Western Cape Government

Education

FOR YOU

# PHYSICAL SCIENCES
# PAPER 1

## GRADE 12

## MNED PLC CLUSTER PAPER
## SEPTEMBER 2024



**MARKS: 150**

**TIME: 3 hours**

**This paper consists of 19 pages and 3 data sheets**

**INSTRUCTIONS AND INFORMATION**

1. Write your name in the space below and submit the question paper with your answer sheets.

   **NAME AND SURNAME**: _____

   **GRADE**: _____

2. This question paper consists of **10 QUESTIONS**. Answer ALL the questions on your ANSWER SHEETS.
3. Start EACH question on a NEW page on your ANSWER SHEETS.
4. Number the answers correctly according to the numbering system used in this question paper
5. Leave ONE line between two sub questions, 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 (concise) motivations, discussions etc. where required.
12. Write neatly and legibly.

## QUESTION 1 (MULTIPLE-CHOICE)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) on your ANSWER SHEETS.

1.1 A car with mass (**m**) accidentally crashes into an oncoming truck with mass (**4m**). Compared to the magnitude of the force of the truck on the car, the force of the car on the truck during the collision is ...

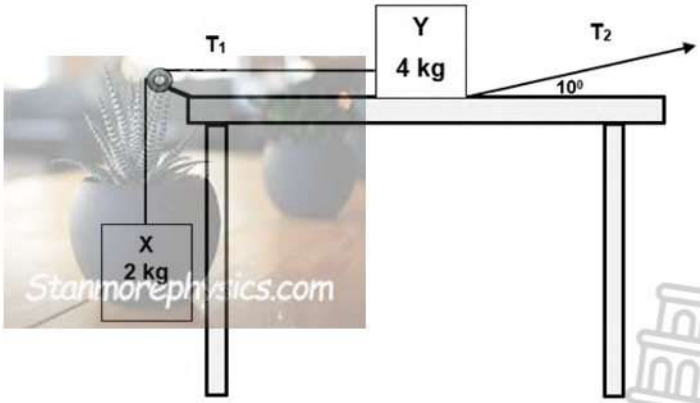
A zero

B the same

C smaller than

D greater than (2)

1.2 In the diagram below, a 4 kg wooden block, **Y**, connected to a 2 kg mass, **X**, by an inelastic rope, $\mathbf{T_1}$, and a frictionless pulley, is held in place by a light, inelastic rope, $\mathbf{T_2}$, at an angle of 10°.




How do the magnitudes of the tension in ropes $\mathbf{T_1}$ and $\mathbf{T_2}$ compare respectively?

A $T_1 = T_2$

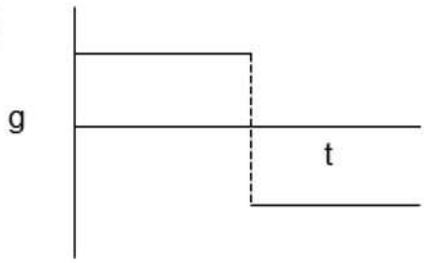
B $T_1 > T_2$

C $T_1 + T_2 = 0$

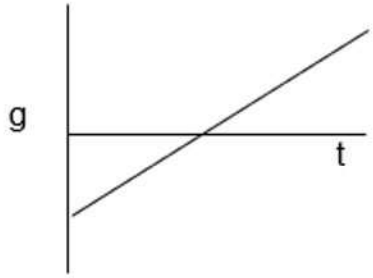
D $T_1 < T_2$ (2)

1.3 Which of the following graphs represents the graph of *gravitational acceleration versus time* for a stone that is projected vertically upwards and then falls back to the earth?

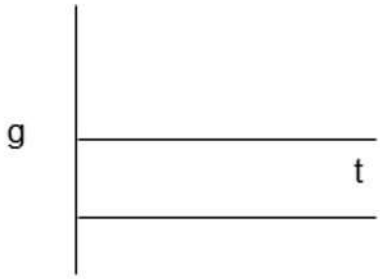
A



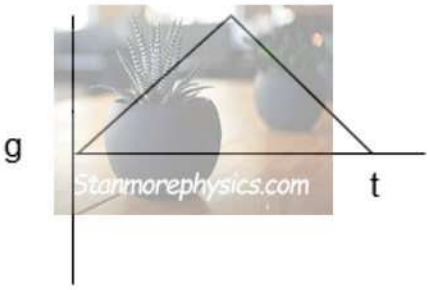

B




C




D




(2)

1.4 An object **P**, mass **m**, is moving at constant velocity **v** along a smooth, horizontal surface. An identical object **Q** is dropped onto object **P** and stays there. Which one of the following represents the velocity of the combination **P + Q** ?

A zero

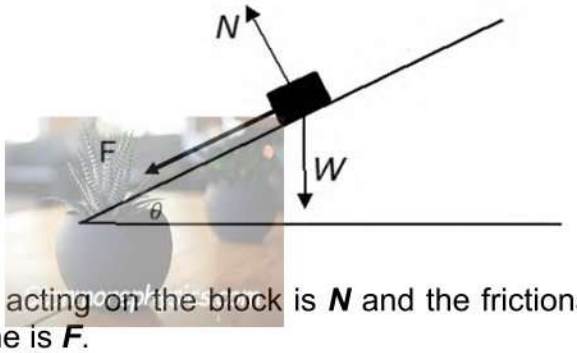
B ½v

C v

D 2v

(2)

1.5 A block of weight (***w***) slides at a constant speed (***v***) up a plane inclined at an angle θ to the horizontal, over a time interval, ***Δt***. The coefficient of kinetic friction between the slope and block is, **μ**.




The normal force acting on the block is ***N*** and the frictional force between the block and the plane is ***F***.

What is the power required to move the block up the slope in this manner?

A $(w\sin\theta + \mu N)v\Delta t$

B $\frac{Fv}{\Delta t}$

C $(w\sin\theta + \mu w\cos\theta)v$

D $\frac{W}{\Delta t}$ (2)

1.6 An airplane flies at night and uses its radar system to navigate. It transmits a signal with a frequency of **f Hz**. The airplane moves between high cliffs, and the signal picked up by the radar system is **(f + 20) Hz**. Choose the correct statement regarding the sound that the airplane picks up.

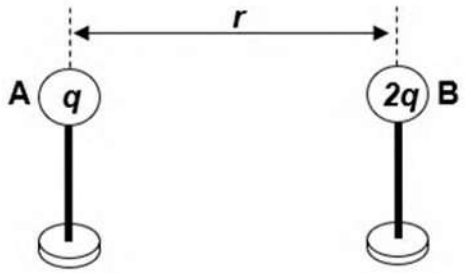
A The sound's pitch increases as the airplane moves towards the cliffs.

B The sound's pitch remains the same as the airplane moves towards the cliffs.

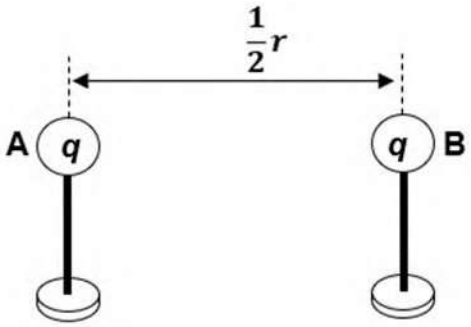
C The sound's pitch decreases as the airplane moves away from the cliffs.

D The sound's pitch decreases as the airplane moves towards the cliffs. (2)

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




The charge on sphere **B** and the distance between the charges are halved.




What will the new force be between the charges?

