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education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

NATIONAL SENIOR SERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

JUNE 2021

MARKS: 150

TIME: 3 hours

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

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INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line open between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions et cetera where required.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A ball is thrown vertically upwards.

Which ONE of the following physical quantities is NOT equal to zero when the ball reaches its maximum height?

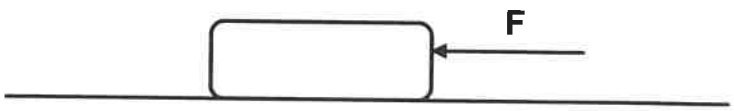
A Net force

B Momentum

C Velocity

D Kinetic energy (2)

1.2 An object of mass **m** stays at rest when a horizontal force of magnitude **F** is exerted on it, as shown in the diagram below.



The force **F** increases but the object still remains at rest.

Which ONE of the following forces also increases as force **F** increases?

A Normal force

B Gravitational force

C Static frictional force

D Kinetic frictional force (2)

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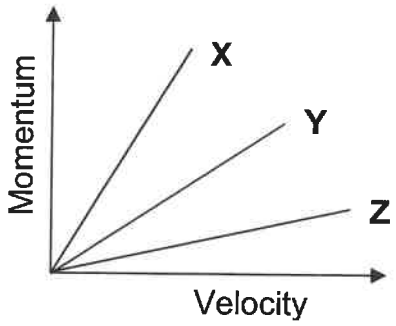
1.3 Three objects, **X**, **Y** and **Z**, are accelerated in a straight line on a horizontal surface. The following momentum versus velocity graphs represent the movement of each object:



Which ONE of the following statements is correct?

A The masses of the three objects are equal.

B Object **X** has the smallest mass.

C Object **Y** has the smallest mass.

D Object **Z** has the smallest mass. (2)

1.4 A ball of mass m is dropped from a height *h* above the ground. After it moved a distance *x*, the kinetic energy of the ball is ...

A $mg(h + x)$

B $mg(h - x)$

C mgx

D $\frac{1}{2}mgh$ (2)

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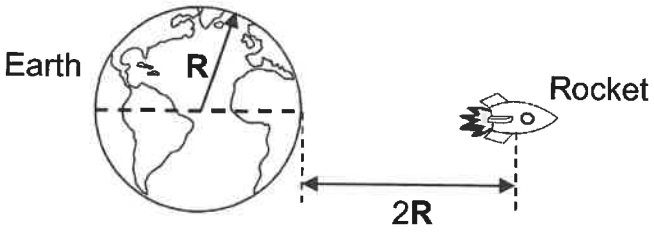
1.5 A rocket, of mass m, is launched from the surface of the Earth, of radius **R**. At a distance 2**R** above the surface of the Earth, the mass of the rocket is ½m. See the diagram below.



The magnitude of the gravitational acceleration of the rocket now changes to ...

A $\frac{½\,g}{3}$

B $\frac{½\,g}{4}$

C $\frac{½\,g}{6}$

D $\frac{½\,g}{9}$

(2)

1.6 Astronomers observe the spectral lines of a star.

Which ONE of the following describes the effect of the Doppler shift on the spectral lines if the star moves AWAY from the earth?

The spectral lines ...

A appear dimmer.

B undergo no change.

C are shifted to the red end of the spectrum.

D are shifted to the blue end of the spectrum. (2)

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1.7 A positive point charge is placed HALF WAY between two charges **X** and **Y**.
In which ONE of the following will the net force on the point charge be the largest?

A +1 nC (X) ⊕ +1 nC (Y)

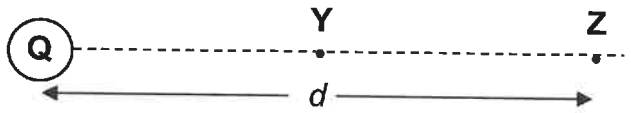
B +1 nC (X) ⊕ +2 nC (Y)

C +1 nC (X) ⊕ -2 nC (Y)

D +1 nC (X) ⊕ -1 nC (Y)

(2)

1.8 Point **Z** is a distance *d* from a charge **Q**.
Point **Y** is halfway between **Z** and the charge **Q** as shown in the diagram below.



The electric field at point **Z** is **E**. The electric field at point **Y** is...

A $\frac{\mathbf{E}}{4}$

B $\frac{\mathbf{E}}{2}$

C 2**E**

D 4**E**

(2)

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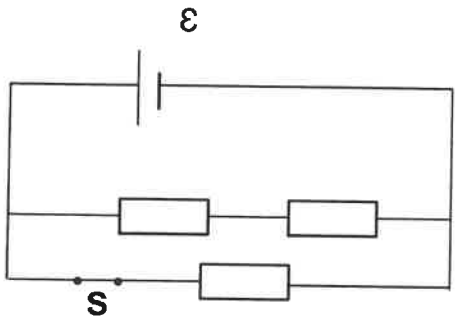
1.9 A cell, with emf **ε** is connected as shown in the circuit diagram below. The switch **S** is initially closed.



