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EDUCATION

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Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2026

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

This question paper consists of 20 pages, including 3 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions.
3. Start EACH question on a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instrument.
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, et cetera where required.
11. You are advised to use the attached DATA SHEET.
12. Write neatly and legibly.

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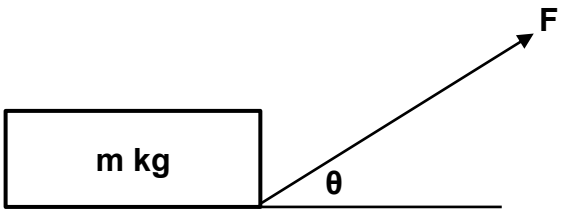
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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 to 1.10) in the ANSWER BOOK, for example 1.11 B.

1.1 A constant force **F** is applied to a block of mass, m at an angle **θ** to the horizontal but the block did not move. The coefficient of static frictional force between the block and the surface is μ_s.

The magnitude of the static frictional force is equal to:



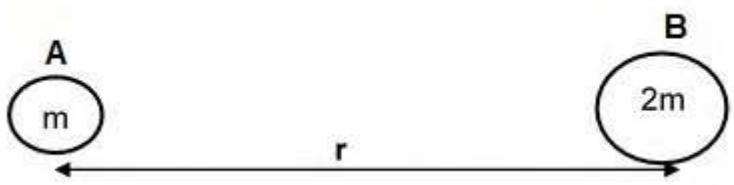
A F

B Fcosθ

C $\mu_s(mg - F\cos\theta)$

D $\mu_s(mg - F\sin\theta)$ (2)

1.2 Two isolated bodies, **A** and **B**, having masses m and 2m respectively, are placed at a distance **r** apart.



Consider the following statements regarding the gravitational force exerted by the bodies on each other.

(i) The force exerted by body **B** on body **A** is half that exerted by body **A** on body **B**.
(ii) The force exerted on the bodies is independent of the masses of the bodies.
(iii) The force exerted on body **A** by body **B** is equal but opposite to that exerted on body **B** by body **A**.
(iv) The forces will always be attractive.

A (i), (ii) and (iv) only.

B (iii) and (iv) only.

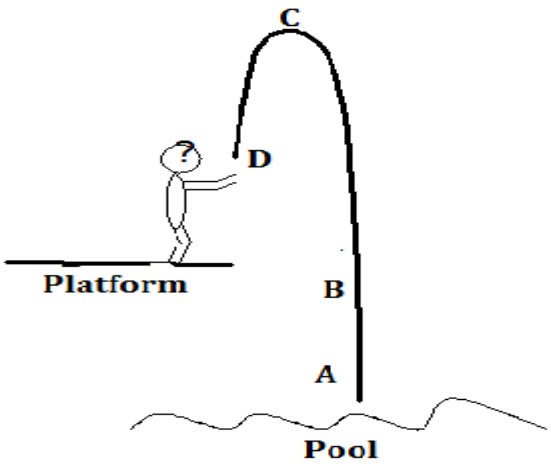
C (ii), (iii), and (iv) only.

D (iv) only. (2)

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1.3 A boy standing on a platform throws a stone up and into a pool that is below the platform. At which **ONE** of the positions **A, B, C** or **D** will the magnitude of the stone's Momentum be a maximum?



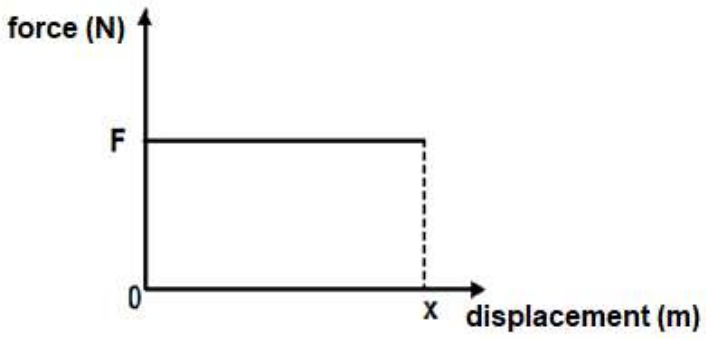
A Position **A**

B Position **B**

C Position **C**

D Position **D** (2)

1.4 The graph below represents a constant force **F** acting on an object over a displacement **X**. The force and displacement are in the same direction.



Which ONE of the following statements can be deduced from the graph?

A The gradient of the graph represents the work done by the force.

B The gradient of the graph represents the change in kinetic energy of the object.

C The area under the graph represents the work done by the force.

D The area under the graph represents the power dissipated by the force. (2)

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1.5 A net force **F** accelerates two isolated objects, **X** and **Y** from rest in a straight line for time **t** as shown below. Object **X** experiences an acceleration of **a** and object **Y** an acceleration of **2a**. The mass of object **X** is TWICE that of object **Y**.



If the amount of work done by force **F** on Object **X** is **W**, then the amount of work done by a force **F** on Object **Y** is:

A ½ W

B W

C 4 W

D 2 W (2)

1.6 A listener moves at constant velocity towards a stationary source of sound. The frequency of sound heard by the listener is higher than the frequency of the sound emitted by the source, because …

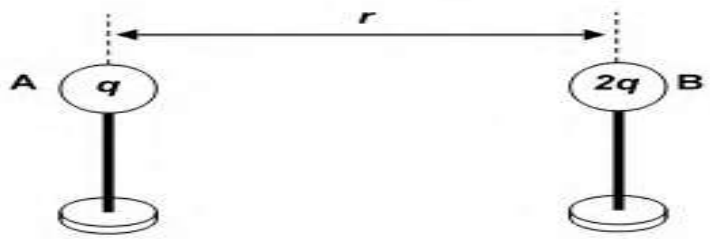
A the wavelength observed by the listener becomes longer.

B more wave fronts reach the listener per second.

C less wave fronts reach the listener per second.

D the wavelength observed by the listener becomes shorter. (2)

1.7 The sketch diagram below shows two small metal spheres, **A** and **B**, on insulated stands carrying charges of magnitude ***q*** and ***2q*** respectively. The distance between the centres of the two spheres is ***r***.



The spheres exert a force of magnitude **F** on each other. What is the magnitude of the force that the spheres will exert on each other if the distance between them is $\frac{1}{2}$**r**?

A **F**

B 4 **F**

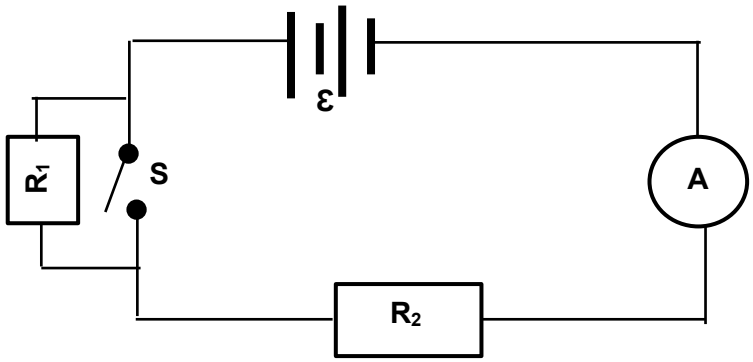
C $\frac{1}{2}$**F**

D 2 **F** (2)

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1.8 A battery of emf Ɛ and negligible internal resistance is connected in a circuit, as shown in the diagram below. The resistances of R_1 and R_2 are high.



