basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2025

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces 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 subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. 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 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 The net force acting on an object on a horizontal surface is always …

A in the direction of motion of the object.

B in the direction of acceleration of the object.

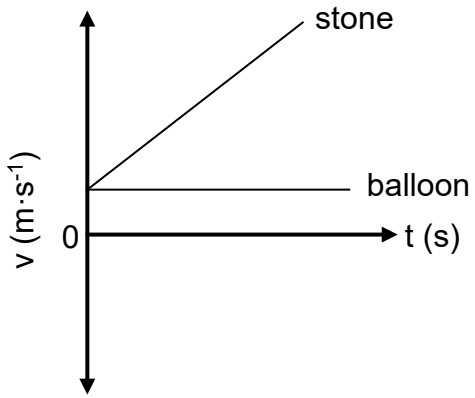
C zero when the object moves at constant acceleration.

D increasing when the object moves at constant acceleration. (2)

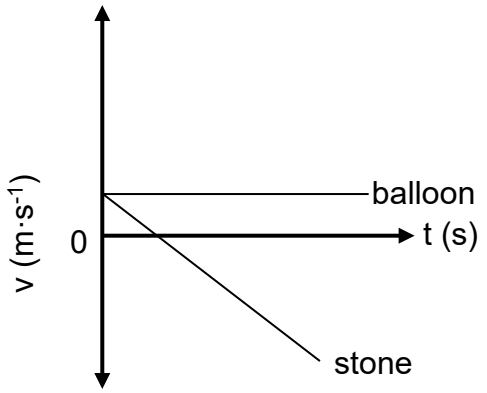
1.2 A hot-air balloon is moving upwards at a constant velocity. A small stone is dropped from THE BALLOON. Which ONE of the following graphs represents the motions of the balloon and the stone?

Ignore the effects of friction on the stone.

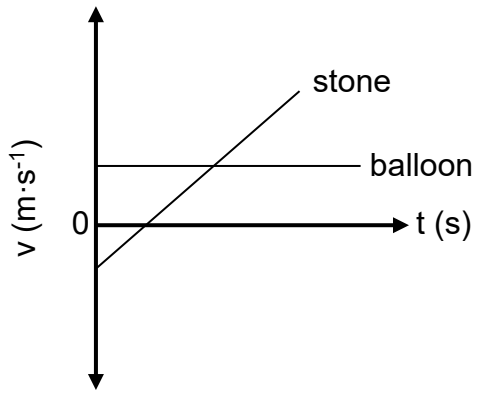
A



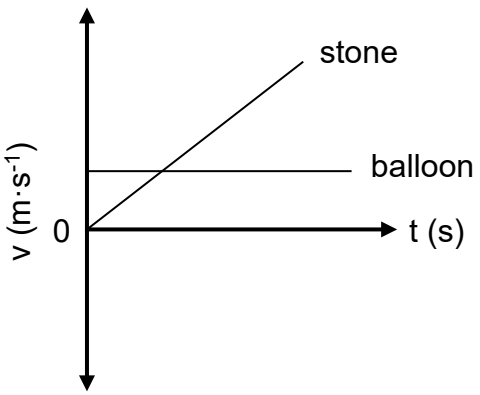
B



C

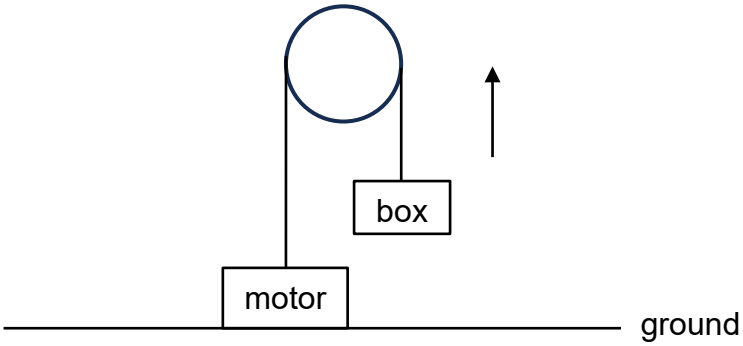


D



(2)

1.3 A motor fixed to the ground is used to lift a box vertically upwards at a CONSTANT VELOCITY.



Consider the statements below for the upward motion of the box.