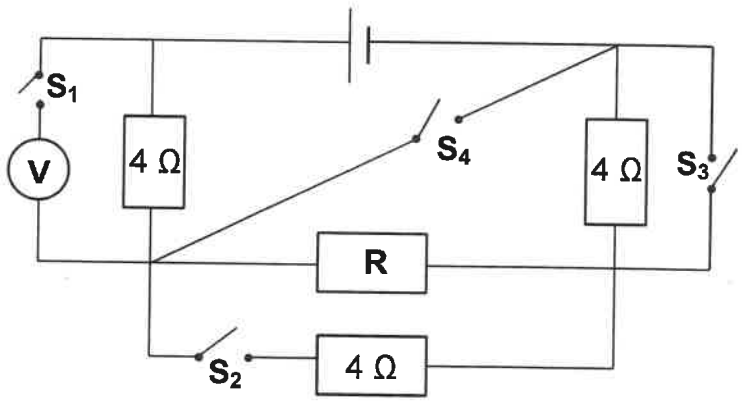
The switch **S** is now opened.

Which ONE of the following represents the changes in the emf (**ε**) and the total resistance in the circuit correctly?

	EMF (ε)	TOTAL RESISTANCE
A	Remains the same	Remains the same
B	Remains the same	Increases
C	Decreases	Decreases
D	Decreases	Increases

(2)

1.10 Observe the following circuit diagram:



Which ONE of the switches must be closed to increase the power in resistor **R** the most?

A **S_1**

B **S_2**

C **S_3**

D **S_4**

(2)
[20]

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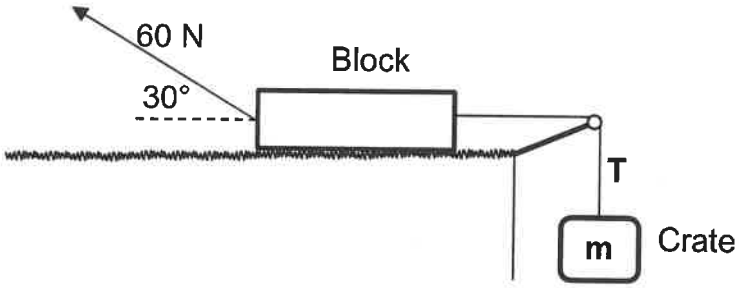
QUESTION 2 (Start on a new page.)

A block, of mass 5,3 kg, is connected to a crate, of mass **m**, by a light inextensible string **T** that is hanging over a frictionless pulley.

A force of 60 N is applied to the block at an angle of 30° to the horizontal as shown in the diagram below. The block accelerates to the RIGHT.

The magnitude of the kinetic frictional force between the block and the surface is 4,83 N. Ignore the mass of the string as well as any rotational effects.



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

2.2 Draw a labelled free-body diagram for the block. (5)

2.3 Apply Newton's Second Law to each of the objects and calculate the mass **m** of the crate if the tension **T** in the string is 80 N (5)

2.4 The block moves on the surface. How would the frictional force on the block change?

Choose from INCREASES, DECREASES or REMAINS THE SAME? (1)
[13]

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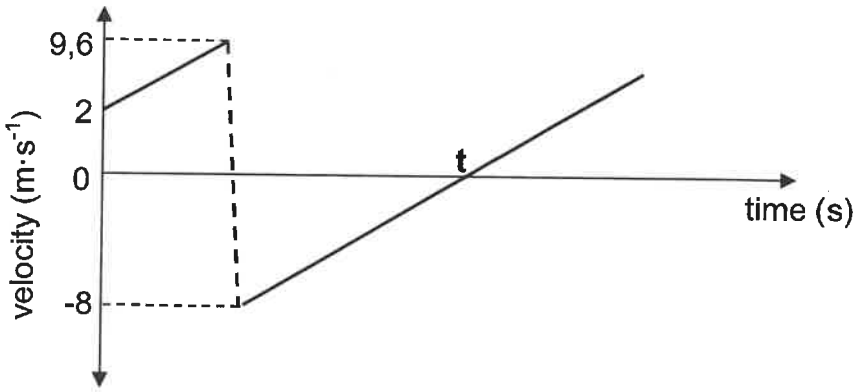
QUESTION 3 (Start on a new page.)

A ball, of mass 0,2 kg, is thrown vertically downwards from the top of a high building. The ball bounces from the floor. The velocity versus time graph below shows the motion of the ball with the downwards motion taken as positive. Ignore the effects of air friction.



3.1 Write down the magnitude of the velocity with which the ball bounces from the floor. (1)

3.2 Write down the magnitude and direction of the acceleration of the ball at time **t**. (2)

3.3 Is the collision of the ball with the floor ELASTIC or INELASTIC? Explain the answer with reference to the graph. (2)

3.4 Calculate the:

3.4.1 Height from where the ball was thrown (3)

3.4.2 Magnitude of the displacement of the ball from the moment it was thrown until the time **t** (5)

3.5 Draw a position–time graph for the complete motion of the ball, from when it was thrown until the maximum height was reached after the bounce. Use the floor as the reference point (zero position).

Clearly indicate the following on the graph:

- The height from where the ball was thrown
- Time **t**

(4)
[17]

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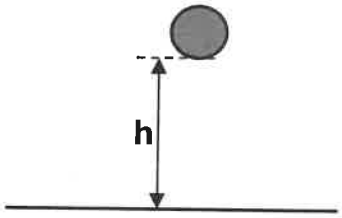
QUESTION 4 (Start on a new page.)

A cricket ball, of mass 0,15 kg, is dropped from rest from a height **h**.
It reaches the ground with a speed of 6,2 $m \cdot s^{-1}$ and is in contact with the ground for 0,02 s.

The ball bounces straight upwards with a speed of 3,62 $m \cdot s^{-1}$.
Ignore the effects of air resistance.