Which ONE of the following combinations about the ammeter readings will be CORRECT when switch **S** is open and when switch **S** is closed?

	SWITCH OPEN	SWITCH CLOSED
A	Ammeter reads only the current in R_1	Ammeter reads only the current in R_2
B	Ammeter reads only the current in R_2	Ammeter reads the current in both R_1 and R_2
C	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in both R_1 and R_2
D	Ammeter reads the current in both R_1 and R_2	Ammeter reads the current in R_2 only

(2)

1.9 Which ONE of the following changes to the design of an AC generator will increase its maximum emf?

A Increase the number of turns on the coil.

B Use larger brushes.

C Change the polarity of the magnets.

D Use larger slip rings. (2)

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1.10 When **GREEN** light is incident on the cathode of a photo-electric cell and an ammeter connected in the circuit registers a current. The green light is then replaced with **BLUE** light with a lower intensity and incident on the same photo-electric cell.

How does the number of photo-electrons emitted per second and the speed of the photo-electrons for **BLUE** light compare with that of **GREEN** light?

	AMOUNT OF PHOTOELECTRONS PER SECOND	**SPEED OF PHOTOELECTRONS**
A	Decreases	Decreases
B	Increases	Decreases
C	Decreases	Increases
D	Stays the same	Increases

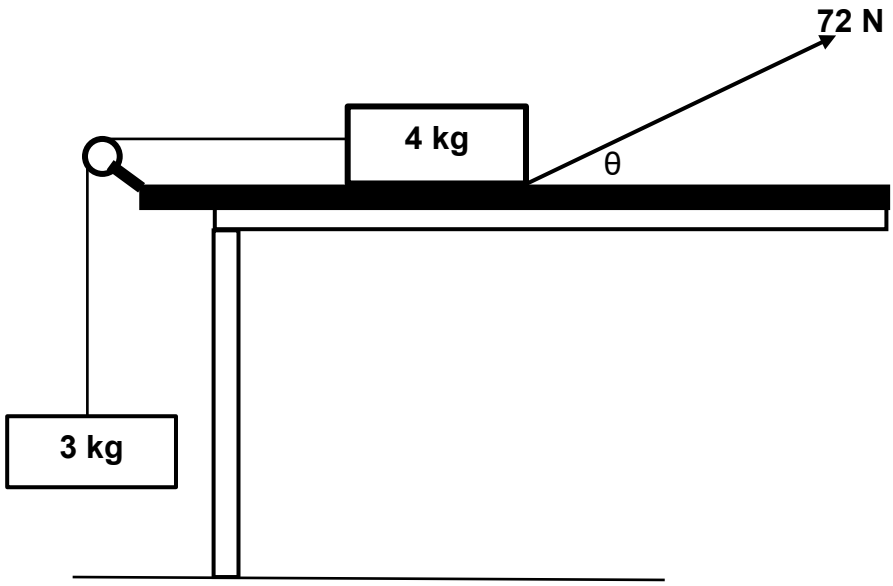
(2)
[20]

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QUESTION 2

A block of mass **4 kg** is at rest on a rough horizontal surface. The block is connected to another block of mass **3 kg** by means of a light inextensible string which hangs over a frictionless pulley. The surface exerts a force of 12,5 N perpendicular to the surface on the 4 kg block. A force of **72 N** is applied to the 4 kg block at an angle θ to the horizontal as shown in the diagram below. The system accelerates to the right. The coefficient of kinetic friction between the surface and the 4 kg block is 0,25. Ignore the effects of air friction.



2.1 Give one word or phrase that describes the underlined words. (1)

2.2 Calculate the angle θ. (2)

2.3 Draw a labelled free-body diagram indicating ALL the forces acting on the **4 kg block**. (5)

2.4 State Newton's Second law in words. (2)

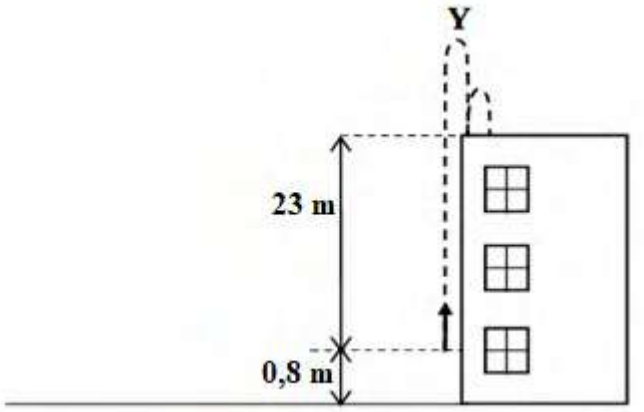
2.5 Apply Newton's Second Law to each of the blocks separately and calculate the magnitude of the acceleration of the blocks. (6)
[16]

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QUESTION 3

A boy kicks a ball of mass 700 g vertical upwards from a height of 0,8 m above the ground. The ball moves past the top of a building, 23 m higher than the point from where he kicked the ball. The ball falls back and hits the roof of the building 3,5 s after the ball was kicked. The ball bounces once on the roof of the building and then comes to rest on the roof of the building. Ignore all effects of air resistance.



3.1 Write down the magnitude and direction of the acceleration of the ball at point **Y** indicated in the sketch above. (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity with which the ball was kicked (3)

3.2.2 Maximum height that the ball reaches above the ground (4)

3.2.3 Velocity with which the ball hit the roof for the first time (3)

3.3 By referring to the sketch only, state if the collision of the ball with the roof is ELASTIC or INELASTIC. Explain the answer. (2)

3.4 The ball leaves the roof with a velocity of 6,3 $m \cdot s^{-1}$ after it bounced off the roof. Calculate the net force exerted on the ball by the roof if the ball was in contact with the roof for 0,01 s. (4)

3.5 Sketch a position versus time graph for the complete motion of the ball, from the moment it was kicked until it comes to rest after bouncing. Use the top of the roof as the **zero position**.

Indicate the following very clearly on the graph:

- The position of the ball when the boy kicks it.
- The position of the ball at point **Y**.
- The time when the ball hits the roof the first time. (3)

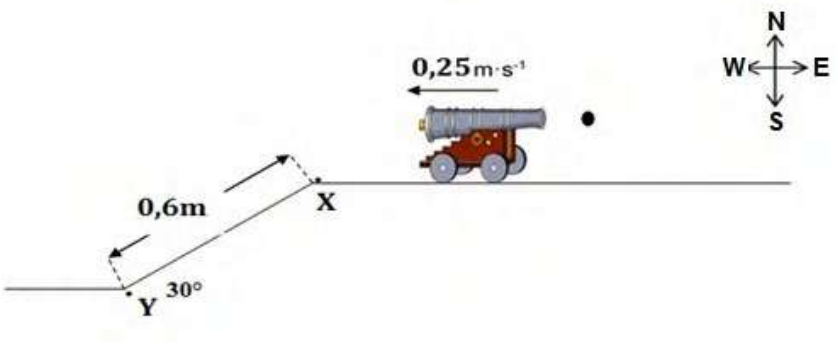
[20]

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QUESTION 4

A toy canon, mass 1,8 kg, is at rest on a rough horizontal surface as shown in the diagram below. A steel ball, mass 0,07 kg, is fired horizontally to the east from the canon. Immediately after firing the ball, the canon moves at 0,25 m·s^{-1} to the west.



