GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION
PREPARATORY EXAMINATION
2015

10841

PHYSICAL SCIENCES: PHYSICS

FIRST PAPER

MARKS: 150
TIME: 3 hours

18 pages and
3 data sheets

GAUTENG DEPARTMENT OF EDUCATION

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PHYSICAL SCIENCES: PHYSICS
(First Paper)

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INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK provided.
2. The question paper consists of TWELVE questions. Answer ALL the questions in the ANSWER BOOK provided.
3. Start EACH question on a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between subsections, 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. You are advised to use the attached DATA SHEETS.
9. Show the formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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, for example 1.11 D.

1.1 An object is free falling towards the surface of the earth.

Which ONE of the following best describes the direction of **acceleration** of the object?

A The acceleration is 9,8 $m \cdot s^{-2}$ downward.

B The acceleration is 9,8 $m \cdot s^{-2}$ upward.

C The acceleration is less than 9,8 $m \cdot s^{-2}$ downward.

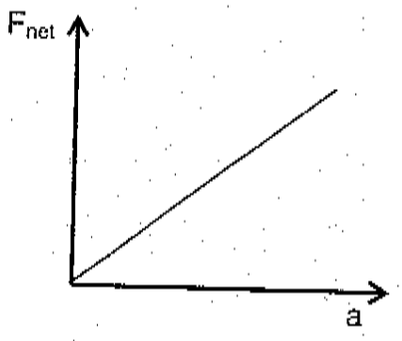
D The acceleration is less than 9,8 $m \cdot s^{-2}$ upward.

(2)

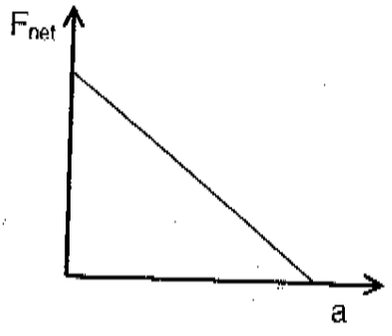
1.2 A 1 kg mass has a constant acceleration.

Which ONE of the following sketch graphs correctly shows the relationship between the net force, F_{net} and acceleration, a?

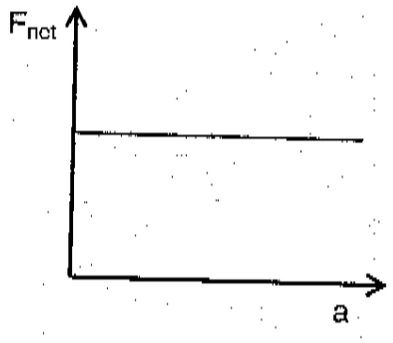
A



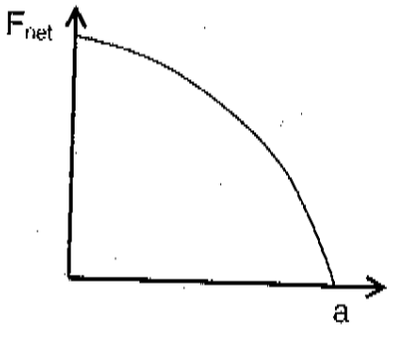
B



C

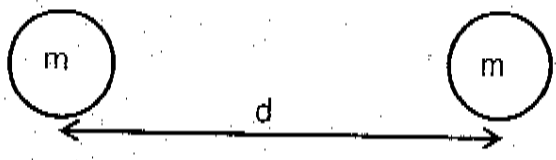


D



(2)

1.3 Two objects, each of mass **m** are placed a distance **d** apart as shown below. The gravitational force between them is **F** .



The magnitude of the force increases to **4F** when the ...

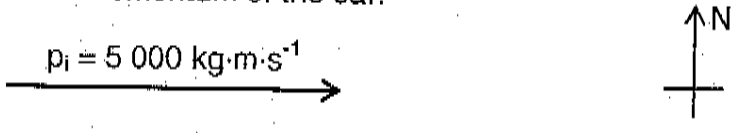
A distance between the objects decreased to $\frac{1}{4}$**d**.

B distance between the objects decreased to $\frac{1}{2}$**d**.

C mass of each object decreased to $\frac{1}{4}$ **m**.