4.1 Define the term *impulse*. (2)

4.2 Calculate the:

4.2.1 Magnitude of the momentum of the ball when it reaches the ground (3)

4.2.2 Impulse on the cricket ball during the collision with the ground (5)

4.2.3 Magnitude of the force that the ground exerts on the ball (5)

4.3 Proof by means of a calculation that it is an inelastic collision. (4)

4.4 Calculate which percentage of the kinetic energy is transferred to other forms of energy. (4)

[23]

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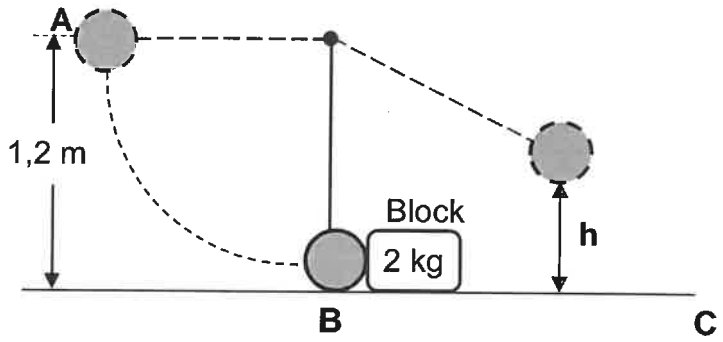
QUESTION 5 (Start on a new page.)

A steel ball, of mass 5 kg, is connected to a string and swings from rest at point **A**. As the steel ball swings through the lowest position at point **B**, it collides with a stationary block of mass 2 kg.

Immediately after the collision the block moves at a speed of 4,95 $m \cdot s^{-1}$ to the right on a frictionless track **BC**. After the collision, the steel ball swings to a maximum height **h**.

Ignore the effects of friction and assume that there is no loss of mechanical energy during the collision.



5.1 Explain what is meant by an *isolated system* as used in Physics. (2)

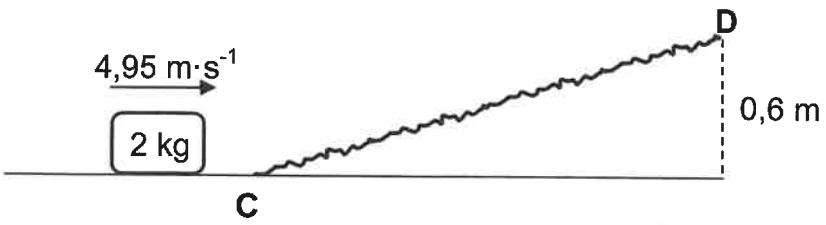
5.2 Calculate the:

5.2.1 Velocity of the steel ball immediately after the collision (7)

5.2.2 Height **h** reached by the steel ball (4)

5.2.3 Time for the block, from the moment it started to move, to reach point **C**, 12 m from point **B** (3)

The block moves from point **C** with a speed of 4,95 $m \cdot s^{-1}$ up a rough inclined plane to point **D**, 0,6 m above the horizontal as shown in the diagram below.



5.3 State the work-energy principle in words. (2)

5.4 The block reaches point **D** with a speed of 2 $m \cdot s^{-1}$.
Using energy principles, calculate the work done by friction when the 2 kg block moves from point **C** to point **D**. (4)
[22]

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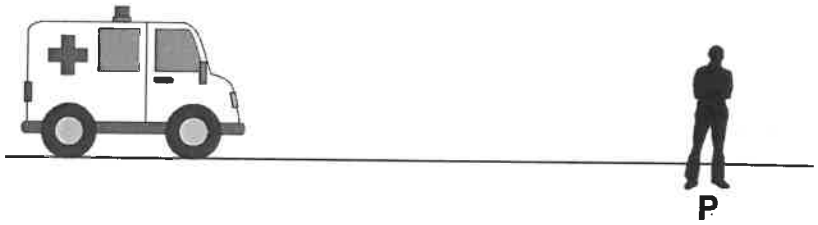
QUESTION 6 (Start on a new page.)

An ambulance moves at a constant speed along a straight horizontal road towards a stationary listener. The listener measures a frequency that is 20% MORE than the frequency of the sound emitted by the siren of the ambulance.



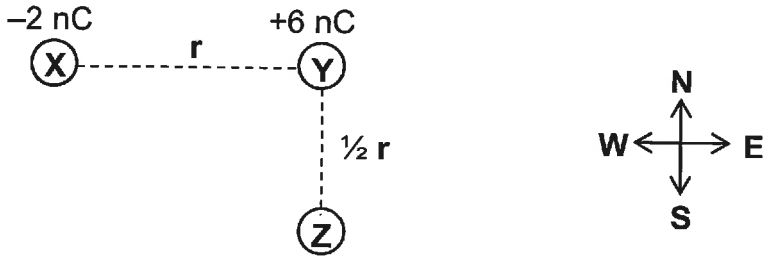
6.1 State the Doppler effect in words. (2)

6.2 Calculate the speed of the ambulance.
Take the speed of sound in air as 340 $m \cdot s^{-1}$. (4)

6.3 How does the frequency the listener hears at point **P** compare to the frequency of the siren when the ambulance is at point **P**?
Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)
[7]

QUESTION 7 (Start on a new page.)

Three point charges **X**, **Y** and **Z** are arranged as shown in the diagram below. The charges of **X** and **Y** are –2 nC and +6 nC respectively. Point charge **Y** experiences a net force of 5×10^{-3} N in the direction 32° west of the line **YZ**.



