basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2024

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces 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. 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. Give 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

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 Several forces are acting on a moving object.

Which ONE of the following statements is CORRECT when these forces are in equilibrium?

A The velocity of the object is increasing.

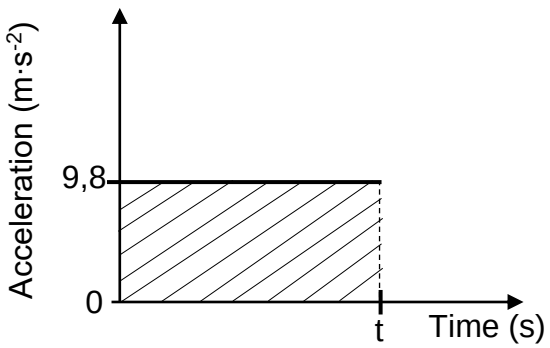
B The object is moving at a constant velocity.

C The kinetic energy of the object is decreasing.

D The object has a non-zero acceleration. (2)

1.2 A stone thrown vertically downwards from the top of a building takes t seconds to strike the ground. Consider the acceleration-time graph below for the motion of the stone.

The effects of air friction are ignored.



What does the shaded area between 0 and t seconds, shown in the graph, represent?

A The final velocity of the stone

B The change in position of the stone

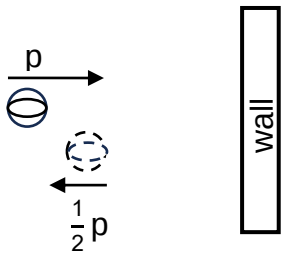
C The constant velocity of the stone

D The change in velocity of the stone (2)

1.3 A ball moving horizontally has constant momentum p and kinetic energy K. The ball collides with a wall and bounces back horizontally.

Immediately after the collision, the ball has momentum $\frac{1}{2}$ p.

The mass of the ball remains constant.



Which ONE of the following is the kinetic energy of the ball immediately after the collision?

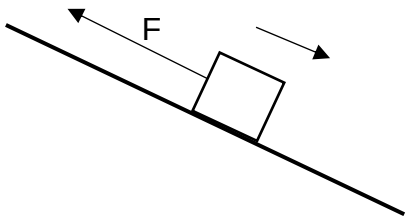
A $\frac{1}{4}$K

B $\frac{1}{2}$K

C 2K

D 4K (2)

1.4 A force F acts on a box as the box moves from rest down a rough incline at a constant acceleration. The force is parallel to the incline, as shown in the diagram below.



Choose the option that CORRECTLY completes the following statement.

The work done by the gravitational force is … the work done by the frictional force and the work done by F.

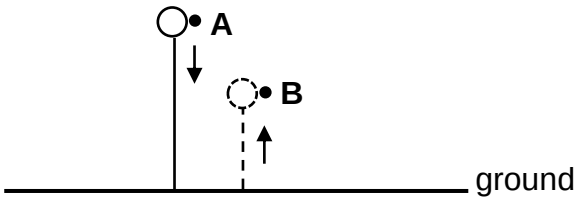
A equal to the sum of

B less than the sum of

C greater than the sum of

D equal to the difference between (2)

1.5 A ball falling vertically downwards from point **A** strikes the ground with velocity v and bounces, reaching a maximum height at point **B**, as shown in the diagram below.



Which ONE of the combinations below is CORRECT for the direction of the impulse on the ball upon striking the ground and the magnitude of the velocity with which the ball leaves the ground?

	DIRECTION OF THE IMPULSE ON THE BALL	**MAGNITUDE OF THE VELOCITY WITH WHICH THE BALL LEAVES THE GROUND**
A	Upward	Greater than v
B	Downward	Greater than v
C	Upward	Less than v
D	Downward	Less than v

(2)

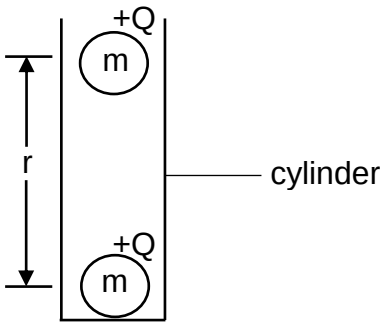
1.6 The absorption spectrum of an element surrounding a moving star is observed on Earth and found to be red shifted.

Which ONE of the following combinations is CORRECT for the movement of the star and the frequency of the observed light on Earth?

	MOVEMENT OF STAR	**FREQUENCY OF OBSERVED LIGHT ON EARTH**
A	Away from Earth	Decreased
B	Towards Earth	Decreased
C	Away from Earth	Increased
D	Towards Earth	Increased

(2)

1.7 Two small identical spheres, each with mass m and charge +Q, are placed in a vertical cylinder. The spheres remain stationary when their centres are r metres apart, as shown in the diagram below. Ignore ALL frictional effects.



Which ONE of the following expressions can be used to CORRECTLY calculate the distance r?

A $\sqrt{\frac{kQ^2}{mg}}$

B $\sqrt{\frac{kmg}{Q^2}}$

C $\sqrt{\frac{Q^2}{kmg}}$

D $\sqrt{\frac{mg}{kQ^2}}$ (2)

1.8 The kilowatt-hour (kWh) is a unit of …

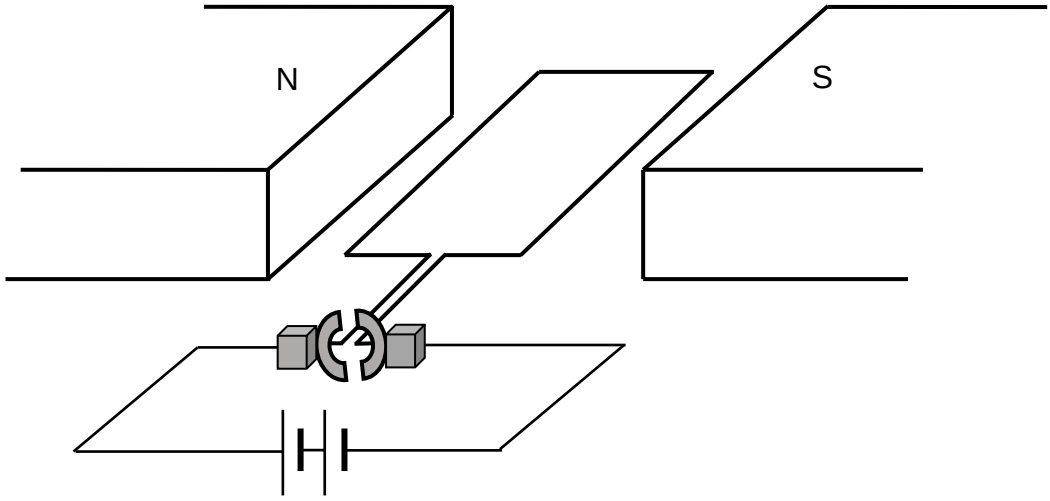
A power.

B electric current.

C electrical energy.

D potential difference. (2)

1.9 The diagram below shows a simplified electric motor. The rotation of the coil is observed from the battery.



Which ONE of the following statements is CORRECT while the motor is in operation?

The coil and the …

A slip rings rotate anti-clockwise.

B slip rings rotate clockwise.

C commutator rotate clockwise.

D commutator rotate anti-clockwise. (2)

1.10 Which of the following statements is/are TRUE for the photoelectric effect?

The photoelectric effect demonstrates that:

(i) Light has a wave nature
(ii) Light has a particle nature
(iii) Light energy is quantised

A (i) only

B (ii) only

C (i) and (iii) only

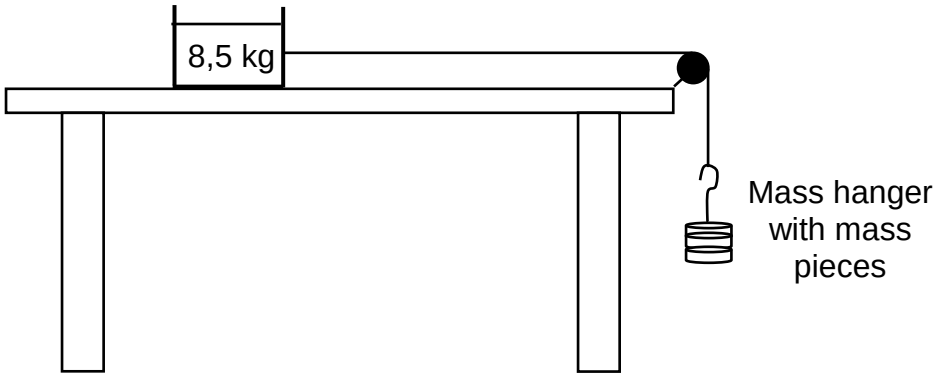
D (ii) and (iii) only (2)

[20]

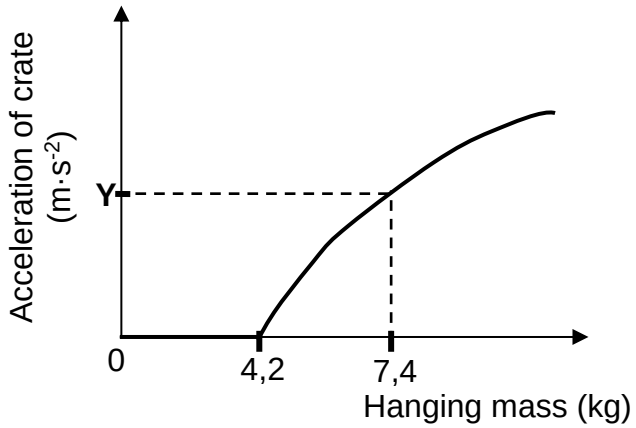
QUESTION 2 (Start on a new page.)

