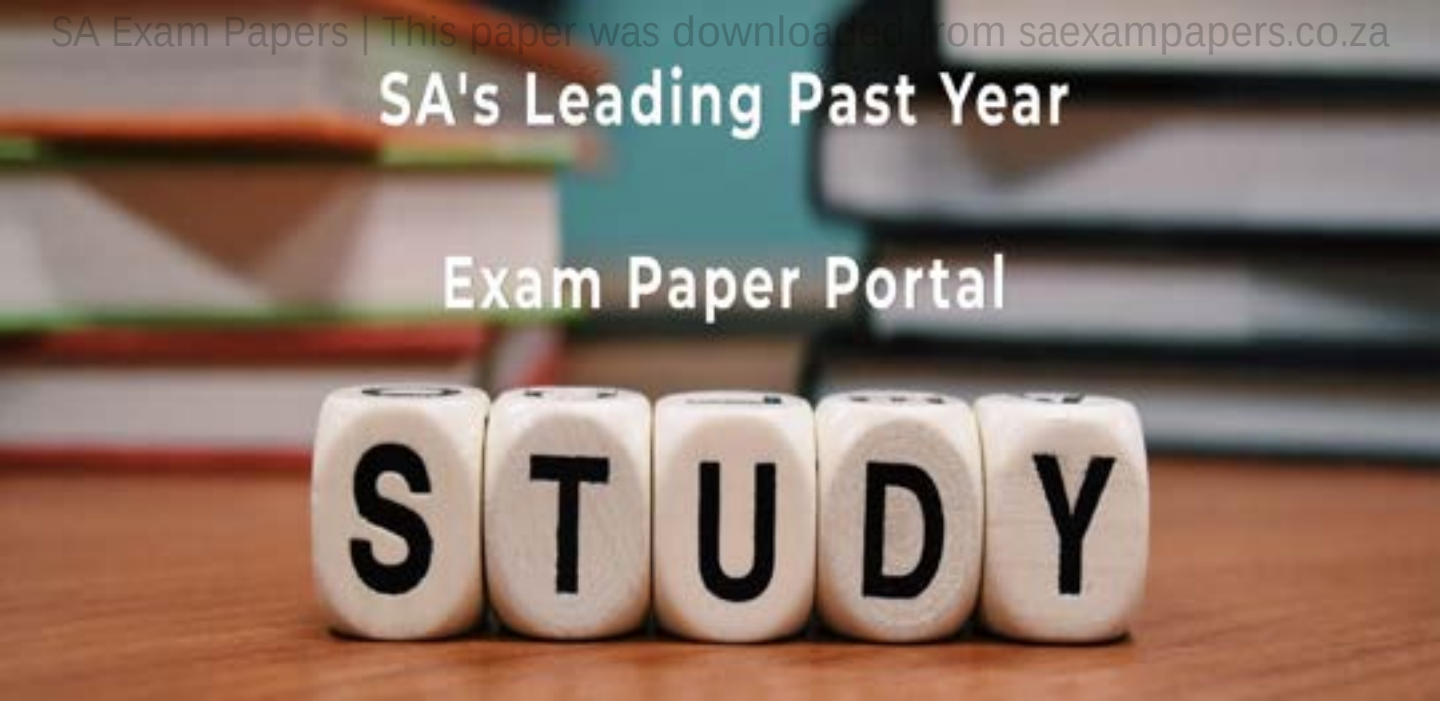


education

Department of
Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2023

MARKS: 150

TIME: 3 HOURS

This question paper consists of 15 pages and 3 data sheets.

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.

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 the ANSWER BOOK, e.g. 1.11 E.

1.1 A body is moving at CONSTANT VELOCITY. The net force acting on it is ...

A zero.

B constant.

C increasing.

D decreasing. (2)

1.2 A ball has a mechanical energy E when it is at rest h metres above the ground. The ball is then dropped from this rest position. What is the kinetic energy of the ball when it is $\frac{1}{3}$ h metres above the ground?