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

4.2 Calculate the speed of the steel ball immediately after it was fired. (3)

4.3 Modern cars have airbags that are designed to minimise injury to passengers during a collision. Explain how airbags minimise injury to passengers during collision. (2)

4.4 The canon reaches point **X** with a speed of 0,25 m·s^{-1} and then moves down a rough inclined surface **XY** 0,6 m along at angle of 30° to the horizontal as shown in the diagram above. The frictional force between the surface and the canon is 1,85 N.

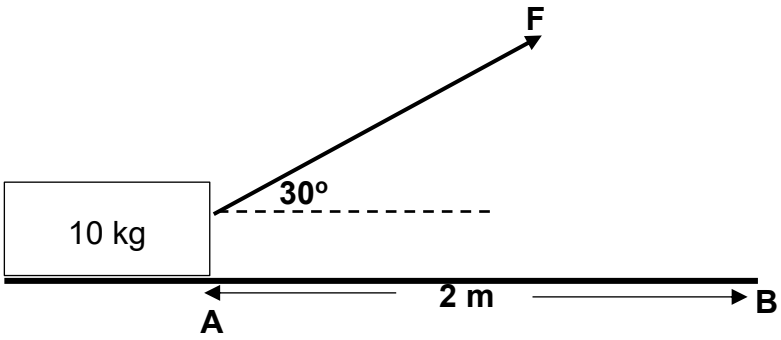
Using **ENERGY PRINCIPLES** only, calculate the velocity of the canon at point **Y**, the bottom of the inclined surface. (5)
[12]

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QUESTION 5

A constant force **F** is applied at an angle of 30° to the horizontal on a crate of mass 10 kg that is initially at rest, as shown in the diagram below. A constant frictional force of 10 N acts on the crate as it moves from rest at point **A** along a horizontal surface to point **B**. The distance between point **A** and point **B** is 2 m. The speed of the crate at point **B** is 2 m·s^{-1}.



5.1 Define the term *non-conservative force*. (2)

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

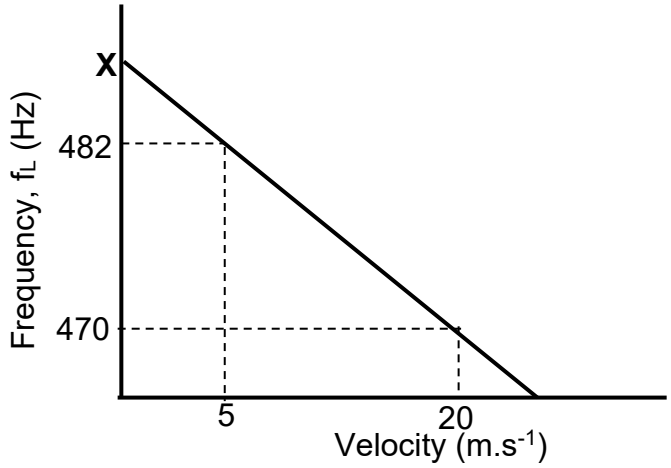
5.3 A 2 kg object is now placed in the crate. What effect will this change have on the work done by the same force **F** when the crate is again moved from point **A** to point **B**? Write down only INCREASES, DECREASES or REMAINS THE SAME. (2)
[8]

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QUESTION 6

A fire truck with its siren on, is moving along a straight horizontal road. A detector placed on the side of the road records the frequency of the sound by the siren and velocity of the fire truck. The values are used to obtain the graph below, NOT DRAWN TO SCALE. Take velocity of sound in air as 340 $m.s^{-1}$.



6.1 Define the phenomenon represented on the graph above. (2)

6.2 Is the fire truck moving TOWARDS or AWAY from the detector? Explain your answer. (2)

6.3 Write down the relationship between the velocity of the fire truck and the observed frequency. (2)

6.4 What does **X**, the intercept on the vertical axis, represent? (2)

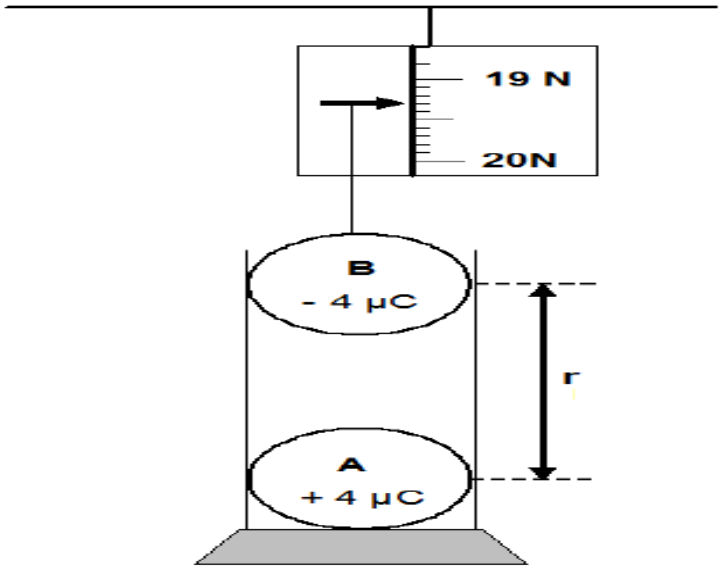
6.5 Calculate the frequency of the siren of the fire truck. (5)
[13]

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QUESTION 7

Sphere **A** has a charge of +4 µC and is placed in an insulated cylinder. A second identical sphere **B**, with opposite charge and mass 500 g, hangs vertically at rest at a distance **r,** directly above sphere **A**. Sphere **B** is attached to a scale as shown in the diagram below.

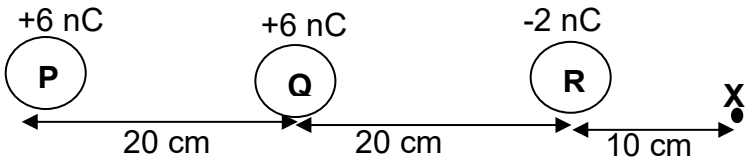


7.1 Draw the electric field pattern due to spheres **A** and **B**. (3)

7.2 What is the magnitude of the upward force that acts on sphere **B**? (1)

7.3 Calculate the distance **r** between spheres **A** and **B**. (5)

The diagram below shows three identical insulated metal spheres. Spheres **P** and **Q** each carry a charge of 6 nC and **R** carrying a charge of -2 nC. The point **X** is 10 cm to the right of **R** as shown in the diagram below.



