education

Department of Education
FREE STATE PROVINCE

# PREPARATORY EXAMINATION

## GRADE 12

# PHYSICAL SCIENCES: PHYSICS (P1)

## SEPTEMBER 2022

## MARKS: 150

## TIME: 3 HOURS

**This question paper consists of 14 pages and 3 data sheets.**

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## INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of 10 questions. Answer ALL 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. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places where applicable.

10. Give brief motivations, discussions, et cetera where required.

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

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## QUESTION 1: MULTIPLE-CHOICE QUESTION

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

1.1 A block is at rest on a table. Which ONE of the following best describes the normal force acting in this situation?

A Force of the block on the table.
B Force of the table on the block.
C Force of the table on the earth.
D Force of the block on the earth. (2)

1.2 An object moving at a constant velocity has momentum *p* and kinetic energy *E*. What will the kinetic energy of the object be if its momentum is changed to *2p* while its mass remains constant?

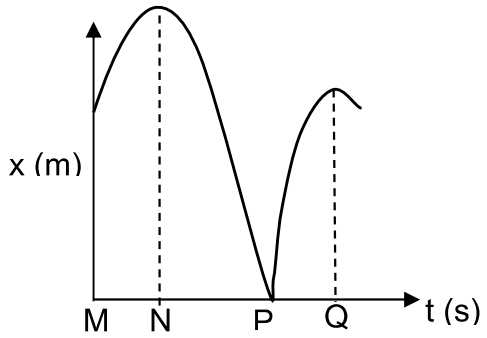
A $\frac{1}{4}$ E

B $\frac{1}{2}$ E

C 2 E

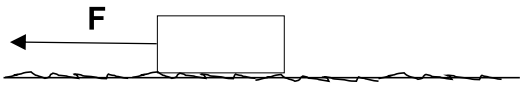
D 4 E (2)

1.3 The position-time graph below shows the motion of a ball that is thrown vertically UPWARDS. It bounces off the ground. At what time during its motion does the ball have the most kinetic energy?




A M
B N
C Q
D P (2)

1.4 A block being pulled by force **F** and moving to the left on a rough horizontal surface, is slowing down.




The directions of the resultant force and the acceleration are:

| | DIRECTION OF THE RESULTANT FORCE | DIRECTION OF THE ACCELERATION |
|---|---|---|
| A | to the right | to the left |
| B | to the right | to the right |
| C | to the left | to the left |
| D | to the left | to the right |

(2)

1.5 Which ONE of the following units is equivalent to the watt?

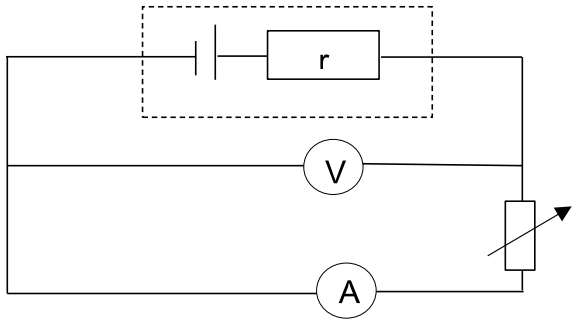
A $A \cdot \Omega$

B $A \cdot V^{-1}$

C $A \cdot V$

D $A \cdot \Omega^2$ (2)

1.6 A variable resistor is included in the circuit below.



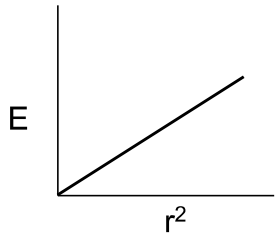

The resistance of the variable resistor is decreased. Which ONE of the following combinations of changes will occur in the ammeter and voltmeter readings?

| | AMMETER READING | VOLTMETER READING |
|---|---|---|
| A | Unchanged | Unchanged |
| B | Increases | Decreases |
| C | Unchanged | Decreases |
| D | Increases | Increases |

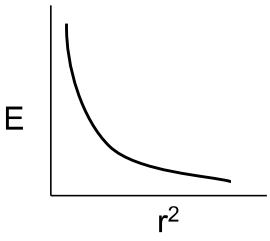
(2)

1.7 Which of the following graphs best represents the relationship between the electric field **E** caused by a point charge at a point and the distance **r** of that point from the point charge?

