KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

PREPARATORY EXAMINATION

SEPTEMBER 2024

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 in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists 10 questions. Answer ALL the 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.
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 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 number (1.1-1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 If an object is at rest, it can be concluded that…

A no external forces act on it
B the net force acting on the object is zero
C the object is prevented from moving by friction
D the object experiences a net force greater than zero (2)

1.2 The physical quantity represented by the expression $\frac{(v_f^2 - v_i^2)}{2\Delta x}$ is equivalent to….

A Velocity
B Acceleration
C momentum
D Kinetic Energy (2)

1.3 A builder throws a brick vertically upwards with an initial velocity of 7,35 $m \cdot s^{-1}$. When the brick reaches its maximum height, then the …

A acceleration of the brick is 7,35 $m \cdot s^{-2}$ and its potential energy is a maximum.
B velocity of the brick is 0 $m \cdot s^{-1}$ and its potential energy is a minimum
C velocity of the brick is 9,8 $m \cdot s^{-1}$ and its potential energy is a maximum.
D acceleration of the brick is 9,8 $m \cdot s^{-2}$ and its kinetic energy is a minimum. (2)

1.4 Impulse is…

A the change in object's kinetic energy.
B the product of the net force acting on an object and the object's mass.
C the rate of change in momentum.
D the product of the net force acting on an object and the time the net force acts on the object. (2)

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1.5 A motor lifts a box of mass **m** through a vertical height of **h** at a constant speed of **v** in time Δt . Which of the following is equal to the rate at which work is done to lift a box?

A mgv

B mgh

C $\frac{(\frac{1}{2}mv^2)}{\Delta t}$

D $\frac{(mgh-\frac{1}{2}mv^2)}{\Delta t}$ (2)

1.6 Which one of the following is the main principle applied when measuring the rate of blood flow?

A Newton's second law of motion
B Photoelectric effect
C Doppler effect
D rate of change in momentum (2)

1.7 Two small, identical spheres X and Y on insulated stands, carry charges of -q and +3q respectively. When placed with their centres a distance **r** apart, X exerts an electrostatic force of magnitude **F** on Y.



Y is now brought into contact with X and then moved so that the centres of Y and X are a distance $\frac{1}{2}$ r. apart. The magnitude of the electrostatic force which X now exerts on Y is:

A 12**F**

B $\frac{4}{3}$**F**

C $\frac{3}{4}$ **F**

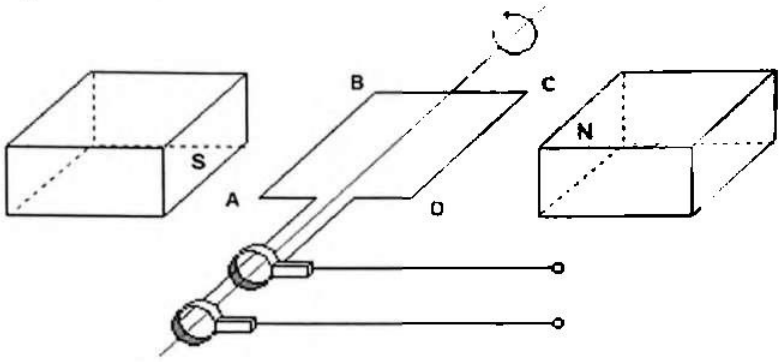
D $\frac{1}{12}$**F** (2)

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1.8 The minimum value of the resistance that can be obtained by connecting two 6 Ω resistors is ...

A 1 Ω
B 2 Ω
C 3 Ω
D 12 Ω (2)

1.9 A coil is rotated anti-clockwise in a uniform magnetic field. The generator diagram below shows the position at the instant the coil lies parallel to the magnetic field.



The direction of the current when the coil is in the position shown above is ...

A A to B
B B to A
C C to B
D D to C (2)

1.10 In an experiment on the photoelectric effect, a scientist shines Orange light on a metal surface and observes that electrons are ejected from the metal surface. Later the scientist shines Green light, with the same intensity as the Orange light, on the same metal surface.

Which ONE of the statements below will be the CORRECT observation as a result of this change?

