basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: PHYSICS (P1)

2022

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 in 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 A bucket is at rest on a table.

Which ONE of the following is the reaction force to the weight of the bucket, as described by Newton's Third Law?

A Force of the table on Earth

B Force of the bucket on Earth

C Force of the bucket on the table

D Force of the table on the bucket (2)

1.2 A ball is dropped from a small height above the ground.

Ignore air resistance.

The following pairs show physical quantities associated with the ball while it is falling to the ground.

In which ONE of these pairs will BOTH quantities change while the ball is falling?

A Mechanical energy and weight

B Kinetic energy and momentum

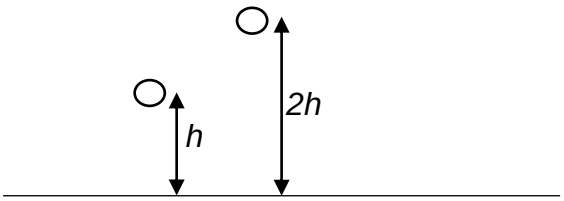
C Gravitational acceleration and kinetic energy

D Gravitational potential energy and gravitational force (2)

1.3 A ball is dropped from height *h* and strikes the floor with momentum **p**.

Ignore air resistance.

The ball is NOW dropped from height *2h*.



Which ONE of the following represents the momentum with which the ball NOW strikes the floor?

A **p**

B $\sqrt{2}\,\mathbf{p}$

C $2\sqrt{\mathbf{p}}$

D 2**p** (2)

1.4 Object X exerts a gravitational force **F** on object Y when the distance between the centres of the objects is **r**.

The distance **r** is now DOUBLED.

Which ONE of the following represents the gravitational force that X now exerts on Y?

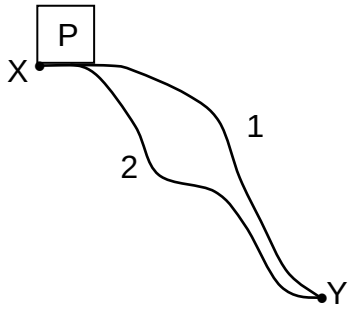
A $\frac{1}{4}\mathbf{F}$

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

C 2**F**

D 4**F** (2)

1.5 A force **F** moves an object P from point X to point Y along two different paths, 1 and 2, as shown below.



The work done by **F** in moving the object is the same for both paths. Which ONE of the following can be used to describe force **F**?

A Normal force

B Tension force

C Frictional force

D Gravitational force (2)

1.6 Which ONE of the following can be explained by the Doppler effect?

A A stethoscope is used to listen to a person's heartbeat.

B An echo is heard when sound waves are reflected off a cliff.

C The spectrum of light from an approaching star is shifted towards shorter wavelengths.

D Sound intensity decreases when the sound source moves away from a stationary listener. (2)

1.7 Two oppositely charged point charges move towards each other.

Which ONE of the following is CORRECT?

The point charges move at …

A constant velocity.

B decreasing velocity.

C constant acceleration.

D increasing acceleration. (2)

1.8 Which ONE of the following phrases describes the emf of a battery?

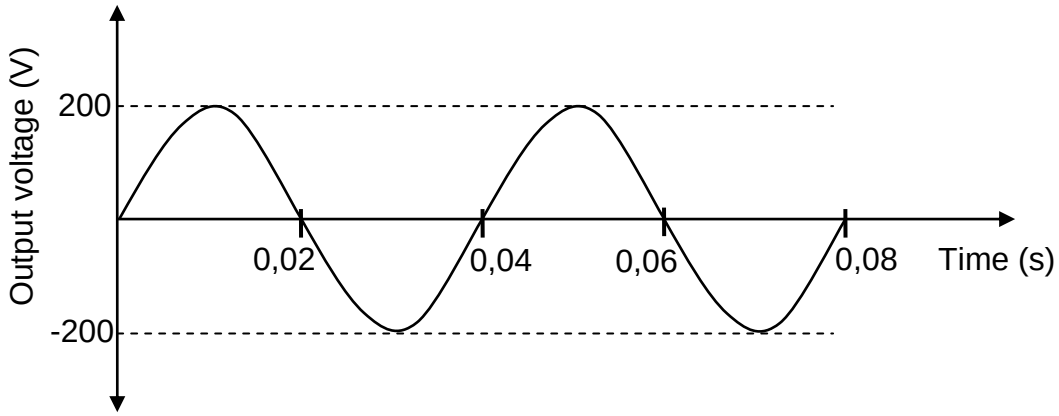
A Energy supplied per unit time

B Charge transferred per unit time

C Current supplied per unit charge

D Maximum energy supplied per unit charge (2)

1.9 The graph below represents the output voltage versus time for an AC generator.



The speed of rotation of the generator's coil is now DOUBLED.

Which ONE of the combinations below shows the CORRECT new peak output voltage and the time for ONE rotation?

	PEAK OUTPUT VOLTAGE (V)	**TIME FOR ONE ROTATION (S)**
A	400	0,02
B	200	0,02
C	200	0,04
D	100	0,04

(2)

1.10 A photon of light of energy 2***X*** joules is shone onto a metal surface with work function ***X*** joules.

Which ONE of the following represents the maximum kinetic energy (in joules) of the electron ejected from the metal by this photon?

A Zero

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

C ***X***

D 2***X*** (2)

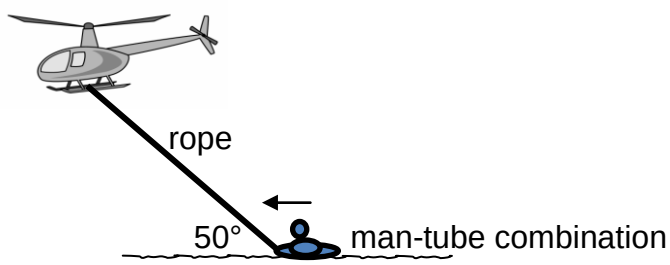
[20]

QUESTION 2 (Start on a new page.)

A man faces difficulty while swimming in a dam. During the rescue operation, an inflated tube attached to a helicopter by a rope is dropped from the helicopter.

The man, of mass 70 kg, holds onto the inflated tube of mass 4 kg, while the helicopter is flying horizontally at a CONSTANT speed. An average frictional force of 300 N is exerted on the man-tube combination while they are dragged horizontally along the surface of the water by the helicopter. The rope makes an angle of 50° with the surface of the water, as shown in the diagram below.

Assume that the rope is inextensible and massless, and the water of the dam does not flow.



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

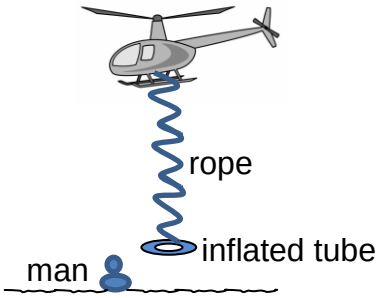
2.2 Draw a free-body diagram of the man-tube combination while they are being dragged. (4)

2.3 Calculate the tension in the rope. (4)

2.4 How will the answer to QUESTION 2.3 change if the helicopter ACCELERATES while dragging the man? The frictional force and the angle between the rope and the surface of the water remain the same.

Choose from INCREASES, DECREASES or NO CHANGE. Give a reason for the answer. (2)

In another rescue operation, the inflated tube of mass 4 kg is dropped from the stationary helicopter and it strikes the water at a speed of 16 $m \cdot s^{-1}$. The tube sinks vertically downwards into the water to a depth of 0,8 m and then rises to the surface. The rope hangs loosely.



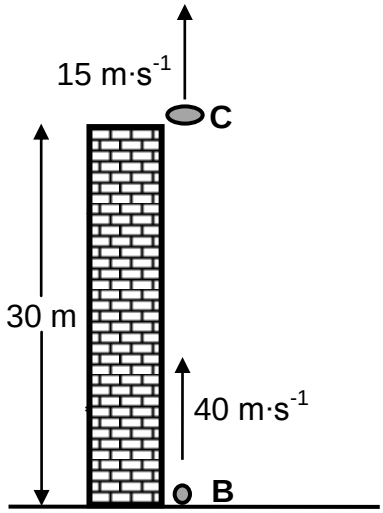
2.5 Calculate the magnitude of the average upward force exerted on the inflated tube while it is sinking. Assume that the average upward force is constant for the motion. (5)

[17]

QUESTION 3 (Start on a new page.)

A small disc, **C**, is thrown vertically upwards at a speed of 15 m·s^{-1} from the edge of the roof of a building of height 30 m. AFTER 0,5 s, a small ball **B** is shot vertically upwards from the foot of the building at a speed of 40 m·s^{-1} in order to hit disc **C**.

Ignore the effects of air resistance.



3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Time taken by disc **C** to reach its maximum height (3)

3.2.2 Maximum height above the ground reached by disc **C** (4)

3.3 Calculate the time from the moment that disc **C** was thrown upwards until the time ball **B** hits the disc. (6)

3.4 On the same set of axes, sketch graphs of velocity versus time for disk **C** and ball **B** from the moment that disc **C** was thrown upwards until ball **B** hits disc **C**.

Label the graph for ball **B** as B and the graph for disc **C** as C.

Clearly indicate the following on the graphs:

- The initial velocities of ball **B** and disc **C**
- The time at which ball **B** was shot upward
- The time at which disc **C** reaches its maximum height
- The time at which ball **B** hits disc **C**

(5)
[20]

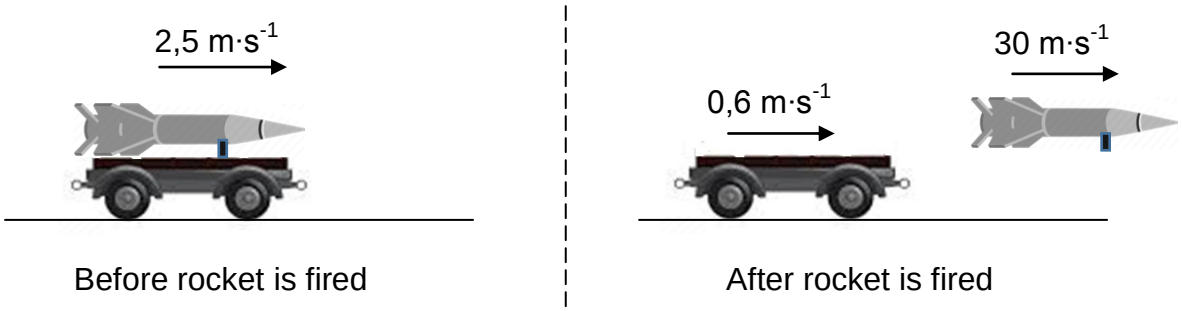
QUESTION 4 (Start on a new page.)

