

Hillcrest High School

PHYSICAL SCIENCE P1 TRIALS 2023

Grade 12

MARKS: 150

TIME: 3 Hours

EXAMINER: Ms N. Badenhorst

MODERATOR: Mrs J. Knox-Whitehead

Instructions:

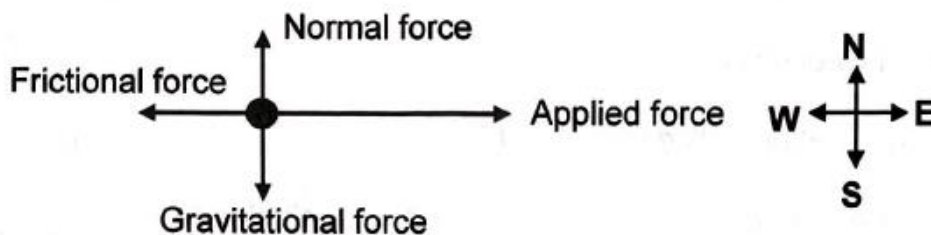
1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
SECTION B (130)

Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A**QUESTION 1: MULTIPLE CHOICE QUESTIONS**

Four options are provided as possible answers to the following questions. Each question has only one correct answer. Write only the letter (A-D) next to the question number (1.1-1.10) in the answer book.

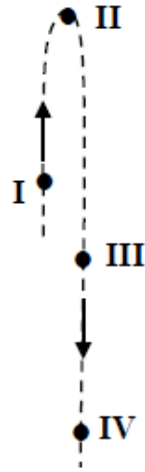
- 1.1 The free-body diagram below shows the relative magnitudes and directions of all the forces acting on an object.



The object is...

- A accelerating eastward
 - B accelerating westward
 - C at rest
 - D moving with constant velocity
- 1.2 From the top of the building, ball **X** is thrown vertically **upwards** and another ball **Y**, is thrown vertically **downwards**. Both the balls are thrown at the same speed.
- Ignore the effects of friction.
- Which ball(s) will have a greater speed when it hits the ground?
- A **X**
 - B **Y**
 - C **X AND Y** would have the same speed
 - D Depends on the mass of the ball

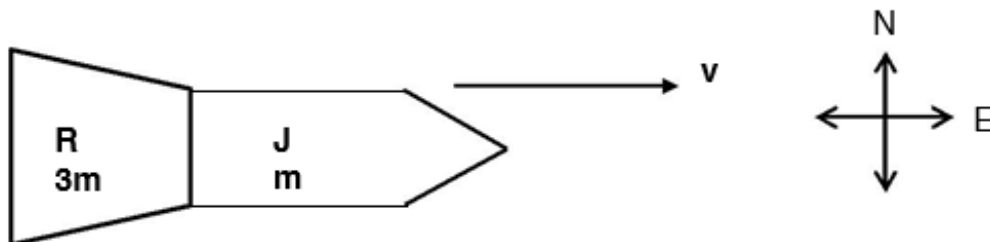
1.3 The diagram below shows a section of the path of a stone projected vertically upwards



At which ONE of the positions indicated on the diagram will the magnitude of the momentum of the stone be the GREATEST? Ignore the air resistance.

- A I
- B II
- C III
- D IV

1.4 A spacecraft, made up of two modules R and J of masses $3m$ and m respectively, is travelling horizontally at a velocity v due east. An explosion causes the two modules to separate.



Module J continues in its original direction immediately after the explosion with a velocity of $3v$. What will be the **magnitude and direction** of module R's velocity immediately after the explosion?

	Magnitude of velocity of R	Direction of R after explosion
A	$1v$	East
B	$1v$	West
C	$1/3v$	East
D	$1/3v$	West

1.5 A police car, with its siren on, is moving away at constant speed from a stationary observer.

The siren emits a sound of constant frequency

Which of the following characteristics, associated with the sound emitted by the siren is/are

CORRECT, as perceived by the observer?