In an experiment, a crate of mass 8,5 kg, lying stationary on a rough horizontal table, is connected to a mass hanger by means of a light inextensible string passing over a frictionless pulley, as shown in the diagram below. Mass pieces are added to the mass hanger and the acceleration of the crate is measured. The experiment is repeated several times by adding different masses to increase the hanging mass each time.

Ignore the effects of air friction.



The results obtained were used to draw the sketch graph below.



2.1 Define the term *static friction*. (2)

2.2 Draw a labelled free-body diagram showing ALL the HORIZONTAL forces acting on the crate JUST BEFORE it starts moving. (2)

2.3 Calculate the:

2.3.1 Coefficient of static friction (μ_s) (4)

2.3.2 Magnitude of the acceleration represented by **Y** on the graph if the coefficient of kinetic friction between the crate and the table is 0,40 (5)

2.4 A 5 kg block is now placed inside the crate and the experiment is repeated. How will this affect the maximum static frictional force now experienced by the crate? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

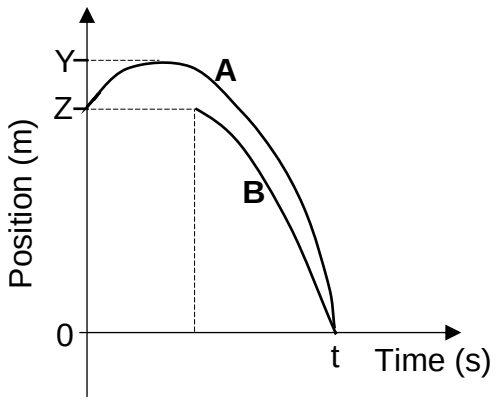
[15]

QUESTION 3 (Start on a new page.)

Ball **A** is thrown vertically upwards at 12 $m \cdot s^{-1}$ from the top of a building. Two seconds after ball **A** was thrown upwards, ball **B** is thrown vertically downwards at 5,4 $m \cdot s^{-1}$ from the top of the same building. Both balls, **A** and **B**, strike the ground at time t seconds.

Ignore the effects of air friction.

The position-time sketch graphs for both balls are shown below.



3.1 Using EQUATIONS OF MOTION ONLY, calculate the value of EACH of the following, as shown in the graphs:

3.1.1 t (5)

3.1.2 Z (3)

3.1.3 Y (4)

3.2 On the same set of axes, sketch the velocity-time graphs for ball **A** and ball **B** while they are in free fall. Label the graphs **A** and **B** for ball **A** and ball **B** respectively.

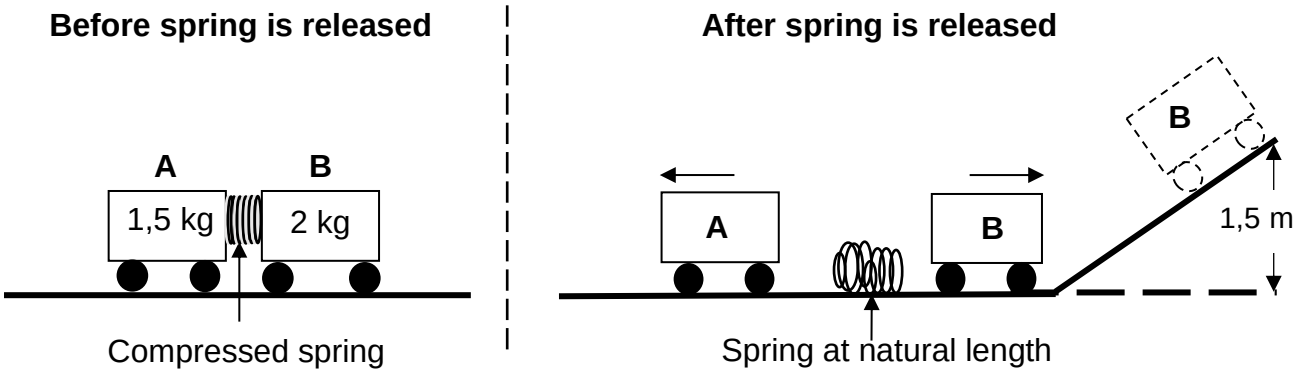
Clearly indicate the following on the graphs:

- The initial velocity of each ball
- The time at which each ball is thrown
- The time at which the balls strike the ground (4)

[16]

QUESTION 4 (Start on a new page.)

Two trolleys, **A** and **B**, of masses of 1,5 kg and 2 kg respectively, are held in a stationary position on a straight, horizontal, frictionless track, with a compressed spring between them. The trolleys are released and the spring takes t seconds to return to its natural length. The spring then falls to the ground.
Trolley **A** moves to the left, while trolley **B** moves to the right and then up a frictionless inclined plane, rising to a maximum vertical height of 1,5 m, as shown in the diagram below.



Ignore the rotational effects of the wheels.

4.1 Write down the *principle of conservation of mechanical energy* in words. (2)

4.2 Calculate the speed of trolley **B** at the bottom of the inclined plane. (4)

4.3 For the t seconds that the spring takes to return to its natural length:

4.3.1 Calculate the change in momentum of trolley **B** (3)

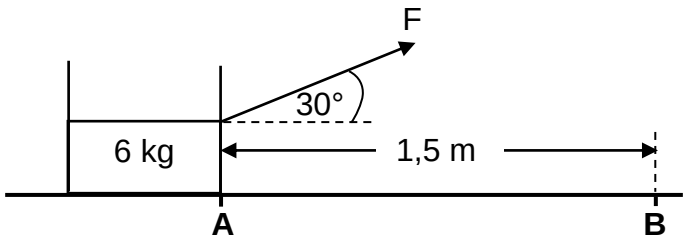
4.3.2 Write down the change in momentum of trolley **A** (1)

4.4 Calculate the speed of trolley **A** after t seconds. (2)
[12]

QUESTION 5 (Start on a new page.)

A constant force F is applied at an angle of 30° to the horizontal on a crate of mass 6 kg that is initially at rest, as shown in the diagram below.

A constant frictional force of 10 N acts on the crate as it moves from rest at point **A** along a horizontal surface to point **B**. The distance between point **A** and point **B** is 1,5 m. The speed of the crate at point **B** is 2 $m \cdot s^{-1}$.



5.1 Define the term *work done by a force*. (2)

5.2 Draw a labelled free-body diagram showing ALL the forces acting on the crate as it moves. (4)

5.3 Using ENERGY PRINCIPLES ONLY, calculate the magnitude of force F. (4)

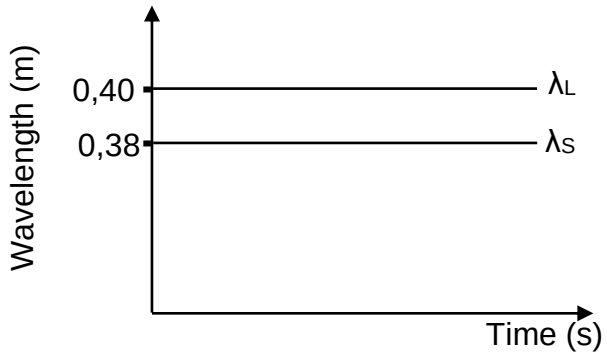
5.4 A 2 kg object is placed in the crate. What effect will this have on the work done by the same force F when the crate is again moved from point **A** to point **B**? Write only INCREASES, DECREASES or REMAINS THE SAME. (2)
[12]

QUESTION 6 (Start on a new page.)

A stationary listener, standing on the roadside, records the wavelength of the sound emitted by the siren of a police car travelling at a constant velocity.

In the wavelength-time graph below, NOT drawn to scale, λ_L is the wavelength of the sound recorded by the listener and λ_S is the wavelength of the sound emitted by the siren.

