



DEPARTMENT OF EDUCATION

NATIONAL  
SENIOR CERTIFICATE

Stanmorephysics.com

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2021

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 3 data sheets

**Downloaded from Stanmorephysics.com****INSTRUCTIONS AND INFORMATION**

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer QUESTION 10.4 on the attached graph paper. Answer ALL the other questions in the ANSWER BOOK
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

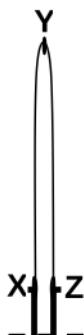
**Downloaded from Stanmorephysics.com****QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

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, e.g. 1.11 E. Each question has only ONE correct answer.

- 1.1 Which ONE of the following physical quantities is represented by the ratio  $\frac{\Delta v}{\Delta t}$  ? (2)
- A Acceleration
  - B Displacement
  - C Momentum
  - D Net force
- 1.2 A satellite orbits Earth at a height where it experiences a gravitational force four times **less than** that on the surface of the Earth. If Earth's radius is R, then the height of the satellite above Earth's surface is ... (2)
- A 4R.
  - B 3R.
  - C 2R.
  - D R.

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- 1.3 A ball thrown vertically upwards from point **X** reaches its greatest height at point **Y** and returns to the same level as **X** at point **Z**, as shown in the diagram below.



Neglect the effects of air resistance.

Which ONE of the following statements is CORRECT?

- A The acceleration at point **Y** equals zero
- B The speed at **X** equals the speed at **Z**
- C It takes longer time from **X** to **Y** than **Y** to **Z**
- D The velocity at **X** equals the velocity at **Z**

(2)

- 1.4 The net force acting on a moving object is ZERO.

Which statement about the *momentum* and *kinetic energy* of the object is CORRECT?

	<b>MOMENTUM</b>	<b>KINETIC ENERGY</b>
A	Stays constant	Changes
B	Stays constant	Stays constant
C	Changes	Changes
D	Changes	Stays constant

(2)

- 1.5 Which ONE of the following is the BEST indication that *mechanical energy is conserved*?

- A  $W_{\text{net}} + \Delta E_k = 0$
- B  $E_p + E_k = 0$
- C  $\Delta E_k + \Delta E_p = 0$
- D  $\Delta p + \Delta E_p = 0$

(2)

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- 1.6 A sound source recedes (moves away) from a stationary observer at constant velocity.

Which ONE of the following CORRECTLY describes how the observed *frequency* and *wavelength* differ from that of the sound source?

	FREQUENCY	WAVELENGTH
A	Greater than	Greater than
B	Greater than	Less than
C	Less than	Greater than
D	Less than	Less than

(2)

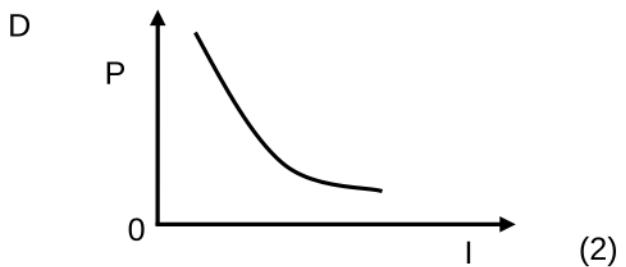
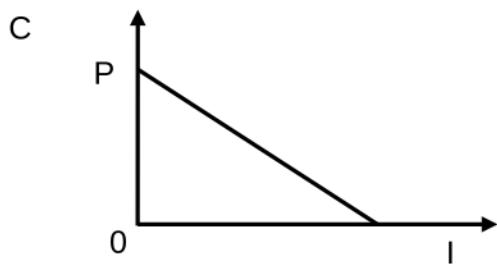
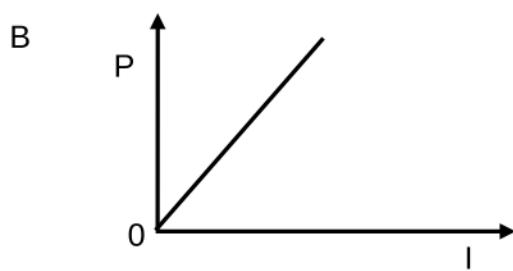
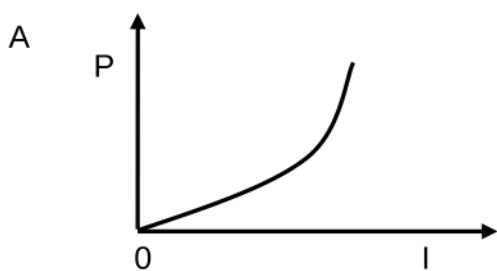
- 1.7 Two identical conducting spheres **M** and **N** carry charges of  $+12,8 \times 10^{-19}$  C and  $-12,8 \times 10^{-19}$  C, respectively. The spheres are allowed to touch.

How many electrons does **M** gain when the spheres touch?

- A 2  
B 4  
C 6  
D 8

(2)

- 1.8 Which ONE of the following graphs best represents the relationship between the *current* (I) and the *power output* (P) for an appliance with constant resistance?

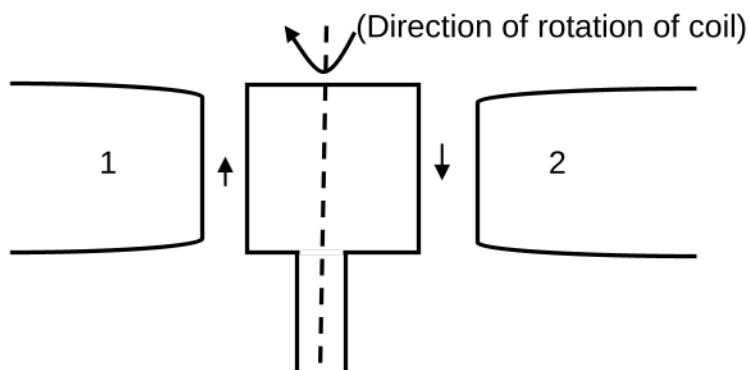


(2)

1.9

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A current-carrying, rectangular coil is in a magnetic field. The direction of conventional current in the coil is as shown in the diagram below.



The coil is turning clockwise.

Which combination correctly indicates the polarity of magnets 1 and 2?

	<b>MAGNET 1</b>	<b>MAGNET 2</b>
A	South	North
B	North	North
C	South	South
D	North	South

(2)

1.10 Ultra-violet light emits electrons from a Zn plate.

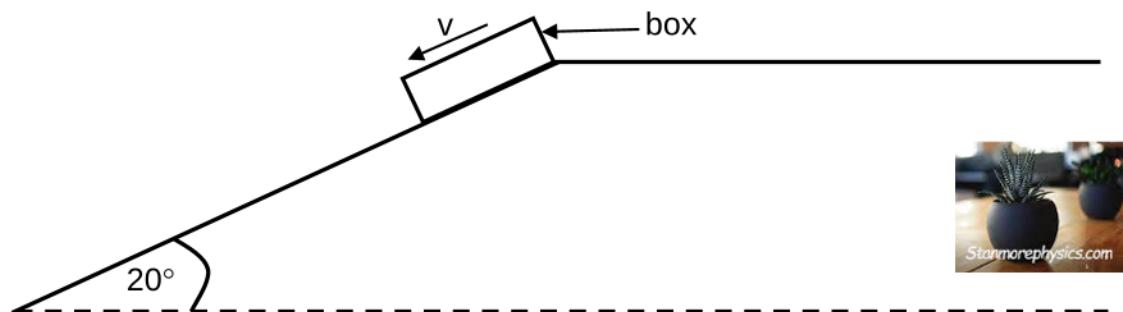
How would the maximum kinetic energy,  $E_{k(\max)}$ , of the photoelectrons and the number of photoelectrons emitted per second be affected by using *more intense* ultra-violet light?

