



# education

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Noordwes Departement van Onderwys  
North West Department of Education  
**NORTH WEST PROVINCE**

NATIONAL  
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets

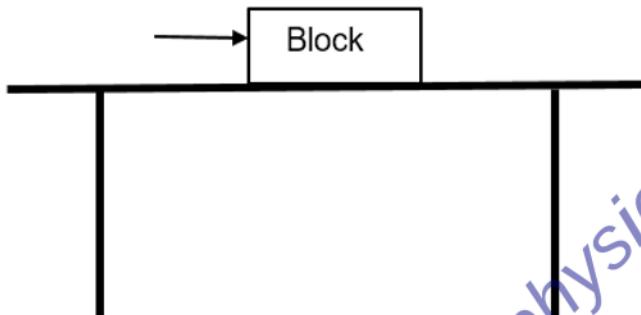
## INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.
2. This question paper consists of ELEVEN 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 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 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, etc. where required.
12. Write neatly and legibly.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are given 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, e.g. 1.11 E.

- 1.1 A wooden block placed on a table is pushed, causing it to accelerate. Which ONE of the following statements regarding the frictional force is correct?



The frictional force is:

- A Increasing as the speed increases
  - B Equal and opposite to the pushing force
  - C Greater than the pushing force
  - D Less than the pushing force
- (2)
- 1.2 The kinetic energy of an object with momentum 'p' and mass 'm' is:
- A  $2pm$
  - B  $\frac{p^2m}{2}$
  - C  $\frac{p^2}{2m}$
  - D  $\frac{pm}{2}$
- (2)

1.3 The mechanical energy of a free falling body is conserved. It can be concluded that:

- A The body experiences no air friction as it falls through the air
- B The potential energy is equal to the kinetic energy at any point during the motion
- C The sum of the potential and kinetic energies at any point during the motion is zero
- D The work done by Earth on the body is zero throughout its fall

(2)

1.4 An object, with mass  $m$ , is accelerated vertically upwards by an applied force  $\mathbf{F}$  acting on it. Ignore the effects of air friction.



Which ONE of the following is true for the work done by the applied force  $\mathbf{F}$  and the net force  $\mathbf{F}_{\text{net}}$  respectively?

	WORK DONE BY $\mathbf{F}$	WORK DONE BY $\mathbf{F}_{\text{net}}$
A	$\Delta U + \Delta K$	$\frac{1}{2}mv^2$
B	$\Delta U - \Delta K$	$\frac{1}{2}mv^2$
C	$\Delta U + \Delta K$	$\Delta K$
D	$mgh + \frac{1}{2}mv^2$	$\Delta U$

(2)

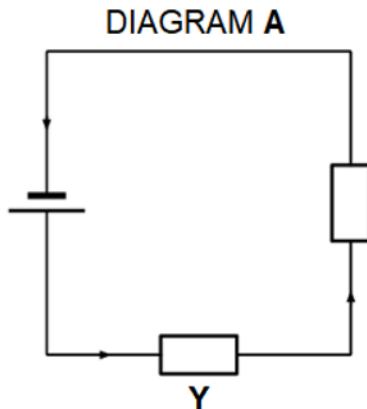
- 1.5 When two identical metal spheres **F** and **G** are brought in to contact and then separated, it is found that the charge on each sphere is now -5 nC. Which ONE of the following combinations is CORRECT regarding the original charges on the spheres BEFORE they made contact?

	SPHERE F(nC)	SPHERE G (nC)
A	+25	-15
B	-7	-3
C	-5	neutral
D	-7	+2

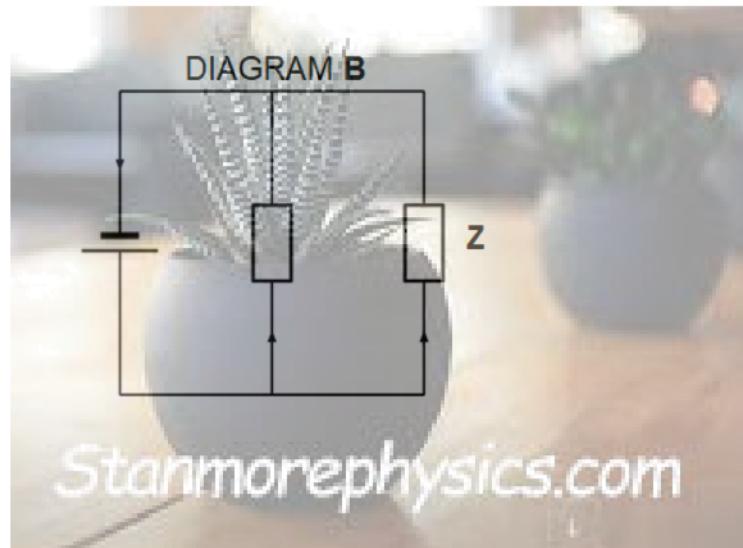
(2)

- 1.6 In the circuit diagrams below, the cells are identical as well as all resistors. The resistance of the connecting wires as well as the internal resistance of the cell can be ignored.

The power dissipated in resistor **Y** in DIAGRAM **A** is  $P$ . The power dissipated in resistor **Z** in DIAGRAM **B** is...



A  $\frac{1}{2}P$



- B  $P$   
C  $4P$   
D  $2P$

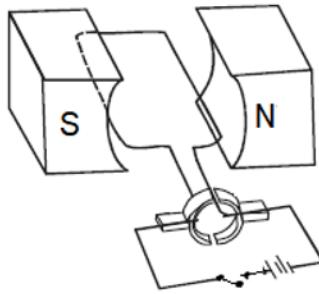
(2)

- 1.7 The emf of a battery can be defined as the:

- A Rate at which current is delivered  
B Rate at which energy is delivered  
C Product of potential difference and current  
D Total amount of energy supplied per coulomb of charge in a cell

(2)

1.8 The following diagram shows a simple electric motor.



When the switch is closed, the coil rotates:

- A Clockwise and then anticlockwise after a half cycle
- B Anticlockwise and then clockwise after a half cycle
- C Continuous clockwise
- D Continuous anticlockwise

(2)

1.9 The theory that the universe is expanding is supported by the:

- A Blue shift of light from distant galaxies
- B Red shift of light from distant galaxies
- C Attraction between Sun and Earth
- D Rotation of Earth around Sun

(2)

1.10 Metals with different work functions are illuminated with light of different frequencies and intensities. The maximum kinetic energy of photo electrons emitted by each metal depends on:

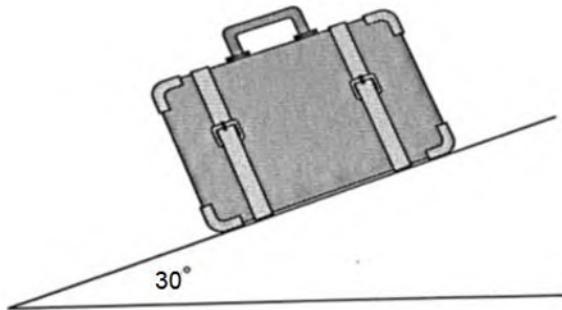
- A Work function, frequency and intensity
- B Work function and intensity
- C Frequency and intensity
- D Work function and frequency

(2)

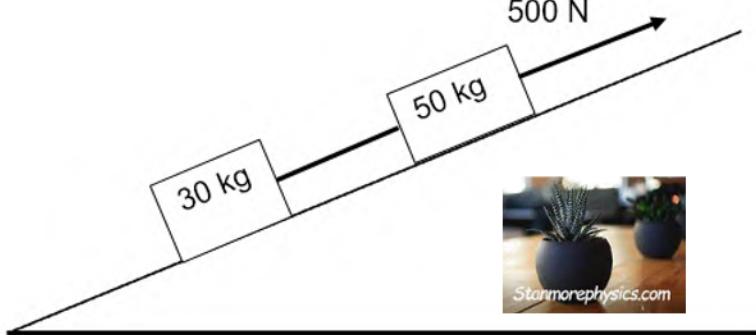
[20]

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

- 2.1 The sketch below shows a large suitcase with a mass of 32 kg rests on a rough incline at an angle of  $30^\circ$  to the ground.



