KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

JUNE EXAMINATION

2025

MARKS: 150

TIME: 3 hours

This question paper consists of 11 pages and 3 data sheets.

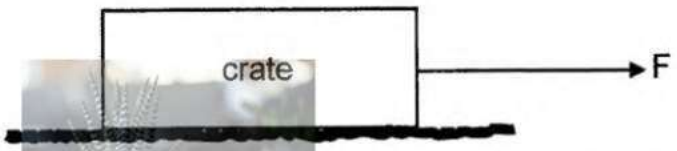
INSTRUCTIONS AND INFORMATION

1. This question paper consists of EIGHT 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. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions et cetera where required.
10. You are advised to use the attached DATA SHEETS.
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. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 A horizontal force F is applied to a crate, causing it to move over a rough, horizontal surface as shown below.



The kinetic frictional force between the crate and the surface on which it is moving depends on …

A the applied force F.
B how fast the crate moves on the surface.
C the surface area of the crate in contact with the floor.
D the upward force exerted by the surface on the crate. (2)

1.2 Two forces, F_1 and F_2, can be represented with a single force of 8 N. If the magnitude of F_1 is 3 N, which one of the following can be the magnitude of force F_2?

A 3 N
B 4 N
C 10 N
D 13 N (2)

1.3 Two hypothetical planets, X and Y, have the same mass. The diameter of planet Y is twice that of planet X.

If the acceleration due to gravity on the surface of planet X is g, then the acceleration due to gravity on the surface of planet Y will be …

A $\frac{1}{4}g$
B $\frac{1}{2}g$
C $\frac{1}{16}g$
D $2g$

(2)

1.4 A ball is thrown vertically upwards into the air. Ignore the effects of air friction. The NET FORCE acting on the ball when the ball is at its highest point is ...

A zero.
B equal to the weight of the ball.
C less than the weight of the ball.
D greater than the weight of the ball. (2)

1.5 Which ONE of the following statements is always TRUE for inelastic collisions in an isolated system?

A Both momentum and kinetic energy are conserved.
B Both momentum and kinetic energy are not conserved.
C Momentum is conserved, but kinetic energy is not conserved.
D Kinetic energy is conserved, but momentum not conserved. (2)

1.6 An object moving horizontally at a constant velocity suddenly encounters a rough horizontal surface. The object continues to move over this rough surface. Which ONE of the following statements is CORRECT?

The net work done on the object during the motion over the rough surface is ...

A zero
B positive
C negative
D constant (2)

1.7 The hooter of a car emits sound of constant frequency as the car moves away from a stationary listener.

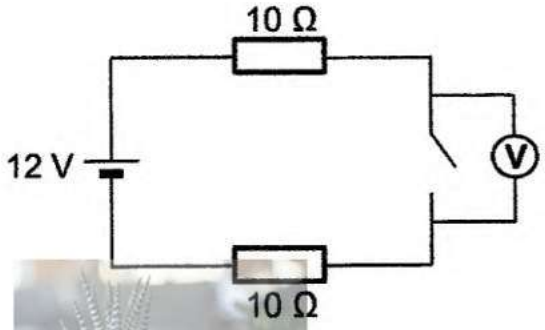
Which ONE of the following properties of the sound heard by the listener will NOT change?

A Speed
B Frequency
C Both frequency and loudness
D Both wavelength and frequency (2)

1.8 Two point charges, each with charge +q, are placed a distance d apart. The force experienced by each point charge has a magnitude F. The charges are now both doubled and the distance between them is halved. The magnitude of the force experienced by each point charge is ...

A 2F
B 4F
C 8F
D 16F (2)

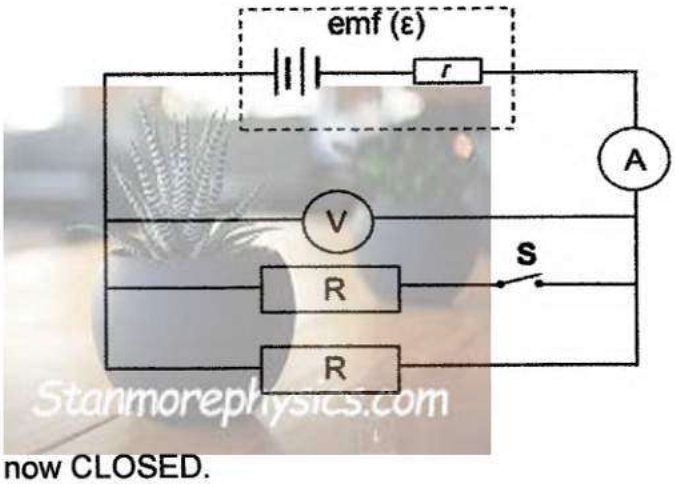
1.9 In the circuit shown below, the switch is open. The reading on the voltmeter is:



A 0 V
B 6 V
C 12 V
D 0,6 V

(2)

1.10 In the circuit below the battery has an emf (ε) and internal resistance r. With switch **S** open, readings are registered on the ammeter and voltmeter.