Take the speed of sound in air to be 343 $m \cdot s^{-1}$.



6.1 Name the phenomenon that explains why the wavelengths shown in the graph differ. (1)

6.2 Is the car moving TOWARDS or AWAY FROM the listener? Give a reason for the answer. (2)

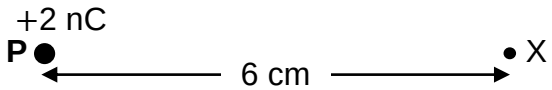
6.3 Calculate the:

6.3.1 Frequency of the sound emitted by the siren (3)

6.3.2 Magnitude of the velocity of the car (6)
[12]

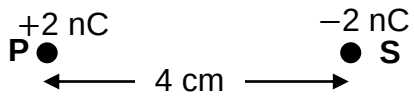
QUESTION 7 (Start on a new page.)

P is a +2 nC point charge. X is a point 6 cm away from charge **P**, as shown in the diagram below.



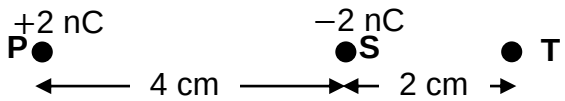
7.1 Calculate the magnitude of the electric field at X. (3)

Point charge **S**, with a charge of −2 nC, is placed 4 cm to the right of charge **P**, as shown in the diagram below.



7.2 Draw the resultant electric field pattern due to charges **P** and **S**. (3)

7.3 A third point charge **T** is placed 2 cm to the right of **S**, as shown in the diagram below. Point charge **T** experiences a net electrostatic force of 2,5 x 10^{-4} N to the left.



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

7.3.2 What is the polarity of charge **T**? Choose from POSITIVE or NEGATIVE. (1)

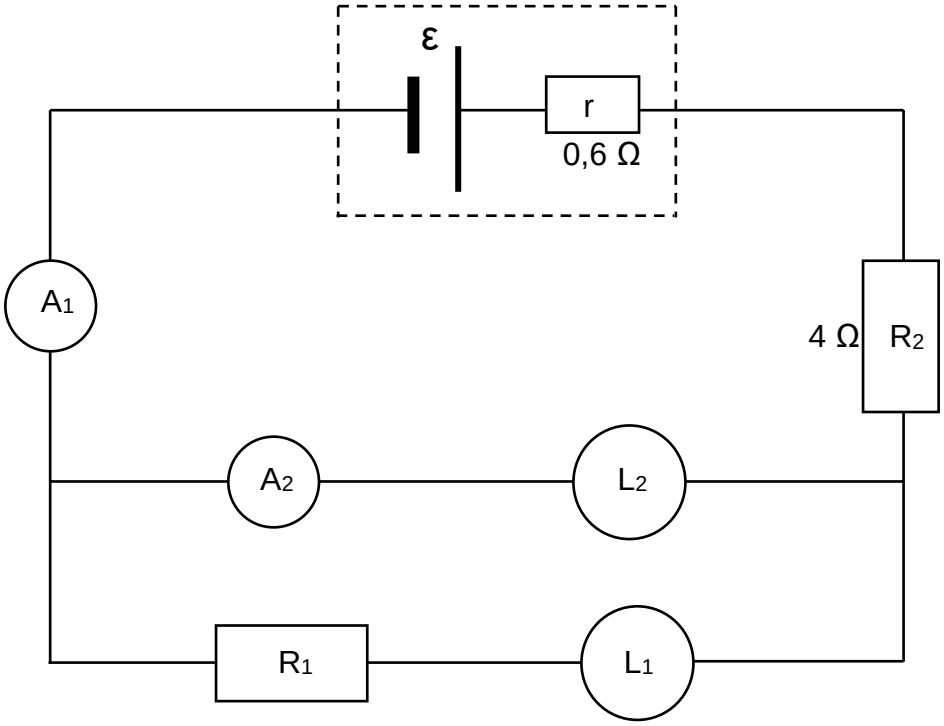
7.3.3 Calculate the magnitude of charge **T**. (5)
[14]

QUESTION 8 (Start on a new page.)

L_1 and L_2 are two light bulbs that have the following ratings:

L_1: 36 W ; 20 V and L_2: 48 W ; 32 V

The two bulbs are connected as shown in the circuit diagram below. The battery has an internal resistance of 0,6 Ω while the conducting wires and the ammeters have negligible resistance. R_1 and R_2 are resistors.



8.1 Define the term *power*. (2)

8.2 If both light bulbs operate as RATED, calculate the:

8.2.1 Reading on ammeter A_2 (3)

8.2.2 Reading on ammeter A_1 (3)

8.2.3 Resistance of resistor R_1 (4)

8.2.4 Emf of the battery (4)

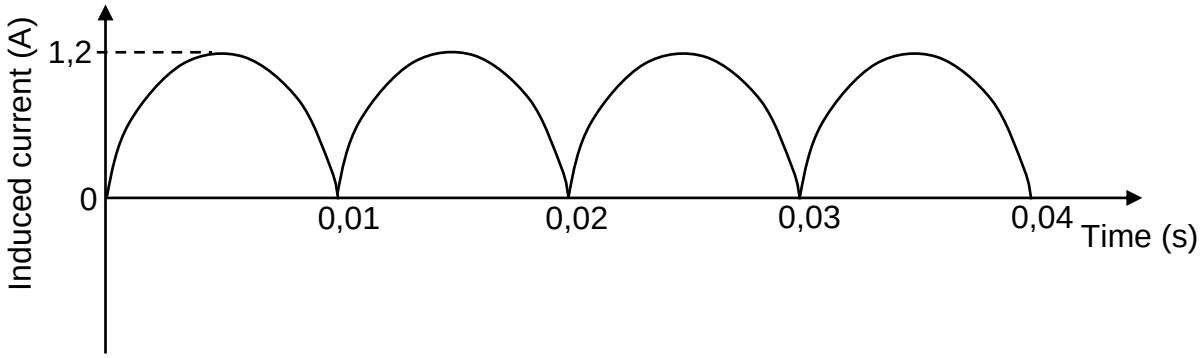
8.3 Bulb L_1 burns out after a while. Assume that the resistance of bulb L_2 remains constant.

Will bulb L_2 continue to glow after bulb L_1 burns out? Choose from YES or NO. Support your answer with a suitable calculation. (5)

[21]

QUESTION 9 (Start on a new page.)

The graph below shows how the induced current in a generator varies with time.



9.1 Name the type of generator. Choose from AC or DC. (1)

9.2 State the energy conversion that takes place in this generator while it is in operation. (2)

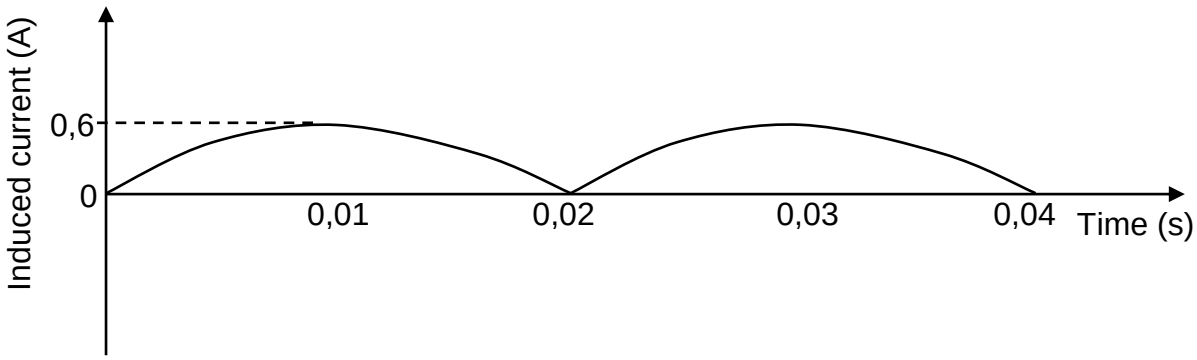
9.3 Give a reason why this generator is NOT suitable for the transmission of electricity over long distances. (1)

9.4 Calculate the frequency at which the coil rotates in the generator. (2)

9.5 Define the term *root mean square (rms) current.* (2)

9.6 Calculate the root-mean-square current delivered by the generator. (3)

9.7 The graph below shows how the induced current varies with time after a change was made to the operation of the generator.



Fully describe the change that was made. (2)

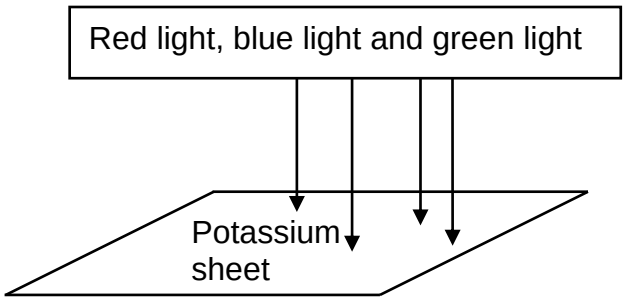
[13]

QUESTION 10 (Start on a new page.)

