EXAMINATION	NATIONAL SENIOR CERTIFICATE
GRADE	12
DATE	NOVEMBER 2025
SUBJECT	PHYSICAL SCIENCES
PAPER	1
MARK TOTAL	150
DURATION (HOURS)	3
NUMBER OF PAGES	20

SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

SUID-AFRIKAANSE KOMPREHENSIEWE ASSESSERINGSINSTITUUT

INSTRUCTIONS AND INFORMATION

1. This question paper consists of **10 QUESTIONS**. Answer **ALL** the questions in the **ANSWER BOOK**.

2. Start **EACH** question on a **NEW** page in the answer book.

3. Number the questions correctly according to the numbering system used in this question paper.

4. Leave **ONE** line between two sub questions, for example between **QUESTION 2.1** and **QUESTION 2.2**.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. Show **ALL** the 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, *et cetera* where required.

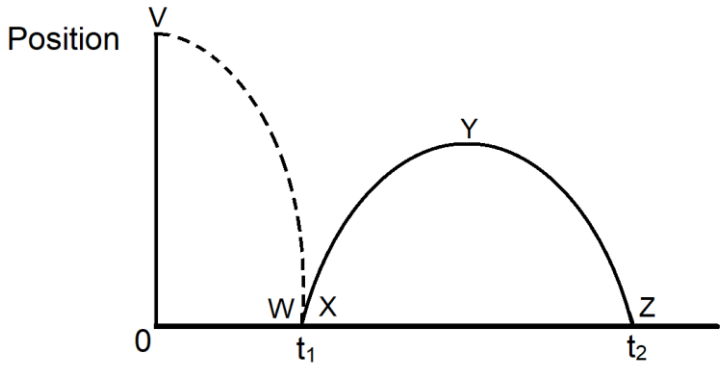
10. You are advised to use the **ATTACHED DATA SHEETS**.

11. Write neatly and legibly, in **BLUE** ink only.

QUESTION 1

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Below is a position-time sketch graph for a ball that is dropped from position **V**, hits the ground at position **W** and bounces back from position **X**. The ball reaches its highest position at position **Y** after the bounce and returns to the ground for the second time at position **Z**. Take upward as the positive direction.



At which two positions (**V**-**Z**) does the ball have the same velocity?

A **V** and **W**

B **V** and **Y**

C **X** and **Y**

D **W** and **Z** (2)

1.2 The gravitational force exerted by object **A** on object **B**, is **F**. The distance between the centres of the two objects is now doubled and the mass of object **A** is tripled. What will be the new gravitational force exerted by object **A** on object **B**?

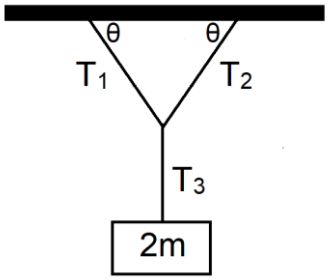
A $\frac{3}{2}$**F**

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

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

D $\frac{9}{4}$**F** (2)

1.3 Below is a diagram of an object with mass **2m**, suspended by three ropes, **T_1**, **T_2** and **T_3**, from a roof. The diagram is not drawn to scale.



Which one of the following statements about tensions **T_1**, **T_2** and **T_3** is ALWAYS CORRECT?

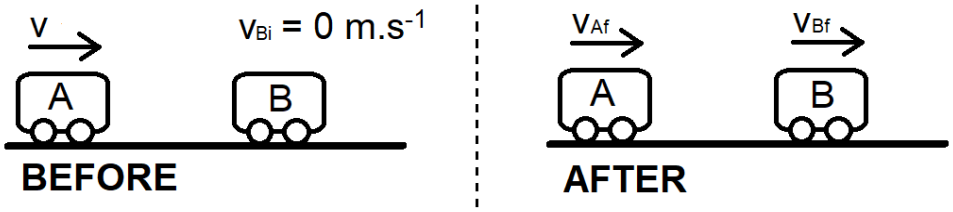
A $T_1 = T_2 < T_3$

B $T_1 = T_2 > T_3$

C $T_1 = T_2 = T_3$

D $T_3 > T_1 > T_2$ (2)

1.4 Cart **A** moves at a velocity **v** to the right while cart **B** is stationary. Cart **A** collides with cart **B** and shortly after the collision both carts move to the right. Assume that the two carts are identical, see the diagram below. Ignore the effect of air resistance or any other external forces.



Which of the following statements is true?