Switch **S** is now CLOSED.

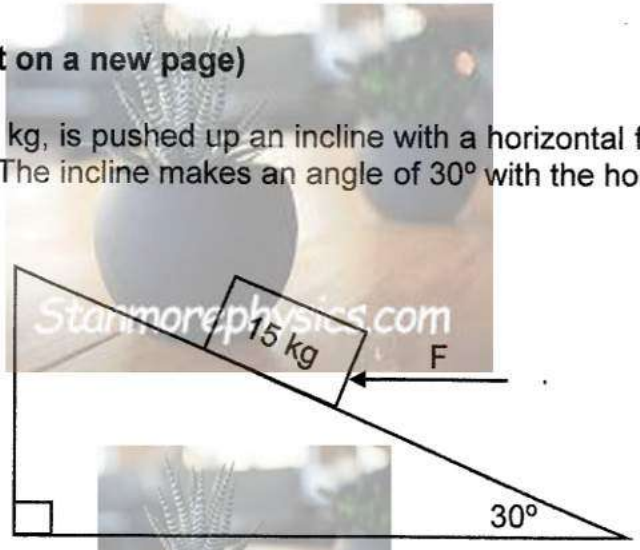
How do the readings on the ammeter and voltmeter change?

	AMMETER READING	VOLTMETER READING
A	increases	remains the same
B	increases	decreases
C	decreases	remains the same
D	decreases	decreases

(2)
[20]

QUESTION 2 (Start on a new page)

A block, of mass 15 kg, is pushed up an incline with a horizontal force F, as shown in the diagram below. The incline makes an angle of 30° with the horizontal.



The coefficient of kinetic friction between the block and the surface is 0,20.

2.1 Define the term *kinetic frictional force*. (2)

2.2 Draw a labelled free-body diagram showing ALL the forces acting on the block. (4)

2.3 The block moves up the plane at a CONSTANT VELOCITY.

2.3.1 State Newton's First Law of Motion in words. (2)

2.3.2 Calculate the magnitude of the force F. (6)

2.4 A satellite that is 1000 km above the surface of the Earth is accelerating towards the Earth. If the weight of the satellite at 1000 km above the surface of the Earth is 3 800 N, calculate its weight on the surface of the Earth. (5)

[19]

QUESTION 3 (Start on a new page)

A ball of mass 0,5 kg is dropped from a height of 1,2 m onto a hard floor. It bounces to a maximum height of 0,8 m. The floor exerts a force of 50 N on the ball.

Ignore the effects of air friction.

3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)

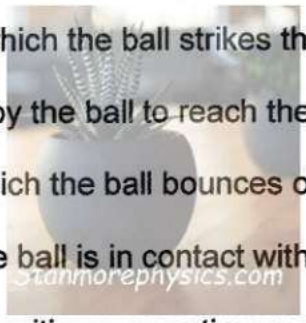
3.2 Calculate the:

3.2.1 Velocity at which the ball strikes the floor (4)

3.2.2 Time taken by the ball to reach the floor from the moment it is dropped (3)

3.2.3 Speed at which the ball bounces off the floor (3)

3.2.4 Time that the ball is in contact with the floor (4)



3.3 Sketch a graph of position versus time representing the entire motion of the ball. USE THE GROUND AS ZERO REFERENCE.

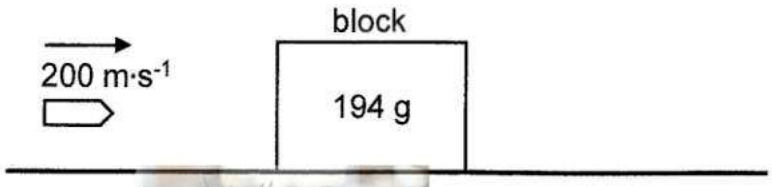
Indicate the following on the graph:

- Height from which the ball is dropped
- Height reached by the ball after the bounce
- Time at which the ball reaches the floor
- Time at which the ball bounces off the floor (5)

[21]

QUESTION 4 (Start on a new page)

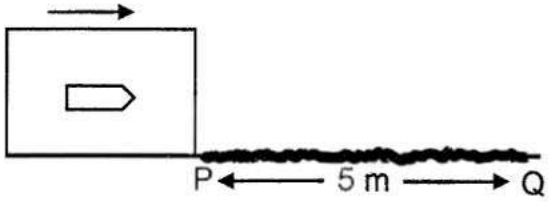
A bullet of mass 6 g is shot horizontally into a 194 g wooden block, which is at rest on a horizontal surface. The bullet hits the block with a velocity of 200 $m \cdot s^{-1}$ and remains stuck in the block. Ignore the effects of friction.



