GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2026

10841

PHYSICAL SCIENCES: PHYSICS

(PAPER 1)

PHYSICAL SCIENCES: Paper 1

10841E

TIME: 3 hours

MARKS: 150

17 pages + 3 data sheets

X05

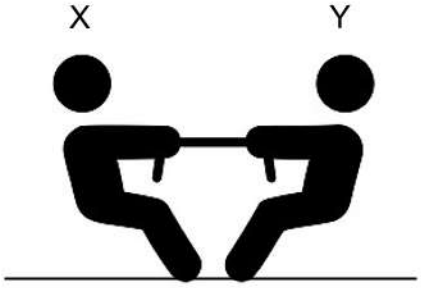
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. You are advised to use the attached DATA SHEETS.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Start EACH question on a NEW page in the ANSWER BOOK.
8. Leave ONE line open between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
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, etc. 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. 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 D.

1.1 Two learners are playing tug-of-war on a rough surface.



Learner **Y** is winning and is accelerating backwards.

At this moment, the magnitude of the force of tension on learner **Y** is …

A greater than the force of tension on learner **X**.
B smaller than the force of tension on learner **X**.
C equal in magnitude to the force of tension on learner **X**.
D equal to the force of friction experienced by learner **X**. (2)

1.2 Two cyclists, **A** and **B**, have the same mass and are riding identical bicycles, but on different roads. Neither cyclist is pedalling when they enter a rough section of road at the same speed. For cyclist **A**, the kinetic coefficient of friction between the tyre and the road is μ_k. For cyclist **B**, the kinetic coefficient of friction is $\frac{1}{2}\mu_k$.

The frictional force acting on bicycle **A** is **f**, and the resulting acceleration has magnitude **a**. The force of friction and the acceleration experienced by cyclist **B** is:

	FORCE OF FRICTION	ACCELERATION
A	f	a
B	f	½ a
C	½ f	a
D	½ f	½ a

(2)

1.3 Two identical balls are thrown from the edge of a cliff with the same initial velocity. Ball **D** is thrown vertically upwards, while ball **E** is thrown vertically downwards. Ignore all effects of air friction.

How do the kinetic energies of the balls compare just before they hit the ground at the bottom of the cliff?

The kinetic energy of …

A ball **D** is greater than that of ball **E**.
B ball **E** is greater than that of ball **D**.
C the two balls are the same.
D ball **D** is zero. (2)

1.4 Block **A**, with a mass **2m**, moves to the right on a frictionless horizontal surface at a constant speed **v**. Block **A** collides with block **B**, mass **½m**, that moves to the left at a speed of **4v**.

What is the speed of block **B** immediately after the collision?

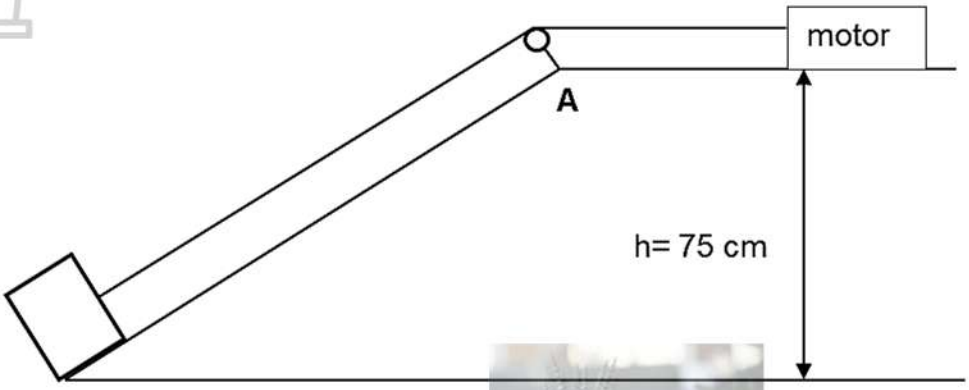
A $\frac{v}{2}$

B v

C 3v

D 0 (2)

1.5 An object of mass 0,25 kg is attached to a motor by a light, inextensible string that runs over a frictionless pulley. The motor is used to lift the object from the bottom of a frictionless surface, as shown in the diagram below. The object is raised to a vertical height of 75 cm at a constant speed of 0,40 $m \cdot s^{-1}$.