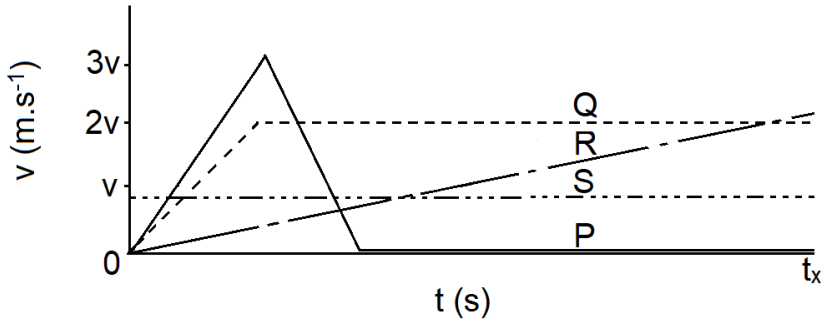
A After the collision both cart **A** and cart **B** move to the right with a velocity of **2v**.

B The total linear momentum is always conserved in collisions.

C The total momentum is not conserved because the magnitude of the final velocity of both carts is less than **v**.

D The total momentum is conserved and both carts move with a velocity of $\frac{1}{2}$**v** to the right. (2)

1.5 Four cars **P**, **Q**, **R** and **S** were racing for a period of t_x seconds. The velocity-time graph below represents the motion of the four cars.



Arrange the cars in descending order from the furthest to the shortest distance travelled at t_x.

A PQRS

B SRQP

C QRSP

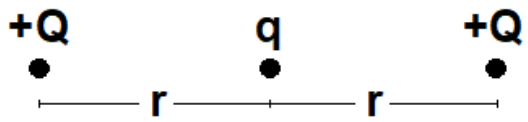
D RPQS (2)

1.6 A listener runs away from a stationary sound source with a constant velocity. Which one of the following describes how the observed frequency and wavelength differ from that of the sound source?

	Observed frequency	Observed wavelength
A	Higher	Shorter
B	Higher	Longer
C	Lower	Shorter
D	Lower	Longer

(2)

1.7 Two identical, positive charges **+Q** are placed at equal distance from charge **q**, as indicated in the diagram below.



What should be the charge on **q** in terms of **Q** to create a system of three charges in equilibrium?

A $\mathbf{q} = +\frac{\mathbf{Q}}{\sqrt{2}}$

B $\mathbf{q} = -\frac{\mathbf{Q}}{2}$

C $\mathbf{q} = -\frac{\mathbf{Q}}{4}$

D $\mathbf{q} = +\frac{\mathbf{Q}}{4}$ (2)

1.8 The cost of running a 1500 W appliance for 45 minutes is **X**. What is the cost per kWh?

A $\frac{8}{9}\mathbf{X}$

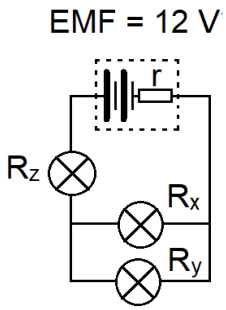
B $\frac{9}{8}\mathbf{X}$

C $\frac{2}{75}\mathbf{X}$

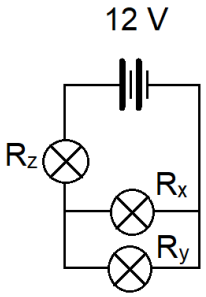
D $\frac{75}{2}\mathbf{X}$ (2)

1.9 Three identical resistors (R_x, R_y and R_z) are placed in different electrical circuit setups as illustrated by A–D. In which of the circuit setups below will R_x shine the brightest?

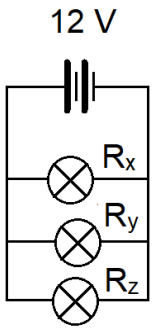
A



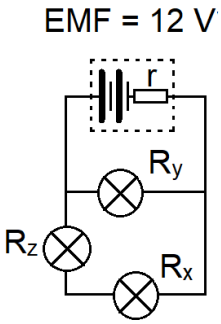
B



C

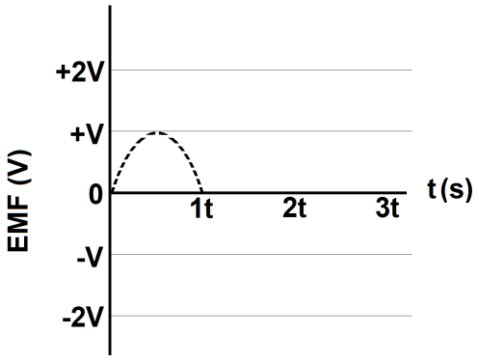


D



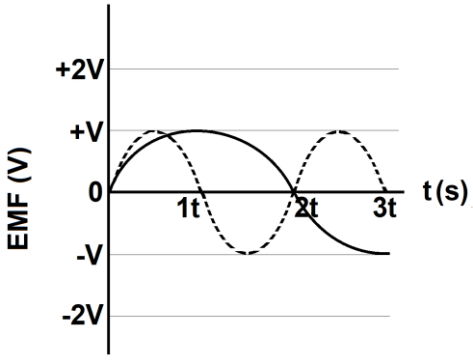
(2)

1.10 Below is part of a graph of the output potential difference that will be obtained by an AC generator. The graph in dotted line (- - -) represents half of a rotation.