4.1 State the *principle of conservation of linear momentum* in words. (2)

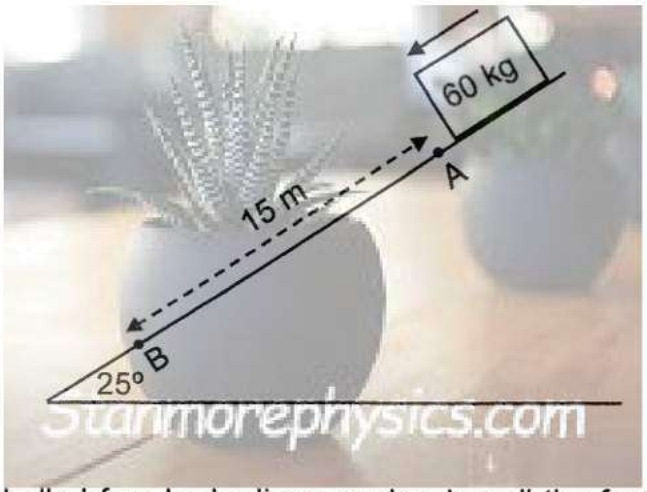
4.2 Calculate the speed of the block-bullet system immediately after the bullet struck the block. (4)

Immediately after the impact, the block-bullet system enters a rough section PQ, which is 5 m long, before coming to rest at Q.



4.3 Calculate the acceleration of the block-bullet system. (4)

4.4 A box, of mass 60 kg, slides down a rough incline which makes an angle of 25° with the horizontal. The box experiences a constant frictional force of 180 N.



4.4.1 Draw a labelled free-body diagram showing all the forces acting on the box. (3)

4.4.2 Write down the name of the force which does zero work on the box. (1)

The box now passes point A on the incline at a speed of 4 m·s^{-1} before passing point B, which is 15 m lower down the incline.

4.4.3 Calculate the kinetic energy of the box as it passes point A. (3)

4.4.4 Calculate the magnitude of the resultant force acting on the box between point A and B. (2)

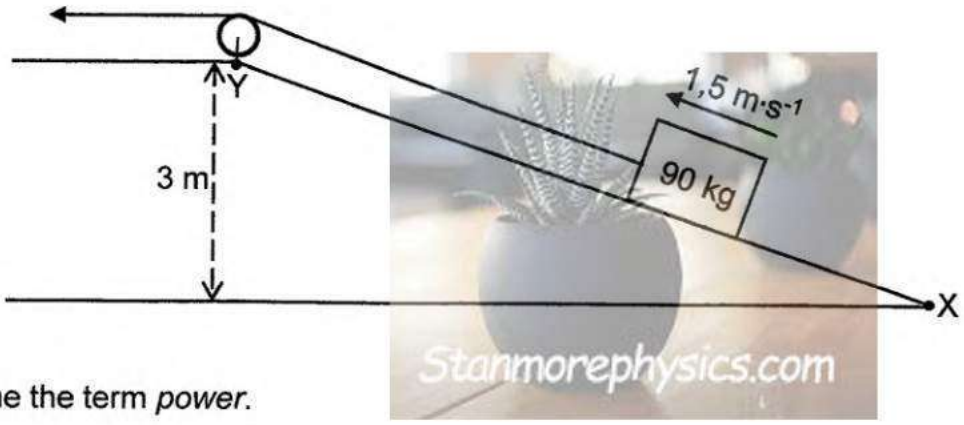
4.4.5 State the *work-energy theorem* in words. (2)

4.4.6 Use the WORK-ENERGY THEOREM to calculate the speed of the box as it passes point B. (4)

[25]

QUESTION 5 (Start on a new page)

A 200 W motor operating at 85% efficiency pulls a crate of mass 90 kg up a slope at a constant speed of 1,5 m·s^{-1}. It takes 30 s to raise the crate from point X to Y of the slope.



5.1 Define the term *power*. (2)

5.2 Calculate the:

5.2.1 Energy supplied by the motor to the crate in 30 s (4)

5.2.2 Gain in gravitational potential energy of the crate between X and Y (3)

5.2.3 Magnitude of the frictional force acting on the crate between X and Y (5)

[14]

QUESTION 6 (Start on a new page)

A traffic officer is sitting in a police car which is travelling at a constant velocity. The siren of the police car emits sound waves of frequency 1500 Hz.

A detector that is placed on the side of the road records a frequency of 1695 Hz. The police car takes 1,5 s to reach the detector.

Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1 Name and state the phenomenon described above. (3)

6.2 Write down ONE medical instrument that makes use of the phenomenon in QUESTION 6.1. (1)

6.3 Calculate the distance between the police car and the detector. (5)

6.4 Draw a graph of the frequency heard by the traffic officer sitting in the police car as it moves towards and away from the detector versus time.