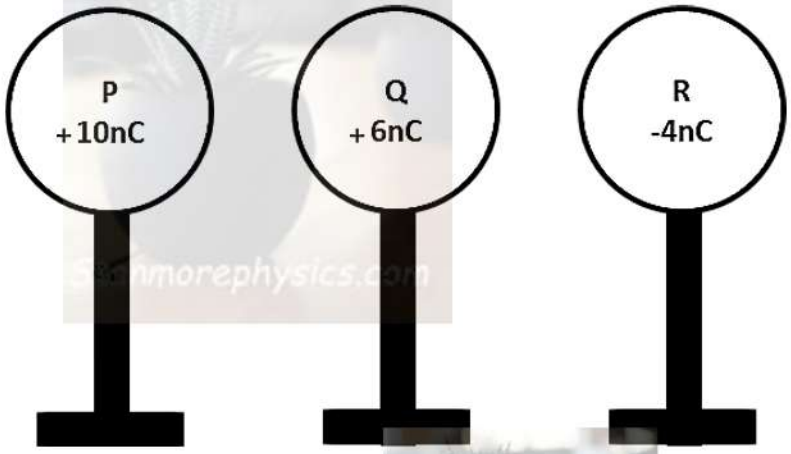
Which of the following gives the rate of increase of potential energy of the object (in watt) if the object is moved from the bottom of the slope to point **A**?

A $0,25 \times 9,8 \times 0,40$
B $0,25 \times 9,8 \times 0,75$
C $\frac{1}{2} \times 0,25 \times (0,40)^2$
D $0,25 \times 0,75 \times 0,40$ (2)

1.6 In which of the following applications of the Doppler effect are sound waves used to determine the speed of a moving object?

A Measuring the speed between the Earth and the Moon
B Measuring the blood flow speed using ultrasound imaging
C Determining satellite motion for communication and GPS
D Determining the speed of a satellite orbiting the Earth (2)

1.7 Three graphite-coated spheres (**P**, **Q** and **R**) are charged and placed on separate isolated stands, as shown in the diagram below.



Sphere **Q** is brought into contact with sphere **P**. The two spheres are placed back in their original positions. Sphere **Q** is then brought into contact with sphere **R** and then placed back in its original position.

The charge (in nC) on sphere **Q** is now:

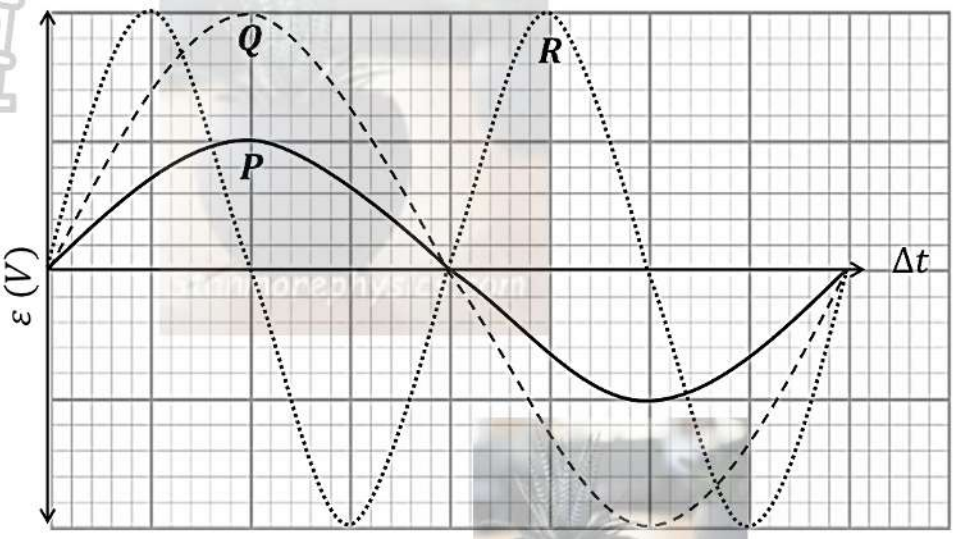
A +4
B +2
C -2
D +12 (2)

1.8 Which of the following is the unit of measurement for the rate of flow of charge?

A Volt
B Watt
C Coulomb
D Ampère (2)

1.9 Graph **P** represents the output emf of an AC generator.

Graphs **Q** and **R** show the output emf of the same generator after two SEPARATE changes have been made.