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

B $\frac{2}{3}$ E

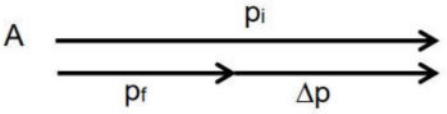
C E

D $\frac{3}{2}$ E (2)

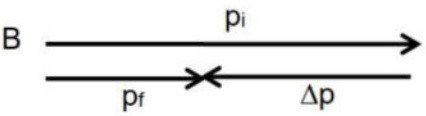
1.3 A car of mass **m** is travelling at a constant velocity and has momentum **p**. The driver notices an object ahead of him and applies the brakes so that the momentum of the car changes to $\frac{1}{2}$ **p**.

Which ONE of the diagrams below correctly shows the relationship between p_i, p_f and Δp?

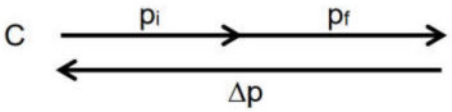
A



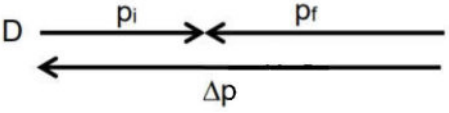
B



C

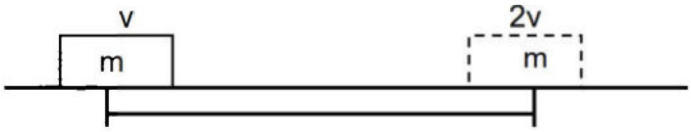


D



(2)

1.4 An object of mass m is accelerated from a velocity v to a velocity 2v, as shown in the diagram below.



What is the net work done on the object?

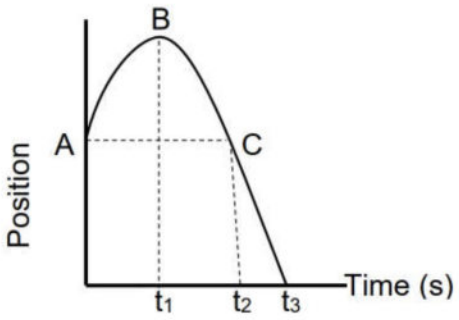
A mv^2

B $\frac{1}{2}mv^2$

C $\frac{3}{2}mv^2$

D $2mv^2$ (2)

1.5 A ball is thrown vertically upwards with velocity **v**, from the top of building, h metres above the ground. A, B and C are the positions of the ball during its motion as shown in the position-time graph below.



Which ONE of the following is correct for the VELOCITY and DISPLACEMENT of the ball when it is at point C?

	Velocity ($m \cdot s^{-1}$)	**Displacement (m)**
A	v	2h
B	v	0
C	0	2h
D	-v	0

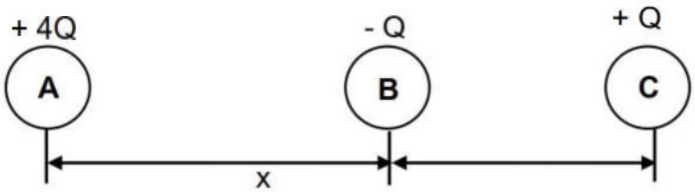
(2)

1.6 Astronomers observed that light from a distant star undergoes a red shift. Which ONE of the following combinations is correct for the OBSERVED WAVELENGTH and the OBSERVED FREQUENCY when compared to the wavelength and frequency of the light source?

	OBSERVED WAVELENGTH	OBSERVED FREQUENCY
A	Lower than	Lower than
B	Higher than	Lower than
C	Lower than	Higher than
D	Higher than	Higher than

(2)

1.7 Three small identical spheres **A**, **B** and **C** carry charges as shown in the diagram below. The distance between spheres **A** and **B** is **x**.