7.4 Define *electric field at a point* in words. (2)

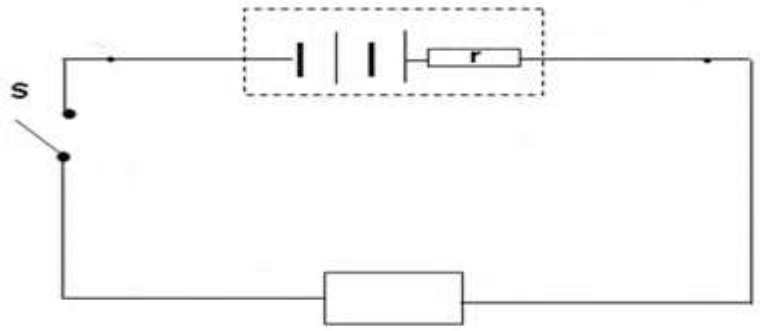
7.5 Calculate the net electric field at point **X** due to spheres **P**, **Q** and **R**. (5)
[16]

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QUESTION 8

Grade 12 learners conducted an experiment to determine the emf, Ɛ and the internal resistance **r** of a battery by connecting three resistors one after the other in the circuit diagram below. Each time they read and recorded the reading of the voltmeter and ammeter.



The readings obtained are recorded in the table below:

Number of resistors	Voltmeter reading (V)	Ammeter reading (A)
1	7,8	3,5
2	9,6	2,0
3	10,2	1,5

8.1 Sketch this circuit in your ANSWER BOOK. Show in your sketch where the learners connected the ammeter and the voltmeter. (2)

8.2 Define the term *emf* of a battery. (2)

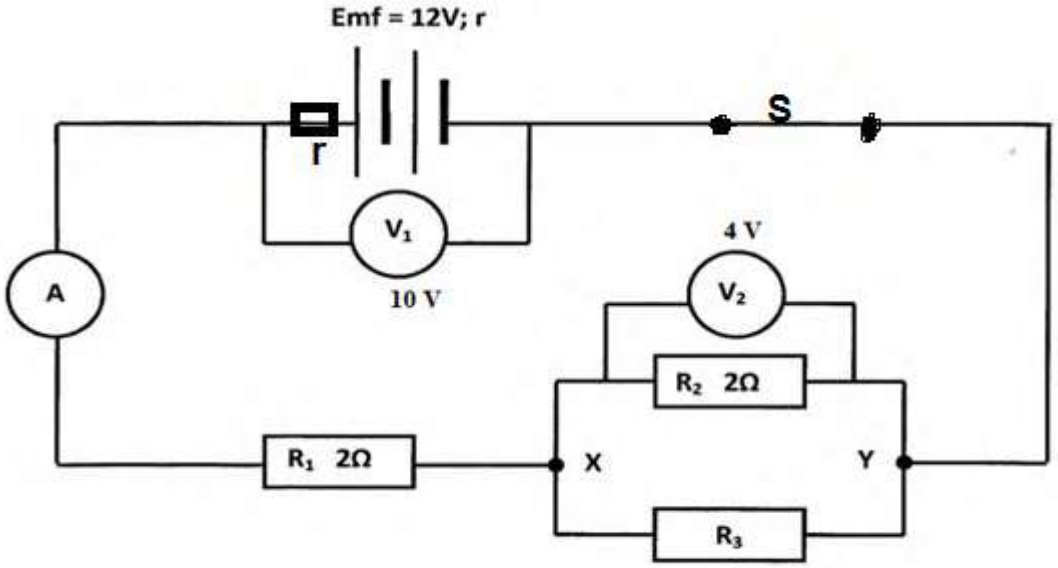
8.3 Calculate the emf, Ɛ of the battery, from the results of their investigation. (6)

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8.4 In the circuit diagram represented below, the battery has an unknown internal resistance and an emf of 12 V. When current flows through the circuit, the voltmeter across the battery V_1 reads 10 V and a voltmeter across R_2 V_2 reads 4 V.



Calculate the:

8.4.1 Resistance of resistor R_3 (6)

8.4.2 Internal resistance of the battery (3)

8.5 R_3 is now removed from the circuit and replaced with a wire of negligible resistance. What will be the effect on the reading on V_1. Write down INCREASE, DECREASE or REMAINS THE SAME. Explain your answer. (3)

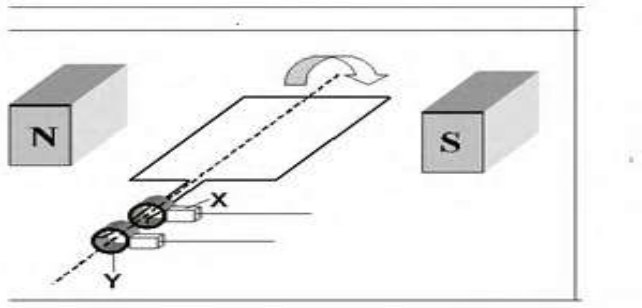
[22]

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QUESTION 9

The simplified diagram below represent an alternating current (AC) generator that is rotated clockwise.



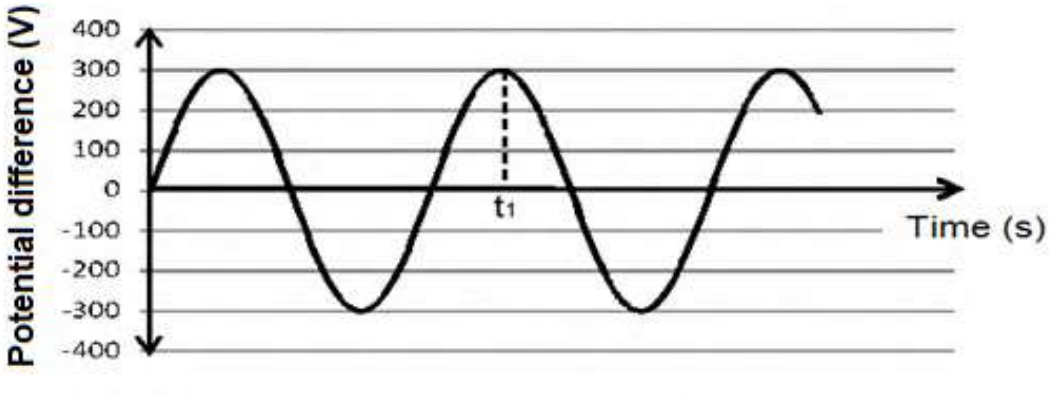
9.1 Write down the energy conversion that takes place in an AC generator. (1)

9.2 Write down the name of the following components:

9.2.1 **X** (1)

9.2.2 **Y** (1)

9.3 The maximum current output of this AC generator is 21 A. A graph of the potential difference output of the generator against time is shown below.



9.3.1 Define the term *root mean square (rms) potential difference*. (2)

9.3.2 Calculate the average power output for this generator. (5)

[10]

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QUESTION 10

Learners perform an experiment to investigate the effect of the wavelength of light on the photo-electric effect. They irradiate a metal surface **M** with three light sources of different wavelengths and note the ejection of the photoelectrons from the metal surface.