	<b><math>E_{k(\max)}</math></b>	<b>Number of photoelectrons emitted per second</b>
A	Decreased	Increased
B	Unchanged	Unchanged
C	Unchanged	Increased
D	Increased	Unchanged

(2)  
[20]

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

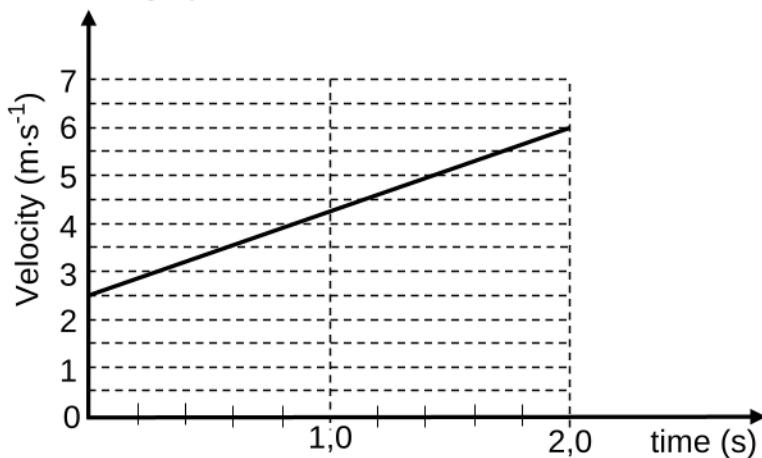
A box of mass 65 kg slides down an incline, as shown in the diagram below.



The incline makes an angle of  $20^\circ$  with the horizontal. The frictional force acting on the box is constant.

- 2.1 Define the term *frictional force*. (2)
- 2.2 Draw a labelled free-body diagram for the box as it slides down the incline. (3)

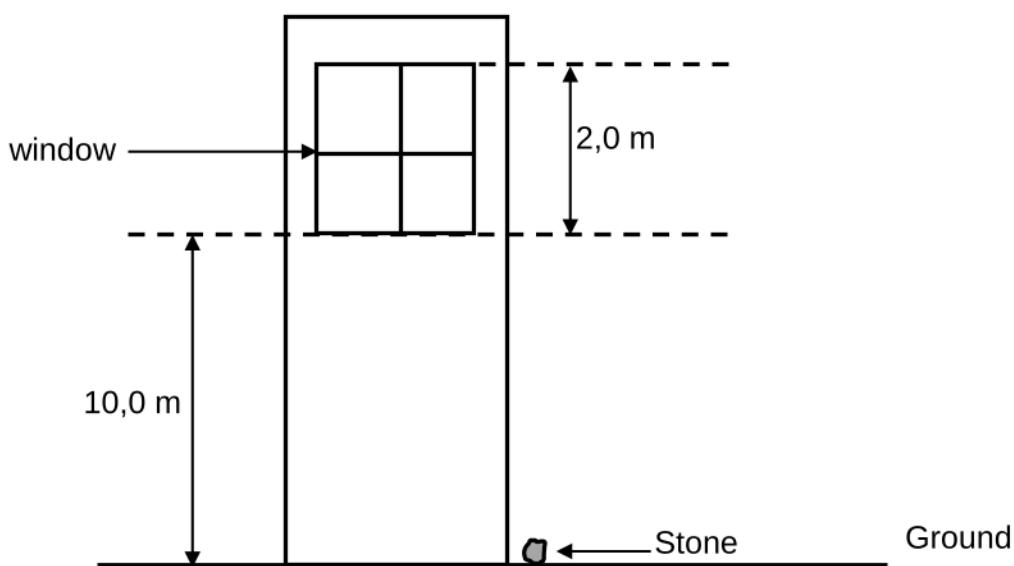
The velocity versus time graph for the box as it moves down the incline is shown below.



- 2.3 Use the data in the graph to show that the magnitude of the acceleration of the box is  $1.75 \text{ m}\cdot\text{s}^{-2}$ . (3)
- 2.4 State, in words, *Newton's second Law of motion* in terms of acceleration. (2)
- 2.5 Calculate the:
- 2.5.1 Resultant force acting on the box (3)
- 2.5.2 Kinetic frictional force acting on the box (4)
- [17]**

**Downloaded from Stanmorephysics.com****QUESTION 3 (Start on a new page)**

A stone is thrown vertically from the ground. It passes a 2,0 m high window whose sill is 10,0 m above the ground. The stone takes 0,15 s to travel the 2,0 m height of the window. Diagram is not drawn to scale.

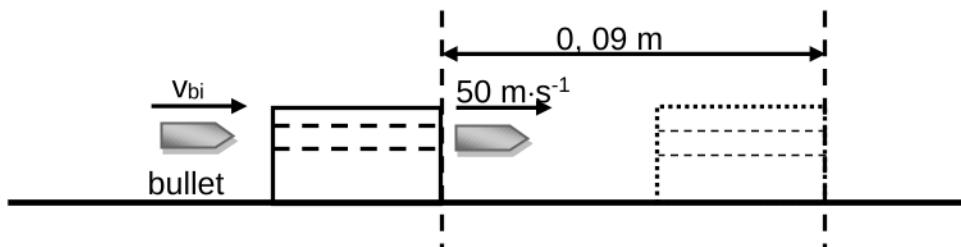


Neglect the effects of air resistance (*i.e. the stone moves under the influence of gravitational force only*).

- 3.1 Write down the term which describes the bracketed statement. (1)
- 3.2 USE EQUATIONS OF MOTION to calculate the:
  - 3.2.1 The speed with which the stone is thrown (5)
  - 3.2.2 Maximum height above the ground that the stone reaches (4)
- 3.3 Sketch a velocity versus time graph to illustrate the motion of the stone from the moment it leaves the ground until it reaches its maximum height. (Take upwards as the positive direction).  
Clearly show the value of the initial velocity on the graph. (3)
- 3.4 Write down the magnitude of the acceleration of the stone at the maximum height. (1)  
[14]

**Downloaded from Stanmorephysics.com****QUESTION 4 (Start on a new page)**

A bullet of mass 2 g travelling horizontally strikes a 1 kg wooden block which is at rest.

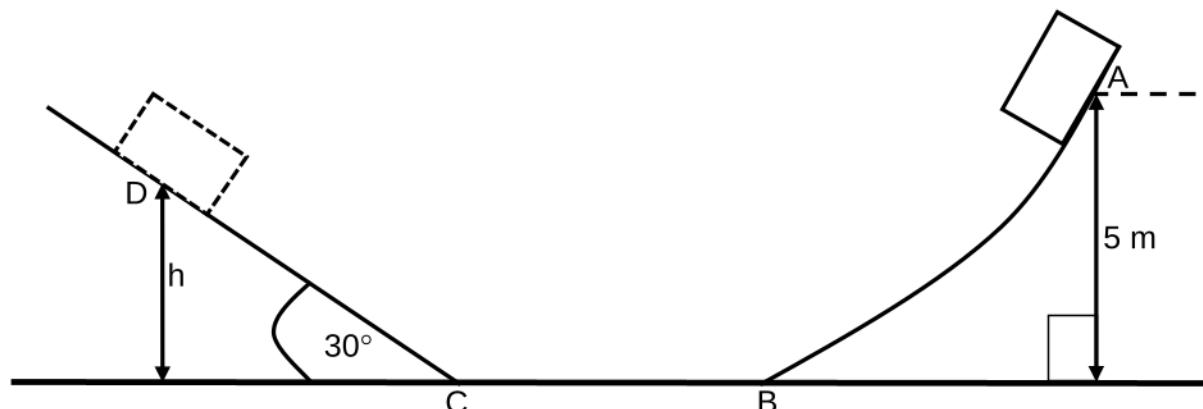


The bullet emerges instantly on the opposite side of the block with a reduced velocity of  $50 \text{ m}\cdot\text{s}^{-1}$ . The frictional force acting on the block is  $1,96 \text{ N}$ . The block is observed to travel  $0,09 \text{ m}$  before stopping, as shown in the diagram above.

- 4.1 State, in words, *Newton's second Law of motion* in terms of momentum. (2)
- 4.2 Calculate the magnitude of the initial velocity of the bullet WITHOUT USING ENERGY PRINCIPLES. (7)
- 4.3 Draw a labelled vector diagram (not to scale) to illustrate the relationship among the initial momentum  $\mathbf{p}_i$ , the final momentum  $\mathbf{p}_f$  and the change in momentum  $\Delta\mathbf{p}$  for the bullet. (2)  
[11]

**Downloaded from Stanmorephysics.com****QUESTION 5 (Start on a new page)**

A block is released from rest at point **A** and slides down a curved frictionless track **AB** and then moves along a frictionless horizontal track **BC**, and finally moves up a ROUGH inclined plane **CD**.