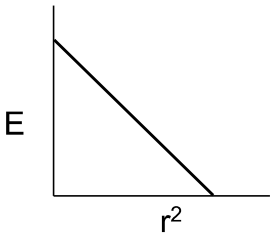
A



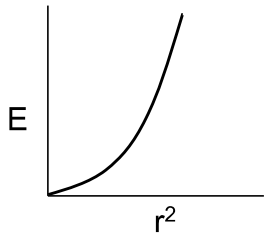

B




C

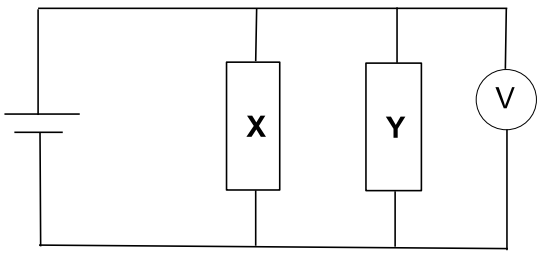



D




(2)

1.8 In the circuit below the resistance of **X** is R, and that of **Y** is 2R.




If the power dissipated by **Y** is P, then the power dissipated by **X** will be …

A $\frac{1}{4}$ P

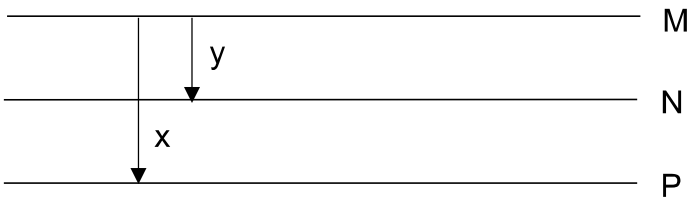
B $\frac{1}{2}$ P

C 2 P

D 4 P

(2)

1.9 The diagram shows three energy levels (M, N and P) in an atom.




The energy related to the photon ejected due to transition **x** is DOUBLE that of the photon ejected during transition **y**.

The wavelength of the photon ejected due to transition **x** is $\lambda$. The wavelength of the photon ejected due to transition **y** will be …

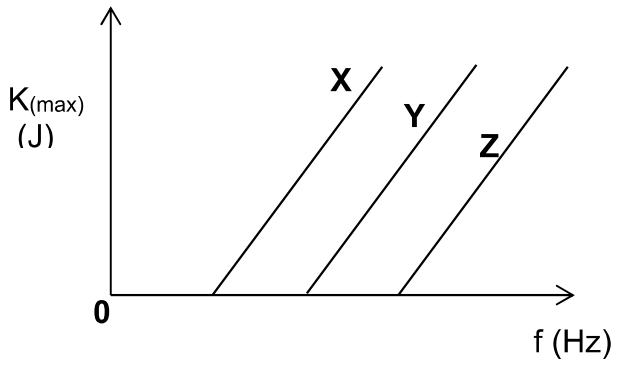
A $\frac{1}{3}\lambda$

B $\frac{1}{2}\lambda$

C $2\lambda$

D $3\lambda$ (2)

1.10 The graph below shows three different results (**X**, **Y** and **Z**) of an experiment involving the photoelectric effect.




Which ONE of the following best explains the lines X, Y and Z on the graph?

A The same metal, with a different threshold frequency is used.

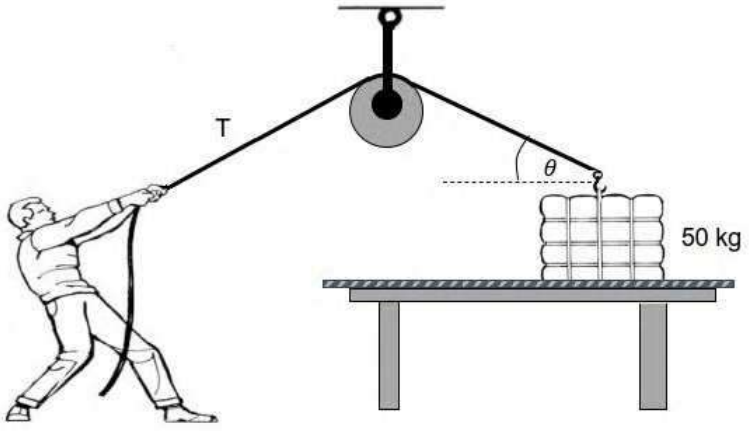
B The same metal, with the same threshold frequency is used.