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

7.2 Draw a labelled free-body diagram to show the electrostatic forces on point charge **Y** due to the point charges **X** and **Z**. Also indicate the net force on point charge **Y**. (3)

7.3 What is the nature of the charge on point charge **Z**? Choose from POSITIVE or NEGATIVE. (1)

7.4 Calculate the:

7.4.1 Magnitude of the force that point charge **X** exerts on **Y** (3)

7.4.2 Charge of **Z** (5)
[14]

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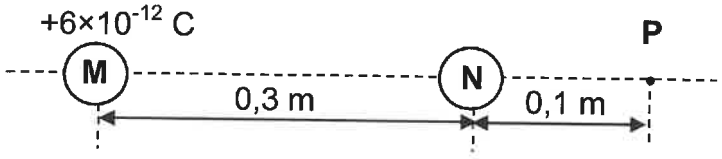
QUESTION 8 (Start on a new page.)

Charge **N** has an excess of 6×10^{6} electrons. A charge **M** of 6×10^{-12} C is placed 0,3 m to the left of charge **N**.

P is a point 0,1 m to the right of charge **N** as shown in the diagram below.



8.1 Define the term *electric field* at a point. (2)

8.2 Draw the electrical field pattern around charge **M** only. (2)

8.3 Calculate the nature and the magnitude of the charge on **N**. (4)

8.4 Calculate the magnitude of the net electric field at point **P**. (5)
[13]

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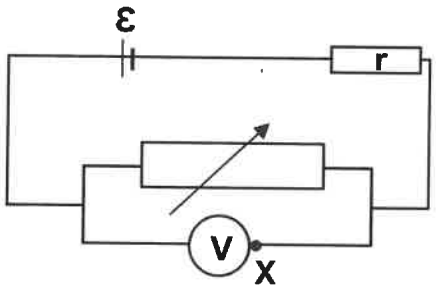
QUESTION 9 (Start on a new page.)

In an experiment learners use the circuit diagram shown below to determine the resistance of a unknown resistor **r**.

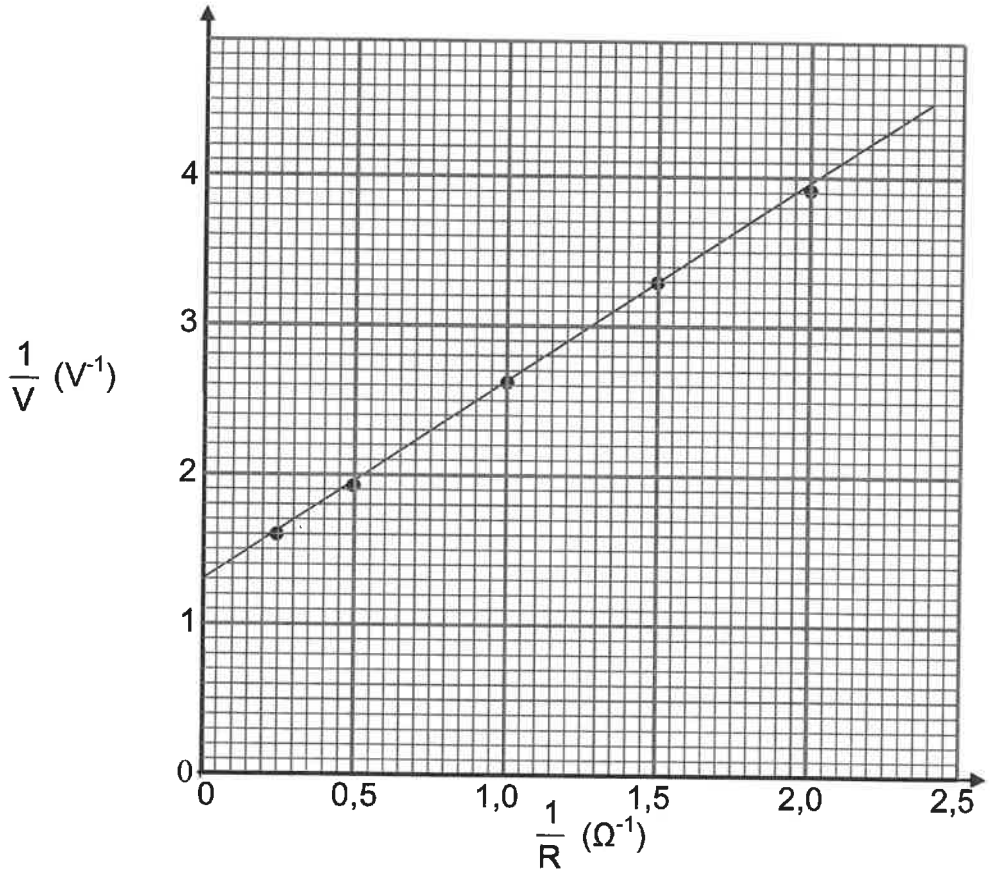


The circuit diagram consists of a cell with emf **ε** and resistor **r**. A voltmeter is connected over a variable resistor that can be set to *known values* R.

The equation that is used by the learners, is:

$$\frac{1}{V} = \frac{r}{\varepsilon R} + \frac{1}{\varepsilon}$$

A graph from the results obtained is shown below.