(i) The rate at which work is done by the motor on the box increases.
(ii) The rate at which work is done by the motor on the box is constant.
(iii) The mechanical energy of the box increases.
(iv) The mechanical energy of the box is constant.

Which of the statements above are CORRECT?

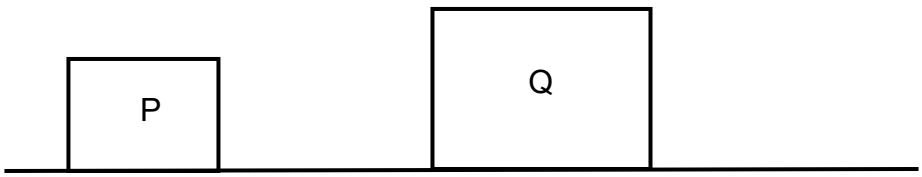
A (i) and (iii) only

B (ii) and (iv) only

C (ii) and (iii) only

D (i) and (iv) only (2)

1.4 Objects P and Q, with masses m and 2m respectively, have the same momentum.



The velocity of P is …

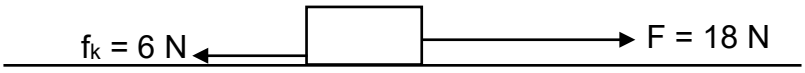
A equal to the velocity of Q.

B half the velocity of Q.

C twice the velocity of Q.

D four times the velocity of Q. (2)

1.5 A block moves along a rough horizontal surface while a horizontal force F of magnitude 18 N and a constant kinetic frictional force of magnitude 6 N act on it.



Which ONE of the following combinations of ACCELERATION and NET WORK DONE ON THE BLOCK is CORRECT?

	ACCELERATION	**NET WORK DONE ON THE BLOCK**
A	Constant	Increases
B	Increases	Constant
C	Increases	Increases
D	Constant	Constant

(2)

1.6 A star's spectrum, observed from Earth, is red shifted. Which ONE of the following statements is CORRECT?

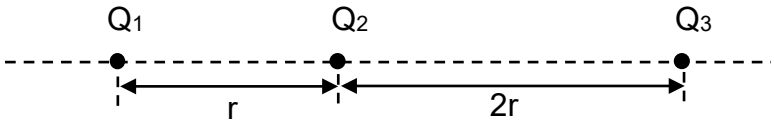
A The speed of light is increasing.

B The star is moving towards Earth.

C The frequency of each spectral line has increased.

D The wavelength of each spectral line has increased. (2)

1.7 Three point charges, Q_1, Q_2 and Q_3, are fixed in a straight line. Q_1 is r metres from Q_2, while Q_3 is 2r metres from Q_2, as shown in the diagram below.



The magnitude of the charge on Q_2 is q. The net electrostatic force on charge Q_1 is zero.

What is the magnitude of charge Q_3 in terms of q?

A $\frac{1}{9}q$

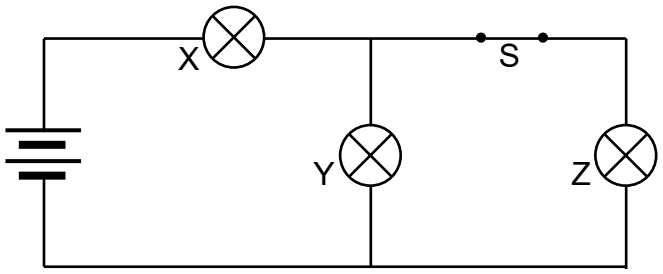
B $\frac{1}{3}q$

C 3q

D 9q (2)

1.8 Three identical light bulbs, X, Y and Z, are connected in a circuit, as shown in the diagram below. Switch S is initially closed.

Ignore the internal resistance of the battery.



Switch S is now opened.

How will the brightness of bulbs X and Y be affected?