C Different metals, all with the same threshold frequencies are used.

D Different metals, all with different threshold frequencies are used. (2)
**[20]**

## QUESTION 2

A man applies a constant pulling force to move a heavy parcel of mass 50 kg horizontally using a light inextensible rope which passes over a light frictionless pulley, as shown in the diagram below. The parcel stays at rest. The magnitude of the maximum static frictional force experienced by the parcel is 120 N and the coefficient of maximum static friction for the two surfaces is 0,34.




2.1 Draw a labelled free-body diagram showing ALL forces exerted on the parcel. (4)

2.2 Define the term *frictional force* in words. (2)

2.3 Calculate the magnitude of the vertical component of the tension in the rope. (4)

2.4 Determine the magnitude of the tension in the rope (**T**). (4)

2.5 The man now increases the magnitude of his pulling force. Under the action of this new constant force, the parcel begins to slide horizontally along the table.

How will the magnitude of the following forces change as the parcel begins to slide across the table surface?

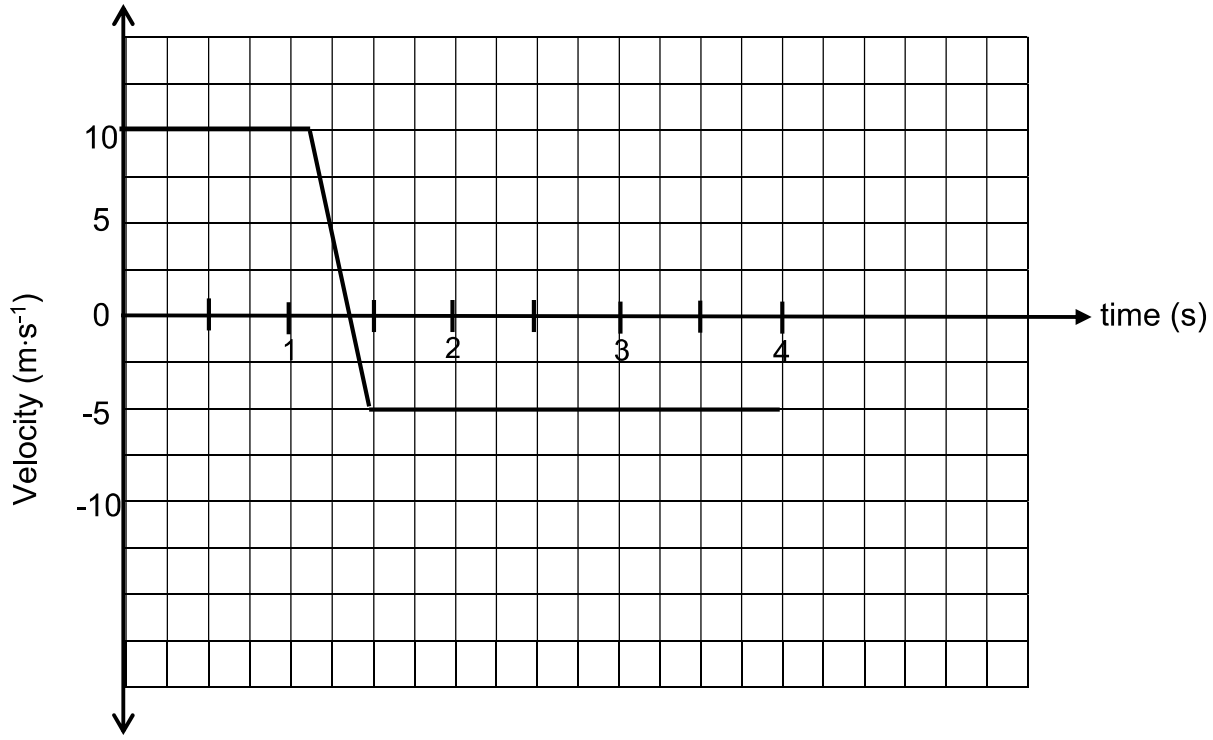
Choose from INCREASES, DECREASES or REMAINS THE SAME.

2.5.1 The normal force (1)

2.5.2 The frictional force (1)
**[16]**

## QUESTION 3

Car **P**, mass **m**, is initially travelling eastwards when it collides with another car **Q** of mass 1,7 **m** which is travelling westwards at 15 $m \cdot s^{-1}$. Ignore the rotation effects of the wheels and friction. The graph below shows how the velocity of car **P** changes with time. Take the initial motion of car **P** as positive.