9.1 Which variable must be kept constant during the experiment? (1)

9.2 What is the polarity of the connector point on the voltmeter connected to point **X**? Choose from POSITIVE or NEGATIVE. (1)

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9.3 Write down the mathematical relationship for the gradient of the graph. (1)

9.4 What does the y-intercept of the graph represent? (1)

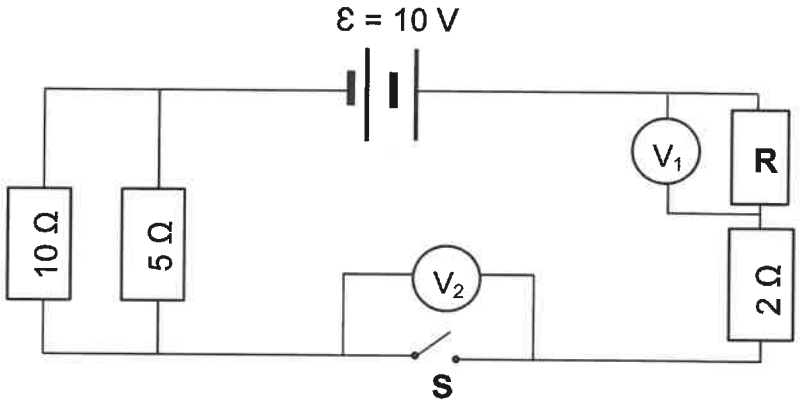
9.5 Use the information in the graph to calculate the:

9.5.1 Emf ($\mathcal{E}$) of the cell (2)

9.5.2 Resistance **r** (3)
[9]

QUESTION 10 (Start on a new page.)

Four resistors, a switch, two voltmeters and a battery are connected as shown in the circuit diagram below. The battery has an emf of 10 V. Switch **S** is open.



10.1 Write down the reading on voltmeter V_2. (1)

When switch **S** is closed, the reading on voltmeter V_1 is 2 V.

10.2 Write down the reading on voltmeter V_2 after the switch is closed. (1)

10.3 Calculate the:

10.3.1 Resistance of the parallel connection (3)

10.3.2 Resistance **R** (5)

The 5 Ω resistor is now removed from the circuit.

10.4 How will the following values change? Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.4.1 The total resistance of the circuit. (1)

10.4.2 The reading on the voltmeter V_1 (1)
[12]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS / *TABEL 1: FISIESE KONSTANTES*

NAME / NAAM	SYMBOL / SIMBOOL	VALUE / WAARDE
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of 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	$9,11 \times 10^{-31}\ kg$

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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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = F\cdot v_{ave}$ / $P_{gemid} = F\cdot v_{gemid}$	

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

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

ALTERNATING CURRENT / WISSELSTROOM

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

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DEPARTMENT: EDUCATION
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NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

JUNE 2020

MARKING GUIDELINES / *NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consists of 13 pages. /

Hierdie nasienriglyne bestaan uit 13 bladsye.

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QUESTION 1 / VRAAG 1

1.1 A ✓✓ (2)

1.2 C ✓✓ (2)

1.3 D ✓✓ (2)

1.4 C ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 C ✓✓ (2)

1.8 D✓✓ (2)

1.9 B ✓✓ (2)

1.10 C ✓✓ (2)

[20]

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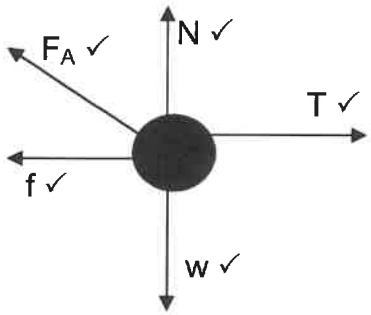
QUESTION 2 / VRAAG 2

2.1 Is the force that opposes the motion ✓of a moving object relative to a surface. ✓

Note: If any one of the underlined key words in the **correct context** is omitted, deduct 1 mark

(2)

2.2



(5)

Accepted labels / Aanvaarde benoemings	
w	F_g / F_w / force of earth on block / weight / mg / gravitational force
F_A	$F_{applied}$ / 60 N
T	Tension in rope / F_T
N	Normal force / F_N
f	friction / f_k / kinetic friction / F_f

Notes/Aantekeninge:
- Any additional forces: deduct 1 mark: max $^4/_5$
- No labels: deduct 1 mark: max $^4/_5$
- No arrows: $^0/_5$
- Force(s) not touching object: deduct 1 mark: max $^4/_5$

2.3

For the Block:
$F_{net} = ma$
$-F_x - f + T = ma$ } Any one ✓
$-60\cos30°$ ✓ $-4{,}83 + 80 = 5{,}3a$ ✓
$a = 4{,}38\ m{\cdot}s^{-2}$

For crate:
$F_{net} = ma$
$mg - T = ma$
$m(9{,}8) - 80 = m(4{,}38)$ ✓
$m = 14{,}76\ kg$ ✓

(5)

2.4 Remains the same / *Bly dieselfde* ✓ (1)

[13]

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QUESTION 3 / VRAAG 3

3.1 8 ($m \cdot s^{-1}$) ✓

Note: -8 ($m \cdot s^{-1}$) $0/1$

(1)

3.2 9,8 $m \cdot s^{-2}$ ✓ downwards/*afwaarts* ✓ (2)

3.3 Inelastic/*Onelasties* ✓

The speed with which the ball leaves the ground is smaller than the speed with which it hits the ground. ✓
Die spoed waarmee die bal die grond verlaat is kleiner as die spoed waarmee dit die grond verlaat.

