education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCE: PHYSICS (P1)

SEPTEMBER 2026

MARKS: 150

TIME: 3 hours

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

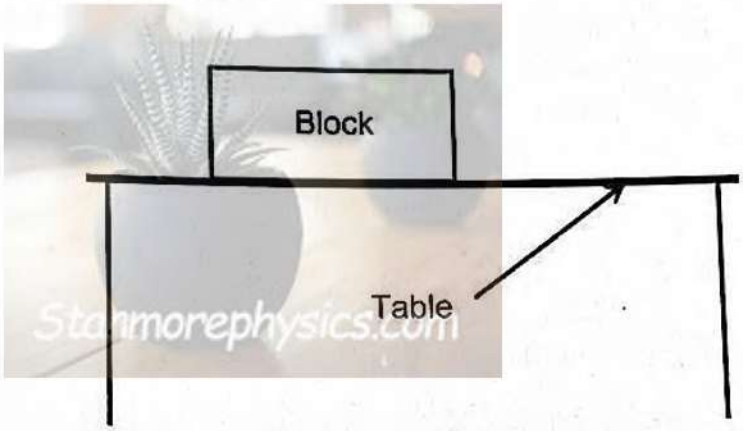
INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of TEN 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 subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
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, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 A block is resting on a table as shown below. What is the reaction force to the weight of the block?



A The force of the table on the block.

B The force of the block on the table.

C The force of the block on the Earth.

D The force of the Earth on the block. (2)

1.2 A ball is projected vertically upwards with a velocity of 12 $m \cdot s^{-1}$ from the top of a building and it returns after some time. (Air friction is ignored).

Which of the following combinations of velocity and acceleration is true about the ball when it is at its maximum height?

	VELOCITY	ACCELERATION
A	12 $m \cdot s^{-1}$	0 $m \cdot s^{-2}$
B	0 $m \cdot s^{-1}$	12 $m \cdot s^{-2}$
C	12 $m \cdot s^{-1}$	9,8 $m \cdot s^{-2}$
D	0 $m \cdot s^{-1}$	9,8 $m \cdot s^{-2}$

(2)

1.3 Impulse is equal to the ...

A rate of change of momentum of an object.

B change in momentum of an object.

C rate of change of kinetic energy of an object.

D change in kinetic energy of an object. (2)

1.4 The power provided by an electrical motor is 40 W. What is the energy provided by the motor over a period of three hours?

A 432 000 J

B 7 200 J

C 120 J

D 13,33 J (2)

1.5 A source produces sound with a frequency of 800 Hz.

Scenario 1: The source approaches a stationary listener with velocity **v** and the listener records a frequency of f_1.

Scenario 2: The listener approaches a stationary source with velocity **v** and he records a frequency of f_2.

Which ONE of the following mathematical expressions are CORRECT regarding the two scenarios?

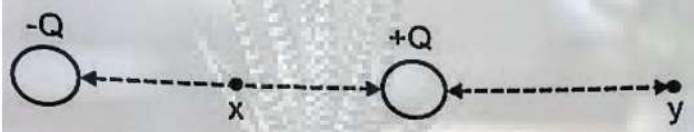
A $f_1 < f_2 < 800$ Hz

B $f_1 > f_2 > 800$ Hz

C $f_2 < f_1 < 800$ Hz

D $f_2 > f_1 > 800$ Hz (2)

1.6 Two charged spheres of **-Q** and **+Q** are put on a straight line. **X** and **Y** are two points that lie on the same straight line with the charged spheres as shown below.

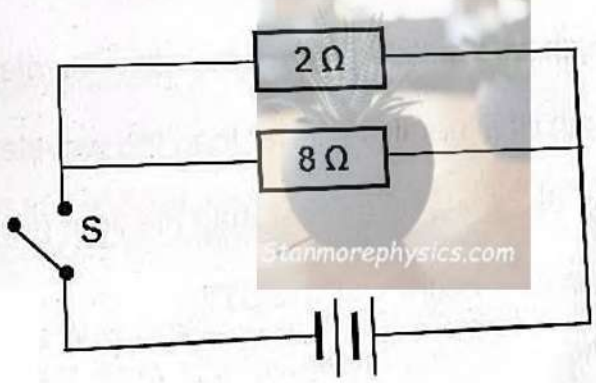


Which ONE of the following correctly represents the directions of the RESULTANT electric field strengths at points **X** and **Y**?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD STRENGTH AT X	DIRECTION OF THE RESULTANT ELECTRIC FIELD STRENGTH AT Y
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

1.7 In the circuit diagram shown below, the power dissipated by the 4 Ω resistor is equal to **P**.



The power dissipated by the 8 Ω resistor is ...

A ½ **P**

B ¼ **P**

C 2 **P**

D 4 **P**

(2)

1.8 Fleming's Left hand rule is used to determine the direction of ...

A current flow in a circuit.

B induced emf in a conductor.

C magnetic field around a conductor.

D force experienced by a current-carrying conductor in a magnetic field. (2)

1.9 The component responsible for delivering current to the external circuit in a DC generator is the ...

A coil.

B battery.

C commutator.

D slip rings. (2)

1.10 An electron will be ejected from a metal surface if the ...

(i) threshold wavelength of a metal is longer than the wavelength of the photon.
(ii) threshold wavelength of a metal is shorter than the wavelength of the photon
(iii) threshold frequency of a metal is greater than the light frequency.

Which of the statements above is/are CORRECT?

A (i) only

B (i) and (ii) only

C (ii) and (iii) only

D (i) and (iii) only

(2)
[20]

QUESTION 2 (Start on a new page.)

A 7,65 kg block moves on a surface **ABCD**. It is first pulled on the rough part **AB** by a force F_1 at a constant velocity of 3 $m \cdot s^{-1}$. Upon reaching point **B**, the force F_1 is removed and the block slides from point **B** to **C** which is a smooth surface. At point **C**, a new force F_2 is applied on the block so that it moves from point **C** to **D**, which is rough, at an acceleration of 0,37 $m \cdot s^{-2}$.

The diagram below shows the motion of the block from point **A** to point **D**.