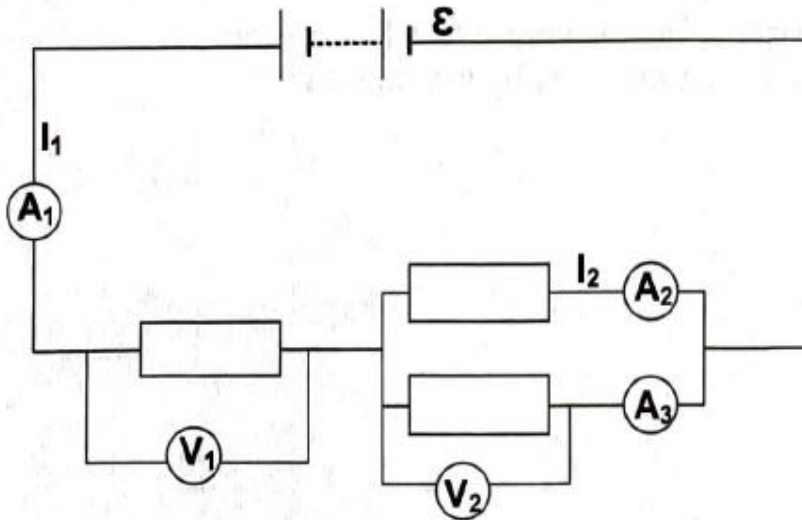
- (i) The speed remains the same.
- (ii) The frequency increases
- (iii) The wavelength increases
- (iv) The frequency decreases

- A (iii) only
- B (i), (iii) and (iv)
- C (i) and (iii) only
- D (i) and (ii) only

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

- A $W_{net} + \Delta Ek = 0$
 B $Ep + Ek = 0$
 C $\Delta Ek + \Delta Ep = 0$
 D $\Delta p + \Delta Ep = 0$

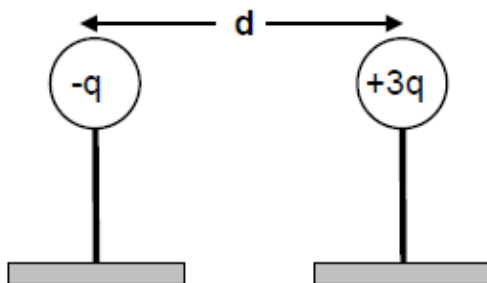
1.7 The sketch below, show a battery of emf ϵ , connected in a circuit containing three resistors. Ignore the internal resistance of the battery.



Which ONE of the following combinations best describes the readings of ammeter A3 and voltmeter V2.

	Reading on A ₃	Reading on V ₂
A	$I_1 - I_2$	$\epsilon - V_1$
B	$I_1 - I_2$	$\epsilon + V_1$
C	$I_1 + I_2$	$\epsilon + V_1$
D	$I_1 + I_2$	$\epsilon - V_1$

- 1.8 Two small identical metal spheres, on insulated stands, carry charges $-q$ and $+3q$ respectively. When the centres of the spheres are a distance d apart, the spheres exert an electrostatic force of magnitude F on each other.



The spheres are now made to touch and brought back to the same positions as before.

The magnitude of the electrostatic force which the spheres now exert on each other, in terms of F , is:

- A** $\frac{4}{3}F$
- B** $\frac{1}{3}F$
- C** $\frac{1}{2}F$
- D** $3F$

- 1.9 A learner lists the following as factors that affect the magnitude of the current induced in an AC generator:

- (i) The number of turns (windings) of the coil
- (ii) The strength of the magnetic field
- (iii) The speed of rotation of the coil

Which ONE of the combinations below is CORRECT?

- A (i) and (ii) only
- B (i) and (iii) only
- C (ii) and (iii) only
- D (i), (ii) and (iii)

1.10 The spectrum of light from most stars contains lines corresponding to helium gas.

Diagram A shows the helium spectrum as observed in a laboratory.

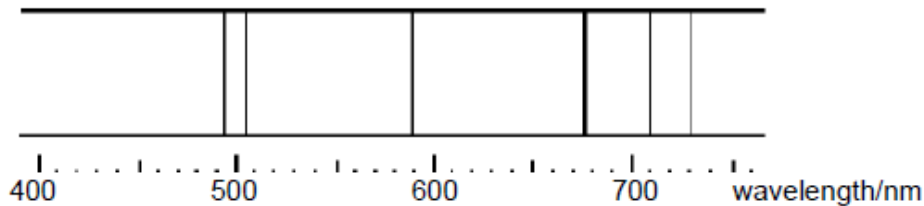
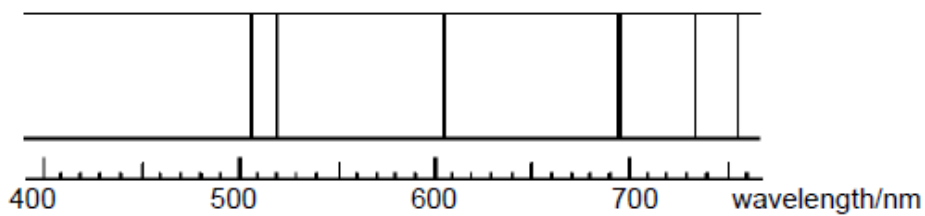


Diagram B shows the helium spectrum of light from a distant star.