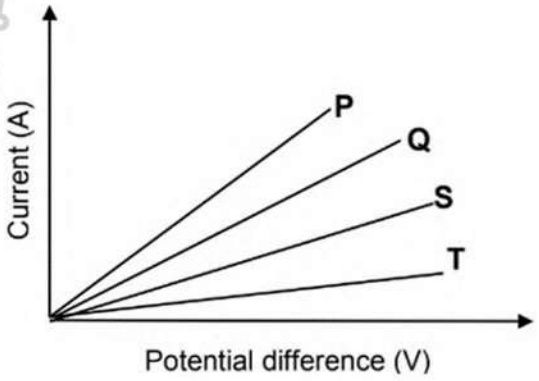
A F

B 4F

C 2F

D ½ F (2)

1.8 The current versus potential difference graphs below were obtained for four resistors **P**, **Q**, **S** and **T**.




The resistor with the LEAST resistance is:

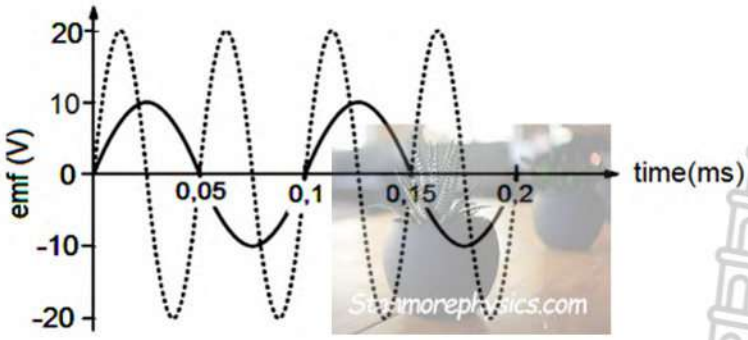
A T

B S

C Q

D P (2)

1.9 In the graph shown, the solid curve indicates how the emf produced by a simple generator varies with time. The broken curve indicates the output of the same generator after a change was made to the generator.




What change was made to produce the result shown in the graph?

A The area of the coil was doubled.

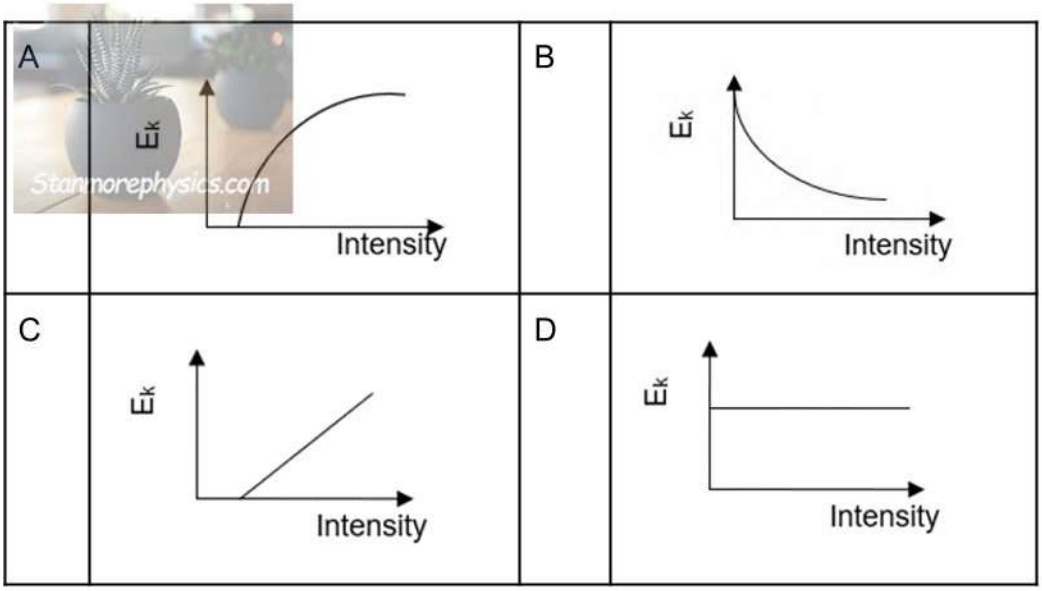
B A commutator was added.

C The speed of rotation of the coil was doubled.

D The number of turns in the coil was doubled. (2)

1.10 Blue light of different intensities is incident on a photo-electric cell. Photo-electrons are emitted from the surface of the metal.

Which ONE of the following graphs represents the correct relationship between the maximum kinetic energy of the emitted photoelectrons and the intensity of the incident light?

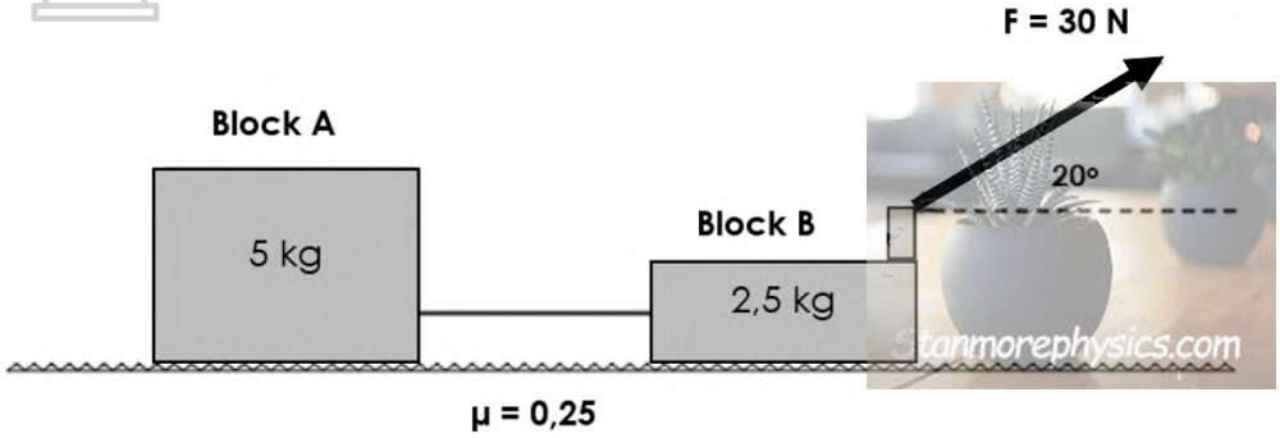



(2)

**[20]**

**QUESTION 2 (Start on a new page)**

Two blocks, **A**, of mass of 5 kg, and **B**, of mass 2,5 kg are connected by a light inextensible string. A 30 N force is applied at an angle of 20° to block **B** as shown in the diagram. The applied force causes both blocks to accelerate across a rough floor which has a kinetic coefficient of 0,25.




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

2.2 Calculate the magnitude of the frictional force acting on the 5 kg block. (3)

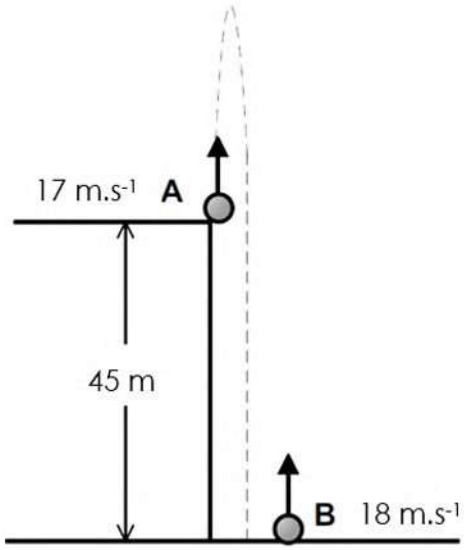
2.3 Draw a fully labelled free-body diagram of the forces acting on block **A**. (5)

2.4 Determine the acceleration of the blocks. (6)

**[16]**

**QUESTION 3 (Start on a new page)**

A ball, **A**, is projected vertically upward from a height, 45 m, with a speed of 17 $m \cdot s^{-1}$. TWO SECONDS after ball **A** is projected vertically upward, a second identical ball **B** is thrown vertically upward from the ground with a speed of 18 $m.s^{-1}$ as shown in the diagram below. Both balls undergo free fall and eventually hit the ground.