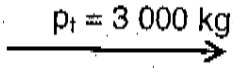
D mass of each object increased to **4m**. (2)

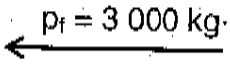
1.4 A car has an initial momentum of 5 000 kg·m·s^{-1} east. The vector below shows the initial momentum of the car.

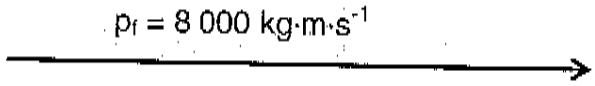


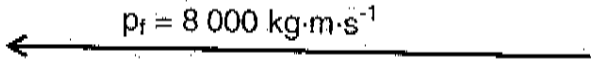
This car is involved in a collision and the change in momentum of the car is represented below.

The vector representing the final momentum of the car **after** the collision is ...

A 

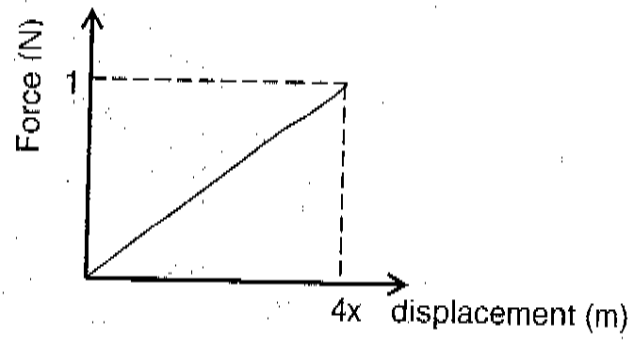
B 

C 

D 

(2)

1.5 The graph below shows the relationship between the applied force (F) on an object and the displacement (x) of the object in the direction of the applied force.



The average work in joules, done by the applied force for a displacement of 4x m is ...

A ½x

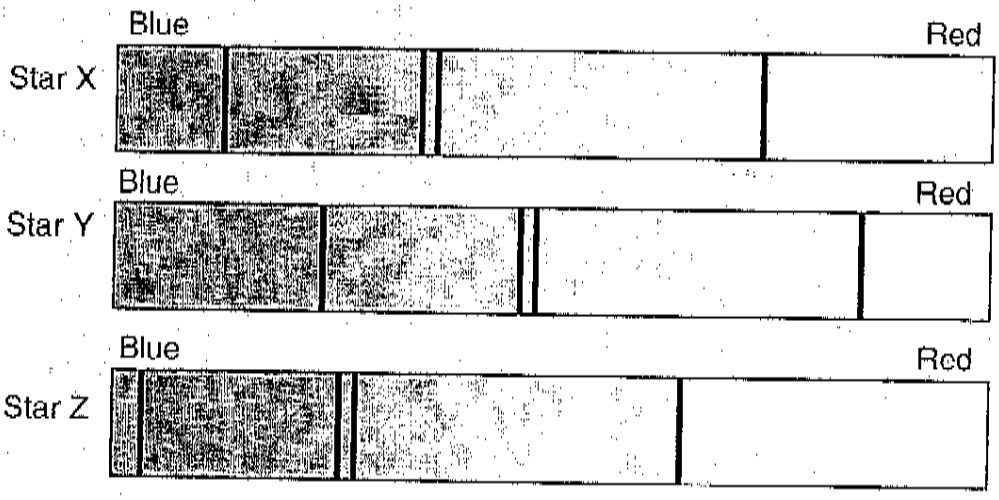
B 2x

C 3x

D 4x

(2)

1.6 Study the following absorption spectra for three different stars as observed from earth.

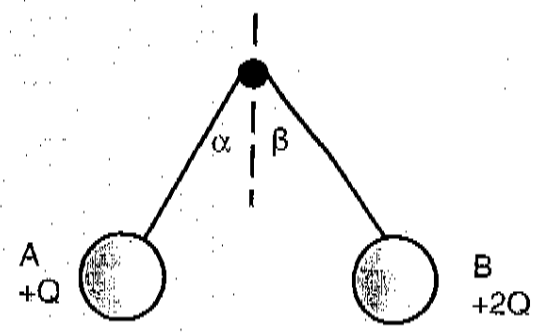


Which ONE of the following combinations correctly describes the speed of the stars relative to earth?