4.1 What is meant by an *isolated system* in physics? (2)

During an experiment, a rocket of unknown mass is mounted on a toy cart of mass 20 kg. The cart-rocket combination moves at a constant speed of 2,5 $m \cdot s^{-1}$ along a horizontal floor.

At a certain instant, the rocket is fired horizontally in the direction of motion at a speed of 30 $m \cdot s^{-1}$. As a result, the cart slows down to a speed of 0,6 $m \cdot s^{-1}$, as shown in the diagram below.

Ignore frictional effects.



Before rocket is fired After rocket is fired

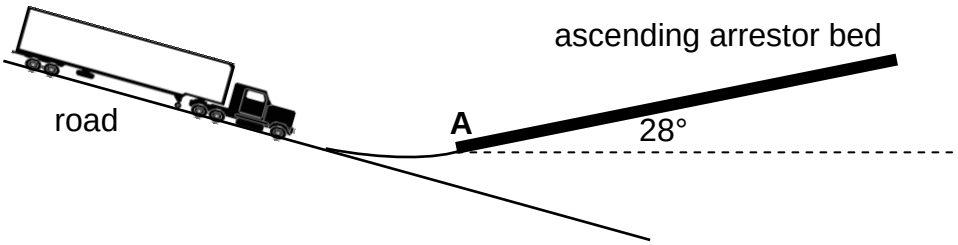
4.2 Use relevant physics principles to explain why the firing of the rocket will slow down the cart. (2)

4.3 Calculate the mass of the rocket at the instant the rocket was fired from the toy cart. (5)
[9]

QUESTION 5 (Start on a new page.)

Arrestor beds are used to help moving trucks to come to a stop when their brakes fail.

The driver of a 30 000 kg truck driving down a steep road drives onto an ASCENDING arrestor bed inclined at 28° to the horizontal, as shown in the diagram below.



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

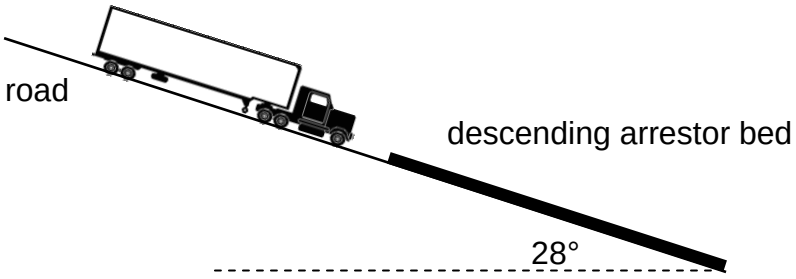
The truck with failed brakes passes point **A** at the beginning of the arrestor bed at a speed of 33 $m \cdot s^{-1}$. The average frictional force on the truck is 31 000 N while the truck moves up the arrestor bed.

Ignore the rotational effects of the wheels.

5.2 Give a reason why the net work done on the truck, while moving on the arrestor bed, is negative. (1)

5.3 Use ENERGY PRINCIPLES to calculate the minimum length of the arrestor bed needed to bring the truck to a stop. (5)

The diagram below shows the same truck entering a DESCENDING arrestor bed inclined at 28° to the horizontal. The initial speed of the truck and the average frictional force on the truck are 33 $m \cdot s^{-1}$ and 31 000 N respectively.



5.4 Which arrestor bed, ASCENDING or DESCENDING, will be able to stop the truck in a shorter distance?

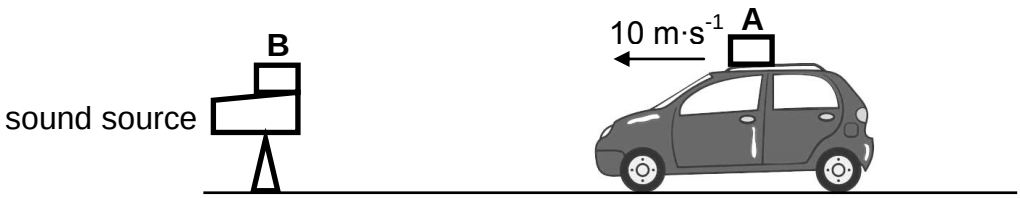
Explain the answer in terms of the forces acting on the truck. (3)
[11]

QUESTION 6 (Start on a new page.)

A car moves at a constant speed of 10 $m \cdot s^{-1}$ TOWARDS a stationary sound source. The sound source emits sound waves of frequency 880 Hz.

A sound detector **A** is attached to the car and another sound detector **B** is attached to the sound source. Detector **B** detects the sound waves reflected from the car.

The speed of sound in air is 340 $m \cdot s^{-1}$.

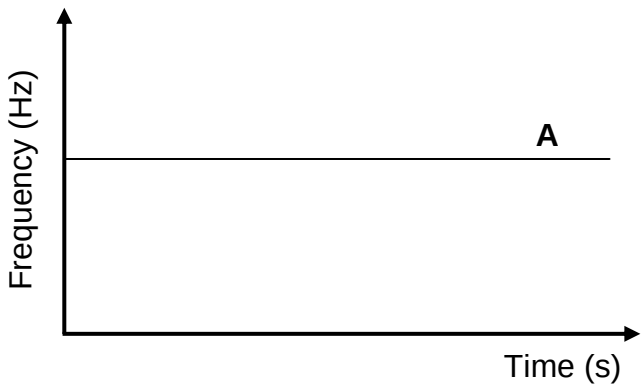


6.1 State the Doppler effect in words. (2)

6.2 Calculate the wavelength of the sound waves emitted by the source. (3)

6.3 Calculate the frequency of the sound waves detected by detector **A**. (4)

The sketch graph below shows the frequency recorded by detector **A**.

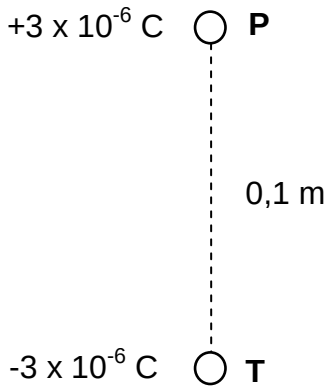


6.4 Redraw the graph above for detector **A** in your ANSWER BOOK. On the same set of axes, sketch the graph of the frequency recorded by detector **B**. Label this graph as B. (2)

[11]

QUESTION 7 (Start on a new page.)

7.1 Two small, identical spheres, **P** and **T**, are placed a distance of 0,1 m apart, as shown in the diagram below. **P** carries a charge of +3 x 10^{-6} C and **T** carries a charge of -3 x 10^{-6} C.

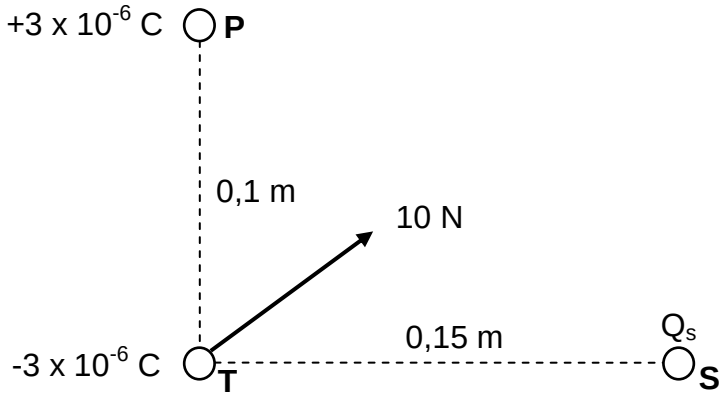


7.1.1 State Coulomb's law in words. (2)

7.1.2 Draw the resultant electric field pattern due to the charges on **P** and **T**. (3)

A third charged sphere **S** of unknown charge Q_s is placed a distance of 0,15 m from sphere **T** such that the three charged spheres are at the vertices of a right-angled triangle.

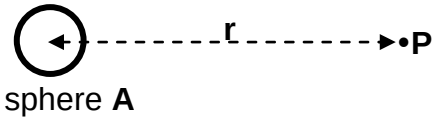
The net electrostatic force on sphere **T** due to the other two charged spheres has a magnitude of 10 N, as shown in the diagram below.



7.1.3 Is charge Q_s POSITIVE or NEGATIVE? (1)

7.1.4 Calculate the number of electrons added to or removed from sphere **S** to give it a charge of Q_s. (6)

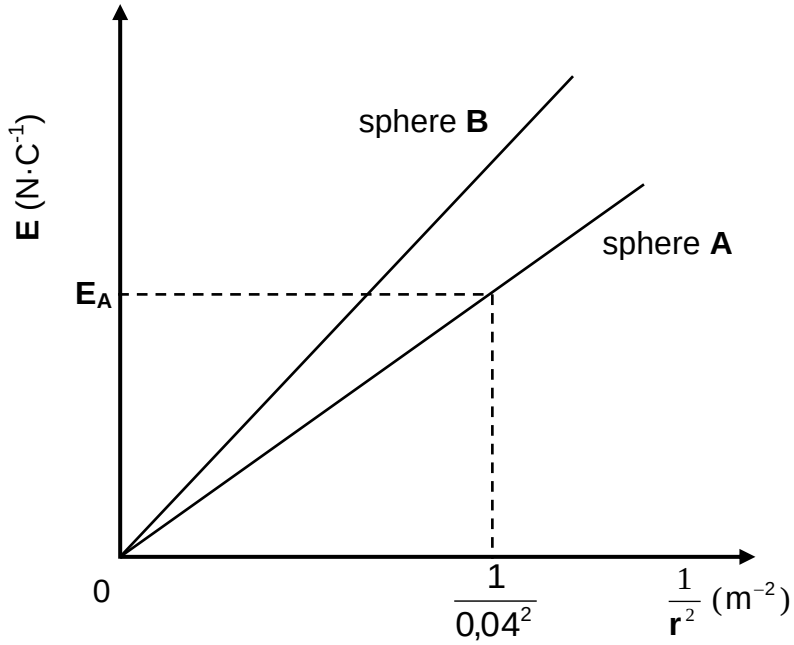
7.2 **P** is a variable point in the electric field of charged sphere **A** and **r** is the distance between point **P** and the centre of sphere **A**. See the diagram below.



A learner determines the magnitude of the electric field (**E**) at point **P** for different values of **r**.

Sphere **A** is then replaced by another sphere, **B**, of a different charge. Another set of results are obtained.

The graphs below are obtained from the results for sphere **A** and sphere **B**. $\mathbf{E_A}$ is the magnitude of the electric field at a distance of 0,04 m from the centre of charged sphere **A**.



Use the graphs to answer the following questions.

