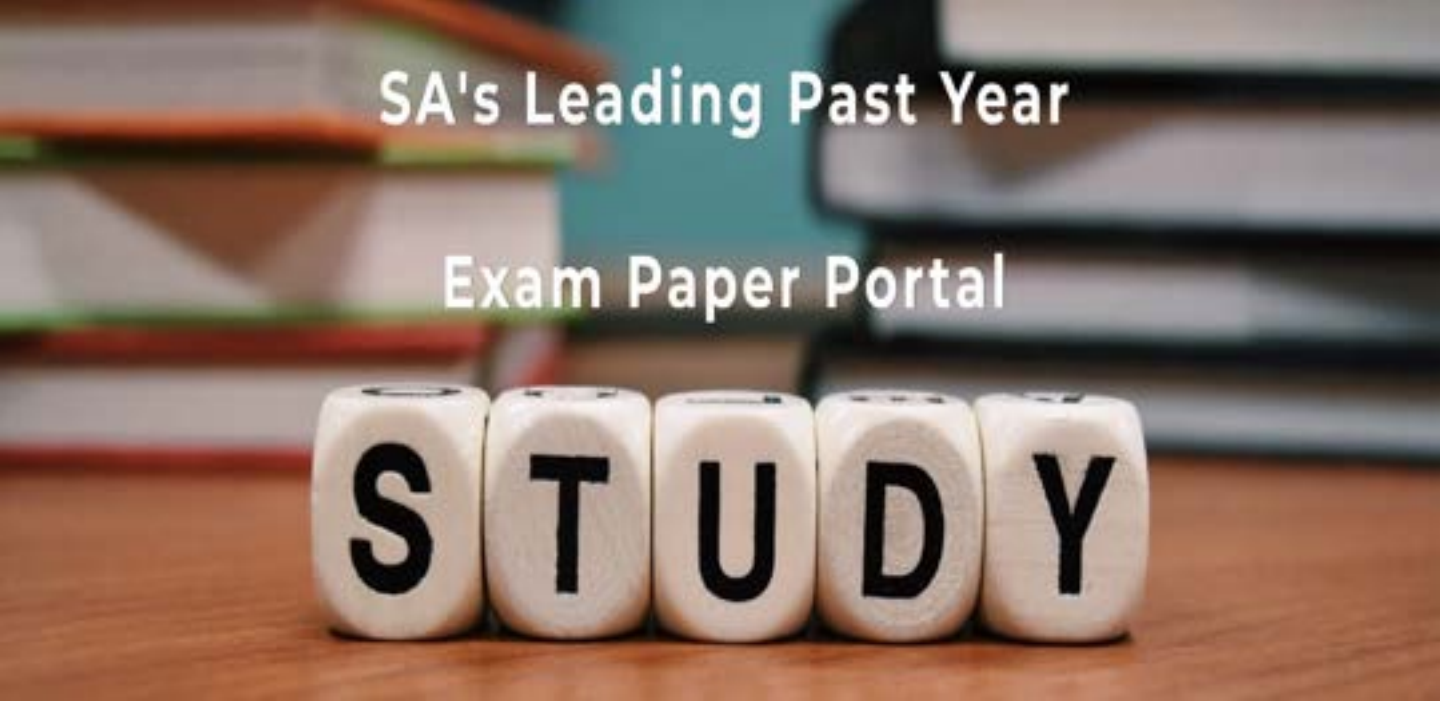


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# PREPARATORY EXAMINATION

## GRADE 12

# PHYSICAL SCIENCES: PHYSICS (P1)

**SEPTEMBER 2021**

**MARKS: 150**

**TIME: 3 HOURS**

## 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket 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 where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.



## QUESTION 1

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

1.1 A car is moving at a CONSTANT velocity on an incline.

Which ONE of the following statements about the forces acting on the car is CORRECT?

A There are no forces acting on the car.

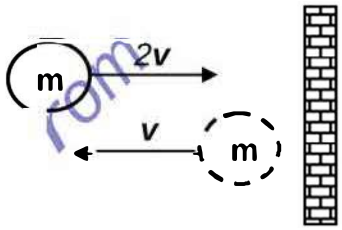
B The net force acting on the car is zero.

C There is a non-zero net force acting on the car.