	Star moving away from earth at the greatest speed	**Star moving towards earth at the greatest speed**
A	Y	Z
B	Y	X
C	Z	Y
D	Z	X

(2)

1.7 Sphere A, with a charge of +Q, and sphere B, with a charge of +2Q, are suspended from the same insulated point as shown in the diagram below. (The diagram is not drawn to scale.)



The spheres are allowed to move freely until they come to rest on their own.

How will the values of the angles α and β compare to each other once the spheres come to rest?

A $\alpha = \beta$

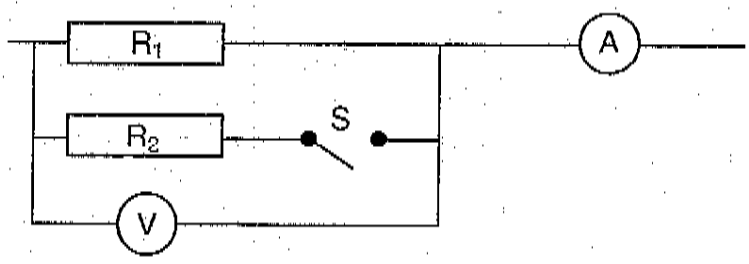
B $\alpha < \beta$

C $\alpha > \beta$

D $\alpha = \beta = 0$

(2)

1.8 The diagram below shows part of a circuit diagram. R_1 and R_2 are identical ohmic resistors connected in parallel. With the switch open, the ammeter reads 1 A and the voltmeter across the parallel section reads 3 V.



Switch S is closed. The reading on the ammeter and voltmeter will now be ...

	Reading on ammeter	Reading on voltmeter
A	greater than 1 A	greater than 3 V
B	less than 1 A	equal to 6 V
C	greater than 1 A	less than 3 V
D	equal to 1 A	equal to 3 V

(2)

1.9 Which ONE of the following phrases correctly explains how a generator works? It works ...

A by converting electrical energy to mechanical energy.

B by using the motor effect.

C according to Lenz's law.

D using electromagnetic induction. (2)

1.10 When an excited 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.

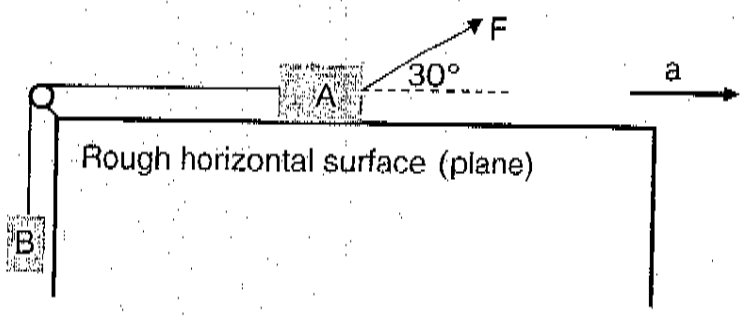
C emission line in an absorption spectrum is observed.

D absorption line in an absorption spectrum is observed.

(2)
[20]

QUESTION 2 (Start on a new page.)

Block A of mass 5 kg is attached to block B of unknown mass. The string joining the blocks is INELASTIC and WEIGHTLESS. The string passes over a frictionless pulley as shown below.



An applied force **F** with magnitude 15 N acts at an angle of 30° relative to the horizontal plane on block A. Block A accelerates at 2,2 $m \cdot s^{-2}$ to the right across the rough horizontal plane.
The coefficient of kinetic friction between the surface of block A and the plane is 0,35.