- 2.1.1 Define *normal force* in words. (2)
- 2.1.2 Draw a labelled free-body diagram of all the forces acting on the suitcase. (3)
- 2.1.3 Calculate the magnitude of the force of friction that keeps the suitcase stationary on the incline. (3)
- 2.1.4 Calculate the coefficient of static friction between the suitcase and the incline, if the suitcase is just about to move on the incline. (3)
- 2.2 On ANOTHER rough inclined plane, two crates 30 kg and 50 kg are connected with a strong string as in the sketch below. The angle of inclination is UNKNOWN.



The ratio of the parallel and perpendicular components of the gravitational force on each crate is **5:3**. A force of 500 N is applied as shown on the 50 kg crate so that the crates move with an acceleration of  $2 \text{ m}\cdot\text{s}^{-2}$  up the incline.

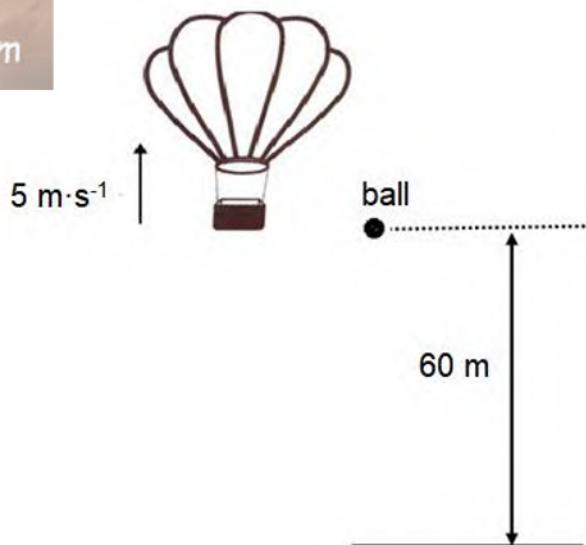
- 2.2.1 Calculate the magnitude of the TOTAL FRICTIONAL FORCE present. (6)
- 2.2.2 Calculate the magnitude of the tension in the string connecting the two crates. (2)

[19]

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



A hot air balloon is rising upwards with a constant velocity of  $5 \text{ m}\cdot\text{s}^{-1}$ . When the balloon is 60 m above the ground, a ball is released from it and the ball falls freely.



- 3.1 Define the term *free fall*. (2)
- 3.2 What is the velocity of the ball at the moment when it is released from the balloon? (1)
- 3.3 Calculate maximum height reached by the ball. (4)
- 3.4 How far apart will the ball and the balloon be, 3 s after the ball is released? (6)

The ball hits the ground, bounces vertically upwards to a height of 8 m above the ground. It falls back to the ground and bounces again to reach a height of 5 m above the ground.

- 3.5 Explain why the ball does not reach the same height during the second bounce? (2)  
**[15]**

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

A trolley **R**, of mass 15 kg, travelling east collides with a stationary trolley **S** of mass 13,5 kg, and they stick together on impact. After the collision, they continue to move eastwards with a velocity of  $4,4 \text{ m}\cdot\text{s}^{-1}$ . Ignore the effects of friction.



- 4.1 State the principle of conservation of momentum in words. (2)
- 4.2 Calculate the speed of trolley **R** before collision. (3)

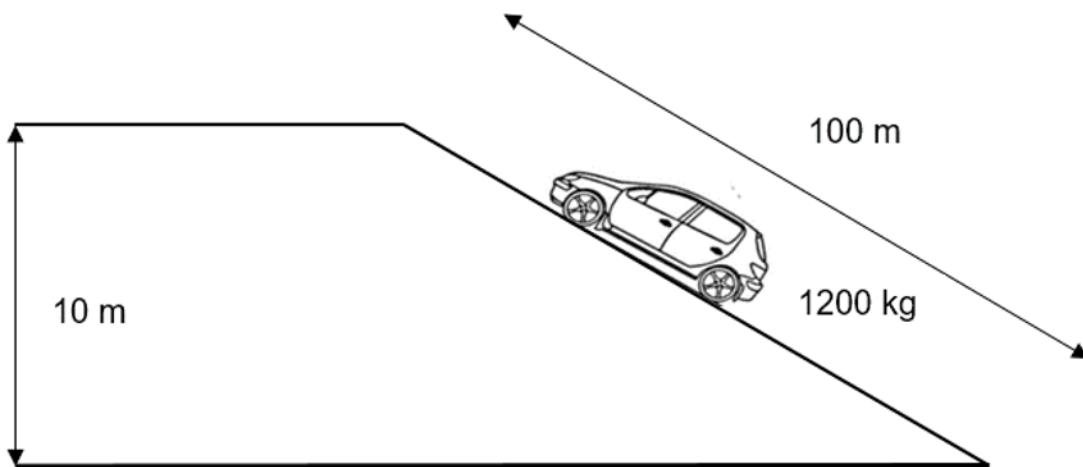
After the collision, the coupled trolleys enter into a rough surface and come to rest in 3 s.

- 4.3 Calculate the magnitude of the frictional force that brought the trolleys to rest. (4)  
[9]

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

A car with mass of 1200 kg and engine power of 62 kW needs to climb an incline with a constant speed of  $6 \text{ m}\cdot\text{s}^{-1}$ .

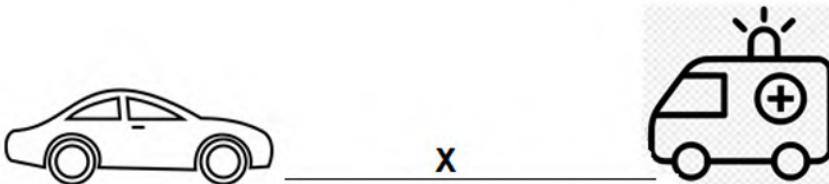
The length of the incline is 100 m and its vertical height is 10 m. The car experiences a frictional force of 820 N while moving up the incline. Ignore the rotational effects of the wheels of the car.