Which of the following combinations indicate possible changes that have been made to represent graphs **Q** and **R** respectively in comparison to graph **P**?

	GRAPH Q	GRAPH R
A	Increased rotational frequency	Number of windings increased
B	Number of windings decreased	Decreased rotational frequency
C	Number of windings increased	Increased rotational frequency
D	Decreased rotational frequency	Number of windings decreased

(2)

1.10 The wavelength of a monochromatic light source **P** is half that of a monochromatic light source **Q**.

Compared to the energy of a photon from source **Q**, the energy of a photon from source **P** is:

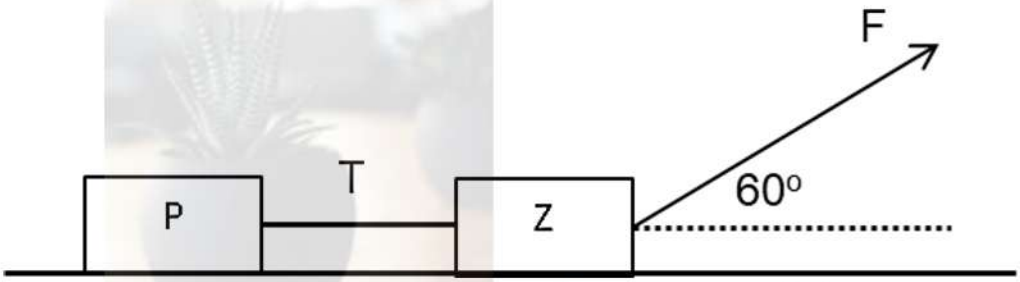
A A quarter of the energy
B Half the energy
C Equal to the energy
D Twice the energy

(2)

[20]

QUESTION 2 (Start on a new page.)

Two crates, **P** and **Z**, with the same mass are connected by a light, inextensible string and pulled to the right across a rough horizontal surface. A force **F** of 250 N acts on crate **Z** at an angle of 60° to the horizontal. The two crates experience identical frictional forces, and the system accelerates to the right.



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 crate **Z**. (5)

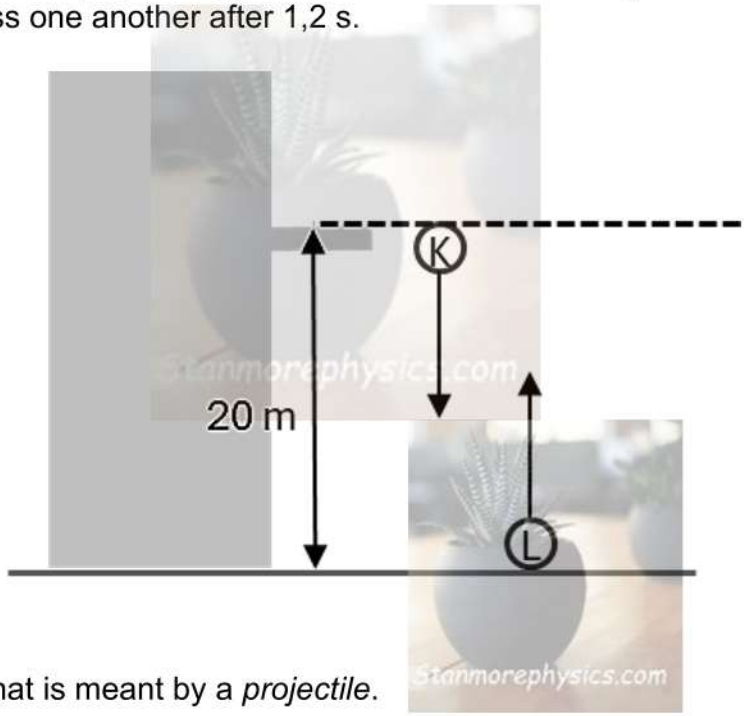
2.3 Calculate the magnitude of the tension in the string. (5)

2.4 Will the coefficient of kinetic friction on crate **Z** be LARGER THAN, SMALLER THAN or EQUAL TO the coefficient of kinetic friction on crate **P**?

Explain the answer without doing a calculation. (3)
[15]

QUESTION 3 (Start on a new page.)

Ball **L** is thrown vertically upwards from the ground with an initial velocity **v**. At the same moment, a second ball, **K**, is dropped from rest from a balcony 20 m above the ground. The two balls pass one another after 1,2 s.