2.1 Define Newton's Second Law in words. (2)

2.2 Draw a labelled FREE BODY diagram of all the forces acting on block A. (5)

2.3 Calculate the magnitude of the frictional force experienced by block A. (3)

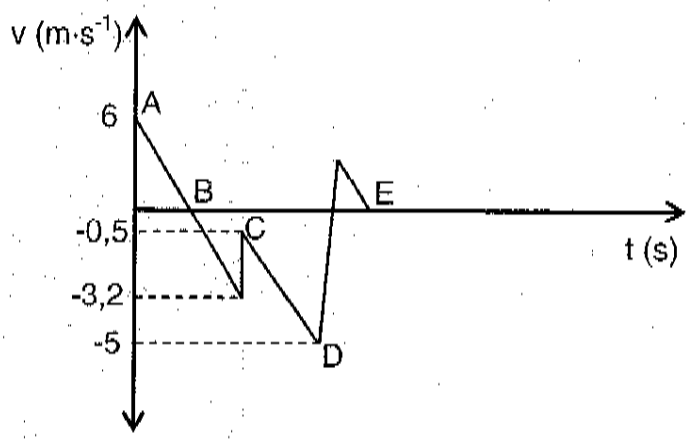
2.4 Calculate the mass of block B. (5)
[15]

QUESTION 3 (Start on a new page.)

The velocity-time sketch graph for a ball of mass 160 g, thrown vertically upwards with a velocity of 6 $m \cdot s^{-1}$ from a certain height above the ground, is shown below.

On the way down the ball crashes through a thin horizontal glass pane and then continues downward, eventually bouncing on the ground.

Ignore all effects of air friction and assume none of the broken pieces of glass sticks to the ball.



3.1 Write down the magnitude and direction of the acceleration of the ball when it reaches position B as indicated on the graph. (2)

3.2 How many times did the ball bounce on the ground? (1)

3.3 According to the graph, which direction, DOWNWARDS or UPWARDS is taken as the positive direction? (1)

3.4 Calculate the distance between the pane of glass and the initial position from which the ball was thrown. (4)

3.5 Draw a rough position-time graph for the motion of the ball. Show the points **A** to **E** on the graph. Do not show any displacement or time values on the graph. **Take the initial position of the ball as zero.** (5)

[13]

QUESTION 4 (Start on a new page.)

Mars has an average radius of 3 390 km and a mass of $6,39 \times 10^{23}$ kg. Mars has two moons.

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

4.2 If the gravitational force exerted by Mars on one of its moons with mass $1,08 \times 10^{16}$ kg, is $5,71 \times 10^{15}$ N, calculate the distance between the centre of this moon and the surface of Mars. (6)

[8]

QUESTION 5 (Start on a new page.)

An ice-skater with a mass of 54 kg, is holding a box as part of her act. She skates with a velocity of 0,08 $m \cdot s^{-1}$ east. She throws the 1,5 kg box directly away from her with a velocity of 10,2 $m \cdot s^{-1}$ east.

5.1 State the principle of conservation of linear momentum. (2)

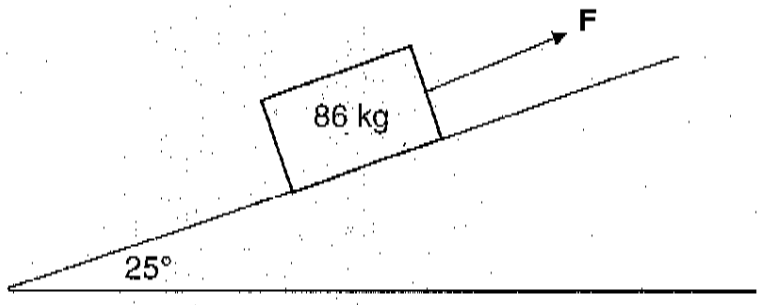
5.2 Calculate the ice-skater's velocity immediately after throwing the box away from her. (4)

5.3 Calculate the magnitude of the force exerted on the box by the ice-skater if she exerted this force for 1,2 s. (3)

[9]

QUESTION 6 (Start on a new page.)

A box of mass 86 kg is accelerating down a surface inclined at 25° to the horizontal.



A man applies a force **F** upwards parallel to the plane in an attempt to prevent the box from sliding down the inclined plane. In spite of the man's efforts the box is accelerating down the inclined plane.

6.1 What is a non-conservative force? (2)

6.2 The coefficient of kinetic friction (μ_k) between the box and the surface of the plane is 0,22.
Prove that the magnitude of the kinetic frictional force is 168,04 N. (2)

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

6.4 Draw a labelled FREE BODY diagram of all the forces acting on the box. (4)

6.5 The box accelerates parallel down the inclined plane for a distance of 0,9 m at 1,54 $m \cdot s^{-2}$. Use the work-energy theorem and calculate the work done by the man on the box. (5)
[15]

QUESTION 7 (Start on a new page.)