- 5.1 Write down the work-energy theorem in words. (2)
- 5.2 Draw a free body diagram of all the forces acting on the car. (4)
- 5.3 If the engine of the car is 83% effective, determine whether it has enough power to get to the top of the incline maintaining the constant speed of  $6 \text{ m}\cdot\text{s}^{-1}$ . (7)  
[13]

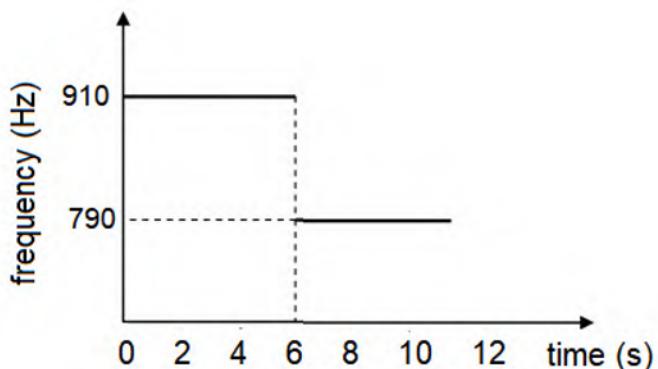
**QUESTION 6 (Start on a new page)**

The siren of a stationary ambulance emits sound waves at a frequency of 850 Hz. An observer who is travelling in a car at a constant speed in a straight line, begins measuring the frequency of the sound waves emitted by the siren when he is at a distance **X** from the ambulance at time,  $t = 0$



The observer continues measuring the frequency as he APPROACHES, PASSES, AND MOVES AWAY from the ambulance.

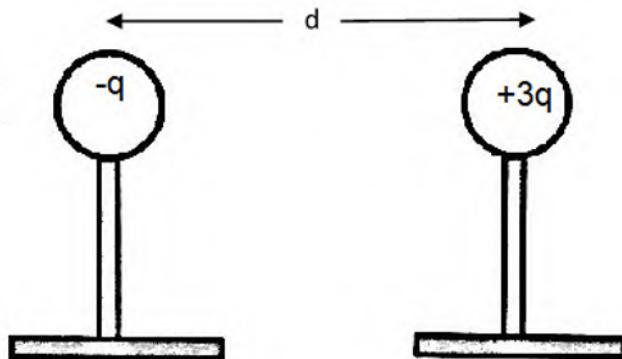
The measured frequencies are plotted against time as shown below:



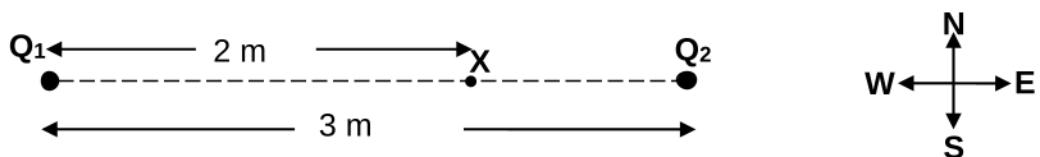
- 6.1 State the *Doppler effect* in words. (2)
- 6.2 Calculate the speed of the car. Take the speed of sound in air as  $340 \text{ m}\cdot\text{s}^{-1}$ . (5)
- 6.3 Determine the distance **X** between the car and the ambulance when the observer BEGINS measuring the frequency. (3)  
**[10]**

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

- 7.1 Two small identical metal spheres, on insulated stands, carry charges  $-q$  and  $+3q$  respectively. ONE sphere exerts an electrostatic force of magnitude ' $F$ ' on the other when they are separated by a distance 'd',



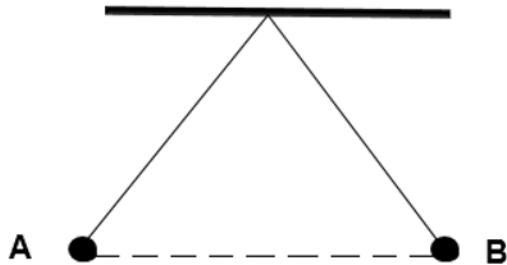
- 7.1.1 State Coulomb's law in words. (2)
- 7.1.2 The spheres are now made to touch each other and are then brought back to the same distance  $d$  apart. By making use of suitable calculations, determine the new electrostatic force in terms of  $F$  that the spheres exert on each other? Show all the calculations to verify your answer. (5)
- 7.2 Two charges,  $Q_1$  with  $-6 \times 10^{-9}$  C and  $Q_2$  with  $-8 \times 10^{-9}$  C are separated by a distance of 3 m. X is a point between charges  $Q_1$  and  $Q_2$  and is 2 m from charge  $Q_1$  as shown below.



- 7.2.1 Calculate the magnitude of the net electric field at the point X. (4)  
[11]

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

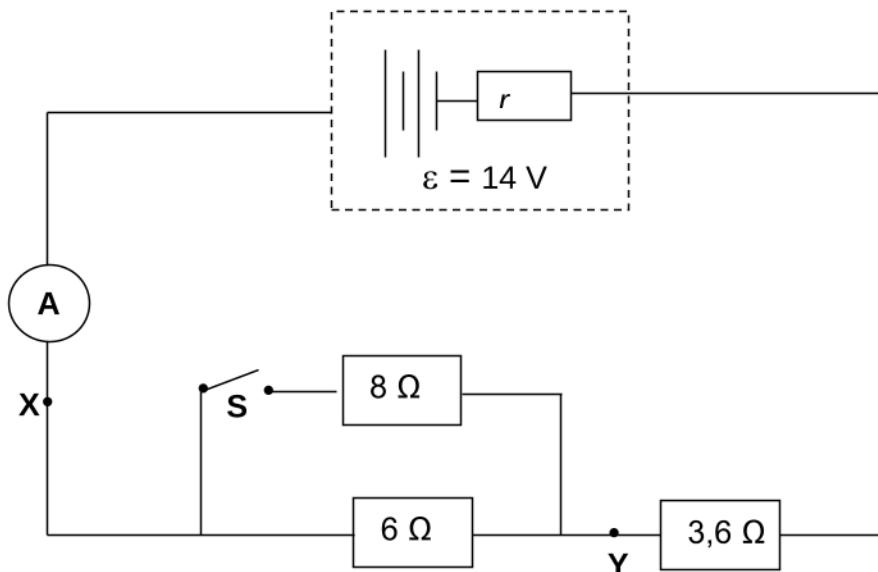
Two small, identical positively charged balls, **A** and **B** are suspended by non-conducting threads as shown in the diagram below. Magnitude of the electrostatic force exerted on ball **A** by ball **B** is  $3,23 \times 10^{-5}$  N. The charge on each ball is 4,8 nC.



- 8.1 Draw electric field pattern caused by these metal balls. (2)
- 8.2 Calculate the electric field strength at **B** due to **A** (3)
- 8.3 Calculate the distance between the centres of **A** and **B** (3)  
**[8]**

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

A battery with an emf of 14 V and unknown internal resistance 'r' is connected in a circuit as shown below.



When the switch **S** is open, the ammeter reading is 1,4 A.