3.1 Define the term *projectile*. (2)

3.2 Calculate the:

3.2.1 time taken by ball **A** to reach its maximum height (3)

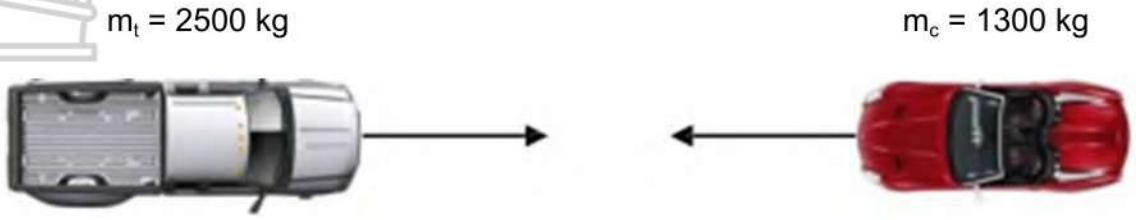
3.2.2 maximum height reached by ball **A** above the ground. (4)

3.3 Calculate the velocity of ball **B** when ball **A** passes its original position on its way down. (5)

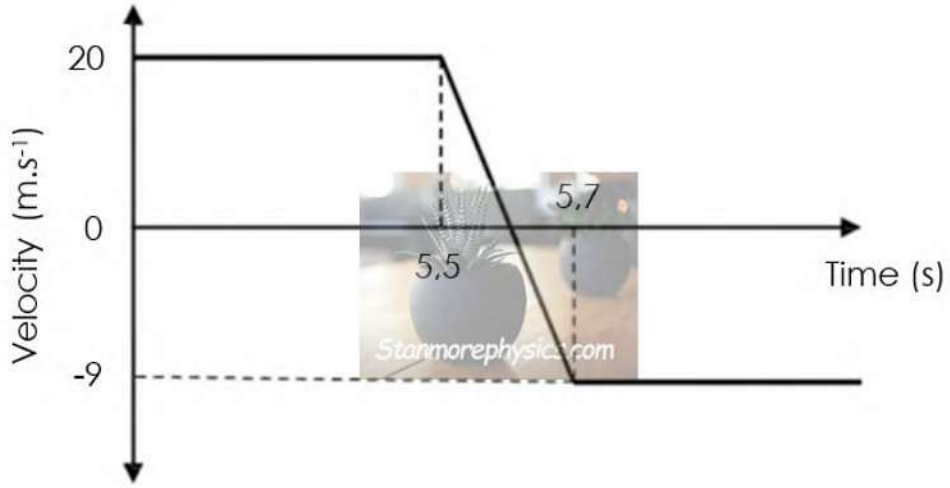
**[14]**

**QUESTION 4 (Start on a new page)**

A car, mass 1300 kg, moves to the left on a narrow road. It collides head-on with a pickup truck, mass 2500 kg, moving in the opposite direction as shown. After the collision the two vehicles move together.




The following velocity-time graph is plotted for the car:




4.1 Calculate the momentum of the car before the collision. (3)

4.2 Calculate the magnitude of the velocity of the pickup truck before the collision. (4)

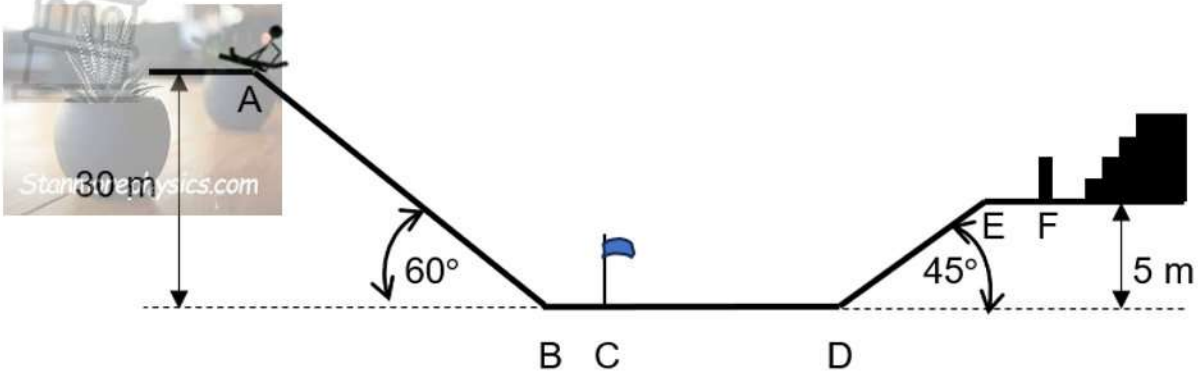
4.3 Calculate the magnitude of the net force on the car. (4)

4.4 Determine, by means of calculations, whether this collision is elastic or inelastic. (5)

**[16]**

**QUESTION 5 (Start on a new page)**

5.1 In the Winter Olympics a skier with a mass 100 kg (including skis) moves along a race course as shown below:




*Note that:*

- The skier pushes off from the starting point at **A** with a speed of **2 m.s$^{-1}$**.
- Point **C** is the finishing line.
- Due to the hard compactness of the surface between points **A, B, C** and **D** the friction can be neglected over this part of the course.
- The surface between points **D** and **E** is purposefully made up of soft compact snow to slow the skier down before they reach the top of the second slope at point **E**.
- Due to friction the skier comes to a total standstill at the barrier **F** after they have traveled the **50 m** between points **E** and **F**.

5.1.1 State the *Principle of Conservation of Mechanical Energy*. (2)

5.1.2 Determine the total mechanical energy of the skier at point **A**. (3)

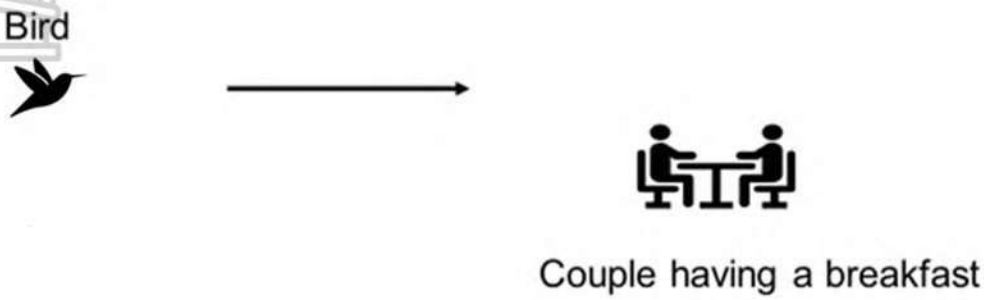
5.1.3 Using energy principles only, determine the speed at which the skier crosses the finish line at **C**. (3)

5.2 If the average frictional force on the skier due to the soft snow on the slope between **D** and **E** is 300 N, using only energy principles, determine the skier's speed at point **E**. (7)

**[15]**

**QUESTION 6 (Start on a new page)**

A couple having breakfast at a rest stop hears a sound produced by a bird flying at a CONSTANT velocity towards them, as indicated in the diagram below.




