.1 The motion during which the only force acting on an object is the gravitational force. ✓✓ (2/0) (2)

3.2.1 P ✓ (1)

3.2.2 Q ✓ (1)

3.3 0 ($m.s^{-1}$) ✓ (1)

3.4.1 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓

100✓$= \{0\Delta t + \frac{1}{2}(9.8)\Delta t^2\}$✓

$\Delta t = 4,52s$✓

OR

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$✓

-100✓$= 0\Delta t + \frac{1}{2}(-9.8)\Delta t^2$✓

$\Delta t = 4,52s$✓

OR

$v_f^2 = v_i^2 + 2a\Delta y$

$= (0)^2 + 2(9,8)(100)$

$v_f = 44,27 m\cdot s^{-1}$

$\Delta x = \frac{(v_i+v_f)}{2}\Delta t$✓

100✓$= \frac{(0+44,27)}{2}\Delta t$✓

$\Delta t = 4,52s$✓ (4)

3.4.2 **POSITIVE MARKING FROM 3.3**
Option 1 (DOWN AS POSITIVE)

$v_f^2 = v_i^2 + 2a\Delta y$✓

$= (0)^2 + 2(9,8)(100)$✓

$v_f = 44,27 m\cdot s^{-1}$✓

POSITIVE MARKING FROM 3.3 & 3.4.1
Option 2(DOWN AS POSITIVE)

$v_f = v_i + a\Delta t$✓

$= 0 + 9,8(4,52)$✓

$v_f = 44,30 m\cdot s^{-1}$✓

(3)

3.5 $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$\Delta y = 0 + \frac{1}{2}(9.8).3^2$✓

$\Delta y = 44,1$ m

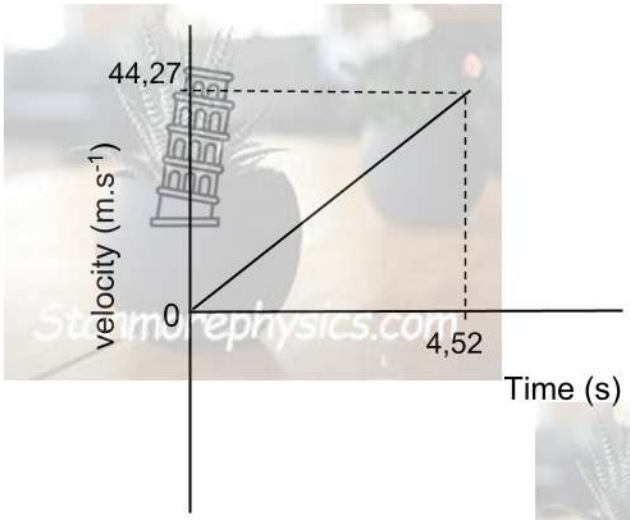
Height traveled by hot-air balloon = 62,1 – ✓ 44,1 = 18 m.

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ (Or $\Delta y = v.\Delta t$) ✓

$18 = v.\ 3 + 0$ ✓

$= 6 m\cdot s^{-1}$ upwards✓ (5)

3.6 DOWN AS POSITIVE



(4)

Criteria	
Correct shape	✓
Initial velocity	✓
Final velocity	✓
Time taken for the ball to strike the ground	✓

[21]

QUESTION 4

4.1 The product of an object's mass and its velocity. ✓✓ (2)

4.2 $p = mv$ ✓
$= 0,02 \times 300$ ✓
$= \underline{6\ kg.m.s^{-1}, East}$/To the right ✓ (3)

4.3 The <u>total linear momentum</u> of an <u>isolated system</u> <u>remains constant</u> (is conserved). ✓✓ Stanmorephysics.com

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

(2)

4.4.1 POSITIVE MARKING FROM 4.2
$m_1v_i + m_2v_i = m_1v_f + m_2v_f$ ✓
$(0,02 \times 300)$ ✓ $+ 0 = (0,02 \times 180) + 5v_f$ ✓
$v_f = 0,48\ m.s^{-1}$ ✓ (4)