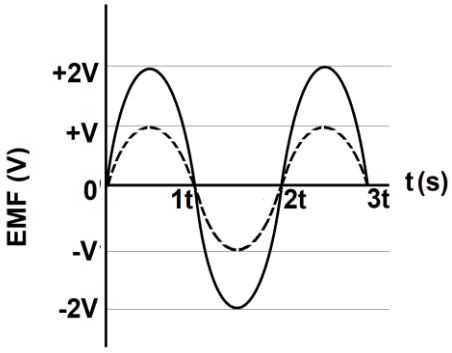


The generator is now rotated at HALF its original speed. Which option represents the shape of the original graph of an AC generator (- - -) as well as the new shape for half the speed (——).

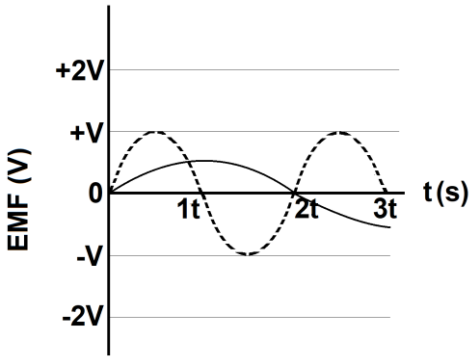
A



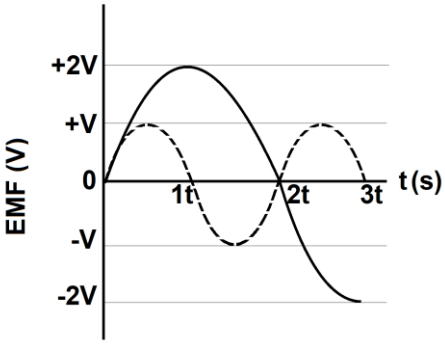
B



C



D

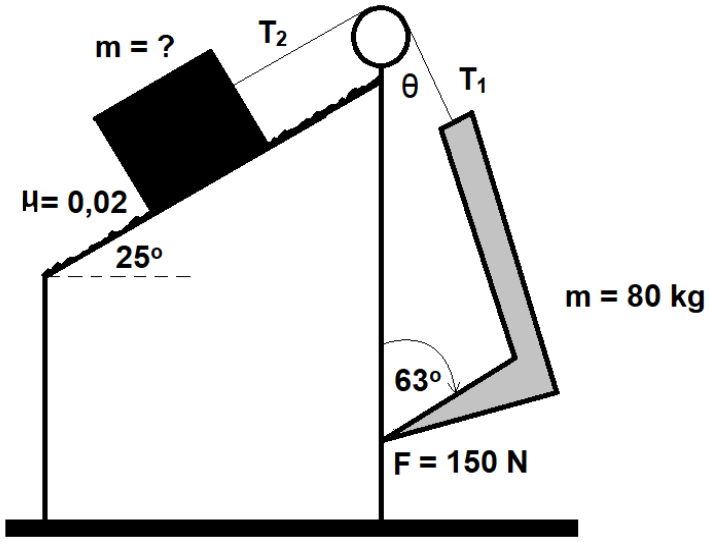


(2)

[20]

QUESTION 2 (Start on a new page)

An object of mass 80 kg hangs from a rope attached to a heavy block as seen in the diagram below. The block is heavy enough to keep the object from sliding down the side of the wall. Assume the rope is light and inextensible and the pulley is frictionless. Tension $\mathbf{T_1}$ forms an angle θ with the vertical plane while $\mathbf{T_2}$ is parallel to the rough surface of the slope. The object's edge applies a force of 150 N to the wall at an angle of 63° to the vertical surface. The diagram is not drawn to scale.



2.1 State *Newton's third law* in words. (2)

2.2 Identify and state ONE action-reaction pair of forces in the diagram above. (1)

2.3 Draw a labelled free body diagram of all the forces acting on the object. (3)

2.4 Make use of horizontal and vertical vectors to calculate the tension $\mathbf{T_1}$. (6)

The coefficient of static friction between the heavy block and the incline is 0,02.
The incline forms a 25° angle with the horizontal plane.