10.1 Define the term *photoelectric effect*. (2)

10.2 Red light, blue light and green light are shone simultaneously on a sheet of potassium, as shown in the diagram below. Each colour of light consists of a single frequency.

Two maximum kinetic energies of the ejected electrons are possible, namely 6,96 x 10^{-20} J and 2,65 x 10^{-20} J. Each ejected electron has only one of these maximum kinetic energies.



10.2.1 Which colour of light is responsible for ejecting electrons that have a maximum kinetic energy equal to 2,65 x 10^{-20} J? (1)

10.2.2 Explain the answer to QUESTION 10.2.1. (2)

10.2.3 The electrons with a maximum kinetic energy of 2,65 x 10^{-20} J are ejected by light that has a frequency of 5,85 x 10^{14} Hz.

Calculate the frequency of the light that ejected electrons with a maximum kinetic energy of 6,96 x 10^{-20} J. (5)

10.2.4 The intensity of the red light is increased, while the intensities of the blue light and green light remain the same.

What effect will this change have on the rate at which electrons are ejected? Choose from INCREASES, DECREASES or REMAINS THE SAME. (2)

10.3 Some of the atoms of a hot gas, made up of a single element, are in an excited state. The spectrum formed by the hot gas is observed on a screen in a darkened room. The spectrum consists of specific coloured lines on a black background.

10.3.1 Name the type of spectrum formed. (1)

10.3.2 Explain the presence of the coloured lines in the spectrum. (2)

[15]

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 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* $\Delta K = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ 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*

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

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*

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

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Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

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

NOVEMBER 2024

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 22 pages.
Hierdie nasienriglyne bestaan uit 22 bladsye.

QUESTION 1/*VRAAG 1*

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

[20]

QUESTION 2/*VRAAG 2*

2.1

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 force that opposes the tendency of motion of a stationary object relative/parallel to a surface ✓✓/ *Die krag wat die geneigdheid vir beweging van 'n stilstaande voorwerp relatief/parallel tot die oppervlak teenstaan.* (2)

2.2

Accept/Aanvaar

	Accepted labels/*Aanvaarde benoemings*
f_s	static friction/*statiese wrywing*/ f / F_f /F_w *(only Afrikaans)*
T	F_T/F_{string}/tension/*spanning*/F_{tou}

Notes/*Aantekeninge*
- Do not penalize if vertical forces (w, N) are shown/ *Moenie penaliseer indien vertikale kragte (w, N) getoon nie.*
- Mark is awarded for label and arrow/*Punt word toegeken vir byskrif en pyltjie.*
- Do not penalize for length of arrows/*Moenie vir die lengte van die pyltjies penaliseer nie*.
- If arrows do not touch the dot/*Indien pyle nie die kolletjie raak nie*: Max/*Maks* $^1/_2$
- Any other additional force(s) except w and N/*Enige ander addisionele krag(te) behalwe w en N: Max*/*Maks* $^1/_2$
- If everything correct, but no arrows/*Indien alles korrek, maar geen pyltjies*: Max/*Maks* $^1/_2$ (2)

2.3.1

OPTION 1/*OPSIE 1*

For hanging m/*Vir hangende m*:

$F_{net} = ma$
$mg - T = 0$ or $T - mg = 0$
$T = mg$
$T = 4,2(9,8)$ ✓
$= 41,16$ N

For crate/*Vir krat:*

$F_{net} = ma$
$T - f_s^{max} = ma$
$T - \mu_s mg = ma$
$T - f_s^{max} = 0$
$f_s^{max} = T$
$\mu_s N = T$
$f_s^{max} = \mu_s N$

✓Any one / *Enige een*

$\mu_s(8,5)(9,8)$ ✓ $= 41,16$
$\mu_s = 0,49$ ✓

OPTION 2/*OPSIE 2*

$f_s^{max} = T = w_{hanging}$

$f_s^{max} = m_{hanging}g$
$\mu_s N = m_{hanging}g$
$\mu_s m_{crate}.g = m_{hanging}g$
$f_s^{max} = \mu_s N$

✓Any one / *Enige een*

$\mu_s(8,5)(9,8)$ ✓ $= 4,2(9,8)$ ✓

OR

$\mu_s(8,5) = 4,2$
$\mu_s = 0,49$ ✓

(4)

2.3.2

For crate/*Vir krat:*

$F_{net} = ma$
$T - f_k = ma$
OR $f_k - T = ma$
$T - \mu_k mg = ma$

✓Any one /*Enige een*

$T - 0,4(8,5)(9,8)$ ✓$= 8,5a$ …… Eqn (1)

For hanging mass/*Vir hangende massa:*

$F_{net} = ma$
$mg - T = ma$
$7,4(9,8) - T$ ✓$= 7,4a$ …….. Eqn (2)

✓Any one /*Enige een*

$Y = a = 2,47\ (m \cdot s^{-2})$ ✓

NOTE: T can be calculated first (54,32 N)
***NOTA**: T kan eerste bereken word (54,32 N)* (5)

2.4 INCREASES ✓ f_s^{max} α N **OR** f_s^{max} α m **OR** $f_s^{max} = \mu_s N$ **OR** the normal force acting on the crate increases **OR** increase in mass/weight of crate (increases the normal force) ✓

NEEM TOE f_s^{maks} *α N* **OF** f_s^{max} α m ***OF*** $f_s^{max} = \mu_s N$ ***OF*** *die normaalkrag wat op die krat inwerk, neem toe* ***OF*** *toename in massa/gewig van krat veroorsaak (toename in normaalkrag)* (2)

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QUESTION 3/*VRAAG 3*

3.1.1

Marking criteria/*Nasienkriteria*

- Formula with $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ /*Formule met* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
- Correct substitution into formula for ball A/*Korrekte vervanging in formule vir bal A* ✓
- Correct substitution into formula for ball B/*Korrekte vervanging in formule vir bal B*✓
- $\Delta y_A = \Delta y_B$ ✓

Final answer/*Finale antwoord*: 4 (s) ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

Ball A/*Bal A*

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

$= 12t + \frac{1}{2}(-9,8)t^2$ ✓ .....Eqn (1)

Ball B/*Bal B*

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

$= -5,4(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$✓..... Eqn (2)

$12t + \frac{1}{2}(-9,8)t^2 = -5,4(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

Ball A/*Bal A*

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

$= -12t + \frac{1}{2}(9,8)t^2$ ✓ .....Eqn (1)

Ball B/*Bal B*

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

$= 5,4(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓.....Eqn (2)

$-12t + \frac{1}{2}(9,8)t^2 = 5,4(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓

$t = 4$ (s) ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

Take time for ball B as x/Neem tyd vir bal B as x

Ball A/*Bal A*

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

$= 12(x + 2) + \frac{1}{2}(-9,8)(x + 2)^2$ ✓

$=(-4,9)x^2 - (7,6)x + (4,4)$ .....Eqn (1)

Ball B/*Bal B*

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

$= (-5,4)x + \frac{1}{2}(-9,8)x^2$ ✓

$= (-5,4)x + (-4,9)x^2$ ..... Eqn (2)

$(-4,9)x^2 - (7,6)x + (4,4) = (-5,4)x + (-4,9)x^2$ ✓

$x = 2$

$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*
Ball A/*Bal A*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$=(-12)(x + 2) + \frac{1}{2}(9,8)(x + 2)t^2$ ✓
$=(4,9)x^2 + (7,6)x + (-4,4)$ .....Eqn (1)

Ball B/*Bal B*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= (5,4)x + \frac{1}{2}(9,8)x^2$ ✓ ..... Eqn (2)

$(4,9)x^2 + (7,6)x + (-4,4) = (5,4)x + (4,9)x^2$ ✓
$x = 2$
$t = 4$ (s) ✓

<u>OPTION 3/*OPSIE 3*</u>:
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$
$-12 = 12 + (-9,8)t$
$\Delta t = 2,45$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
Ball A: $\Delta y = (-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2$ .....Eq 1 ✓
Ball B: $\Delta y = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ....Eq 2 ✓
Equating
$(-12)(t - 2,45) + \frac{1}{2}(-9,8)(t - 2,45)^2 = (-5,4)(t - 2) + \frac{1}{2}(-9,8)(t - 2)^2$ ✓
$t = 4$ (s) ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

$v_f = v_i + a\Delta t$
$12 = -12 + (9,8)\Delta t$
$\Delta t = 2,45$ s

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
Ball A: $\Delta y = (12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2$ .....Eq 1 ✓
Ball B: $\Delta y = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ....Eq 2 ✓
Equating
$(12)(t - 2,45) + \frac{1}{2}(9,8)(t - 2,45)^2 = (5,4)(t - 2) + \frac{1}{2}(9,8)(t - 2)^2$ ✓
$t = 4$ (s) ✓

(5)

NOTE:
Dashed arrows: prior calculation not necessary to show, subsequent substitutions need to be correct for marks to be awarded. If first calculations are wrong, no credit given for subsequent substitutions.
(This will be applied if a candidate changes a single step calculation into a multistep calculation.)
Solid arrows: prior calculation(s) necessary for subsequent substitution(s). Marks may be awarded for follow-up marking.