2.1 Define the term *resultant force*. (2)

2.2 What is the magnitude of the resultant force acting on the block as it moves from point **A** to **B**? (1)

2.3 Draw a labelled force diagram showing all the forces acting on the block as it moves through **AB**. (4)

2.4 What is the magnitude of the velocity of the block when it reaches point **C**? (1)

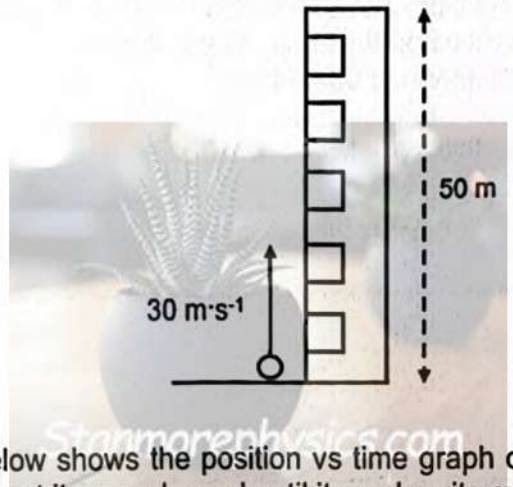
2.5 F_2 has a magnitude of 65 N. Calculate the kinetic frictional coefficient that the block experiences as it moves through **CD**. (4)

2.6 The surface **CD** is now replaced with a new one that has a greater kinetic frictional coefficient. How will this affect the acceleration of the block at **CD**? Write only INCREASE, DECREASE or REMAIN THE SAME.

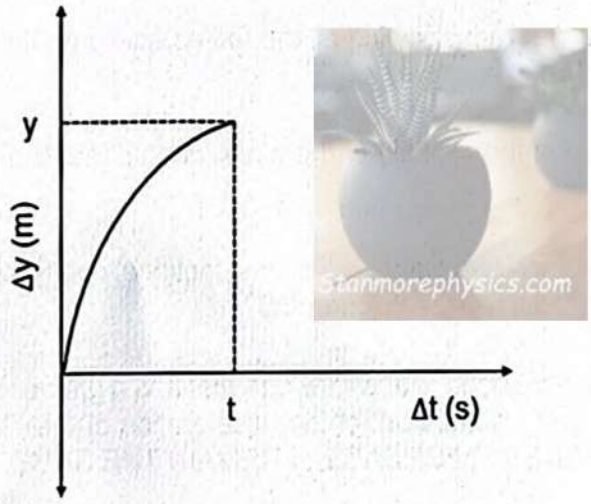
Explain the answer using principles of physics. (4)
[16]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards from the bottom of a 50 m tall building with a velocity of 30 m·s^{-1}.



The graph below shows the position vs time graph of the motion of the ball from the moment it was released until it reaches its maximum height.



Ignore the effects of air friction.

3.1 Define the term *projectile*. (2)

3.2 Using EQUATIONS OF MOTION ONLY:

3.2.1 Determine if **y** is ABOVE or BELOW the top of the building (4)

3.2.2 Calculate the value of **t** (3)

3.3 Draw a labelled velocity vs time graph for the motion of the ball from the moment it was thrown until it reaches its maximum height.

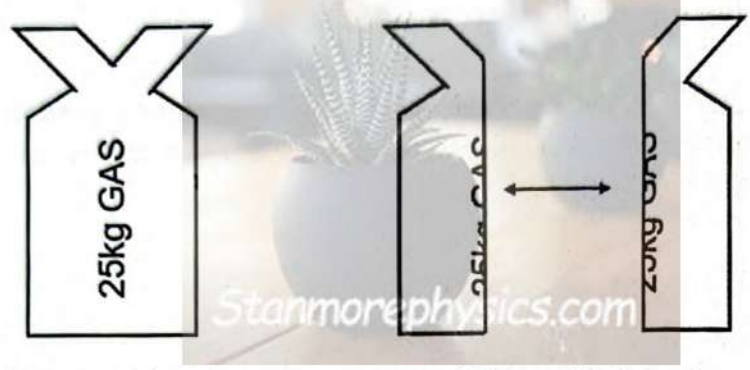
Show the following on the graph:

- Velocity at which the ball was thrown
- Time at which the ball reaches maximum height (2)

3.4 Calculate, using EQUATIONS OF MOTION ONLY, the velocity needed to be added to or subtracted from the 30 $m \cdot s^{-1}$ to ensure that the ball stops at the top of the building. (4)
[15]

QUESTION 4 (Start on a new page.)

A 25 kg gas cylinder rolling to the right in an isolated system at an unknown constant speed, suddenly explodes into two equal pieces **A** and **B**. After the explosion, piece **A** rolls to the left at 1,8 $m \cdot s^{-1}$ and piece **B** rolls to the right. The explosion is **elastic**.



Before explosion After explosion

4.1 Explain what is meant by an *isolated system.* (2)

4.2 Calculate the:

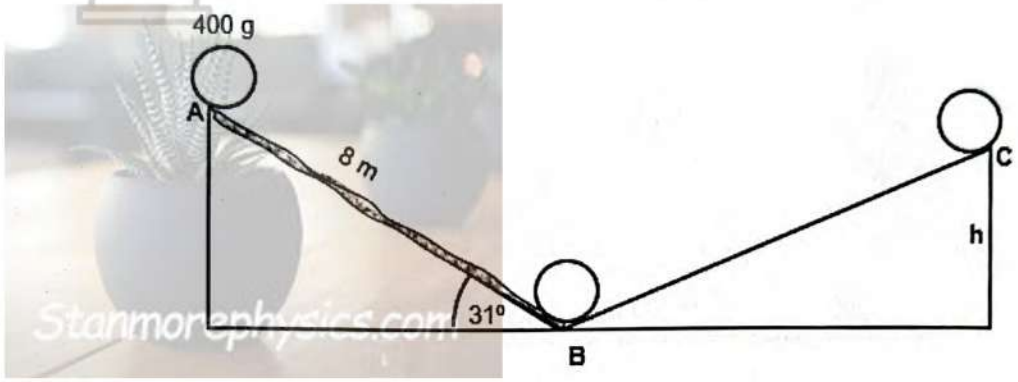
4.2.1 Momentum of piece **A** right after the explosion (4)

4.2.2 Speed of the cylinder before the explosion (6)
[12]

QUESTION 5 (Start on a new page.)

A ball with a mass of 400 g, initially at rest, rolls down a rough incline **AB** of length 8 m that makes an angle of 31° to the horizontal. Upon reaching point **B**, the ball rolls up the second SMOOTH incline and stops at point **C** which is at a height **h** above the ground.

Ignore the rotational effects of the ball as well as air friction.



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

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the ball as it rolls from point **A** to **B**. (3)

The ball experiences a frictional force of 0,22 N.

5.3 Use ENERGY PRINCIPLES ONLY to calculate the:

5.3.1 Speed of the ball at point **B** (4)

5.3.2 Height **h** (3)

5.4 Calculate the work done by friction from point **A** to **B**. (3)
[15]

QUESTION 6 (Start on a new page.)

6.1 Jordan is standing 5 metres away from his phone when it suddenly rings. He hears the pitch of the sound from the phone at a frequency of 290 Hz. He runs towards the phone at a constant speed and reaches it in 0,5 seconds.