D The weight of the car is equal to the normal force. (2)

1.2 A ball of mass **m** strikes a wall perpendicularly at a speed 2***v***. Immediately after the collision the ball moves in the opposite direction at a speed ***v***, as shown in the diagram below.

The magnitude of the impulse of the ball is …




A 0

B **mv**

C 2**mv**

D 3**mv** (2)

1.3 A stone is dropped from a certain height above the ground. Which ONE of the following combinations is TRUE while the stone is moving downwards? Ignore the effects of air resistance.

| | NET FORCE ACTING ON THE STONE | MECHANICAL ENERGY OF THE STONE |
|---|---|---|
| A | Remain the same | Increases |
| B | Decreases | Remains the same |
| C | Remain the same | Remain the same |
| D | Increases | Decreases |

(2)

1.4 Which ONE of the following forces is an example for *conservative* force?

A Gravitational force.

B Tension in a chord.

C Frictional force.

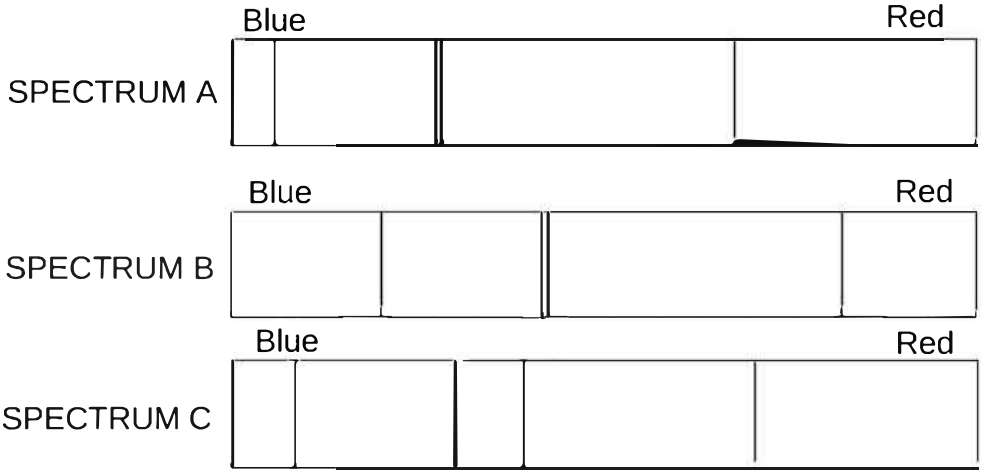
D Normal force. (2)

1.5 Which ONE of the following combinations is TRUE for an elastic collision?

| | TOTAL LINEAR MOMENTUM | TOTAL KINETIC ENERGY |
|---|---|---|
| A | Conserved | Conserved |
| B | Not conserved | Not conserved |
| C | Conserved | Not conserved |
| D | Not conserved | Conserved |

(2)

1.6 SPECTRUM A represents the visible light spectrum recorded on earth. SPECTRA B and C are recorded from two stars **Y** and **Z** respectively




Which ONE of the following combinations most correctly describes the movement of the stars relative to earth?

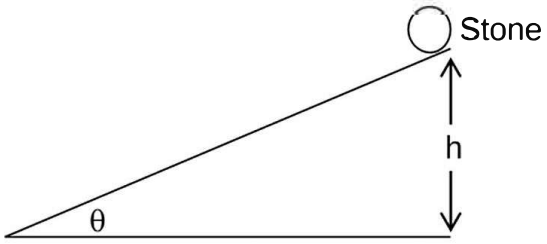
A Star **Y** is moving away from the earth and star **Z** is moving towards the earth.

B Star **Y** is moving towards the earth and star **Z** is moving away from the earth.

C Both Star **Y** and star **Z** are moving towards the earth.

D Both Star **Y** and star **Z** are moving away from the earth. (2)

1.7 A stone starting from rest and rolls down a frictionless track, reaches the bottom of the track with a speed ***v***. What change must be effected on the track for the stone to reach a speed of ***2v*** at the bottom of the track?




A Double the height of the track.

B Increase the height by a factor $\sqrt{2}$.

C Increase the height by four times.

D keep the height the same, but make the track twice steeper. (2)

1.8 Two identical charged spheres kept at a distance *d* apart. The force exerted on one charge by the other is **F**. What is the new force, when the charge on one sphere is DOUBLED?