9.1 Calculate the:

9.1.1 Total resistance of the circuit when the switch **S** is open. (3)

9.1.2 Internal resistance of the battery. (3)

9.1.3 Energy dissipated at  $6 \Omega$  resistor in three minutes. (3)

9.2 The switch **S** is now closed. Calculate the current through  $8 \Omega$  resistor. (6)

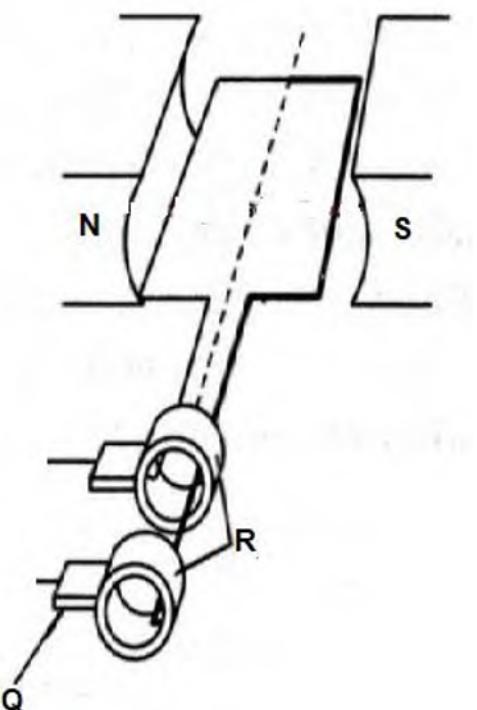
9.3 A conducting wire of negligible resistance is now connected between points **X** and **Y**. What effect will it have on the temperature of the battery?

Choose from INCREASE, DECREASE or STAYS THE SAME.

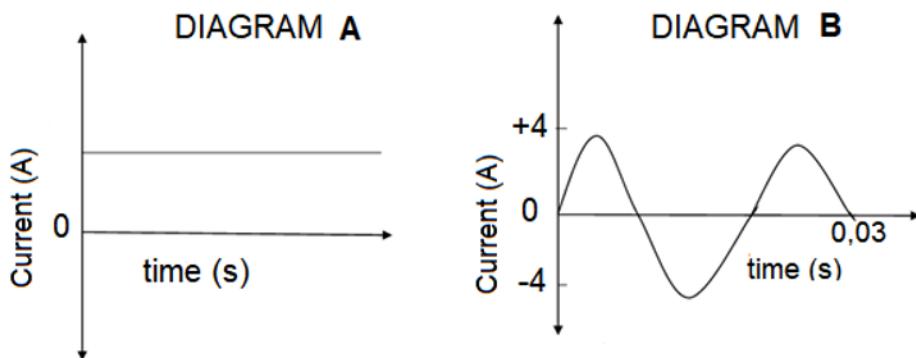
Give a reason for your answer. (2)  
[17]

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

- 10.1 A simplified diagram of an electric generator is given below.



- 10.1.1 Is this an AC or a DC generator? (1)
- 10.1.2 Name the parts labelled **Q** and **R**. (2)
- 10.2 Current-time graphs from two different sources are shown in the following diagrams **A** and **B**.



- 10.2.1 Name the types of CURRENTS shown by diagrams **A** and **B**. (2)
- 10.2.2 Calculate the frequency of the current shown in diagram **B**? (2)

- 10.3 The rms voltage of 200 V is applied to an electric kettle of resistance  $10\ \Omega$ .

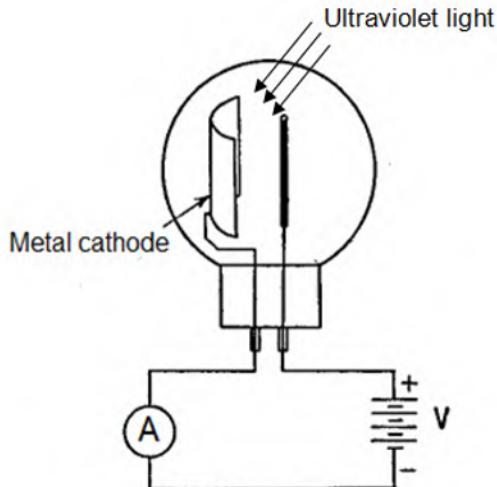
10.3.1 Calculate the peak voltage. (3)

10.3.2 Calculate the rms value of the current. (3)

10.3.3 Calculate the average power dissipated by the kettle. (3)  
[16]

### QUESTION 11 (Start on a new page)

The diagram below shows a photoelectric cell. An ammeter is connected as shown in the diagram.



- 11.1 Define the term *work function* in words. (2)

When an ultraviolet light of wavelength 200 nm falls on to the metal cathode of work function of  $2.3 \times 10^{-19}\ \text{J}$ , photoelectrons are released.

- 11.2 Calculate the:

11.2.1 Frequency of ultraviolet light (2)

11.2.2 Threshold frequency of the metal (3)

11.2.3 Maximum kinetic energy of the photoelectron (4)

- 11.3 The intensity of the incident light is LOWERED. Will the reading on the ammeter INCREASE, DECREASE or STAYS THE SAME? (1)  
[12]

**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 <i>Swaartekragversnelling</i>	g	$9,8 \text{ m}\cdot\text{s}^{-2}$
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	$6,67 \times 10^{-11} \text{ N}\cdot\text{m}^2\cdot\text{kg}^{-2}$
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	$3,0 \times 10^8 \text{ m}\cdot\text{s}^{-1}$
Planck's constant <i>Planck se konstante</i>	h	$6,63 \times 10^{-34} \text{ J}\cdot\text{s}$
Coulomb's constant <i>Coulomb se konstante</i>	k	$9,0 \times 10^9 \text{ N}\cdot\text{m}^2\cdot\text{C}^{-2}$
Charge on electron <i>Lading op elektron</i>	e	$1,6 \times 10^{-19} \text{ C}$
Electron mass <i>Elektronmassa</i>	$m_e$	$9,11 \times 10^{-31} \text{ kg}$
Mass of the Earth <i>Massa van die Aarde</i>	M	$5,98 \times 10^{24} \text{ kg}$
Radius of the Earth <i>Radius van die Aarde</i>	$R_E$	$6,38 \times 10^6 \text{ m}$

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**

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G \frac{m_1 m_2}{d^2}$ 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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = F v_{ave}$ / $P_{gemid} = F v_{gemid}$	

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

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

## ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1 Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$	

## ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE

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

## ALTERNATING CURRENT/WISSELSTROOM

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



## education

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### NATIONAL SENIOR CERTIFICATE/ NASIONALE SENIOR SERTIFIKAAT

GRADE/GRAAD 12

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

SEPTEMBER 2021

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/ PUNTE: 150

These marking guidelines consist of 17 pages including 2 pages with the cognitive grid./ Hierdie nasienriglyne bestaan uit 17 bladsye nwat 2 bladsye met die kognitiewe tabel insluit.

**QUESTION 1/VRAAG 1**

1.1	D	✓✓	(2)
1.2	C	✓✓	(2)
1.3	A	✓✓	(2)
1.4	C	✓✓	(2)
1.5	B	✓✓	(2)
1.6	C	✓✓	(2)
1.7	D	✓✓	(2)
1.8	C	✓✓	(2)
1.9	B	✓✓	(2)
1.10	D	✓✓	(2)
			<b>[20]</b>

**QUESTION 2 /VRAAG 2**

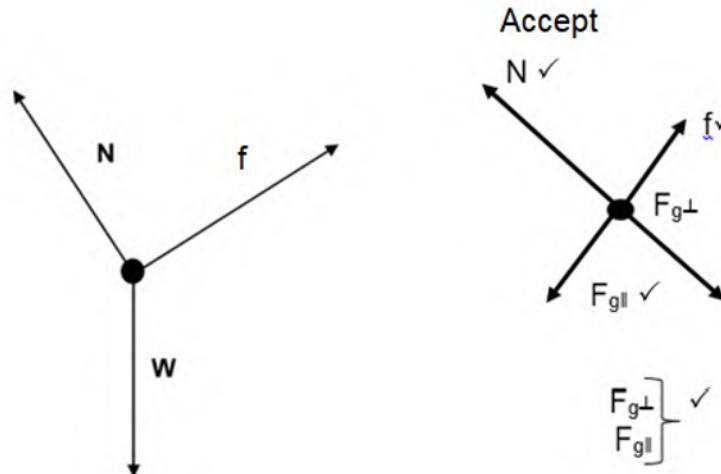
- 2.1.1 The force or the component of a force which a surface exerts on an object with which it is in contact, and which is perpendicular to the surface. ✓✓

/Die krag of die komponent van die krag wat 'n voorwerp op 'n oppervlakte uitoefen waarmee dit in kontak is, en wat loodreg op die oppervlakte is.

