LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

EPHSCP1

This question paper consists of 17 pages and 3-paged data sheets

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN 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 sub questions, 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 ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 (1.1-1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 When two surfaces touch each other, the component of the contact force parallel (tangential) to the surfaces is called the …

A applied force.

B normal force.

C gravitational force.

D frictional force. (2)

1.2 A person is transported to the mythical planet Mango, which is EIGHT times as massive as Earth and has TWICE the diameter.

The person's weight on the planet Mango compared to his/her weight on Earth would be …

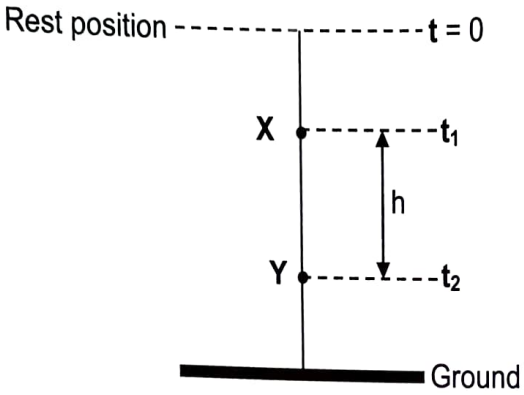
A 2 times larger.

B 2 times smaller.

C 4 times larger.

D 4 times smaller. (2)

1.3 The acceleration of free fall is determined by measuring the times t_1 and t_2 taken for a steel ball to fall from rest and pass points **X** and **Y**. The distance between **X** and **Y** is **h** as shown in the diagram below.



Which ONE of the following is the CORRECT expression used to calculate the acceleration due to gravity?

A $\frac{h}{(t_2 - t_1)^2}$.

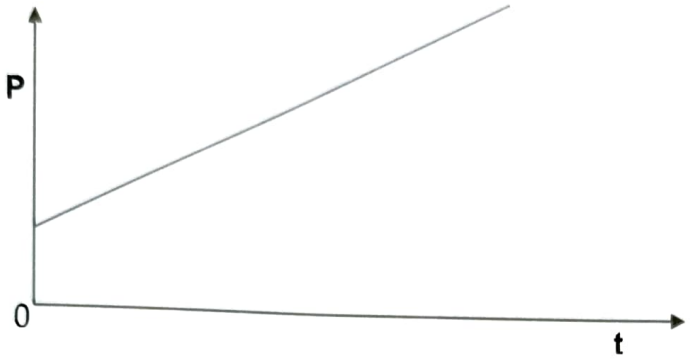
B $\frac{2h}{(t_2 - t_1)^2}$.

C $\frac{h}{2(t_2 - t_1)^2}$.

D $\frac{2h}{(t_2^2 - t_1^2)}$.

(2)

1.4 The sketch graph below represents the relationship between momentum (**P**) and the time (**t**), for a body travelling in a straight line.



Which ONE of the following conclusions based on the graph is TRUE about the *net force* acting on the body?

The net force …

A is exactly zero.

B uniformly increases.

C uniformly decreases.

D remains constant. (2)

1.5 A block **X** of mass 3 kg is accelerated *from rest* by a force of 5 N for 2 s. An identical block **Y** (of mass 3 kg) is accelerated *from rest* by a force of 5 N for 4 s.

Which ONE of the following ratios, E_{K_f} (**X**) : E_{K_f} (**Y**), is correct?

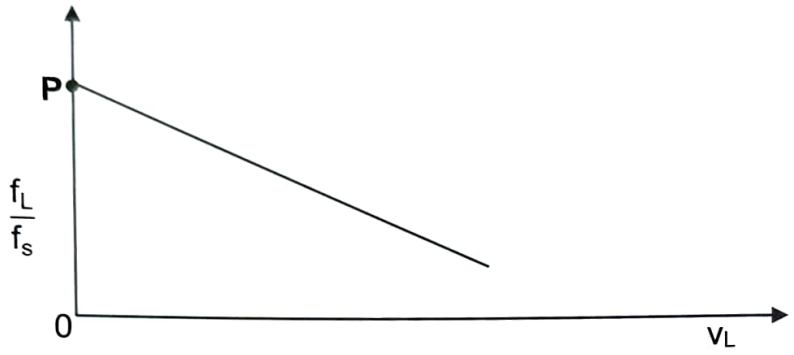
A 1 : 2

B 2 : 1

C 1 : 4

D 4 : 1 (2)

1.6 The sketch graph below represents the relationship between the *ratio of the observed frequency to the source frequency* $\left(\frac{f_L}{f_s}\right)$ and *the speed of the listener* (v_L) for a stationary source.