The wavelength of the sound detected as the bird approaches the couple is 0,14 m and the wavelength of the sound detected while the bird flies away from them is 0,2 m. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1 State the *Doppler Effect* in words. (2)

6.2 Determine the frequency of the sound detected as the bird flies towards the couple (3)

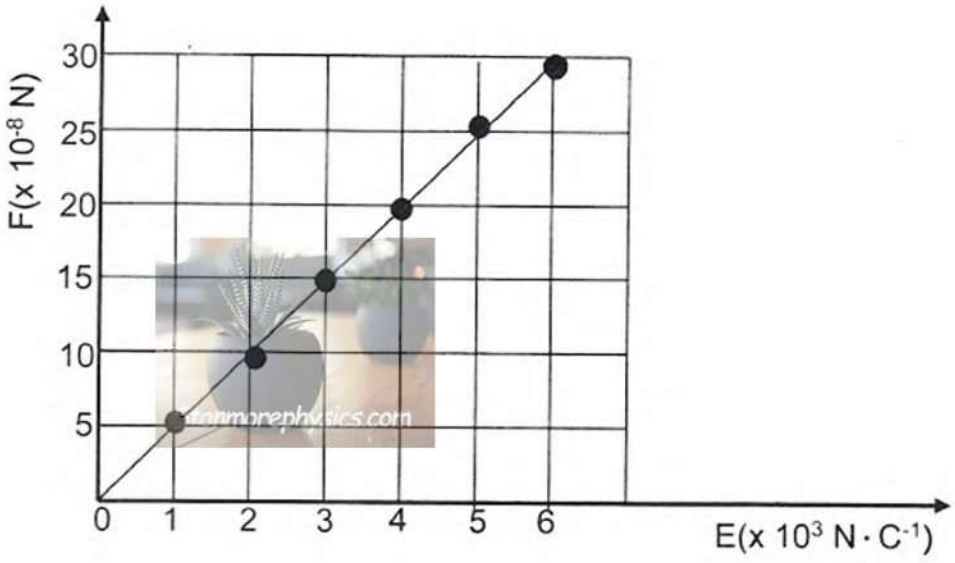
6.3 Calculate the speed of the bird. (6)

6.4 Will the frequency of the source INCREASE, DECREASE or REMAIN THE SAME if the velocity of the bird decreases as it flies towards the couple? (1)

**[12]**

**QUESTION 7 (Start on a new page)**

7.1 The relationship between the *electrostatic force* (**F**) experienced by a test charge and the magnitude of the *electric field strength* (**E**) the charge is placed in, is investigated.
The results obtained are shown in the graph below.




7.1.1 Describe, in words, an *electric field*. (1)

7.1.2 For this investigation, write down the independent variable. (1)

7.1.3 State, in words, the relationship between **F** and **E** as depicted by the graph. (1)

7.1.4 Write down the NAME of the physical quantity represented by the gradient of the graph. (1)

7.1.5 Calculate the value of the gradient of the graph. (3)

7.1.6 Write down the magnitude of the test charge used in this investigation. (1)

7.1.7 Calculate the number of electrons that were removed or added to obtain this test charge. (2)

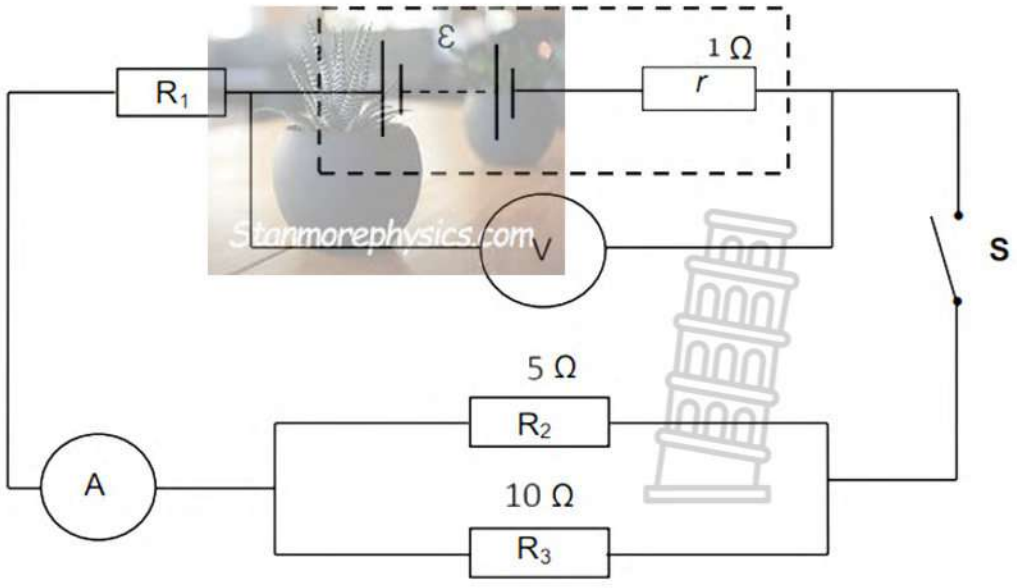
7.2 An unknown point charge, **R**, is placed 3 cm to the right of charge **P** which has a charge of +8 nC.


Calculate the charge of **R** if the net electric field strength at point **X** is $9 \times 10^4$ $N.C^{-1}$ to the LEFT. (6)

**[16]**

**QUESTION 8 (Start on a new page)**

A battery with an internal resistance (**r**) of 1 Ω is connected to three resistors, $\mathbf{R_1}$ (of unknown resistance), $\mathbf{R_2}$ (5 Ω), $\mathbf{R_3}$ (10 Ω), a high resistance voltmeter and an ammeter of negligible resistance, as shown in the circuit diagram below. The resistance of the connecting wires must be ignored.




When switch **S** is **OPEN**, the voltmeter reads 20 V.

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

Switch **S** is now **CLOSED**, the ammeter reads a current of 1,62 A.

8.2 Calculate the:

8.2.1 Equivalent resistance of the resistors in parallel. (2)

8.2.2 Resistance of resistor $\mathbf{R_1}$. (4)

8.2.3 Potential difference across the parallel set of resistors ($\mathbf{R_3}$ and $\mathbf{R_2}$). (4)

8.2.4 Energy dissipated as heat inside the battery if the current flows for 15 s. (3)

8.3 The 5 Ω resistor is now removed.

8.3.1 How would the ammeter reading change if the 5 Ω resistor is removed? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

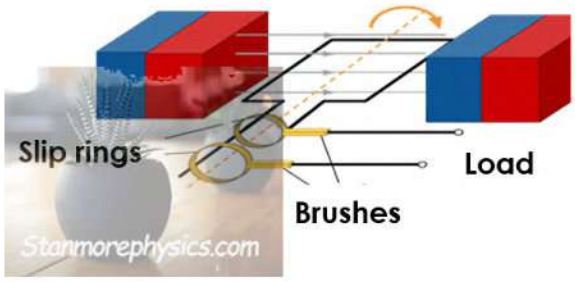
8.3.2 Explain your answer to QUESTION 8.3.1 (2)

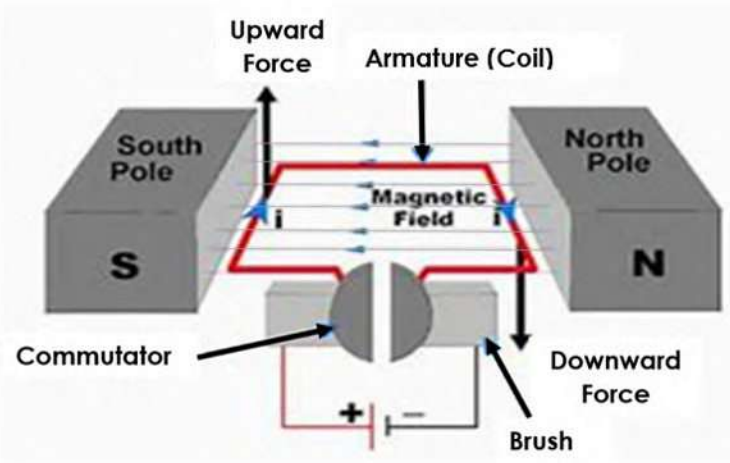
**[18]**

**QUESTION 9 (Start on a new page)**

9.1 The diagrams below illustrate two devices (**X** and **Y**) that operate oppositely to one another.

Device **X**:




Device **Y**:

9.1.1 Identify between the two devices which one is an AC generator? (1)

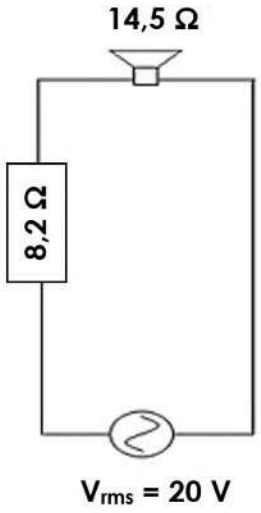
9.1.2 State the *energy conversions* that occur on device **Y**. (1)

9.1.3 Name the *principle* on which the generator operates. (1)

9.1.4 Name ONE structural difference between the two devices. (1)

9.1.5 Write down ONE way to improve the efficiency of the device **X**. (1)

9.2 An AC source in a circuit delivers alternating voltages at audio frequency to a speaker.




9.2.1 Determine the peak voltage that the source can deliver. (3)

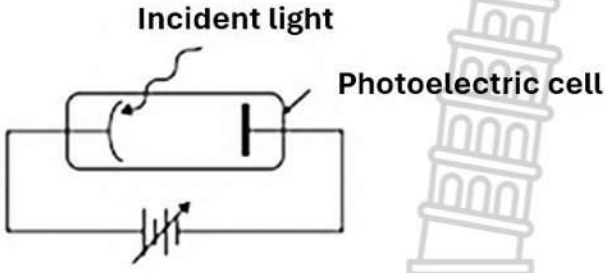
9.2.2 Calculate the average power delivered to the speaker. (5)

**[13]**

**QUESTION 10 (Start on a new page)**

10.1 A photo-electric experiment was conducted by shining different frequencies of light onto a plate made of an unknown metal.

The diagram shows the setup with respect to the frequency of incident light.

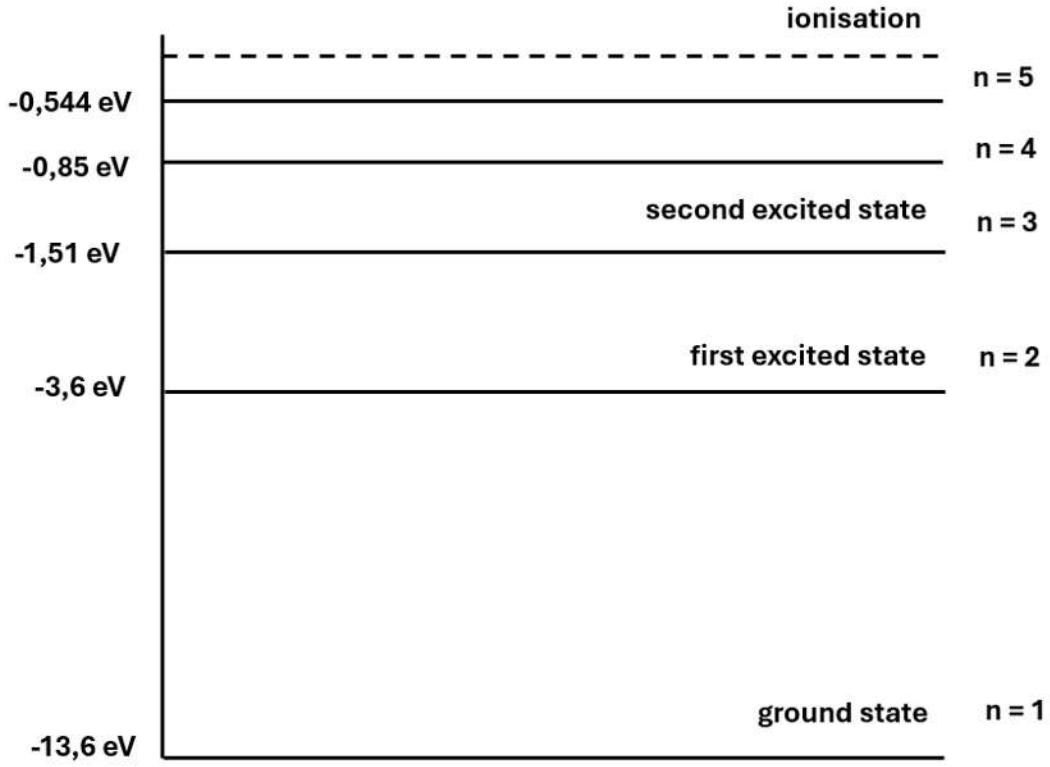



The incident light has a frequency of $7,73 \times 10^{14}$ Hz and the work function of the metal surface is $3,7 \times 10^{-19}$ J.

10.1.1 Define the term *work function*. (2)

10.1.2 Determine the maximum velocity at which electrons are emitted from the metal surface. (4)

10.2 The energy level diagram of a particular element is shown below.




10.2.1 Explain how a line emission spectrum is produced when a high voltage is applied to a low-pressure gas. (2)

10.2.2 Determine the transition energy, in *eV*, on the energy diagram from the second excited state to the ground state. (2)

**[10]**

**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<br>*Swaartekragversnelling* | g | $9{,}8\ m{\cdot}s^{-2}$ |
| Universal gravitational constant<br>*Universele gravitasiekonstant* | G | $6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$ |
| Radius of the Earth<br>*Radius van die Aarde* | $R_E$ | $6{,}38 \times 10^{6}\ m$ |
| Mass of the Earth<br>*Massa van die Aarde* | $M_E$ | $5{,}98 \times 10^{24}\ kg$ |
| Speed of light in a vacuum<br>*Spoed van lig in 'n vakuum* | c | $3{,}0 \times 10^{8}\ m{\cdot}s^{-1}$ |
| Planck's constant<br>*Planck se konstante* | h | $6{,}63 \times 10^{-34}\ J{\cdot}s$ |
| Coulomb's constant<br>*Coulomb se konstante* | k | $9{,}0 \times 10^{9}\ N{\cdot}m^2{\cdot}C^{-2}$ |
| Charge on electron<br>*Lading op elektron* | e | $-1{,}6 \times 10^{-19}\ C$ |
| Electron mass<br>*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*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{\ max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$ |
| $F = G\frac{m_1 m_2}{d^2}$ 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* $W_{net} = \Delta E_k$<br>$\Delta K = K_f - K_i$ 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<br>$E = hf$ 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*<br>$E = hf$ *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 ($\varepsilon$) = I(R + r)<br>emk ($\varepsilon$) = I(R + r) |
| $R_s = R_1 + R_2 + \ldots$<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ | $q = I\Delta t$ |
| $W = Vq$<br>$W = VI\Delta t$<br>$W = I^2R\Delta t$<br>$W = \frac{V^2\Delta t}{R}$ | $P = \frac{W}{\Delta t}$<br>$P = VI$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |

## ALTERNATING CURRENT/*WISSELSTROOM*

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

Western Cape Government
Education
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# PHYSICAL SCIENCES
# PAPER 1
# MARKING GUIDELINE Draft 2


**MARKS: 150**

**TIME: 3 hours**

**This marking guideline consists of 14 pages**

**QUESTION/VRAAG 1 (MULTIPLE-CHOICE)**


| | | | |
|---|---|---|---|
| 1.1 | B ✓✓ | | (2) |
| 1.2 | D✓✓ | | (2) |
| 1.3 | C✓✓ | | (2) |
| 1.4 | B✓✓ | | (2) |
| 1.5 | C/D✓✓ | Accept both | (2) |
| 1.6 | A✓✓ | | (2) |
| 1.7 | C✓✓ | | (2) |
| 1.8 | D✓✓ | | (2) |
| 1.9 | C✓✓ | | (2) |
| 1.10 | D✓✓ | | (2) |