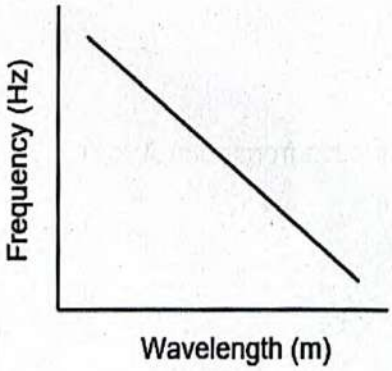
Take the speed of sound in air as 344 $m \cdot s^{-1}$.

6.1.1 State the phenomenon described in the scenario above. (2)

6.1.2 Calculate the speed at which Jordan runs towards the phone. (2)

6.1.3 Calculate the wavelength of the sound that comes from the phone. (6)

6.2 The graph below shows data of a distant star that is moving relative to the Earth.



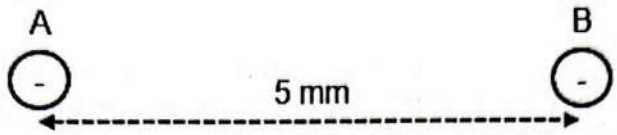
6.2.1 Is the star moving towards or away from the Earth? (1)

6.2.2 Explain your answer in QUESTION 6.2.1. (2)

[13]

QUESTION 7 (Start on a new page.)

Two identical negatively charged spheres **A** and **B** are placed 5 mm apart. Charge **A** experiences an electrostatic force of 12,4 N as a result of **B**.



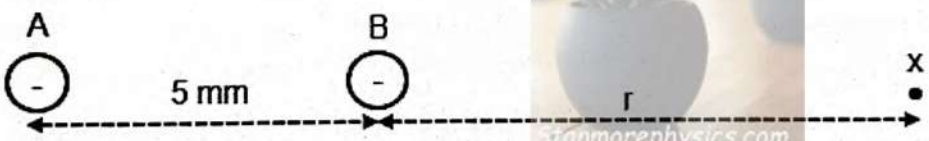
7.1 Draw the resultant electric field pattern that exists between charges **A** and **B**. (3)

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

7.3 Calculate the charge on each sphere. (4)

7.4 How many electrons in excess does sphere **B** have? (3)

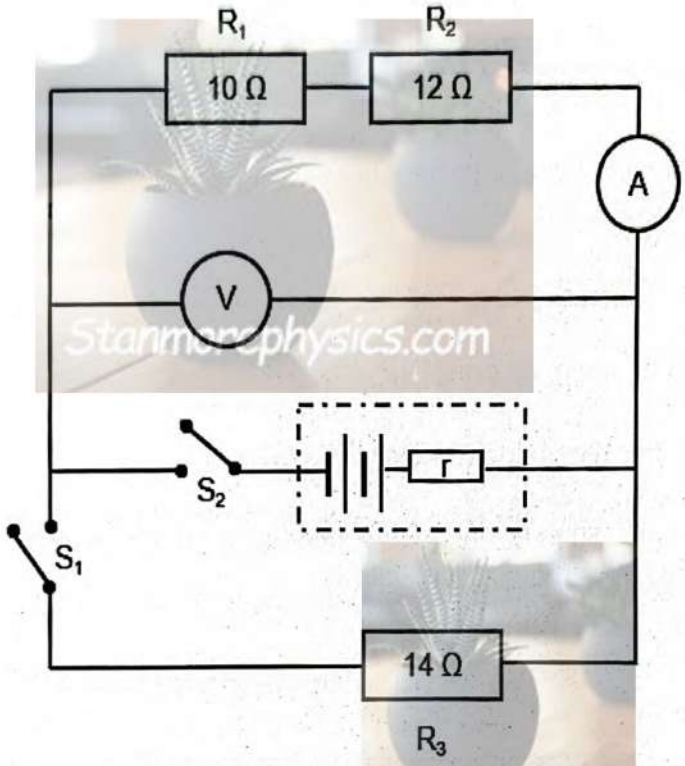
A net electric field strength of 7 500 $N.C^{-1}$ is experienced by a point **x**, which is a distance **r** from sphere **B**. See the diagram below.



7.5 Calculate the magnitude of **r**. (6)
[18]

QUESTION 8 (Start on a new page.)

The circuit diagram below shows three resistors, R_1 = 10 Ω, R_2 = 12 Ω and R_3 = 14 Ω, an ammeter of negligible resistance, a voltmeter, and a battery with an internal resistance of 1,8 Ω. The conductors are ohmic.



When both switches are closed, the voltmeter reads 38 V.

8.1 Explain the meaning of the term *ohmic conductor*. (2)

8.2 Calculate the:

8.2.1 Total external resistance of the circuit (4)

8.2.2 Current passing through ammeter A (3)

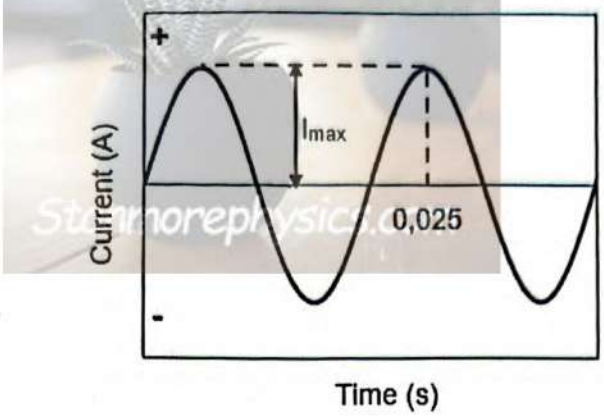
8.2.3 Emf of the battery (4)

Switch S_1 is now OPENED and S_2 remains closed.

8.3 How will the reading on the voltmeter change? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)
[14]

QUESTION 9 (Start on a new page.)

The graph below was drawn using data from an AC generator.



9.1 State the energy conversion that takes place in this generator. (2)

9.2 Calculate the frequency of this generator. (3)

9.3 Define the term *root mean square voltage*. (2)

In investigating the electrodynamic properties of a toaster, a designer measures the maximum value of the current supplied to this toaster by the above generator as 12,4 A. The toaster has an average power rating of 900 W.

9.4 Calculate the:

9.4.1 Root mean square current of this generator (3)

9.4.2 Maximum voltage supplied to the toaster (4)

[14]

QUESTION 10 (Start on a new page.)

A photon of red light with $2,1 \times 10^{-12}$ J is shone onto a metal surface to eject an electron. The maximum kinetic energy of the ejected photoelectron is $1,1 \times 10^{-12}$ J.