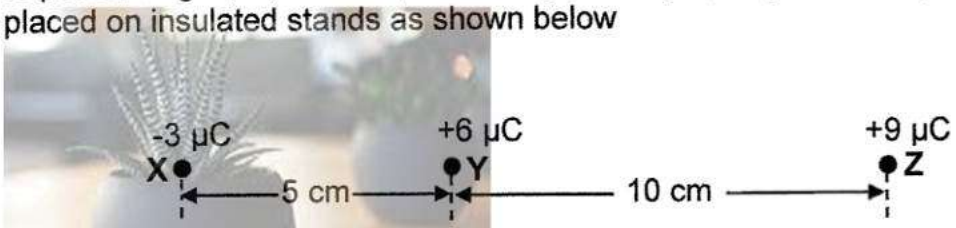
Indicate the following on the graph:

- The frequency heard by the traffic officer
- Time taken by police car to reach the detector

(2)
[11]

QUESTION 7 (Start on a new page)

Three point charges, **X**, **Y** and **Z**, with charges of -3 µC, +6 µC and +9 µC respectively, are placed on insulated stands as shown below



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

7.2 Calculate the net force acting on point charge **Z**. (5)

7.3 Point charges **X** and **Y** are brought into contact and then separated.

Point charge **X** is returned to its original position, while point charge **Y** is removed.

7.3.1 In which direction did electrons flow? Choose from **X** to **Y** or **Y** to **X**. (1)

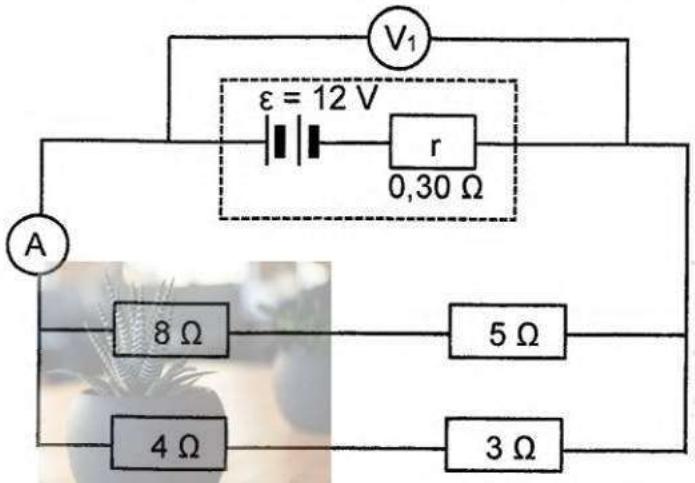
7.3.2 Calculate the number of electrons transferred to or from point charge **X**. (4)

7.3.3 Point **T** is placed between point charges **X** and **Z**.

Calculate the distance between point charges **X** and **T** where the net electric field is equal to zero. (4)
[16]

QUESTION 8 (Start on a new page)

The battery in the circuit below has an emf of 12 V and internal resistance 0,30 Ω. The resistance of the connecting wires and ammeter can be ignored.



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

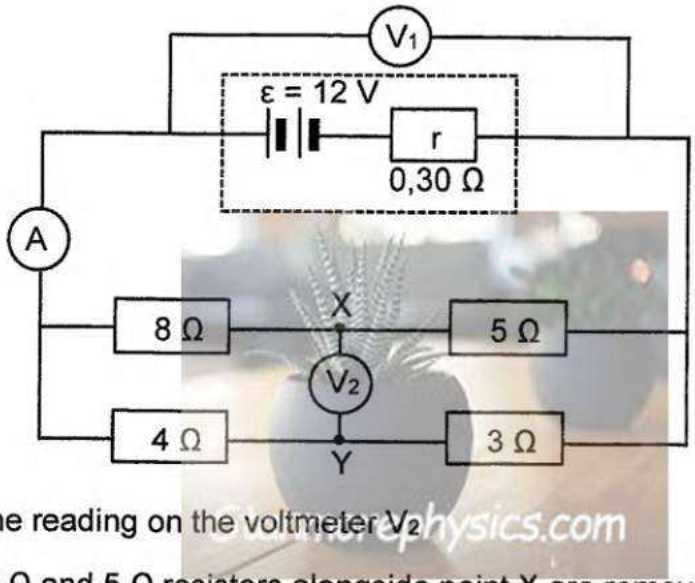
8.2 Determine the:

8.2.1 Total external resistance of the circuit (3)

8.2.2 Reading on ammeter A (3)

8.2.3 Current through the 8 Ω resistor (4)

The voltmeter V_2 with a very high resistance is now placed between points X and Y, as shown in the diagram below.



8.3 Calculate the reading on the voltmeter V_2. (4)

8.4 When the 8 Ω and 5 Ω resistors alongside point X are removed, the reading on voltmeter V_1 increases. Explain this observation. (3)

8.5 The cost of energy is R2,59 per kWh. How many 80 W light bulbs can you have on for 8 hours per day if your budget for lighting is R300 per month? Assume that an average month has 30 days. (5)

[24]

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

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

$F_{net} = ma$	$p = mv$
$f_s^{(max)} = \mu_s N$	$f_k = \mu_k N$
$w = mg$	$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gem} = Fv_{gem}$	

WAVES, SOUND AND LIGHT/GOLWE, KLANK EN LIG

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

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

FINAL

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EDUCATION
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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1

2025 JUNE EXAMINATION

MARKING GUIDELINES

MARKS: 150

These marking guidelines consist of 11 pages.