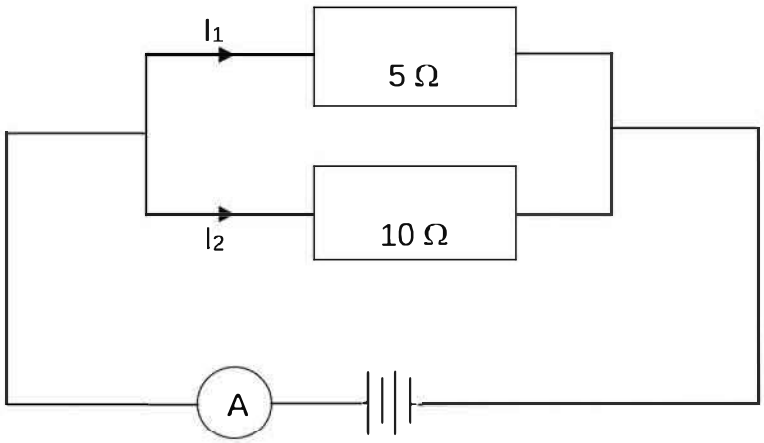
A $2\mathbf{F}$

B $\mathbf{F}$

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

D $\frac{1}{4}\mathbf{F}$ (2)

1.9 5 Ω and 10 Ω resistors are connected in parallel as shown in the diagram.




The relationship between current $I_1$ and current $I_2$ can be expressed as:

A $I_2 = I_1$

B $I_2 = \frac{1}{2} I_1$

C $I_2 = \frac{1}{3} I_1$

D $I_2 = \frac{3}{2} I_1$ (2)

1.10 When an electron moves from a higher energy level to a lower energy level a specific …

A emission line in an emission spectrum is observed.

B absorption line in an emission spectrum is observed.

C emission line in an absorption spectrum is observed.

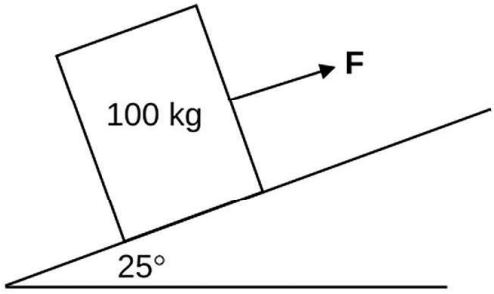
D absorption line in an absorption spectrum is observed. (2)

**[20]**

## QUESTION 2

A block of mass 100 kg is sliding **down** a rough inclined surface at a CONSTANT speed when a force **F** is applied parallel to the inclined plane as indicated in the diagram below.

The coefficient of kinetic friction for the surfaces is 0,29.




2.1 Define the term *normal* force in words. (2)

2.2 Draw a labelled free-body diagram for the block. (4)

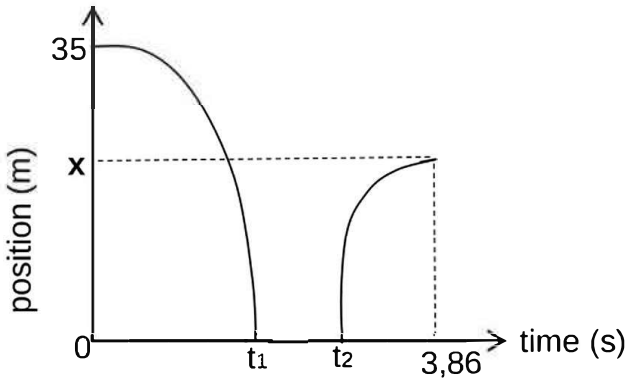
2.3 Calculate the magnitude of the applied force, **F**. (5)

2.4 Name the force that will form an action-reaction pair with the normal force in this case. (1)
**[12]**

## QUESTION 3

The position – time graph below, not according to scale, represents the motion of a ball thrown vertically downwards with a speed of 3,28 $m \cdot s^{-1}$ from the edge of the roof of a 35 m high building. The ball hits the ground and is in contact with the ground for 0,1 s. The ball then bounces off to a maximum height **x** above the ground. Ignore the effects of air resistance.