A The speed of the ejected electrons will decrease.
B The number of ejected electrons per second will increase.
C The maximum kinetic energy of the ejected electrons will increase.
D The number of ejected electrons per second will decrease. (2)

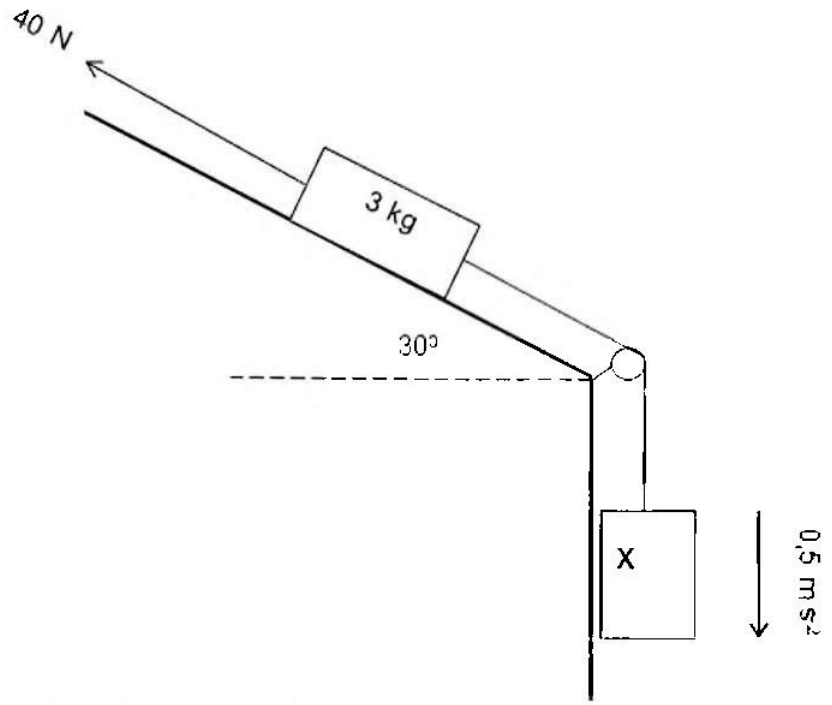
[20]

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QUESTION 2

2.1 A block of mass 3 kg is connected with a light inextensible string that is hanging over a frictionless pulley, to another block of mass X as shown in the diagram below.

The 3 kg block, placed on an inclined plane at an angle of 30° to the horizontal, is pulled by a constant force of 40 N along the incline, while, the block of mass X accelerates at 0,5 $m \cdot s^{-2}$ downward.



The coefficient of kinetic friction between the 3 kg block and the surface is 0,2. Ignore the effects of air friction.

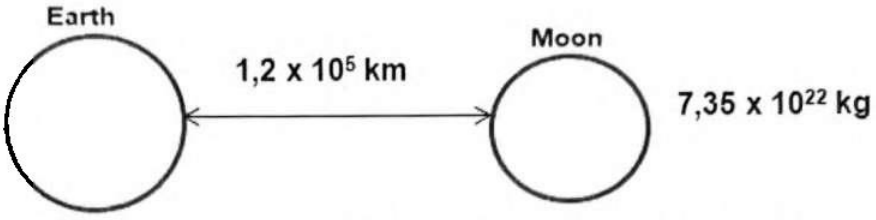
2.1.1 State *Newton's Second Law of Motion* in words. (2)

2.1.2 Draw a labelled free-body diagram indicating ALL the forces acting on the 3 kg block as it moves down the inclined plane. (5)

2.1.3 Calculate X, the mass of the hanging block. (6)

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2.2 The Moon which has the mass of $7,35 \times 10^{22}$ kg is $1,2 \times 10^{5}$ km away from Earth as shown in the diagram below.



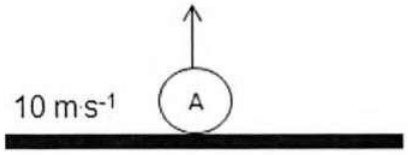
The gravitational force between the Moon and Earth is $1,91 \times 10^{20}$ N.

2.2.1 State Newton's Law of Universal Gravitation in words. (2)

2.2.2 Calculate the radius of the Moon. (5)
[20]

QUESTION 3

3.1 Ball **A** is projected vertically upwards at a velocity of 10 $m \cdot s^{-1}$ from the ground as shown in the diagram below.