7.2.1 State the proportionality between the magnitude of electric field **E** at a point and $\frac{1}{\mathbf{r}^2}$. (1)

7.2.2 Calculate $\mathbf{E_A}$ if the numerical value of the gradient of the graph for sphere **A** is 680. (4)

7.2.3 How does the magnitude of the charge on sphere **B** compare to the magnitude of the charge on sphere **A**?

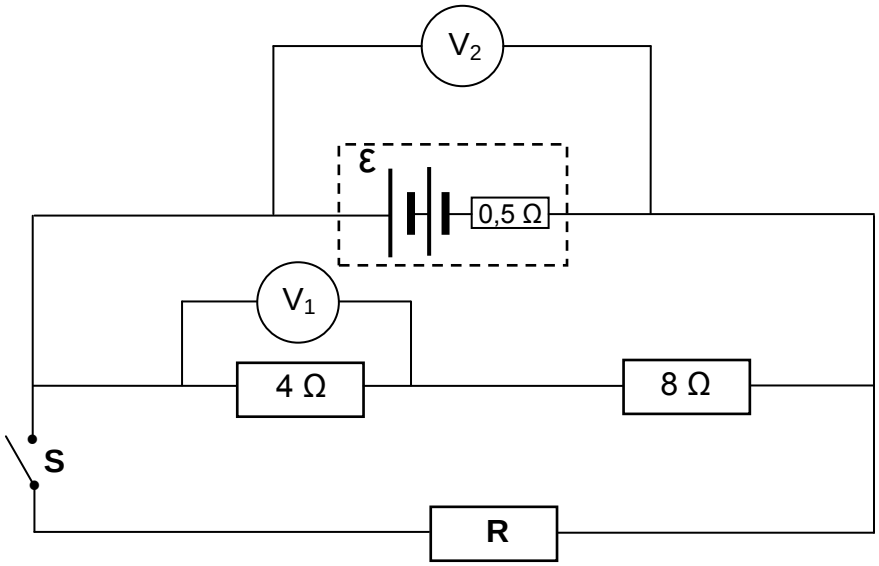
Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (3)

[20]

QUESTION 8 (Start on a new page.)

In the circuit below a battery of UNKNOWN emf and an internal resistance of 0,5 Ω is connected to two resistors of 4 Ω and 8 Ω each, and a resistor **R** of unknown resistance.

Ignore the resistance of the connecting wires.



8.1 The three external resistors are ohmic conductors.

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

8.2 When switch **S** is OPEN, voltmeter V_1 reads 3,2 V.

Calculate the:

8.2.1 Current through the battery (3)

8.2.2 Emf of the battery (4)

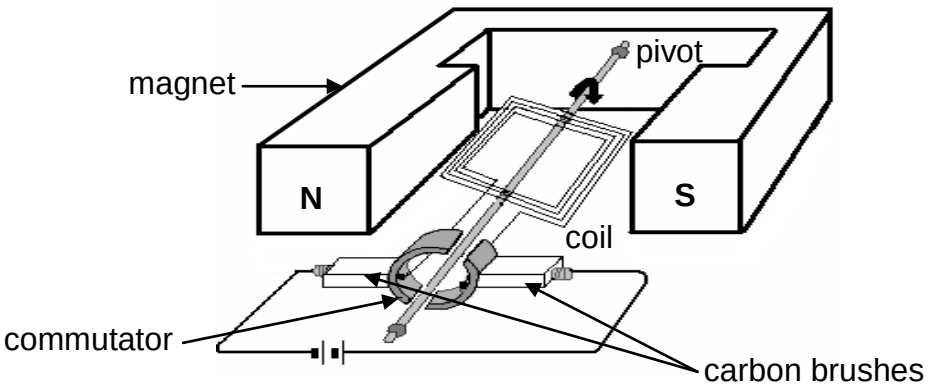
8.3 When switch **S** is CLOSED, voltmeter V_2 reads 8,8 V.

8.3.1 Calculate the resistance of resistor **R**. (5)

8.3.2 The battery becomes heated when voltmeter V_2 is replaced by a connecting wire. Explain this observation. (3)
[17]

QUESTION 9 (Start on a new page.)

9.1 The simplified sketch of an electric motor is shown below.

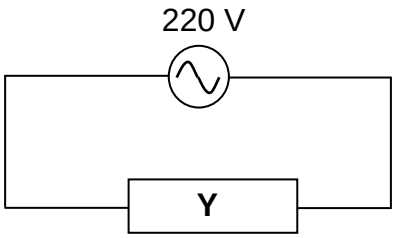


9.1.1 Write down the energy conversion that takes place in this motor. (1)

9.1.2 Is the motor above an AC motor or a DC motor? (1)

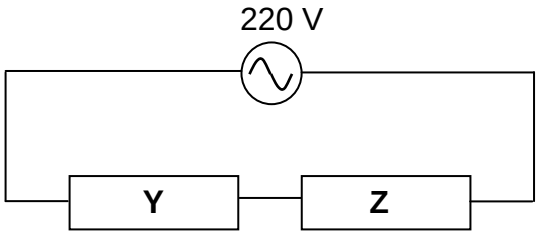
9.1.3 What is the function of the commutator in this motor? (1)

9.2 A resistor **Y** is rated 220 V, 100 W and is connected to a 220 V AC source, as shown in the circuit below.



9.2.1 Calculate the resistance of resistor **Y**. (3)

Another resistor **Z** with a rating 220 V, *X* W, is now connected in series to resistor **Y** and to the same AC source. See the diagram below.



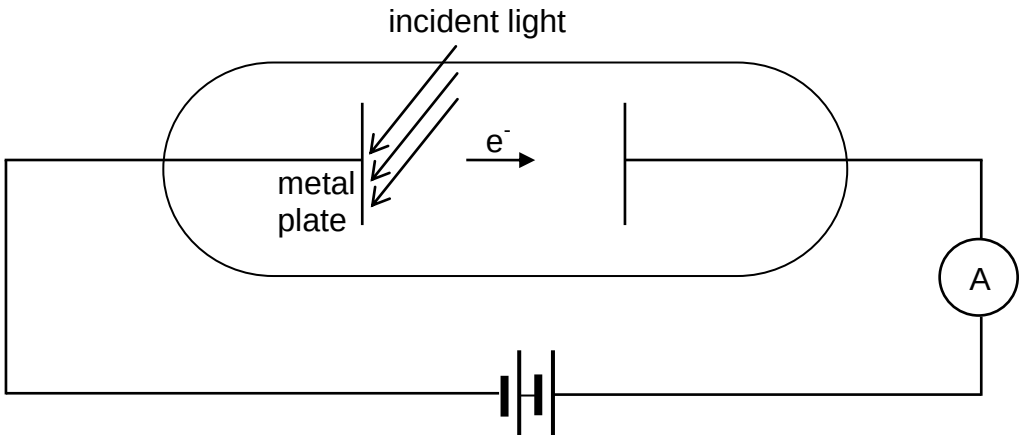
The power dissipated by resistor **Y** changes to 80 W, while its resistance remains constant.

9.2.2 Calculate the power rating *X* of resistor **Z**, assuming that resistor **Z** has constant resistance. (6)

[12]

QUESTION 10 (Start on a new page.)

10.1 The apparatus illustrated in the simplified diagram below is used to demonstrate the photoelectric effect.



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

Incident light of frequency 1,2 x 10^{15} Hz is shone onto the metal plate and electrons are emitted.

Calculate the:

10.1.2 Number of photoelectrons emitted in one second if the total energy transferred by the light to the metal plate per second is 1,75 x 10^{-9} J (4)

10.1.3 Maximum speed of a photoelectron if the threshold frequency of the metal plate is 9,09 x 10^{14} Hz (5)

10.2 Briefly explain how an emission spectrum is formed in terms of energy transitions. (2)

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

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN

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

2022

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 28 pages./
Hierdie nasienriglyne bestaan uit 28 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 B ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 D ✓✓ (2)

1.9 A ✓✓ (2)

1.10 C ✓✓ (2)

[20]

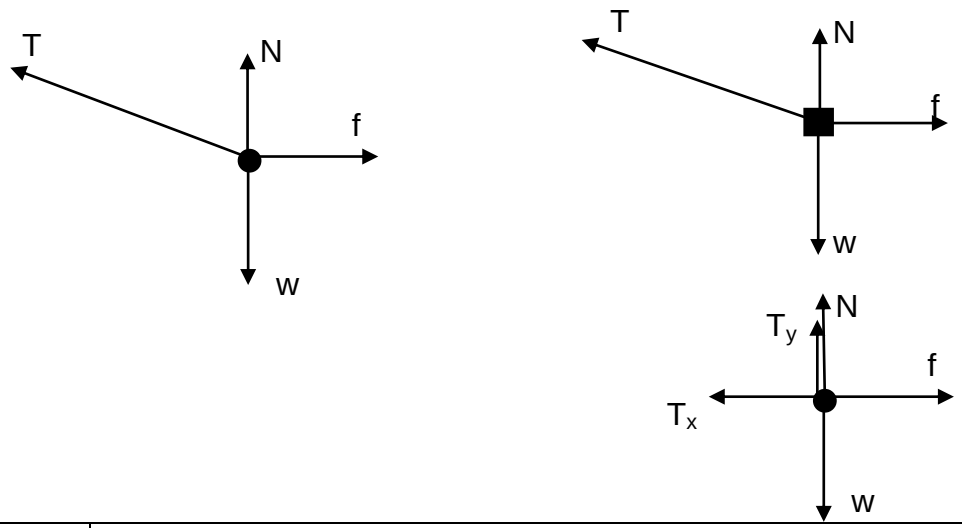
QUESTION 2/*VRAAG 2*

2.1

Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.*

A body will remain in its state of rest or motion at constant velocity unless a (non-zero) resultant/net force/unbalanced force acts on it. ✓✓
'n Liggaam sal in sy toestand van rus of beweging teen konstante snelheid volhard, tensy 'n (nie-nul) resulterende/netto krag/ongebalanseerde krag daarop inwerk.
OR/*OF*
A body will remain in its state of rest or uniform motion in a straight line unless a (non-zero) resultant/net force acts on it. ✓✓
'n Liggaam sal in sy toestand rus of uniforme beweging in 'n reguit lyn volhard, tensy 'n (nie-nul) resulterende/netto krag daarop inwerk. (2)