	BRIGHTNESS OF BULB X	BRIGHTNESS OF BULB Y
A	Increases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Decreases	Decreases

(2)

1.9 How does the commutator in a DC motor ensure that the coil rotates continuously in ONE direction?

A By reducing friction

B By converting AC to DC

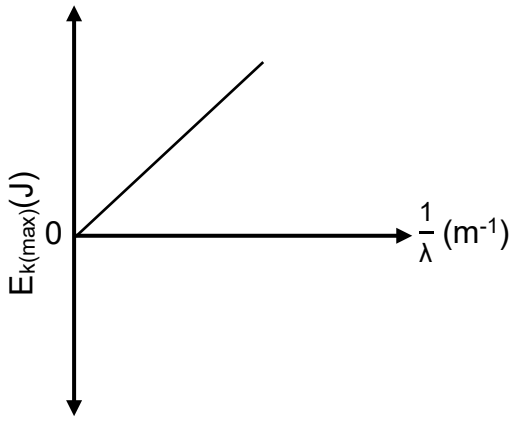
C By reversing the direction of the current in the coil

D By maintaining electrical contact between the external and the internal circuits (2)

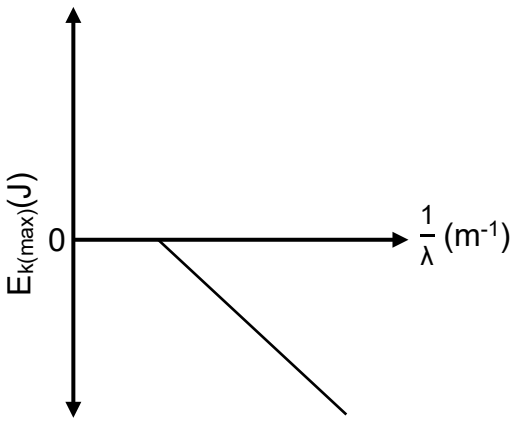
1.10 Light of different wavelengths is incident on a metal surface.

Which ONE of the following graphs shows the CORRECT relationship between the maximum kinetic energy of the photoelectrons, $E_{k(max)}$, and the inverse of the wavelength of the incident light, $\frac{1}{\lambda}$?

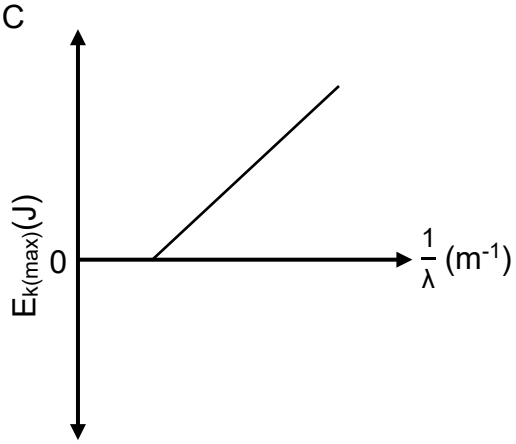
A



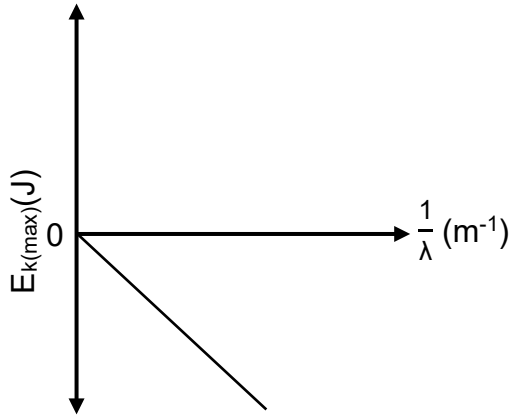
B



C



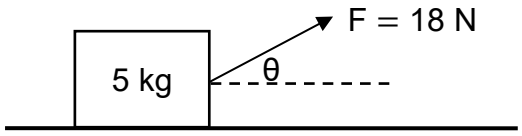
D



(2)
[20]

QUESTION 2 (Start on a new page.)

A block of mass 5 kg is at rest on a rough horizontal surface. When a constant force F of magnitude 18 N acts on the block at an angle θ to the horizontal, the block experiences maximum static friction. See the diagram below.



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 the block. (4)

2.3 The horizontal component of force F is 15 N.

Calculate:

2.3.1 θ (2)

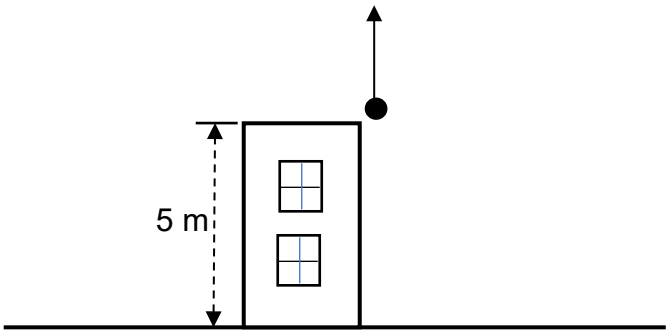
2.3.2 The coefficient of static friction (5)

2.4 Angle θ is decreased while the magnitude of force F remains constant.

How will the friction acting on the block be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (4)
[17]

QUESTION 3 (Start on a new page.)