NOTA:
Gebroke pyle*: vorige berekening nie nodig om te wys nie, alle volgende invervangings moet korrek wees om punte toe te ken. Indien eerste berekening verkeerd is, geen punte toegeken vir volgende invervangings nie.*
(Dit word toegepas wanneer 'n kandidaat 'n enkel-stap berekening verander in 'n multi-stap berekening)
Soliede pyle*: vorige berekeninge is nodig vir alle volgende invervangings. Punte mag toegeken word vir opvolg nasien.*

POSITIVE MARKING FROM QUESTION 3.1.1/*POSITIEWE NASIEN VANAF VRAAG 3.1.1*

3.1.2

Marking criteria/*Nasienkriteria*
- Correct formula to calculate Δy./*Korrekte formule om Δy te bereken.* ✓
- Correct substitution to calculate Δy./*Korrekte vervanging om Δy te bereken.* ✓
- Correct final answer./*Korrekte finale antwoord:* 30,4 m ✓

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

OPTION 1/*OPSIE 1*

Ball A/*Bal A*

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

$= (12)(4) + \frac{1}{2}(-9,8)(4)^2$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

OPTION 2/*OPSIE 2*

Ball B/*Bal B*

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

$= (-5,4)(4 - 2) + \frac{1}{2}(-9,8)(4 - 2)^2$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

Ball A/*Bal A*

$v_f = v_i + a\Delta t$

$v_f = 12 + (-9,8)(4)$

$v_f = -27,2\ m{\cdot}s^{-1}$

OPTION 3/*OPSIE 3*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(-27,2)^2 = (12)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

OPTION 4/*OPSIE 4*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \left(\frac{12 + (-27,2)}{2}\right)4$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

Ball B/*Bal B*

$v_f = v_i + a\Delta t$

$v_f = -5,4 + (-9,8)(4 - 2)$

$v_f = -25\ m{\cdot}s^{-1}$

OPTION 5/*OPSIE 5*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(-25)^2 = (-5,4)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

OPTION 6/*OPSIE 6*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓

$= \left(\frac{-5,4 + (-25)}{2}\right)(4 - 2)$ ✓

$\Delta y = -30,4$ m

$Z = 30,4$ (m) ✓

<table>
<tr><th colspan="2">DOWNWARDS AS POSITIVE/AFWAARTS AS POSITIEF</th></tr>
<tr><td><u>OPTION 1/OPSIE 1</u>
Ball A/Bal A
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (-12)(4) + \frac{1}{2}(9,8)(4)^2$ ✓
$\Delta y = 30,4$ m
Z = 30,4 (m) ✓</td><td><u>OPTION 2/OPSIE 2</u>
Ball B/Bal B
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (5,4)(4 - 2) + \frac{1}{2}(9,8)(4 - 2)^2$ ✓
$\Delta y = 30,4$ m
Z = 30,4 (m) ✓</td></tr>
<tr><td rowspan="2">Ball A/Bal A
$v_f = v_i + a\Delta t$
$v_f = -12 + (9,8)(4)$
$v_f = 27,2$ m·s^{-1}</td><td><u>OPTION 3/OPSIE 3</u>
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(27,2)^2 = (12)^2 + 2(9,8)\Delta y$ ✓
$\Delta y = -30,4$ m
Z = 30,4 (m) ✓</td></tr>
<tr><td><u>OPTION 4/OPSIE 4</u>
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{-12 + 27,2}{2}\right)4$ ✓
$\Delta y = 30,4$ m
Z = 30,4 (m) ✓</td></tr>
<tr><td rowspan="2">Ball B/Bal B
$v_f = v_i + a\Delta t$
$v_f = 5,4 + (9,8)(4 - 2)$
$v_f = 25$ m·s^{-1}</td><td><u>OPTION 5/OPSIE 5</u>
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(25)^2 = (5,4)^2 + 2(9,8)\,\Delta y$ ✓
$\Delta y = 30,4$ m
Z = 30,4 (m) ✓</td></tr>
<tr><td><u>OPTION 6/OPSIE 6</u>
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{5,4 + 25}{2}\right)(4 - 2)$ ✓
$\Delta y = 30,4$ m
Z = 30,4 (m) ✓</td></tr>
</table>

(3)

3.1.3 **POSITIVE MARKING FROM QUESTION 3.1.1 and 3.1.2**
POSITIEWE NASIEN VANAF VRAAG 3.1.1 en 3.1.2

Marking criteria/*Nasienkriteria*
- Correct equation to calculate Δy./*Korrekte vergelyking om Δy te bereken.* ✓
- Correct substitution to calculate Δy./*Korrekte vervanging om Δy te bereken.* ✓
- Adding 30,4 to Δy/ *Bytel van 30,4 by Δy* ✓
- Correct final answer./*Korrekte finale antwoord:* 37,75 m ✓
- Range/*Gebied* 37,72 – 37,75 m
- **Note/*Nota*: v_f and v_i can be interchanged / v_f en v_i *kan omgeruil wees***

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

OPTION 1/*OPSIE 1*

Ball A/*Bal A*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (12)^2 + 2(-9,8)\Delta y$ ✓
$\Delta y = 7,35$ m

Ball A/*Bal A*

$v_f = v_i + a\Delta t$
$0 = 12 + (-9,8)\Delta t$
$\Delta t = 1,22$ s

OPTION 2/*OPSIE 2*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{12 + 0}{2}\right)1,22$ ✓
$\Delta y = 7,32$ m

OPTION 3/*OPSIE 3*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (12)(1,22) + \frac{1}{2}(-9,8)(1,22)^2$ ✓
$\Delta y = 7,35$ m

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

OPTION 1/*OPSIE 1*

Ball A/*Bal A*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = (-12)^2 + 2(9,8)\Delta y$ ✓
$\Delta y = 7,35$ m

Ball A/*Bal A*

$v_f = v_i + a\Delta t$
$0 = -12 + (9,8)\Delta t$
$\Delta t = 1,22$ s

OPTION 2/*OPSIE 2*

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$= \left(\frac{-12 + 0}{2}\right)1,22$ ✓
$\Delta y = -7,32$ m

OPTION 3/*OPSIE 3*

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (-12)(1,22) + \frac{1}{2}(9,8)(1,22)^2$ ✓
$\Delta y = -7,35$ m

$Y = 7,35 + 30,4$ ✓
$= 37,75$ (m) ✓

(4)

3.2 **POSITIVE MARKING FROM QUESTION 3.1.1**
POSITIEWE NASIEN VANAF VRAAG 3.1.1

Marking criteria:

- Correct initial velocities of both balls A and B with correct shape (straight lines with both positive / both negative slopes) ✓
- Correct initial times for balls A and B with B starts after the intercept of A ✓
- Both graphs end at 4 s (accept t) ✓
- Graphs parallel to each other and B to the right of A ✓

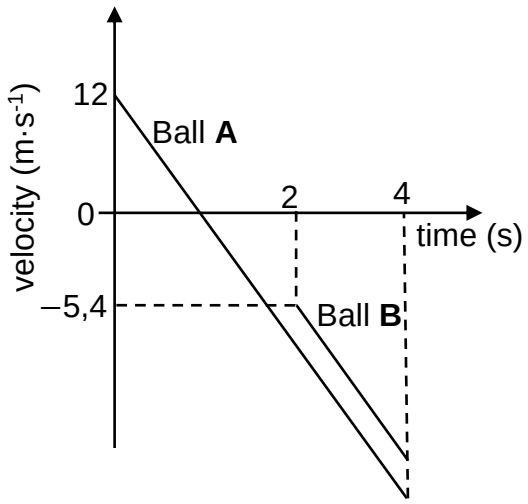
NB: No labels A and B, deduct 1 mark

Nasienkriteria:

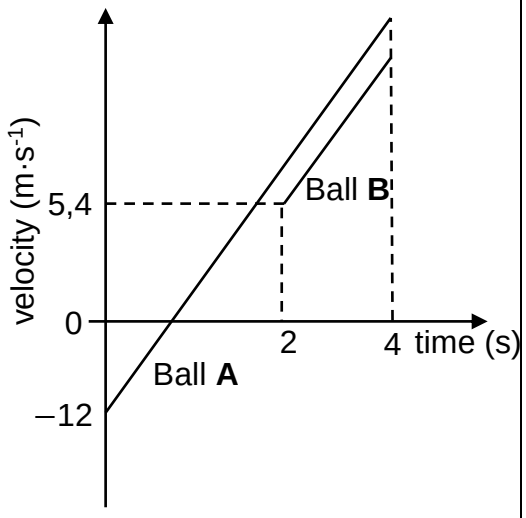
- *Korrekte aanvanklike snelhede van beide bal A en B met korrekte vorm (reguit lyne met beide positiewe / beide negatiewe helling)*
- *Korrekte aanvanklike tye van beide bal A en B met B wat begin na die afsnit van A*
- *Beide grafieke eindig by 4 s (aanvaar t)*
- *Grafieke parallel tot mekaar en B is regs van A*

***NB:** Geen byskrifte A and B, trek 1 punt af*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF



DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF



(4)
[16]

QUESTION 4/*VRAAG 4*

4.1 **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 total mechanical energy/sum of gravitational potential energy and kinetic energy, in an isolated system remains constant/is conserved. ✓✓
Die totale meganiese energie/som van gravitasie potensiële energie en kinetiese energie in 'n geïsoleerde sisteem bly konstant/ behoue. (2)

4.2

OPTION 1/*OPSIE 1*

$\text{Total } E_{mech(top/bo)} = \text{Total } E_{mech(bottom/onder)}$
$(E_p + E_k)_{top/bo} = (E_p + E_k)_{bottom/onder}$
$(mgh + \frac{1}{2}mv^2)_{top/bo} = (mgh + \frac{1}{2}mv^2)_{bottom/onder}$
✓Any one/*Enige een*

$(2)(9,8)(1,5) + 0$ ✓ $= 0 + \frac{1}{2}(2)v^2$ ✓ **OR/*OF***

$(9,8)(1,5) + 0 = 0 + \frac{1}{2}v^2$

$v = 5,42 \text{ m·s}^{-1}$ ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta E_k + \Delta E_p$
$W_{nc} = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$
✓Any one/*Enige een*

✓ ✓

$0 = [0 - \frac{1}{2}v_i^2] + [(9,8)(1,5 - 0)]$
$v_i = 5,42 \text{ m·s}^{-1}$✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta E_k$
$F_g\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$mg\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓Any one/*Enige een*

$(9,8)(1,5)\cos180^\circ$ ✓ $= 0 - \frac{1}{2}v_i^2$ ✓

$v_i = 5,42 \text{ m·s}^{-1}$ ✓

OPTION 4/*OPSIE 4*

$\Delta E_k = -\Delta E_p$ ✓
$[0 - \frac{1}{2}v_i^2]$✓ $= -[(9,8)(1,5$ ✓ $- 0)]$
$v_i = 5,42 \text{ m·s}^{-1}$✓

OR/*OF*

$-\Delta E_k = \Delta E_p$ ✓
$-[0 - \frac{1}{2}v_i^2]$✓ $= [(9,8)(1,5$ ✓ $- 0)]$
$v_i = 5,42 \text{ m·s}^{-1}$✓

OPTION 5/*OPSIE 5*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
0 ✓ $= v_i^2 + 2(9,8)(-1,5)$ ✓
$v_f = -5,42 \text{ m·s}^{-1}$
speed $= 5,42 \text{ m·s}^{-1}$ ✓

OR/*OF*

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
0 ✓ $= v_i^2 + 2(-9,8)(1,5)$ ✓
speed $= v_f = 5,42 \text{ m·s}^{-1}$ ✓

(4)

NOTE: v_i and v_f can be interchanged but then 9,8 and 1,5 must have the same signs/***NOTA**: v_i en v_f kan omgeruil word maar dan moet 9,8 en 1,5 dieselfde tekens hê.*

4.3.1 **POSITIVE MARKING FROM QUESTION 4.2**
POSITIEWE NASIEN VANAF VRAAG 4.2

$\Delta p = mv_f - mv_i$
$F_{net}\Delta t = \Delta p$
✓ any one /enige een

$= \underline{2(5,42 - 0)}$ ✓ **OR/*OF*** $\underline{2(-5,42 - 0)} = -10,84\ kg\cdot m\cdot s^{-1}$
$= \underline{10,84\ kg\cdot m\cdot s^{-1}\ right/regs}$ ✓ (3)

4.3.2 **POSITIVE MARKING FROM QUESTION 4.3.1**
POSITIEWE NASIEN VANAF VRAAG 4.3.1
$\underline{10,84\ kg\cdot m\cdot s^{-1}\ left/links/opposite\ direction/teenoorgestelde\ rigting}$ ✓ (1)

4.4 **POSITIVE MARKING FROM QUESTION 4.2 and 4.3.1**
POSITIEWE NASIEN VANAF VRAAG 4.2 en 4.3.1

$\Delta p_A = mv_f - mv_i$		$\Sigma p_i = \Sigma p_f$
$\underline{-10,84 = 1,5(v_f - 0)}$ ✓	**OR/OF**	$\underline{0 = 1,5v_f + (2)(5,42)}$ ✓
$v_f = -7,23\ m\cdot s^{-1}$		$v_f = -7,23\ m\cdot s^{-1}$
$v = 7,23\ m\cdot s^{-1}$ ✓		$v = 7,23\ m\cdot s^{-1}$ ✓
$\underline{10,84 = 1,5(v_f - 0)}$ ✓	**OR/OF**	$\underline{0 = 1,5v_f + (2)(-5,42)}$
$v = 7,23\ m\cdot s^{-1}$ ✓		$v = 7,23\ m\cdot s^{-1}$ ✓

(2)
[12]

QUESTION 5/*VRAAG 5*

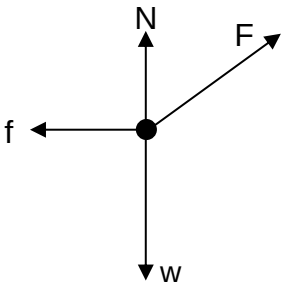
5.1

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.*

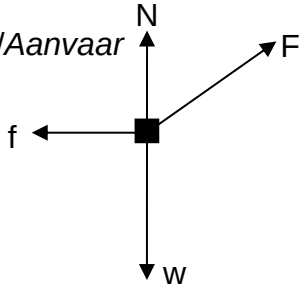
The work done on an object by a constant force F is F Δx cos θ, where F is the magnitude of the force, Δx the magnitude of the displacement and θ the angle between the force and the displacement. ✓✓
Die arbeid verrig op 'n voorwerp deur 'n konstante krag F is F Δx cos θ, waar F die grootte van die krag, Δx die grootte van die verplasing en θ die hoek tussen die krag en die verplasing is.

OR/*OF*
The work done on an object is the product of the force and the displacement of the object in the direction of the displacement ✓✓
Die arbeid verrig op 'n voorwerp is die produk van die krag en die verplasing van die voorwerp in die rigting van die verplasing. (2)

5.2



Accept/*Aanvaar*



Accepted labels/*Aanvaarde benoemings*	
w	F_w / F_g / mg /58,8 N / gravitational force / *gravitasiekrag* / weight / *gewig*
f	F_f / f_k / (kinetic) Friction / *(kinetiese) wrywing* / F_w *(Afrikaans)*
N	F_N / Normal force / *Normaalkrag*
F	F_A / Applied force /*Toegepaste krag* / F_T *(Afrikaans)*

Notes/*Aantekeninge:*
- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalize 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* $^3/_4$
- If everything is correct, but no arrows/*Indien alles korrek is, maar geen pyltjies*: Max/*Maks* $^3/_4$
- If force(s) do not make contact with the dot /Indien krag(te) nie met die kolletjie kontak maak nie: Max/Maks $^3/_4$
- If components drawn for F/*Indien komponente van F geteken:* Max/maks $^3/_4$

(4)

5.3

Marking criteria/*Nasienkriteria*

- Correct formula for/ *korrekte formule vir* W_{net} / W_{nc}. ✓
- Correct substitution to calculate work done by the forces/ *Korrekte vervanging om arbeid verrig deur die kragte te bereken* ✓
- Correct substitution to calculate change in kinetic energy and gravitational potential energy/ *Korrekte vervanging vir die berekening van die verandering in kinetiese energie en gravitasie potensiële energie*✓
- Correct final answer / *Korrekte finale antwoord: 20,79 N* ✓
- Range/Gebied: 20,769 - 20,79 N

OPTION 1/*OPSIE 1*

$$W_{nc} = \Delta E_k + \Delta E_p$$
$$W_{nc} = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$
$$W_F + W_f = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = \frac{1}{2}m\left(v_f^2 - v_i^2\right) + mg(h_f - h_i)$$