3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Speed of the ball at time $t_1$ (3)

3.2.2 Time, $t_1$, it takes the ball to hit the ground (3)

3.2.3 Height, **x**, reached by the ball after it bounces off the ground (7)

3.3 Draw the velocity-time graph for the ball from the moment it is thrown until it reaches the maximum height **x** after the first bounce.

Indicate:

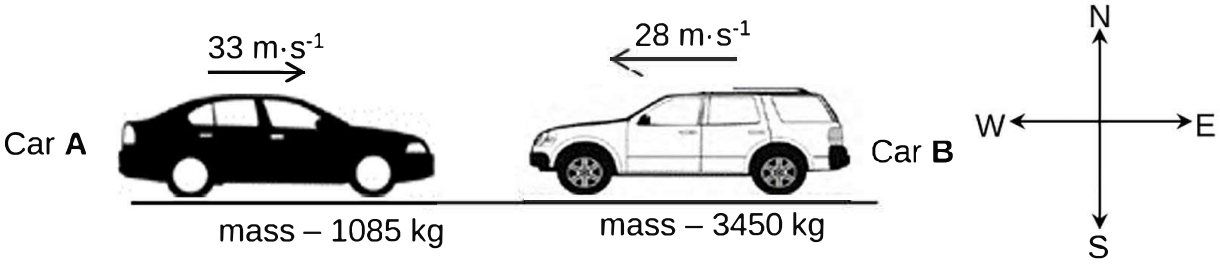
(i) The values of time $t_1$ and $t_2$
(ii) The velocities of the ball at time $t_1$ and $t_2$ (3)

**[18]**

## QUESTION 4

Car **A** of mass 1 085 kg travelling east at a speed of 33 $m \cdot s^{-1}$, collides head on with car **B** of mass 3 450 kg travelling west at a speed of 28 $m \cdot s^{-1}$. Immediately after the collision, car **A** moves west at a speed of 5 $m \cdot s^{-1}$. Ignore friction.




4.1 State *Newton's second law of motion* in terms of momentum in words. (2)

4.2 Calculate the:

4.2.1 Velocity of car **B** after collision (5)

4.2.2 Magnitude of the impulse on car **B** during the collision (3)

4.3 Airbags serves as a safety feature during collision.

4.3.1 Use the relevant laws of physics to explain the purpose of air bags in cars. (3)

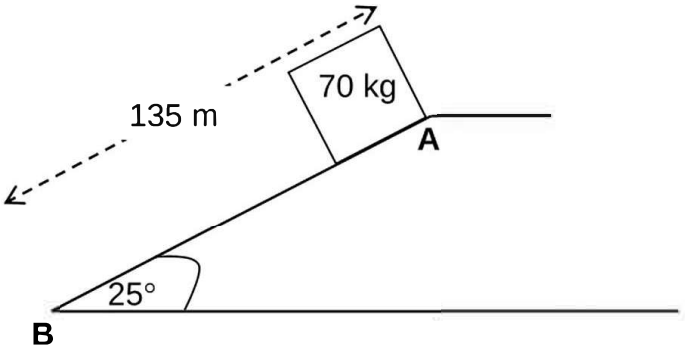
4.3.2 Which driver sustains more injuries during above collision? Choose from CAR A or CAR B (1)

**[14]**

## QUESTION 5

A 70 kg crate, starts from rest at point **A** (top of slope) and slides down a slope inclined at 25° to the horizontal. The distance from point **A** to point **B** is 135 m.




The total kinetic friction between the crate and the surface is 150 N.

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

5.2 Calculate the net work done on the crate, as it slides from point **A** to point **B**. (4)

5.3 Calculate the time it takes the crate to slide from point **A** to point **B**. (6)
**[12]**

## QUESTION 6

An ambulance moving at a constant speed along a straight horizontal road, emits sound with a constant frequency. When the ambulance **approaches** a detector mounted next to the road a frequency of **f** is recorded. After **passing** the detector, a frequency of 0,55 **f** is recorded.