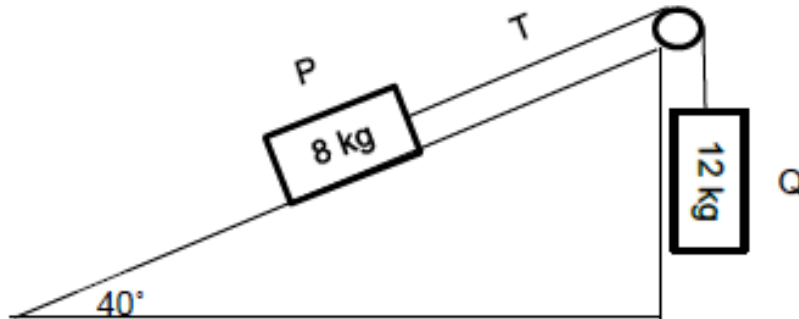
The diagram illustrates that the star:

- A is moving away from the earth
- B is stationary
- C is moving towards the earth
- D has an increasing frequency

[2 x 10 = 20]

Section B**Question 2**

Block P, with a mass of 8kg, is connected to block Q, with a mass of 12kg, with a light, inextensible string, T, which passes over a frictionless pulley. Block P is on a rough plane inclined at an angle of 40° to the horizontal as shown in the diagram below.



The coefficient of kinetic friction between block P and the inclined plane is 0.24.

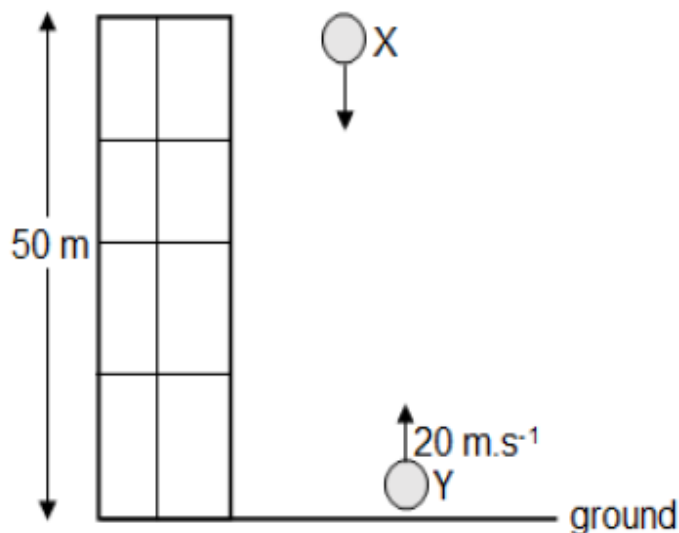
- 2.1 State *Newton's Second Law* in words. (2)
- 2.2 Draw a labelled free-body diagram for block P. (4)
- 2.3 Calculate the kinetic frictional force on block P as it is moving upward on the inclined plane. (3)
- 2.4 Calculate the tension in the string, T, which connects block P and Q. (7)

[16]

Question 3

Ball Y is thrown vertically upwards from the ground at a velocity of $20\text{m}\cdot\text{s}^{-1}$.

AT THE SAME INSTANT, a second ball X is dropped from a balcony 50 m above the ground. Refer to the diagram below. Ignore the effects of air resistance.