The results obtained are shown in the table below:

LIGHT SOURCE	WAVELENGTH ($\times 10^{-9}$ M)	EJECTION OF PHOTOELECTRONS
A	480	Electrons ejected and moving away from the metal
B	620	No electrons ejected
C	570	Electrons ejected and NOT moving away from the metal

10.1 Define *the photo-electric effect* in words. (2)

10.2 Give a reason why light source **B** did not eject electrons from the metal surface **M**. (2)

10.3 Calculate the:

10.3.1 Work function of the metal **M** (3)

10.2.2 Maximum speed with which the electrons will be ejected from the metal surface **M** when it is irradiated with light source **A** (5)

10.4 Light source **A** is BLUE light and light source **B** is ORANGE light. Which colour is possibly light source **C**?

Choose only between VIOLET, GREEN or RED. (1)
[13]

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

TABLE 2: FORMULAE/TABEL 2: FORMULES

MOTION/BEWEGING

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

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

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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 $E_k = \frac{1}{2}mv^2$	$W_{nett} = \Delta K$ or/*of* $W_{nett} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ or/of $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

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

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

ELECTROSTATICS/*ELEKTROSTATIKA*

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

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ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf (ε) = I(R + r)
$R_s = R_1 + R_2 + R_3 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$Q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

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NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIORSERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2026

PHYSICAL SCIENCES P1/ *FISIESE WETENSKAPPE V1* MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: **150**

This marking guideline consists of 14 pages./
Hierdie nasienriglyn bestaan uit 14 bladsye.

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QUESTION/*VRAAG* 1: MULTIPLE-CHOICE QUESTIONS
MEERVOUDIGEKEUSE-VRAE

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

[20]

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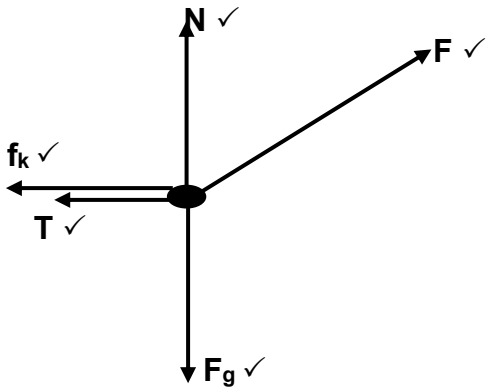
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QUESTION/*VRAAG* 2

2.1 Normal force / *Normaalkrag* ✓ (1)

2.2 $N = mg - F\sin\theta$
$12,5 = 4 \times 9,8 - 72\sin\theta$ ✓
$\theta = 21,77^0$ ✓ (2)

2.3



(5)

Accepted labels / *Aanvaarde benoemings*	
w	Fg /weight / 39,2 N / mg/ *Fw* / gravitational force / *gewig/ gravitasiekrag*
f_k	f/frictional force /F_f / *wrywingskrag*
T	F_T / Tension /*Spanning*
F	F_{appled} / F_A
N	Normal force/*Normaalkrag* / F_N

- Mark awarded for arrow and label/ *Punt toegeken vir pyltjie en benoeming*
- Do not penalise for length of arrows since drawing is not drawn to scale.
- *Moenie penaliseer vir die lengte van die pyltjies nie aangesien tekening nie volgens skaal geteken is nie.*
- Any other additional force(s)/ *Enige addisionele kragte* $^4/_5$
- If force(s) do not make contact with body/ *As kragte nie kontak maak met liggaam* Max/*Maks* $^4/_5$
- All forces correct but no arrows $^4/_5$

2.4 When a net force acts on an object, the object will accelerate in the direction of the force at an acceleration directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die krag teen 'n versnelling direk eweredig aan die krag en omgekeerd ewerewig aan die massa van die voorwerp.
The net force acting on an object is equal to the rate of change of momentum of the object (in the direct of the force) 2 or 0
Die netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum van die voorwerp (in die rigting van die voorwerp) 2 of D (2)

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2.5 **POSITIVE MARKING FROM QUESTION 2.2 / POSITIEWE NASIEN VANAF VRAAG 2.2**

$F_{net} = ma$
$F\cos\theta - T - f = ma$ } Any one / *Enige een* ✓
$T - mg = ma$

$\underline{72\cos 21{,}77^0}$ ✓ $- T - \underline{(0{,}25 \times 12{,}5)}$ ✓ $= 4a$
$\underline{63{,}740 - T} = 4a$

Any one / *Enige een* 4a or/ *of* 3a ✓

$\underline{T - 3(9{,}8)}$ ✓ $= 3a$
$a = 4{,}91\ m.s^{-2}$ ✓

(6)
[16]

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QUESTION/*VRAAG* 3

3.1 9,8 m.s^{-2} downwards / *afwaarts* ✓ (1)

3.2.1

UPWARD POSITIVE / *OPWAARTS POSITIEF*

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

$\underline{23 = v_i(3,5) + \frac{1}{2} \times (-9,8)(3,5)^2}$ ✓

$v_i = 23,72\ m\cdot s^{-1}$ ✓

UPWARD NEGATIVE / *OPWAARTS NEGATIEF*

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

$\underline{-23 = v_i(3,5) + \frac{1}{2} \times (9,8)(3,5)^2}$ ✓

$v_i = 23,72\ m\cdot s^{-1}$ ✓ (3)

3.2.2 **POSITIVE MARKING FROM QUESTION 3.2.1 / *POSITIEWE NASIEN VANAF VRAAG 3.2.1***

UPWARD POSITIVE / *OPWAARTS POSITIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{0^2 = (23,72)^2 + 2(-9,8)\Delta y}$ ✓

$\Delta y = 28,71$ m

Max Height/ *Maksimum hoogte* = 28,71 $\underline{+ 0,8}$ ✓ = 29,51 m ✓

UPWARD NEGATIVE / *OPWAARTS NEGATIEF*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$\underline{0^2 = (-23,72)^2 + 2(9,8)\Delta y}$ ✓