For sphere **B** to experience a ZERO net electrostatic force, what must the distance between spheres **B** and **C** be?

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

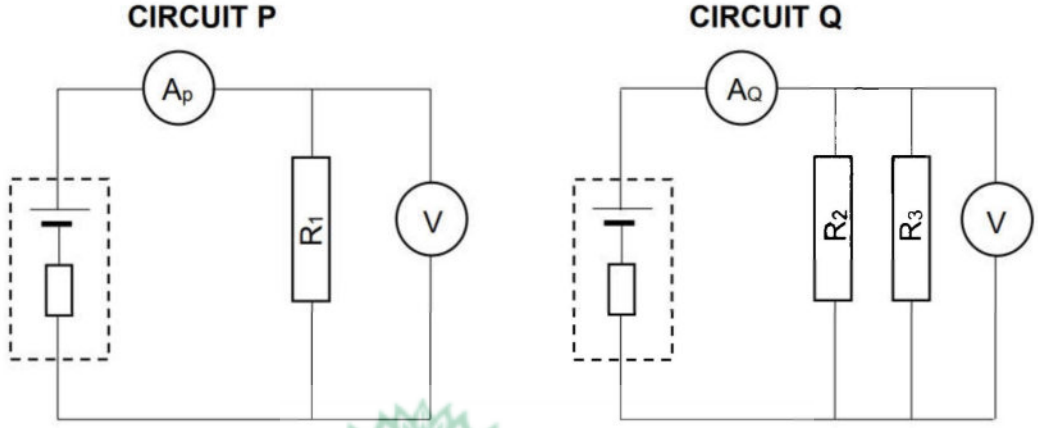
B $\frac{1}{2}x$

C 2 x

D 4 x

(2)

1.8 The batteries in CIRCUITS P and Q are identical. Resistors R_1, R_2 and R_3 are identical. The ammeters and conducting wires have negligible resistance, the voltmeters have very high resistance, while the resistance of the batteries CANNOT be ignored.



Which ONE of the following combinations is correct for the VOLTMETER READING and the AMMETER READING in circuits P and Q?

	VOLTMETER READING	AMMETER READING
A	$V_P > V_Q$	$A_P > A_Q$
B	$V_P < V_Q$	$A_P > A_Q$
C	$V_P > V_Q$	$A_P < A_Q$
D	$V_P < V_Q$	$A_P < A_Q$

(2)

1.9 Which ONE of the energy conversions below takes place when a DC motor is in operation?

A Kinetic energy to Electrical energy.

B Electrical energy to Kinetic energy.

C Potential energy to Electrical energy.

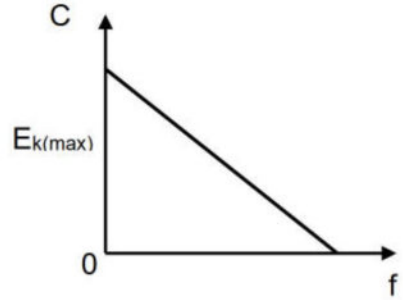
D Electrical energy to Potential energy. (2)

1.10 Which ONE of the following graphs correctly illustrates the relationship between maximum kinetic energy ($E_{k(max)}$) of the emitted electrons from a metal surface and frequency (f) of the incident light?

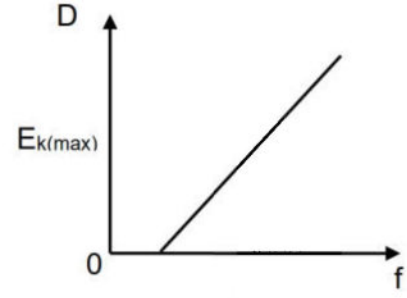
A

B

C



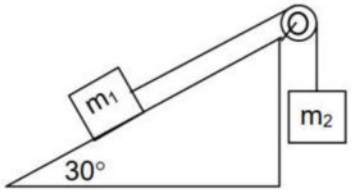
D



(2)
[20]

QUESTION 2 (Start on a new page.)