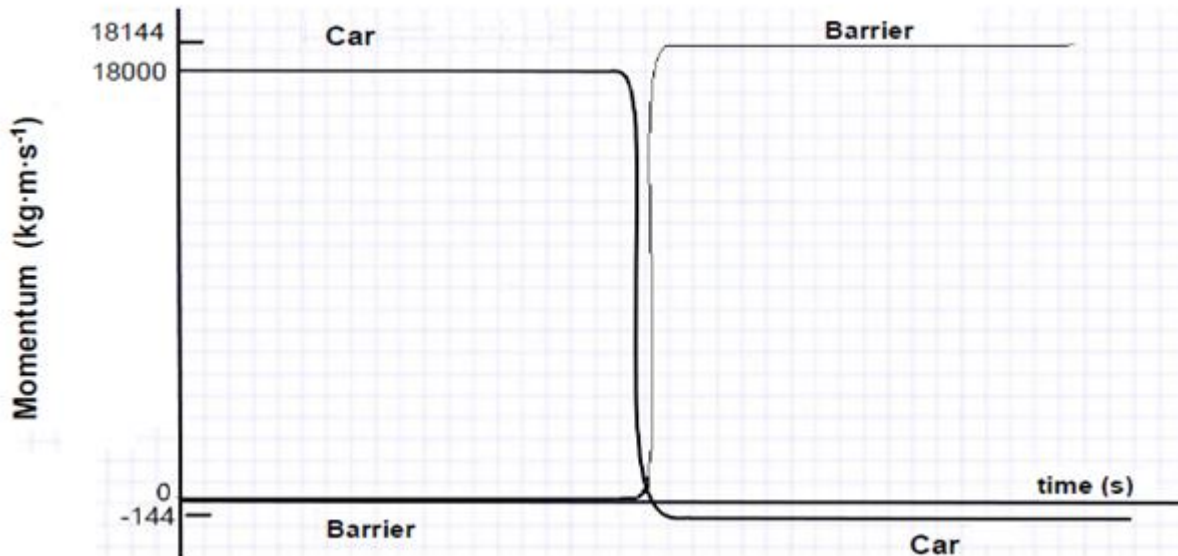
- 3.1 Define the term *projectile*. (2)
- 3.2 Calculate the time it will take the balls to pass each other. (5)
- 3.3 Calculate how high above the ground ball X will be at the instant the two balls just pass each other. (4)
- 3.4 Draw the position-time graph for ball X from the moment it is dropped until it passes ball Y. Indicate the following on the graph:
- Initial position of ball X
 - Position of ball X, above the ground, when it passed ball Y.
 - Time it takes the balls to pass each other. (4)

[15]

Question 4

A car with a mass of 900kg is moving east and collides with a free-standing barrier that has a mass of 3 200 kg.

Study the following **MOMENTUM-TIME** graph of the car and the barrier below and answer the questions that follow.



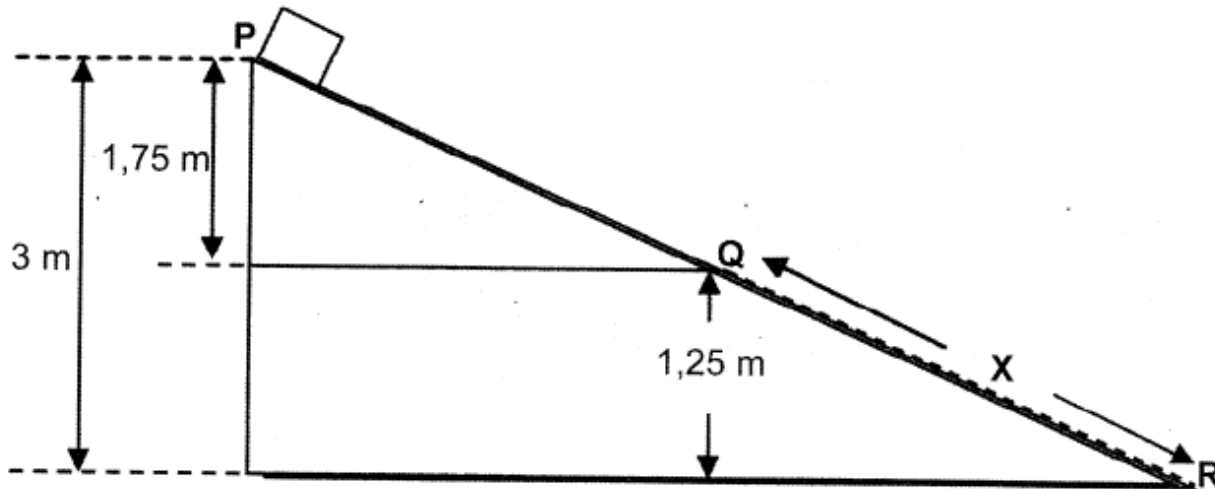
- 4.1 State the *law of conservation of linear momentum* in words. (2)
- 4.2 Use the information given on the graph and calculate the:
- 4.2.1 Final speed and direction of the car (4)
- 4.2.2 Impulse on the car (4)
- 4.3 Is this collision elastic or inelastic? (5)
- Use calculations to verify your answer. (5)

[15]

Question 5

A 4kg box is held stationary at point P, the top of a plane PQR, inclined at an angle to the horizontal.