$\Delta y = -28,71$ m ✓

Max Height/ *Maksimum hoogte* = 28,71 $\underline{+ 0,8}$ ✓ = 29,51 m ✓

OPTION 2 / *OPSIE 2*

UPWARD POSITIVE / *OPWAARTS POSITIEF*

$v_f = v_i + a\Delta t$

$0 = 23,72 + (-9,8)\Delta t$

$\Delta t = 2,42$ s

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

$\Delta y = \underline{(23,72)(2,42) + \frac{1}{2}(-9,8)(2,42)^2}$ ✓

$\Delta y = 28,71$ m

Max Height / *Maksimum hoogte* = 28,71 $\underline{+ 0,8}$ ✓ = 29,51 m ✓

UPWARD NEGATIVE / *OPWAARTS NEGATIEF*

$v_f = v_i + a\Delta t$

$0 = -23,72 + (9,8)\Delta t$

$\Delta t = 2,42$ s

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

$\Delta y = \underline{(-23,72)(2,42) + \frac{1}{2}(9,8)(2,42)^2}$ ✓

$\Delta y = -28,71$ m

Max Height/ *Maksimum hoogte* = 28,71 $\underline{+ 0,8}$ ✓ = 29,51 m ✓

OPTION 3 / *OPSIE 3*

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

UPWARD POSITIVE / *OPWAARTS POSITIEF*

$v_f = v_i + a\Delta t$

$0 = 23,72 + (-9,8)\Delta t$

$\Delta t = 2,42$ s

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

$= \left(\frac{0 + 23,72}{2}\right)(2,42)$

= 28,70 m

Max Height / *Maksimum hoogte* = 28,70 $\underline{+ 0,8}$ ✓ = 29,50 m ✓

UPWARD NEGATIVE / *OPWAARTS NEGATIEF*

$v_f = v_i + a\Delta t$

$0 = -23,72 + (9,8)\Delta t$

$\Delta t = 2,42$ s

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

$= \left(\frac{0 - 23,72}{2}\right)(2,42)$ ✓

= 28,70 m

Max Height / *Maksimum hoogte* = 28,70 $\underline{+ 0,8}$ ✓ = 29,50 m ✓ (4)

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3.2.3 **POSITIVE MARKING FROM QUESTION 3.2.1 / *POSITIEWE NASIEN VANAF VRAAG 3.2.1***

OPTION 1 / *OPSIE 1*

UPWARD POSITIVE / *OPWAARTS POSITIEF*

$v_f = v_i + a\Delta t$ ✓
$v_f = 23,72 + (-9,8)(3,5)$ ✓
$v_f = -10,58$
$v_f = 10,58$ m.s^{-1} downwards / *afwaarts* ✓

UPWARD NEGATIVE / *OPWAARTS NEGATIEF*

$v_f = v_i + a\Delta t$ ✓
$v_f = -23,72 + (9,8)(3,5)$ ✓
$v_f = 10,58$ m.s^{-1}downwards/ *afwaarts* ✓

OPTION 2 / *OPSIE 2*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (23,72)^2 + 2(-9,8)(23)$ ✓
$v_f^2 = 10,58$ m.s^{-1} ✓ downwards / *afwaarts* ✓

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = (23,72)^2 + 2(-9,8)(23)$ ✓
$v_f^2 = 10,58$ m.s^{-1} ✓ downwards / *afwaarts* ✓ (3)

OPTION 3 / *OPSIE 3*

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

$23 = \left(\frac{v_f + 23,72}{2}\right)x3,5$

$v_f = -10,56$

$= 10,56$ m.s^{-1} downwards / *afwaarts* ✓

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

$-23 = \left(\frac{v_f + -23,72}{2}\right)x3,5$

$v_f = 10,56$ m.s^{-1} downwards / *afwaarts* ✓

3.3 Inelastic, ✓ the ball bounces to a lower height than the maximum height before the bounce ✓
Onelasties, die bal bons tot 'n laer hoogte as die maksimum hoogte voor die bons

OR/*OF*

Inelastic, ✓ Maximum height before bounce > Maximum height after bounce ✓
Onelasties, Maksimum hoogte voor bons > Maksimum hoogte na bons (2)

3.4 **POSITIVE MARKING FROM QUESTION 3.2.3 / *POSITIEWE NASIEN VANAF VRAAG 3.2.3***

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$ } Any one / *enige een* ✓
F_{net} x 0,01 ✓ = 0,7 [6,3 – (-10,58)] ✓
$F_{net} = 1181,6$ N Upwards/*opwaarts* ✓

$F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$ } Any one ✓
F_{net} x 0,01 ✓ = 0,7 [-6,3 – (10,58)] ✓
$F_{net} = -1181,6$
$F_{net} = 1181,6$ N Upwards/Opwaarts ✓ (4)

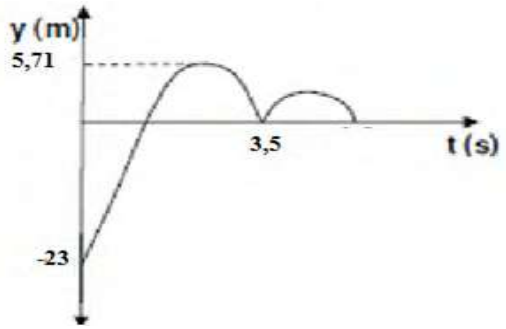
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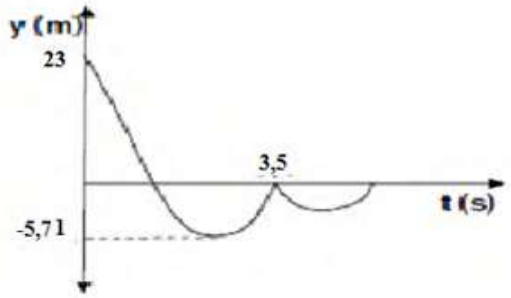
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3.5 **POSITIVE MARKING FROM QUESTION 3.2.2 / *POSITIEWE NASIEN VANAF VRAAG 3.2.2***

UPWARD POSITIVE / *OPWAARTS POSITIEF*



UPWARD NEGATIVE / *OPWAARTS NEGATIEF*



Marking criteria for graph / *Nasienkriteria vir grafiek*	
Graph starts at -23 m at t = 0 s / *Grafiek begin by – 23 m by t = 0 s*	✓
Correct shape / *Korrekte vorm*	✓
Maximum height = 5,71 m [(Answer of h in Q 3.2.2) -23] / *Maksimum hoogte = 5,71 m [Antwoord van h in V 3.2.2) – 23]*	✓
Deduct 1 mark if axes are not labelled./ *Trek 1 punt af as asse nie benoem is nie.* If ground as zero position, maximum $\frac{2}{3}$	

(3)
[20]

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QUESTION/*VRAAG* 4

4.1 The total linear momentum of an isolated system remains constant. ✓✓
The total linear momentum of an isolated system is conserved.

Die totale lineêre momentum in 'n geisoleerde sisteem bly konstant.
Die totale lineêre momentum in 'n geisoleerde sisteem bly behoue. (2)

4.2 $\sum p_i = \sum p_f$
$m_A v_i + m_B v_i = (m_A + m_B) v_f$ } Any one / *Enige een* ✓
$0 = 1,8(0,25) + 0,7v_f$ ✓
$v_f = 0,64\ m.s^{-1}$ ✓ (3)

4.3 (The soft surface) increases the contact time and decreases the net force on the person. ✓
(Die sagte oppervlak) verhoog die kontaktyd en verminder die netto krag op die persoon.
$F_{net}\ \alpha\ \frac{1}{\Delta t}$ ✓ (2)

4.4 **OPTION 1 / *OPSIE 1***
$W_{net} = \Delta E_k$
$W_{w//} + W_f = ½mv_f^2 - ½mv_i^2$ } Any one / *Enige een* ✓
$(1,8\times9,8\times\text{Sin } 30°)(0,6)\text{Cos } 0°$ ✓ + $(1,85)(0,6)\text{Cos } 180°$ ✓ = $½(1,8)v_f^2 - ½(1,8)(0,25)^2$ ✓
$v_f = 2,17\ m\cdot s^{-1}$ ✓