A block $\mathbf{m_1}$ of mass 8 kg is connected by a light inextensible string which runs over a light frictionless pulley to block $\mathbf{m_2}$ also of mass 8 kg. Block $\mathbf{m_1}$ is moving up an incline as shown in the diagram below. The coefficient of kinetic friction between block m_1 and the incline is 0,2.



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

2.2 Draw a labelled free-body diagram showing ALL the forces acting on block m_1. (4)

2.3 Consider the forces acting on each block separately, and calculate the magnitude of the acceleration of the system. (6)

2.4 According to Newton's Third law, which force is the reaction to the weight of block m_2? (2)

2.5 While the blocks are moving, the string breaks. What is the direction of the acceleration of block m_1 immediately after the string breaks? Write only UP or DOWN the incline. (1)

[15]

QUESTION 3 (Start on a new page.)

A crane is lifting bricks on a wooden pallet at a constant velocity. When the pallet reaches a height of 17,2 m above the ground, one of the bricks falls from the pallet.

Ignore the effect of friction.

The position versus time graph shows the motion of the brick from the moment it falls from the pallet, until it strikes the ground.

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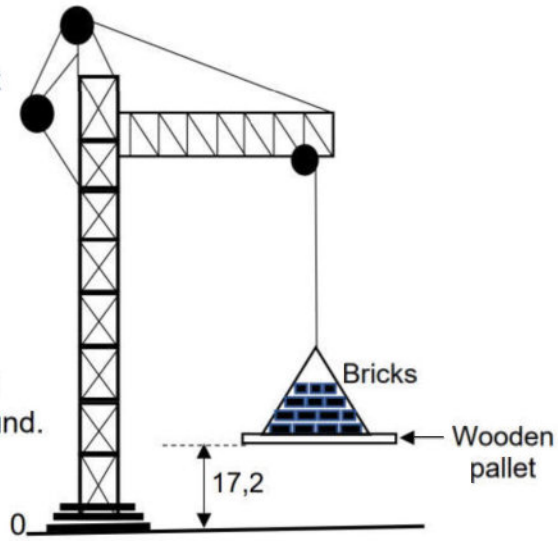
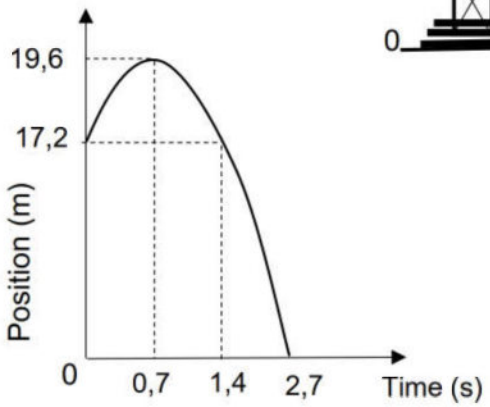




3.1 Explain what is meant by the term *free fall*. (2)

3.2 Write down the time taken by the brick to reach its maximum height after falling off the pallet. (1)

3.3 Calculate the velocity of the brick just before it falls off the pallet. (3)

3.4 Calculate the distance covered by the brick during the last second of its free fall. (5)

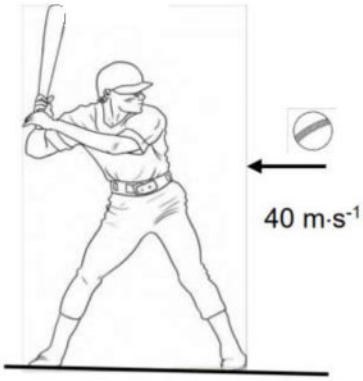
3.5 Draw an acceleration versus time graph for the motion of the brick from the moment it falls from the wooden pallet until it just reaches the ground. (2)

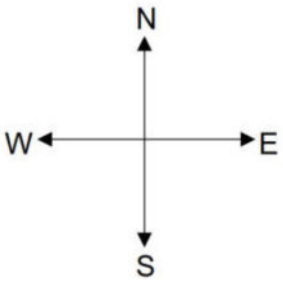
[13]

QUESTION 4 (Start on a new page.)