A ball is projected vertically upwards from the top of a building that is 5 m high.
Ignore the effects of friction.



The table below shows the magnitude of the velocity of the ball at THREE different times during its motion.

TIME (s)	MAGNITUDE OF VELOCITY ($m \cdot s^{-1}$)
0	15
p	0
3,36	q

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

3.2 Using EQUATIONS OF MOTION ONLY, calculate the value of p. (3)

The ball strikes the ground 3,36 seconds after it was thrown upwards.

3.3 Calculate q. (3)

The ball bounces to a maximum height of 3 m after it struck the ground.

3.4 Is the collision with the ground ELASTIC or INELASTIC?

Explain the answer WITHOUT the use of calculations. (3)

3.5 Sketch a velocity versus time graph for the motion of the ball from the time it was projected until it reached the maximum height after it bounced.

Show the following NUMERICAL VALUES on the graph:

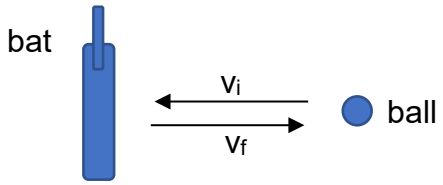
- The initial velocity
- Time p
- Velocity q

(4)
[15]

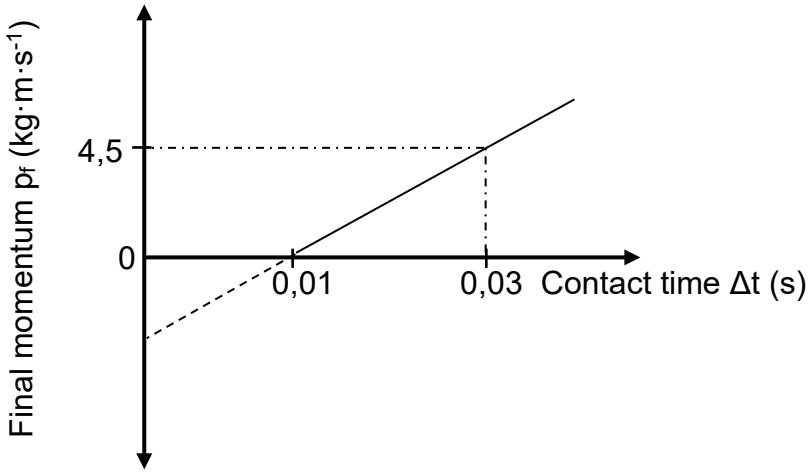
QUESTION 4 (Start on a new page.)

Cricketers at an academy conduct an experiment to determine the relationship between the contact time and the final momentum of a ball for a constant average net force.

A cricket ball of mass 150 g is thrown horizontally with a certain initial velocity and is struck by a bat so that the ball moves in the opposite direction, as shown in the diagram below. The average net force acting on the ball is horizontal.



The experiment is repeated using the same ball. The average net force and the initial velocity of the ball are kept constant. The contact time between the bat and the ball is changed EACH time. The results obtained are shown in the sketch graph below.