OR/*OF*
The speed with which the ball hits and leaves the ground is not the same. ✓
Die spoed waarteen die bal die grond tref en verlaat is nie dieselfde nie. (2)

3.4.1

Downwards as positive: ***Afwaarts as positief:***	**Upwards as positive:** ***Opwaarts as positief:***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(9,6)^2 = (2)^2 + 2(9,8)\,\Delta y$ ✓	$(-9,6)^2 = (-2)^2 + 2(-9,8)\,\Delta y$ ✓
$\Delta y = 4,5$ m ✓	$\Delta y = -4,5$
	$\Delta y = 4,5$ m ✓

(3)

3.4.2

POSITIVE MARKING FROM QUESTION 3.4.1 ***POSITIEWE NASIEN VANAF VRAAG 3.4.1***	
Marking criteria/*Nasienriglyne* • Appropiate formula ✓ • Correct substitution✓ • Calculation of Δy (height of the bounce) ✓ • Subtraction of two heights✓ • Final answer✓	
Downwards as positive: ***Afwaarts as positief:***	**Upwards as positive:** ***Opwaarts as positief:***
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0^2 = (-8)^2 + 2(9,8)\,\Delta y$ ✓	$0^2 = (8)^2 + 2(-9,8)\,\Delta y$ ✓
$\Delta y = -3,27$	$\Delta y = 3,27$ m ✓
$\Delta y = 3,27$m ✓	
$\Delta y = 4,5$ -✓ 3,27 = 1,23 m ✓	$\Delta y = 4,5$ -✓ 3,27 = 1,23 m ✓

(5)

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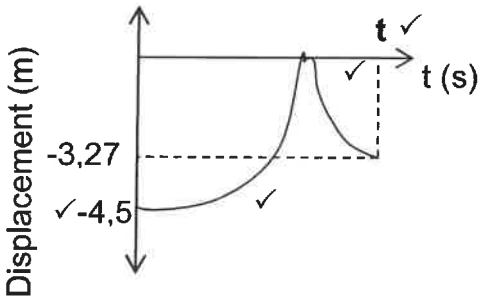
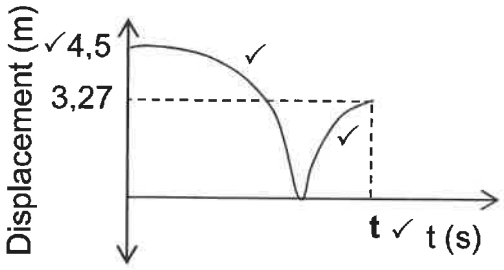
3. 5 **POSITIVE MARKING FROM QUESTION 3.4.1**
POSITIEWE NASIEN VANAF VRAAG 3.4.1

Downwards as positive:
Afwaarts as positief:



Upwards as positive:
Opwaarts as positief:



CRITERIA	
Y-intercept at ±4,5 m	✓
First part parabola to the t-axis.	✓
Second part is a parabola on the same side of t-axis and correctly drawn as indicated	✓
t correctly indicated at turning point of second parabola.	✓

(4)
[17]

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QUESTION 4 / VRAAG 4

4.1 The product of the resultant/ net force acting on an object and the time the resultant/ net force acts on the object. ✓✓

Note: If any one of the underlined key words in the **correct context** is omitted, deduct 1 mark

(2)

4.2.1

Downwards as positive

$F_{net} \cdot \Delta t = mv_f - mv_i$ ✓

$F_{net} \cdot \Delta t = (0,15)(-3,62)$ ✓ $- (0,15)(6,2)$ ✓

$F_{net} \cdot \Delta t = -1,47$

$F_{net} \cdot \Delta t = 1,47$ N·s ✓ upwards / *Opwaarts* ✓

Upwards as positive

$F_{net} \cdot \Delta t = mv_f - mv_i$ ✓

$F_{net} \cdot \Delta t = (0,15)(3,62)$ ✓ $- (0,15)(-6,2)$ ✓

$F_{net} \cdot \Delta t = 1,47$ N·s ✓ upwards / *Opwaarts* ✓

(5)

4.2.2

Downwards as positive

$F_{net} \cdot \Delta t = \Delta p = mv_f - mv_i$
$(F_g - F_N) \cdot \Delta t = \Delta p$ } Any one ✓

$[(0,15)(9,8) - F_N]$ ✓ $(0,02)$ ✓ $= -1,47$ ✓

$F_N = -74,97$

$F_N = 74,97$ N ✓

Upwards as positive

$F_{net} \cdot \Delta t = \Delta p = mv_f - mv_i$
$(F_N - F_g) \cdot \Delta t = \Delta p$ } Any one ✓

$[F_N - (0,15)(9,8)]$ ✓ $(0,02)$ ✓ $= 1,47$ ✓

$F_N = 74,97$ N ✓

(5)

4.2.3

Upwards as positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = (3,62)^2 + 2(-9,8)\,\Delta y$ ✓

$\Delta y = 0,67$ m ✓

Downwards as positive

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = (-3,62)^2 + 2(9,8)\,\Delta y$ ✓

$\Delta y = -0,67$

$\Delta y = 0,67$ m ✓

(3)

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4.3

$(E_k)_i = \frac{1}{2}mv_i^2$ ✓
$= \frac{1}{2}(0,15)(6,2)^2$ ✓
$= 2,88$ J

NOTE:
If started off with $(E_k)_i = (E_k)_f$ Max $^3/_4$

$(E_k)_f = \frac{1}{2}mv_f^2$
$= \frac{1}{2}(0,15)(-3,62)^2$ ✓ OR $\frac{1}{2}(0,15)(3,62)^2$
$= 0,98$ J

$(E_k)_i \neq (E_k)_f$ ✓ (4)

4.4

POSITIVE MARKING FROM QUESTION 4.3
POSITIEWE NASIEN VANAF VRAAG 4.3
$\Delta E = 0,98 - 2,88 = -1,9$ J

$$\%\text{Energy converted} = \frac{1,9\checkmark}{2,88\checkmark} \times 100\checkmark = 65,97\% \checkmark$$