While standing still near a railroad crossing, a girl hears a train horn in the distance. The horn emits a sound of frequency 430 Hz.

The speed of sound in air is taken as 335 $m \cdot s^{-1}$.

7.1 State the Doppler effect. (2)

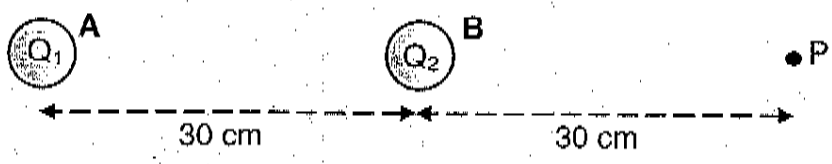
7.2 The train is moving with a constant velocity of 25 $m \cdot s^{-1}$ in a straight line towards the girl who is standing still at the crossing. Calculate the wavelength of the sound observed by the girl while the train is approaching her. (6)

7.3 Will the frequency of the sound observed by the train driver be HIGHER, LOWER or THE SAME as that emitted by the horn of the train? Give reasons for the answer. (3)
[11]

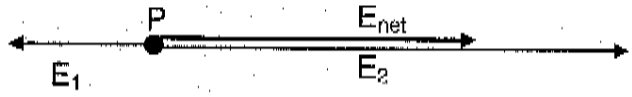
QUESTION 8 (Start on a new page.)

Two identical conducting spheres **A** and **B** with charges of Q_1 and Q_2 respectively are placed in fixed positions along the same straight line as shown in the diagram below.

Spheres **A** and **B** are placed 30 cm from each other. Point **P** is positioned 30 cm to the right of sphere **B** on the same straight line.



The charge on sphere **B** is positive. The net electric field E_{net} at point **P** as a result of the two charges Q_1 and Q_2 is towards the right as shown in the diagram below.



8.1 What is the sign of the charge on sphere **A**? Give a reason for the answer. (3)

8.2 The net electric field at point **P** is 1 600 $N \cdot C^{-1}$ to the right and the charge on sphere **B** has a magnitude of +12 nC.
Calculate the magnitude of the charge on sphere **A**. (7)

A proton is placed at point **P** without changing the charges and positions of spheres **A** and **B**.

8.3 Calculate the net electrostatic force experienced by the proton. (4)
[15]

QUESTION 9 (Start on a new page.)

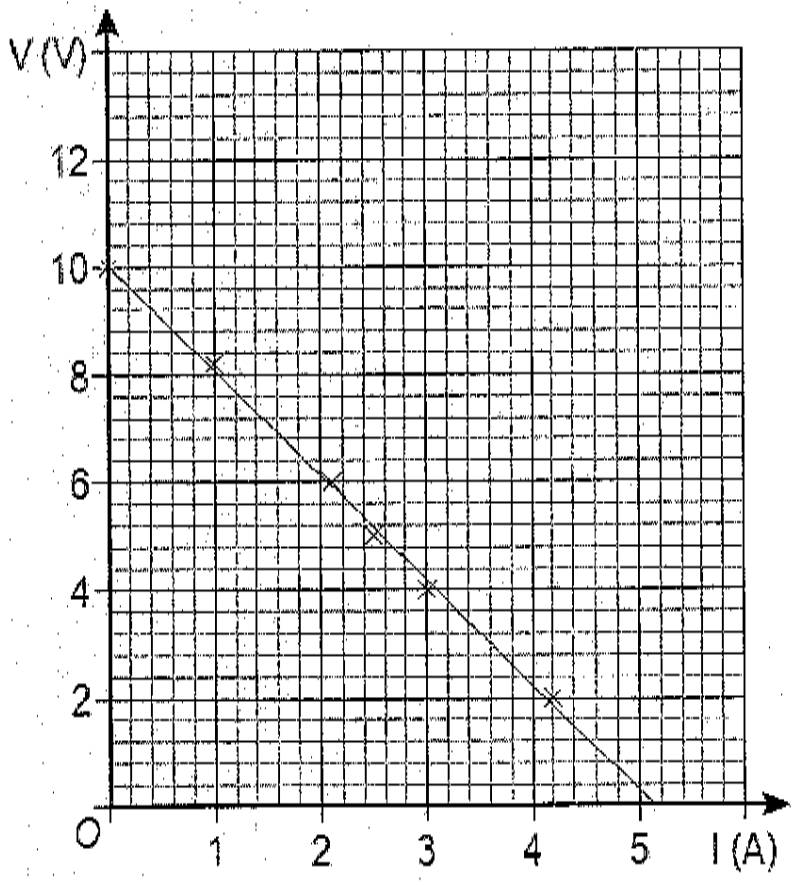
Learners investigate how a CHANGE IN THE TOTAL CURRENT of the circuit affects the INTERNAL RESISTANCE OF A CELL. Two groups of learners were given the following apparatus:

GROUP A	GROUP B
• A new AAA cell • Voltmeter • Ammeter • Rheostat • Switch • Connecting wires	• A new AAA cell with a **higher** internal resistance than for group A. • Voltmeter • Ammeter • Rheostat • Switch • Connecting wires

9.1 Write down the independent variable for the investigation. (1)

9.2 Refer to the apparatus provided to the learners and draw the appropriate circuit diagram required for the investigation. (3)

Group A use their readings to draw the following graph.

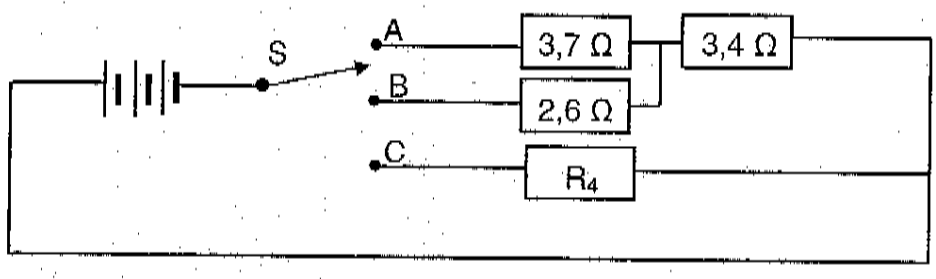


9.3 Use the graph and determine the internal resistance of the AAA cell provided to group A. (3)

9.4 The AAA cell provided to group **B** has a higher internal resistance.
How will the gradient of the graph drawn by group **B** compare to that of group **A**?
Write only GREATER THAN, SMALLER THAN or THE SAME AS. (1)
[8]

QUESTION 10 (Start on a new page.)

The diagram below shows the circuit for an electric blanket. It has three different resistance settings **A**, **B** and **C** to regulate the amount of HEAT generated by the blanket.



The electric blanket is connected to a battery with an emf of 20 V and an internal resistance of 1 Ω.

10.1 With the switch connected to position **A**, calculate the:

10.1.1 Total resistance of the external circuit. (2)

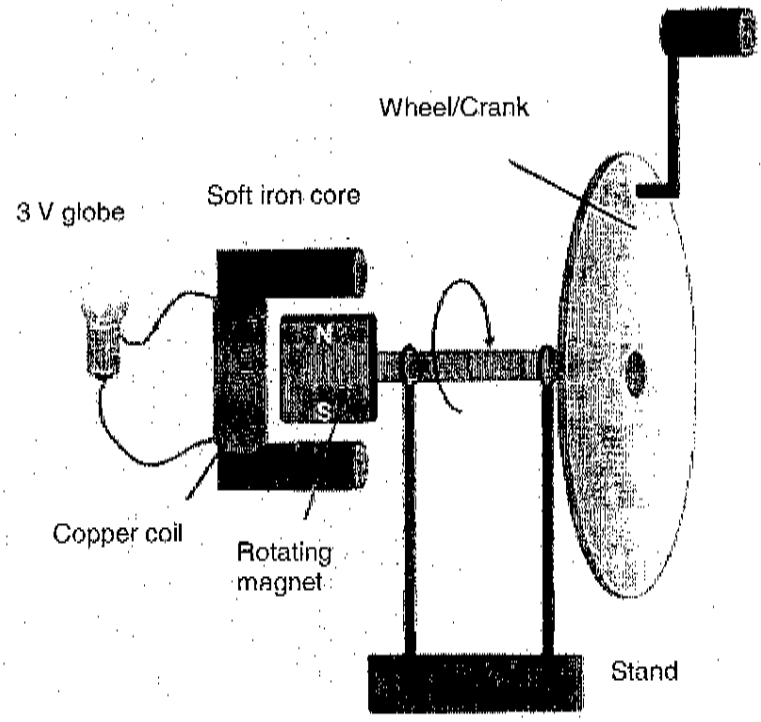
10.1.2 Total current through the circuit. (3)