4.1 Define the term *impulse*. (2)

4.2 Calculate the:

4.2.1 Average net force acting on the ball (3)

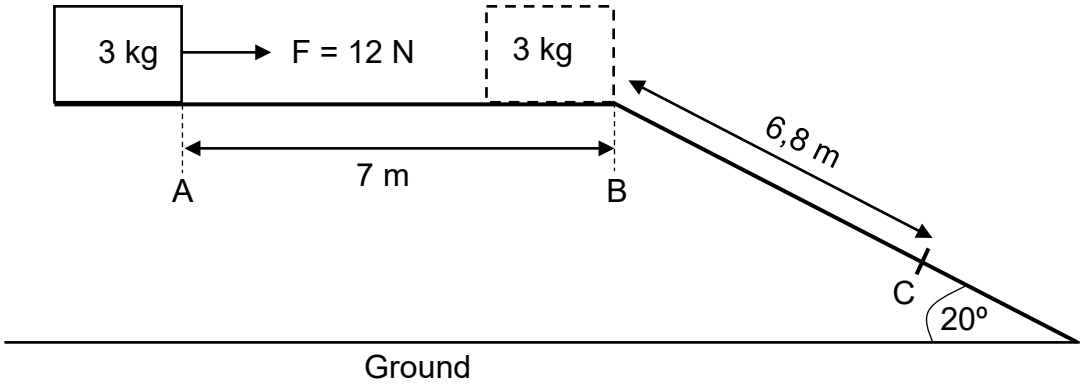
4.2.2 Magnitude of the initial velocity of the ball (4)

4.3 Redraw the graph in the ANSWER BOOK and label it as A.

On the same set of axes, draw the graph that will be obtained when a ball with a bigger mass is used, without changing the initial velocity and average net force. Label this as B. (2)
[11]

QUESTION 5 (Start on a new page)

A crate of mass 3 kg is at rest at point A on a frictionless horizontal surface. A constant horizontal force F of 12 N acts on the crate and moves it from point A to point B. The crate then moves down a rough plane, inclined at 20° to the horizontal. The distance from point A to point B is 7 m and from point B to point C is 6,8 m, as shown in the diagram below.



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

5.2 Using ENERGY PRINCIPLES ONLY, calculate the kinetic energy of the crate at point B. (3)

Force F is removed when the crate reaches point B. The crate then experiences a constant frictional force of 21 N as it moves down the incline.

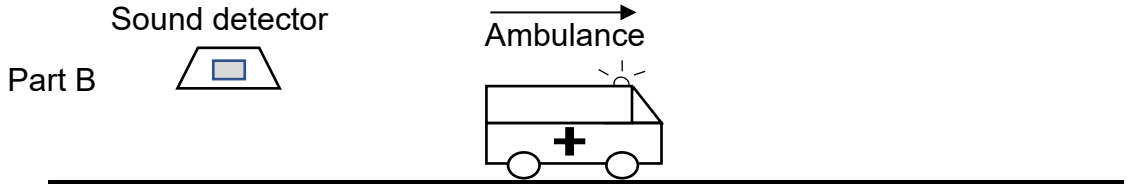
5.3 Draw a free-body diagram showing ALL the forces acting on the crate as it moves down the incline. (3)

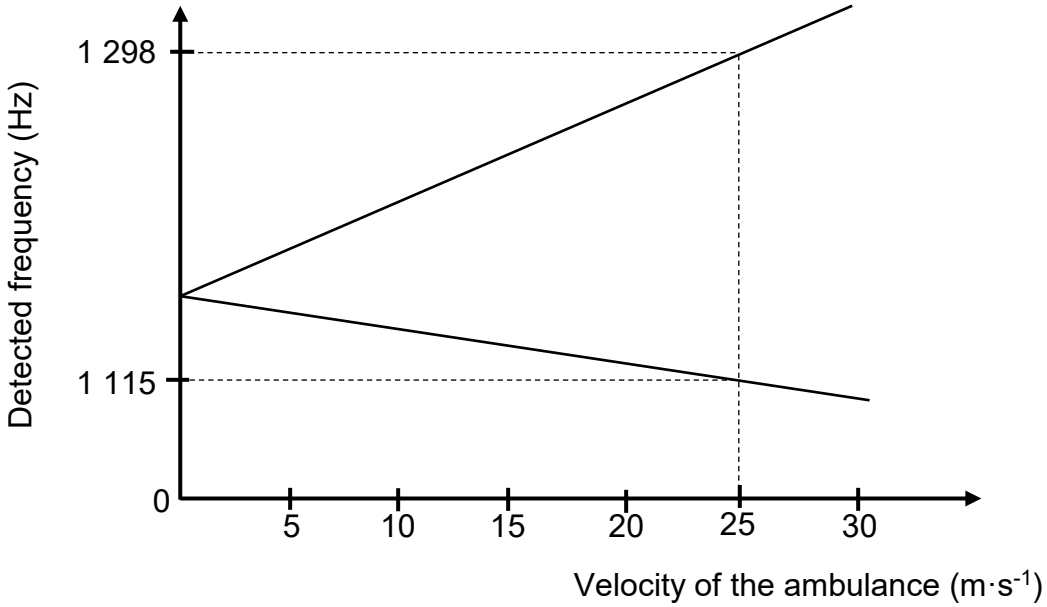
5.4 Using ENERGY PRINCIPLES ONLY, determine whether the crate will pass point C. (5)
[13]

QUESTION 6 (Start on a new page.)