**[20]**

## QUESTION/VRAAG 2

2.1 **Marking criteria/Nasienkriteria**

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

When a resultant/net force acts on an object, the object will accelerate in the direction of the force. The acceleration is directly proportional to the resultant/net force and inversely proportional to the mass of the object. ✓✓

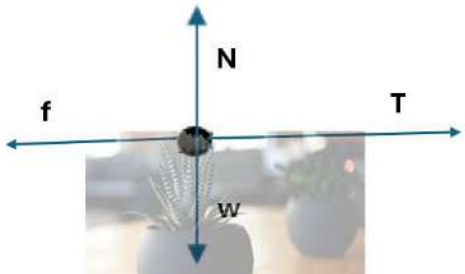
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel. Die versnelling is direk eweredig aan die netto/resulterende krag en omgekeerd eweredig aan die massa van die voorwerp. ✓✓

**OR/OF**

The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. **(2 or 0)**
Die resulterende/netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum in die rigting van die resulterende/netto krag. **(2 or 0)** (2)

2.2 $f = \mu N$ ✓
$= 0,25(5)(9,8)$✓
$= 12,25$ N✓ (3)

2.3




**Mark allocations/ Punte toekenning:**

✓N $F_N$/Normal/$F_{normal}$/$F_{normaal}$/Normaal
✓f (kinetic) friction /$F_f$/$f_k$/(kinetiese) wrywing /$F_w$
✓w $F_g$/$F_w$/weight/mg/gravitational force
$F_g$/$F_w$/gewig/mg/gravitasiekrag
✓T $F_T$/$F_{string}$/tension/spanning/$F_{tou}$ (5)
✓ If arrows touch the dot/Indien pyle die kolletjie raak

**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.
- Any other additional force(s)/Enige ander addisionele krag(te): Max/Maks 4/5
- If everything correct, but no arrow heads/Indien alles korrek, maar geen pyltjies: Max/Maks 4/5

2.4 **For block A/ Vir blok A**

$F_{net} = ma$ ✓
$T - f = ma$
$T - 12,25 = 5a$ ✓ **Positive marking from Q2.2**

**For block B/Vir blok B**

$F_{net} = ma$
$F_x - T - f = ma$
$30\cos 20^\circ$ ✓ $- T - 0,25[2,5(9,8) + 30\sin 20^\circ]$ ✓ $= 2,5a$ ✓
$28,19 - T - 3,56 = 2,5a$
$24,63 - T = 2,5a$

$T - 12,25 = 5a$ ……(1)
$24,63 - T = 2,5a$ ……(2)
$12,38 = 7,5a$ ……(1) + (2)

$a = 1,65\ m{\cdot}s^{-2}$ ✓ (6)

**[16]**

**QUESTION/VRAAG 3**

3.1 (Motion of) an object which has been given an initial velocity and then moves under the influence of the gravitational force only. ✓✓ (2 or 0)
(Beweging van) 'n voorwerp wat 'n aanvanklike snelheid gegee het en dan slegs onder die invloed van die gravitasiekrag beweeg. ✓✓ (2 or 0) (2)

3.2.1

**OPTION 1/OPSIE 1**
**UPWARD POSITIVE**
$v_f = v_i + a\Delta t$✓
$0 = 17 + (-9,8)\ \Delta t$✓
$\Delta t = 1,73$ s✓

**OPTION 2/OPSIE 2**
**DOWNWARD POSITIVE**
$v_f = v_i + a\Delta t$✓
$0 = -17 + (9,8)\ \Delta t$✓
$\Delta t = 1,73$ s✓

**OPTION 3/OPSIE 3**
**UPWARD POSITIVE**
$v_f^2 = v_i^2 + 2a\Delta y$
$(0)^2 = (17)^2 + 2(-9,8)\Delta y$✓
$\Delta y = 14,74$ m
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$✓
$14,74 = (17)\Delta t + ½\ (-9,8)\Delta t^2$
$\Delta t = 1,73$ s✓

**OPTION 4/OPSIE 4**
**DOWNWARD POSITIVE**
$v_f^2 = v_i^2 + 2a\Delta y$
$(0)^2 = (-17)^2 + 2(9,8)\Delta y$✓
$\Delta y = -14,74$ m
$\Delta y = v_i\Delta t + ½\ a\Delta t^2$✓
$-14,74 = (-17)\Delta t + ½\ (9,8)\Delta t^2$
$\Delta t = 1,73$ s✓ (3)

3.2.2

**OPTION 1/OPSIE 1**
**UPWARD POSITIVE**
$v_f^2 = v_i^2 + 2a\Delta y$✓
$(0)^2 = (17)^2 + 2(-9,8)\Delta y$✓
$\Delta y = 14,74$ m

Height/Hoogte = 45 + 14,74✓
= 59,74 m✓

**OPTION 2/OPSIE 2**
**DOWNWARD POSITIVE**
$v_f^2 = v_i^2 + 2a\Delta y$✓
$(0)^2 = (-17)^2 + 2(9,8)\Delta y$✓
$\Delta y = -14,74$ m

Height/Hoogte = 45 + 14,74✓
= 59,74 m✓ (4)

3.3

**POSITIVE MARKING FROM Q3.2.1**
**OPTION 1/OPSIE 1**
**UPWARD POSITIVE**
Time taken by ball **A** = 1,73 x 2✓
= 3,46 s

Time taken by ball **B** = 3,46 - 2✓
= 1,46 s
$v_f = v_i + a\Delta t$✓
$v_f = 18 + (-9,8)(1,46)$✓
$v_f = 3,69$ m.s$^{-1}$ upward/opwaarts✓

**POSITIVE MARKING FROM Q3.2.1**
**OPTION 2/OPSIE 2**
**DOWNWARD POSITIVE**
Time taken by ball **A** = 1,73 x 2✓
= 3,46 s

Time taken by ball **B** = 3,46 - 2✓
= 1,46 s
$v_f = v_i + a\Delta t$✓
$v_f = -18 + (9,8)(1,46)$✓
$v_f = -3,69$ m.s$^{-1}$ (5)
$v_f = -3,69$ m.s$^{-1}$ upward/ opwaarts✓ **[14]**

**QUESTION/VRAAG 4**

4.1 $p = mv$ ✓ *Left as positive/Links as positief*
$= (1300)(20)$✓
$= 26\ 000\ kg.m.s^{-1}$ left/ links✓ (3)

4.2 $\sum p_i = \sum p_f$ *Left as positive/Links as positief*
$(m_c.v_{ic}) + (m_t.v_{it}) = (m_c + m_t)v_f$ ✓ (Any one of the correct formulae)
$(26000)+(2500)\ v_{it}$ ✓ $= (1300 + 2500)(-9)$ ✓ **Positive marking from Q4.1**
$v_{it} = -24,08\ m.s^{-1}$
$= 24,08 m.s^{-1}$ ✓ (to the right/ na regs) (4)

4.3 $F_{net} = \frac{m(v_f - v_i)}{\Delta t}$✓ *Left as positive/Links as positief*
$= \frac{1300(-9 - 20)}{(0,2)}$✓
$= -188500$
$F_{net} = 188500\ N$✓ (to the right/ na regs) (4)

4.4 $\sum K_i = \frac{1}{2} m_c v_{ic}^2 + \frac{1}{2} m_t v_{it}^2$ ✓ *Left as positive/Links as positief*
$= \frac{1}{2}(1300)(20^2) + \frac{1}{2}(2500)(-24,08)^2)$ ✓ **Positive marking from Q4.2**
$= 984808J$ Accept: $9,85 \times 10^5 J$