3.1 Explain what is meant by a *projectile*. (2)

3.2 Use only equations of motion and calculate:

3.2.1 The magnitude of the initial velocity of ball **L** as it is thrown upwards (5)

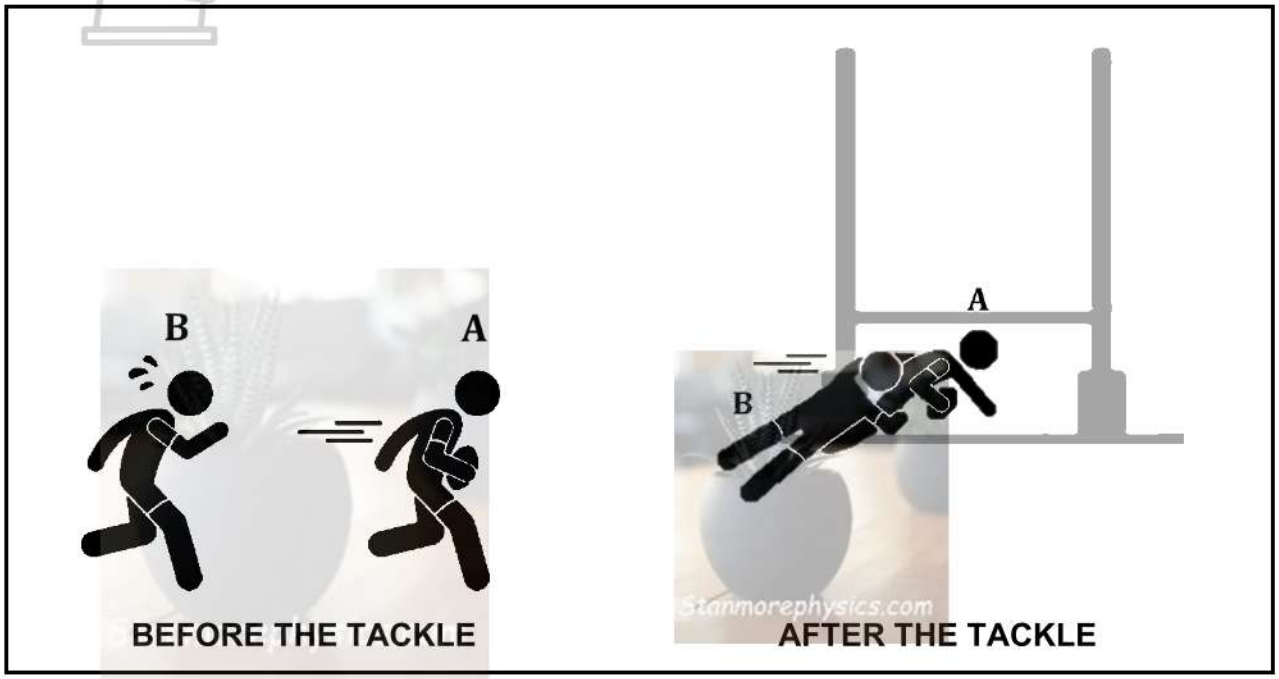
3.2.2 The final velocity at which ball **K** reaches the ground (3)

3.3 On the same set of axes, sketch a position-time graph for both ball **K** and ball **L** for the first 1,2 s. Indicate ALL relevant position and time values. Use the ground as zero reference. (4)

[14]

QUESTION 4 (Start on a new page.)

During a rugby match, player **A** (mass 130 kg) runs toward the try line with a kinetic energy of 260 J. He is tackled from behind by player **B** (mass 120 kg) running at a velocity of 2,5 $m \cdot s^{-1}$. Player **B** holds onto player **A** as they move across the try-line together.



Ignore the mass of the rugby ball.

4.1 Define the term *momentum*. (1)

4.2 Calculate the velocity of the rugby players after the tackle. (5)

4.3 The bottom parts of rugby poles are covered in thick sponge during a rugby match to protect players should they collide with the pole during the match.