OPTION 2 / *OPSIE 2*
$W_{net} = \Delta E_k$
$W_w + W_f = ½mv_f^2 - ½mv_i^2$ } Any one / *Enige een* ✓
$(1,8\times9,8)(0,6)\text{Cos } 60°$ ✓ + $(1,85)(0,6)\text{Cos } 180°$ ✓ = $½(1,8)v_f^2 - ½(1,8)(0,25)^2$ ✓
$v_f = 2,17\ m\cdot s^{-1}$ ✓

OPTION 3 / *OPSIE 3*
$W_{net} = \Delta E_k$
$F_{net}\cdot\Delta x\cdot\text{Cos}\theta = ½mv_f^2 - ½mv_i^2$ } Any one / *Enige een* ✓
$(1,8\times9,8\times\text{Sin}30° - 1,85)$ ✓ $(0,6)\text{Cos}0°$ ✓ = $½(1,8)v_f^2 - ½(1,8)(0,25)^2$ ✓
$v_f = 2,17\ m\cdot s^{-1}$

OPTION 4 / *OPSIE 4*
$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$ } Any one / *Enige een* ✓
$(1,85)(0,6)\text{Cos } 180°$ ✓ = $½(1,8)v_f^2 - ½(1,8)(0,25)^2$ ✓ + 0 – $1,8(9,8)(0,6\sin30°)$ ✓
$v_f = 2,17\ m\cdot s^{-1}$ ✓ (5)
[12]

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QUESTION/*VRAAG* 5

5.1 A force for which the work done in moving an object between two points depends on the path taken. ✓✓
Is 'n krag waarvoor die arbeid verrig om 'n voorwerp tussen twee punte te beweeg, afhanklik is van die roete wat gevolg word. (2)

5.2 **OPTION 1 / *OPSIE 1***
$W_{net} = \Delta E_k$
$W_F + W_f = ½mv_f^2 - ½mv_i^2$
$F(2)\text{Cos } 30°$ ✓ $+ (10)(2)\text{Cos } 180°$ ✓ $= ½(10)(2)^2 - ½(10)(0)^2$ ✓
$F = 23{,}09$ N ✓

OPTION 2 / *OPSIE 2*
$W_{nc} = \Delta E_k + \Delta E_p$
$W_F + W_f = ½mv_f^2 - ½mv_i^2 + mgh_f - mgh_i$
$F(2)\text{Cos } 30°$ ✓ $+ (10)(2)\text{Cos } 180°$ ✓ $= ½(10)(2)_f^2 - ½(10)(0)^2$ ✓ $+ 0$
$F = 23{,}09$N ✓ (4)

5.3 Remains the same / *bly dieselfde* ✓✓ (2)
[8]

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QUESTION/*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. ✓✓
Is die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het. (2)

6.2 Away from. ✓The observed frequency is decreasing. ✓
Weg van. Die waargenome frekwensie neem af. (2)

6.3 As the listener's velocity increases, the observed frequency decreases. ✓✓
Soos die luisteraar se snelheid toeneem, neem die waargenome frekwensie af. (2)

6.4 The intercept on the vertical axis represents the frequency of the source, f_s. ✓✓
Die afsnit op die vertikale as verteenwoordig die frekwensie van die bron, fs. (2)

6.5 **OPTION 1 / *OPSIE 1***

Gradient = $\frac{492-470}{5-20}$ ✓✓

Gradient = $\frac{-f_s}{v}$ ✓

$\frac{22}{-15} = \frac{-f_s}{340}$ ✓

f_s = 498,67 Hz ✓

OPTION 2 / *OPSIE 2*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

492 ✓= $\frac{340-5}{340}$ ✓✓x f_s

f_s = 499,34 Hz ✓

OPTION 3 / *OPSIE 3*

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

470 ✓= $\frac{340-20}{340}$ ✓✓x f_s

f_s = 499,38 Hz ✓

Range (498,67 Hz – 499,38 Hz) (5)

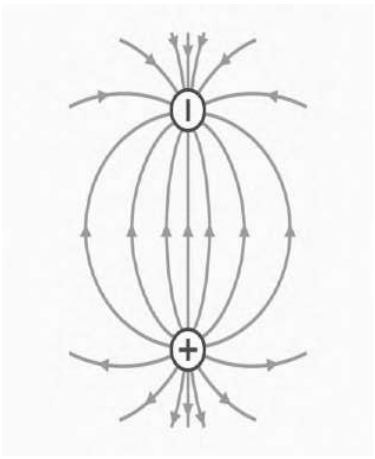
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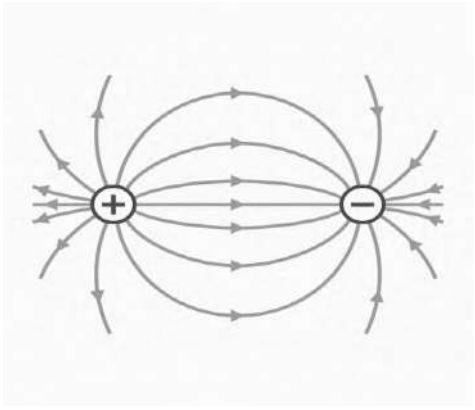
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QUESTION/*VRAAG 7*

7.1





Marking Criteria / *Nasienkriteria*	
Shape of electric field /*Vorm van elektriese veld*	✓
Correct direction of field lines / *Korrekte rigting van die veldlyne*	✓
No field lines crossing each other / No field lines inside the spheres / *Geen veldlyne kruis / geen veldlyne binne die sfeer nie*	✓

(3)

7.2 19,3 N ✓ (1)

7.3 **POSITIVE MARKING FROM QUESTION 7.2 / *POSITIEWE NASIEN VANAF VRAAG 7.2***

$F_{net} = ma$
$F_{net} = 0$
$T - mg - F_E = 0$
$19,3 - (0,5)(9,8)$ ✓$= F_E$
$F_E = 14,4N$

$F = \frac{kQ_1Q_2}{r^2}$ ✓
$14,4$ ✓ $= \frac{(9\times10^9)(4\times10^{-6})(4\times10^{-6})}{r^2}$ ✓
r = 0,1 m ✓ (5)

7.4 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 eenheidpositiewe-lading wat by daardie (punt geplaas) is, ondervind word. (2)

7.5 $E = \frac{kQ_Q}{r^2}$ ✓

$E_{net} = \frac{9\times10^9\times6\times10^{-9}}{0,5^2}$ ✓+ $\frac{9\times10^9\times6\times10^{-9}}{0,3^2}$ ✓ - $\frac{9\times10^9\times2\times10^{-9}}{0,1^2}$ ✓

$E_{net} = -9,84 \times 10^2\ N.C^{-1}$
$E_{net} = 9,84 \times 10^2\ N.C^{-1}$ left / *links* ✓ (5)
[16]