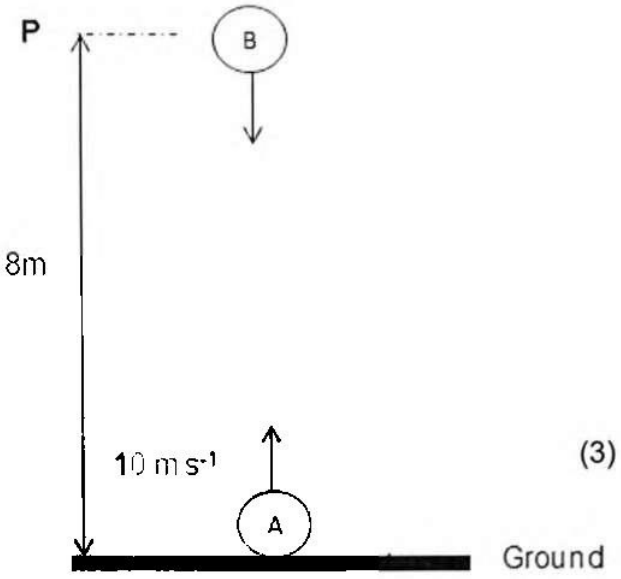
Ignore the effects of air resistance. Use the ground as zero reference.

3.1.1 Explain the term *Projectile* (2)

3.1.2 Draw a labelled free-body diagram indicating ALL the forces acting on ball **A** just before it reaches the maximum height. (1)

3.1.3 Write down the magnitude of ball **A**'s Kinetic energy at its maximum height (1)

3.2 0,5 s AFTER ball **A** is projected upwards, a second ball, **B**, is dropped from a point **P** which 8 m above the ground as shown in the diagram below.



(3)

3.2.1 Calculate the time it takes for the ball to reach its maximum height. (3)

3.2.2 Calculate the time at which ball **B** meets ball **A.** (4)

3.3.3 On the same system of axes, draw a position – time graphs for ball A and ball B, indicating the whole motion until the instant the two balls meet. Use ground as reference. Take upward as positive.

Clearly show the following on your graph:

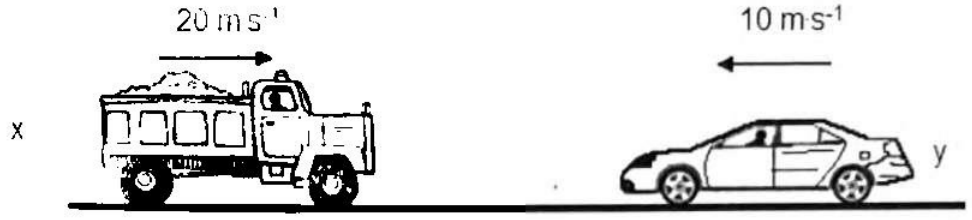
- Initial position for the two balls.
- The time at which the balls meet.

(3)
[14]

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QUESTION 4

A Truck of mass x, travelling at a velocity of 20 $m \cdot s^{-1}$ to the right on a straight horizontal road, collides head-on, with a car of mass y travelling at 10 $m \cdot s^{-1}$ to the left. The collision between the vehicles is INELASTIC.



The vehicles stick together during the collision and move to the right. The vehicles have a combined mass of 2300 kg and a kinetic energy of 258750 J.

4.1 State the *principle of conservation of linear momentum* in words. (2)

4.2 Calculate the speed of the vehicles after the collision. (3)

4.3 Show by means of a calculation that the Truck has a mass of 1916,67 kg. (4)

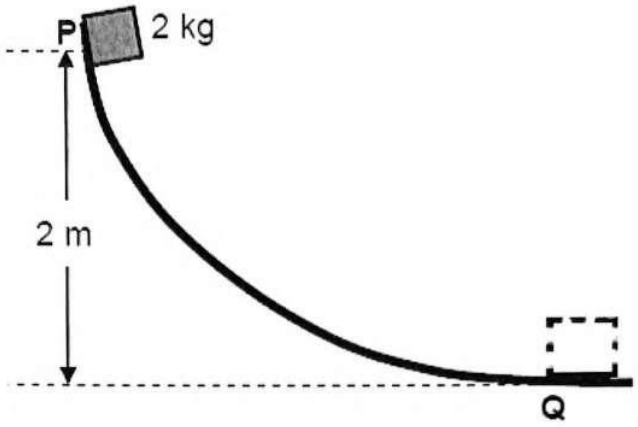
4.4 Hence, determine the magnitude of impulse experienced by the Truck. (3)

[12]

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QUESTION 5

A block of mass 2 kg is released from rest at point P and slides down a rough curved slope from a vertical height of 2 m, as shown in the diagram below. It reaches its lowest position, point Q, at a speed of 5 $m \cdot s^{-1}$.