$\sum K_f = \frac{1}{2}(m_c + m_t)v_f^2$
$= \frac{1}{2}(1300 + 2500)(-9^2)$ ✓
$= 153900\ J$
$\sum K_i \neq \sum K_f$ ✓
:.the collision is inelastic/die botsing is onelasties.✓ (5)

**[16]**

**QUESTION/VRAAG 5**

5.1.1 The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant. ✓✓ (2 or 0)

Die totale meganiese energie (som van gravitasie potensiële energie en kinetiese energie) in 'n geïsoleerde stelsel bly konstant. ✓✓ (2 or 0) (2)

5.1.2 $E_{mech} = E_k + E_p$
$= \frac{1}{2}mv_i^2 + mgh$ ✓ (Any one of the correct formulae)
$= \frac{1}{2}(100)(2)^2 + (100)(9,8)(30)$ ✓
$= 200 \text{ J} + 29\,400 \text{ J}$
$E_{mech} = 29\,600 \text{ J}$ ✓ (3)

5.1.3 $E_{tot(A)} = E_{k(B)} + E_{p(B)}$
$29\,600 \text{ J} = \frac{1}{2}mv^2 + mg(0)$
$29\,600$ ✓$= \frac{1}{2}(100)v^2$ ✓ **Positive marking from Q5.1.2**
$v_{(B)} = 24,33 \text{ m.s}^{-1}$

Since no friction between B and C: $v_{(C)} = v_{(B)} = 24,33 \text{ m.s}^{-1}$ ✓ (must state explicitly to get this mark))

Aangesien daar geen wrywing tussen B en C is nie: $v_{(C)} = v_{(B)} = 24,33 \text{m.s}^{-1}$ ✓ (moet uitdruklik verklaar word om hierdie punt te kry)) (3)

5.2 **OPTION 1/ OPSIE 1:**

$\sin 45^\circ = \frac{5}{\Delta x}$
$\Delta x = \frac{5}{\sin 45^\circ}$
$= 7,07 \text{ m}$ ✓
$W_{friction} = F_{friction}\Delta x \cos 180^\circ$
$W_{friction} = (300 \text{ N})(7,07 \text{ m})(-1)$ ✓
$W_{friction} = -2\,121 \text{ J}$

$W_{nc} = \Delta E_p + \Delta E_k$ ✓
$W_{friction} = (mgh_f - mgh_i) + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$
$-2\,121$✓ $= [(100)(9,8)(5)$ ✓$- 0] + [\frac{1}{2}(100)v_f^2 - \frac{1}{2}(100)(24,33)^2]$ ✓
**Positive marking from Q5.1.3**
$-2\,121 = 4900 + 50v_f^2 - 29\,597,45$
$v_E = 21,25 \text{ m.s}^{-1}$ ✓ (7)

**OPTION 2/ OPSIE 2:**

$\sin 45^\circ = \frac{5}{\Delta x}$

$\Delta x = \frac{5}{\sin 45^\circ}$

$= 7,07 \text{ m}$ ✓

Define (+) up the slope: / Definieer (+) op die helling op:

$F_{net} = - mg.\sin 45^\circ - F_{friction}$

$F_{net} = - (100)(9,8)\sin 45^\circ - 300 \text{ N}$ ✓

$F_{net} = -692,96 - 300$

$F_{net} = -992,96 \text{ N}$

$F_{net} = 992,96 \text{ N, down the slope}$ ✓

$W_{net} = \Delta Ek$ ✓

$F_{net}\Delta x\cos 180^\circ = \frac{1}{2}mv_E^2 - \frac{1}{2}mv_D^2$

$(992,96)(7,07)\cos 180^\circ$ ✓ $= \frac{1}{2}(100)v_E^2 - \frac{1}{2}(100)(24,33)^2$ ✓

**Positive marking from Q5.1.3**

$-7\,020,23 = 50v_E^2 - 29\,597,45$

$22\,577,22 = 50v_E^2$

$v_E^2 = 451,54$

$v_E = 21,25 \text{ m.s}^{-1}$ ✓

**OPTION 3: / OPSIE 3:**

$\sin 45^\circ = \frac{5}{\Delta x}$

$\Delta x = \frac{5}{\sin 45^\circ}$

$= 7,07 \text{ m}$ ✓

$W_{friction} = F_{friction}\,\Delta x \cos 180$

$W_{friction} = 300 \text{ N} \times -7,07 \text{ m}$ ✓

$W_{friction} = -2\,121 \text{ J}$

$E_{k(D)} = W_{friction} + E_{p(E)} + E_{k(E)}$ ✓

$\frac{1}{2}(100)(24,33)^2$ ✓ $= 2\,121\text{J}$ ✓ $+ (100)(9,8)(5) + \frac{1}{2}(100)v_E^2$ ✓

**Positive marking from Q5.1.3**

$29\,597,45 = 2\,121 + 4\,900 + 50v_E^2$

$v_E = 21,25 \text{ m.s}^{-1}$ ✓

**[15]**

**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. □□ (2 or 0)

Die verandering in frekwensie (of toonhoogte) van die klank wat deur 'n luisteraar opgespoor word, omdat die klankbron en die luisteraar verskillende snelhede het relatief tot die medium van klankvoortplanting. □□ (2 or 0) (2)

6.2 $v = \lambda f$ □
$340 = 0,14f$ □
$f = 2\,428,57$ Hz □ (3)

6.3 $f_L = \frac{(v \pm v_L)}{(v \pm v_s)} \cdot f_s$ □

Consider the bird flying towards the couple/Oorweeg die voël wat na die paartjie vlieg:
$2428,57$ □ $= \frac{(340+0)}{(340-v_s)} \cdot f_s$ □ **Positive marking from Q6.2**

$340f_s = 825713,8 - 2428,57v_s$ .....(1)

$\frac{340}{0,2}$ □ $= \frac{(340-0)}{(340+v_s)} \cdot f_s$ □
$340f_s = 578\,000 + 1\,700v_s$ ..... (2)

Equate equation (1) and (2):

$578000 + 1700v_s = 825713,8 - 2428,57v_s$

$4128,57v_s = 247713,8$

$v_s = 60$ m·s$^{-1}$ □ (6)

6.4.1 REMAINS THE SAME □– (The frequency of the source is constant, only the observed frequency changes)
BLY DIESELFDE □– (Die frekwensie van die bron is konstant, slegs die waargenome frekwensie verander) (1)

**[12]**

**QUESTION/VRAAG 7**

7.1.1 The area/space around a charged object where a point charge will experience an electrostatic force. ✓
Die area/ruimte rondom 'n gelaaide voorwerp waar 'n puntlading 'n elektrostatiese krag sal ervaar.✓ (1)

7.1.2 Electric field strength/ Elektriese veldsterkte✓ (1)

7.1.3 The electrostatic force is directly proportional to the electric field ✓ (1)
Die elektrostatiese krag is direk eweredig aan die elektriese veld

7.1.4 Charge ✓ (1)

7.1.5 gradient/helling = $\frac{\Delta y}{\Delta x}$

$= \frac{(30\times10^{-8} - 10\times10^{-8})}{(6\times10^{3} - 2\times10^{3})}$ ✓ ✓

$= 5\times10^{-11}$ ✓ (3)

7.1.6 $Q = 5\times10^{-11}C$ ✓ (500nC) **Positive marking from Q7.1.5** (1)

7.1.7 $n = \frac{Q}{q_e}$

$n = \frac{5\times10^{-11}}{1,6\times10^{-19}}$ ✓ **Positive marking from Q7.1.6**

$= 3,125\times10^{8}$ electrons ✓ (2)

7.2 ***Right is positive/ Regs is positief***

$E_1 = \frac{kQ_1}{r^2}$ ✓

$= \frac{(9\times10^{9})(8\times10^{-9})}{(2\times10^{-2})^2}$ ✓

$= 1,8\times10^{5}\ N.C^{-1}$ right / regs

$E_2 = \frac{(9\times10^{9})(Q_2)}{(1\times10^{-2})^2}$ ✓

$E_{net} = E_1 + E_2$

$-9\times10^{4} = (+1,8\times10^{5}) + E_2$ ✓

$E_2 = -2,7\times10^{5}$

$-2,7\times10^{5} = \frac{(9\times10^{9})(Q_2)}{(1\times10^{-2})^2}$ ✓

$Q_2 = 3\times10^{-9}\ C$ ✓ (6)

**[16]**

**QUESTION/VRAAG 8**

8.1 **Marking criteria**
If any of the underlined key words/phrases in the correct context are omitted: - 1 mark per word/phrase.