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

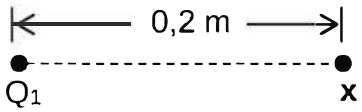
6.2 Calculate the speed of the ambulance. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (6)

6.3 State TWO applications of the Doppler effect. (2)
**[10]**

## QUESTION 7

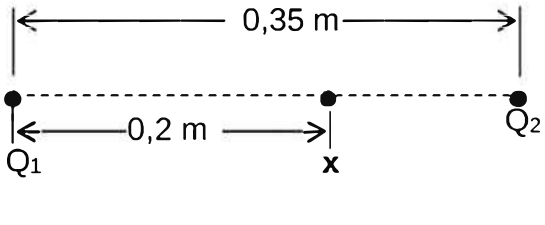
**x** is a point 0,2 m from point charge, $Q_1$, carrying charge $-3x10^{-5}$ C.

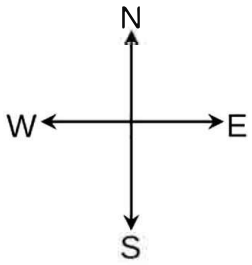



7.1 Define *electric field at a point* in words. (2)

7.2 Draw the electric field pattern due to the charge $Q_1$. (2)

Now another point charge $Q_2$, carrying a charge of $+12x10^{-5}$ C is placed at a distance of 0,35 m from $Q_1$ as shown below.




7.3 Calculate the net electric field at point **x** due to the two charges. (6)

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

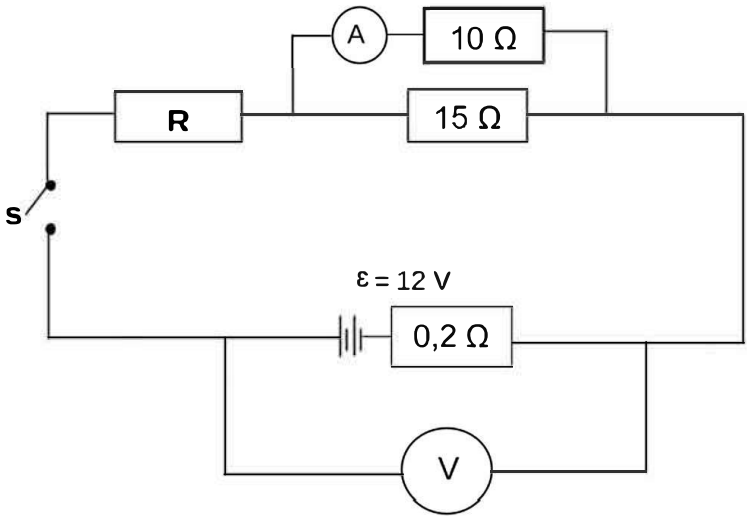
7.5 Calculate the magnitude of the electrostatic force exerted by charge $Q_2$ on charge $Q_1$. (3)

7.6 Charge $Q_2$ is moved further west. How will this change affect the net electrostatic force at this new distance?
Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)
**[16]**

## QUESTION 8

A battery has an emf (ε) of 12 V and an internal resistance of 0,2 Ω. The resistances of the connecting wires are negligible, as shown in the circuit below.




8.1 What is the meaning of the underlined words? (2)

When switch **S** is CLOSED, the voltmeter reading decreases from 12 V and the ammeter reading is 0,9 A.

8.2 Explain why the voltmeter reading decreases. (2)

Calculate the:

8.3 Total current in the circuit (4)

8.4 Resistance of resistor **R** (5)

8.5 The total power dissipated by the battery (3)

8.6 Will the ammeter reading INCREASE, DECREASE or REMAIN THE SAME if the 15 Ω resistor is removed? Give a reason for the answer. (2)

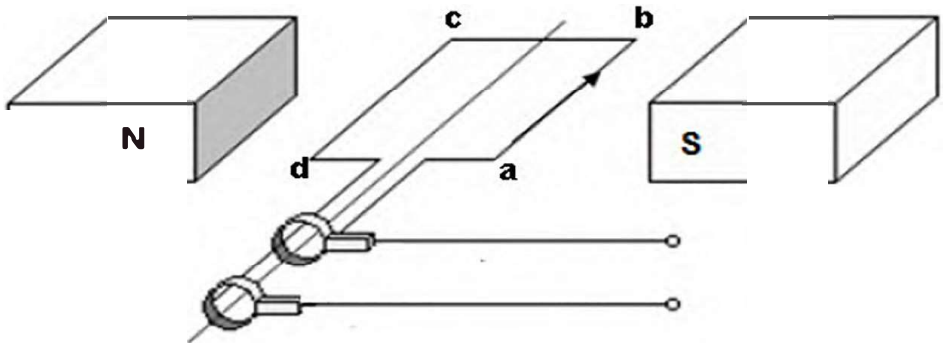
**[18]**

## QUESTION 9

9.1 The diagram below represents a simplified electric machine. The coil **abcd** rotates at 20 cycles per second.

The direction of the current in the coil is from **a** to **b**.