4.4.2 **OPTION 1**

$v_f^2 = v_i^2 + 2a\Delta y$

180^2 ✓$= \underline{300^2 + 2a(0, 3)}$ ✓

$a = -\ 96000\ m.s^{-2}$

$v_f = v_i + a\Delta t$ ✓

$\underline{180 = 300 + (-96000)\Delta t)}$ ✓

$\Delta t = 0, 00125$ s. ✓

$\Delta x = v_i\Delta t + ½\ a\Delta t$ ✓

$\underline{0, 3 = 300\Delta t + ½\ (-96000)\ \Delta t^2}$ ✓

$\Delta t = 0, 00125$ s ✓

OPTION 2

$v_f^2 = v_i^2 + 2a\Delta y$

$\underline{180^2 = 300^2 + 2a(0, 3)}$ ✓

$a = -\ 96000\ m.s^{-2}$

Fnet=ma

= 0,02 x 96000 ✓

= 1920 N

$F_{net}\Delta t = \Delta p$ ✓

$F_{net}\Delta t = m(v_f - v_i)$

$\underline{1920 \times \Delta t = 0,02\ (180 - 300)}$ ✓

$\Delta t = 0, 00125$ s. ✓

OPTION 3

Wnet = ΔEk

$F_{net}\Delta x\cos\theta = ½\ m(v_f^2 - v_i^2)$

Fnet x 0, 3 x cos180° ✓$= ½\ 0, 02\ (180^2 - 300^2)$ ✓

Fnet= 1920 N

$F_{net}\Delta t = \Delta p$ ✓

$F_{net}\Delta t = m(v_f - v_i)$

$\underline{1920 \times \Delta t = 0,02\ (180 - 300)}$ ✓

$\Delta t = 0, 00125$ s. ✓

(5)
[16]

QUESTION 5

5.1 The total mechanical energy of an isolated system is conserved. ✓✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. Stanmorephysics.com (2)

5.2 $mgh_i + \frac{1}{2}mv_i^2 = mgh_f + \frac{1}{2}mv_f^2$ ✓
$(0,1)(9,8)(0,3)$ ✓ $+ 0 = 0 + \frac{1}{2}(0.1)(v)^2$ ✓
$v = 2,42\ m.s^{-1}$ ✓ (4)

5.3 A collision during which (both momentum and) kinetic energy are conserved. ✓✓ (2)

5.4 **POSITIVE MARKING FROM 5.2**
$m_1v_i + m_2v_i = m_1v_f + m_2v_f$ ✓
$(0,1 \times 2,42)$ ✓ $+ 0 = 0,1\ v_{f1} + 0,92\ v_{f2}$ ✓
$0,242 = 0,1\ v_{f1} + 0,92\ v_{f2}$ … eqn (1)
$\sum E_{kbefore} = \sum E_{kafter}$
$\frac{1}{2}mv_i^2 + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_i^2 + \frac{1}{2}mv_i^2$ ✓
$\{\frac{1}{2}(0,1)\ 2,42^2$ ✓ $+ 0 = \{\frac{1}{2}0,1\ v_{f1}^2 + \frac{1}{2}0,92\ v_{f2}^2\}$ ✓
$0,29 = 0,05\ v_{f1}^2 + 0,46\ v_{f2}^2$ … eqn (2)
$V_{f2} = 0,48\ m.s^{-1}$ ✓ (7)

5.5 Frictional force. ✓ (1)

5.6 **POSITIVE MARKING FROM 5.4**
OPTION 1
$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$Wnc = (0,92)(9,8)(0,01)$ ✓ $- 0 + (0-)\frac{1}{2}(0.92)(0,48)^2$ ✓
$Wnc = -0,016\ J$ ✓