An investigation is performed to determine the relationship between the velocity of a moving sound source and the frequency of the sound detected.

The siren of an ambulance produces sound with a constant frequency. The ambulance, with its siren on, moves towards a stationary sound detector (Part A) and away from the stationary sound detector (Part B) at constant velocities. The experiment is repeated for different velocities of the ambulance. The detected frequency is measured for EACH velocity. The results obtained are shown in the graph below.





6.1 STATE the Doppler effect. (2)

6.2 For this experiment, write down:

6.2.1 The independent variable (1)

6.2.2 A controlled variable (1)

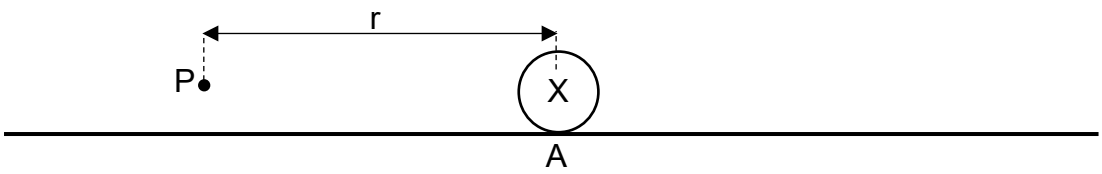
6.3 What conclusion can be made for Part B of this experiment? (2)

6.4 Calculate the speed of sound in air. (6)

[12]

QUESTION 7 (Start on a new page.)

A sphere X is placed at point A on a horizontal surface. X carries a charge of $+3 \times 10^{-7}$ C. Point P is r metres to the left of point A.



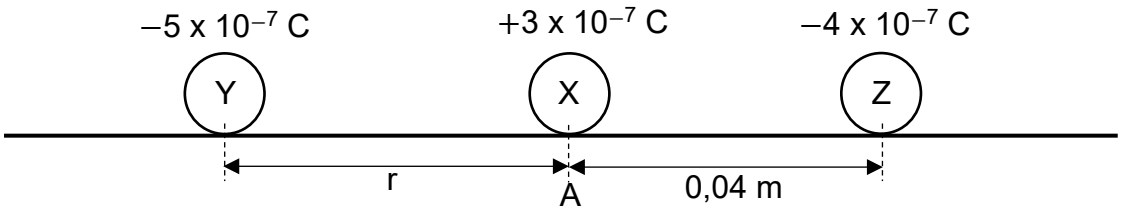
The magnitude of the electric field at point P is $1,08 \times 10^{6}$ N·C^{-1}.

7.1 Describe an *electric field*. (2)

7.2 Draw the electric field pattern due to the charge on sphere X. (2)

7.3 Show, by means of a calculation, that r = 0,05 m. (3)

Sphere Y, carrying a charge of -5×10^{-7} C, is now fixed at point P and sphere Z, carrying a charge of -4×10^{-7} C, is fixed 0,04 m to the right of sphere X.



7.4 The NET FORCE acting on sphere X is 0,0427 N at point A.

Is the surface frictionless? Choose from YES or NO. Explain the answer by means of a calculation. (6)