5.1 Is mechanical energy conserved while the wooden block slides down the slope? Give a reason for the answer. (2)

5.2 State the work-energy theorem in words. (2)

5.3 Use the work-energy theorem to calculate the work done by the kinetic frictional force experienced by the wooden block as it slides from **P** to **Q**. (6)

[10]

QUESTION 6

The siren of a stationary police car emits sound waves of wavelength 0, 24 m.

The stationary listener now hears a sound with a frequency of 50 Hz **higher than** the sound emitted by the siren.

Assume that the speed of sound in air is 340 $m \cdot s^{-1}$.

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

6.2 Calculate the frequency of the sound emitted by the siren. (3)

6.3 The police car moves a distance of x in 15 seconds. Calculate the distance x. (6)

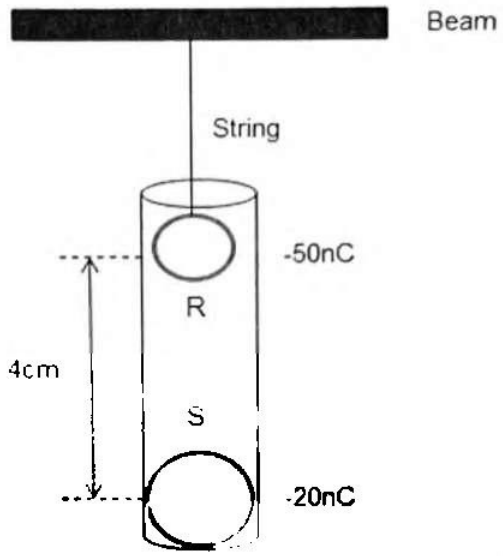
6.4 State ONE application of Doppler effect in medicine. (1)

[12]

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QUESTION 7

7.1 A small sphere, **R**, with a charge of -50nC, is placed in a narrow, cylindrical glass tube vertically above sphere **S**, with a charge of -20nC. Sphere **R** is suspended from a light string secured to a beam as shown in the diagram. The mass of sphere **S** is TWICE the mass of sphere **R**. Ignore the effects of air friction.



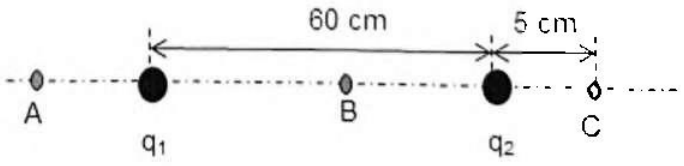
Both spheres come to equilibrium when the tension on the string is 8 N.

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

7.1.2 Draw a labelled free-body diagram indicating ALL the forces acting on sphere **R**. (3)

7.1.3 Calculate the mass of sphere **S**. (6)

7.2 Two point charges, q_1 and q_2 are placed 60 cm apart. Charge q_1 carries +30μC and q_2 carries -90μC. Points A, B and C along a straight line are positions in the electric field surrounding the charges. C is 5 cm from point charge q_2 as shown in the diagram below.