4.1 A 400 g ball is approaching a baseball player horizontally in a westerly direction at a speed of 40 $m \cdot s^{-1}$ as indicated in the diagram. The baseball player exerts a force of 400 N on the ball in an easterly direction.

The ball is in contact with the bat for 0,1 s.



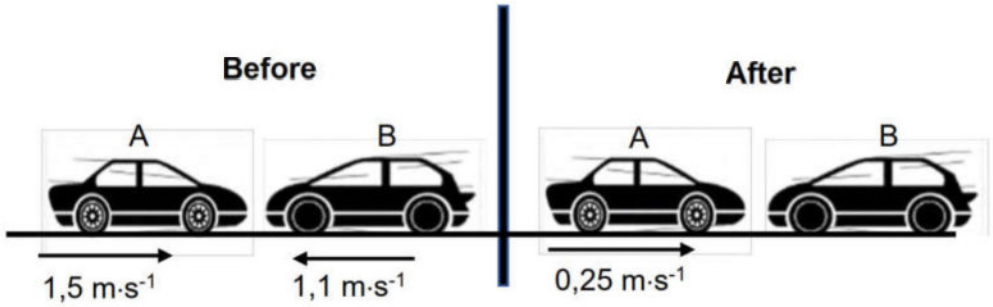


4.1.1 Define *impulse*. (2)

4.1.2 Calculate the velocity of the ball immediately after contact with the bat. (4)

4.2 When cars are equipped with flexible bumpers, they will bounce off each other during low-speed collisions, thus causing less damage. In one such accident, car **A** with mass 1 750 kg, travelling to the right at 1,5 $m \cdot s^{-1}$, collides with car **B** of mass 1 450 kg travelling to the left at 1,1 $m \cdot s^{-1}$. Measurements show that the speed of car **A** after the collision is 0,25 $m \cdot s^{-1}$ in its original direction.

Ignore the effects of friction during the collision.



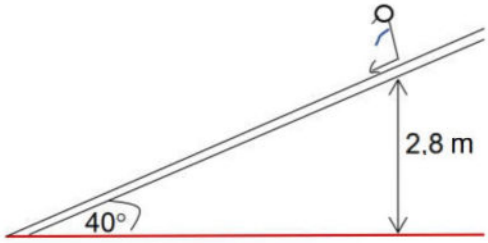
4.2.1 Calculate the velocity of car **B** immediately after the collision. (5)

4.2.2 'When cars are equipped with flexible bumpers, they will bounce off each other during low-speed collisions, thus causing less damage.' Explain how flexible bumpers reduce damages during low-speed collisions. (3)

[14]

QUESTION 5 (Start on a new page.)

After an emergency landing at Bloemfontein Airport, a passenger of mass 70 kg evacuates the stationary aeroplane using the evacuation slide that makes an angle of 40° with the horizontal. When the passenger reaches a height of 2,8 m above the ground, the passenger has a speed of 0,35 $m \cdot s^{-1}$.



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

A constant frictional force acts on the passenger as he moves down the slide.

5.2 Draw a labelled free-body diagram showing all the forces exerted on the passenger. (3)

5.3 Name a non-conservative force acting on the passenger. (1)

The coefficient of kinetic friction of the surface is 0,112.

5.4 Using energy principles, calculate the velocity of the passenger at the lowest point of the slide. (6)

5.5 The angle between the horizontal and the slide is increased. How will the change influence the frictional force acting on the passenger?