3.1 Define the term *impulse* in words. (2)

3.2 Calculate the velocity of car **Q** after the collision. (5)

3.3 It is observed that the kinetic energy of the system DECREASES by 175000 J after the collision.

3.3.1 Is the collision ELASTIC or INELASTIC? (1)

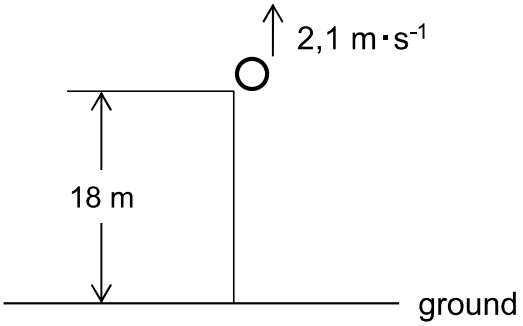
3.3.2 Calculate mass *m.* (5)

3.3.3 USING THE GRAPH, calculate the magnitude of the net force exerted on car **P** during the collision. (4)

**[17]**

## QUESTION 4

A ball is thrown vertically UPWARDS from the top of a building 18 m above the ground with a speed of 2,1 $m \cdot s^{-1}$. Ignore air resistance.




4.1 Explain what is meant by the term *projectile*. (2)

4.2 Write down the magnitude and direction of the acceleration of the ball when it reaches its maximum height. (2)

4.3 Calculate the speed at which the ball strikes the ground. (3)

4.4 Calculate the height above the ground reached by the ball 1,6 s after it is thrown vertically upward. (4)

On reaching the ground, the ball bounces ELASTICALLY from the ground with negligible contact time.

4.5 Sketch the velocity-time graph for the complete motion of the ball until it reaches its maximum height after rebounding.

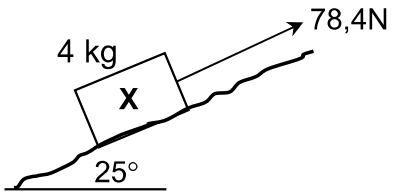
Show the following on the graph:

- The velocity of the ball when thrown upwards
- The velocity of the ball when reaching the ground (3)

**[14]**

## QUESTION 5

Block **X** of mass 4 kg is initially at rest at the bottom of an incline, which makes an angle of 25º with the horizontal. A 78,4 N force, acting parallel to the incline, pulls block X up the incline. Block X experiences a constant frictional force of 13 N.




5.1 Define the term *conservative force* in words and give an example of such a force acting on block X. (3)

5.2 Draw a free body diagram indicating all the forces parallel to the incline, acting on the block. (3)

5.3 Using energy principles only, calculate the speed of block **X** after it has moved 3 m up the incline. (5)
**[11]**

## QUESTION 6

An ambulance moves away from an accident scene at a constant speed. Its siren produces sound waves with a frequency of 890 Hz. A person standing at the accident scene measures a change of 89 Hz in the frequency of the sound produced by the siren as it moves away.

6.1 NAME and DESCRIBED the phenomenon above. (3)

6.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the speed of the ambulance. (5)

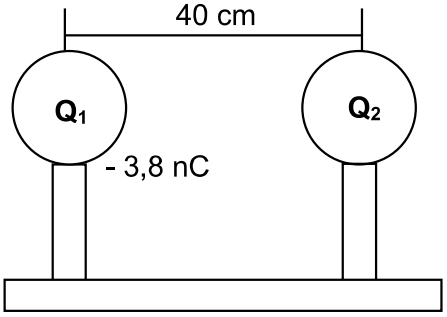
6.3 How will the frequency measured by the person be affected if the speed of the ambulance increases?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 State ONE use of the Doppler-flow meter in the medical field. (1)
**[10]**

## QUESTION 7

7.1 Two identical charged metal spheres $Q_1$ and $Q_2$ are placed on insulated stands with their centres 40 cm apart. The charge on $Q_1$ is -3,8 nC. The electrostatic force of attraction between the two spheres is 8,54 x $10^{-7}$ N.