2.2 **ACCEPT/*AANVAAR***



	Accepted symbols/*Aanvaarde simbole*
N ✓	F_N /Normal/Normal force/*Normaal/Normaalkrag*/$F_{buoyant}$
f ✓	F_f /f_k/frictional force/*wrywingskrag*/kinetic frictional force/*kinetiese wrywingskrag/300 N*
w ✓	F_g/mg/Weight/G*ewig*/$F_{Earth\ on\ man}$/ *$F_{Aarde\ op\ man}$*/F_w/Gravitational force/ *Gravitasiekrag/* 686 N
T ✓	Tension/*Spanning*/$F_{Tension}$/$F_{Spanning}$ /F_T/F_S / **ACCEPT/ *AANVAAR*** F/$F_{applied}$/$F_{toegepas}$

Notes/*Aantekeninge*
- Mark is awarded for label and arrow./*Punt word toegeken vir byskrif en pyltjie.*
- Do not penalise for length of arrows./*Moenie vir die lengte van die pyltjies penaliseer nie*.
- Deduct 1 mark for any additional force /*Trek 1 punt af vir enige addisionele krag*
- If T is not shown but T_Y and T_X are shown give 1 mark for both.
  Indien T nie aangetoon is nie maar T_Y en T_X *is getoon, ken 1 punt toe vir beide.*

(4)

2.3

OPTION 1/*OPSIE 1*

$F_{net} = ma$
$T\cos50° - F_f = ma$ ✓Any one/*Enige een*
$T\cos50° - 300$ ✓$= 0$ ✓ **OR/*OF*** $T\cos50° = 300$ ✓✓
$T = 466{,}72$ N ✓(468,75 N)

OR/*OF*
$F_{net} = 0$ ✓✓
$T\cos50° = F_f$ ✓✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta E_k$ ✓
$T\Delta x\cos0º + f\Delta x\cos180º = 0$ ✓
$T\cos50° - 300$ ✓ $= 0$
$T = 466{,}72$ N ✓(468,75 N)

OR/*OF*
$W_{net} = 0$ ✓✓
$T\Delta x\cos50º = -f\Delta x\cos180º$ ✓✓

NOTE/*AANTEKENING*
Can use sin40º instead of cos50º.
Kan ook sin40º i.p.v. cos50º gebruik.

(4)

2.4 Increases/*Neem toe* ✓

F_{net} increases / F_{net} is not zero / $T_x > f$ / $T\cos50º > f$ ✓
F_{net} neem toe / *F_{net} is nie nul nie* / $T_x > f$ / $T\cos50º > f$

(2)

2.5

Marking criteria Options 1 & 2/*Nasienkriteria Opsies 1 & 2*

- Substitution to calculate a/*Vervanging om a te bereken* ✓
- Formula to calculate $F_{up/water}$/*Formule om $F_{op/water}$ te bereken* ✓
- Substitution to calculate $F_{up/water}$/*Vervanging om $F_{op/water}$ te bereken* ✓✓
- Final answer/*Finale antwoord*: 679,20 N ✓

OPTION 1/*OPSIE 1*

DOWNWARDS AS POSITIVE/ *AFWAARTS AS POSITIEF:*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (16)^2 + 2a\,(0{,}8)$ ✓
$a = -160\ m\cdot s^{-2}$

$F_{net} = ma$
$F_g - F_{up/op} = ma$ ✓Any one/*Enige een*
$(4)(9{,}8) - F_{up/op}$ ✓$= (4)(-160)$ ✓
$F_{up/op} = -679{,}20$ N
$F_{up/op} = 679{,}20$ N ✓

UPWARDS AS POSITIVE/ *OPWAARTS AS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (-16)^2 + 2a(-0{,}8)$ ✓
$a = 160\ m\cdot s^{-2}$

$F_{net} = ma$
$-F_g + F_{up/op} = ma$ ✓Any one/*Enige een*
$-(4)(9{,}8) + F_{up/op}$ ✓$= (4)(160)$ ✓
$F_{up/op} = 679{,}20$ N ✓

OPTION 2/*OPSIE 2*

DOWNWARDS AS POSITIVE/ ***AFWAARTS AS POSITIEF***	**UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF***
$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$
$0,8 = \left(\frac{16 + 0}{2}\right)\Delta t$	$-0,8 = \left(\frac{-16 + 0}{2}\right)\Delta t$
$\Delta t = 0,1$ s	$\Delta t = 0,1$ s
$v_f = v_i + a\Delta t$ $0 = 16 + a(0,1)$ ✓ $a = -160$ m·s^{-2}	$v_f = v_i + a\Delta t$ $0 = -16 + a(0,1)$ ✓ $a = 160$ m·s^{-2}
OR/*OF*	**OR/*OF***
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $0,8 = (16)(0,1) + \frac{1}{2}(a)(0,1)^2$ ✓ $a = -160$ m·s^{-2}	$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-0,8 = (-16)(0,1) + \frac{1}{2}(a)(0,1)^2$ ✓ $a = 160$ m·s^{-2}
$F_{net} = ma$ $F_g - F_{up/op} = ma$ ✓Any one/*Enige een* $(4)(9,8) - F_{up/op}$ ✓$= (4)(-160)$ ✓ $F_{up/op} = -679,20$ N $F_{up/op} = 679,20$ N ✓	$F_{net} = ma$ $-F_g + F_{up/op} = ma$ ✓Any one/*Enige een* $-(4)(9,8) + F_{up/op}$ ✓$= (4)(160)$ ✓ $F_{up/op} = 679,20$ N ✓

USING ENERGY PRINCIPLES/GEBRUIK VAN ENERGIE BEGINSELS
Marking criteria OPTIONS 3 to 5/Nasienkriteria OPSIES 3 to 5

- Formula / *Formule* ✓
- Substitution / *Vervanging* ✓✓✓
- Final answer/*Finale antwoord*: 679,20 N ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$
$F_{net}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige een*
$(4)(9,8)(0,8)\cos0°$✓ + $F_{up/op}(0,8)\cos180°$ ✓ $= \frac{1}{2}(4)(0 - 16^2)$ ✓
$F_{up/op} = 679,20$ N ✓

OPTION 4/*OPSIE 4*

$W_{nc} = \Delta K + \Delta U$
$F_{up/op}\Delta x\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$ ✓Any one/*Enige een*
$F_{up/op}(0,8)\cos180°$ ✓ $= \frac{1}{2}(4)(0 - 16^2)$ ✓+ $(4)(9,8)(0 - 0,8)$ ✓
$F_{up/op} = 679,20$ N ✓

OPTION 5/*OPSIE 5*

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

$$0,8 = \left(\frac{16 + 0}{2}\right)\Delta t$$

$$\Delta t = 0,1 \text{ s}$$

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = (p_{tube/band})_f - (p_{tube/band})_i$
$(F_g - F_{up/op})\Delta t = m(v_{tube/band(f)} - v_{tube/band(i)})$
✓Any one/*Enige een*

$[(4)(9,8)$ ✓ $- F_{up/op}](0,1)$ ✓ $= (4)(0 - 16)$ ✓
$F_{up/op} = 679,20$ N ✓ (5)

[17]

QUESTION 3/*VRAAG 3*

3.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.*

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

(2)

3.2.1

OPTION 1/ *OPSIE 1*	**OPTION 2/ *OPSIE 2***
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $0 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓	**Motion from top/*Beweging van bo*** **UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-15 = 0 + (-9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $15 = 0 + (9,8)\Delta t$ ✓ $\Delta t = 1,53$ s ✓
OPTION 3/ *OPSIE 3*	**OPTION 4/ *OPSIE 4***
UPWARDS AS POSITIVE/ ***OPWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $-15 = 15 + (-9,8)\Delta t$ ✓ $\Delta t = 3,06$ s Δt up = 1,53 s ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $v_f = v_i + a\Delta t$ ✓ $15 = -15 + (9,8)\Delta t$ ✓ $\Delta t = 3,06$ s Δt up = 1,53 s ✓	**UPWARDS AS POSITIVE/** ***OPWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (15)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ $\Delta t = 3,06$ s Δt up = 1,53 s ✓ **DOWNWARDS AS POSITIVE/** ***AFWAARTS AS POSITIEF*** $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $0 = (-15)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓ $\Delta t = 3,06$ s $\Delta t_{up} = 1,53$ s ✓

(3)

Marking criteria OPTIONS 5 to 7/*Nasienkriteria OPSIES 5 tot 7*

- Any formula relating Δy and Δt/ **OR/*OF*** $F_{net}\Delta t = m\Delta v$✓
- Substitution to calculate Δt/*Vervanging om Δt te bereken* ✓
- Final answer/*finale antwoord*: 1,53 s ✓

OPTION 5/*OPSIE 5*

$(E_{mech})_{Top/Bo} = (E_{mech})_{30\ m}$

$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{30\ m}$

$(mgh + ½mv^2)_{Top/Bo} = (mgh + ½mv^2)_{30\ m}$

$(9,8)h + 0 = 0 + (½)(15)^2$

$\Delta h = 11,48$ m

OPTION 6/*OPSIE 6*

$W_{nc} = \Delta K + \Delta U$

$W_{nc} = \Delta K + mg(h_f - h_i)$

$0 = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$

$0 = ½(0 - 15^2) + (9,8)\Delta h$

$\Delta h = 11,48$ m

OPTION 7/*OPSIE 7*

$W_{net} = \Delta E_k$

$w\Delta y\cos\theta = ½mv_f^2 - ½mv_i^2$

$(9,8)\Delta y\cos 180^o = 0 - ½(15)^2$

$\Delta y = 11,48$ m

OPTION A/*OPSIE A*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + ½a\Delta t^2$✓

$11,48 = (15)\Delta t + ½(-9,8)\Delta t^2$ ✓

$\Delta t = 1,53$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + ½a\Delta t^2$ ✓

$11,48 = (-15)\Delta t + ½(9,8)\Delta t^2$ ✓

$\Delta t = 1,53$ s ✓

OPTION B/*OPSIE B*

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

$11,48 = \left(\frac{15 + 0}{2}\right)\Delta t$ ✓

$\Delta t = 1,53$ s ✓

OPTION 8/*OPSIE 8*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

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

$\Delta y = \left(\frac{15 + 0}{2}\right)\Delta t$

$\Delta y = 7,5\ \Delta t$

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

$0 = (15)^2 + 2(-9,8)(7,5\Delta t)$ ✓

$\Delta t = 1,53$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

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

$\Delta y = \left(\frac{-15 + 0}{2}\right)\Delta t$

$\Delta y = -7,5\Delta t$

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0 = (-15)^2 + 2(9,8)(-7,5\Delta t)$ ✓

$\Delta t = 1,53$ s ✓

OPTION 9/*OPSIE 9*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/ *Enige een*

$-(9,8)\Delta t = 0 - 15$ ✓

$\Delta t = 1,53$ s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$F_{net}\Delta t = m\Delta v$
$F_{net}\Delta t = m(v_f - v_i)$ } ✓Any one/ *Enige een*