✓ Any one/ *Enige een*

$F(1, 5)\cos30° + 10(1,5)\cos180°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓ $+ 0$

$F = 20,78$ N ✓

OPTION 2/*OPSIE 2*

$$W_{net} = \Delta E_k$$
$$W_F + W_f = \Delta E_k$$
$$F\Delta x\cos\theta + f\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓Any one/ *Enige een*

$F(1,5)\cos30° + 10(1,5)\cos180°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓

$F = 20,78$ N ✓

OPTION 3/*OPSIE 3*

$$W_{net} = \Delta E_K$$
$$(F\cos\theta - f)\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓ Any one/ *Enige een*

$(F\cos30° - 10)(1,5)\cos0°$ ✓ $= ½(6)(2^2 - 0^2)$ ✓

$F = 20,78$ N ✓

OPTION 4/*OPSIE 4*

$$W_{net} = \Delta E_K$$
$$(F_x - f)\Delta x\cos\theta = ½mv_f^2 - ½mv_i^2$$

✓ Any one/ *Enige een*

$(F_x - 10)(1,5)\cos0^o = ½(6)(2^2 - 0^2)$ ✓

$F_x = 18$ N

$F_x = F\cos 30°$

$18 = F\cos 30°$ ✓

$F = 20,78$ N ✓

(4)

5.4 REMAINS THE SAME / *BLY DIESELFDE* ✓✓ (2)

[12]

QUESTION/*VRAAG 6*

6.1 Doppler Effect/*Doppler-effek* ✓ (1)

6.2 Away from / W*eg van* ✓
Wavelength of sound detected/observed by the listener is longer than wavelength of sound emitted by the source ✓
OR
Frequency detected by the listener is lower than the frequency of the source.
OR
$\lambda_L > \lambda_S$
OR
$f_L < fs$
Golflengte van die klank wat deur die luisteraar waargeneem word, is langer as die golflengte van klank wat deur die bron vrygestel word.
OF
Frekwensie waargeneem deur luisteraar is laer as die frekwensie van die bron
OF
$\lambda_L > \lambda_S$
OF
$f_L < fs$ (2)

6.3.1 $v = f\lambda$ ✓
$343 = f(0,38)$ ✓
$f = 902,63$ Hz ✓ (3)

If c = fλ used, penalize 1 mark
Indien c = fλ gebruik penaliseer 1 punt

If 340 used, penalize 1 mark for answer
Indien 340 gebruik penaliseer 1 punt vir antwoord

6.3.2
POSITIVE MARKING FROM QUESTION 6.3.1/
POSITIEWE NASIEN VANAF VRAAG 6.3.1
$v = f\lambda$
$343 = f(0,4)$ ✓
$f_L = 857,5$ Hz

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_S \quad \textbf{OR/}\textit{OF} \quad f_L = \frac{v}{v + v_s} f_S \ ✓$$

$$857,5 ✓ = \frac{343}{343 + v_s} ✓ (902,63) ✓$$

$v_s = 18,05 \text{ m·s}^{-1}$ ✓ (Range/*Gebied*: 18,05 m·s^{-1} to/*tot* 18,45 m·s^{-1})

If wavelengths are substituted instead of frequencies/*Indien golflengtes invervang in plaas van frekwensies* max/*maks* $^2/_6$
If wavelengths are swopped/*Indien golflengtes omgeruil* max/*maks* $^3/_6$ (6)

[12]

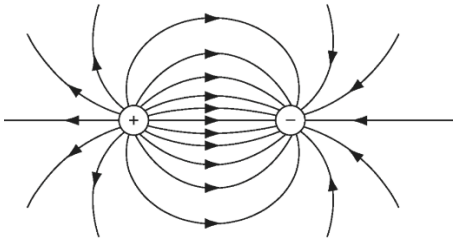
QUESTION 7/VRAAG 7

7.1

$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9 \times 10^9)(2 \times 10^{-9})}{(0{,}06)^2} \checkmark$$
$$= 5 \times 10^3 \text{ N·C}^{-1} \checkmark \ (5\,000 \text{ N·C}^{-1})$$

(3)

7.2



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: If learner draws field pattern of two like charges: $^0/_3$ If only one charge is drawn, $^0/_3$ *Nota: Indien leerder elektrieseveld van twee gelyke ladings teken:* $^0/_3$. *Indien slegs een lading geteken is,* $^0/_3$	

(3)

7.3.1

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.*

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 their charges and inversely proportional to square of the distance between them. ✓✓
Die grootte van die elektrostatiese krag wat een puntlading op 'n ander puntlading uitoefen is direk eweredig aan die produk van die groottes van die ladings en omgekeerd eweredig aan die kwadraat van die afstand tussen hulle.

(2)

NOTE: If reference to masses / If the word FORCE in context omitted $^0/_2$
***NOTA**: Indien verwysing na massa* / Indien die woord KRAG in konteks uitgelaat $^0/_2$

7.3.2 POSITIVE / *POSITIEF* ✓ (1)

7.3.3 **POSITIVE MARKING FROM Q 7.1 IN TERMS OF CONVERSIONS /**
POSITIEWE NASIEN VANAF V 7.1 IN TERME VAN OMSKAKELINGS

OPTION 1/*OPSIE 1*

Marking criteria/*Nasienkriteria:*

- Formula for Coulomb's law./ Formule vir *Coulomb se wet.* ✓
- Correct substitution in Coulomb's formula for BOTH F_{ST} and F_{PT}./ *Korrekte vervanging in Coulomb se formule vir BEIDE F_{ST} en F_{PT}.* ✓
- Substitution of 2,5 x 10^{-4} N for F_{net}. ✓/*Vervanging van 2,5 x 10^{-4} N vir F_{net}.*
- Subtraction of/*Aftrek van* ($F_S - F_P$ **OF/*OR*** $F_P - F_S$) ✓
- Correct final answer/*Korrekte finale antwoord*: 6,25 x 10^{-9} C✓

$F = \frac{kQ_1Q_2}{r^2}$ ✓ ✓Both/*Beide*

$F_{ST} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$ $F_{PT} = \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$

$F_{net} = F_{ST} - F_{PT}$

$2,5 \times 10^{-4}$ ✓$= \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$ ✓ $- \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$

$Q_T = 6,25 \times 10^{-9}$ C ✓

OR/*OF*

$-F_{net} = F_{PT} - F_{ST}$

$-2,5 \times 10^{-4}$ ✓$= \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,06)^2}$ ✓ $- \frac{(9 \times 10^9)(2 \times 10^{-9})Q_T}{(0,02)^2}$

$Q_T = 6,25 \times 10^{-9}$ C ✓

OPTION 2/*OPSIE 2*

Marking criteria/*Nasienkriteria*

- Correct substitution for S to find E_S./*Korrekte vervanging vir S om E_S te verkry* ✓
- Subtraction of /*Aftrek van* ($E_P - E_S$) **OF/*OR*** ($E_S - E_P$) ✓
- Formula /*Formule*: F = Eq ✓
- Correct substitution in /*Korrekte vervanging in* F = Eq ✓.
- Final answer /*Finale antwoord*: Q_T= 6,25 x 10^{-9} C ✓

RIGHT AS POSITIVE/*REGS AS POSITIEF*

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

$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= 45\,000$ N·C^{-1}

$E_{net} = E_P - E_S$

$E_{net} = 5 \times 10^3 - \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= -4 \times 10^4$ N·C^{-1} (40 000)

F = Eq ✓

$-2,5 \times 10^{-4} = (-4 \times 10^4)Q_T$ ✓

$Q_T = 6,25 \times 10^{-9}$ C ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

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

$E_S = \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓

$= 45\,000$ N·C^{-1}

$E_{net} = E_S - E_P$

$= \frac{(9 \times 10^9)(2 \times 10^{-9})}{0,02^2}$ ✓ $- 5 \times 10^3$

$= 4 \times 10^4$ N·C^{-1}

F = Eq ✓

$2,5 \times 10^{-4} = (4 \times 10^4)Q_T$ ✓

$Q_T = 6,25 \times 10^{-9}$ C ✓

(5)
[14]

QUESTION 8/*VRAAG 8*

8.1 The rate at which work is done/dissipated OR energy transferred OR Work done per unit time ✓✓ **(2 or/*of* 0)**
Die tempo waarteen arbeid verrig OF energie oorgedra word OF Arbeid verrig per eenheidstyd (2)

8.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
P = VI✓ 48 = 32 I✓ I = 1,5 A✓	$P = \frac{V^2}{R}$ $48 = \frac{32^2}{R}$ R = 21,33 Ω $P = I^2R$✓ : 48 = I^2(21,33)✓ : I = 1,5 A ✓ V = IR✓ : 32 = I(21,33)✓ : I = 1,5 A✓

(3)

8.2.2

POSITIVE MARKING FROM QUESTION 8.2.1.
POSITIEWE NASIEN VANAF VRAAG 8.2.1.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
For L_1 / *Vir* L_1 P = VI 36 = 20I✓ I = 1,8 A	$P = \frac{V^2}{R}$ $36 = \frac{20^2}{R}$ R = 11,11 Ω $P = I^2R$: 36 = I^2(11,11)✓ : I = 1,8 A V = IR : 20 = I(11,11)✓ : I =1,8 A

I_{TOT} = 1,5 + 1,8 ✓
= 3,3 A ✓

(3)

8.2.3

POSITIVE MARKING FROM QUESTION 8.2.2.
POSITIEWE NASIEN VANAF VRAAG 8.2.2.