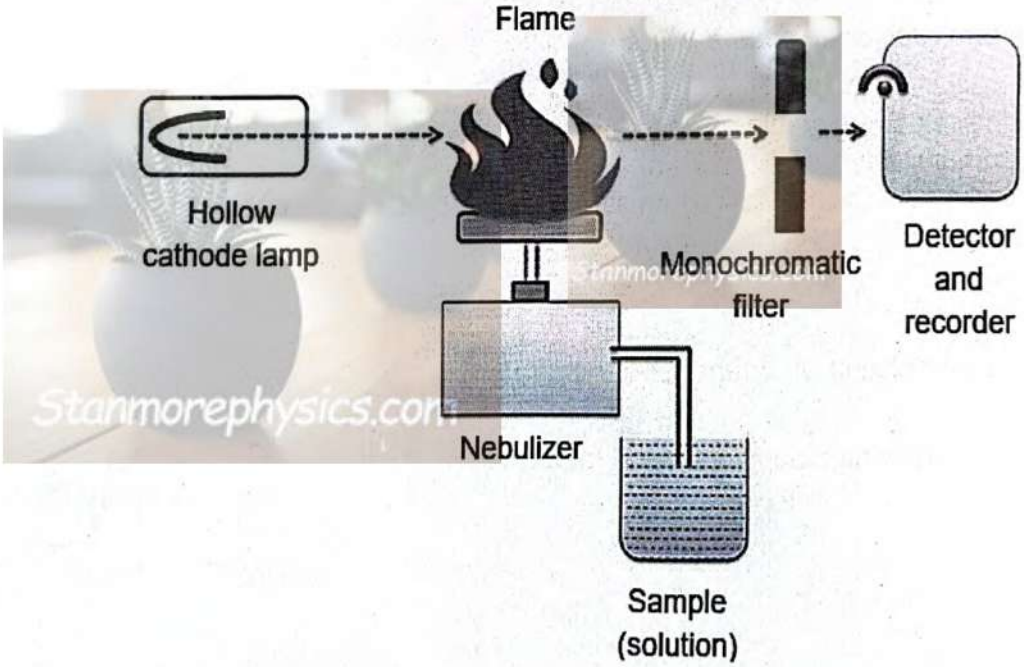
10.1 Define the term *photon*. (2)

10.2 Calculate the:

10.2.1 Maximum speed of the ejected photoelectron (3)

10.2.2 Threshold wavelength of the metal surface upon which the red light is shone (5)

10.3 In the laboratory, a teacher demonstrates how different types of spectra are formed. The teacher uses a light source, hot gas, diffraction grating and a detector in the demonstration.



Name and describe the type of spectrum formed during this demonstration. (3)
[13]

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	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
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 elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$

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

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

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

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

education

Department:
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North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE 12/*GRAAD 12*

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

SEPTEMBER 2026

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 148

These marking guideline consist of 18 pages.
Hierdie nasienriglyne bestaan uit 18 bladsye.

QUESTION/*VRAAG 1*

1.1	C	✓✓	(2)
1.2	D	✓✓	(2)
1.3	B	✓✓	(2)
1.4	A	✓✓	(2)
1.5	B	✓✓	(2)
1.6	D	✓✓	(2)
1.7	Removed/*Verwyder*		
1.8	D	✓✓	(2)
1.9	C	✓✓	(2)
1.10	A	✓✓	(2)

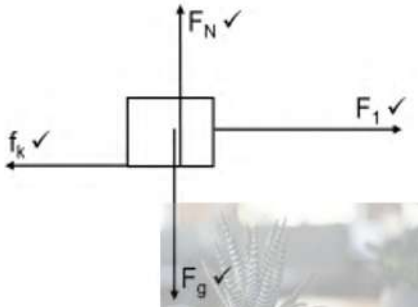
[18]

QUESTION/*VRAAG* 2

2.1 The sum of two or more vectors. ✓✓/ *Die vektorsom van twee of meer vektore.*
OR/*OF*
A single vector having the same effect as two or more vectors together.
'n Enkele vektor wat dieselfde effek het as twee of meer vektore tesame.
(2 or/*of* 0) (2)

2.2 0 (N) ✓ (1)

2.3



Accepted labels/Aanvaarde benoemings	
F_N	N/normal force/*normaalkrag*
F_1	F/Fapp/applied force/F_A/*toegepaste krag*
F_g	F_w/w/gravitational force/weight/*gravitasiekrag/gewig*
f_k	f/f_f/(kinetic) friction/*(kinetiese) wrywing*

***Notes/Aantekeninge*:**
- Mark awarded for label and arrow and the origin of the force./*Punt toegeken vir benoeming en pyltjie en die oorsprong van die krag.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te)*: Max/*Maks* ¾
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* ¾
- If free body diagram drawn/In*dien vryliggaamdiagram geteken*: Max/*Maks* ¾
- If force/s do not originate from point of application/*Indien kragte nie aangedui is vanaf punt waar dit toegepas word nie:* Max/*Maks* ¾

(4)

2.4 3 m·s^{-1} ✓ (1)

2.5

$F_{net} = ma$
$F - f_f = ma$
$65 - f_f = 7,65 \times 0,37$ ✓
$f_f = 62,1695$ N ✓ Both/*Albei*
$f_k = \mu_k F_N / \mu mg / \mu_k N$
$62,1695 = \mu \times (7,65 \times 9,8)$ ✓
$\mu = 0,83$ ✓ (4)

2.6 DECREASE/*AFNEEM* ✓

- A greater kinetic frictional coefficient increases the frictional force/*'n Groter kinetiese wrywingskoëffisiënt verhoog die wrywingskrag*✓
- Increase in friction reduces the net force/*Toename in wrywing verlaag die nettokrag* ✓
- The net force is directly proportional to acceleration/*Die nettokrag is direk eweredig aan versnelling*/F_{net} α a ✓ (4)

[16]

QUESTION/*VRAAG* 3

3.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

If gravity/gravitation without force is used ½
Indien gravitasie sonder krag gebruik word ½

An object which has been given an initial velocity and then moves under the influence of the gravitational force only.✓✓
'n Voorwerp waaraan 'n beginsnelheid gegee is en wat dan slegs onder die invloed van die gravitasiekrag beweeg. (2)

3.2.1

Marking criteria/*Nasienkriteria*

- Below the top of the building/*Onder die bopunt van die gebou*
- Formula with Δy/*Formule met* Δy
- Correct substitution into formula/*Korrekte vervanging in formule*
- Correct final answer/*Korrekte finale antwoord*: 45,92 (m)

NOTE for 3.2.1: If energy principles used ($^2/_4$) for "below" and final answer.