$(9,8)\Delta t = 15 - 0$ ✓

$\Delta t = 1,53$ s ✓

(3)

3.2.2

POSITIVE MARKING FROM QUESTION 3.2.1/
POSITIEWE NASIEN VANAF VRAAG 3.2.1

Marking criteria/*Nasienkriteria*

- Formula to calculate Δy/*Formule om Δy te bereken* ✓
- Substitution to calculate Δy/*Vervanging om Δy te bereken* ✓
- Substitution of/*Vervanging van* 30 m ✓
- Final answer/*Finale antwoord*: 41,48 m ✓

NOTE/*AANTEKENING*

v_f and v_i can be swopped
v_f en v_i kan omgeruil word

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/
OPWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{(15)(1,53) + \frac{1}{2}(-9,8)(1,53)^2}$ ✓
$= 11,48$ m

Height/*hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{(-15)(1,53) + \frac{1}{2}(9,8)(1,53)^2}$ ✓
$= -11,48$ m

Height/*Hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

OPTION 2/*OPSIE 2*

UPWARDS AS POSITIEF/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{0 = (15)^2 + (2)(-9,8)\Delta y}$ ✓
$\Delta y = 11,48$ m

Height/*hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

DOWNWARDS AS POSITIEF/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$\underline{0 = (-15)^2 + (2)(9,8)\Delta y}$ ✓
$\Delta y = -11,48$ m

Height/*Hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

OPTION 3/*OPSIE 3*

UPWARDS AS POSITIEF/
OPWAARTS AS POSITIEF

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

$\Delta y = \left(\frac{15+0}{2}\right)(1,53)$ ✓
$= 11,48$ m

Height/*Hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

DOWNWARDS AS POSITIEF/
AFWAARTS AS POSITIEF

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

$\Delta y = \left(\frac{-15+0}{2}\right)(1,53)$ ✓
$= -11,48$ m

Height/*Hoogte* = 11,48 + 30 ✓
= 41,48 m ✓

OPTION 4/*OPSIE 4*

UPWARDS AS POSITIEF/
OPWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(-15)^2 + (2)(-9,8)(-30)}$ ✓
$v_f = -28,51\ m\cdot s^{-1}$

$v_f^2 = v_i^2 + 2a\Delta y$
$\underline{(-28,51)^2 = (0)^2 + (2)(-9,8)\Delta y}$ ✓
$\Delta y = 41,48$ m
Height/*Hoogte* = 41,48 m ✓

DOWNWARDS AS POSITIEF/
AFWAARTS AS POSITIEF

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = \underline{(15)^2 + (2)(9,8)(30)}$ ✓
$v_f = 28,51\ m\cdot s^{-1}$

$v_f^2 = v_i^2 + 2a\Delta y$
$\underline{(28,51)^2 = (0)^2 + (2)(9,8)\Delta y}$ ✓
$\Delta y = 41,48$ m

Height/*Hoogte* = 41,48 m ✓

OPTION 5/ *OPSIE 5*

$(E_{mech})_{Top/Bo} = (E_{mech})_{30\ m}$
$(E_P + E_K)_{Top/Bo} = (E_P + E_K)_{30\ m}$
$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{30\ m}$
✓Any one/*Enige een*

$(9,8)h + 0 = (9,8)(30✓) + (½)(15)^2$ ✓
h = 41,48 m ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta E_k$
$w\Delta x\cos 180° = ½m(v_f^2 - v_i^2)$
✓Any one/*Enige een*

$(9,8)(\Delta x)\cos 180° = ½(0 - 15^2)$ ✓
Δx = 11,47 m
Height above the ground/*hoogte bokant grond*= 30 +✓ 11,47 = 41,48 m ✓

OPTION 7/*OPSIE 7*

$W_{nc} = \Delta E_p + \Delta E_k$
$0 = mg(h_f - h_i) + ½m(v_f^2 - v_i^2)$
✓Any one/*Enige een*

$0 = (9,8)(h_f - 0) + ½(0 - 15^2)$ ✓
h = 11,47 m
Height above the ground/*hoogte bokant grond*= 30 +✓ 11,47 = 41,48 m ✓ (4)

3.3

POSITIVE MARKING FROM QUESTION 3.2.2/
POSITIEWE NASIEN VANAF VRAAG 3.2.2

Marking criteria/*Nasienkriteria*

- Formula/*Formule* ✓
- Substitute to calculate Δy_B/*Vervang om Δy_B te bereken* ✓
- Substitute to calculate Δy_C/*Vervang om Δy_c te bereken* ✓
- Substitute/*Vervang* Δt + 0,5 or/*of* Δt – 0,5 ✓
- Equating y_B and y_C ✓
- Final answer/*Finale antwoord:* 1,71 s ✓

OPTION 1/*OPSIE 1*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

Take y_C as height of disc above ground at meeting point / *neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt*:

$\Delta y_C = v_i\Delta t + ½a\Delta t^2$ ✓
$y_C - 30 = 15\Delta t + ½(-9,8)\Delta t^2$ ✓
$y_C = 15\Delta t - 4,9\Delta t^2 + 30$….. (1)

Take y_B as height of ball above ground at meeting point/*Neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt*:

$\Delta y_B = v_i\Delta t + ½a\Delta t^2$
$y_B - 0 = 40(\Delta t - 0,5✓) + ½(-9,8)(\Delta t - 0,5✓)^2$ ✓
$y_B = 44,9t - 21,225 - 4,9t^2$…..(2)

At meeting point/*By ontmoetingspunt*:

$y_C = y_B$
$15\Delta t - 4,9\Delta t^2 + 30 = 44,9t - 21,225 - 4,9t^2$ ✓
Δt = 1,71 s ✓

DOWNWARDS AS POSITIVE/
AFWAARTS AS POSITIEF

Take y_C as height of disc above ground at meeting point/*neem hoogte y_C as die hoogte van teiken bokant grond by ontmoetingspunt*:

$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$y_C - 30 = \underline{-15\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$y_C = -15\Delta t + 4,9\Delta t^2 + 30$….. (1)

Take y_B as height of ball above ground at meeting point/*neem hoogte y_B as die hoogte van bal bokant grond by ontmoetingspunt*:

$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$y_B - 0 = \underline{-40}(\Delta t - 0,5\checkmark) \underline{+ \frac{1}{2}(9,8)}(\Delta t - 0,5\checkmark)^2$ ✓
$y_B = -44,9t + 21,225 + 4,9t^2$…..(2)

At meeting point/*By ontmoetingspunt*:

$y_C = y_B$ ∴ $\underline{-15\Delta t + 4,9\Delta t^2 + 30 = -44,9t + 21,225 + 4,9t^2}$ ✓
$\Delta t = 1,71$ s ✓

<u>OPTION 2</u>/*<u>OPSIE 2</u>*
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF:*

$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{15\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓
$= 15\Delta t - 4,9\Delta t^2$….. (1)

$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{40}(\Delta t - 0,5\checkmark) \underline{+ \frac{1}{2}(-9,8)} (\Delta t - 0,5\checkmark)^2$ ✓

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y_C = 40(\Delta t - 0,5) + \frac{1}{2}(-9,8)(\Delta t - 0,5)^2$
$\Delta y_C = -4,9\Delta t^2 + 44,9\Delta t - 51,225$ …..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk:*
$\underline{15\Delta t = 44,9\Delta t - 51,225}$ ✓
$\Delta t = 1,71$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF:*

$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= \underline{-15\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$= 4,9\Delta t^2 - 15\Delta t$ …..(1)

$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-40}(\Delta t - 0,5\checkmark) \underline{+ \frac{1}{2}(9,8)}(\Delta t - 0,5\checkmark)^2$ ✓

Δy_C in terms of/*in terme van* Δy_B:
$30 + \Delta y_C = (-40)(t - 0,5) + \frac{1}{2}(9,8)(\Delta t - 0,5)^2$
$\Delta y_C = 4,9\Delta t^2 - 44,9\Delta t + 51,225$…..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk*:
$\underline{-15\Delta t = -44,9\Delta t + 51,225}$ ✓
$\Delta t = 1,71$ s ✓

OPTION 3/*OPSIE 3*

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

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

$= \underline{15}(\Delta t + 0,5$✓$) \underline{+ \frac{1}{2}(-9,8)}(\Delta t + 0,5)^2$ ✓

$= -4,9t^2 + 10,1\Delta t + 6,275$…..(1)

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

$= \underline{40\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

Δy_C in terms of/*in terme van* Δy_B:

$30 + \Delta y = 40\Delta t + \frac{1}{2}(-9,8)t^2$

$\Delta y = -4,9\Delta t^2 + 40t - 30$ …..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk*:

$\underline{10,1\Delta t + 6,275 = 40\Delta t - 30}$ ✓

$\Delta t = 1,21$ s

$\Delta t_{TOT} = 1,21 + 0,5$

$= 1,71$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*

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

$= \underline{-15}(\Delta t + 0,5$✓$) \underline{+ \frac{1}{2}(9,8)}(\Delta t + 0,5)^2$ ✓

$= 4,9\Delta t^2 - 10,1\Delta t + 6,275$…..(1)

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

$= \underline{-40\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓

Δy_C in terms of/*in terme van* Δy_B:

$30 + \Delta y = -40\Delta t + \frac{1}{2}(9,8)t^2$

$\Delta y = -4,9\Delta t^2 - 40\Delta t - 30$…..(2)

Equate (1) and (2)/*Stel (1) en (2) gelyk*:

$\underline{-10,1\Delta t + 6,275 = -40\Delta t - 30}$ ✓

$\Delta t = 1,21$ s

$\Delta t_{TOT} = 1,21 + 0,5$

$= 1,71$ s ✓

OPTION 4/*OPSIE 4*

Marking criteria:	***Nasienkriteria:***
• Formula: $\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓	• *Formule:* $\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
• Substitute to calculate Δy_B ✓	• *Vervang om Δy_B te bereken* ✓
• Substitute to calculate Δy_C ✓	• *Vervang om Δy_c te bereken* ✓
• Substitute $\Delta t = 0,5$ ✓	• *Vervang* $\Delta t = 0,5$ ✓
• Adding Δy_B and Δy_C ✓	• *Som van Δy_B en Δy_C* ✓
• Final answer: 1,71 s ✓	• *Finale antwoord:* 1,71 s ✓

UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*

Displacement of C after 0,5 s/*Verplasing van C na 0,5 s*

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

$= 15(0,5) + \frac{1}{2}(-9,8)(\underline{0,5}\checkmark)^2$

$\Delta y_C = 6,28$ m

Velocity of C after 0,5 s/ *Snelheid van C na 0,5 s*

$v_f = v_i + a\Delta t$

$= 15 + (-9,8)(0,5)$

$= 10,10\ m\cdot s^{-1}$

Displacement of C at meeting point/*Verplasing van C by ontmoetingspunt*

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

$= \underline{10,1\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$= 10,1\Delta t - 4,9\Delta t^2$