(4)
[23]

QUESTION 5 / VRAAG 5

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

OR/*OF*

A system that has no net force (or no force) acting on it.
'n Stelsel waarop geen netto/eksterne krag inwerk nie. (2)

5.2.1

$(E_m)_A = (E_m)_B$
$(mgh + \frac{1}{2}mv^2)_A = (mgh+\frac{1}{2}mv^2)_B$ } Any one ✓
$5(9,8)(1,2)$ ✓ $+ 0 = 0 + \frac{1}{2}(5)v^2$ ✓
$v = 4,85$ m·s^{-1}

$\Sigma p_i = \Sigma p_f$
$(mv_i)_1 + (mv_i)_2 = (mv_f)_1 + (mv_f)_2$ } Any one ✓
$(5)(4,85)$ ✓ $+ 0 = 5v_f + (2)(4,95)$ ✓
$v_f = 2,87$ m·s^{-1} (to the right) ✓ (7)

5.2.2

POSITIVE MARKING FROM QUESTION 5.2.1
$(E_m)_B = (E_m)_C$
$(mgh + \frac{1}{2}mv^2)_B = (mgh+\frac{1}{2}mv^2)_C$ } Any one ✓
$0 + \frac{1}{2}(5)(2,87)^2$ ✓ $= (5)(9,8)h + 0$ ✓
$h = 0,42$ m ✓

NOTE:
Don't penalize for the omission of zero's

(4)

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5.2.3
$\Delta x = v_i \Delta t$ ✓
$12 = (4,95)\Delta t$ ✓
$\Delta t = 2,42$ s ✓
(3)

5.3
The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓
Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in kinetiese energie van die voorwerp.

ACCEPT:
The work done on an object by a resultant/net force is equal to the change in the object's kinetic energy.
Die arbeid verrig op die voorwerp deur 'n resulterende/netto krag is gelyk aan die verandering in kinetiese energie van die voorwerp.

Note: If any one of the underlined key words in the **correct context** is omitted, deduct 1 mark

(2)

5.4
OPTION 1
$W_{net} = \Delta E_k$
$W_{Fg} + W_f = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one ✓
$(2\times9,8)(0,6)\cos180°$ ✓ $+ W_f = \frac{1}{2}(2)(2)^2 - \frac{1}{2}(2)(4,95)^2$ ✓
$W_f = -8,74$ J ✓
(4)

OPTION 2
$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = [\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2] + [mgh_f - mgh_i]$ } Any one ✓
$W_f = [\frac{1}{2}(2)(2)^2 - \frac{1}{2}(2)(4,95)^2]$ ✓ $+ [(2)(9,8)(0,6) - 0]$ ✓
$W_f = -8,74$ J ✓
(4)
[22]

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QUESTION 6 / VRAAG 6

6.1

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

OR

The change in frequency (or pitch) of the sound detected by a listener ✓as a result of the relative motion between the source and the observer.✓
Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar as gevolg van die relatiewe beweging tussen die bron en die waarnemer.

Note: If any one of the underlined key words in the **correct context** is omitted, deduct 1 mark

(2)

6.2

Marking criteria/*Nasienriglyne*

- Appropiate formula/Toepaslike formule ✓
- Ratio $f_L:f_s$ = 1,2 : 1 / *Verhouding* $f_L:f_s$ = 1,2 : 1 ✓
- Substitution of fraction / *Invervanging van breuk* ✓
- Final answer / *Finale antwoord* ✓

$f_L = \frac{v \pm v_L}{v \pm v_S} f_S$ ✓ OR $f_L = \frac{v}{v - v_S} f_S$ ✓

✓

$(120) = \frac{340}{340 - v_s}$ ✓ (100)

$V_s = 56{,}67\ m \cdot s^{-1}$ ✓

(4)

6.3

Equal to/ *Gelyk aan*✓

(1)

[7]

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QUESTION 7 / VRAAG 7

7.1

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

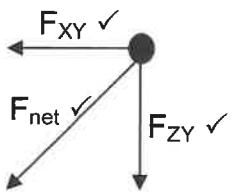
Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die groottes van die ladings ✓ en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. ✓

Note: If any one of the underlined key words in the **correct context** is omitted, deduct 1 mark

- If masses used ($^0/_2$)

(2)

7.2



Accepted labels / Aanvaarde benoemings	
F_{XY}	Force of X on Y / F_X / *Krag van X op Y*
F_{ZY}	Force of Z on Y / F_Z / *Krag van Z op Y*

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 pyle penaliseer nie.*
- Deduct 1 mark if force(s) do not make contact with dot. / *Trek 1 punt af indien krag(te) nie met die kolletjie kontak maak nie.*
- If arrows missing/*Indien pylpunte uitgelaat word:* Max/*Maks* $^2/_3$

(3)

7.3

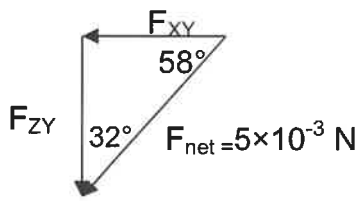
Negative / *Negatief* ✓ (1)

7.4.1

$F_X = F_{net}\sin 32°$ ✓
$= (5\times10^{-3})\sin 32°$ ✓
$= 2{,}65\times10^{-3}$ N ✓

OR/*OF*

$F_X = F_{net}\cos 58°$ ✓
$= (5\times10^{-3})\cos 58°$ ✓
$= 2{,}65\times10^{-3}$ N ✓