The portion PQ of the plane is smooth while the portion QR is rough.



- 5.1 Determine the speed of the box at position **Q**. (4)
- 5.2 The box experiences a kinetic frictional force of 15 N as it moves with a **CONSTANT VELOCITY**, from **Q** to **R**, down the plane.
- 5.2.1 State the *Work-Energy Theorem* in words. (2)
- 5.2.2 Draw a labelled free-body diagram showing **ALL** forces acting on the box as it moves from **Q** to **R**. (3)
- 5.2.3 Use the **ENERGY PRINCIPLES** to calculate the distance **X**, between **Q** and **R**. (5)
- 5.3 The angle between the incline and the horizontal is now increased.
How will this increase affect the coefficient of kinetic friction of the box?
Write only **INCREASE**, **DECREASE** or **REMAIN THE SAME**. (1)

[15]

Question 6

A sound source, moving at a constant speed of $240\text{m}\cdot\text{s}^{-1}$ towards a detector, emits sound at a constant frequency. The detector records a frequency of $5\,100\text{ Hz}$.

Take the speed of sound in air as $340\text{m}\cdot\text{s}^{-1}$.

6.1 Define the Doppler effect. (2)

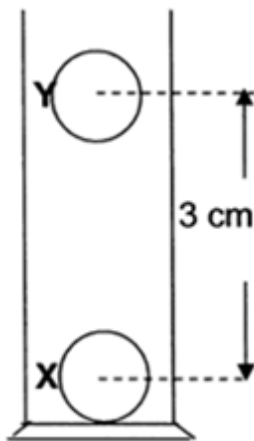
6.2 Calculate the wavelength of the sound emitted by the source. (6)

[8]

Question 7

A polystyrene ball, **X**, which is covered with graphite, is positively charged and placed in a gas cylinder. The mass of the ball is 10g . An identical ball, **Y**, of mass 10g , which is neutral, is now dropped in the gas cylinder. **Y** makes contact with **X** and is then repelled upward by **X**.

Y comes to rest when the vertical distance between the centres of the two balls is 3 cm , as shown in the sketch below. Assume that no charges are transferred between the cylinder and the spheres.



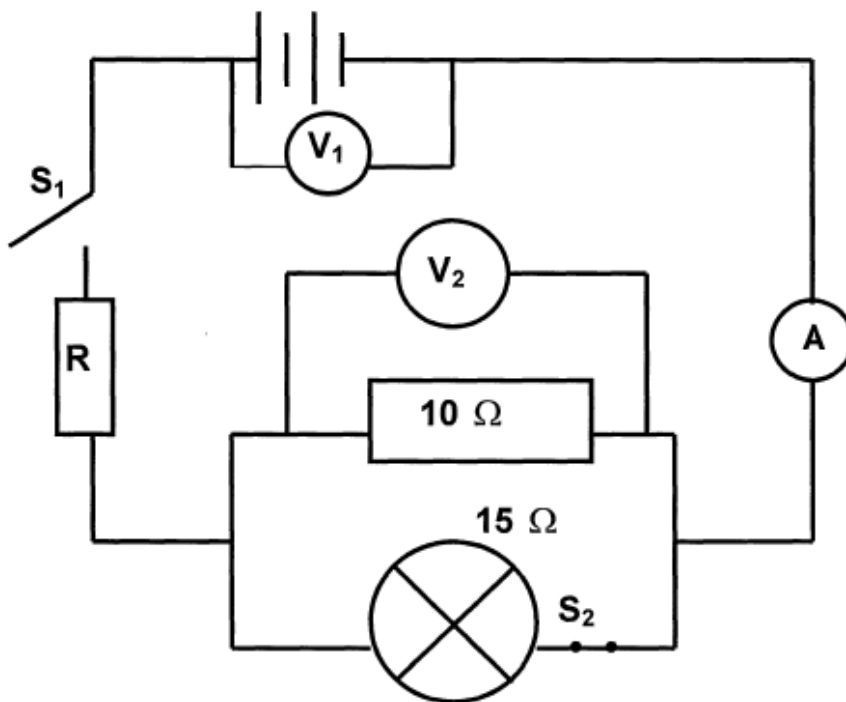
7.1 State, in words, Coulomb's law. (2)

7.2 Draw a free body diagram of all the forces acting on sphere Y. (2)

- 7.3 What is the magnitude of Y's weight? (2)
- 7.4 Prove that the ORIGINAL charge on X was $2 \times 10^{-7} \text{ C}$. (5)
- 7.5 Suppose Y was originally not neutral, but had a charge of $-1 \times 10^{-7} \text{ C}$.
X, still has a charge of $2 \times 10^{-7} \text{ C}$.
- 7.5.1 Calculate the new charge on each sphere after they have separated again. (2)

[13]**Question 8**

The battery in the following circuit has an emf of 24 V and an internal resistance of 1,5, Ω .