2 or/of 0

(2)

- 2.1.2



Accept

**Accept the following symbols**

N ✓	F <sub>N</sub> /Normal/Normal force Normaal/Normaalkrag
-----	--

f ✓	F <sub>f</sub> /frictional force / Wrywingskrag
-----	---

w ✓	F <sub>g</sub> /mg/weight/F <sub>earth</sub> on suitcase/gravitational force Gewig/F <sub>aarde</sub> op tas/gravitasiekrag
-----	--

(3)

- 2.1.3  $F_f = F_{g\parallel}$  ✓  
 $F_f = mg \sin\theta$  ✓ Any one / Enige een

$$F_f = 32 \times 9,8 \times \sin 30^\circ \checkmark$$

$$F_f = 156,8 \text{ N} \checkmark$$

(3)

- 2.1.4  $f_s^{\max} = \mu_s N \checkmark$   
 $156,8 = \mu_s \times 32 \times 9,8 \cos 30^\circ \checkmark$   
 $\mu_s = 0,58 \checkmark$

(3)



**OPTION 3 / OPSIE 3****System approach / Sisteem benadering**

$$\frac{mg \sin \theta}{mg \cos \theta} = \frac{5}{3} \checkmark$$

$$\theta = 59,04^\circ$$

$$F_{\text{net}} = ma \quad \left. \begin{array}{l} \\ T - F_{g\parallel} - F_f(80) = ma \end{array} \right\} \text{Any one } \checkmark$$

$$500 - (80)(9,8)(\sin 59,04) - F_f(80) \checkmark = (80)(2) \checkmark$$

$$500 - 672,3 - F_f(80) = 160$$

$$F_f(80) = -332,3 \text{ N}$$

**Maximum marks/ Maksimum punte 4/6**

**2.2.2 POSITIVE MARKING FROM QUESTION 2.2.1 /**

***POSITIEWE NASIEN VANAF 2.2.1***

$$F_{f(\text{Tot})} = 332,3 \text{ N}$$

**OPTION 1 / OPSIE 1**

$$F_{f(50)} = \left(\frac{5}{8}\right) - 332,3 \text{ N}$$

$$F_{f(50)} = -207,69 \text{ N}$$

Substitute in equation (1)

*Substitusie in vergelyking (1)*

$$-T = 20,19 + F_{f(50)}$$

$$-T = 20,19 + -207,69 \checkmark$$

$$T = 187,5 \text{ N} \checkmark$$

**OPTION 2 / OPSIE 2**

$$F_{f(30)} = \left(\frac{3}{8}\right) - 332,3 \text{ N}$$

$$F_{f(30)} = -124,613 \text{ N}$$

Substitute in equation (2)

*Substitusie in vergelyking (2)*

$$T = 312,11 + 3/5 F_{f(30)}$$

$$T = 312,11 + -124,613 \checkmark$$

$$T = 187,5 \text{ N} \checkmark$$

(2)

[19]

**QUESTION 3/ VRAAG 3**

- 3.1 Motion during which the only force acting on an object is the force of gravity.  
*Beweging waar die enigste krag wat op die voorwerp inwerk gravitadsiekrag is.*  $\checkmark\checkmark$  2 or/of 0 marks

(2)

- 3.2  $5 \text{ m}\cdot\text{s}^{-1}$  upwards / opwaarts  $\checkmark$

(1)

- 3.3 **Marking Criteria / Nasien kriteria**

- Any appropriate formula / *Enige aanvaarbare formule*  $\checkmark$
- All substitutions to calculate the value of  $\Delta y$  / *Alle substitusies om die waarde van  $\Delta y$  te bereken*  $\checkmark$
- Addition of  $60 + \Delta y$  / *Som van  $60 + \Delta y$*   $\checkmark$
- Final answer / *Finale antwoord*  $\checkmark$

**UPWARDS AS POSITIVE / OPWAARTS AS POSITIEF****OPTION 1 / OPSIE 1**

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

$$(0)^2 = 5^2 + 2(-9,8)\Delta y \quad \checkmark$$

$$\Delta y = 1,28 \text{ m}$$

The ball will reach a maximum height of  $(60 + 1,28) \checkmark = 61,28 \text{ m} \checkmark$  above the ground

*/Die bal sal 'n maksimum hoogte van  $(60 + 1,28) = 61,28 \text{ m}$  bo die grond bereik*

**DOWNWARDS AS POSITIVE / AFWAARTS AS POSITIEF**

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

$$(0)^2 = -5^2 + 2(9,8)\Delta y \quad \checkmark$$

$$\Delta y = -1,28 \text{ m} \checkmark$$

$$\text{Height} = 1,28 \text{ m}$$

The ball will reach a maximum height of  $(60 + 1,28) \checkmark = 61,28 \text{ m} \checkmark$  above the ground

*/Die bal sal 'n maksimum hoogte van  $(60 + 1,28) = 61,28 \text{ m}$  bo die grond bereik*

**OPTION 2 / OPSIE 2**

$$v_f = v_i + a\Delta t$$

$$0 = 5 + (-9,8)\Delta t$$

$$\Delta t = 0,51 \text{ s}$$

Any one / Enige een  $\checkmark$

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

$$\left( \frac{5+0}{2} \right) 0,51 \checkmark$$

$$= 1,28 \text{ m}$$

The ball will reach a maximum height of  $(60 + 1,28) \checkmark = 61,28 \text{ m} \checkmark$  above the ground

*/Die bal sal 'n maksimum hoogte van  $(60 + 1,28) = 61,28 \text{ m}$  bo die grond bereik*

**OPTION 3 / OPSIE 3**

$$v_f = v_i + a\Delta t$$

$$0 = 5 + (-9,8)\Delta t$$

$$\Delta t = 0,51 \text{ s}$$

Any one / Enige een  $\checkmark$

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

$$\Delta y = 5 \times 0,51 + \frac{1}{2} (-9,8 \times 0,51^2) \checkmark$$

$$= 1,28 \text{ m}$$

The ball will reach a maximum height of  $(60 + 1,28) = 61,28 \text{ m} \checkmark$  above the ground

*/Die bal sal 'n maksimum hoogte van  $(60 + 1,28) = 61,28 \text{ m}$  bo die grond bereik*

(4)

3.4

**OPTION 1 / OPSIE 1**

The hot- air balloon moved upwards at a constant velocity.

/Die warmlugballon het opwaarts beweeg teen 'n konstante snelheid.