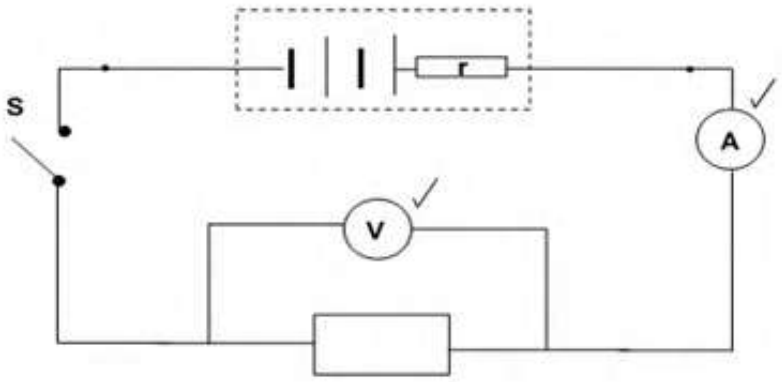
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QUESTION/*VRAAG 8*

8.1



Voltmeter may be connected across the battery / *Voltmeter kan oor die battery gekoppel word* (2)

8.2 The maximum energy provided by a battery per unit charge passing through it. ✓✓
Die maksimum energie wat 'n battery lewer per eenheidslading wat daardeur vloei. (2)

8.3 Solve simultaneously for Ɛ and **r** using any two sets of readings.
Los gelyktydig op vir Ɛ en r deur enige twee stelle lesings te gebruik.

$\varepsilon = IR + Ir$
$\varepsilon = V + Ir$ } Any one / *Enige een* ✓
$\varepsilon = 10,2 + 1,5r$ ✓ … (I)
$\varepsilon = 9,6 + 2r$ ✓ … (II)
$(0 = -0,6 + 0,5r$ ✓
$r = 1,2\ \Omega$
$\varepsilon = 9,6 + 2(1,2)$ ✓
$\varepsilon = 12\ V$ ✓ (6)

8.4 8.4.1 For R_1:

$R = \frac{V}{I}$ ✓
$2 = \frac{6}{I}$ ✓
$I = 3\ A$

$2 = \frac{4}{I}$ ✓
$I = 2\ A$
$I_{R3} = 3 - 2$ ✓ $= 1\ A$

$R_3 = \frac{4}{1}$ ✓
$R_3 = 4\ \Omega$ ✓ (6)

8.4.2 **POSITIVE MARKING FROM QUESTION 8.4.1 / *POSITIEWE NASIEN VANAF VRAAG 8.4.1***

OPTION 1 / *OPSIE 1*
Emf / *emk* = IR + Ir ✓
12 = 10 + 3r ✓
r = 0,67 Ω ✓

OPTION 2 / *OPSIE 2*
$V_{int} = Ir$ ✓
$12 - 10 = 3r$ ✓
r = 0,67 Ω ✓ (3)

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8.5 Decrease ✓
Total external resistance, R_{total} will decreases. Total current (in circuit) increases ✓
V_{int} will also increase ✓
V_1 will decrease
Afneem
Totale eksterne weerstand, R_{totaal}, sal afneem. Totale stroom (in stroombaan) neem toe
V_{int} sal ook toeneem
V neem af (3)
[22]

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QUESTION/*VRAAG* 9

9.1 Mechanical energy to electric energy / *Meganiese energie na elektriese energie* ✓ (1)

9.2 9.2.1 Brush(es) / Carbon brush(es) / *borsels / koolstof borsels* ✓ (1)

9.2.2 Slip rings / *Sleepringe* ✓ (1)

9.3.1 The rms potential difference is the AC potential difference which dissipates/produces the same amount of energy as an equivalent DC potential difference. ✓✓
Die wgk potensiaalverskil is die WS-potensiaalverskil wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente GS-potensiaalverskil. (2)

9.3.2

OPTION 1 / *OPSIE 1*

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$

$V_{rms} = \frac{300}{\sqrt{2}}$ ✓

V_{rms} = 212,13 V

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$I_{rms} = \frac{21}{\sqrt{2}}$ ✓

I_{rms} = 14,85 A

$P_{ave} = V_{rms}I_{rms}$ ✓
= (212,13)(14,85) ✓
= 3150,13 W ✓

OPTION 2 / *OPSIE 2*

$P_{ave} = V_{rms}I_{rms}$ ✓

$P_{ave} = \frac{V_{max}}{\sqrt{2}} \times \frac{I_{max}}{\sqrt{2}}$

$P_{ave} = \left[\frac{300}{\sqrt{2}} \checkmark \times \frac{21}{\sqrt{2}} \checkmark\right] \checkmark$

P_{ave} = 3150 W ✓

OPTION 3 / *OPSIE 3*

$P_{ave} = \frac{V_{max}.I_{max}}{2}$ ✓✓

$P_{ave} = \frac{300 \text{ x } 21}{2}$ ✓✓

P_{ave} = 3150 W ✓

(5)
Range/*Reikwydte* (3 150 W – 3 150,13 W) **[10]**

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QUESTION/*VRAAG* 10

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

10.2 Energy of light B is lower than the work function of the metal ($E<W_o$). ✓✓
Energie van lig B is laer as die arbeidsfunksie van die metaal ($E<W_o$).

OR/*OF*

Frequency of light B is lower than the threshold freque
($f_B<f_0$). ✓✓
Frekwensie van lig B is laer as die drumpelfrekwensie van die metaal ($f_B < f_0$).

OR/*OF*

Wavelength of light source B is greater than cut-off wavelength of the metal ✓✓
Golflengte van ligbron B is groter as die afsny-golflengte van die metaal (2)

10.3 10.3.1 $W_o = \frac{hc}{\lambda}$ ✓
$= \frac{(6,63\times10^{-34})(3\times10^{8})}{(570\times10^{-9})}$ ✓
$= 3,49\times10^{-19}$ J ✓

OR/*OF*

$f_0 = \frac{c}{\lambda}$
$= \frac{((3\times10^{8})}{(570\times10^{-9})}$ ✓
$= 5,263 \times 10^{14}$ Hz

$W_o = hf_0$ ✓
$= (6,63 \times 10^{-34})(5,263 \times 10^{14})$
$= 3,49 \times 10^{-19}$ J ✓ (3)

10.3.2 **POSITIVE MARKING FROM QUESTION 10.3.1 / *POSITIEWE NASIEN VANAF VRAAG 10.3.1***

$E = W_o + E_{k(max\ /\ maks)}$ ✓
$\frac{hc}{\lambda} = W_o + \frac{1}{2}mv_{max\ /\ maks}^2$
$\frac{(6,63\times10^{-34})(3\times10^{8})}{(480\times10^{-9})}$ ✓ $= 3,49\times10^{-19}$ ✓ $+ \frac{1}{2}(9,11\times10^{-31})v_{max\ /\ maks}^2$ ✓

$v_{max\ /\ maks} = 37\ 8845,09\ m\cdot s^{-1}$ ✓ / $3,79\times10^{5}\ m\cdot s^{-1}$ (5)

10.4 Green / *Groen* ✓ (1)
[13]

TOTAL/*TOTAAL*: 150

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