Which of the following combinations correctly represents the *value of* ***P*** and the *direction* in which the listener moves?

	VALUE OF P	DIRECTION
A	1	Away from the source
B	1	Towards the source
C	2	Towards the source
D	2	Away from the source

(2)

1.7 Two point charges, **X**, with a charge of +q, and **Y**, with a charge of -2q, are separated by a distance **r**. **X** exerts an electrostatic force, **F**, on **Y**.

The charges on **X** and **Y** are EACH increased by +3q.

Which ONE of the following CORRECTLY represents the new force exerted by charge **X** on charge **Y**?

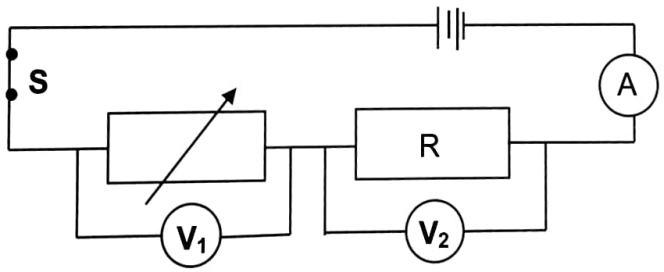
A $\frac{1}{2}$F

B F

C 2F

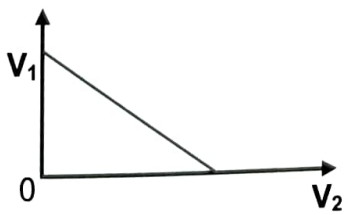
D 4F (2)

1.8 In the circuit represented by the diagram below, V_1 is connected across a rheostat (variable resistor).

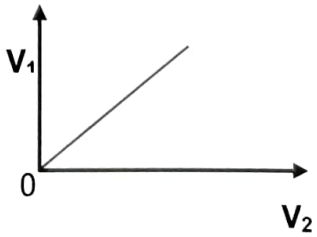


Which ONE of the following sketch graphs represents the relationship between the readings on V_1 and V_2 as the resistance of the rheostat is increased?

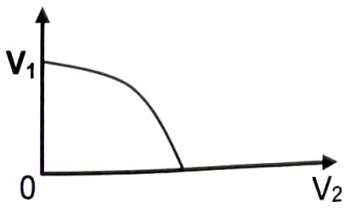
A



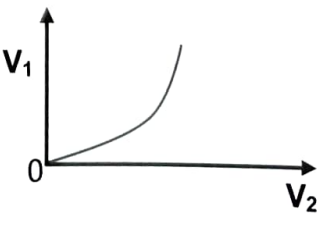
B



C



D



(2)

1.7 Two point charges, **X**, with a charge of +q, and **Y**, with a charge of -2q, are separated by a distance **r**. **X** exerts an electrostatic force, **F**, on **Y**.

The charges on **X** and **Y** are EACH increased by +3q.

Which ONE of the following CORRECTLY represents the new force exerted by charge **X** on charge **Y**?