The coefficient of kinetic friction between the block and incline **CD** is 0,35.

- 5.1 State, in words, the *principle of conservation of mechanical energy*. (2)
- 5.2 Use the *principle of conservation of mechanical energy* to calculate the speed of the block at point **B**. (4)
- 5.3 Using energy principles, calculate the maximum height **h** reached by the block. (6)  
**[12]**

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

When a sound source moves in an easterly direction towards a stationary learner at  $15 \text{ m}\cdot\text{s}^{-1}$ , the frequency observed by the listener is  $f_1$ . When the source is stationary and the learner moves in a westerly direction towards the source at  $25 \text{ m}\cdot\text{s}^{-1}$ , the frequency observed by the learner is  $f_2$ . The learner notes that  $f_2$  is greater than  $f_1$  by the 37 Hz.

- 6.1 Write down the NAME of the phenomenon that the learner observes and state this phenomenon in words. (3)
- 6.2 Assuming that the speed of the sound in air is  $340 \text{ m}\cdot\text{s}^{-1}$ , calculate the frequency of the source. (6)
- 6.3 Calculate the wavelength of the sound observed by the STATIONARY learner. (3)
- 6.4 Write down ONE applications of the phenomenon referred to in QUESTION 6.1 in the medical field. (1)

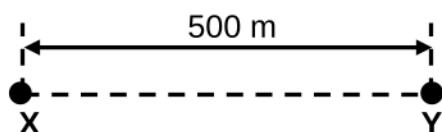
6.5

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The spectral lines from a distance star are shifted towards the longer wavelength of the spectrum. Does this represent RED SHIFT or BLUE SHIFT?

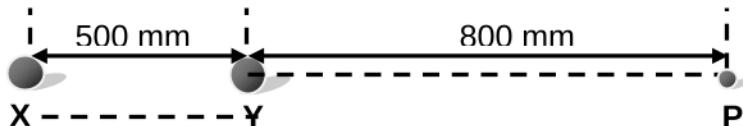
(1)  
[14]**QUESTION 7 (Start on a new page)**

Two identical NEGATIVELY charged spheres, X and Y, having charges of the SAME MAGNITUDE, are placed 500 mm apart in a vacuum, as shown in the diagram below. The magnitude of the electrostatic force that the one sphere exerts on the other is 0,288 N.



- 7.1 State Coulomb's Law in words. (2)
- 7.2 Calculate the:
- 7.2.1 Magnitude of the charge on EACH sphere (4)
  - 7.2.2 Number of EXCESS electrons on sphere Y (3)

P is a point 800 mm from sphere Y, as shown in the diagram below.

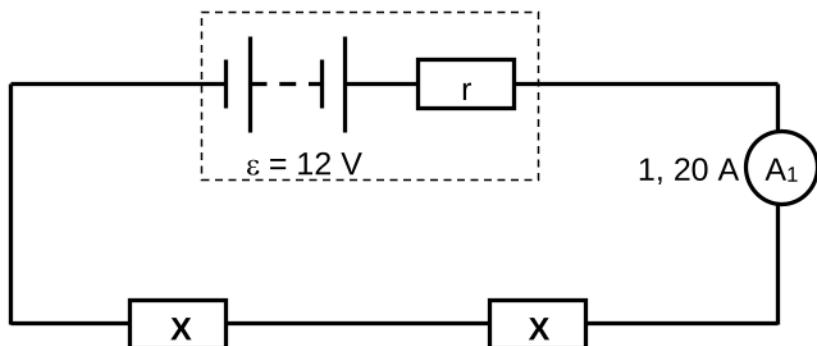


- 7.3 Define the term *electric field* at a point in words. (2)
- 7.4 What is the direction of the *net* electric field at P? Choose from LEFT or RIGHT. (1)
- 7.5 Calculate the number of electrons that must be removed from sphere Y so that the net electric field at P is  $4 \times 10^4 \text{ N}\cdot\text{C}^{-1}$  to the right. (7)  
[19]

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

A battery with an emf of 12 V and internal resistance  $r$  is connected in series to two identical resistors, EACH with resistance  $X$ , as shown in circuit diagram **1** below.

CIRCUIT DIAGRAM **1**

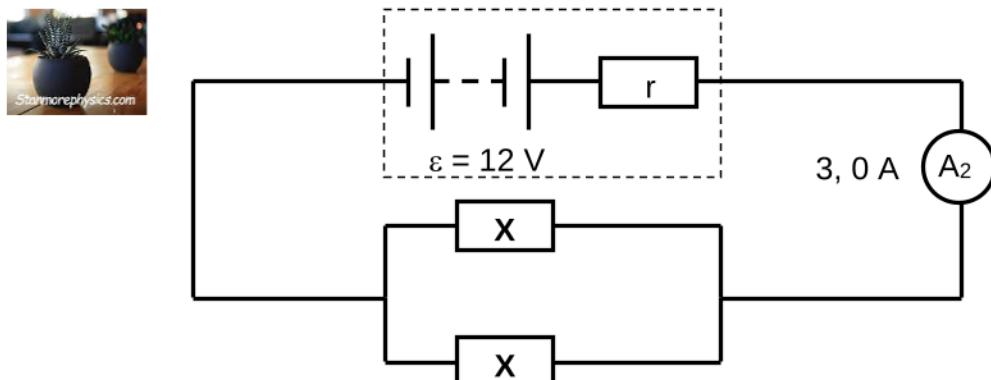


The ammeter reading,  $A_1$ , is 1,20 A.

- 8.1 Define the term *internal resistance of a battery*. (2)

The same battery is now connected to the same two resistors in parallel, as shown in circuit diagram **2** below.

CIRCUIT DIAGRAM **2**



The ammeter reading,  $A_2$ , is 3,0 A.

- 8.2 Show that the total external resistance in circuit **1** is FOUR times that in circuit **2**. (3)

- 8.3 Using the two circuits and the equation  $\epsilon = I(R + r)$ , Calculate the:

- 8.3.1 Resistance  $X$  (3)

- 8.3.2 Internal resistance of the battery  $r$ . (2)

The resistors in circuits **1** and **2** are replaced by *identical* 12 V non-ohmic bulbs.

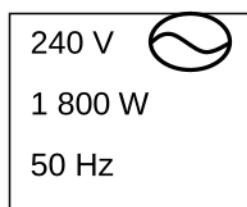
- 8.4 **Downloaded from Stanmorephysics.com**  
Show that a bulb in circuit **2** will glow brighter than a bulb in circuit **1** when the circuit functions initially. (4)

- 8.5 Explain why the resistance of a bulb in circuit **2** will not be the same as the resistance of a bulb in circuit **1** after a while. (3)

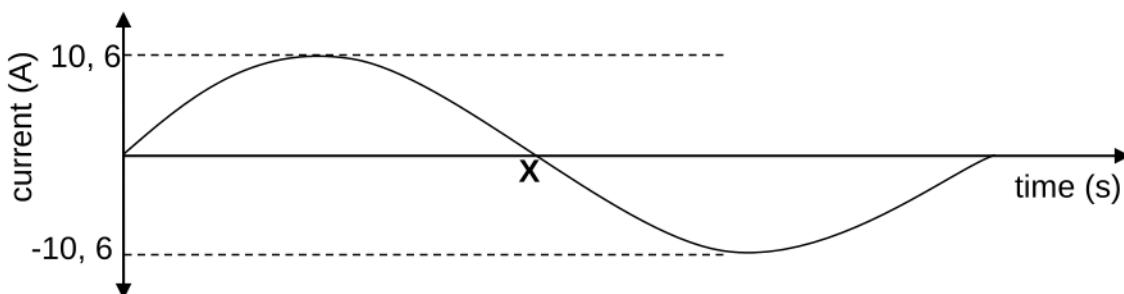
[17]

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

- 9.1 An engineer has an electric drill, which operates from an alternating current supply. The drill is rated as follow:



The current passing through the drill when operating is represented in the graph below.