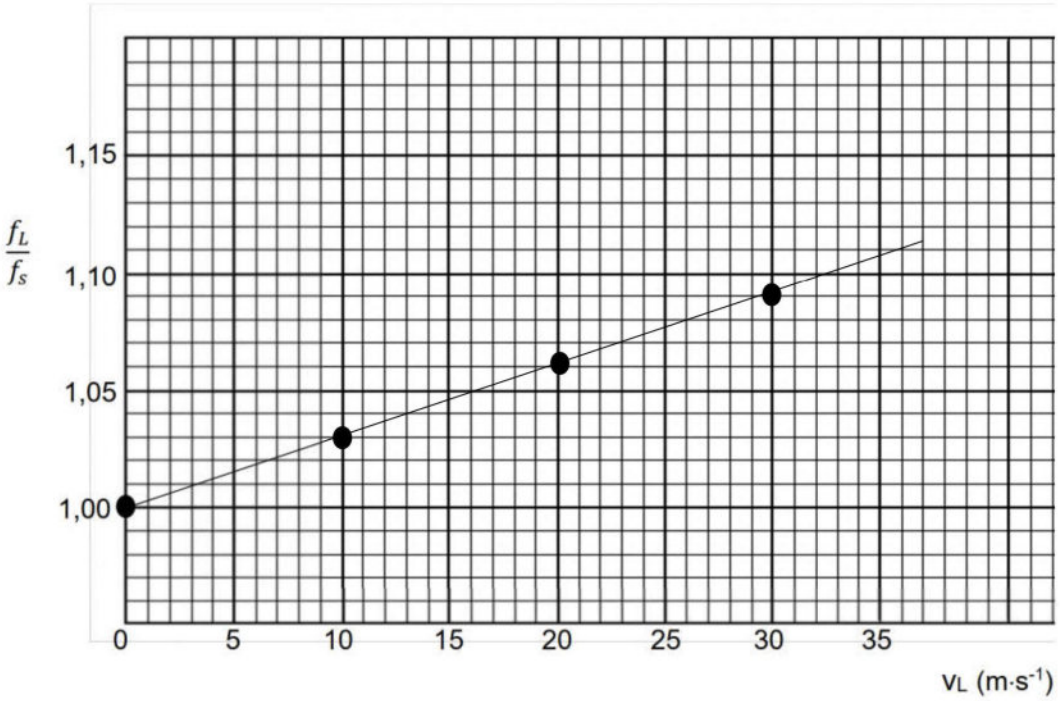
Write only INCREASES, DECREASES or STAYS THE SAME. Explain the answer. (3)

[15]

QUESTION 6 (Start on a new page.)

A learner investigates the relationship between the ratio of the observed frequency to the source frequency $\left(\frac{f_L}{f_s}\right)$ and the velocity with which the listener moves relative to the stationary source. The experiment is repeated by increasing the magnitude of the constant velocity with which the observer moves relative to the same stationary source.

The observed frequency (f_L) is recorded and the ratio $\left(\frac{f_L}{f_s}\right)$ is calculated for each experiment. The graph below shows the results obtained.



6.1 State in words the phenomenon described above. (2)

Use the graph to answer the following questions.

6.2 Is the learner moving TOWARDS or AWAY FROM the stationary source? Explain your answer. (2)

6.3 What does the gradient of the graph represent? (1)

6.4 Calculate the speed of sound in air during the experiment. (4)

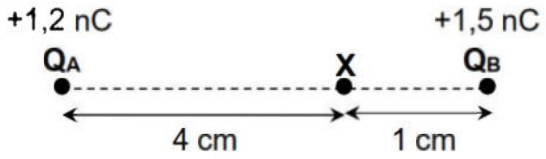
6.5 An observation of the spectrum of a distant star shows that it is moving away from the earth. Explain, in terms of the frequencies of the spectral line, how it is possible to conclude that the star is moving away from the earth. (2)

[11]

QUESTION 7 (Start on a new page.)