9.1.1 What type of electric machine is represented by the above diagram? (1)

9.1.2 Name the principle on which the machine operates. (1)

9.1.3 In which direction is the coil rotating?
Choose from CLOCKWISE or ANTICLOCKWISE. (1)

9.1.4 How long does it take for the coil **abcd** to complete one rotation? (3)

9.1.5 State ONE way in which this machine can produce a lower output voltage without changing its construction. (1)

9.2 An electrical device is rated 220 V, 1850 W.

9.2.1 Define the term *rms voltage* in words. (2)

Calculate the:

9.2.2 Rms current passing through the appliance when it is operating. (3)

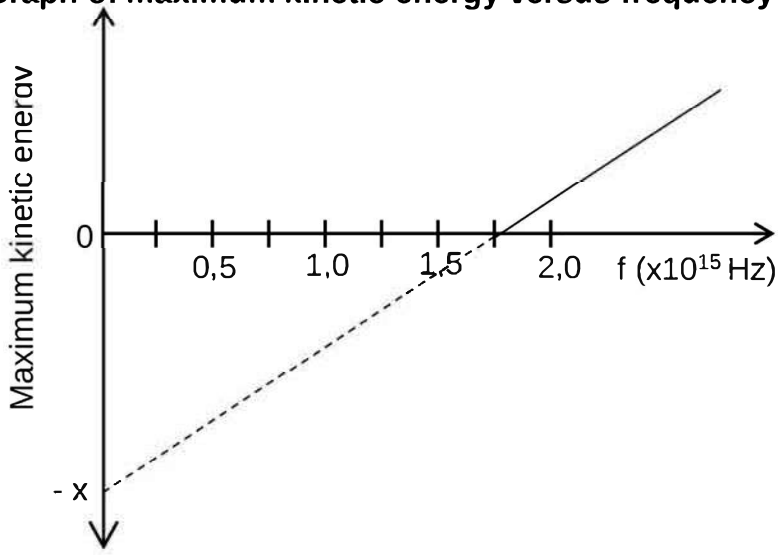
9.2.3 Resistance of the device. (3)
**[15]**

## QUESTION 10

An experiment is conducted to investigate the relationship between the frequency of light incident on a metal cathode and the maximum kinetic energy of the emitted electrons from the surface of a metal cathode of a photocell.
The graph represents the results obtained.

**Graph of maximum kinetic energy versus frequency of light**




10.1 For this investigation, write down the following:

10.1.1 Controlled variable (1)

10.1.2 Dependent variable (1)

10.2 Name the phenomenon on which this experiment is based. (1)

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

10.4 Calculate the:

10.4.1 Value of **x** as shown on the graph (3)

10.4.2 Frequency of the incident light that will emit electrons from the surface with a maximum speed of $5{,}23 \times 10^5$ m·s$^{-1}$ (4)

10.5 The intensity of the light is now increased. State how this change affects the current in the photocell .
Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain your answer. (3)
**[15]**

**GRAND TOTAL: 150**

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

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

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

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

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

### MOTION/*BEWEGING*

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

### FORCE/*KRAG*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<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* $E = h\frac{c}{\lambda}$ |
| $E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar*<br>$E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or/*of* $K_{max} = \frac{1}{2}mv^2_{max}$ | |

## ELECTROSTATICS/*ELEKTROSTATIKA*

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

## ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

| | |
|---|---|
| $R = \frac{V}{I}$ | emf ($\varepsilon$)= I(R + r)<br>emk ($\varepsilon$)= I(R + r) |
| $R_s = R_1 + R_2 + \ldots$<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$ | $q = I\,\Delta t$ |
| $W = Vq$<br>$W = VI\Delta t$<br>$W = I^2R\Delta t$<br>$W = \frac{V^2\Delta t}{R}$ | $P = \frac{W}{\Delta t}$<br>$P = VI$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |

## ALTERNATING CURRENT/*WISSELSTROOM*

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