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

$$\Delta y = (5)(3) + 0 \quad \checkmark$$

$$\Delta y = 15 \text{ m}$$

After 3 s the hot- air balloon will be 15 m above the starting point.

/Na 3 s sal die warmlugballon 15 m bo die beginpunt wees.

The distance travelled by the ball after 3s / Afstand deur bal beweeg na 3s.

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

$$\Delta y = (5)(3) + \frac{1}{2} (-9,8) (3)^2 \quad \checkmark$$

$$\Delta y = -29,1 \text{ m} \quad \checkmark$$

The ball is 29,1 m below the point from where it was released.

After 3 s the hot air balloon and the ball will be  $(15 + 29,1) \checkmark = 44,1 \text{ m} \checkmark$  apart

/ Die bal is 29,1 m onder die punt vanwaar dit laat val is. Na 3s sal die bal en die warmlugballon  $(15 + 29,1) = 44,1 \text{ m}$  van mekaar wees.

**OPTION 2 / OPSIE 2**

$$V_{\text{ave}} = \frac{\Delta y}{\Delta t} \quad \checkmark$$

$$\Delta t$$

$$\Delta y = (5)(3) \quad \checkmark \\ 15 \text{ m}$$

$$V_f = V_i + a \Delta t \\ = 5 + (-9,8)(3) \\ = -24,4 \text{ m}\cdot\text{s}^{-1}$$

$$\Delta y = \left( \frac{V_i + V_f}{2} \right) \Delta t \\ = \left( \frac{-24,4 + 5}{2} \right) (3) \quad \checkmark \\ = -29,1 \text{ m} \quad \checkmark$$



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The ball is 29,1 m below the point from where it was released.

After 3 s the hot air balloon and the ball will be  $(15 + 29,1) \checkmark = 44,1 \text{ m} \checkmark$  apart

/ Die bal is 29,1 m onder die punt vanwaar dit laat val is. Na 3s sal die bal en die warmlugballon  $(15 + 29,1) = 44,1 \text{ m}$  van mekaar wees.

(6)

3.5

**ANY ONE**

Some of the ball's kinetic energy is converted into heat and sound energy.

/ Sommige van die energie van die bal word omgeskakel in hitte en klank energie.  $\checkmark \checkmark$

OR/OF

The collision between the ball and the ground is inelastic.  $\checkmark \checkmark$

/ Die botsing tussen die bal en die grond is onelasties

(2)

[15]

#### QUESTION 4 / VRAAG 4

- 4.1 The total linear momentum of an isolated system is conserved both in magnitude and direction ✓✓ (2)

*Die totale liniére momentum van 'n geslote sisteem bly behoue in grootte en rigting. (2 orlof 0)*

- 4.2  $\Sigma P_{\text{before}} = \Sigma P_{\text{after}}$  ✓

$$(15) (V_R) + 0 = (15 + 13,5)(4,4) \checkmark$$

$$V_R = 8,36 \text{ m}\cdot\text{s}^{-1}. \checkmark$$

(3)

- 4.3

**OPTION 1 / OPSIE 1**

$$v_f = v_i + a\Delta t \checkmark$$

$$0 = 4,4 + (a)(3) \checkmark$$

$$a = -1,47 \text{ m}\cdot\text{s}^{-2}$$

$$F_f = F_{\text{net}} = ma$$

$$F_f = (15 + 13,5)(-1,47) \checkmark$$

$$F_f = 41,9 \text{ N} \checkmark$$

$$\text{Accept} - 41,9 \text{ N}$$

**OPTION 2 / OPSIE 2**

$$F_{\text{net}} \Delta t = \Delta P = m(v_f - v_i) \checkmark$$

$$F_{\text{net}} (3) \checkmark = 28,5 (0-4,4) \checkmark$$

$$F_{\text{net}} = F_f$$

$$F_{\text{net}} = -41,8 \text{ N}$$

$$F_f = 41,8 \text{ N} \checkmark$$

$$\text{Accept} - 41,8 \text{ N}$$

(4)

[9]

#### QUESTION 5 / VRAAG 5

- 5.1 The net/total work done on an object is equal to the change in the object's kinetic energy. ✓✓

*/ Die netto werk verrig op 'n voorwerp is gelyk aan sy verandering in kinetiese energie.*

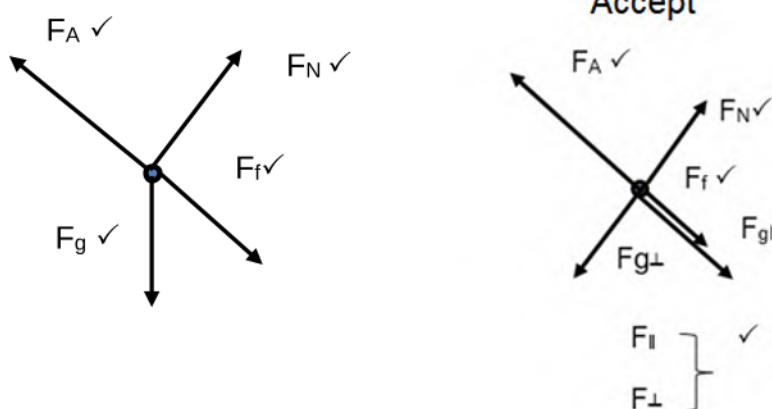
OR

The work done on an object by a resultant/net force is equal to the change in the objects kinetic energy. ✓✓

*/ Die werk verrig op 'n voorwerp deur 'n netto/resultante krag is gelyk aan sy verandering in kinetiese energie.*

(2)

5.2



**Accept the following symbols / Aanvaar die volgende simbole**

F <sub>A</sub> ✓	Applied Force /Force by engine/ Toegepaste krag/krag van engin
N ✓	F <sub>N</sub> /Normal/Normal force / Normaal / Normaalalkrag
f ✓	F <sub>f</sub> /frictional force / Wrywingskrag
w ✓	F <sub>g</sub> /mg/weight/F <sub>earth</sub> on car/gravitational force Gewig/F <sub>aarde</sub> op tas/gravitasiekrag

(4)

5.3

**OPTION 1 / OPSIE 1**

**Marking Criteria for Option 1**

- Any appropriate formula / Enige aanvaarbare formule ✓
- Substitution of 0,1 in equation of  $W_{net}$  ✓ / Substitusie van 0,1 in vergelyking van  $W_{net}$  ✓
- All substitutions to calculate  $W_{net}$  ✓ / Alle substitusies om  $W_{net}$  te bereken✓
- Substituting  $W_{net} = 0$  ✓ / Vervanging van  $W_{net} = 0$  ✓
- Calculation of the power required ✓ / Berekening van die drywing benodig✓
- Calculation of the power of the engine ✓ / Berekening van die drywing van die motor✓
- Stating the car has enough power ✓ / Staat dat die motor genoeg drywing het✓

$$W_{net} = \Delta K$$

$$W_{g\parallel} + W_{Ff} + W_{FA} = \Delta K$$

$$mg \sin\theta \Delta x \cos\theta + F_f \Delta x \cos\theta + F_A \Delta x \cos\theta = \Delta K$$

$$W_{net} = (1200) (9,8) (0,1) \checkmark (100) (\cos 180^\circ) + (820)(100)(\cos 180^\circ) +$$

$$+ F_A (100)(\cos 0^\circ) \checkmark = 0 \checkmark$$

$$F_A = 1996 \text{ N upward /opwaarts}$$

$$\text{Power} = F_A v$$

$$P_{\text{required}} = (1996)(6) \checkmark$$

$$= 11976 \text{ W}$$

$$= 11,976 \text{ kW}$$

Accept range P/ Aanvaar interval van = 11,972 kW to 11,977 kW

$$\text{Real power of the engine / Werklike drywing van die motor} = (62) \left( \frac{83}{100} \right) \checkmark$$

$$P_{\text{Engine}} = 51,460 \text{ kW}$$

$\sin\theta = 10/100$ $\sin\theta = 0,1$ $F_{net} = F_{g\parallel} + F_f + F_A$ $F_{g\parallel} = mg \sin\theta$
---

or

$$P_{\text{Engine}} = 51460 \text{ W}$$

$P_{\text{Engine}} > P_{\text{required}}$  The car has enough power✓ / Die motor het genoegsame drywing