Use appropriate Physics principles to explain how the sponge protects a rugby player during contact. (4)

4.4 Calculate the magnitude of the net force exerted by player **B** on player **A** during the tackle in 0,8 s. (4)

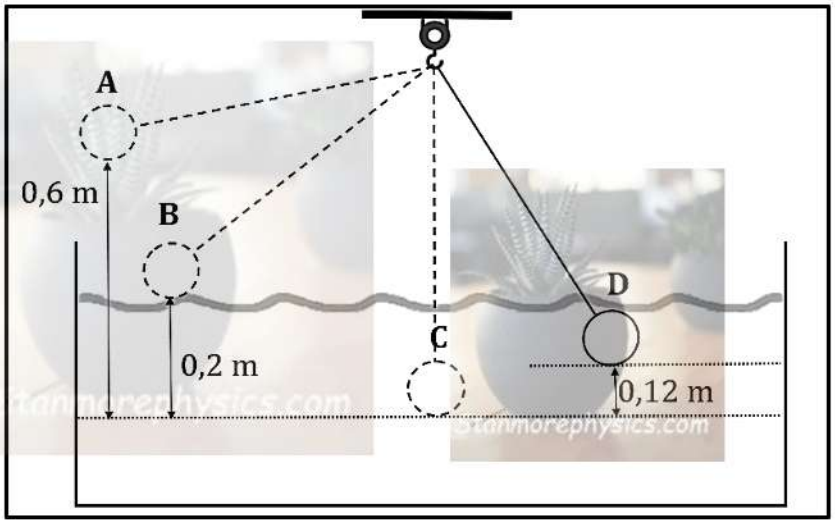
[14]

QUESTION 5 (Start on a new page.)

An experiment is set up to determine the work done by water on an object moving through it.

A pendulum consisting of a thin metal rod and metal bob (sphere) is attached to a hook hanging from a ceiling. The hook allows the pendulum to swing back and forth freely.

The pendulum is released from height **A** and swings through a water tank as indicated in the diagram.



The pendulum strikes the water at point **B**, moves through the water and stops at point **D** before moving backwards.

The metal bob (sphere) has a mass of 1,5 kg. Ignore the effect of air resistance, the mass of the rod, and any resistance experienced by the **rod** when the pendulum moves below the surface of the water.

Use ENERGY PRINCIPLES to answer the questions that follow.

5.1 State the *principle of conservation of mechanical energy* in words. (2)

5.2 Consider the motion from point **A** to point **D**. Identify the conservative force acting on the bob (sphere). Explain the answer. (3)

5.3 Calculate the work done by the water on the bob (sphere) as it moves from point **B** to point **D** below the surface of the water. (7)
[12]

QUESTION 6 (Start on a new page.)

A blind person taps a stick that emits a sound pulse, such as a click or ultrasonic ping. The sound reflects off a solid object and returns to the stick's sensor.

The frequency emitted by the stick is 40 kHz, while the speed of sound in air is 343 $m \cdot s^{-1}$. The source is kept stationary while the object is moving. The observed frequency is 40,232 kHz.

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

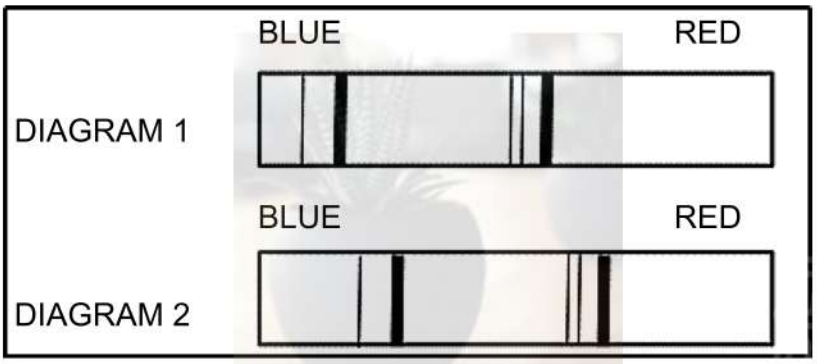
6.2 Does ultrasound refer to sound of a HIGH or LOW frequency? (1)

6.3 Is the object moving towards the source or away from the source? Give a reason for the answer. (2)

6.4 Calculate the speed at which the object is moving. (4)

The Doppler effect can also be used to explain the motion of the stars in our universe.

The two diagrams below represent the emission spectra of a specific gas found in stars.
Diagram 1 represents the emission spectrum of the gas in the Sun.
Diagram 2 represents the emission spectrum of the gas in a distant star.