NOTA vir 3.2.1: *Indien energiebeginsels gebruik* ($^2/_4$) *vir "onder" en finale antwoord.*

Below the top of the building/*Onder die bopunt van die gebou*. ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*
(note: v_f and v_i can be switched/*nota: v_f en v_i kan omgeruil word*)

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**	**OPTION/*OPSIE* 3**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$0^2 = 30^2 + 2(-9,8)\Delta y$ ✓	$0 = 30 + (-9,8)(\Delta t)$	$0 = 30 + (-9,8)(\Delta t)$
$\Delta y = 45,92$ (m) ✓	$t = 3,06$ s	$t = 3,06$ s
	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = \frac{v_i + v_f}{2} \times \Delta t$ ✓
	$= 30(3,06) + \frac{1}{2}(-9,8)(3,06^2)$ ✓	$\Delta y = \boxed{\frac{0 + 30}{2} 3,06}$ ✓
	$\Delta y = 45,92$ (m) ✓	$\Delta y = 45,92$ (m) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

OPTION/*OPSIE* 4	**OPTION/*OPSIE* 5**	**OPTION/*OPSIE* 6**
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f = v_i + a\Delta t$	$v_f = v_i + a\Delta t$
$0^2 = -30^2 + 2(9,8)\Delta y$ ✓	$0 = -30 + (-9,8)(\Delta t)$	$0 = -30 + (-9,8)(\Delta t)$
$\Delta y = -45,92$	$t = 3,06$ s	$t = 3,06$ s
$\Delta y = 45,92$ (m) ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓	$\Delta y = \frac{v_i + v_f}{2} = \Delta t$ ✓
	$= -30(3,06) + \frac{1}{2}(9,8)(3,06^2)$ ✓	$\Delta y = \boxed{\frac{0 + (-30)}{2} 3,06}$ ✓
	$\Delta y = -45,92$	$\Delta y = -45,92$
	$\Delta y = 45,92$ (m) ✓	$\Delta y = 45,92$ (m) ✓

(4)

3.2.2

POSITIVE MARKING FROM 3.2.1/*POSITIEWE NASIEN VANAF 3.2.1*
(award marks if calculated in 3.2.1/*ken punte toe indien bereken in 3.2.1*)

Marking criteria/*Nasienkriteria*

- Formula with Δt/*Formule met* Δt
- Correct substitution into formula/*Korrekte vervanging in formule*
- Correct final answer/*Korrekte finale antwoord*: 3,06 (s)

NOTE for 3.2.2: If energy principles used $(^1/_3)$ for final answer.
NOTA vir 3.2.2: *Indien energiebeginsels gebruik* $(^1/_3)$ *vir finale antwoord.*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**	**OPTION/*OPSIE* 3**
$v_f = v_i + a\Delta t$ ✓	$\Delta y = \frac{v_i + v_f}{2} \times \Delta t$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$0 = 30 + (-9,8)(\Delta t)$ ✓	$45,92 = \frac{v_i + 30}{2}\Delta t$ ✓	$45,92 = 30(t) + \frac{1}{2}(-9,8)(\Delta t)^2$ ✓
$t = 3,06$ (s) ✓	$t = 3,06$ (s) ✓	$t = 3,06$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

OPTION/*OPSIE* 4	**OPTION/*OPSIE* 5**	**OPTION/*OPSIE* 6**
$v_f = v_i + a\Delta t$ ✓	$\Delta y = \frac{v_i + v_f}{2} \times \Delta t$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$0 = -30 + (9,8)(\Delta t)$ ✓	$-45,92 = \frac{v_i + (-30)}{2}\Delta t$ ✓	$-45,92 = -30(t) + \frac{1}{2}(9,8)(\Delta t)^2$ ✓
$t = 3,06$ (s) ✓	$t = 3,06$ (s) ✓	$t = 3,06$ (s) ✓

(3)

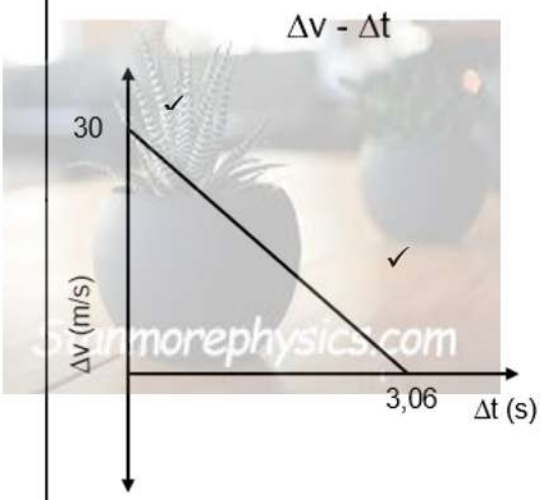
3.3

POSITIVE MARKING FROM 3.2.1 AND 3.2.2
POSITIEWE NASIEN VANAF 3.2.1 EN 3.2.2

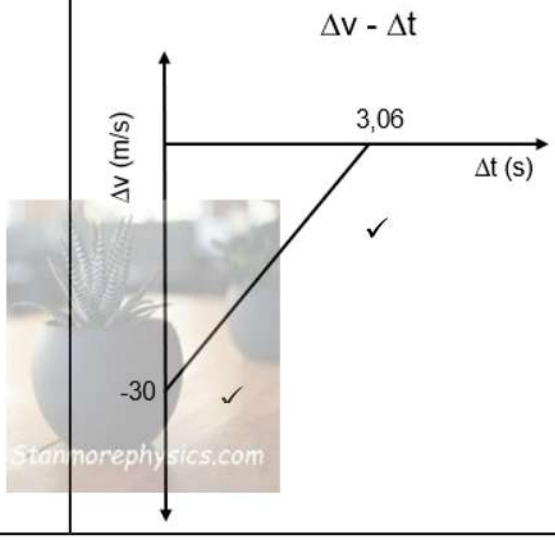
Marking criteria/*Nasienkriteria*

- Initial velocity of 30 m·s^{-1} for the ball/A*anvanklike snelheid van 30 m·s^{-1} vir die bal*
- Correct shape and graph stops at time of 3,06 s/*Korrekte vorm en grafiek eindig by tyd 3,06 s*

OPTION/*OPSIE* 1
(UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*)



OPTION/*OPSIE* 2
(DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*)



(2)

3.4

Marking criteria/*Nasienkriteria*

- Formula that leads to the final answer/*Formule wat lei tot die antwoord*
- Correct substitution into formula/*Korrekte vervanging in formule*
- Subtraction of the initial velocity (30 m·s^{-1})/*Aftrek van die aanvanklike snelheid (30 m·s^{-1})*
- Correct final answer/*Korrekte finale antwoord*: 1,30 m · s^{-1}

OPTION/*OPSIE* 1
(UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = \underline{v_i^2 + 2(-9,8)50}$ ✓

$v_i = 31,30495168$ m·s^{-1}

$v_i = \underline{31,30495168 - 30}$ ✓

$v_i = 1,30$ m·s^{-1} ✓

OPTION/*OPSIE* 2
(DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF*)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = \underline{v_i^2 + 2(9,8)50}$ ✓

$v_i = 31,30495168$ m·s^{-1}

$v_i = \underline{31,30495168 - 30}$ ✓

$v_i = 1,30$ m·s^{-1} ✓

(4)

[15]