2.5 Define *frictional force* in words. (2)

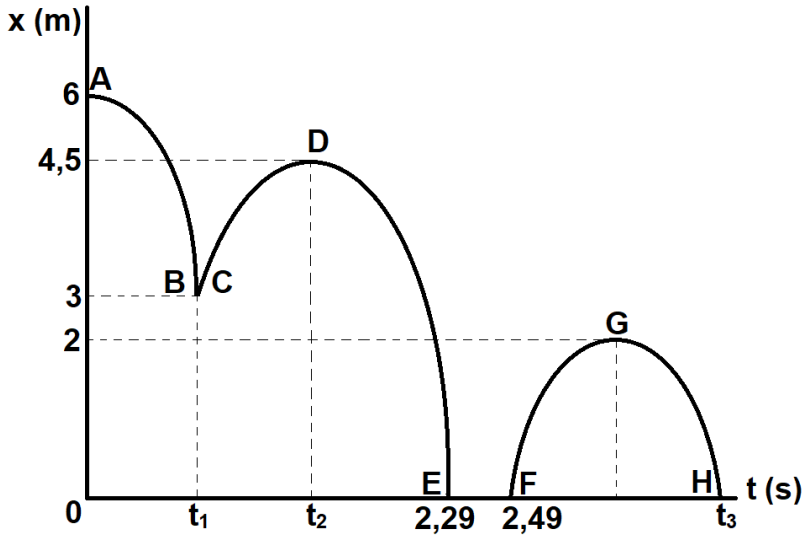
2.6 Determine the magnitude of tension $\mathbf{T_2}$. (1)

2.7 Calculate the minimum mass the heavy block should have to keep the object from sliding down the wall. (4)

[19]

QUESTION 3 (Start on a new page)

A ball is dropped from position **A** and reaches a ledge at point **B**, 3 m below point **A**. The ball leaves the ledge, point **C**, with a velocity of 5,42 m.s^{-1} upwards and reaches the ground at point **E** where it stays in contact with the ground before it bounces again and reaches the ground for a second time at point **H** with a velocity of 6,26 m.s^{-1}.



Ignore the effects of air friction and take **UPWARDS** as **POSITIVE**.

3.1 Calculate the time t_1. (3)

3.2 How long does it take the ball to move from point **D** to point **E**? (3)

3.3 Define *impulse* in words. (2)

3.4 Calculate the magnitude of the net force exerted by the ball on the ground, between points **E** and **F**. Assume that the ball has a mass of 100 g. (3)

3.5 Draw a sketch graph of the velocity vs time for the ball from position **A** to **H**. Show all significant velocity and time values. The sketch graph needs to represent relative proportions but does not need to be drawn to scale. (4)

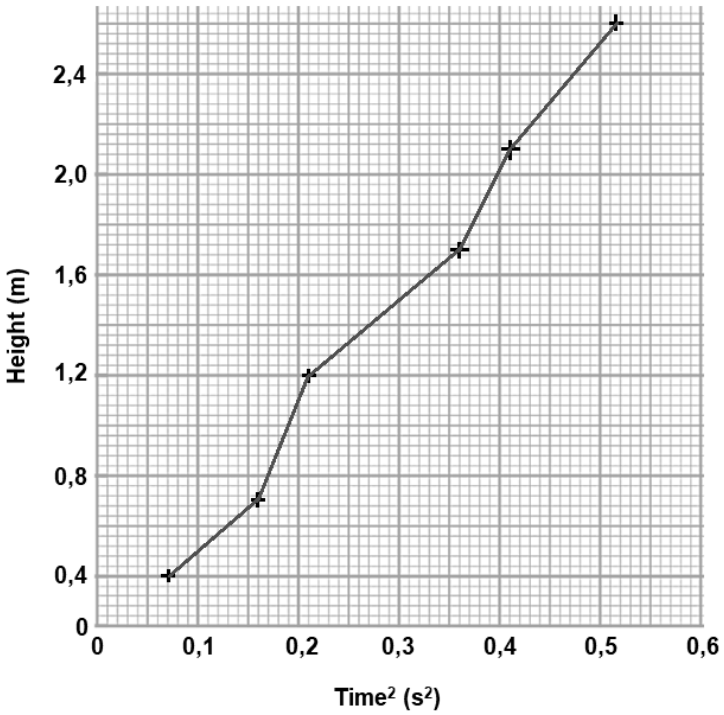
[15]

QUESTION 4 (Start on a new page)

A learner decided to perform an experiment to measure acceleration due to gravity. The learner drops a small ball from various heights and records the time it takes to reach the ground. Below is a table of the results.