7.1 Two point charges **A** and **B**, carrying charges of +1,2 nC and +1,5 nC respectively are placed 5 cm apart along a straight line in a vacuum, as shown in the diagram below.

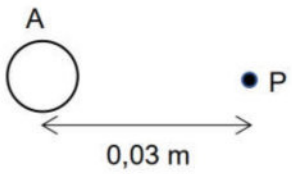
An electron is placed at point **X**, 4 cm to the right of point charge **A**.



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

7.1.2 Calculate the net electrostatic force experienced by the electron. (5)

7.2 **P** is a point in an electric field 0,03 m from charged sphere **A**, as shown in the diagram below. The electric field experienced at point **P** due to the charged sphere **A** is $4x10^7$ N·C^{-1} to the right.



7.2.1 Calculate the magnitude of the charge on sphere **A**. (3)

7.2.2 Is the charge on sphere **A** POSITIVE or NEGATIVE? (1)

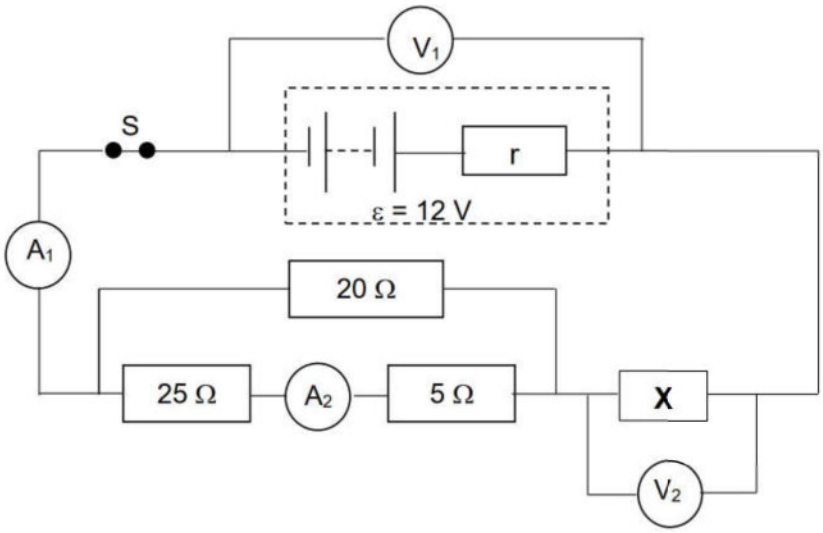
7.2.3 A point charge **X,** carrying an excess of 938 electrons, is now placed at point **P**.

Calculate the magnitude of the electrostatic force experienced by point charge **X**. (4)

[15]

QUESTION 8 (Start on a new page.)

The diagram below shows a circuit with a battery of emf 12 V and internal resistance **r**. The battery is connected to resistors of 25 Ω, 20 Ω, 5Ω and resistor **X** of unknown resistance. The ammeters, switch and the conducting wires have negligible resistance, while the voltmeters have very high resistance.



8.1 Explain what is meant by an emf of 12 V. (2)

When switch S is closed, the reading on ammeter A_2 is 0,2 A and the reading on voltmeter V_2 is 5,5 V.

8.2 Calculate the:

8.2.1 Reading on ammeter A_1 (3)

8.2.2 Resistance of resistor **X** (3)

8.2.3 Total external resistance of the circuit (3)

8.2.4 Internal resistance (r) of the battery (3)

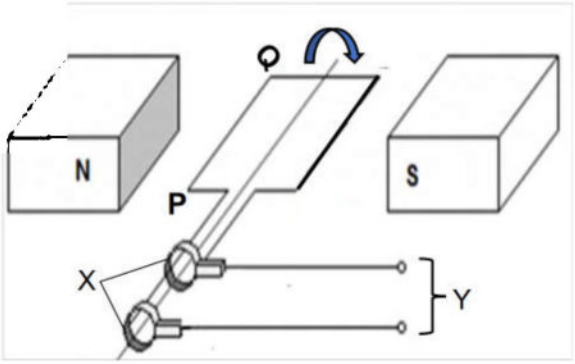
8.3 Resistor **X** is replaced by another ammeter.