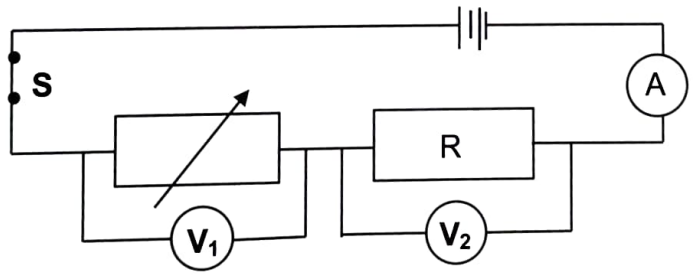
A $\frac{1}{2}$F

B F

C 2F

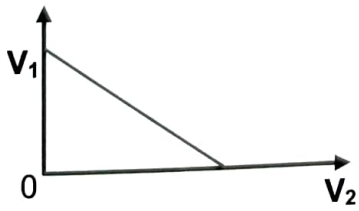
D 4F (2)

1.8 In the circuit represented by the diagram below, V_1 is connected across a rheostat (variable resistor).

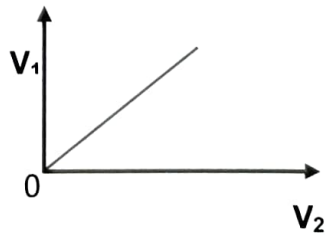


Which ONE of the following sketch graphs represents the relationship between the readings on V_1 and V_2 as the resistance of the rheostat is increased?

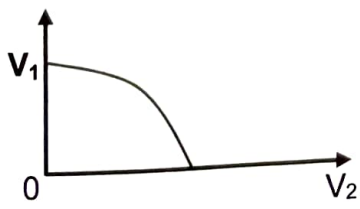
A



B



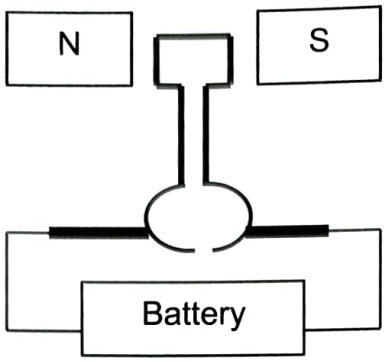
C



D

(2)

1.9 The diagram below represents an electrical machine.



Which ONE of the following represents the CORRECT type of the machine?

A DC generator

B DC motor

C AC generator

D AC motor (2)

1.10 An atom in its ground state absorbs energy **E** and is excited to a higher energy state.

When the atom returns to the ground state, a photon with energy …

A **E** is absorbed.

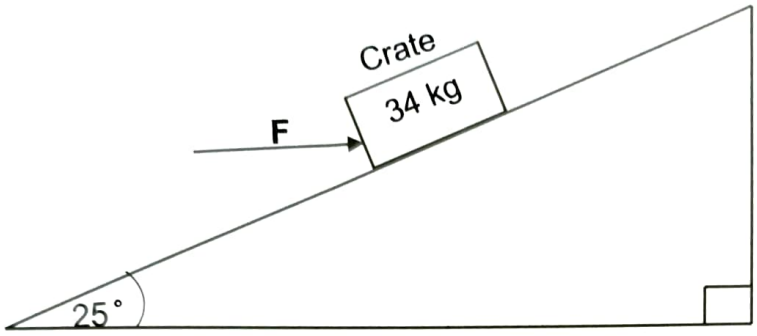
B **E** is released.

C 2**E** is absorbed.

D 2**E** is released. (2)
[20]

QUESTION 2 (Start on a new page)

2.1 A physics learner pushes a 34 kg crate up the plane with a horizontal force of magnitude **F** (parallel to the horizontal), as shown in the diagram below.



The coefficient of kinetic friction between the crate and the surface is 0,25.

2.1.1 Suggest a reason as to why the coefficient of kinetic friction is dimensionless (i.e. has no units). (1)

The crate moves up the plane at a CONSTANT VELOCITY.

2.1.2 State, in words, *Newton's First Law of Motion*. (2)

2.1.3 Draw a labelled free-body diagram for the crate whilst in motion. (4)

2.1.4 Using an appropriate calculation, show that the kinetic frictional force acting on the crate is 75,495 + 0,106·F. (3)