Height (m)	Time (s)	t^2 (s^2)
0,4	0,27	0,07
0,7	0,40	0,16
1,2	0,47	0,22
1,7	0,60	0,36
2,1	0,64	0,41
2,5	0,72	0,52

The learner then plots a graph for height vs time squared, as demonstrated below:



4.1 Explain why the learner plotted the graph for height vs time squared and not for height vs time. Use appropriate equations to support your explanation. (2)

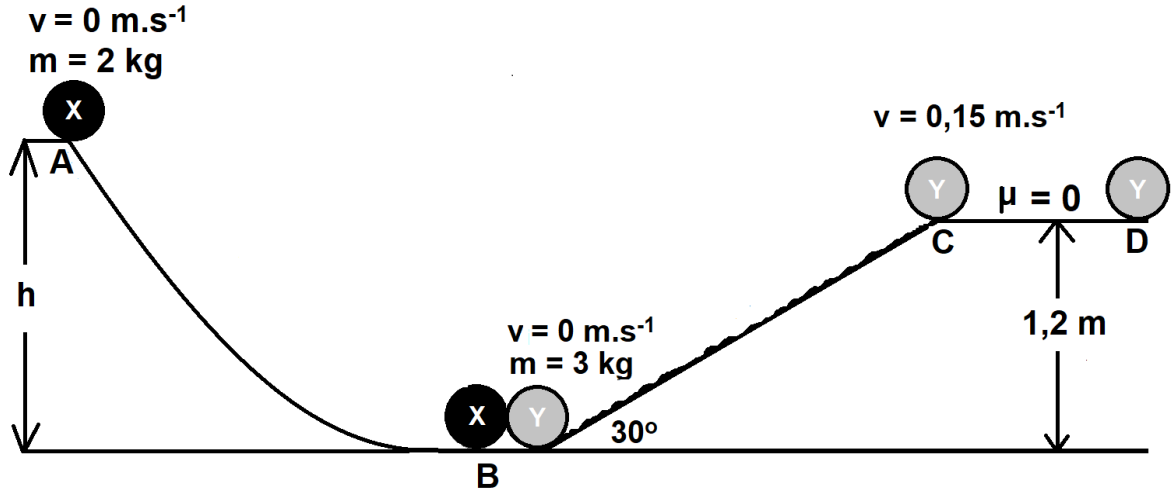
4.2 List THREE mistakes made by the learner in the graph above. (3)

4.3 Take the **gradient of the graph to be 4,88**. Make use of an equation of motion that describes the relationship between height and time squared together with the equation **y = mx + c** to determine the acceleration due to gravity. (3)

[8]

QUESTION 5 (Start on a new page)

A 2 kg ball (**X**) rolls from rest, down a smooth curved slope, from point **A** to point **B**.
At point **B** the 2 kg ball collides with a stationary, 3 kg ball (**Y**).



5.1 Calculate the mechanical energy of ball **X** at point **B** if the ball reaches a velocity of 6 $m.s^{-1}$ at point **B**. (3)

5.2 Determine the height, **h**, from which ball **X** was dropped at position **A**. (3)

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

5.4 Calculate the velocity of ball **Y** immediately after the collision at point **B**. Assume ball **X** rolls backward with a velocity of 2 $m.s^{-1}$ after the collision. (4)

After the collision ball **Y** rolled from point **B**, up a rough incline, to point **C**. The incline forms a 30° angle with the horizontal plane. Ball **Y** reaches point **C** with a velocity of 0,15 $m.s^{-1}$. After passing point **C** ball **Y** rolled towards point **D**. Assume that the surface between point **C** and **D** is frictionless.

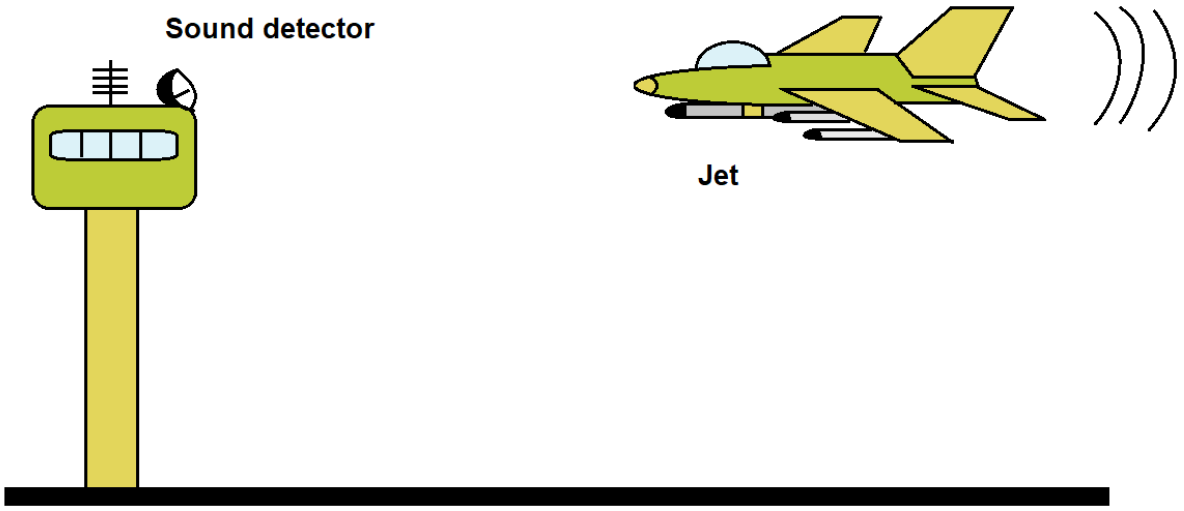
5.5 Make use of energy principles to calculate the frictional force that ball **Y** experiences between points **B** and **C**. (5)