- 9.1.1 Define the term *root mean square (rms)* for an alternating current. (2)

Calculate the:

- 9.1.2 Time X indicated on the graph (3)

- 9.1.3 Root mean square (rms) current the drill draws when operating (3)

- 9.1.4 Resistance of the drill (3)

- 9.2 Explain why the transmission of the electrical energy is carried out using alternating currents and high voltages.

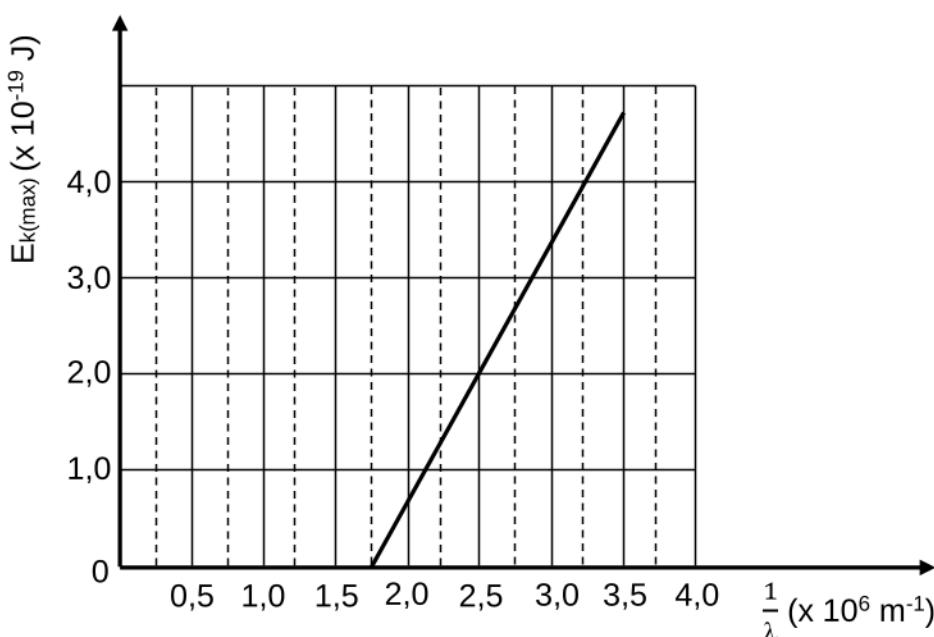
- 9.2.1 From the scientific point of view (1)

- 9.2.1 From the economic point of view (1)

[13]

**Downloaded from Stanmorephysics.com****QUESTION 10 (Start on a new page)**

Light with different wavelength ( $\lambda$ ) is incident on a metal surface. The variation of the maximum kinetic energy  $E_{k(\max)}$  of electrons emitted from the metal surface with inverse of wavelength ( $\frac{1}{\lambda}$ ), is shown in the graph below.



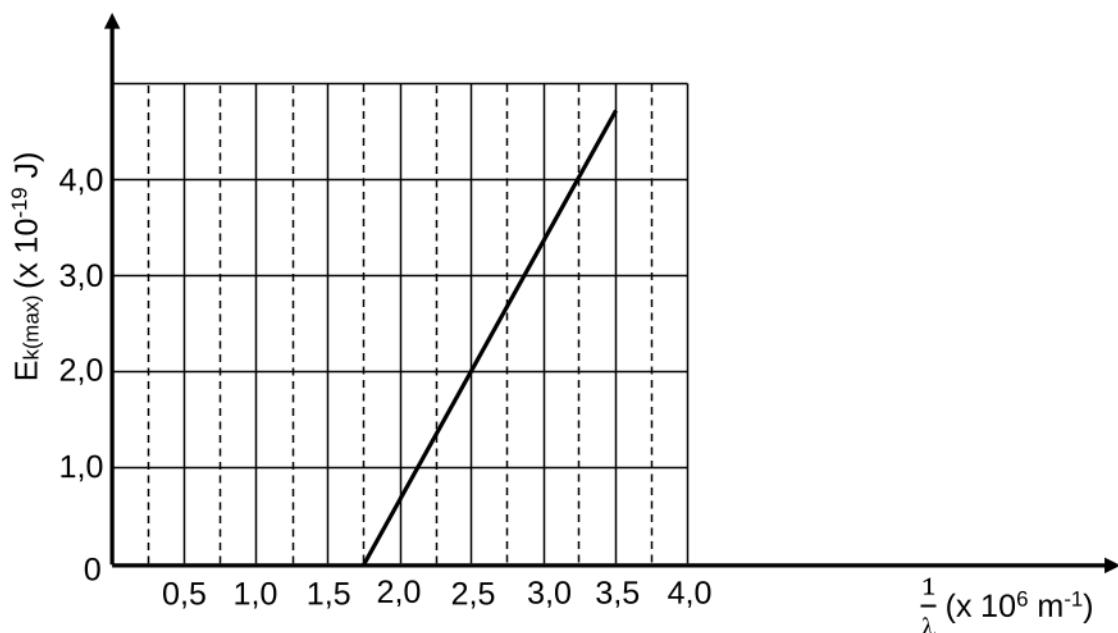
- 10.1 Define the term *work function* of a metal in words. (2)
- 10.2 Use the graph to determine the threshold frequency of the metal. (3)
- 10.3 Calculate the work function of the metal. (3)
- Caesium metal has a work function of  $2,48625 \times 10^{-19} \text{ J}$ .
- 10.4 On the graph paper provided, draw a graph to show the variation of the maximum kinetic energy  $E_{k(\max)}$  for caesium metal with  $\frac{1}{\lambda}$ . Label your graph P.  
Show, by means of a suitable calculation, how you have arrived at the  $\frac{1}{\lambda}$ -intercept (5)
- [13]**

**TOTAL: 150**

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**QUESTION 10.4**

Name of learner: .....



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## DATA FOR PHYSICAL SCIENCES GRADE 12

### PAPER 1 (PHYSICS)

**TABLE 1: PHYSICAL CONSTANTS**

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 m·s <sup>-2</sup>
Universal gravitational constant	G	6,67 × 10 <sup>-11</sup> N·m <sup>2</sup> ·kg <sup>-2</sup>
Speed of light in a vacuum	c	3,0 × 10 <sup>8</sup> m·s <sup>-1</sup>
Planck's constant	h	6,63 × 10 <sup>-34</sup> J·s
Coulomb's constant	k	9,0 × 10 <sup>9</sup> N·m <sup>2</sup> ·C <sup>-2</sup>
Charge on electron	e	-1,6 × 10 <sup>-19</sup> C
Electron mass	m <sub>e</sub>	9,11 × 10 <sup>-31</sup> kg

**Downloaded from Stanmorephysics.com****TABLE 2: FORMULAE****MOTION**

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

**FORCE**

$F_{net} = ma$	$p = mv$
$F_{net} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{r^2}$	$g = \frac{Gm}{r^2}$

**WORK, ENERGY AND POWER**

$W = F \Delta x \cos \theta$	$U = mgh$ OR $E_p = mgh$
$K = \frac{1}{2} mv^2$ OR $E_k = \frac{1}{2} mv^2$	$W_{net} = \Delta K$ OR $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = F v_{ave}$	

**Downloaded from Stanmorephysics.com****WAVES, SOUND AND LIGHT**

$v = f \lambda$	$T = \frac{1}{f}$
$f_L = \frac{V \pm V_L}{V \pm V_s} f_s$	$E = hf \quad \text{OR} \quad E = h \frac{c}{\lambda}$
$E = W_o + K_{\max} \quad \text{OR} \quad E = W_o + E_{k(\max)}$ where $E = hf \quad \text{and} \quad W_o = hf_o \quad \text{and} \quad K_{\max} = \frac{1}{2}mv_{\max}^2 \quad \text{OR} \quad E_{k(\max)} = \frac{1}{2}mv_{\max}^2$	