Displacement of B at meeting point/*Verplasing van B by ontmoetingspunt*

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

$= \underline{40\Delta t + \frac{1}{2}(-9,8)\Delta t^2}$ ✓

$= 40t - 4,9t^2$

At meeting point/*By ontmoetingspunt*:

$\underline{\Delta y_C + \Delta y_B = -[10,1\Delta t - 4,9\Delta t^2] + 40\Delta t - 4,9\Delta t^2}$ ✓

$36,28 = -10,10\Delta t + 40\Delta t$

$\Delta t = 1,21$ s

$\Delta t_{tot} = 1,21 + 0,5 = 1,71$ s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*
Displacement of C after 0,5 s/*Verplasing van C na 0,5 s*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= -15(0,5) + \frac{1}{2}(9,8)(\underline{0,5}\checkmark)^2$
$\Delta y_C = -6,28$ m

Velocity of C after 0,5 s/ *Snelheid van C na 0,5 s*
$v_f = v_i + a\Delta t$
$= -15 + (9,8)(0,5)$
$= -10,10\ m\cdot s^{-1}$

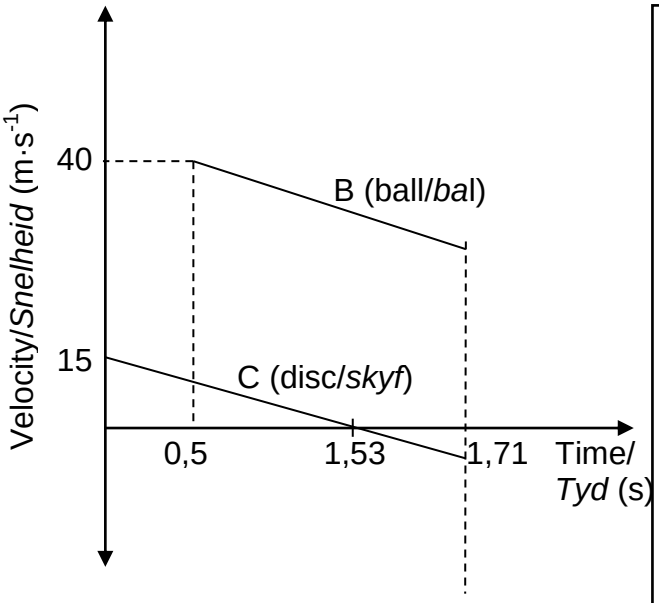
Displacement of C at meeting point/*Verplasing van C by ontmoetingspunt*
$\Delta y_C = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-10,1\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$= -10,1\Delta t + 4,9\Delta t^2$

Displacement of B at meeting point/*Verplasing van B by ontmoetingspunt*
$\Delta y_B = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$= \underline{-40\Delta t + \frac{1}{2}(9,8)\Delta t^2}$ ✓
$= -40t + 4,9t^2$
At meeting point/*By ontmoetingspunt*:
$\underline{\Delta y_C + \Delta y_B = -[-10,1\Delta t + 4,9\Delta t^2] - 40\Delta t + 4,9\Delta t^2}$✓
$-36,28 = 10,10\Delta t - 40\Delta t$
$\Delta t = 1,21$ s
$\Delta t_{tot} = 1,21 + 0,5 = 1,71$ s ✓

(6)

3.4 **POSITIVE MARKING FROM QUESTIONS 3.2.1 AND 3.3 /**
POSITIEWE NASIEN VANAF VRAE 3.2.1 EN 3.3.

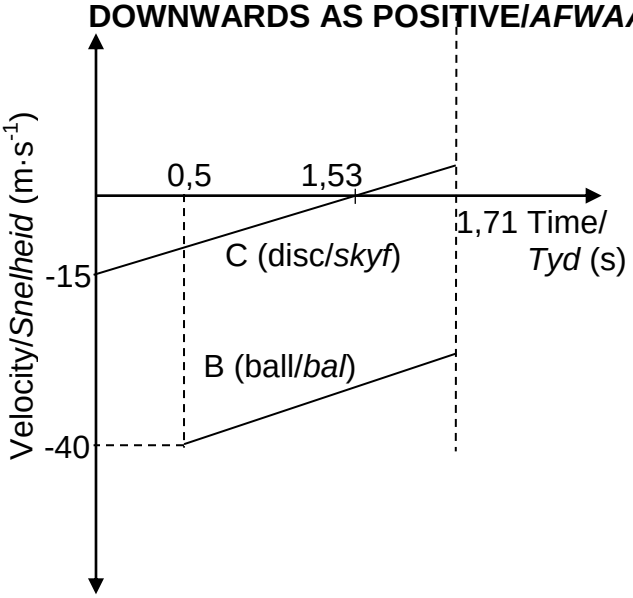
UPWARDS AS POSITIVE/*OPWAARTS AS POSITIEF*



Marking criteria:
- Initial velocities 40 and 15 and straight lines ✓
- B starting at 0,5 s ✓
- Parallel lines with negative gradient ✓
- Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
- Time at which B hits C (answer from 3.3) 1,71 s ✓

Nasienkriteria:
- *Aanvanklike snelhede* 40 *en* 15 en reguitlyne ✓
- *B begin by 0,5 s*✓
- *Parallelle lyne met negatiewe gradiënt* ✓
- *Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1)* 1,53 s ✓
- *Tyd wanneer B vir C tref (antwoord van 3.3)* 1,71s ✓

DOWNWARDS AS POSITIVE/*AFWAARTS AS POSITIEF*



Marking criteria:
- Initial velocities -40 and -15 and straight lines ✓
- B starting at 0,5 s ✓
- Parallel lines with positive gradient ✓
- Time at which disc reaches maximum height (answer from 3.2.1) 1,53 s ✓
- Time at which B hits C (answer from 3.3) 1,71 s ✓

Nasienkriteria:
- *Aanvanklike snelhede* -40 *en* -15 en reguitlyne ✓
- *B begin by 0,5 s*✓
- *Parallelle lyne met positiewe gradiënt* ✓
- *Tyd wanneer skyf maks hoogte bereik (antwoord van 3.2.1)* 1,53 s ✓
- *Tyd wanneer B vir C tref (antwoord van 3.3)* 1,71s ✓

(5)
[20]

QUESTION 4 /*VRAAG 4*

4.1 A system on which the resultant/net external force is zero./*'n Sisteem waarop die resultante/netto eksterne krag nul is*. ✓✓ (2 or/*of* 0) (2)

4.2
1. According to Newton 3rd Law ✓ the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓

OR

2. The toy cart exerts a force on the rocket to the right ✓and the rocket exerts a force on the toy cart to the left/opposite to direction of motion. ✓

OR

3. The rocket experiences a change in momentum to the right ✓, the toy cart experiences a change in momentum to the left. ✓

OR

4. $\Delta p_{toy\ cart} = -\Delta p_{rocket}$ ✓✓

OR

5. Total momentum is conserved / remains constant. ✓
The momentum of the rocket increases. Therefore, the momentum of the toy cart must decrease. ✓

OR

6. The rocket experiences an impulse to the right ✓ therefore, the toy cart experiences an impulse to the left. ✓

OR

7. $Impulse_{rocket} = -Impulse_{toy\ cart}$ ✓✓

1. Volgens Newton se derde wet ✓ oefen die vuurpyl 'n krag op die speelgoedwaentjie na links uit/ teen die bewegingsrigting. ✓

OF

2. Die speelgoedwaentjie oefen 'n krag op die vuurpyl na regs ✓ en die vuurpyl oefen 'n krag op die speelgoedwaentjie na links/teen die bewegingsrigting ✓.

OF

3. Die vuurpyl ondervind 'n verandering in momentum na regs ✓, die speelgoedwaentjie ondervind 'n verandering in momentum na links. ✓

OF

4. $\Delta p_{speelgoedwaentjie} = -\Delta p_{vuurpyl}$

OF

5. *Totale momentum bly behoue.* ✓
Die momentum van die vuurpyl neem toe. Dus moet d*ie momentum van die speelgoedwaentjie af neem*. ✓

OF

6. Die vuurpyl ondervind 'n impuls na regs ✓ dus ondervind die *speelgoedwaentjie 'n impuls na links.* ✓

OF

7. $Impuls_{vuurpyl} = -Impuls_{speelgoedwaentjie}$ ✓✓ (2)

4.3

OPTION 1/*OPSIE 1*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ ✓Any one/*Enige een*
$mv_i = m_1v_{1f} + m_2v_{2f}$

$\underline{(20 + m_2)2,5}$ ✓ $= \underline{20(0,6)}$ ✓ $+ \underline{m_2(30)}$ ✓
$m_2 = 1,38$ kg ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\sum p_i = \sum p_f$
$(m_1 + m_2)v_i = m_1v_{1f} + m_2v_{2f}$ ✓Any one/*Enige een*
$mv_i = m_1v_{1f} + m_2v_{2f}$

$\underline{(20 + m_2)(-2,5)}$ ✓ $= \underline{20(-0,6)}$ ✓ $+ \underline{m_2(-30)}$ ✓
$m_2 = 1,38$ kg ✓

OPTION 2/*OPSIE 2*

RIGHT AS POSITIVE/*REGS AS POSITIEF*

$\Delta p_{\text{toy cart/}speelgoedwaentjie} = -\Delta p_{\text{rocket/}vuurpyl}$
$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$ ✓Any one/*Enige een*

(20) ✓$\underline{(0,6 - 2,5)}$ ✓ $= \underline{-(m)(30 - 2,5)}$ ✓
$m_2 = 1,38$ kg ✓

LEFT AS POSITIVE/*LINKS AS POSITIEF*

$\Delta p_{\text{toy cart/}speelgoedwaentjie} = -\Delta p_{\text{rocket/}vuurpyl}$
$m_1(v_{1(f)} - v_{1(i)}) = -m_2(v_{2(f)} - v_{2(i)})$ ✓Any one/*Enige een*

(20) ✓$\underline{[-0,6 - (-2,5)]}$ ✓ $= \underline{-(m)[(-30 - (-2,5)]}$ ✓
$m_2 = 1,38$ kg ✓

(5)
[9]

QUESTION 5/*VRAAG 5*

5.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: -1 punt per word/frase.