OPTION 2
$Wnet = \Delta Ek$ ✓
$Wnet = \frac{1}{2}mv_i^2 + \frac{1}{2}mv_i^2$
$= 0 - \frac{1}{2}(0.92)(0,48)^2$ ✓
$= -0,106\ J$
$Wnet = W_N + W_{Fg} + W_{fk}$
$-0,106 = 0 + (0,92 \times 9,8 \times 0,01 \times \cos 180^o) + W_{fk}$ ✓
$W_{fk} = -0,016\ J$ ✓ (4)

[20]

QUESTION 6

6.1 The change in frequency of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓
Or
The change in frequency of the sound detected by a listener due to the relative motion between the source of the sound and the listener. ✓✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. Stanmorephysics.com

(2)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

250✓$= \left(\frac{340+0}{340-v_s}\right)$ ✓ 228, 26 ✓

$v_s = 29,57\ m.s^{-1}$ ✓

$120km.h^{-1} = 33,33\ m.s^{-1}$ which is greater than $29,57\ m.s^{-1}$, therefore car does not exceed the speed limit. ✓

(6)

6.3 **POSITIVE MARKING FROM 6.2**

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$

$F_L = \left(\frac{340 - 0}{340+29,57}\right)$ ✓ 228, 26 ✓

$F_L = 210\ Hz$ ✓

(3)

6.4.1 Away ✓ (1)

6.4.2 Spectral lines of the star show a red shift✓, which is a shift towards longer wavelengths (lower frequency end) ✓ (2)

[14]

QUESTION 7

7.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

(2)

7.2 $F = \frac{kQ_1Q_2}{r^2}$✓

$F = \frac{(9\times10^{9}\times8\times10^{-9}\times2\times10^{-9})}{(0,2)^2}$ ✓✓

$F = 3 \times 10^{-6}$N✓

(4)

7.3 **S** to **T**✓ (1)

7.4 The electric field at a point is the electrostatic force experienced per unit positive charge placed at that point. ✓✓

Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.

(2)

7.5 $E_S = \frac{kQ}{r^2}$ ✓

$= \{\frac{9\times10^{9}\times3\times10^{-9}}{(0,3)^2}\}$✓

$= 300$ N.C^{-1} to the left.

$E_T = \frac{kQ}{r^2}$

$= \{\frac{9\times10^{9}\times3\times10^{-9}}{(0,1)^2}\}$✓

$= 2700$ N.C^{-1} to the left.

$E_{net} = E_S + E_T$

$E_{net} = 300 +$ ✓2700

$= 3000$ N.C^{-1} ✓ to the left ✓

(6)
[15]

QUESTION 8

8.1.1 Ohm's law. ✓
The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓
Marking criteria
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
(3)

8.1.2 Gradient = $\frac{\Delta I}{\Delta V}$
$= \frac{(1,0-0,2)\checkmark}{(3,0-0,6)\checkmark}$ (any two correct points can be used)
$= \frac{1}{3}$
Resistance = 3 Ω ✓ (3)

8.1.3 Decreases. ✓ (1)

8.2.1 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_P} = \{\frac{1}{12} + \frac{1}{(6+2)}\}$ ✓

RP= 4, 8 Ω ✓

OR

$R_p = (\frac{1}{R_1} + \frac{1}{R_2})^{-1}$)✓

$R_p = (\frac{1}{12} + \frac{1}{(6+2)})^{-1}$ ✓

RP= 4, 8 Ω ✓ (3)

8.2.2 V = IR
= 0, 3 x 12 ✓
= 3, 6 V
$I_2 = \frac{V}{R}$
$= \frac{3,6}{8}$ ✓
= 0, 45 A
$I = I_1 + I_2$ = (0, 3 +✓ 0, 45)
I = 0, 75 A ✓ (4)

8.2.3

8.2.3 $V_{lost} = Ir$
V_{lost} = 0, 75 x 0.2 ✓= 0, 15 V (4)

$V_R = \varepsilon - V_{lost} - V_P = (6,75 - 0,15 - 3,6)$ ✓ = 3 V

$R = \frac{V}{I}$

$= \frac{3}{0,75}$ ✓

R = 4 Ω ✓

[18]

TOTAL [150]