## **OPTION 2**

### **Marking Criteria for Option 1**

- Any appropriate formula ✓
- Substitution of 0,1 in equation of  $\Delta K$  ✓
- All substitutions to calculate  $\Delta K$  ✓
- Substituting  $\Delta K = 0$  ✓
- Calculation of the power required ✓
- Calculation of the power of the engine ✓
- Stating the car has enough power ✓
- *Enige aanvaarbare formule* ✓
- *Substitusie van 0,1 in vergelyking  $\Delta K$*  ✓
- *Alle substitusies om  $\Delta K$  te bereken* ✓
- *Vervanging van  $\Delta K = 0$*  ✓
- *Berekenig van die drywing benodig* ✓
- *Berekening van die drywing van die motor* ✓
- *Staaf dat die motor genoeg drywing het* ✓

$$W_{\text{net}} = \Delta K$$

$$W_{\text{gll}} + W_{\text{Ff}} + W_{\text{FA}} = \Delta K$$

$$mg \sin\theta \Delta x \cos\theta + F_f \Delta x \cos\theta + W_{\text{FA}} = \Delta K$$

$$(1200)(9,8)(0,1) \checkmark (100)(\cos 180^\circ) + (820)(100)(\cos 180^\circ + W_{\text{FA}}) \checkmark = 0 \checkmark$$

$$W_{\text{FA}} = 199600 \text{ J}$$

$$v = \frac{\Delta x}{\Delta t}$$

$$6 = \frac{100}{\Delta t}$$

$$\Delta t = 16,67 \text{ s}$$

$$P = \frac{W}{\Delta t}$$

$$P_{\text{required}} = \frac{199600}{16,67} \checkmark$$

$$P = 11973,61 \text{ W}$$

Accept range  $P = 11972 \text{ W}-11977 \text{ W}$

*Aanvaarbare interval  $P = 11972 \text{ W}-11977 \text{ W}$*

$$P_{\text{required}} = 11,974 \text{ kW}$$

$$\text{Real power of the engine/Werklike drywing van motor} = (62000) \left( \frac{83}{100} \right) \checkmark$$

$$P_{\text{Engine}} = 51460 \text{ W}$$

$$P_{\text{Engine}} = 51,460 \text{ kW}$$

} Any one / Enige een✓

$$P_{\text{Engine}} > P_{\text{required}}$$

The car has enough power  
*/Die motor het genoeg drywing✓*

(7)

[13]

**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 die frekvensie (toonhoogte) van die waargenome klank deur die luisteraar agt die klankbron en die luisteraar wat verskillende snelhede reeltief tot mekaar het.

(2)

6.2

**OPTION 1 / OPSIE 1**

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

$$910 \checkmark = \frac{(340+v_L)}{(340-v_s)} 850 \checkmark$$

$$v_L = 24 \text{ m} \cdot \text{s}^{-1} \checkmark$$

**OPTION 2 / OPSIE 2**

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

$$790 \checkmark = \frac{(340-v_L)}{(340+v_s)} 850 \checkmark$$

$$v_L = 24 \text{ m} \cdot \text{s}^{-1} \checkmark$$

(5)

6.3

**OPTION 1/ OPSIE 1**

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

$$\Delta x = (24)(6) + \frac{1}{2} \times 0 \times 6^2 \checkmark$$

$$\Delta x = 144 \text{ m} \checkmark$$

**OPTION 2 / OPSIE 2**

$$\Delta x = v \Delta t \checkmark$$

$$\Delta x = 24 \times 6 \checkmark$$

$$\Delta x = 144 \text{ m} \checkmark$$

(3)

[10]

**QUESTION 7 / VRAAG 7**

- 7.1.1 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 their charges✓ and inversely proportional to the square of the distance (r) between them ✓

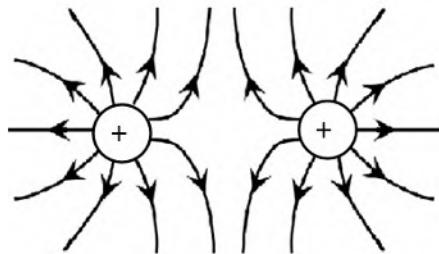
/ Die groote van die elektrostatisiese krag wat deur een puntlading ( $Q_1$ ) op 'n ander puntlading ( $Q_2$ ) uitgeoefen word, is direk eweredig aan die produk van die groottes van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle

(2)

<p>7.1.2</p> <p><b>OPTION 1</b></p> <p><b>Before contact/Voor kontak</b></p> $F = \frac{kQ_1Q_2}{r^2} \quad \checkmark$ $F = \frac{k(q)(3q)}{d^2} \quad \checkmark$ $F = 3 \frac{kq^2}{d^2}$ <p><b>After contact/Na kontak</b></p> <p>New Charge <math>q_{\text{new}} = \frac{Q_1 + Q_2}{2}</math></p> $= \frac{-q + 3q}{2} \quad \left. \right\} \quad \checkmark$ $= q$ $F_{\text{new}} = \frac{kqq}{d^2}$ $= \frac{kq^2}{d^2} \quad \checkmark$ $F_{\text{new}} = \frac{E}{3} \quad \checkmark$	<p><b>OPTION 2</b></p> $F = \frac{kQ_1Q_2}{r^2} \quad \checkmark$ $F = \frac{k q \times 3q}{d^2} \quad \checkmark$ $= \frac{3 k q^2}{d^2} \quad \checkmark$ $F_{\text{new}} = \frac{kQ_1Q_2}{r^2}$ $= \frac{kq^2}{d^2} \quad \checkmark$ $F_{\text{new}} = \frac{E}{3} \quad \checkmark$	<p>(5)</p>
<p>7.2.1</p> $E = \frac{kQ}{r^2} \quad \checkmark$ <p>'E' at 'X' due to <math>Q_1</math></p> $E = \frac{(9,0 \times 10^9) (6 \times 10^{-9})}{2^2} \quad \checkmark$ $= 13,5 \text{ N}\cdot\text{C}^{-1} \text{ to the left/na links}$ <p>'E' at x due to <math>Q_2</math></p> $E = \frac{kQ}{r^2}$ $E = \frac{(9,0 \times 10^9) (8 \times 10^{-9})}{1^2} \quad \checkmark$ $= 72,0 \text{ N}\cdot\text{C}^{-1} \text{ to the right/na regs}$ <p>Net electric field at X / Netto elektriese veld by X = <math>72,0 - 13,5 = 58,5 \text{ N}\cdot\text{C}^{-1}</math></p>	<p>(4)</p> <p>[11]</p>	