QUESTION 1

1.1 D✓✓ (2)

1.2 C ✓✓ (2)

1.3 A ✓✓ (2)

1.4 B ✓✓ (2)

1.5 C ✓✓ (2)

1.6 C ✓✓ (2)

1.7 A ✓✓ (2)

1.8 D ✓✓ (2)

1.9 C ✓✓ (2)

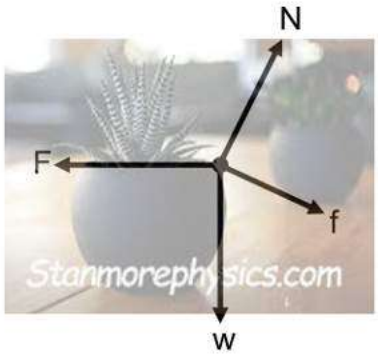
1.10 B ✓✓ (2)

[20]

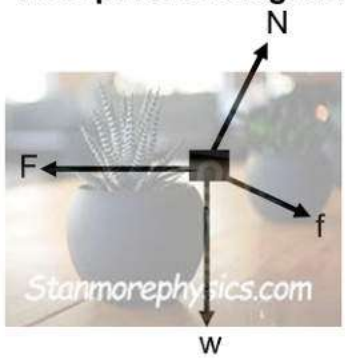
QUESTION 2

2.1 Force that opposes the motion of a moving object relative to the surface. ✓✓ (2)

2.2



Accept force diagram:



Accepted labels	
w	F_g/ F_w/ weight/gravitational force✓
F	F_a/applied force✓
f	(kinetic) friction/F_f/f_k✓
N	F_N /Normal/F_{normal} ✓

Notes
- Mark awarded for label and arrow.
- Do not penalise for length of arrows since drawing is not to scale.
- Any other additional force(s): Max $^{3}/_{4}$
- If everything correct, but no arrows: Max/*Maks* $^{3}/_{4}$

(4)

2.3.1 **Marking criteria**

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

A body will remain in its state of rest or motion at constant velocity unless a non-zero resultant/net force acts on it.✓✓ (2)

2.3.2

$F_{net} = ma$
$F\cos\Theta + mg\sin\Theta + f_k = ma$ } ✓ Any one

$F\cos30° - (15)(9,8)\sin30°$ ✓ $- 0,2$✓✓$[F\sin30° + (15)(9,8)\cos30°)]$ ✓ $= 0$✓

$F = 129,19$ N ✓ (6)

2.4

OPTION 1 $g = \frac{G M_E}{r^2}$ $= \frac{(6,67\times10^{-11})((5,98\times10^{24})}{(6,38\times10^{6}+1000\times10^{3})^2}$ ✓ $= 7,32\ m\cdot s^{-2}$	$w = mg$ $3800 = m(7,32)$ ✓ $m = 518,88$ kg $w = mg$ ✓ $= (518,88)(9,8)$ ✓ $= 5085,02$ N ✓
OPTION 2 $F = \frac{GmM_E}{R^2}$ ✓ 3800 ✓$= \frac{GmM_E}{(R+1X10^6)^2}$ ✓ $3800\ (\ 6,38x10^6 + 1x10^6)^2 = F(6,38x10^6)^2$ ✓ $F=5084,58N$✓	
OPTION 3 $3800 = \frac{GmM_E}{(R+1X10^6)^2}$ ✓ $3800 = \frac{(6,67X10^{-11})(m)(5,98\times10^{24})}{(6,38X10^6 + 1X10^6)^2}$ ✓ $m = 518,88$ kg $w = mg$ ✓ $= (518,88)(9,8)$ ✓ $= 5085,02$ N ✓	

(5)

[19]

QUESTION 3

3.1 50 N✓ downwards✓ (2)

3.2.1

OPTION 1 (Accept if 0^2 is omitted) **UPWARDS AS POSITIVE**	**OPTION 2** (Accept if 0^2 is omitted) **UPWARDS AS NEGATIVE**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $= \underline{(0)^2 + (2)(-9,8)(-1,2)}$ ✓ $v_f = 4,85\ m{\cdot}s^{-1}$ ✓ downwards✓	$V_f^2 = v_i^2 + 2a\Delta y$ ✓ $= \underline{(0)^2 + (2)(9,8)(1,2)}$ ✓ $v_f = 4,85\ m{\cdot}s^{-1}$ ✓ downwards✓

(4)