5.6 What is the magnitude of the velocity of ball **Y** at point **D**? Motivate your answer. (2)

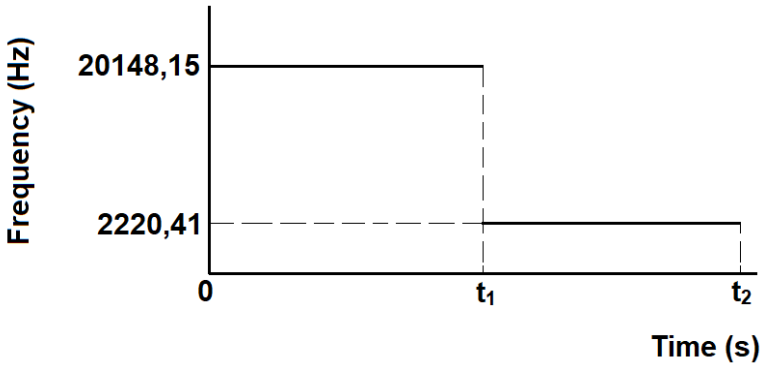
[19]

QUESTION 6 (Start on a new page)

A jet is moving at a constant speed along a straight horizontal path. The jet's engine emits sound waves with a constant frequency. A sound detector at the airport control tower is in line with the oncoming jet (see diagram below) and records the frequencies of the emitted sound waves.



The graph representing the recorded frequencies is shown below.



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

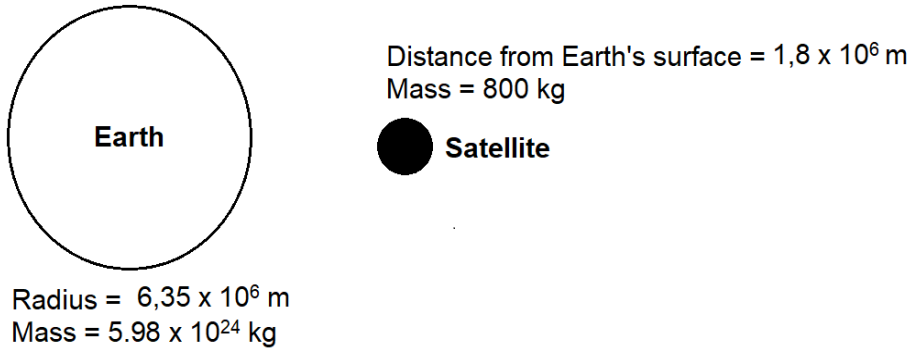
6.2 Explain why the frequency of the sound waves produced by a jet engine dropped after the jet had passed the control tower. Refer to both the frequency and the wavelength of the passing jet engine's sound waves. (2)

6.3 Calculate the speed of the jet if the speed of sound in the air is 340 $m.s^{-1}$. (5)

[9]

QUESTION 7 (Start on a new page)

7.1 The Earth has a mass of 5,98 x 10^{24} kg and a radius of 6,35 x 10^{6} m. A particular satellite with a mass of 800 kg orbits the Earth at a distance of 1,8 x 10^{6} m from the Earth's surface. The diagram below shows the position of the satellite relative to the Earth.

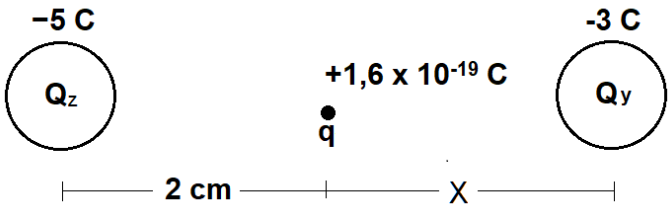


7.1.1 State *Newton's universal gravitational law* in words. (2)

7.1.2 Define the term *weight* in words. (2)

7.1.3 Calculate the force that the Earth exerts on the satellite. (4)

7.2 A positive test charge **q** reaches an equilibrium position between two fixed charges $\mathbf{Q_z}$ and $\mathbf{Q_y}$. $\mathbf{Q_z}$ has a charge of -5 C and $\mathbf{Q_y}$ has a charge of -3 C. See diagram below.