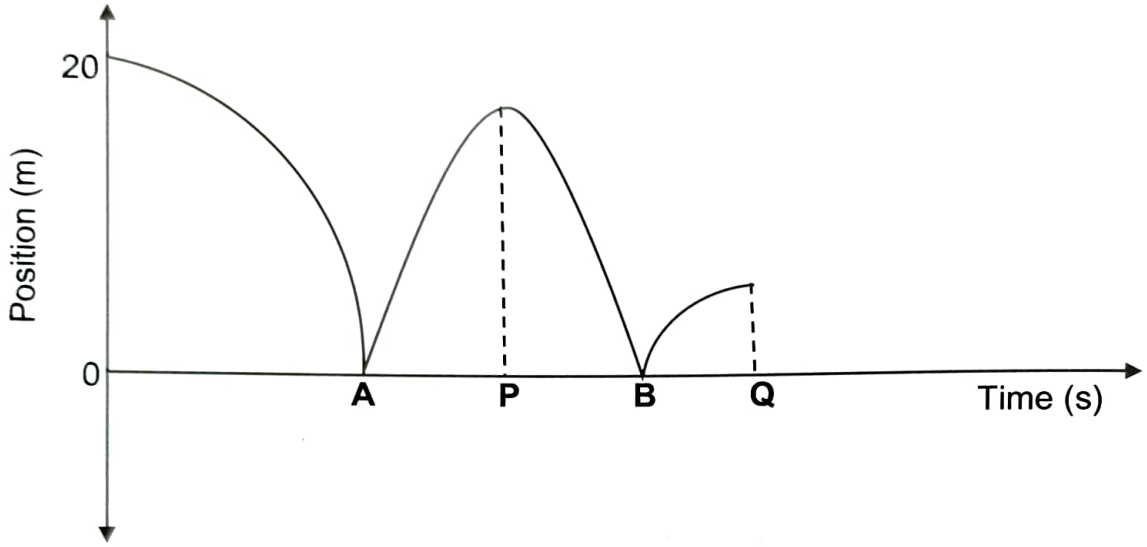
2.1.5 Hence or otherwise, calculate the magnitude of the force F. (3)

2.2 The mass of the Earth is $5,98 \times 10^{24}$ kg and the radius of the Earth is $6,38 \times 10^{6}$ m. A small satellite that is 1000 km above the surface of the Earth is accelerating towards the Earth. The only force acting on the satellite is the gravitational force of the Earth. If the weight of the satellite is 3 660 N at 1000 km above the surface of the Earth, calculate its weight on the surface of the Earth. (4)

[17]

QUESTION 3 (Start on a new page)

A ball is dropped from a height of 20 m and rebounds with a velocity which is **three-quarter** of the velocity with which it hits the ground. The ball bounces two times, as shown in the position-versus-time sketch graph below.



The effects of air resistance and the time lapse with the ground are neglected.

3.1 Define the term *free fall*. (2)

3.2 State the acceleration of the ball the instant it reaches the maximum height after the FIRST bounce. (2)

3.3 Calculate the time interval between the FIRST and SECOND bounces (Δt_{AB}), by using the equations of motion. (6)

3.4 Sketch a velocity-versus-time graph for the motion of the ball from the instant it is dropped until it reaches the maximum height after the first bounce.

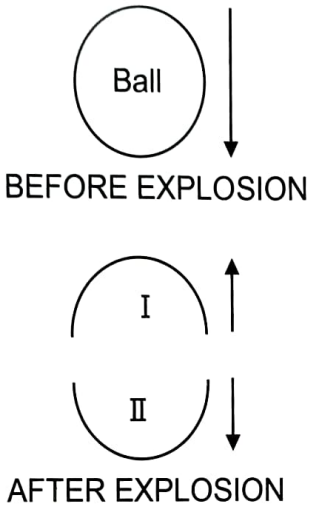
Clearly indicate the values of the following on the graph:

- The times **A** and **P**
- The velocity with which it hits the ground
- The velocity with which it rebounds

(3)
[13]

QUESTION 4 (Start on a new page)

A ball is falling freely. When its downwards speed reaches 9,2 $m \cdot s^{-1}$, it explodes into two *equal* parts. Part I goes straight up to a height of 13,7 m above the point of explosion.