7.2.1 Define the electric field at a point. (2)

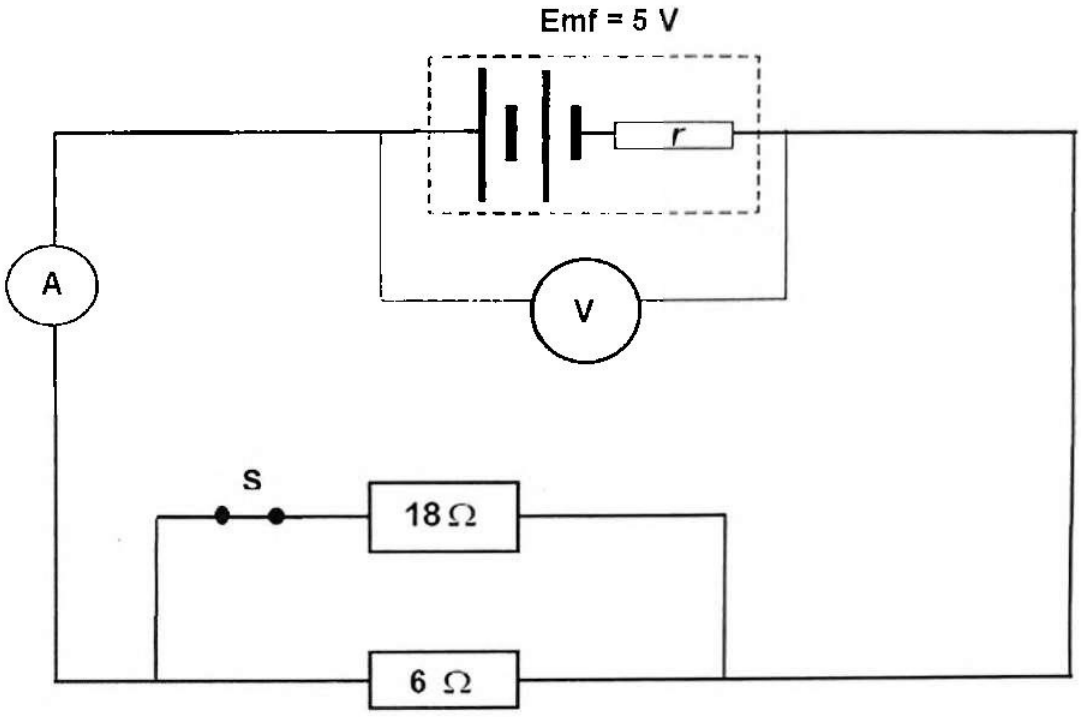
7.2.2 Explain why the net electric field is not ZERO at positions **B** and **C**. (2)

7.2.3 **A** is 80 cm from point charge **q_2**. Calculate the net electric field at **A**. (6)
[21]

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QUESTION 8.

The battery in the circuit below has an emf of 5 V and internal resistance **r**. The resistance of the connecting wires and ammeter can be ignored.



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

Switch S is closed, and the ammeter reading is 0,4 A.

8.2 Calculate the:

8.2.1 Reading on the voltmeter. (4)

8.2.2 Energy dissipated in the 18 Ω resistor in 5 minutes. (4)

8.2.3 Internal resistance the cell. (4)

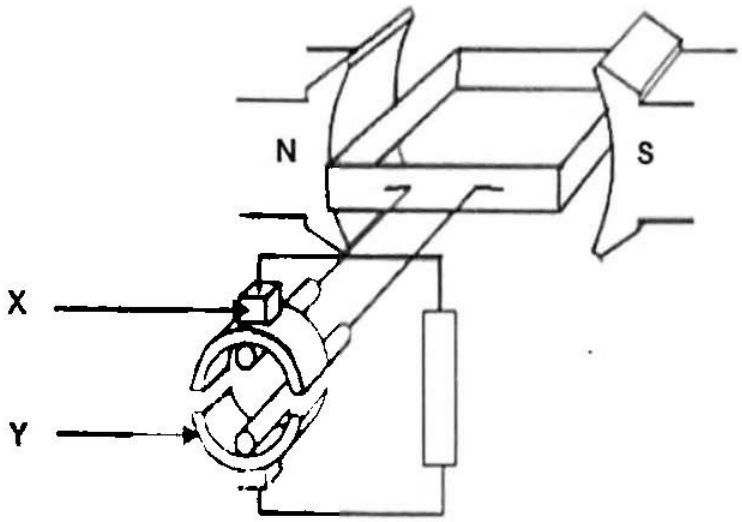
8.3 How will the reading on voltmeter V change when switch **S** is opened? Choose from INCREASES, DECREASES or REMAINS THE SAME (1)

[15]

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QUESTION 9.

9. 1 AC generators and DC generators differ in their construction and the type of current they deliver.