**ELECTROSTATICS**

$F = \frac{kQ_1 Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e} \quad \text{OR} \quad n = \frac{Q}{q_e}$	

**ELECTRIC CIRCUITS**

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

**ALTERNATING CURRENT**

$I_{\text{rms}} = \frac{I_{\text{max}}}{\sqrt{2}}$ $V_{\text{rms}} = \frac{V_{\text{max}}}{\sqrt{2}}$	$P_{\text{average}} = V_{\text{rms}} I_{\text{rms}}$ $P_{\text{average}} = I_{\text{rms}}^2 R$ $P_{\text{average}} = \frac{V_{\text{rms}}^2}{R}$
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SERTIFIKAAT**

**GRADE/GRAAD 12**

**PHYSICAL SCIENCES: PHYSICS (P1)  
FISIESE WETENSKAPPE (V 1)**

**SEPTEMBER 2021**

**MARKING GUIDELINES**

**NASIENRIGLYNE**

**MARKS/PUNTE: 150**

**These marking guidelines consists of 16 pages./ Hierdie nasienriglyne bestaan uit 16 bladsye.**

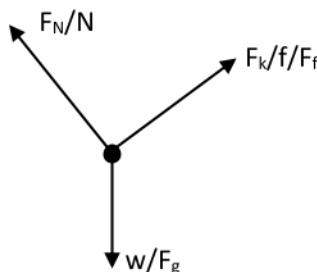
**QUESTION 1/VRAAG 1**  
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- |      |      |                    |
|------|------|--------------------|
| 1.1  | A ✓✓ | (2)                |
| 1.2  | D ✓✓ | (2)                |
| 1.3  | B ✓✓ | (2)                |
| 1.4  | B ✓✓ | (2)                |
| 1.5  | C ✓✓ | (2)                |
| 1.6  | C ✓✓ | (2)                |
| 1.7  | D ✓✓ | (2)                |
| 1.8  | A ✓✓ | (2)                |
| 1.9  | A ✓✓ | (2)                |
| 1.10 | C ✓✓ | (2)<br><b>[20]</b> |

**QUESTION 2/VRAAG 2**  
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- 2.1 The force that opposes the motion of an object✓ and which acts parallel to the surface. ✓  
*Die krag wat die beweging van 'n voorwerp teenwerk✓ en wat parallel met die oppervlak inwerk.✓* (2)

2.2



Accepted symbols	
$F_N$ ✓	$N$ /Normal force/ $N$ /normaal-krag
$f$ ✓	$F_f$ / $f_k$ /frictional force/kinetic frictional force $F_f$ / $f_k$ /wrywingskrag/kinetiese wrywingskrag
$w$ ✓	$F_g$ / $mg$ / weight /Gravitational force/ $F_{\text{Earth on box}}$ $F_g$ / $mg$ /gewig/gravitasie krag/ $F_{\text{aarde op blok}}$

**NOTES/**

- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If all forces are correctly drawn and labelled, but no arrows, deduct 1 mark.
- If force(s) do not make contact with the dot:  
max.  $\frac{2}{3}$

**LET WEL**

Punt word toegeken vir byskrif en pylpunt.  
 Moenie straf vir die lengte van pyle nie.  
 Trek 1 punt af vir enige bykomende krag.  
 As alle kragte korrek getrek en gemerk word,  
 maar geen pyle nie, trek 1 punt af.  
 Indien krag(te) nie kontak met die kolletjie maak  
 nie: maksimum. 2/3

(3)

2.3

OPTION 1:/OPSIE 1	OPTION 2:/ OPSIE 2	Marking Criteria:/ <u>nasien riglyne</u>
$a = \text{gradient}$ $= \frac{\Delta v}{\Delta t}$ $= \frac{6-2,5}{2,0-0} \checkmark$ $= 1,75 \text{ m}\cdot\text{s}^{-2}$	$\checkmark$ Any one Enige een $v_f = v_i + a\Delta t \checkmark$ $6 = 2,5 \checkmark + a(2) \checkmark$ $a = 1,75 \text{ m}\cdot\text{s}^{-2}$	$\text{Gradient} / \frac{\Delta v}{\Delta t} \checkmark$ Numerator as shown ✓ Denominator as shown ✓ $\text{Teller} \checkmark \text{ en noemer} \checkmark \text{getoon}$

2.4 When a (non-zero) resultant/net force acts on an object, the object accelerates in the direction of the (net) force at an acceleration which is directly proportional to the (net) force ✓ and inversely proportional to the mass of the object. ✓

**OR**

The (non-zero) 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 force.

Wanneer 'n (nie-nul) resultante / netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die (netto) krag teen 'n versnelling wat direk eweredig is aan die (netto) krag ✓ en omgekeerd eweredig aan die massa van die voorwerp. ✓

**OF**

Die (nie-nul) resultante / netto krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp in die rigting van die resultante krag.

(2)

2.5.1

$$\begin{aligned} F_{\text{net}} &= ma \checkmark \\ &= (65) (1,75) \checkmark \\ &= 113,75 \text{ N, downhill} \\ &\quad \text{afwaarts} \checkmark \end{aligned}$$

**Marking criteria:Nasienriglyne:**

- Formula ✓ /formule✓
- Substitution ✓ /vervanging✓
- Magnitude + direction ✓ /grootte en rigting✓

(3)

2.5.2

**POSITIVE MARKING FROM QUESTION 2.5.1**  
**POSITIEWE NASIEN VANAF VRAAG 2.5.1**

$$\begin{aligned} F_{\text{net}} &= ma \\ w_{\parallel} + (-f_k) &= ma \\ mgs \sin \theta - f_k &= ma \\ \therefore (65) (9,8) (\sin 20^\circ) \checkmark - f_k &= (65) (1,75) \checkmark \\ \therefore 217,8668 - f_k &= 113,75 \\ \therefore 217,8668 - 113,75 &= f_k \\ \therefore 104,1168 \text{ N} &= f_k \checkmark \\ \therefore \text{The kinetic frictional force/die kinetiese wrywingskrag is} \\ &104,1168 \text{ N} \end{aligned}$$

(4)  
[17]

**QUESTION 3/VRAAG 3**  
**Downloaded From Stanmorephysics.com**

3.1 Free fall ✓/vryval✓

(1)

3.2.1 **Consider the window (bottom to top) / Beskou die venster(onder tot bo)**

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

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

$$\therefore v_i = 14,06833 \text{ m}\cdot\text{s}^{-1}$$

**Now consider motion from ground to bottom of the window:**  
**Oorweeg nou beweging vanaf die grond tot onderkant die venster**

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

$$\therefore (14,06833)^2 \checkmark = v_i^2 + 2(-9,8)(10,0) \checkmark$$

$$\therefore v_i^2 = 393,918$$

$$\therefore v_i = \pm 19,85 \text{ m}\cdot\text{s}^{-1}$$

$$\therefore \text{The launch speed is/ Die lanseringsnelheid is } 19,85 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(5)

3.2.2

**OPTION 1:/OPSIE 1**

**Consider motion from bottom of window up:**  
**Oorweeg beweging van onder venster boontoe:**

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

$$\therefore (0)^2 = (14,06833)^2 + 2(-9,8)\Delta y \checkmark$$

$$\therefore \Delta y = 10,0979 \text{ m} \checkmark$$

$$\therefore \text{The height/die hoogte is } 10,0 \checkmark + 10,0979 = 20,0979 \text{ m}$$

**OPTION 2:/OPSIE 2**

**Consider motion from ground:**  
**Oorweeg beweging van die grond af:**

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

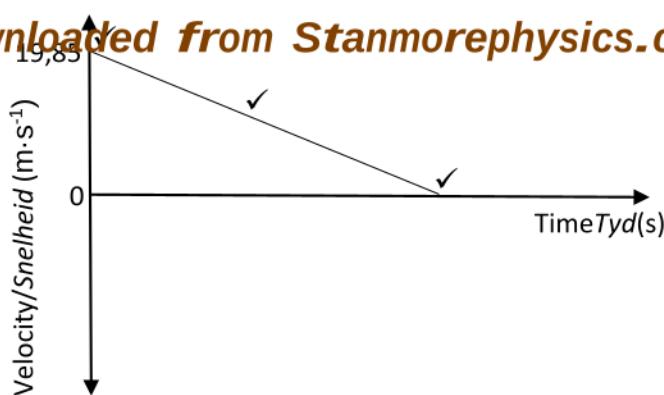
$$\therefore (0)^2 \checkmark = (19,85)^2 + 2(-9,8)\Delta y$$

$$\therefore \Delta y = 20,1032 \text{ m}$$

$$\therefore \text{The height/die hoogte is } 20,1032 \text{ m} \checkmark$$

(4)