(3)

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7.4.2 ***Marking criteria/Nasienriglyne:***

- Any appropriate formula ✓
- Correct substitution: both sides of equation for F_{XY} ✓
- F_{ZY} as $4{,}24\times10^{-3}$ ✓
- Final answer ✓

POSITIVE MARKING FROM QUESTION 7.4.1
POSITIEWE NASIEN VANAF VRAAG 7.4.1

$F_{XY} = \frac{kQ_1Q_2}{r^2}$

$2{,}65\times10^{-3} = \frac{(9\times10^9)(2\times10^{-9})(6\times10^{-9})}{r^2}$ ✓

Any correct formula ✓

$r = 6{,}38\times10^{-3}$ m

$F_{ZY} = \frac{kQ_1Q_2}{r^2}$

$4{,}24\times10^{-3}$ ✓ $= \frac{(9\times10^9)(6\times10^{-9})Q_Z}{(3{,}19\times10^{-3})^2}$ ✓

$Q_Z = 7{,}99\times10^{-10}$ C ✓

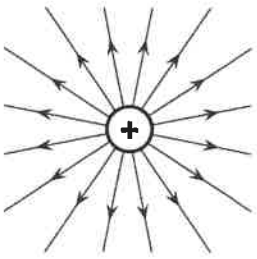
(5)
[14]

QUESTION 8 / VRAAG 8

8.1 **Marking criteria/Nasienriglyne:**
-1 mark for each of the 5 key words omitted in the correct context.
-1 punt vir elk van die 5 sleutelwoorde weggelaat in die korrekte konteks.

The electric field at a point is the (electrostatic) force experienced per unit positive charge placed at that point. ✓✓
Die elektriese veld by 'n punt is die (elektrostatiese) krag wat per positiewe eenheids-lading wat by daardie punt geplaas is, ondervind word. (2)

8.2



Shape / *Vorm*	✓
Direction / *Rigting*	✓

(2)

8.3 $n = \frac{q}{q_e}$ ✓

$q = (6\times10^6)(-1{,}6\times10^{-19})$ ✓

$= -9{,}6\times10^{-13}$ C ✓ & charge indicated as negative ✓ (4)

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8.4 **POSITIVE MARKING FROM QUESTION 8.1**
POSITIEWE NASIEN VANAF VRAAG 8.1

$E_M = \frac{kQ}{r^2}$ ✓
$= \frac{(9\times10^{9})(6\times10^{-12})}{(0,4)^2}$ ✓
$= 0,34\ N\cdot C^{-1}$ (to the right)

$E_N = \frac{kQ}{r^2}$
$= \frac{(9\times10^{9})(9,6\times10^{-13})}{0,1^2}$ ✓
$= 0,86\ N\cdot C^{-1}$ (to the left)

$E_{net} = E_N - E_M$
$= 0,86 - 0,34$ ✓
$= 0,53\ N\cdot C^{-1}$ ✓

(5)
[13]

QUESTION 9 / VRAAG 9

9.1 Temperature (of the rheostat) / *Temperatuur (van die reostaat)* ✓ (1)

9.2 Negative/*Negatief* (1)

9.3 $\frac{r}{\varepsilon}$ ✓ (1)

9.4 $\frac{1}{\varepsilon}$ ✓ (1)

9.5.1 $\frac{1}{\varepsilon} = 1,3$ ✓
$\varepsilon = 0,77\ V$ ✓ (2)

9.5.2 **POSITIVE MARKING FROM QUESTION 9.5**

- **Note: Can use any applicable coordinates of a point on the line.**

OPTION 1

$\frac{r}{\varepsilon} = \text{Gradient} = \frac{3,3-1,3}{1,5-0}$ ✓

$\frac{r}{0,77}$ ✓ $= \frac{2}{1,5}$

$r = 1,03\ \Omega$ ✓

OPTION 2

$\frac{1}{V} = \frac{r}{\varepsilon R} + \frac{1}{\varepsilon}$

$3,3 = \frac{r}{0,77}$ ✓ $(1,5) + 1,3$ ✓

$r = 1,03\ \Omega$ ✓

(3)
[9]

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QUESTION 10 / VRAAG 10

10.1 10 V ✓ (1)

10.2 0 (V) ✓ (1)

10.3.1

$$\frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2} \checkmark$$
$$= \frac{1}{10} + \frac{1}{5} \checkmark$$
R_p = 3,33 Ω ✓ (3)

10.3.2

POSITIVE MARKING FROM QUESTION 10.3.1
POSITIEWE NASIEN VANAF VRAAG 10.3.1

OPTION 1	**OPTION 2**
$R = R_p + R_s$ $= 3,33 + 2$ ✓ $= 5,33\ \Omega$ $V = IR$ $8 = I\,(5,33)$ ✓ $I = 1,5$ A $V = IR$ ✓ $2 = 1,5(R)$ ✓ $R = 1,33\ \Omega$ ✓	$R_{ext} = R_p + R_s + R$ $= 3,33 + 2 + R$✓ $V=IR$✓ $10 = I(5,33+R)$ ✓ $I=\frac{10}{5,33+R}$ For resistor R: $V = IR$ $2=\frac{10}{5,33+R}(R)$ ✓ $R = 1,33\ \Omega$ ✓

(5)

10.4.1 Increases/*Toeneem* ✓ (1)

10.4.2 Decreases/*Afneem* ✓ (1)

[12]

TOTAL/*TOTAAL*: 150

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