3.2.2

OPTION 1 **UPWARDS AS POSITIVE** **POSITIVE MARKING FROM Q 3.2.1**	**OPTION 1** **UPWARDS AS NEGATIVE** **POSITIVE MARKING FROM Q 3.2.1**
$v_f = v_i + a\Delta t$ ✓ $[\underline{-4,85 = 0 + (-9,8)\ \Delta t}\ ]$✓ $\Delta t = 0,49$ s ✓	$v_f = v_i + a\Delta t$ ✓ $[\underline{4,85 = 0 + (9,8)\ \Delta t}\ ]$✓ $\Delta t = 0,49$ s ✓
OPTION 2 **UPWARDS AS POSITIVE** **POSITIVE MARKING FROM Q 3.2.1**	**OPTION 2** **UPWARDS AS NEGATIVE** **POSITIVE MARKING FROM Q 3.2.1**
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $[-1,2 = \left(\frac{0 - 4,85}{2}\right)\Delta t]$ ✓ $\Delta t = 0,49$ s ✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $[1,2 = \left(\frac{0 + 4,85}{2}\right)\Delta t\ ]$✓ $\Delta t = 0,49$ s ✓
OPTION 3 **UPWARDS AS POSITIVE**	**OPTION 3** **UPWARDS AS NEGATIVE**
$\Delta y = v_i\,\Delta t + \frac{1}{2}a\,\Delta t^2$ ✓ $[-1,2 = 0 + \frac{1}{2}(-9,8)\,\Delta t^2]$ ✓ $\Delta t = 0,49$ s ✓	$\Delta y = v_i\,\Delta t + \frac{1}{2}a\,\Delta t^2$ ✓ $[1,2 = 0 + \frac{1}{2}(9,8)\,\Delta t^2]$ ✓ $\Delta t = 0,49$ s ✓

(3)

3.2.3

OPTION 1 **UPWARDS AS POSITIVE**	**OPTION 1** **UPWARDS AS NEGATIVE**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = v_i^2 + (2)(-9,8)(0,8)}$ ✓ $v_i = 3,96\ m{\cdot}s^{-1}$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $\underline{0 = v_i^2 + (2)(9,8)(-0,8)}$ ✓ $v_i = -3,96\ m{\cdot}s^{-1}$ $v_i = 3,96\ m{\cdot}s^{-1}$ ✓
OPTION 2 $(U + K)_{top} = (U + K)_{bottom}$ ✓ $(mgh + \frac{1}{2}mv^2)_{top} = (mgh + \frac{1}{2}mv^2)_{bottom}$ $[(0,5)(9,8)(0,8) + 0 = 0 + (\frac{1}{2})(0,5)\,v^2]$✓ $v = 3,96\ m{\cdot}s^{-1}$✓	

(3)

3.2.4 **POSITIVE MARKING FROM QUESTIONS 3.2.1 & 3.2.3**

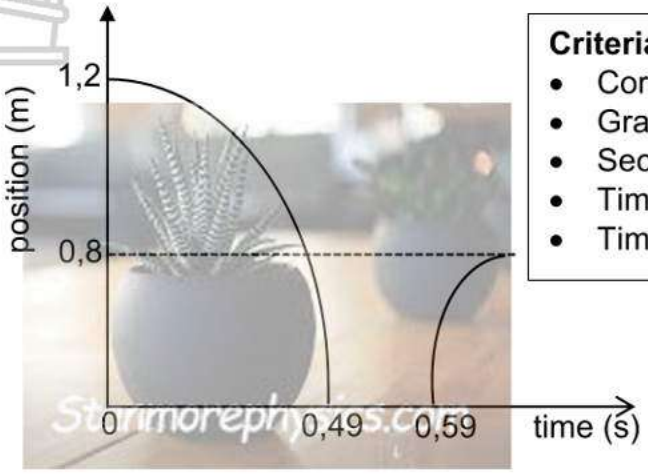
$F_{net}\Delta t = m(v_f - v_i)$ ✓

$F_{floor} + F_g = m(v_f - v_i)$

$\underline{50 - (0,5)(9,8)\Delta t}$ ✓ $= 0,5[3,96 - (-4,85)]$ ✓

$\Delta t = 0,098$ s ✓ (4)

3.3 **POSITIVE MARKING FROM Q 3.2.2**



Criteria
- Correct shape✓
- Graph starts at 1,2 m at t = 0✓
- Second maximum height at 0,8 m✓
- Time at which ball reaches the floor✓
- Time at which ball leaves the floor✓

(5)

[21]

QUESTION 4

4.1 **Marking criteria**

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

In an <u>isolated</u> system the total <u>linear momentum is conserved/remains constant</u>. ✓✓ (2)

4.2

TO THE RIGHT AS POSITIVE

$\sum p_i = \sum p_f$
$m_b v_{ib} + m_{bl} v_{ibl} = (m_b + m_{bl}) v_f$ } ✓Any one

$\underline{(0,006)(200)} + 0$ ✓ $= (0,006 + 0,194)\, v_f$ ✓

$v_f = 6$ m·s^{-1} ✓

TO THE RIGHT AS NEGATIVE

$\sum p_i = \sum p_f$
$m_b v_{ib} + m_{bl} v_{ibl} = (m_b + m_{bl}) v_f$ } ✓Any one