4.1 Define, in words, the term *momentum* as applied in physics. (2)

4.2 Calculate the initial velocity of part I just after the explosion (3)

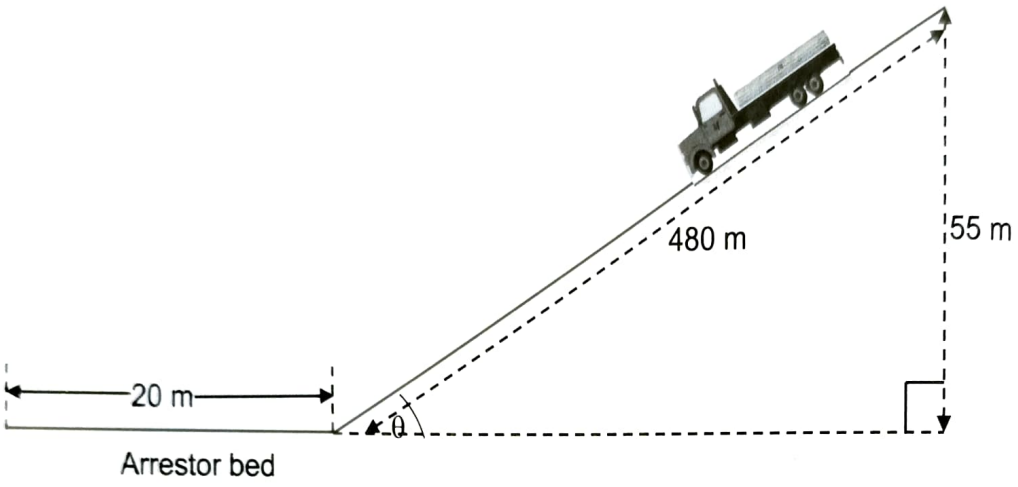
4.3 State the *principle of conservation of linear momentum in words*. (2)

4.4 Calculate the magnitude of the velocity of part II just after the explosion. (4)

[11]

QUESTION 5 (Start on a new page)

A truck of mass 6 000 kg accelerates from REST at the top of a slope to 11 $m \cdot s^{-1}$ at the bottom. The slope is 480 m long and the truck starts 55 m above level ground, as shown in the diagram below.



The average frictional force on the truck during the journey down the slope is $3,84 \times 10^4$ N.

5.1 Classify frictional force as a CONSERVATIVE FORCE or a NON-CONSERVATIVE FORCE (1)

5.2 Define, in words, the term *power* as applied in physics. (2)

5.3 Calculate the power produced by the engine if the truck takes 88 s to reach the bottom of the slope. (6)

At the bottom of the slope the truck cannot stop and enters a gravel arrestor bed. The bed is 20 m long and provides a resistive force of 0,35 times the weight of the truck.

5.4 Use a calculation to determine if the bed is long enough to stop the truck. (4)
[13]

QUESTION 6 (Start on a new page)

6.1 A commuter train passes a passenger platform at a constant speed of 40,0 $m \cdot s^{-1}$. The train horn is sounded at its characteristic frequency of 320 Hz. Take the speed of sound in air to be 340 $m \cdot s^{-1}$.

6.1.1 State *Doppler effect* in words. (2)

Calculate the:

6.1.2 Frequency heard by a person on the platform as the train approaches the platform. (4)

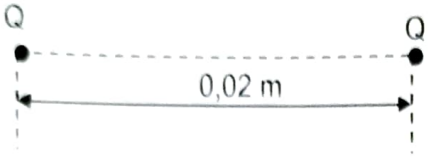
6.1.3 Wavelength detected by a person on the platform as the train approaches. (3)

6.2 A motorcycle starts **from rest** and accelerates along a straight line at 2,81 $m \cdot s^{-2}$. The speed of sound in air is 343 $m \cdot s^{-1}$. A siren at the starting point remains stationary. Use a suitable calculation to prove that the distance that the motorcycle has travelled when the driver hears the frequency of the siren at 90% of the value it has when the motorcycle is stationary, is 209,34 m. (5)