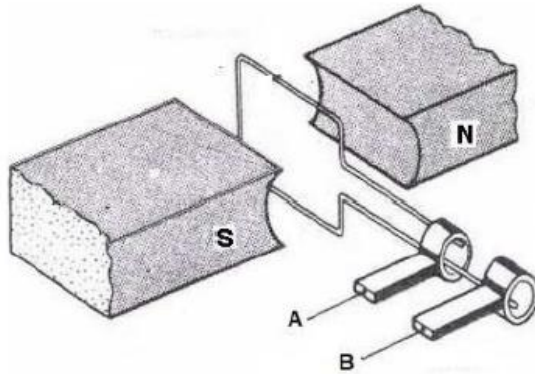
R is a resistor with unknown resistance. The light bulb has a resistance of 15 Ω . The resistance of the switches, S1 and S2, ammeter and conducting wires can be ignored.

- 8.1 State **Ohm's law** in words. (2)
- 8.2 Calculate the effective resistance of the 10 Ω resistor and light bulb. (3)
- When switch S1 is closed, the bulb converts 576 J of energy per minute.*
- 8.3 Calculate the reading on ammeter. (6)

- 8.4 Determine the resistance of resistor R. (5)
- 8.5 Briefly explain what will happen to the reading on voltmeter V_1 when switch S_2 is opened. (4)

[20]**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 15V. 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 axes and indicate the given data. (3)
- 9.5 The specifications of an electric drill are as follows:

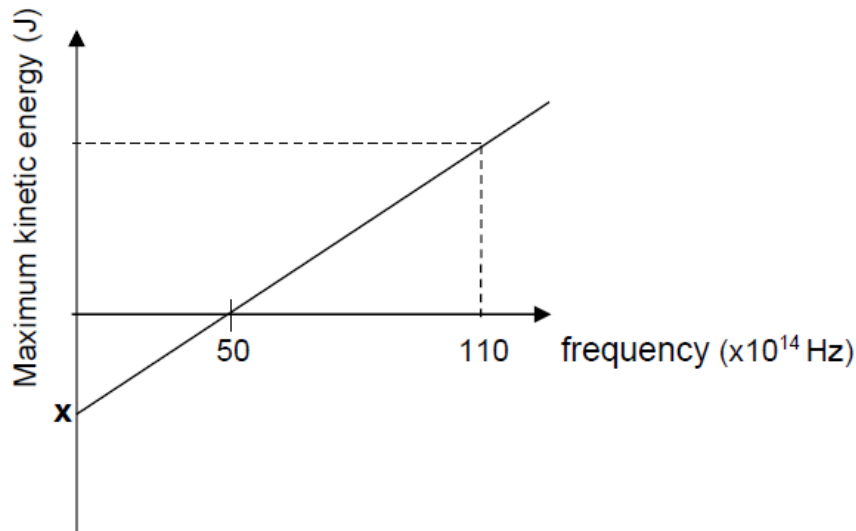
2 100 W; 240 V

- 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 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 a 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 45×10^{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 110×10^{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**

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

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	6,67 x 10 ⁻¹¹ N·m ² ·kg ⁻²
Radius of the Earth <i>Radius van die Aarde</i>	R _E	6,38 x 10 ⁶ m
Mass of the Earth <i>Massa van die Aarde</i>	M _E	5,98 x 10 ²⁴ kg
Speed of light in a vacuum <i>Spied van lig in 'n vakuum</i>	c	3,0 x 10 ⁸ m·s ⁻¹
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 ⁻³⁴ J·s
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 ⁹ N·m ² ·C ⁻²
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 ⁻¹⁹ C
Electron mass <i>Elektronmassa</i>	m _e	9,11 x 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

$F_{\text{net}} = ma$	$p = mv$
$F_{\text{net}} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{r^2}$	$g = \frac{Gm}{r^2}$
$f_s^{\text{max}} = \mu_s N$	$f_k = \mu_k N$

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 $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{av}} = F \cdot v_{\text{av}} / P_{\text{gem}} = F \cdot v_{\text{gem}}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

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

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ 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)
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

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