33

**Downloaded from Stanmorephysics.com****Marking criteria:****Nasienriglyne**

- Shape ✓ / vorm ✓
- Launch velocity ✓ / lanceringssnelheid ✓
- Velocity at max. height / v = 0 ✓ / snelheid by max hoogte / v=0 ✓

(3)

3.4    9,8 m·s⁻² ✓

(1)

[14]

**QUESTION 4/VRAAG 4**

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

*Die totale (lineêre) momentum van 'n geslote sisteem bly konstant (bly behoue) ✓✓*

(2)

4.2 For the block:

Vir die blok:

$$f_k = 1,96 \text{ N}$$

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

$$\therefore -1,96 \checkmark = (1)a \checkmark$$

$$\therefore a = -1,96 \text{ m} \cdot \text{s}^{-2}$$

$$V_f^2 = V_i^2 + 2a\Delta x$$

$$\therefore (0)^2 = V_i^2 + 2(-1,96)(0,09) \checkmark$$

$$\therefore 0 = V_i^2 - 0,3528$$

$$\therefore V_i = 0,59\ 397 \text{ m} \cdot \text{s}^{-1}$$

$$P_{\text{block}} = mv$$

$$= (1)(0,59\ 397) \checkmark$$

$$= 0,59\ 397 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$$

$$\sum p_i = \sum p_f \checkmark$$

$$(0,002)V_{bi} + 0 = (1)(0,59397) + (0,002)(50) \checkmark$$

$$V_{bi} = 346,985 \text{ m} \cdot \text{s}^{-1} \checkmark$$



**Downloaded from Stannmorephysics.com**

The bullet transferred  $0,59\ 397\ \text{kg}\cdot\text{m}\cdot\text{s}^{-1}$  of its momentum to the block /

Die koeël het  $0,59\ 397\ \text{kg}\cdot\text{m}\cdot\text{s}^{-1}$  van sy momentum na die blok oorgedra

∴ Total initial momentum of the bullet,/

Totale aanvanklike momentum van die koeël,

$$p_{\text{bullet/koeël}} = mv_{\text{bullet/koeël}} + p_{\text{block/blok}}$$

$$= (0,002)(50) + \checkmark 0,59\ 397$$

$$= 0,69\ 397\ \text{kg}\cdot\text{m}\cdot\text{s}^{-1}$$

But/maar  $p_{bi} = m_b v_{bi}$

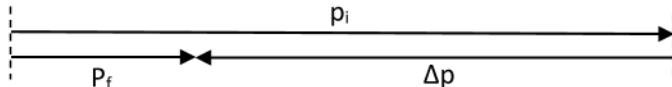
$$\therefore 0,69397 = (0,002)v_{bi} \checkmark$$

$$\therefore v_{bi} = \frac{0,69397}{(0,002)}$$

$$= 346,985\ \text{m}\cdot\text{s}^{-1} \checkmark$$

(7)

4.3



#### Marking criteria/Nasienriglyne

- Initial and final momenta correct ✓/ Aanvanklike en finale momentum korrek ✓
- Change in momentum correctly drawn ✓/ Verandering in momentum korrek getrek ✓

(2)

[11]

## QUESTION 5/VRAAG 5

5.1 The total mechanical energy (sum of the gravitational potential energy and kinetic energy) in an isolated system remains constant (is conserved). ✓✓

Die totale meganiese energie (som van die swaartekrag potensiële energie en kinetiese energie) in 'n geslote sisteem bly konstant (bly behoue). ✓✓

(2)

5.2

$$(E_k + E_p)_B = (E_k + E_p)_A$$

$$\left. \begin{aligned} (\frac{1}{2}mv^2 + mgh)_B &= (\frac{1}{2}mv^2 + mgh)_A \\ (\frac{1}{2}mv^2 + m(9,8)(0)) \checkmark &= \frac{1}{2}m(0)^2 + m(9,8)(5) \checkmark \end{aligned} \right\} \checkmark \text{ Any one/enige een}$$

$$\frac{1}{2}v^2 + 0 = 0 + 49$$

$$\therefore v = 9,8995\ \text{m}\cdot\text{s}^{-1} \checkmark$$

∴ The speed of the block/ Die spoed van die blok is  $9,8995\ \text{m}\cdot\text{s}^{-1}$

Accept/aanvaar: **9,90 m·s<sup>-1</sup>**

(4)

5.3 ~~OPTION 1/OPSIE 1~~ **Downloaded From Stanmorephysics.com**

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

$$W_w + W_{fk} + W_{FN} = \Delta E_k$$

$$mg\Delta x \cos\theta + f_k \Delta x \cdot \cos\beta + 0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$mg\Delta x \cos\theta + \mu_k \cdot mg \cos\alpha \cdot \Delta x \cdot \cos\beta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\underline{(9,8)\Delta x \cos 120^\circ} \checkmark + \underline{(0,35)(9,8) \cos 30^\circ \cdot \Delta x \cos 180^\circ} \checkmark = \frac{1}{2}(0)^2 - \frac{1}{2}(9,8995)^2 \checkmark$$

$$\therefore (-4,9)\Delta x - (2,9705)\Delta x = -49$$

$$\therefore (-7,8705)\Delta x = -49$$

$$\therefore \Delta x = 6,2258 \text{ m}$$

$$\text{But/maar } \frac{h}{\Delta x} = \sin 30^\circ \checkmark$$

$$\therefore h = (\sin 30^\circ)(6,2258) \checkmark$$

$$\therefore h = 3,113 \text{ m}$$

✓ Any one/enige een

**NOTE/LET WEL;**

$W_w$  can also be calculated as follows/  
 $W_w$  kan ook soos volg bereken word:

$$W_w = W_{\parallel} \Delta x \cos\theta$$

$$= mgsin\alpha \cdot \Delta x \cdot \cos\theta$$

$$= m(9,8)(\sin 30^\circ) \Delta x \cdot \cos\theta$$

**OR/OF:**

$$W_w = -\Delta E_p$$

$$= mgh_i - mgh_f$$

$$= m(9,8)(0) - m(9,8)h$$

$$= -m(9,8)h$$

**OPTION 2/OPSIE 2****Downloaded From Stanmorephysics.com**

$$W_{nc} = \Delta E_p + \Delta E_k$$

$$f_k \Delta x \cdot \cos\beta = mgh_f - mgh_i + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\mu_k \cdot mg \cos\alpha \cdot \Delta x \cdot \cos\beta = mgh_f - mgh_i + \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$(0,35)m(9,8)(\cos 30^\circ)\Delta x(\cos 180^\circ) \checkmark = m(9,8)h - m(9,8)(0) \checkmark + 0 - \frac{1}{2}m(9,8995)^2 \checkmark$$

$$(-2,970467135)\Delta x \cdot m = m(9,8)h - 49 \cdot m$$

$$(-2,970467135)\Delta x = (9,8)h - 49$$

$$(-2,970467135)\left(\frac{h}{\sin 30^\circ}\right) \checkmark = (9,8)h - 49$$

$$(-5,94093427)h = (9,8)h - 49$$

$$49 = (9,8)h + (5,94093427)h$$

$$49 = (15,74093427)h \checkmark$$

$$\therefore h = 3,113 \text{ m}$$

} ✓ Any one/enige een

(6)  
[12]

**QUESTION 6/VRAAG 6**

- 6.1 • Doppler effect ✓  
 • The apparent 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. ✓✓

- *Doppler effek* ✓

*Die skynbare 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.* ✓✓

(3)