$\underline{(0,006)(-200)} + 0$ ✓ $= (0,006 + 0,194)\, v_f$ ✓

$v_f = -6$ m·s^{-1}

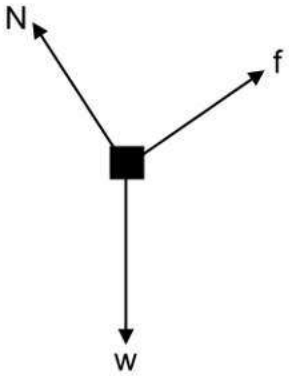
$= 6$ m·s^{-1} ✓ (4)

4.3

OPTION 1	OPTION 2
$v_f^2 = v_i^2 + 2a\Delta x$ ✓ 0^2✓ $= (6)^2 + 2a(5)$ ✓ $a = -3,6\ m\cdot s^{-2}$ $= \underline{3,6\ m\cdot s^{-2}, \text{ to the left}}$ ✓	$W_{net} = \Delta K$ $f\Delta x\cos\Theta = \frac{1}{2}m(v_f^2 - v_i^2)$ $f(5)(\cos180°) = \frac{1}{2}(0,2)(0^2 - 6^2)$ ✓ $f = 0,72\ N$ $F_{net} = ma$ ✓ $\underline{-0,72 = 0,2a}$ ✓ $a = -3,6$ $= \underline{3,6\ m\cdot s^{-2}, \text{ to the left}}$ ✓

(4)

4.4.1



Accepted labels	
w	F_g/ F_w/ weight/gravitational force✓
f	(kinetic) friction/F_f/f_k✓
N	F_N /Normal/F_{normal} ✓

Notes

- Mark awarded for label and arrow.
- Do not penalise for length of arrows since drawing is not to scale.
- Any other additional force(s): Max ⅔
- If everything correct, but no arrows: Max/*Maks* ⅔

(3)

4.4.2 Normal force✓

(1)

4.4.3 $K = \frac{1}{2}mv^2$✓

$= \frac{1}{2}(60)(4)^2$✓

$= 480\ J$✓

(3)

4.4.4 $F_{net} = mg\sin\Theta - f$

$= \underline{(60)(9,8)(\sin25°) - 180}$ ✓

$= 68,5\ N$✓

(2)

4.4.5 **Marking criteria**

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

Work done on an object by a net force is equal to the change in object's kinetic energy. ✓✓ (2)

4.4.6 **POSITIVE MARKING FROM QUESTIONS 4.4.3 & 4.4.4**

$W_{net} = \Delta K$ ✓

$F_{net}\Delta t = K_f - K_i$

$(68,5)(15)\cos 0°$ ✓ $= [\frac{1}{2}(60)v^2 - 480]$ ✓

$v = 7,09\ m\cdot s^{-1}$ ✓ (4)

[25]

QUESTION 5

5.1 Rate at which work is done / energy is expended. ✓✓ (2)

5.2.1

$P = \frac{W}{\Delta t}$ ✓

$(0,85)(200)$ ✓ $= \frac{W}{30}$ ✓

$W = 5100\ J$ ✓ (4)

5.2.2

$U = mgh$ ✓

$= (90)(9,8)(3)$ ✓

$= 2646\ J$ ✓ (3)

5.2.3

$P_{ave} = Fv_{ave}$

$(0,85)(200) = F(1,5)$ ✓

$F = 113,33\ N$

$v = \frac{\Delta x}{\Delta t}$

$1,5 = \frac{\Delta x}{30}$ ✓

$\Delta x = 45\ m$

$F_{net} = ma$ ✓Any one

$F + f + F_g = ma$

$[113,33 - f - (90)(9,8)(\frac{3}{45}) = 0]$ ✓

$f = 54,53\ N$ ✓

$Cos\theta = \frac{3}{45}$

(5)

[14]

QUESTION 6

6.1 Doppler Effect. ✓ The change in frequency of sound detected by a listener because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (3)

6.2 Doppler flow meter / Doppler ultrasound machine✓ (1)

6.3

$$f_L = \frac{v}{v - v_s} \cdot f_s \checkmark$$

$$1695 \checkmark = \frac{340}{340 - v_s} \cdot (1500) \checkmark$$

$$v_s = 39{,}12 \text{ m·s}^{-1}$$

OPTION 1

$$v = \frac{\Delta x}{\Delta t}$$

$$39{,}12 = \frac{\Delta x}{1{,}5} \checkmark$$

$$\Delta x = 58{,}68 \text{ m} \checkmark$$

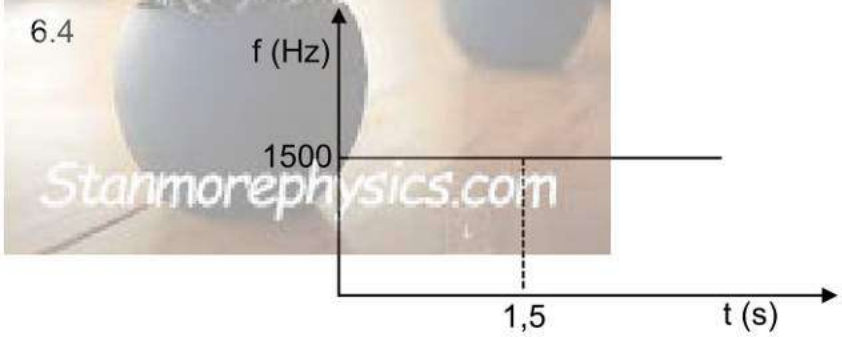
OPTION 2

$$\Delta x = \left(\frac{39{,}12 + 39{,}12}{2}\right)(1{,}5)$$

$$= 58{,}68\text{m}$$

(5)