9.1.1 What type of generator (AC or DC) is illustrated in the diagram? (1)

9.1.2 State the energy conversion that takes place in the generator. (1)

9.1.3 Which component, **X** or **Y**, enables this generator to produce the type of current it delivers? (1)

9.1.4 Will the coil experience a maximum or minimum turning effect (torque) if the coil is in the position as shown in the diagram above? (1)

9.2 An electrical device is connected to a generator which produces an rms potential difference of 210 V. The maximum current passing through the device is 6 A.

Calculate the:

9.2.1 Resistance of the device (5)

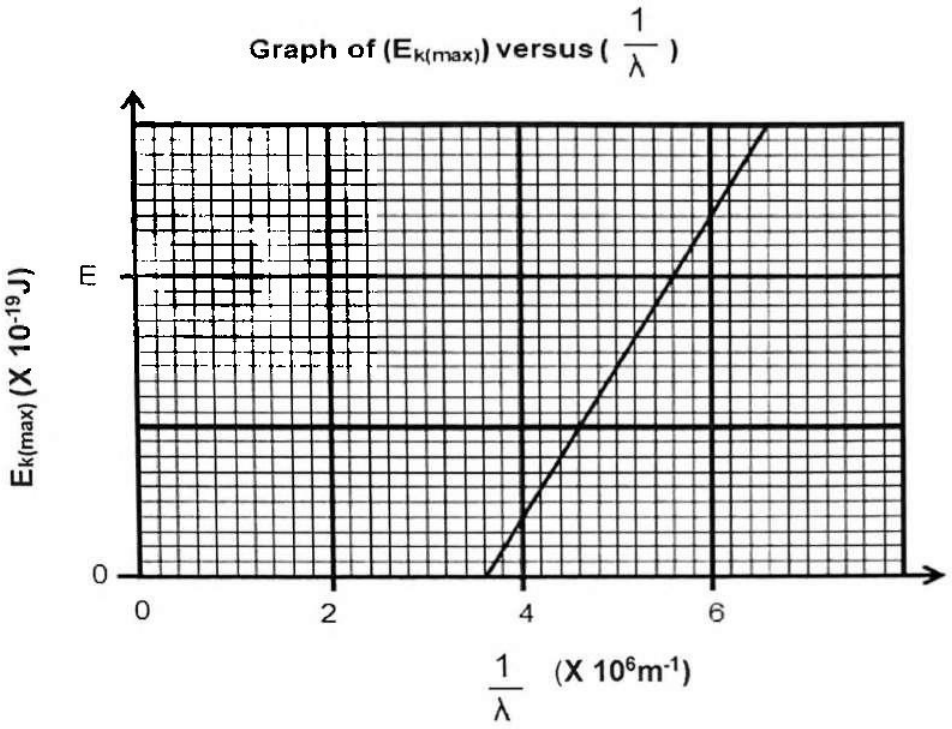
9.2.2 Energy the device consumes in two hours (5)

[14]

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QUESTION 10

In an experiment to demonstrate photoelectric effect, light of different frequencies is shone onto the metal surface of a photoelectric cell. The maximum kinetic energy of the emitted photoelectrons is measured. The graph below shows the results obtained.



10.1 Define the term photoelectric effect. (2)

USE THE GRAPH to answer the following questions:

10.2 Calculate the threshold frequency of the metal in the photoelectric cell (3)

10.3 Calculate the maximum kinetic energy at **E** shown on the graph. (5)

The experiment above is now repeated using light of higher intensity.

10.4 How will EACH of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.4.1 The gradient of the graph (1)

10.4.2 The number of photoelectrons emitted per unit time (1)

[12]

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 *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	G	$6,67 \times 10^{-11}$ $N \cdot m^2 \cdot kg^{-2}$
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 electron*	e	$-1,6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Mass of Earth *Massa van Aarde*	M	$5,98 \times 10^{24}$ kg
Radius of Earth *Radius van Aarde*	R_E	$6,38 \times 10^6$ m

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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

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

WORK, ENERGY AND POWER / 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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F \cdot v_{av}$ / $P_{gem} = F \cdot v_{gem}$	

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 $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/of $E = W_o + K_{(max)}$ where/waar $E = hf$ and/en $W_o = hf_o$ and/en $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/of $K_{(max)} = \frac{1}{2}mv_{max}^2$	

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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

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

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