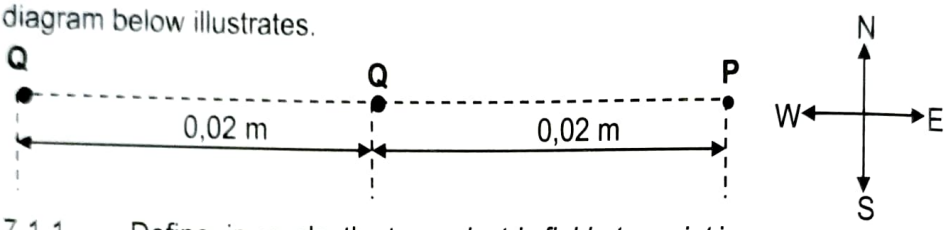
[14]

QUESTION 7 (Start on a new page)

7.1 Two unequal positive point charges, Q_1 and Q_2, are 0,02 m apart, as shown in the diagram below.



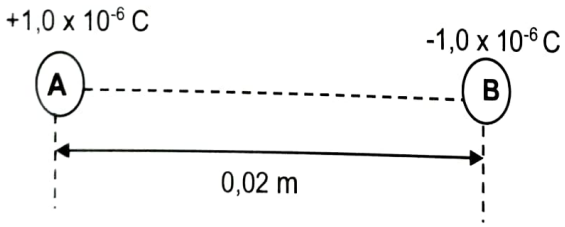
The charge of Q_1 is TWICE that of Q_2 and the electrostatic force that EACH charge experiences is 9×10^{-3} N. Point **P** is 0,02 m away from Q_2, as the diagram below illustrates.



7.1.1 Define, in words, the term *electric field at a point* in space. (2)

7.1.2 Calculate the *net* electric field at point **P** due to charges Q_1 and Q_2. (7)

7.2 Two small spheres, **A** and **B**, are fixed in place and separated by $2,0 \times 10^{-2}$ m in a vacuum. Sphere A has a charge of $+1,0 \times 10^{-6}$ C, and sphere B has a charge of $-1,0 \times 10^{-6}$ C, as shown in the diagram below.



7.2.1 State *Coulomb's Law* in words. (2)

Calculate the:

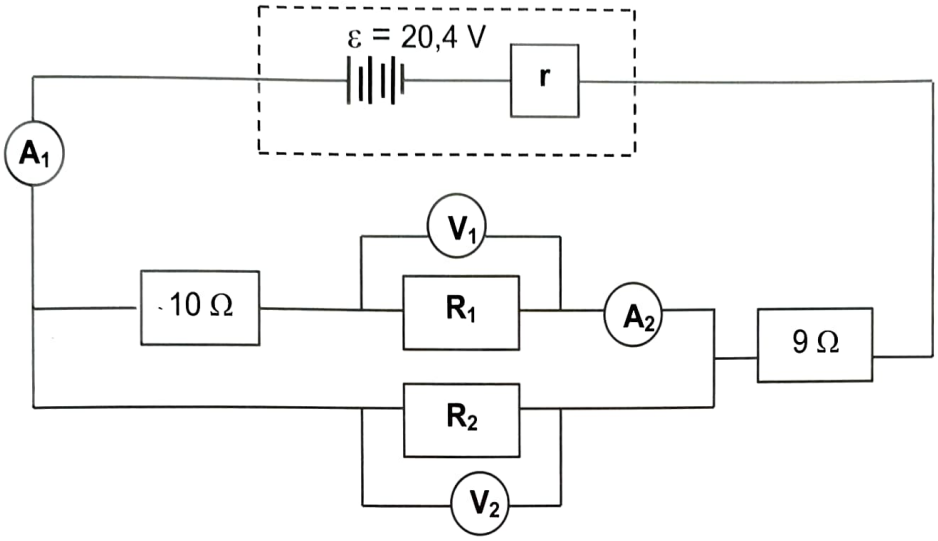
7.2.2 Number of excess electrons on sphere **B** (2)

7.2.3 Using a suitable calculation, show that the number of electrons that must be removed from **A** and put onto **B** to make the electrostatic force that acts on EACH sphere an attractive force whose magnitude is 45,0 N, equals $2,59 \times 10^{12}$. (6)

[19]

QUESTION 8 (Start on a new page)

In the circuit shown in the diagram below, the reading on an ammeter A_1 is *double* that on ammeter A_2 and the reading on voltmeter V_2 is *three* times that on voltmeter V_1.