**6.2** ~~Downloaded from Stanmorephysics.com~~

$$f_1 = \left( \frac{340+0}{340-15} \right) f_s \quad (\text{ignore 0 if omitted/ ignoreer 0 indien uitgelaat})$$

$$f_1 = \left( \frac{68}{65} \right) f_s \quad \checkmark \quad \dots\dots (1)$$

$$f_2 = \left( \frac{340+25}{340+0} \right) f_s \quad (\text{ignore 0 if omitted/ ignoreer 0 indien uitgelaat})$$

$$f_2 = \left( \frac{73}{68} \right) f_s \quad \checkmark \quad \dots\dots (2)$$

$$(1) - (2)$$

$$\therefore f_2 - f_1 = \left( \frac{73}{68} \right) f_s - \left( \frac{68}{65} \right) f_s$$

$$\therefore 37 = f_s \left( \frac{73}{68} - \frac{68}{65} \right)$$

$$\therefore 37 = f_s \left( \frac{121}{4420} \right)$$

$$\therefore 1351,57 \text{ Hz} = f_s \quad \checkmark$$

$\therefore$  The frequency of the source/die frekwensie van die bron is  
1351,57 Hz

(6)

**6.3** **POSITIVE MARKING FROM Q6.2/POSITIEWE NASIEN VANAF V 6.2**

$$v = f\lambda \quad \checkmark$$

$$\therefore 340 = (1 351,57)\lambda \quad \checkmark$$

$$\therefore \lambda = 0,2516 \text{ m} \quad \checkmark$$

$\therefore$  The wavelength/die golflengte is 0,2516 m

] (3)

**6.4** **ANY ONE/ENIGE EEN:**

- Measuring the rate of blood flow in humans and animals. ✓
- Measuring the heartbeat of a foetus in the womb. ✓
- Ultrasound (scanning) ✓

*Meet die tempo van bloedvloei in mense en diere.* ✓

*Meet die hartklop van 'n fetus in die baarmoeder.* ✓

*Ultralank (skandering)* ✓

(1)

**6.5** Red shift/rooi verskuwing ✓

(1)

[14]

## Question 7/VRAAG 7

Downloaded From Stanmorephysics.com

- 7.1 The magnitude of the electrostatic force exerted by one point charge (Q<sub>1</sub>) on another point charge (Q<sub>2</sub>) is directly proportional to the product of the magnitudes of the charges✓ and inversely proportional to the square of the distance(r) between them.✓

*Die grootte van die elektrostatisiese krag wat deur een puntlading (Q<sub>1</sub>) op 'n ander puntlading (Q<sub>2</sub>) 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)

7.2.1

$$F = \frac{KQ_1Q_2}{r^2} \checkmark$$

$$\therefore 2,88 \times 10^{-1} \checkmark = \frac{(9 \times 10^9)Q^2}{(0,5)^2} \checkmark$$

$$\therefore Q^2 = 8 \times 10^{-12}$$

$$\therefore Q = 2,828 \times 10^{-6} \text{ C} \checkmark$$

(4)

7.2.2

**POSITIVE MARKING FROM QUESTION 7.2. /**  
**POSITIEWE NASIEN VANAF V 7.2:**

$$n = \frac{Q}{e} \text{ or/of } n = \frac{Q}{q_e} \checkmark$$

$$\therefore n = \frac{2,828 \times 10^{-6}}{1,6 \times 10^{-19}} \checkmark$$

$$\therefore n = 1,7675 \times 10^{13} \checkmark \text{ electrons/elektrone}$$

(3)

- 7.3 The electrostatic force experienced per unit positive charge placed at that point.✓✓

*Die elektrostatisiese krag per eenheid positiewe-lading wat by daardie punt geplaas is.✓✓*

(2)

- 7.4 West/wes ✓

(1)

75

**POSITIVE MARKING FROM QUESTION 7.2.1 /  
POSITIEWE NASIEN VANAF V 7.2.1:**

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

Take → as positive direction

$$E_{\text{net}} = E_y + (-E_x)$$

$$\therefore 4 \times 10^4 = \frac{(9 \times 10^9)Q_{yf}}{(0,8)^2} - \frac{(9 \times 10^9)(2,828 \times 10^{-6})}{(1,3)^2} \checkmark$$

$$\therefore 4 \times 10^4 = (1,40625 \times 10^{10})Q_{yf} - 15060,35503$$

$$\therefore Q_{yf} = 3,9154 \times 10^{-6} \text{ C}$$

$$\Delta Q_y = Q_{yf} - Q_{yi}$$

$$\Delta Q_y = 3,9154 \times 10^{-6} - \checkmark (-2,828 \times 10^{-6})$$

$$\Delta Q_y = 6,7434 \times 10^{-6} \text{ C}$$

$$n = \frac{Q}{e} \text{ or } n = \frac{Q}{q_e} \checkmark$$

$$\therefore n = \frac{6,7434 \times 10^{-6}}{1,6 \times 10^{-19}} \checkmark$$

$$\therefore n = 4,215 \times 10^{13} \checkmark \text{ electrons}$$

$$\text{Range :} 4,206 \times 10^{13} \text{ to } 4,215 \times 10^{13}$$

**Marking criteria:**

- 1 mark for formula  $E = \frac{KQ}{r^2}$
- 1 mark EACH for substitutions in  $E_y$  and  $E_x$
- 1 mark for  $\Delta Q_y$
- 1 mark for formula  $n = \frac{Q}{e}$
- 1 mark for substitution in formula
- 1 mark for final answer

(7)

[19]

**QUESTION 8/VRAAG 8**

8.1 The maximum energy/work done supplied by a battery per unit charge/coulomb of charge passing through it. ✓✓

*Die maksimum energie/arbeid wat 'n battery lewer per eenheidslading/coulomb van lading wat daardeur vloei.* ✓✓

(2)

8.2

$$\frac{R_s}{R_p} = \frac{R_1 + R_2}{(\frac{R_1 R_2}{R_1 + R_2})} \checkmark$$

$$= \frac{x + x}{(\frac{x \cdot x}{x + x})} \checkmark$$

$$= \frac{2x}{(\frac{x^2}{2x})}$$

$$= 2x \cdot \frac{2x}{x^2}$$

$$= \frac{4x^2}{x^2}$$

$$= 4$$

$$\therefore R_s = 4R_p$$

(3)

8.3.1

**Downloaded from Stanmorephysics.com**

$$\therefore 12 = (1,2)(x + x+r) \checkmark$$

$$\therefore 12 = (1,2)(2x + r)$$

$$\therefore 10 = 2x + r \dots\dots\dots(1)$$

$$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2} = \frac{x \cdot x}{x + x} = \frac{x \cdot x}{2x} = \left(\frac{x}{2}\right)\Omega$$

$$\epsilon = I_2(R + r)$$

$$\therefore 12 = (3,0)\left(\frac{x}{2} + r\right) \checkmark$$

$$\therefore 4 = \frac{x}{2} + r$$

$$\therefore 8 = x + 2r \dots\dots\dots(2)$$

$$\text{From/vanaf (1): } r = 10 - 2x \dots\dots\dots(3)$$

Sub. (3) into (2): *vervang (3) in (2)*

$$\therefore x + 2(10 - 2x) = 8$$

$$\therefore x + 20 = 4x - x$$

$$\therefore 12 = 3x$$

$$\therefore x = 4,0 \Omega \checkmark$$

**Marking Criteria**

- 1 mark for substituting the emf equation for Circuit 1(series)
- 1 mark for substituting the emf equation in Circuit 2(parallel)
- Final Answer **Nasienkriteria**
- 1 punt vir die vervanging van die emk vergelyking vir stroombaan 1
- 1 punt vir die vervanging van die emk vergelyking in stroombaan 2
- Finale Antwoord

(3)

8.3.2

**POSITIVE MARKING FROM 8.3.1: / POSITIEWE NASIEN VANAF V 8.3.1:**

Sub./vervang  $x = 4,0$  into/in (3):

$$r = 10 - 2(4) \checkmark$$

$$= 2 \Omega \checkmark$$

(2)