10.2 How does the total current change when the switch is connected to position **B**?
Write INCREASES, DECREASES or STAYS THE SAME.
Explain the answer. (3)

10.3 Calculate the power output of the electric blanket when the switch is connected to **C** given that the total current at this setting is 2,31 A. (4)
[12]

QUESTION 11 (Start on a new page.)

A learner built the following simple generator based on a dynamo used to power bicycle headlights. He used the generator to demonstrate that he could use mechanical energy to generate electrical energy.



11.1 Is this a DC or an AC generator? Give a reason for the answer. (3)

11.2 How will the learner know that electrical energy is produced? (1)

11.3 Explain how this generator is able to produce electrical current when there is no electrical connection between the rotating magnet and the copper coil. (3)

11.4 List TWO changes that can be made to the generator to INCREASE the BRIGHTNESS of the globe. (2)

A generator (dynamo) used to power a light on a bicycle needs an average power of 6 W and a potential difference of 12 V_{rms} .

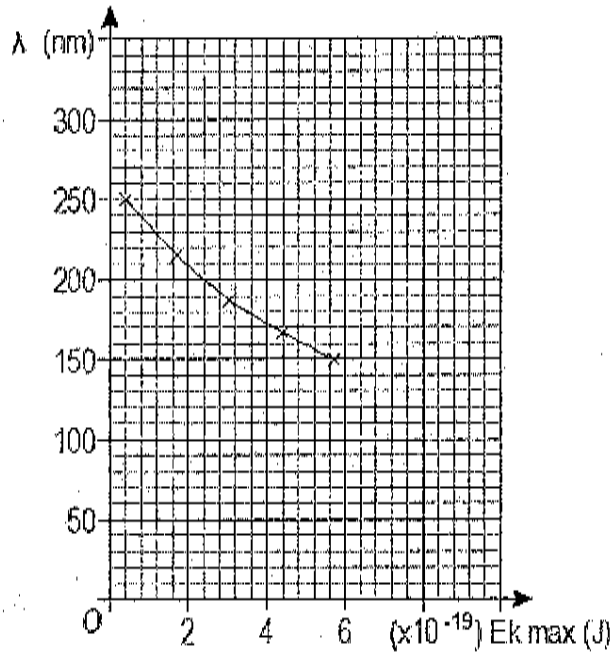
11.5 Calculate the maximum current that can flow through the globe. (4)
[13]

QUESTION 12 (Start on a new page.)

During the investigation of a specific type of cathode of a photoelectric cell, radiation with different wavelengths were used and the following results were obtained.

The graph below was drawn using the results.

Wavelength (nm)	Maximum kinetic energy (J)
250	$0{,}401\times 10^{-19}$
215	$1{,}73\times 10^{-19}$
187	$3{,}04\times 10^{-19}$
167	$4{,}37\times 10^{-19}$
150	$5{,}70\times 10^{-19}$



12.1 Define the **work function** for a specific metal. (2)

12.2 What is the relationship between the wavelength of the radiation and the maximum kinetic energy of the photoelectron?
Explain the answer. (4)

12.3 How does an increase in the intensity of the radiation affect the maximum kinetic energy of the photoelectrons?
Write only INCREASES, DECREASES or STAYS THE SAME. (1)

12.4 The maximum wavelength for the radiation that is able to emit electrons from this cathode is 255 nm.

Calculate the maximum velocity of a photoelectron emitted if radiation with a wavelength of 160 nm is used. (5)
[12]

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 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 elektron*	-e	$-1{,}6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}\ kg$
Mass of earth *Massa van die aarde*	M	$5{,}98 \times 10^{24}\ kg$
Radius of earth *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*

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

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

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

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

END