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$V_{R1} + V_{L1} = V_{//}$ V_{R1} + 20 = 32 V_{R1} = 12 V V = IR ✓ 12 ✓= 1,8 R_1 ✓ R_1 = 6,67 Ω ✓	V = IR ✓ 32 = 1,8R ✓ R = 17,77 Ω $P = \frac{V^2}{R}$ $36 = \frac{20^2}{R}$ R = 11,11 Ω R_1 = 17,77 – 11,11 = 6,67 Ω ✓

(4)

8.2.4

POSITIVE MARKING FROM QUESTION 8.2.2. AND 8.2.3
POSITIEWE NASIEN VANAF VRAAG 8.2.2. EN 8.2.3

OPTION 1/ *OPSIE 1*

$V_2 = I_{TOT} R_2$
$= \underline{3,3(4)}$
$= 13,2$ V

$\varepsilon = V_{ext} + Ir$ ✓
$= \underline{(13,2 + 32)}$ ✓ $+ \underline{3,3(0,6)}$ ✓
$= 47,18$ V ✓
Range/*Gebied*: 47,16 – 47,19 V

OPTION 2/*OPSIE 2*

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

$\frac{1}{R_p} = \frac{1}{21,33} + \frac{1}{11,11 + 6,67}$

OR/OF

$R_{12} = \left(\frac{R_1 R_2}{R_1 + R_2}\right)$

$= \frac{21,33(11,11 + 6,67)}{21,33 + 11,11 + 6,67}$

$R_p = 9,69\ \Omega$

$R_{ext} = R_p + Rs$
$R_{ext} = 9,69 + 4$
$= 13,69\ \Omega$

OPTION 3/*OPSIE 3*

$V = IR$
$32 = 3,3R$
$R_p = 9,7\ \Omega$

$R_{ext} = R_p + Rs$
$R_{ext} = 9,69 + 4$
$= 13,69\ \Omega$

$\varepsilon = I(R + r)$ ✓

$= \underline{3,3(13,69)}$ ✓ $+ \underline{3,3(0,6)}$ ✓
$= 47,18$ V ✓

Range/*Gebied*:
47,16 – 47,19 V

(4)

8.3

POSITIVE MARKING FROM QUESTION 8.2.1. AND 8.2.4
POSITIEWE NASIEN VANAF VRAAG 8.2.1. EN 8.2.4

NO / NEE ✓ Accept Not glow / Aanvaar Nie gloei nie

$P = \frac{V^2}{R}$

$48 = \frac{32^2}{R}$ ✓

$R_{L2} = 21,33\ \Omega$

$R_{L2} = \frac{V}{I}$

$= \frac{32}{1,5}$ ✓

$= 21,33\ \Omega$

$\varepsilon = I(R + r)$ ✓

$\underline{47,18 = I(21,33 + 4 + 0,6)}$ ✓

$I = 1,82$ A ✓

NOTE: If 21,33 Ω already calculated previously award mark
***NOTA**: Indien 21,33 Ω alreeds bereken in vorige vraag, ken punt toe*

(5)
[21]

QUESTION 9/*VRAAG 9*

9.1 DC/*GS* (generator) ✓ (1)

9.2 Mechanical/Kinetic to Electrical ✓✓ **(2 or/*of* 0)**
Meganies/*Kineties na Elektries* (2)

9.3 Power / Energy / Voltage loss cannot be reduced / will be too large✓
Verlies aan drywing / energie / spanning kan nie verminder word nie / sal te groot wees
OR/*OF*
I (current) cannot be made smaller /*I (stroom)kan nie verlaag word nie*
Accept:
Transformers do not use DC / Cannot be stepped-up or down /
Aanvaar:
Transformators gebruik nie GS nie / Kan nie verhoog of verlaag nie (1)

9.4 $f = \frac{1}{T} = \frac{1}{0,02}$ ✓ = 50 Hz ✓
OR/*OF*
$f = \frac{\text{number of waves/cycles}}{\text{time}} = \frac{2}{0,04}$ ✓ = 50 Hz ✓ (2)

9.5 **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.*

Root-mean-square current is the alternating current that dissipates the same amount of energy as an equivalent DC current. ✓✓
Die wortelgemiddeldekwadraat-stroom is die wisselstroom wat dieselfde hoeveelheid energie verbruik as 'n ekwivalente gelykstroom. (2)

9.6 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$= \frac{1,2}{\sqrt{2}}$ ✓
= 0,85 A ✓ (3)

9.7 Speed of rotation halved / *Rotasiespoed halveer* ✓✓
Accept: Frequency was halved / Period was doubled /
Aanvaar: Frekwensie halveer / periode verdubbel
If speed of rotation slower / frequency decreases / period increased $^1/_2$
Indien rotasiespoed stadiger / frekwensie verlaag / periode verhoog : $^1/_2$ (2)
[13]

QUESTION 10/*VRAAG 10*

10.1

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 process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident/shining on that surface.✓✓
Die proses waarmee elektrone vanaf 'n metaaloppervlak vrygestel word wanneer lig (van 'n geskikte frekwensie) invallend is/skyn op die oppervlak (2)

10.2.1 Green/*Groen* ✓ (1)

10.2.2 Only green and blue light eject electrons / red light does not eject electrons.✓
Green has a lower frequency than blue / Green has longer wavelength than blue / Photons of blue light has more energy than photons of green light ✓
and therefore ejects electrons with the lower kinetic energy. /
$f_{green} < f_{blue}$ / blue has a higher frequency than green
Slegs blou en groen lig stel elektrone vry / rooi lig stel nie elektrone vry nie
Groen lig het 'n laer frekwensie as blou lig / Groen het 'n langer golflengte as blou en stel dus elektrone / fotone van blou lig het meer energie as fotone van groen lig en stel elektrone met laer kinetiese energie vry / $f_{groen} < f_{blou}$ / blou het hoër frekwensie as groen (2)

10.2.3

OPTION 1/*OPSIE 1*

$E = W_0 + E_{k(max)}$
$hf = W_0 + E_{k(max)}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $= W_0 + 2,65 \times 10^{-20}$ ✓
$W_0 = 3,61 \times 10^{-19}$ J

$hf = W_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = 3,61 \times 10^{-19} + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓

OPTION 2/*OPSIE 2*

$E = W_0 + E_{k(max)}$
$hf_1 - E_{k(max)1} = hf_2 - E_{k(max)2}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$✓ $- 2,65 \times 10^{-20}$ ✓ $= (6,63 \times 10^{-34})f_2 - 6,96 \times 10^{-20}$ ✓
$f_2 = 6,5 \times 10^{14}$ Hz ✓

OPTION 3/*OPSIE 3*

$E = W_0 + E_{k(max)}$
$hf = hf_0 + E_{k(max)}$ } ✓ Any one/*Enige een*

$(6,63 \times 10^{-34})(5,85 \times 10^{14})$ ✓ $= 6,63 \times 10^{-34} f_0 + 2,65 \times 10^{-20}$ ✓
$f_0 = 5,45 \times 10^{14}$ Hz

$hf = hf_0 + E_{k(max)}$
$(6,63 \times 10^{-34})f = (6,63 \times 10^{-34})(5,45 \times 10^{14}) + 6,96 \times 10^{-20}$ ✓
$f = 6,5 \times 10^{14}$ Hz ✓ (5)

10.2.4 Remains the same/*Bly dieselfde* ✓✓ (2)

10.3.1 (Line) emission spectrum/*(Lyn) emissiespektrum* ✓ (1)

10.3.2 Coloured lines represent (associated) frequencies/wavelengths/energy of the emitted (photons) ✓ when atoms / electrons move to a lower energy level ✓
Gekleurde lyne verteenwoordig (geassosieerde) frekwensies/golflengtes/energie van die vrygestelde (fotone) wanneer atome/elektrone na 'n laer energievlak beweeg. (2)
[15]

TOTAL/*TOTAAL*: 150