8.4

**POSITIVE MARKING FROM QUESTION 8.3: / POSITIEWE NASIEN VANAF V 8.3:**

$$P = I^2R \checkmark$$

$$\text{Ratio/verhouding} = \frac{I^2R}{I^2X}$$

$$= \frac{(1,2)^2 \times (4,0)}{(1,5)^2 \times (4,0)} \checkmark \\ = 0,64 \checkmark$$

$$= 0,64 \checkmark$$

(4)

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8.5 NO CHANGE ✓ When one of the bulbs burns out, potential difference/ current and the resistance across the other bulb remains the same. ✓✓

GEEN VERANDERING ✓ Wanneer een van die gloeilampe uitbrand, bly die potensiaalverskil / stroom en die weerstand oor die ander gloeilamp dieselfde. ✓✓

(3)

[17]

**QUESTION 9/VRAAG 9**

9.1.1 The rms value of AC is the AC current which dissipates the same amount of energy as DC. ✓✓

OR: The root mean square current is the value of the current in an AC circuit that will have the same heating effect as a DC circuit. ✓✓

*Die wkg is die WS wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente GS.* ✓✓

*OF: Die wkg stroom is die waarde van die stroom in 'n WS-stroombaan wat dieselfde verwarmingseffek as 'n GS-stroombaan sal hê.*

(2)

9.1.2

$$T = \frac{1}{f} \quad \checkmark$$

$$\therefore T = \frac{1}{50} \quad \checkmark$$

$$\therefore T = 0,02 \text{ s}$$

$$\therefore x = \frac{0,02}{2}$$

$$\therefore x = 0,01 \text{ s} \quad \checkmark$$

(3)

9.1.3

**OPTION 1/ OPSIE 1:**

$$P_{ave} = I_{rms}V_{rms} \quad \checkmark$$

$$\therefore 1800 = I_{rms}(240) \quad \checkmark$$

$$\therefore I_{rms} = 7,50 \text{ A} \quad \checkmark$$

**OPTION 2/OPSIE 2:**

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

$$\therefore I_{rms} = \frac{10,6}{\sqrt{2}} \quad \checkmark$$

$$\therefore I_{rms} = 7,4953 \text{ A} \quad \checkmark$$

(3)

<u>OPTION 1/ OPSIE 1:</u> $P_{ave} = I^2_{rms}R \checkmark$ $\therefore 1800 = (7,4953)^2R \checkmark$ $\therefore R = 32,04 \Omega \checkmark$	<u>OPTION 2/ OPSIE 2:</u> $P_{ave} = \frac{V^2_{rms}}{R} \checkmark$ $\therefore 1800 = \frac{(240)^2}{R} \checkmark$ $\therefore 32,00 \Omega \checkmark$
<u>OPTION 3/ OPSIE 3:</u>  $R = \frac{V_{rms}}{I_{rms}} \checkmark$ $\therefore R = \frac{240}{7,4953} \checkmark$ $\therefore R = 32,02 \Omega \checkmark$	<u>OPTION 4/ OPSIE 4 :</u>  $R = \frac{V_{max}}{I_{max}} \checkmark$ $\therefore R = \frac{\sqrt{2}(240)}{10,6} \checkmark$ $\therefore R = 32,02 \Omega \checkmark$

(3)

- 9.2.1 With AC, transformers can be used to step up voltage/step down current. ✓ (1)

*Met WS kan transformators gebruik word om spanning te verhoog/stroom te verlaag*

- 9.2.2 Heat/energy loss by transmission cables is minimised by high voltage transmission. ✓ (1)  
*Hitte/energie verlies deur transmissie kabels word verminder deur 'n hoë spanning.* ✓

[13]

## QUESTION 10/VRAAG 10

- 10.1 The minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓✓  
 Die minimum energie wat 'n elektron in die metaal benodig, om uit die metaaloppervlak vrygestel te word. ✓✓ (2)

$\frac{1}{\lambda_0} = 1,75 \times 10^6 \checkmark$  $c = f_0 \lambda_0$ $\therefore c \cdot \frac{1}{\lambda_0} = f_0$ $\therefore (3 \times 10^8)(1,75 \times 10^6) \checkmark = f_0$ $\therefore f_0 = 5,25 \times 10^{14} \text{ Hz} \checkmark$
---

(3)

**10.3 POSITIVE MARKING FROM QUESTION 10.2/  
Downloaded from Stannmorephysics.com****POSITIEWE NASIEN VANAF V 10.2:**

$$W_0 = hf_0 \checkmark$$

$$W_0 = (6,63 \times 10^{-34})(5,25 \times 10^{14}) \checkmark$$

$$W_0 = 3,48\ 075 \times 10^{-19} \text{ J} \checkmark$$

(3)

10.4  $W_0 = hf_0$        $\left. W_0 = \frac{hc}{\lambda_0} \right\} \checkmark$  Any one/enige een

$$\therefore 2,49625 \times 10^{-19} \checkmark = (6,63 \times 10^{-34})(3 \times 10^8) \cdot \frac{1}{\lambda_0} \checkmark$$

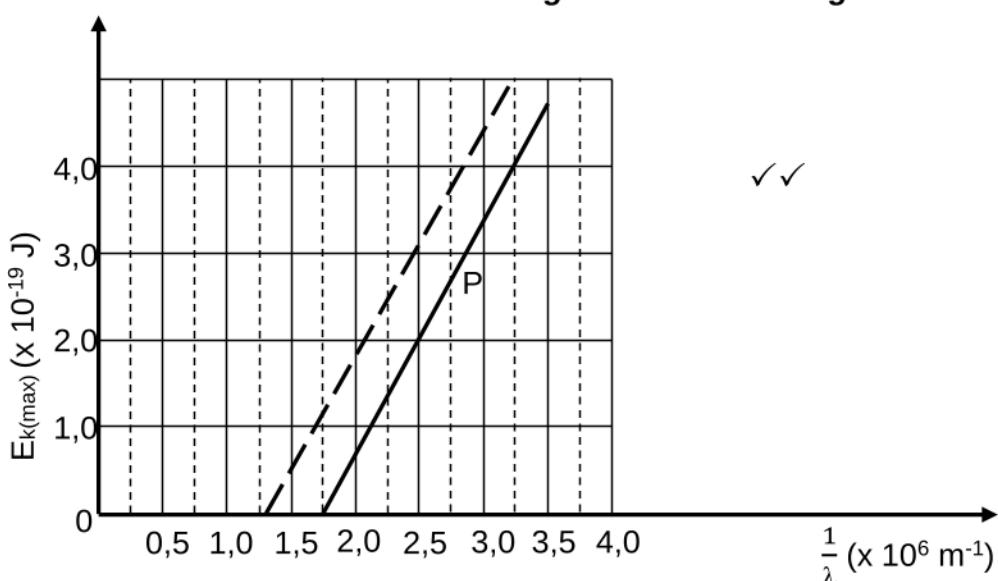
$$\therefore \frac{1}{\lambda_0} = 12\ 50000 \text{ m}^{-1}$$

$$= 1,25 \times 10^6 \text{ m}^{-1}$$

$\therefore$  The graph p is parallel the original graph, but cuts the x – axis at  $1,25(\times 10^6 \text{ m}^{-1})$ . / Die grafiek p is parallel met die oorspronklike grafiek, maar sny die x - as by  $1,25(\times 10^6 \text{ m}^{-1})$ . (See graph below./ sien die grafiek hieronder)

**Graph of maximum kinetic energy versus the reciprocal of  $\lambda$ .**/

**Grafiek van maksimum kinetiese energie teenoor die omgekeerde van  $\lambda$ .**

**Marking criteria:**

- Formula /formule✓
- Left hand substitution /linkerhand vervanging✓
- Right hand substitution/ regterhand vervanging ✓
- x – intercept at  $1,25(\times 10^6 \text{ m}^{-1})$  /x - sny by  $1,25(\times 10^6 \text{ m}^{-1})$  ✓
- Graph P parallel original graph/ Grafiek P parallel aan oorspronklike grafiek✓

(5)  
[13]**GRAND TOTAL/GROOT TOTAAL:****[150]**