QUESTION/*VRAAG* 4

4.1 A system on which the net external force is zero. ✓✓*/'n Sisteem waarop die netto eksterne krag nul is.*
OR/*OF*
A system that excludes external forces that originate outside the colliding bodies./*'n Sisteem wat eksterne kragte wat buite die botsende voorwerpe ontstaan, uitsluit.* **(2 or/*of* 0)** (2)

4.2.1

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
(left as negative/*links as negatief*)	**(left as positive/*links as positief*)**
$p = mv$ ✓	$p = mv$ ✓
$= \underline{12,5 \times (-1,8)}$ ✓	$= \underline{12,5 \times (1,8)}$ ✓
$= -22,5\ kg{\cdot}m{\cdot}s^{-1}$	$= 22,5\ kg{\cdot}m{\cdot}s^{-1}$ ✓ left ✓/*links*
$= 22,5\ kg{\cdot}m{\cdot}s^{-1}$ ✓ left ✓/*links*	

(4)

4.2.2

Marking criteria/*Nasienkriteria*
- Formula/*Formule*: $mv_i = mv_{f1} + mv_{f2}$
- Correct substitution into formula/*Korrekte vervanging in formule*
- Formula/*Formule*: $½\ mv_i^2 = ½\ mv_{f1}^2 + ½\ mv_{f2}^2$
- Correct substitution into formula/*Korrekte vervanging in formule*
- Substitution of 1 into 2/*Vervanging van 1 in 2*
- Correct final answer/*Korrekte finale antwoord*: $1,8\ m{\cdot}s^{-1}$

POSITIVE MARKING FROM 4.2.1/*POSITIEWE NASIEN VANAF 4.2.1*

$mv_i = mv_{f1} + mv_{f2}$ ✓

$\underline{(25 \times v_i) = (-22,5) + (12,5 \times v_{f2})}$ ✓

$25v_i = -22,5 + 12,5\ v_{f2}$

$2v_i + 1,8 = v_{f2}$ …1

$½\ mv_i^2 = ½\ mv_{f1}^2 + ½\ mv_{f2}^2$ ✓

$\underline{½\ 25v_i^2 = ½\ 12,5(1,8)^2 + ½\ 12,5v_{f2}^2}$ ✓

$12,5v_i^2 = 20,25 + 6,25v_{f2}^2$

$2v_i^2 = 3,24 + v_{f2}^2$ … 2

Substitute 1 into 2/*Vervang 1 in 2*:

$\underline{2v_i^2 = 3,24 + (2v_i + 1,8)^2}$ ✓

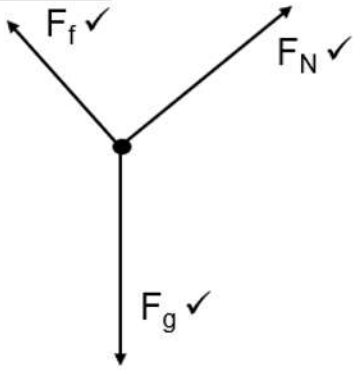
$v_i = 1,8\ m{\cdot}s^{-1}$ ✓

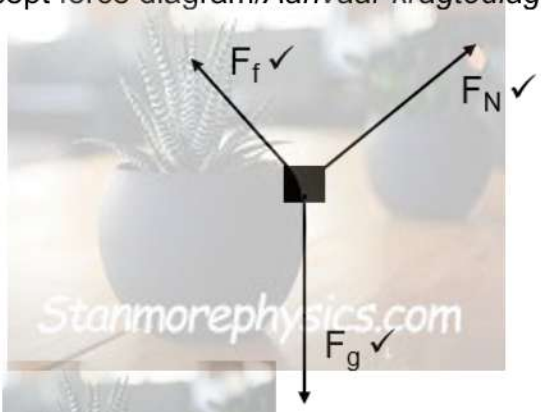
(6)
[12]

QUESTION/*VRAAG* 5

5.1 The net work done on an object is equal to the change in the object's kinetic energy.✓✓/*Die netto arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp.* **(2 or/*of* 0)** (2)

5.2 Accept force diagram/*Aanvaar kragtediagram:*





Accepted labels/Aanvaarde benoemings	
F_N	N/normal force/n*ormaalkrag*
F_g	Fw/w/gravitational force/weight/*gravitasiekrag*/*gewig*
F_f	f/f_k/(kinetic) friction/*(kinetiese) wrywing*

***Notes/Aantekeninge*:**
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)/*Enige ander addisionele krag(te)*: Max/*Maks* ⅔
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* ⅔
- If force(s) do not make contact with the dot/*Indien krag(te) nie met die kolletjie kontak maak nie*: Max/*Maks* ⅔

(3)

5.3.1

Marking criteria/*Nasienkriteria*

- Formula/*Formule*
- Correct substitution into left of formula/*Korrekte vervanging in linkerkant van formule*
- Correct substitution into right of formula/*Korrekte vervanging in regterkant van formule*
- Correct final answer/*Korrekte finale antwoord*: 8,48 m·s^{-1}

OPTION/*OPSIE* 1

$$W_{net} = \Delta E_K \checkmark$$

$$F_{net}\Delta x\cos\theta = \Delta E_K$$

$$\underline{(0,4 \times 9,8 \sin 31° - 0,22)8\cos 0°} \checkmark = \underline{\tfrac{1}{2}(0,4)v_f^2 - 0} \checkmark$$

$$v_f = 8,48 \text{ m·s}^{-1} \checkmark$$

OPTION/*OPSIE* 2

$$h_A = 8\sin 31°$$

$$= 4,1203 \text{ m}$$

$$W_{nc}/W_{nk} = \Delta E_k + \Delta E_p \checkmark$$

$$f\Delta x\cos\theta = \tfrac{1}{2} mv_f^2 - \tfrac{1}{2} mv_i^2 + mgh_f + mgh_i$$

$$\underline{0,22 \times 8\cos 180°} \checkmark = \underline{\tfrac{1}{2}\, 0,4v_f^2 - 0 + 0 - (0,4 \times 9,8 \times 4,1203)} \checkmark$$

$$v_f = 8,48 \text{ m·s}^{-1} \checkmark$$

(4)

5.3.2

POSITIVE MARKING FROM 5.3.1/*POSITIEWE NASIEN VANAF 5.3.1*

Marking criteria/*Nasienkriteria*

- Formula/*Formule*: $mgh_i + \tfrac{1}{2} mv_i^2 = mgh_f + \tfrac{1}{2} mv_f^2$
- Correct substitution into formula/*Korrekte vervanging in formule*
- Correct final answer/*Korrekte finale antwoord*: 3,67 m
- If equations of motion used/*Indien bewegingsvergelykings gebruik*: Max $^1/_3$ for final answer/*Maks* $^1/_3$ *vir finale antwoord*

$$mgh_i + \tfrac{1}{2} mv_i^2 = mgh_f + \tfrac{1}{2} mv_f^2 \checkmark$$

$$\underline{0 + \tfrac{1}{2}\, 0,4(8,48)^2 = (0,4 \times 9,8 \times h) + 0} \checkmark$$

$$h = 3,67 \text{ m} \checkmark$$

(3)