7.5 Sphere Y is brought into contact with sphere X, and is placed back in its original position.

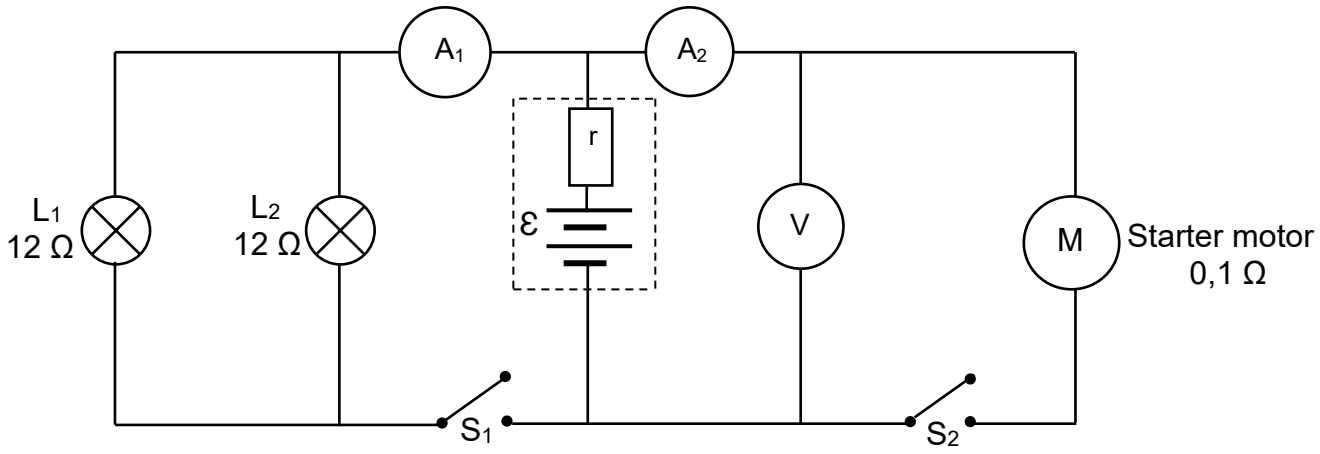
How will the magnitude of the force that sphere X now exerts on sphere Y be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME. (2)

[15]

QUESTION 8 (Start on a new page.)

Two identical headlights, L_1 and L_2, and a starter motor, M, of a car are connected to a battery, as shown in the circuit diagram below. The resistance of each headlight is 12 Ω, while the resistance of the starter motor is 0,1 Ω. The emf (Ɛ) and internal resistance (r) of the battery are unknown.

The ammeters and the connecting wires have negligible resistance, while the voltmeter has a high resistance. Switches S_1 and S_2 are initially open.



8.1 Define the term *emf*. (2)

8.2 Switch S_1 remains open while switch S_2 is closed.
The reading on ammeter A_2 is 120 A.

Calculate the reading on the voltmeter. (3)

8.3 Switch S_1 is now closed and switch S_2 is opened. The power dissipated by each headlight is 15 W.

8.3.1 Calculate the current passing through L_1. (3)

8.3.2 Write down the reading on ammeter A_1. (1)

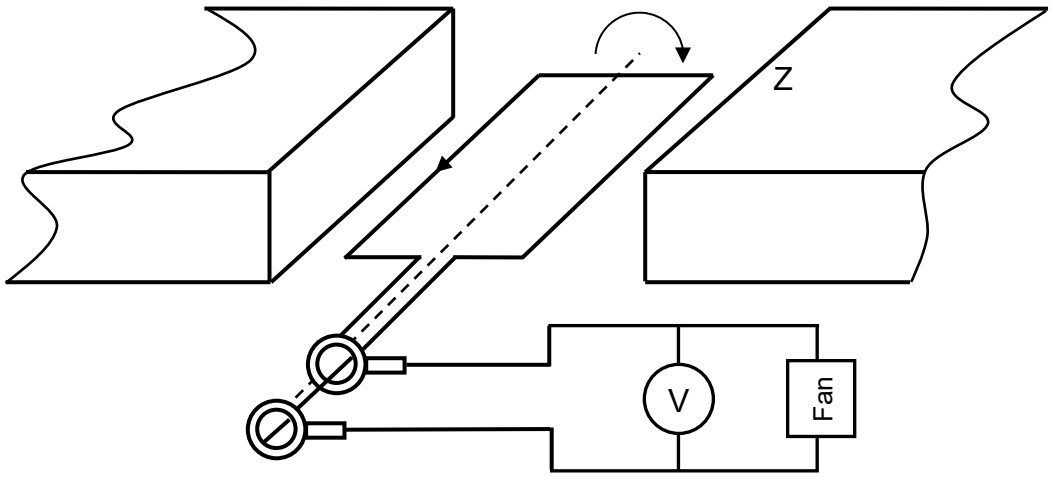
8.4 Calculate the emf of the battery. (6)

8.5 Both switches are now closed.
How will the reading on ammeter A_1 be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer WITHOUT the use of a calculation. (5)
[20]

QUESTION 9 (Start on a new page.)