(Maximum) energy provided (work done) by a battery per coulomb/unit charge passing through it. ✓✓

OR

Work done by the battery to move a unit charge across the circuit.

**Nasienkriteria**
Indien enige van die onderstreepte sleutelwoorde/-frases in die korrekte konteks weggelaat word: - 1 punt per woord/frase.

(Maksimum) energie verskaf (arbeid verrig) deur 'n battery per coulomb/eenheidslading wat daar deur gaan. ✓✓

OF

Arbeid verrig deur die battery om 'n eenheidlading oor die stroombaan te beweeg. (2)

8.2.1 **OPTION 1/ OPSIE 1**

$$\frac{1}{R_p} = \frac{1}{R_5} + \frac{1}{R_{10}}$$

$$= \frac{1}{5} + \frac{1}{10} \checkmark$$

$$R_p = 3{,}33\ \Omega \checkmark$$

**OPTION 2/ OPSIE 2**

$$R_p = \frac{(R_5\ R_{10})}{(R_5 + R_{10})}$$

$$= \frac{(5)(10)}{(5+10)} \checkmark$$

$$= 3{,}33\ \Omega \checkmark$$ (2)

8.2.2 **POSITIVE MARKING FROM 8.2.1 ($R_p$ = 3,33Ω)**

$R_T = R_1 + R_p + r = (R_1 + 3{,}33\ \Omega + 1\ \Omega)$

**OPTION 1/ OPSIE 1**

$\varepsilon = I(R + r)$ ✓

20✓ = 1,62 $(R_1 + 4{,}33)$ ✓

$R_1 = 8{,}02\ \Omega$ ✓

**OPTION 2/ OPSIE 2**

$I_T = \frac{V}{R}$ ✓

$1{,}62 = \frac{20}{(R_1 + 4{,}33)}$ ✓ ✓

$R_1 = 8{,}02\ \Omega$ ✓ (4)

8.2.3 **OPTION 1/ OPSIE 1**

**POSITIVE MARKING FROM QUESTION 8.2.2 ($R_1$ = 8,02 Ω)**

$V = IR$ ✓

$V_{Rp} = \varepsilon - (V_{R1} + V_r)$

$V_{Rp} = 20$ ✓ - [1,62(8,02 + 1)] ✓

$V_{Rp} = 5,39$ V✓

**OPTION 2/ OPSIE 2**

**POSITIVE MARKING FROM QUESTION 8.2.1 ($R_p$ = 3,33 Ω)**

$V_{Rp} = \frac{R_p}{R_T} \times V_T$ ✓

$V_{Rp} = \frac{3,33}{12,35}$ ✓ x 20 ✓

$V_{Rp} = 5,39$ V✓

Or

$V_p = IR_p$ ✓

$V_p = (1,62)$✓ (3,33) ✓

$V_p = 5,39$ V ✓ (4)

8.2.4 $V = Ir = (1,62)(1) = 1,62$ V

**OPTION 1/ OPSIE 1**

$W = VI\Delta t$ ✓

$= (1,62)(1,62)(15)$ ✓

$= 39,37$ J ✓

**OPTION 2/ OPSIE 2**

$W = I^2R\Delta t$ ✓

$W = (1,6)^2(1)(15)$ ✓

$W = 39,37$ J ✓

**OPTION 3/ OPSIE 3**

$W = \frac{V^2\Delta t}{R}$ ✓

$= \frac{(1,62)^2(15)}{1}$ ✓

$= 39,37$ J ✓ (3)

8.3.1 Decrease/ Verlaag✓ (1)

8.3.2 **NEGATIVE MARKING FROM 8.3.1**

The total resistance in the external circuit increases,✓ Current decreases✓ (2)

Die totale weerstand in die eksterne stroombaan neem toe,✓ Stroom neem af✓

**[18]**

**QUESTION/VRAAG 9**

9.1.1 X ✓ (1)

9.1.2 Electrical energy to mechanical energy ✓
Elektriese energie na meganiese energie✓ (1)

9.1.3 Electromagnetic induction ✓
Elektromagnetiese induksie✓ (1)

9.1.4 Any one of the following differences = one mark
Enige een van die volgende verskille = een punt

| X | Y |
|---|---|
| Slip rings<br>Slip ringe | Split ring commutator✓<br>Split ring kommutator |
| Load<br>Las | Power source<br>Kragbron |

(1)

9.1.5 Use of stronger magnets/increased number of coils ✓
Gebruik van sterker magnete/verhoogde aantal spoele✓ (1)

9.2.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓
$V_{max} = 20(\sqrt{2})$ ✓
$V_{max} = 28,28$ V✓ (3)

9.2.2 **OPTION 1/OPSIE 1**

$R_T = 8,2 + 14,5 = 22,7\ \Omega$ ✓

$I_{rms} = \frac{V_{rms}}{R}$
$= \frac{20}{22,7}$ ✓
$= 0,88$ A

$P_{avg} = I_{rms}^2 R$ ✓
$= 0,88^2 \times 14,5$✓
$= 11,23$ W✓
Answer range: 11,23 -11,28W

**OPTION 2/OPSIE 2**

$V_{rms} = \frac{14,5}{(14,5 + 8,2)} \times 20$
$= 12,77$ V

$P_{avg} = \frac{V_{rms}^2}{R}$
$= \frac{(12,77)^2}{14,5}$
$= 11,26$ W
Answer range: 11,23 -11,28W

(5)

**[13]**

**QUESTION/VRAAG 10**

10.1.1 The minimum amount of energy needed to emit an electron from the surface of a metal. ✓✓ (2 or 0)
Die minimum hoeveelheid energie wat nodig is om 'n elektron vanaf die oppervlak van 'n metaal uit te straal✓✓ (2 or 0) (2)

10.1.2
$E = W_o + E_{kmax}$ ✓
$hf = W_o + \frac{1}{2} mv_{max}^2$
$(6,63 \times 10^{-34})(7,73 \times 10^{14})$✓ $= 3,7 \times 10^{-19} + \frac{1}{2} (9,1 \times 10^{-31})v^2$ ✓
$(5,1 \times 10^{-19}) = (3,7 \times 10^{-19}) + \frac{1}{2} (9,1 \times 10^{-31})v^2$
$(1,4 \times 10^{-19}) = \frac{1}{2} (9,1 \times 10^{-31})v^2$
$v_{max} = 5,55 \times 10^5 \text{ m.s}^{-1}$ ✓ (4)

10.2.1 Electrons drop from a higher to a lower energy level ✓ The energy sent out as photons or light energy. ✓
Elektrone daal van 'n hoër na 'n laer energievlak ✓ Die energie wat as fotone of ligenergie uitgestuur word. (2)

10.2.2 Difference between (n= 3) and (n=1) = -13,6 - (-1,5)✓
= -12,1 eV✓

OR

Difference between (n= 1) and (n=3) =(-1,5) - (-13,6)
=12,1 eV (2)

**[10]**

**TOTAL: 150**