**QUESTION 8 / VRAAG 8**

8.1



<b>Guideline for allocating marks/Riglyne vir toekenning van punte</b>	
Arrows point outwards	
Pyle uitwaarts gerig	
Correct shape	
Korrekte vorm	(2)

8.2

$$\begin{aligned} E &= F/Q \checkmark \\ E &= (3,23 \times 10^{-5}) / (4,8 \times 10^{-9}) \checkmark \\ E &= 6729,17 \text{ N.C}^{-1} \checkmark \end{aligned}$$

(3)

8.3

**OPTION 1 OPSIE 1**

$$F = \frac{kQ_1Q_2}{r^2} \checkmark$$

$$3,23 \times 10^{-5} = \frac{(9 \times 10^9 \times 4,8 \times 10^{-9} \times 4,8 \times 10^{-9})}{r^2} \checkmark$$

$$r = 0,08 \text{ m} \checkmark$$

**OPTION 2: POSITIVE MARKING FROM QUESTION 8.2****OPSIE 2: POSITIEWE NASIEN VANAF VRAAG 8.2**

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

$$6729,17 = \frac{9 \times 10^9 \times 4,8 \times 10^{-9}}{r^2} \checkmark$$

$$r = 0,08 \text{ m} \checkmark$$

(3)

[8]

**QUESTION 9 / VRAAG 9**

9.1.1

$$\begin{aligned} V &= IR_T \checkmark \\ 14 &= 1,4 \times R_T \checkmark \\ R_T &= 10 \Omega \checkmark \end{aligned}$$

(3)

9.1.2

**POSITIVE MARKING FROM QUESTION 9.1.1**  
**POSITIEWE NASIEN VANAF VRAAG 9.1.1**

$$\begin{aligned} R_T &= (R_{\text{ext}} + r) \checkmark \\ 10 &= (6+3,6) + (r) \checkmark \\ r &= 0,4 \Omega \checkmark \end{aligned}$$

(3)

9.1.3  $W = I^2 R \Delta t \checkmark$

$$W = 1,4^2 \times 6 \times 3 \times 60 \checkmark$$

$$= 2116,8 \text{ J} \checkmark$$

(3)

9.2

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

$$\frac{1}{R_p} = \frac{1}{8} + \frac{1}{6} \checkmark$$

$$R_p = 3,43 \Omega$$

$$\text{emf } (\varepsilon) = I(R + r) \checkmark / \text{emk } (\varepsilon) = I(R + r)$$

$$14 = I(3,43 + 3,6 + 0,4) \checkmark$$

$$I = 1,88 \text{ A}$$

**OPTION 1**

$$V = IR$$

$$V_p = 1,88 \times 3,43 \checkmark$$

$$= 6,46 \text{ V}$$

$$I_{8\Omega} = \frac{6,45}{8}$$

$$= 0,81 \text{ A} \checkmark$$

**OPTION 2**

$$I_{8\Omega} = \frac{6 \times 1,88}{14} \checkmark$$

$$= 0,81 \text{ A} \checkmark$$

(6)

9.3

Increases  $\checkmark$  / energy transfer from the battery increases.  $\checkmark$

Toeneem  $\checkmark$  / energie oorgedra van die batterij neem toe.  $\checkmark$

**OR / OF**

External resistance decreases because the parallel combination is eliminated by the short circuit.

Die eksterne weerstand neem af omdat die paralelle kombinasie uitgesluit word duer die kortsluiting.

(2)

[17]

**QUESTION 10 / VRAAG 10**10.1.1 AC generator/WS generator  $\checkmark$ 

(1)

10.1.2 Q- Carbon brush / Koolstofborseletjies  $\checkmark$ R- Slip ring / Sleepring  $\checkmark$ 

(2)

10.2.1 Graph A represents direct current.  $\checkmark$ 

Grafiek A verteenwoordig gelykstroom

Graph B represents alternating current.  $\checkmark$ 

Grafiek B verteenwoordig wisselstroom

(2)

$$f = \frac{\text{no of oscillations}}{\text{time}} / \frac{\text{aantal ossilasies}}{\text{tyd}}$$

$$= 1,5 / 0,03 \checkmark$$

$$= 50 \text{ Hz} \checkmark$$

(2)

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

$$200 = \frac{V_{\text{max}}}{\sqrt{2}} \checkmark$$

$$V_{\text{max}} = 282,84 \text{ V} \checkmark$$

(3)

$$10.3.2 V_{\text{rms}} = I_{\text{rms}} \times R \checkmark$$

$$200 = I_{\text{rms}} \times 10 \checkmark$$

$$I_{\text{rms}} = 20 \text{ A} \checkmark$$

(3)

10.3.3 **OPTION 1 / OPSIE 1**

$$\begin{aligned} P_{ave} &= I_{rms}V_{rms} \checkmark \\ &= 20 \times 200 \checkmark \\ &= 4000 \text{ W} \checkmark \end{aligned}$$

**OPTION 2 / OPSIE 2**

$$\begin{aligned} P_{ave} &= \frac{V_{rms}^2}{R} \checkmark \\ &= \frac{200^2}{10} \checkmark \\ &= 4000 \text{ W} \checkmark \end{aligned}$$

**OPTION 3 / OPSIE 3**

$$\begin{aligned} P_{ave} &= I_{rms}^2 R \checkmark \\ &= (20)^2(10) \checkmark \\ &= 4000 \text{ W} \checkmark \end{aligned}$$

(3)

[16]

**QUESTION 11 / VRAAG 11**

- 11.1 The work function of a metal is the minimum energy that an electron needs to be emitted from the metal surface **✓✓ 2 or 0**

*Die werksfunksie van 'n metaal is die minimum hoeveelheid energie benodig om elektrone uit die oppervlakte van die metaal vry te stel*  
**✓✓ 2 or 0**

(2)

11.2.1  $c = f\lambda$

$$\begin{aligned} 3 \times 10^8 &= f (200 \times 10^{-9}) \checkmark \\ f &= 1,5 \times 10^{15} \text{ Hz} \checkmark \end{aligned}$$

(2)

11.2.2  $W_0 = hf_0 \checkmark$

$$\begin{aligned} 2,3 \times 10^{-19} &= 6,63 \times 10^{-34} \times f_0 \checkmark \\ f_0 &= 3,47 \times 10^{14} \text{ Hz} \checkmark \end{aligned}$$

(3)

- 11.2.3 **POSITIVE MARKING FROM QUESTION 11.2.1 / POSITIEWE NASEIN VANAF 11.2.1**

$E = W_0 + E_{k(max)} \checkmark$

$\underline{(6,63 \times 10^{-34})} \underline{(1,5 \times 10^{15})} \checkmark = \underline{(2,3 \times 10^{-19})} + E_k \checkmark$

$E_k = 7,65 \times 10^{-19} \text{ J} \checkmark$

(4)

- 11.3 Decrease/Verminder  $\checkmark$

(1)

[12]

**TOTAL/TOTAAL: 150**