An AC generator operates a fan. The directions of the rotation of the coil and the induced current are shown in the simplified diagram below.

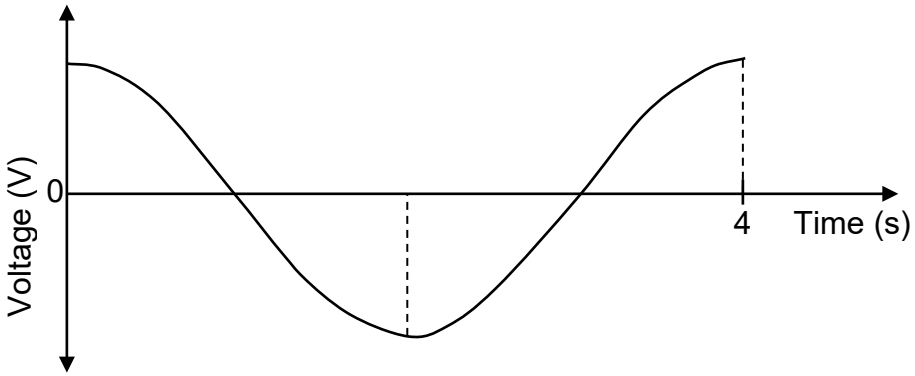


9.1 Define the term *rms potential difference*. (2)

9.2 What is the polarity of the magnet at Z? (2)

9.3 The resistance of the fan is 60 Ω and the maximum potential difference produced by the generator is 311,11 V. Calculate the cost of operating the fan for 1,5 hours if the cost of electricity is R3,33 per kWh. (5)

The voltage versus time graph for this generator is given below.



9.4 Redraw this graph in the ANSWER BOOK and label it as A. On the same set of axes, draw the graph for ONE rotation of the coil when the speed of rotation is doubled. Label this as graph B. (3)

9.5 State ONE way in which this generator can be changed to a DC generator. (1)
[13]

QUESTION 10 (Start on a new page.)

10.1 Learners conduct an experiment to determine whether electrons will be emitted from the surface of different metals when light with a single frequency is incident on the metal. The maximum kinetic energy of emitted electrons are measured when light of frequency $1{,}045 \times 10^{15}$ Hz is used.

The results obtained are shown in the table below.

METALS	ELECTRONS EMITTED	MAXIMUM KINETIC ENERGY (J)
Zinc	Yes	0
Sodium	Yes	$2{,}53 \times 10^{-19}$
Caesium	Yes	$3{,}50 \times 10^{-19}$
Metal M	No	–

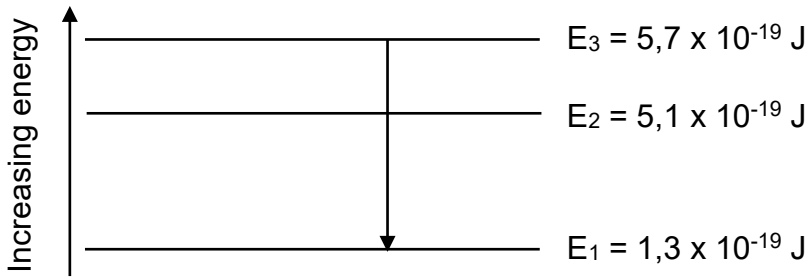
10.1.1 Define the term *work function*. (2)

10.1.2 Write down the threshold frequency of zinc. (1)

10.1.3 How does the work function of sodium compare to that of caesium? Choose from SMALLER THAN, GREATER THAN or EQUAL TO. Explain the answer. (3)

10.1.4 Light of the same frequency, but with a higher intensity, is now incident on metal M. Will electrons now be ejected? Choose from YES or NO. Give a reason for the answer. (2)

10.2 The energy diagram below (NOT drawn to scale) shows the electron energies in different energy levels, E_1, E_2 and E_3, of a certain atom.



10.2.1 An electron of this atom moves from E_3 to E_1. Photon X is emitted. Calculate the frequency of photon X. (4)

10.2.2 Is it possible for a photon with an energy of $2{,}5 \times 10^{-19}$ J to be emitted from this atom? Choose from YES or NO. Give a reason for the answer. (2)

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

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

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* $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ 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* $K_{max} = \frac{1}{2}mv_{max}^2$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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