5.4

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$W = F\cos\theta\Delta x$ ✓ $= \underline{0,22 \cos 180° \times 8}$ ✓ $= -1,76$ J✓	**POSITIVE MARKING FROM 5.3.1** ***POSITIEWE NASIEN VANAF 5.3.1*** $h_A = 8\sin 31°$ $= 4,12$ m $W_{nc}/W_{nk} = \Delta E_K + \Delta E_P$ ✓ $= (½\ mv_f^2 - ½\ mv_i^2) + (mgh_B - mgh_A)$ $= \underline{(½\ 0,4 \times 8,48^2 - 0) + (0 - 0,4 \times 9,8 \times 4,12)}$✓ $= -1,77$ J ✓ (Range/*Gebied*: -1,76 to/*tot* -1,77 J)

(3)
[15]

QUESTION/*VRAAG* 6

6.1.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark/*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The change in frequency (or pitch) of the sound detected by the listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓

Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het.

OR/*OF*

The change in frequency of sound detected by the listener due to relative motion between the source and the listener.

Die verandering in frekwensie van die klank waargeneem deur 'n luisteraar as gevolg van die relatiewe beweging tussen die klankbron en die luisteraar. (2)

6.1.2

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**	**OPTION/*OPSIE* 3**
$v = \frac{\Delta x}{\Delta t}$ $= \frac{5}{0,5}$ ✓ $= 10\ m \cdot s^{-1}$ ✓	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $5 = v_i(0,5) + 0$ ✓ $v_i = 10\ m \cdot s^{-1}$ ✓	$\Delta y = \frac{v_i + v_f}{2}\Delta t$ $5 = \frac{2v}{2}\ 0,5$ ✓ $v = 10\ m \cdot s^{-1}$ ✓

(2)

6.1.3 **POSITIVE MARKING FROM 6.1.2/*POSITIEWE NASIEN VANAF 6.2.1***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ or/*of* $f_L = \frac{v + v_L}{v} f_s$

$290 ✓ = \boxed{\frac{344 + 10}{344 - 0} f_s}$ ✓

$f_s = 281,8097$ Hz

$v = f\lambda$ ✓

$344 = \lambda \times 281,8097$ ✓

$\lambda = 1,22$ m✓

(6)

6.2.1 Away/*Weg* or/*of* Towards/Na✓ (1)

6.2.2

If away in 6.2.1/*Indien weg in 6.2.1*: the frequency is decreasing as the star is moving/moves towards the side of a longer wavelength.✓/*die frekwensie neem af soos wat die ster beweeg/beweeg na die kant met 'n langer golflengte.* This means that the star red shifted.✓/*Dit beteken 'n rooiverskuiwing het plaasgevind.*

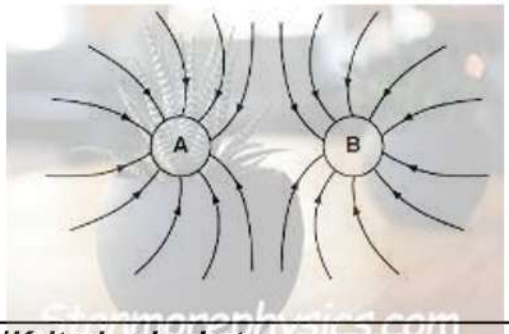
If towards in 6.2.1/*Indien na in 6.2.1*: the frequency is increasing as the star is moving/moves towards the side of a shorter wavelength.✓/*die frekwensie neem toe soos wat die ster beweeg/beweeg na die kant met 'n korter golflengte.*
This means that the star blue shifted.✓/*Dit beteken 'n blouverskuiwing het plaasgevind.*

(2)

[13]

QUESTION/*VRAAG* 7

7.1



Criteria for sketch/*Kriteria vir skets*	Marks/*Punte*
Correct direction of field lines./*Korrekte rigting van veldlyne*.	✓
Correct shape of the electric field lines between charges and on the outside of the charges./*Korrekte vorm van elektrieseveld tussen ladings en die buitekant van die ladings.*	✓
No field lines crossing each other. Field lines must touch the charge, but not go inside the charge./*Geen veldlyne wat mekaar kruis nie. Veldlyne moet die lading raak, maar nie die lading binnegaan nie.*	✓
Note/*Nota*: • If the learner draws a field pattern of two unlike charges: $^0/_3$ • If only one charge is drawn: $^0/_3$ • *Indien leerder 'n elektrieseveld van twee ongelyke ladings teken:* $^0/_3$ • *Indien slegs een lading geteken is:* $^0/_3$	

(3)

7.2

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.* If mass is used/*Indien massa gebruik is:* $^0/_2$ If force is omitted/*Indien krag uitgelaat is:* $^0/_2$

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.✓✓

Die grootte van die elektrostatiese krag wat deur een puntlading op 'n ander puntlading uitgeoefen word, is direk eweredig aan die produk van die grootte van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

(2)

7.3

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$12,4 = \frac{9 \times 10^9 \times Q^2}{(5 \times 10^{-3})^2}$ ✓✓

$Q = 1,86 \times 10^{-7}$ C ✓ (4)

7.4

POSITIVE MARKING FROM 7.3/*POSITIEWE NASIEN VANAF 7.3*

$n = \frac{Q}{q_e}$ ✓

$= \frac{1,86 \times 10^{-7}}{1,6 \times 10^{-19}}$ ✓

$= 1,16 \times 10^{12}$ (electrons/*elektrone*) ✓ (3)

7.5

Marking criteria/*Nasienkriteria*

- Any one of the formulae/*Enige een van die formules*
- Correct substitution of 7 500/*Korrekte vervanging van 7 500*
- Correct substitution into formula: $\frac{kQ_A}{r^2}$/*Korrekte vervanging in formule:* $\frac{kQ_A}{r^2}$
- Correct substitution into formula: $\frac{kQ_B}{r^2}$ /*Korrekte vervanging in formule:* $\frac{kQ_B}{r^2}$
- Addition/*Optel*
- Correct final answer/*Korrekte finale antwoord*: 0,94 m

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

$E_{net} = \frac{kQ_A}{r^2} + \frac{kQ_B}{r^2}$ ✓Anyone/*Enige een*

7 500 ✓ $= \frac{9 \times 10^9 \times 1,86 \times 10^{-7}}{(0,005 + r)^2}$ ✓ + ✓ $\frac{9 \times 10^9 \times 1,86 \times 10^{-7}}{(r)^2}$ ✓

$r = 0,94$ m ✓ (6)

[18]

QUESTION/*VRAAG* 8

8.1 **ANY ONE:**

- A conductor that does not change its resistance/conductance when temperature changes.✓✓
- V is always directly proportional to I at a constant temperature.✓✓
- A conductor for which the resistance remains constant at constant temperature when voltage or current changes.✓✓