The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓
Die netto/totale arbeid op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.
OR/*OF*
The work done on an object by a net force is equal to the change in the object's kinetic energy.
Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

5.2

F_{net} opposite to direction of displacement Δx. ✓ / Both frictional force and gravitational force are in opposite direction of displacement Δx.
F_{net} teenoorgesteld tot rigting van verplasing Δx. / Beide wrywingskrag en gravitasie krag is teenoorgesteld tot die verplasing Δx.

OR/*OF*
ΔK is negative. / The final K is zero. / E_k decreases.
ΔK is negatief. / Die finale K is nul. / E_k neem af.
OR/*OF*
$W_{net} = F_{net}\ \Delta x\cos\theta$ and/*en* $\theta = 180°/\cos\theta = -1$ (1)

5.3

OPTION 1/*OPSIE 1*

$W_{net} = \Delta K$
$W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$mg\sin\theta\Delta x\cos\theta + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓Any one/*Enige een*

$(30\ 000)(9,8)\sin28°\Delta x\cos180°$✓ + $(31\ 000)\Delta x\cos180°$✓
$= \frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓
$\Delta x = 96,64$ m ✓

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta K + \Delta U$
$W_f = \Delta K + mg(h_f - h_i)$
$f\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 + mgh_f - mgh_i$
✓Any one/*Enige een*

$31\ 000\Delta x\cos180°$✓ = $\frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓ + $30\ 000(9,8)(\Delta x\sin28° - 0)$ ✓
$\Delta x = 96,64$ m ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$
$W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$-\Delta E_p + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$-mg(h_f - h_i) + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓Any one/*Enige*

$-(30\ 000)(9,8)(\Delta x\sin28° - 0)$✓ + $(31\ 000)\Delta x\cos180°$✓= $\frac{1}{2}(30\ 000)(0^2 - 33^2)$ ✓
$\Delta x = 96,64$ m ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$
$W_w + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓Any one/*Enige*
$mg\Delta x\cos\theta + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$\underline{(30\ 000)(9{,}8)\Delta x\cos 118°}$✓ + $\underline{(31\ 000)\Delta x\cos 180°}$✓= $\underline{\frac{1}{2}(30\ 000)(0^2 - 33^2)}$ ✓
$\Delta x = 96{,}64$ m ✓

OPTION 5/*OPSIE 5*

$F_{net} = ma$
$F_{net} = F_{w//} + f$
$= \underline{(30\ 000)(9{,}8)\sin 28° + 31\ 000}$✓
$= 169\ 024{,}64$ N

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

$\underline{169\ 024{,}64\Delta x\cos 180°}$✓ = $\underline{\frac{1}{2}(30\ 000)(0^2 - 33^2)}$ ✓
$\Delta x = 96\ 64$ m ✓ (5)

5.4 Ascending/*Opgaande* ✓

1. Ascending/*Opgaande*: $F_{net(A)} = F_{w//} + f$
   Descending/*Afgaande*: $F_{net(D)} = F_{w//} - f$ ✓
   $F_{net(A)} > F_{net(D)}$ ✓

OR/*OF*

2. Ascending: $F_{w//}$ and f are both acting in the opposite to direction of displacement.
   Descending: only f is acting in the opposite direction of displacement. ✓
   Net force for ascending greater than net force for descending. ✓

   Opgaande: $F_{w//}$ en f werk beide teen die rigting van verplasing.
   Afgaande: slegs f werk teen die rigting van verplasing.
   Die netto krag opgaande is groter as die netto krag afgaande.

OR/*OF*

3. Ascending: F_{net} acts opposite to the direction of motion. ✓
   Descending: F_{net} acts downwards in the direction of motion. ✓

   Opgaande: F_{net} werk teen die bewegingsrigting.
   Afgaande: F_{net} werk afwaarts in die bewegingsrigting.

OR/*OF*

4. Ascending: $F_{w(//)}$ acts opposite to the direction of motion
   Descending: $F_{w(//)}$ acts downwards in the direction of motion ✓
   Net force for ascending greater than net force for descending. ✓

   Opgaande: $F_{w(//)}$ werk teen die bewegingsrigting.
   Afgaande: $F_{w(//)}$ werk afwaarts in die bewegingsrigting.
   Die netto krag opgaande is groter as die netto krag afgaande. (3)

[11]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

The (apparent) change in frequency (or pitch) (of the sound) detected by a listener because the source and the listener have different velocities relative to the medium of propagation. ✓✓
Die (skynbare) verandering in die frekwensie (of toonhoogte) (van die klank) waargeneem deur 'n luisteraar omdat die bron en die luisteraar verskillende snelhede relatief tot die voortplantingsmedium het.

OR/*OF*
An (apparent) change in observed/detected frequency/pitch as a result of the relative motion between a source and an observer/listener.
'n (Skynbare) verandering in waargenome frekwensie/toonhoogte as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/ luisteraar. (2)

6.2

$v = f\lambda$ ✓
$340 = (880)\lambda$ ✓
$\lambda = 0{,}39$ m (0,386) ✓ (3)

6.3

OPTION 1/*OPSIE 1*

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

$f_L = \left(\frac{340 + 10}{340}\right)$ ✓ 880 ✓

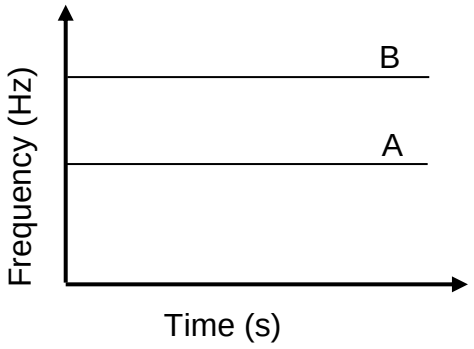
$f_L = 905{,}88$ Hz ✓

POSITIVE MARKING FROM QUESTION 6.2/
POSITIEWE NASIEN VANAF VRAAG 6.2

OPTION 2/*OPSIE 2*

$v = f\lambda$ ✓
$340 + 10$ ✓ $= f_L(0{,}39)$ ✓
$f_L = 897{,}44$ Hz ✓ (4)

6.4



Marking criteria/*Nasienkriteria*
B parallel with A and above A. ✓✓
B parallel aan A en bokant A. **2 or/*of* 0**

(2)
[11]

QUESTION 7/*VRAAG 7*

7.1.1

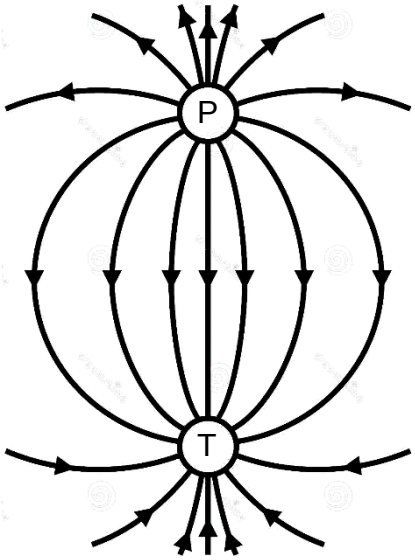
Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.*

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

Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle.

(2)

7.1.2



Criteria for graph/*Kriteria vir grafiek:*	
Correct shape *Korrekte vorm*	✓
Correct direction from P to T. *Korrekte rigting van P na T.*	✓
Lines must not cross and must touch spheres. *Lyne mag nie kruis nie en moet die sfere raak.*	✓
NOTE/*AANTEKENING*: If the net electric field pattern is drawn for two like charges: *Indien die netto elektriese veldpatroon vir twee gelyksoortige ladings geteken is:*	$0/3$

(3)

7.1.3 positive/ *positief* ✓ (1)

7.1.4

Marking criteria/*Nasienkriteria*

- Equation for Coulomb's law./Vergelyking vir *Coulomb se wet.* ✓
- Correct substitution into Coulomb's equation for for F_{TP}. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_{TP}.
- Correct substitution into Coulomb's equation for F_{TS}. ✓
  Korrekte vervanging in Coulomb se vergelyking vir F_{TS}.
- Correct substitution into resultant force equation (Pythagoras equation). ✓
  Korrekte vervanging in resultante krag vergelyking (Pythagoras vergelyking).
- Substitute into Q = ne. /*Vervang in* Q = ne. ✓
- Final answer/*Finale antwoord*: 3,05 x10^{13} ✓

$$F_{net}^2 = F_{TP}^2 + F_{TS}^2$$

$$= \left(\frac{kQ_1Q_2}{r^2}\right)^2 \text{ ✓} + \left(\frac{kQ_1Q_2}{r^2}\right)^2$$

$$10^2 = \left(\frac{(9\times10^9)(3\times10^{-6})(3\times10^{-6})}{0{,}1^2}\right)^2 \text{ ✓} + \left(\frac{(9\times10^9)(3\times10^{-6})Q_2}{0{,}15^2}\right)^2 \text{ ✓}$$

$Q_S = 4{,}887 \times 10^{-6}$ C

↓ $Q_S = ne$

$4{,}887 \times 10^{-6} = n(1{,}6 \times 10^{-19})$ ✓

$n = 3{,}05 \times 10^{13}$ ✓ electrons/*elektrone* (6)

7.2.1 E is <u>directly</u> proportional to $\frac{1}{r^2}$ ./*E is <u>direk</u> eweredig aan* $\frac{1}{r^2}$. ✓

OR/*OF*

$E \alpha \frac{1}{r^2}$ (1)

7.2.2

Gradient = $\frac{\Delta E}{\Delta \frac{1}{r^2}}$ ✓ 680 ✓ $= \frac{E_A - (0)}{\frac{1}{0{,}04^2} - (0)}$ ✓ $E_A = 4{,}25 \times 10^5$ N·C^{-1} ✓	**<u>ACCEPT/*AANVAAR*</u>** $E = \frac{kQ}{r^2}$ ✓ $E_A = \frac{680}{0{,}04^2}$ ✓ ✓ $= 4{,}25 \times 10^5$ N·C^{-1} ✓ **OR/*OF*** y = mx + c / y = mx ✓ $E_A = 680$ ✓ $\left(\frac{1}{0{,}04^2}\right)$ ✓ $= 4{,}25 \times 10^5$ N·C^{-1} ✓

(4)

7.2.3 Greater than / *Groter as* ✓

The gradient is equal to kQ./The gradient is proportional to Q. ✓
Graph of sphere B has a steeper gradient than graph of sphere A. ✓
Die gradiënt is gelyk aan kQ./Die gradiënt is proporsioneel aan Q.
Grafiek vir sfeer B het 'n steiler gradiënt as die grafiek vir sfeer A.