The battery has an emf of 20,4 V and an **unknown** internal resistance **r**.

8.1 Define the term *emf* of a battery. (2)

8.2 Calculate the resistance of:

8.2.1 Resistor R_1 (3)

8.2.2 Resister R_2 (3)

The reading on V_2 is 9 V.

8.3 Calculate the:

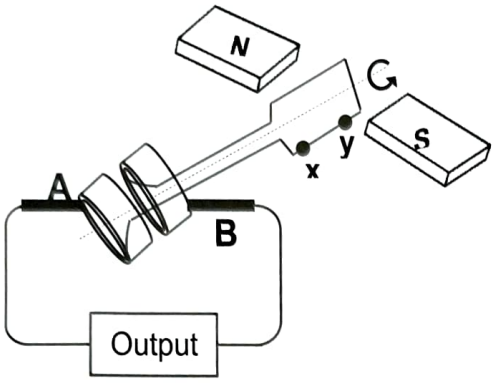
8.3.1 Potential difference across the 10 Ω resistor (3)

8.3.2 Reading on ammeter A_1 (3)

8.3.3 Internal resistance **r** (3)
[17]

QUESTION 9 (Start on a new page)

The diagram represents a simple generator. The coil is rotated in an anti-clockwise direction.



9.1 Does the diagram represent an AC or a DC generator?
Suggest a reason for the answer. (2)

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

9.3 For the parts labelled **A** and **B** in the diagram, write down:

9.3.1 Their name (1)

9.3.2 Their function (1)

9.4 The part **XY** of the coil is about to move upwards. As soon as it moves upwards, will the induced current flow from **X** to **Y** or from **Y** to **X**? (1)

9.5 The peak voltage supplied by this generator is 120 V.

9.5.1 In the position that the coil is shown, is the output voltage 0V, 85 V or 120 V? (1)

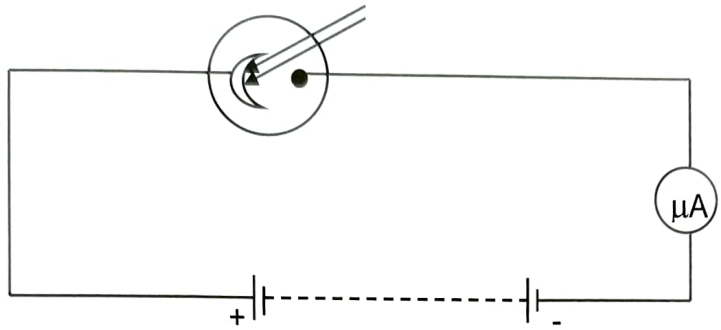
The *rms* value of the current supplied to the external circuit is 1,2 A.

9.5.2 Define the term *rms* for an alternating current. (2)

9.5.3 Calculate the average power output of the generator. (4)
[13]

QUESTION 10 (Start on a new page)

The diagram below shows a photoelectric cell which is connected to an adjustable *emf*.
A group of learners use the device to study the photoelectric effect.



The learners irradiate the cell with blue light of wavelength 470 nm. They record the readings on the ammeter as the cell is irradiated with blue light of *different grades of intensity*.

10.1 Describe the *photoelectric effect* in words. (2)

10.2 For this experiment, write down the following:

10.2.1 Independent variable (1)

10.2.2 ONE factor that must be kept constant (with respect to light) (1)

10.2.3 An investigative question (2)

10.3 The learner observes that the ammeter readings increase when the intensity of the blue light increases. Explain this observation. (2)

10.4 The metal of the photoelectric cell has a work function of 2,35 x 10^{-19} J. calculate the maximum kinetic energy with which the photoelectrons are emitted from the metal. (3)

10.5 Briefly explain why metals shine even when the frequency of the radiation falling on the surface is below the threshold frequency. (2)

[13]

GRAND TOTAL: [150]