ENIGE EEN:

- *'n Geleier waarvan die weerstand/geleidingsvermoë nie verander wanneer die temperatuur verander nie.*
- *V is altyd direk eweredig aan I by 'n konstante temperatuur.*
- *'n Geleier waarvan die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander.* **(2 or/*of* 0)**

Note/*Nota*: If "obeys Ohms law"/*Indien "gehoorsaam Ohm se wet"*
Max/*Maks* ½ (2)

8.2.1

Marking criteria/*Nasienkriteria*

- Any one of the formulae/*Enige een van die formules*
- Addition of 10 Ω and 12 Ω/*Optel van 10 Ω and 12 Ω*
- Correct whole substitution/*Hele substitusie korrek*
- Correct final answer/*Korrekte finale antwoord*: 8,56 Ω m

OPTION/*OPSIE* 1

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_E} = \frac{1}{R_1 + R_2} + \frac{1}{R}$

$\frac{1}{R_E} = \frac{1}{10 + 12\checkmark} + \frac{1}{14}$ ✓

R_E = 8,56 Ω ✓

OPTION/*OPSIE* 2

$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$ ✓

$= \boxed{\frac{(10+12)\checkmark \times 14}{(10+12)+14}}$ ✓

R_p = 8,56 Ω ✓

(4)

8.2.2

$V = IR$ ✓

$38 = I \times 22$✓

I = 1,73 A ✓

(3)

8.2.3

OPTION/*OPSIE* 1 **(POSITIVE MARKING FROM 8.2.1/ *POSITIEWE NASIEN VANAF 8.2.1*)**	**OPTION/*OPSIE* 2** **(POSITIVE MARKING FROM 8.2.1 and 8.2.2 *POSITIEWE NASIEN VANAF 8.2.1 en 8.2.2*)**
V = IR 38 = I x 8,56 ✓ I = 4,439 A Emf/*Emk* (Ɛ) = I(R + r) ✓ = 4,439 (8,56 + 1,8) ✓ = 46 V ✓	V = IR 38 = I x 14 I = 2,71 A I_T = 2,71 + 1,73 ✓ I_T = 4,439 A Emf/*Emk* (Ɛ) = I(R + r) ✓ = 4,439 (8,56 + 1,8) ✓ = 46 V ✓

(4)

8.3 Increase/*Toeneem* ✓ (1)

[14]

QUESTION/*VRAAG* 9

9.1 Mechanical to electrical energy./*Meganiese na elektriese energie*. ✓✓ (2)

9.2

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$f = \frac{1}{T}$ $= \frac{1}{0,02}$ ✓✓ = 50 Hz ✓	$f = \frac{\text{number of waves}}{\text{time}}$ /$f = \frac{\textit{aantal golwe}}{\textit{tyd}}$ $= \frac{1,25}{0,025}$ ✓ ✓ = 50 Hz ✓

(3)

9.3

Marking criteria/*Nasienriglyne*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The AC potential difference which dissipates/produces the same amount of energy/heat as an equivalent direct current (DC) potential difference.✓✓/*Die wissel(WS) potensiaalverskil wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente gelykstroom (GS) potensiaalverskil.* (2)

9.4.1

$I_{rms/wgk} = \frac{I_{max/maks}}{\sqrt{2}}$ ✓

$= \frac{12,4}{\sqrt{2}}$ ✓

$= 8,77$ A ✓ (3)

9.4.2

OPTION/*OPSIE* 1

$P_{ave/gem} = \frac{V_{max/maks} \times I_{max/maks}}{2}$ ✓

900 ✓ $= \frac{V_{max/maks} \times 12,4}{2}$ ✓

$V_{max/maks} = 145,16$ V ✓

OPTION/*OPSIE* 2

POSITIVE MARKING FROM 9.4.1

POSITIEWE NASIEN VANAF 9.4.1

$P_{ave/gem} = V_{rms/wgk} \times I_{rms/wgk}$

$900 = V_{rms/wgk} \times 8,77$ ✓

$V_{rms/wgk} = 102,62$ V

$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$102,62 = \frac{V_{max/maks}}{\sqrt{2}}$ ✓

$V_{max/maks} = 145,13$ V ✓

(Range/*Gebied*: 145,13 - 145,16 V) (4)

[14]

QUESTION/*VRAAG* 10

10.1 A packet of (light) energy. ✓✓/*'n Pakkie (lig)energie.* **(2 or/*of* 0)** (2)

10.2.1
$E_{Kmax/maks} = ½ mv_{max/maks}^2$ ✓
$1,1 \times 10^{-12} = ½ 9,11 \times 10^{-31} v_{max/maks}^2$ ✓
$v_{max/maks} = 1,55 \times 10^9 \text{ m·s}^{-1}$ ✓ (3)

10.2.2
OPTION/*OPSIE* 1

$E = W_0 + E_{Kmax/maks}$ ✓

$E = \frac{hc}{\lambda_0} + E_{Kmax/maks}$

$2,1 \times 10^{-12}$ ✓ $= \frac{(6,63 \times 10^{-34}) \times (3 \times 10^8)}{\lambda_0}$ ✓ $+ 1,1 \times 10^{-12}$ ✓

$\lambda_0 = 1,99 \times 10^{-13}$ m ✓

OPTION/*OPSIE* 2

$E = W_0 + E_{Kmax/maks}$

$2,1 \times 10^{-12}$ ✓ $= W_0 + 1,1 \times 10^{-12}$ ✓ both ✓

$W_0 = \frac{hc}{\lambda_0}$

$W_0 = 1 \times 10^{-12}$

$1 \times 10^{-12} = \frac{(6,63 \times 10^{-34}) \times (3 \times 10^8)}{\lambda_0}$ ✓

$\lambda_0 = 1,99 \times 10^{-13}$ m ✓ (5)

10.3 Emission spectrum/*Emissie(spektrum)* ✓
Emission spectra are formed when certain frequencies of electromagnetic radiation are emitted✓due to an atom making a transition from a higher energy state to a lower energy state.✓
Emissiespektra word gevorm wanneer sekere frekwensies van elektromagnetiese strale uitgestraal word as gevolg van 'n atoom wat terug verander van 'n hoë energie na 'n lae energietoestand.
OF/*OR*
Atoms in a hot gas emit light at characteristic frequencies.✓The spectrum observed is a line spectrum with only a few coloured lines of frequencies unique to the type of atom that is producing the emission lines✓
Atome in 'n warm gas straal lig uit teen kenmerkende frekwensies. Die waargenome spektrum is 'n lynspektrum met net 'n paar gekleurde lyne in frekwensies uniek aan die tipe atoom wat die emissielyne produseer. (3)

[13]

TOTAL/TOTAAL: 148