Will the reading on voltmeter V_1 INCREASE, DECREASE or REMAIN THE SAME? Explain the answer. (4)

[18]

QUESTION 9 (Start on a new page.)

9.1 The diagram below is a simplified representation of a generator. The coil is rotated clockwise.



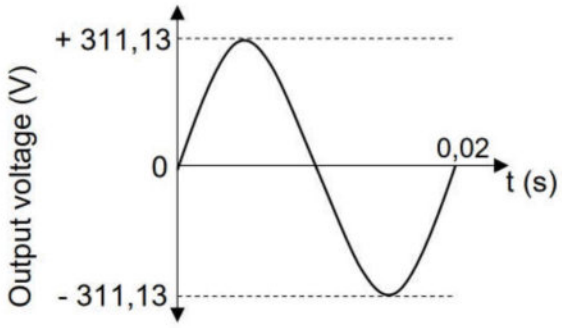
9.1.1 Is the above a **DC** or an **AC** generator? (1)

9.1.2 Write down the name of component **X**. (1)

9.1.3 Write down the function of component **Y**. (1)

9.1.4 Is the direction of the induced current from **P to Q** or from **Q to P**? (1)

9.2 The graph below shows the output voltage from a household AC generator for the rotation of the coil for one complete cycle.



9.2.1 The speed of rotation is doubled. Sketch the graph of the induced emf versus the time for this change for one cycle. Indicate the maximum voltage and relevant time values. (3)

9.2.2 An electrical device is connected to this generator. The maximum current passing through the device is 8 A.

Calculate the:

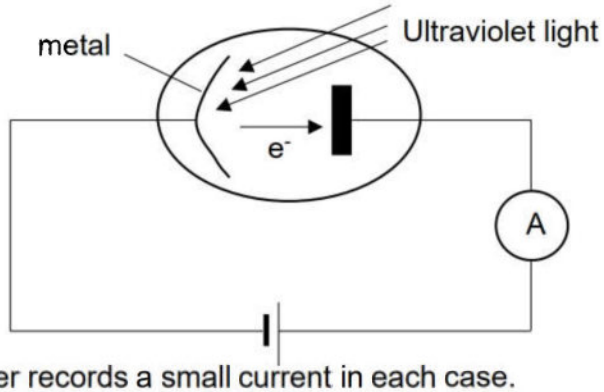
(a) Resistance of the device (4)

(b) Energy the device consumes in two hours (4)

[15]

QUESTION 10 (Start on a new page.)

A learner uses two photoelectric cells to determine the maximum kinetic energy of photoelectrons from caesium and sodium cathodes. Monochromatic light from the SAME SOURCE is shone on the cathode of each photoelectric cell, as shown in the diagram.



The ammeter records a small current in each case.

The learner compiles the following data for the two metals:

METAL	WORK FUNCTION OF THE METAL (J)	MAXIMUM VELOCITY OF THE PHOTOELECTRONS ($m \cdot s^{-1}$)
Caesium	$3,36 \times 10^{-19}$	$7,14 \times 10^{5}$
Sodium	$3,65 \times 10^{-19}$	v_{max}

10.1 Define the term *work function* of a metal. (2)

10.2 Use the information in the table to calculate the wavelength of the light used in the experiment. (5)

10.3 Calculate the maximum velocity of an ejected electron from sodium metal. (4)

10.4 The intensity of the incident light was INCREASED. How does the change affect the reading on the ammeter?

Write down only INCREASE, DECREASE or REMAINS THE SAME.
Explain the answer. (3)
[14]

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

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

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* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ or/*of* $K_{(max/maks)} = \frac{1}{2}mv^2_{max/maks}$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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