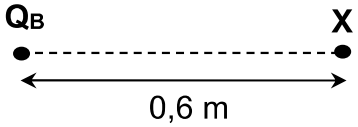



7.1.1 State *Coloumb's law* in words. (2)

7.1.2 Calculate the charge on $Q_2$. (3)

7.1.3 The two spheres are now brought into contact with each other and then separated. Calculate the new charge on EACH sphere. (2)

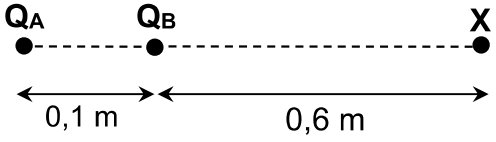
7.2 Point **X** is 0,6 m to the right of charge $Q_B$ which has a charge of +2 x $10^{-6}$ C, as shown in the diagram below.




7.2.1 Draw the electric field pattern due to $Q_B$. (2)

7.2.2 Calculate the magnitude of the electric field due to $Q_B$ at point **X**. (3)

A second charge, $Q_A$ of magnitude +6 x $10^{-6}$ C, is now placed 0,1 m to the left of charge $Q_B$, as shown in the diagram below.




7.2.3 Calculate the magnitude of the net electric field experienced at point **X**. (3)

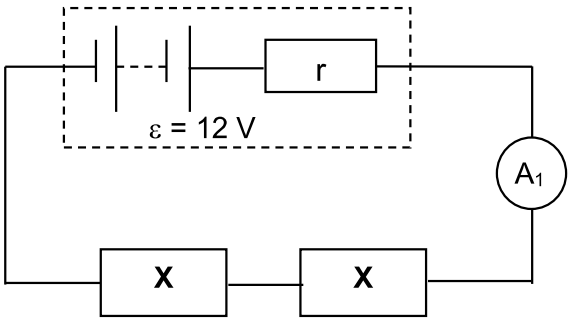
7.2.4 Calculate the magnitude of the net electrostatic force that an electron would experience if it is placed at point **X**. (3)

**[18]**

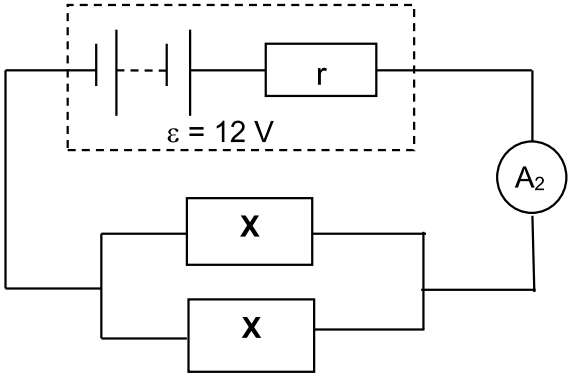
## QUESTION 8

The diagrams below show circuits **1** and **2** with identical batteries (emf 12 V and internal resistance r). The battery in each circuit is connected to two identical resistors, each with resistance X. Ammeters $A_1$ and $A_2$ and the conducting wires have negligible resistance.

**CIRCUIT 1**




**CIRCUIT 2**




8.1 State *Ohm's law* in words. (2)

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

8.3 How would the lost volts in circuit **1** compare to that in circuit **2**?

Choose from GREATER THAN, LESS THAN or THE SAME AS.

Give a reason for the answer. (2)

8.4 The ammeter reading in circuit **2** is 1,5 A, and the internal resistance is 2Ω.

8.4.1 Calculate the value of **X**. (4)

8.4.2 Calculate the ammeter reading in circuit **1**. (2)

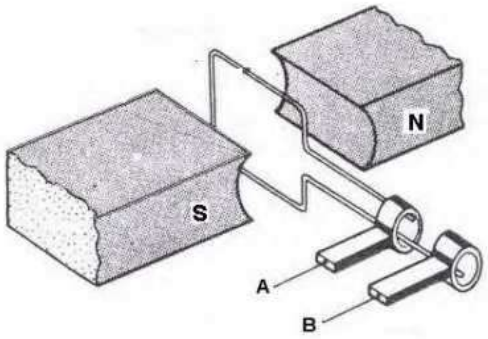
8.5 How will the power dissipated by a resistor in circuit **2,** compare to the power dissipated by a resistor in circuit **1**?

Choose from BIGGER THAN, SMALLER THAN or THE SAME.

Explain the answer. (3)
**[16]**

## QUESTION 9

The simplified diagram below shows a generator.