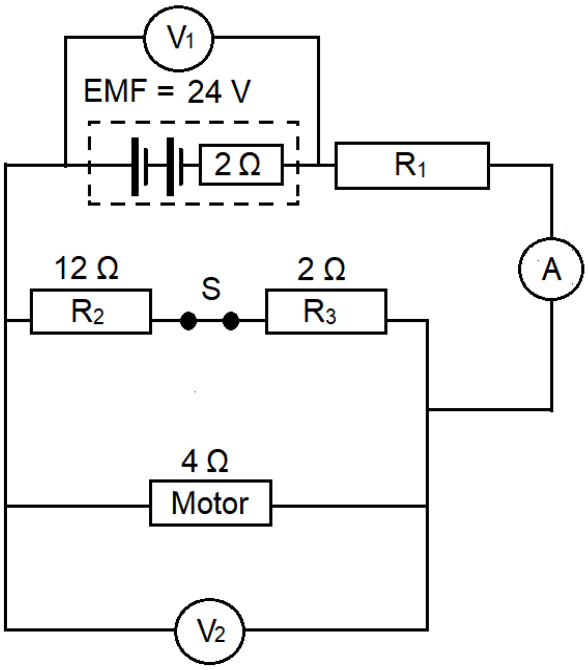


Calculate distance **X** between **q** and $\mathbf{Q_y}$. (4)

[12]

QUESTION 8 (Start on a new page)

In the circuit below a battery with an emf (Ɛ) of 24 V and internal resistance of 2 Ω is used to operate an electric motor with a resistance of 4 Ω. The components are connected as indicated in the diagram below. The resistance of the connecting wires and ammeter is negligible.



When **switch S** is **CLOSED** the motor functions at a maximum power of 8 W.

8.1 Define the term *emf* in words. (2)

8.2 Calculate the current that passes through the electric motor. (3)

8.3 Calculate the effective resistance of the parallel connection. (3)

8.4 Calculate the potential difference of voltmeter **V_2**. (3)

8.5 Calculate the reading on ammeter **A**. (2)

8.6 Calculate the resistance of resistor **R_1**. (4)

8.7 The cost to run the motor is R1,30 per kWh. Calculate how much it will cost to run the motor for 12 hours. (4)

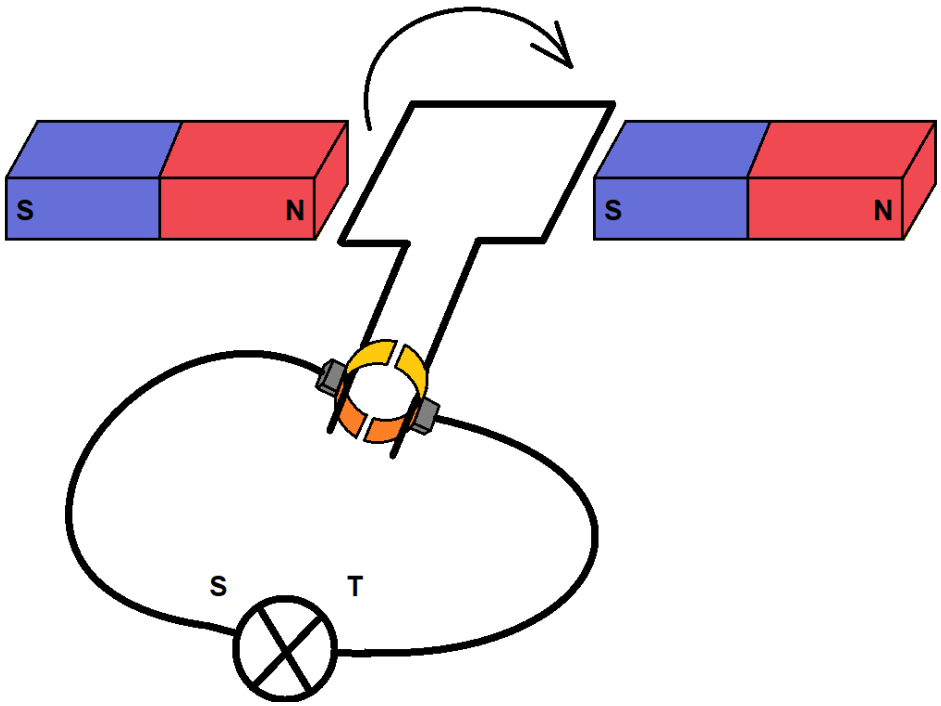
Switch S is now OPENED.