6.4



Criteria
- Correct shape✓
- 1,5 s and 1500 Hz✓

(2)
[11]

QUESTION 7

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

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

(2)

7.2

OPTION 1	OPTION 2
$F = \frac{kQ_1Q_2}{r^2}$ ✓	$E = \frac{kQ}{r^2}$
$F_{XZ} = \frac{(9\times10^9)(3\times10^{-6})(9\times10^{-6})}{(0,15)^2}$ ✓	$E_{XZ} = \frac{(9\times10^9)(3\times10^{-6})}{(0,15)^2}$ ✓
$= 10,8$ N	$= 1,2\times10^6$ N·C^{-1}
$F_{YZ} = \frac{(9\times10^9)(6\times10^{-6})(9\times10^{-6})}{(0,1)^2}$ ✓	$E_{YZ} = \frac{(9\times10^9)(6\times10^{-6})}{(0,1)^2}$ ✓
$= 48,6$ N	$= 5,4\times10^6$ N·C^{-1}
$F_{net} = 48,6 - 10,8 = 37,8$ N to the right ✓	$E_{net} = 5,4\times10^6 - 1,2\times10^6$
	$= 4,2\times10^6$ N·C^{-1}
	$F_{net} = QE$ ✓
	$= (9\times10^{-6})(4,2\times10^6)$ ✓
	$= 37,8$ N to the right ✓

(5)

7.3.1 X to Y ✓ (1)

7.3.2 $Q = \frac{Q_1 + Q_2}{2}$

$= \frac{(-3\times10^{-6}) + (6\times10^{-6})}{2}$ ✓

$= 1,5\times10^{-6}$ C

$n = \frac{Q}{q_e}$ ✓

$= \frac{(1,5\times10^{-6}) - (-3\times10^{-6})}{1,6\times10^{-19}}$ ✓

$= 2,81\times10^{13}$ (electrons) ✓ (4)

7.3.3 $E = \frac{kQ}{r^2}$ ✓

$\frac{(9\times10^9)(1,5\times10^{-6})}{r^2}$ ✓ $= \frac{(9\times10^9)(9\times10^{-6})}{(0,15 - r)^2}$ ✓

$r = 0,04$ m ✓

(4)
[16]

QUESTION 8

8.1 **Marking criteria**
If any of the underlined key words/phrases in the correct context is omitted, deduct 1 mark
The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓

(2)

8.2.1

OPTION 1	OPTION 2
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓ $= \frac{1}{13} + \frac{1}{7}$ ✓ $R_p = 4,55\ \Omega$ ✓	$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$ ✓ $= \frac{13 \times 7}{13 + 7}$ ✓ $= 4,55\ \Omega$ ✓

(3)

8.2.2 **POSITIVE MARKING FROM QUESTION 8.2.1**

$\varepsilon = I(R+r)$ ✓
$12 = I(4,55 + 0,3)$ ✓
$I = 2,47$ A ✓

(3)

8.2.3 $V_{external} = IR$
$= (2,47)(4,55)$ ✓
$= 11,24$ V

I through 8 Ω
$I = \frac{V}{R}$ ✓
$= \frac{11,24}{13}$ ✓
$= 0,8646$ A ✓

(4)

8.3 **POSITIVE MARKING FROM QUESTION 8.2.3**

$V_{5\Omega} = IR$ $= (0,8646)(5)$ ✓ $= 4,323$ V	$I_{3\Omega} = 2,47 - 0,8646 = 1,6054$ $V_{3\Omega} = IR$ $= (1,6054)(3)$ ✓ $= 4,816$ V
$\therefore V_2 = 4,816 \overset{\checkmark}{-} 4,323$ $= 0,49$ V ✓ **(Range: 0,49 – 0,53 V)**	

(4)

8.4
- Total resistance increases ✓
- Total current decreases ✓
- $V_{internal}$ (lost volts) decreases ✓

(3)

8.5 Cost = energy × tariff

$300 \checkmark = (P \times \underline{8 \times 30}) \times 2{,}59 \checkmark$

$P = 482{,}625\ W \checkmark$

$\text{no. of bulbs} = \frac{482{,}625}{80} \checkmark$

$= 6 \checkmark$

(5)
[24]

TOTAL: 150