OR/*OF*

For the same $\frac{1}{r^2}$, E is greater for sphere B. ✓✓

Vir dieselfde $\frac{1}{r^2}$*, is E groter vir sfeer B.*

(3)
[20]

QUESTION 8/*VRAAG 8*

8.1 A conductor (resistor) which obeys Ohm's law./*'n Geleier wat Ohm se wet gehoorsaam.* ✓✓ **(2 or/*of* 0)**

OR/OF
V always directly proportional to I at constant temperature. ✓✓ **(2 or/*of* 0)**
V is altyd direk eweredig aan I by konstante temperatuur.

OR/OF
$\frac{V}{I}$ = constant / k / c*onstant at constant temperature.* ✓✓ **(2 or/*of* 0)**
$\frac{V}{I}$ = konstant / k / *konstant bly by 'n konstante temperatuur.*

OR/OF
A conductor for which the resistance remains constant at constant temperature when voltage or current change. ✓✓ **(2 or/*of* 0)**
'n Geleier waar die weerstand konstant bly by 'n konstante temperatuur wanneer die potensiaalverskil of die stroom verander. (2)

8.2.1 $R = \frac{V}{I}$ ✓

$4 = \frac{3,2}{I}$ ✓

$I = 0,8$ A ✓ (3)

8.2.2

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

OPTION 1/*OPSIE 1*

$\varepsilon = I(R+r)$ ✓ ✓

$= 0,8\ (4 + 8 + 0,5)$ ✓

$= 10$ V ✓

OR/*OF*

$\varepsilon = I(R+r)$ ✓

$= 0,8(4 + 8) + 0,8 \times 0,5$ ✓

$= 10$ V ✓

OPTION 2/*OPSIE 2*

$V_8 = IR$
$= (0,8)(8)$
$= 6,4$ V

$V_{ext} = 3,2 + 6,4$
$= 9,6$ V

$V_{int} = Ir$
$= (0,8)(0,5)$ ✓
$= 0,4$ V

$\varepsilon = I(R + r)$
$= V_{ext} + V_{int}$ ✓Any one/*Enige een*
$= 9,6 + 0,4$ ✓
$= 10$ V ✓

(4)

8.3.1

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

OPTION 1/*OPSIE 1*

$V_{int} = Ir$
$1,2 = I(0,5)$ ✓
$I = 2,4$ A

$R_{ext} = \frac{V}{I}$
$= \frac{8,8✓}{2,4✓}$
$= 3,67\ \Omega$ (3,667)

$R_P = \frac{12R}{12 + R}$

$3,67 = \frac{12R}{12 + R}$ ✓

$R = 5,29\ \Omega$ (5,28) ✓

OR/*OF*

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

$\frac{1}{3,67} = \frac{1}{R} + \frac{1}{12}$ ✓

$R = 5,29\ \Omega$ (5,28) ✓

OPTION 2 /*OPSIE 2*

$V_{int} = 10 - 8,8$
$= 1,2$ V

$V_{int} = Ir$
$1,2 = I(0,5)$ ✓
$I = 2,4$ A

$I_{series\ branch} = \frac{V}{R}$
$= \frac{8,8✓}{8+4}$
$= 0,73$ A (0,733)

$I_R = 2,4 - 0,73$ ✓
$= 1,67$ A (1,667)

$R = \frac{V}{I_R}$
$= \frac{8,8}{1,67}$ ✓
$= 5,27\ \Omega$ (5,28) ✓

(5)

8.3.2 There is a short circuit /*Daar is 'n kortsluiting*.

- The resistance of the connected wire is very low. / The total resistance decreases. ✓
  Die weerstand van die verbindingsdrade is baie klein. /Die totale weerstand neem af.
- $I \alpha \frac{1}{R}$, current delivered by the battery is very high. ✓
  $I \alpha \frac{1}{R}$, *stroom gelewer deur die battery is baie groot.*
- Higher current produces more heat. ✓
  Hoër stroom produseer meer hitte.

OR/*OF*

Any one of the following equations can be used to explain the effect of current on heat/*Enigeen van die volgende vergelykings kan gebruik word om die effek van stroom op hitte te verdudidelik:*

$W = I^2R\Delta t$ / $W = \frac{V^2}{R}\Delta t$ / $W = VI\Delta t$ / $P = I^2R$ / $P = \frac{V^2}{R}$ / $P = VI$ (3)

[17]

QUESTION 9/*VRAAG 9*

9.1.1 Electrical to mechanical/kinetic/rotational ✓
Elektries na meganies/kineties/rotasie (1)

9.1.2 DC/*GS* ✓ (1)

9.1.3 Ensures continuous rotation of the coil. ✓
Verseker aanhoudende rotasie van spoel.

OR/*OF*
Ensures change in direction of the current in the coil. ✓
Verseker verandering van rigting van stroom in spoel. (1)

9.2 **QUESTIONS 9.2.1 AND 9.2.2/*VRAE 9.2.1 EN 9.2.2***
Only penalise once if subscripts are omitted.
Penaliseer slegs een keer indien onderskrifte uitgelaat is.

9.2.1

Marking criteria/*Nasienkriteria:*
- Correct formula to calculate resistance. ✓
  Korrekte formule om weerstand te bereken.
- Substitute into formula to calculate resistance. ✓
  Vervang in formule of weerstand te bereken.
- Final answer/*Finale antwoord:* 484 to/*tot* 493,83 Ω ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$P_{ave} = \frac{V_{rms}^2}{R}$ ✓ $100 = \frac{220^2}{R}$ ✓ R = 484 Ω ✓	$P_{ave} = V_{rms}I_{rms}$ $100 = 220I_{rms}$ I_{rms} = 0,45 A (0,455) $I_{rms} = \frac{V_{rms}}{R}$ ✓ $0,45 = \frac{220}{R}$ ✓ R = 488,89 Ω ✓	$P_{ave} = V_{rms}I_{rms}$ $100 = 220I_{rms}$ I_{rms} = 0,45 A (0,455) $P_{ave} = I_{rms}^2R$ ✓ $100 = (0,45)^2R$ ✓ R = 493,83 Ω ✓

(3)

9.2.2

POSITIVE MARKING FROM QUESTION 9.2.1/
POSITIEWE NASIEN VANAF VRAAG 9.2.1.

Marking criteria:

- Uses power of Y in circuit (80 W) to calculate I_{rms} of the circuit. ✓
- Determines V_{rms} across R_Z in the circuit. ✓
- Uses I_{rms} and V_{rms} across R_Z in the circuit to calculate resistance R_Z. ✓
- Use of any <u>one</u> relevant power equation. ✓
- Uses R_Z and 220 V to calculate X. ✓
- Final answer for X. ✓

Accept range*:*
846,07 W to 856,03 W

Nasienriglyne:

- *Gebruik drywing van Y in stroombaan (80 W) om I_{wgk} te bereken.* ✓
- *Bepaal V_{wgk} oor R_Z in die stroombaan.* ✓
- *Gebruik I_{wgk} en V_{wgk} oor R_Z in die stroombaan om weerstand R_Z te bereken.* ✓
- *Gebruik van <u>enige</u> drywing-formule.*
- *Gebruik R_Z en 220 V om X te bereken.* ✓
- *Finale antwoord vir X.* ✓

Aanvaar gebied:
846,07 W tot 856,03 W

For resistor Y/*Vir resistor Y*

$P_{ave} = I_{rms}^2 R$

$80 = I_{rms}^2 (484)$ ✓

$I_{rms} = 0,407$ A

OR/*OF*

$P_{ave} = \frac{V_{rms}^2}{R}$

$80 = \frac{V_{rms}^2}{484}$

$V_{rms} = 196,77$ V

$I_{rms} = \frac{V_{rms}}{R}$

$= \frac{196,77}{484}$ ✓

$= 0,407$ A

For/*Vir Z*

$V_{rms} = 220 - 196,77$ ✓

$= 23,23$ V

$I_{rms} = \frac{V_{rms}}{R}$

$[0,407 = \frac{23,23}{R}]$ ✓

$R = 57,08\ \Omega$

Range/*Gebied*:
56,66 Ω to/tot 57,13 Ω

X for Z/*X vir Z:*

$X = P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$= \frac{220^2}{57,08}$ ✓

$= 847,93$ W ✓

OR/*OF*

$I_{rms} = \frac{V_{rms}}{R}$

$= \frac{220}{57,08}$

$= 3,85$ A

$X = P_{ave} = I_{rms}^2 R$ ✓

$= \underline{(3,85)^2(57,08)}$ ✓

$= 846,07$ W ✓

OR/*OF*

$I_{rms} = \frac{V_{rms}}{R}$

$= \frac{220}{57,08}$

$= 3,85$ A

$X = P_{ave} = V_{rms} I_{rms}$ ✓

$= (220)(3,85)$ ✓

$= 847$ W ✓

(6)

[12]

QUESTION 10/*VRAAG 10*

10.1.1

Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context are omitted:
- 1 mark per word/phrase.
Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word: - 1 punt per word/frase.

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

10.1.2 For one photon/*Vir een foton*:

NOTE/*LET WEL*
$W_o = hf_o$ $^0/_2$

$E = hf$ ✓
$= (6{,}63 \times 10^{-34})(1{,}2 \times 10^{15})$ ✓
$= 7{,}96 \times 10^{-19}$ J

No of e^- = No of photons/*Hoeveelheid fotone*

$$= \frac{\text{Total energy of photons}}{\text{Energy of one photon}} \,/\, \frac{\text{Totale energie van fotone}}{\text{Energie van een foton}}$$

$$= \frac{1{,}75 \times 10^{-9}}{7{,}96 \times 10^{-19}} \checkmark$$

$= 2{,}2 \times 10^9$ ✓ $(2{,}198 \times 10^9)$ (4)

10.1.3 **POSITIVE MARKING FOR E ONLY FROM QUESTION 10.1.2/ *POSITIEWE NASIEN VIR SLEGS E VANAF VRAAG 10.1.2***

$E = W_0 + K_{max}$
$hf = hf_o + \frac{1}{2}mv_{max}^2$
✓Any one/*Enige een*

$7{,}96 \times 10^{-19}$ ✓ $= (6{,}63 \times 10^{-34})(9{,}09 \times 10^{14})$ ✓ $+ \frac{1}{2}(9{,}11 \times 10^{-31})v_{max}^2$ ✓

$v_{max} = 6{,}51 \times 10^5$ m·s^{-1} ✓ (5)

10.2 An atom (electron) in higher (excited) energy state/level returns to a lower energy state/level. ✓
Energy is released as light (photons/frequencies of light are released). ✓
'*n Atoom (elektron) in 'n hoër (opgewekte) energie toestand/vlak keer terug na 'n laer energievlak (grondvlak).*
Energie word vrygestel as lig (fotone/frekwensies van lig word vrygestel). (2)
[13]

TOTAL/*TOTAAL*: 150