8.8 Will the reading on **V_1** INCREASE, DECREASE or REMAIN THE SAME? (2)

[23]

QUESTION 9 (Start on a new page)

The sketch below represents a DC generator. The diagram is not drawn to scale.



9.1 What energy conversion takes place in a generator? (2)

9.2 Does this generator have SPLIT RINGS or SLIP RINGS? (1)

9.3 In which direction will the current be generated? Choose between **S to T** or **T to S**. (1)

The generator delivers 240 V_{rms} to a 9 W resistor. The peak current in the light bulb is 4 A.

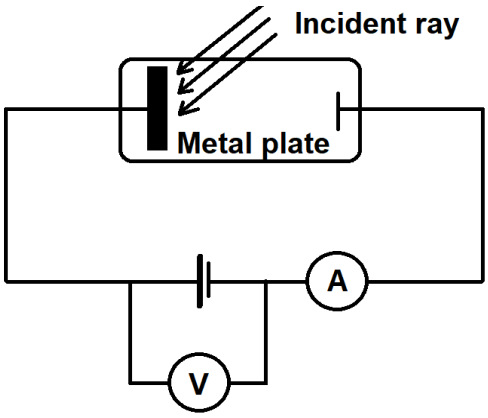
9.4 Calculate the rms current in the light bulb. (3)

9.5 Calculate the resistance of the light bulb. (3)

[10]

QUESTION 10 (Start on a new page)

An investigation is conducted to determine the threshold wavelength of selected metals. The experimental setup is shown in the diagram below:



The threshold wavelengths observed for the selected metals, are recorded in the table below.

Metal	Threshold wavelength (nm)
Sodium	682
Potassium	540
Zinc	294
Copper	266

10.1 Define the term *work function* in words. (2)

Light with a frequency of 7×10^{14} Hz is incident on each of the metals above.

10.2 Calculate the wavelength of a photon of light with a frequency of 7×10^{14} Hz. (3)

10.3 Which metals, listed in the table, emitted electrons at this frequency? (2)

10.4 Calculate the work function of potassium. (4)

10.5 How will the following changes affect the reading on the ammeter?
Choose from INCREASE, DECREASE or STAY THE SAME, **AND** motivate your answer.

10.5.1 Increasing the intensity of the incident light. Motivate your answer. (2)

10.5.2 Decreasing the surface area of the metal. Motivate your answer. (2)

[15]

GRAND 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	6,35 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	3,0 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	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op elektron*	e or q_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*

$v_f = v_i + a\Delta t$ **or/of** $v_f = v_i + g\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ **or/of** $\Delta x = v_i\Delta t + \frac{1}{2}g\Delta t^2$
$v_f^2 = v_i^2 + a\Delta x$ **or/of** $v_f^2 = v_i^2 + g\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ **or/of** $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$ **or/of** $F_g = mg$
$F = \frac{GMm}{r^2}$ **or/of** $g = \frac{GM}{r^2}$	$F_s^{max} = \mu_s N$ **or/of** $F_k = \mu_k N$ $F_s^{maks} = \mu_s N$

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** $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ **or/of** $W_{net} = \Delta E_k$
$W_{nc} = \Delta K + \Delta U$ **or** $W_{nc} = \Delta E_k + \Delta E_p$ $W_{nk} = \Delta K + \Delta U$ **of** $W_{nk} = \Delta E_k + \Delta E_p$	$\Delta K = K_f - K_i$ **or/of** $\Delta E_k = E_{kf} - E_{ki}$
$P_{ave} = Fv_{ave}$ $P_{gem} = Fv_{gem}$	$P = \frac{W}{\Delta t}$

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right)f_s$	$E = hf$ **or/of** $E = \frac{hc}{\lambda}$

$E = W_o + K_{max}$ **or** $E = W_o + E_{k\,(max)}$

$E = W_o + K_{maks}$ **of** $E = W_o + E_{k\,(maks)}$

$E = hf$ **and** $W_o = hf_o$ **and** $K_{max} = \frac{1}{2}mv^2{}_{max}$ **or** $E_{k\,(max)} = \frac{1}{2}mv^2{}_{max}$

$E = hf$ **en** $W_o = hf_o$ **en** $K_{maks} = \frac{1}{2}mv^2{}_{maks}$ **of** $E_{k\,(maks)} = \frac{1}{2}mv^2{}_{maks}$

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*

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

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ **or/of** $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms}I_{rms}$ **or/of** $P_{gem} = V_{wgk}I_{wgk}$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ **or/of** $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P = I^2_{rms}R$ **or/of** $P_{gem} = I^2_{wgk}R$ $P = \frac{V^2_{rms}}{R}$ **or/of** $P = \frac{V^2_{wgk}}{R}$

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