9.1 Is the above a **DC** or an **AC** generator? (1)

9.2 Name the principle on which this generator works. (1)

9.3 State the energy conversion that takes place in this generator. (2)

9.4 The maximum emf generated is 15 V. Draw a graph to illustrate how the induced emf changes with time for one complete rotation of the coil, starting from the position of the coil indicated in the diagram above. Label the axis and indicate the given data. (3)

9.5 The specifications of an electric drill are as follows:

**2 100 W; 240 V**

9.5.1 Define *rms for an alternating voltage*. (2)

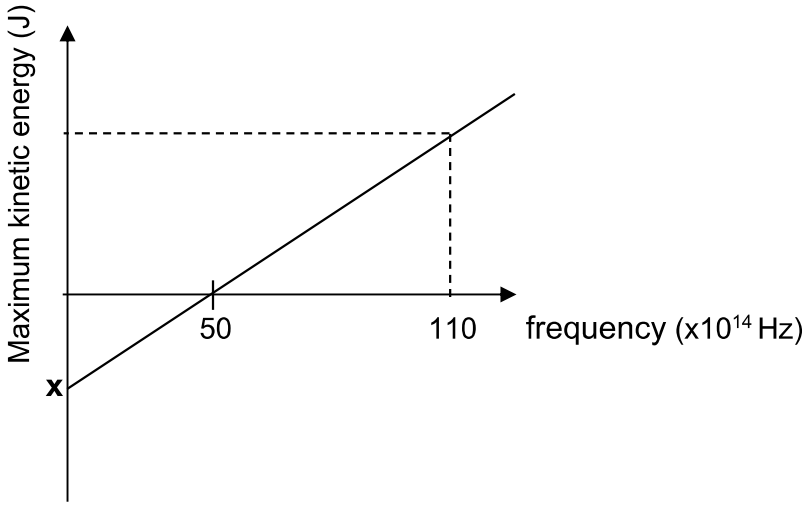
9.5.2 What is the rms voltage for this drill? (1)

9.5.3 Calculate the maximum current value of the current that can flow through the drill. (4)

**[14]**

## QUESTION 10

Different frequencies of light are shone onto the surface of a metal cathode of a photoelectric cell. The graph below shows the relationship between the maximum kinetic energy of the photoelectrons and the frequency of the incident light.




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

10.2 Give a reason why no photo-electrons are released when light of $45 \times 10^{14}$ Hz is used. (2)

10.3 Which quantity can be determined from the gradient of the graph? (1)

10.4 Calculate the magnitude of **x.** (3)

10.5 Light of frequency 110 $\times 10^{14}$ Hz is shone onto the metal cathode.

10.5.1 Calculate the speed of the ejected electrons. (4)

10.5.2 What effect will an increase in the intensity of the light have on the maximum speed of the ejected electrons?

Choose from INCREASES, DECREASES or STAYS THE SAME.

Explain the answer. (2)

**[14]**

**TOTAL: 150**

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# DATA FOR PHYSICAL SCIENCES GRADE 12
# PAPER 1 (PHYSICS)

## *GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12*
## *VRAESTEL 1 (FISIKA)*

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

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

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## TABLE 2: FORMULAE/*TABEL 2: FORMULES*

### MOTION/*BEWEGING*

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

### FORCE/*KRAG*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{\ max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<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* $W_{nc} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$ |
| $P_{av} = Fv_{av}$ / $P_{gemid} = Fv_{gemid}$ | |

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

| | |
|---|---|
| $v = f\lambda$ | $T = \frac{1}{f}$ |
| $f_L = \frac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b}f_b$ | $E = hf$ or /*of* $E = h\frac{c}{\lambda}$ |
| $E = W_o + E_{k(max/maks)}$ or/*of* $E = W_o + K_{max/maks}$ where/*waar*<br>$E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ or/*of*<br>$K_{(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ | |

## ELECTROSTATICS/*ELEKTROSTATIKA*

| | |
|---|---|
| $F = \frac{kQ_1Q_2}{r^2}$ | $E = \frac{kQ}{r^2}$ |
| $V = \frac{W}{q}$ | $E = \frac{F}{q}$ |
| $n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$ | |

## ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

| | |
|---|---|
| $R = \frac{V}{I}$ | emf ( ε )= I(R + r)<br>emk ( ε )= 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$^2$R$\Delta$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*

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

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