6.5 Is the star moving TOWARDS or AWAY from the Sun? Give a reason for the answer by referring to the diagrams above. (3)

6.6 From the comparison of the two diagrams above, what conclusion can be made about the universe? (1)

[13]

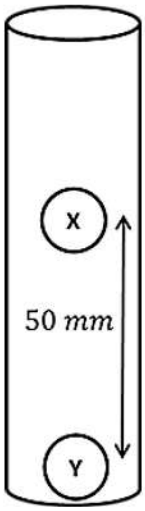
QUESTION 7 (Start on a new page.)

Two identical, positively charged polystyrene spheres, **X** and **Y**, each have a mass of 5×10^{-6} kg.

They are placed in a narrow, vertical tube as indicated in the diagram. Assume that the entire tube is isolated.

Sphere **Y** is fixed to the bottom of the tube and cannot move.

Sphere **X** is suspended 50 mm above sphere **Y**.



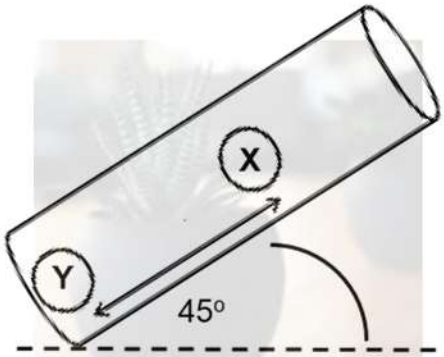
7.1 Draw the electric field pattern between **X** and **Y**. (3)

7.2 State *Coulomb's law* in words. (2)

7.3 Write down the value of the net force experienced by sphere **X**. (1)

7.4 Calculate the magnitude of the charge on each sphere. (4)

7.5 The top of the tube is now carefully tilted 45° to the right.



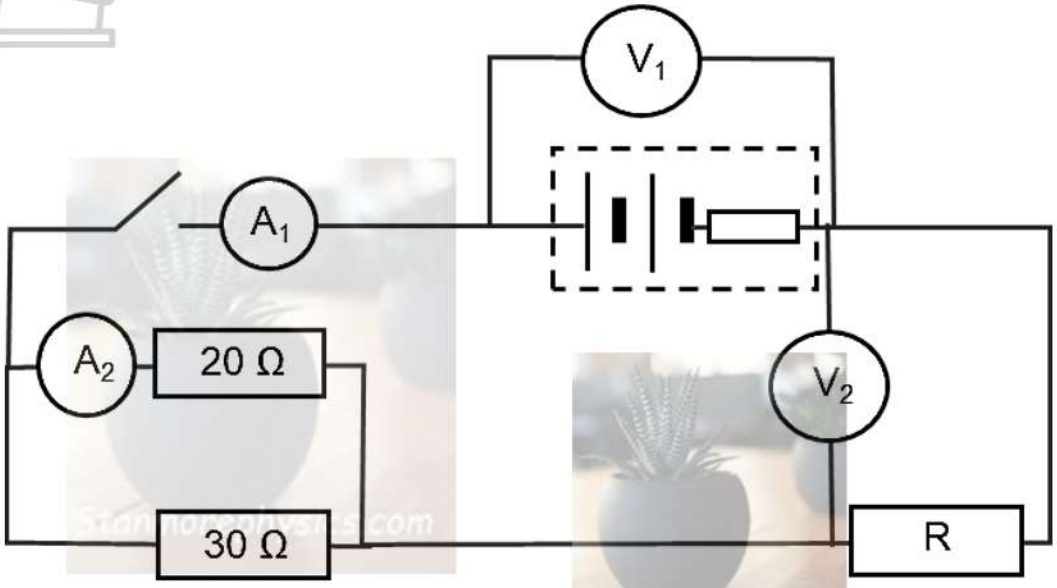
Assume that sphere **X** does NOT come into contact with the tube.

Will the distance between sphere **X** and **Y** INCREASE, DECREASE or REMAIN THE SAME? Explain the answer. (3)

[13]

QUESTION 8 (Start on a new page.)

An electric circuit is set up as shown in the diagram below. The switch, connecting wires and ammeter have negligible resistance while the voltmeters have a very high resistance. The battery has an internal resistance of 1,5 Ω.



The switch is closed. The reading on ammeter A_2 is 0,3 A and the reading on voltmeter V_2 is 2,25 V.

8.1 Define the term *emf*. (2)

8.2 Calculate:

8.2.1 The reading on A_1 (3)

8.2.2 The resistance of resistor **R** (3)

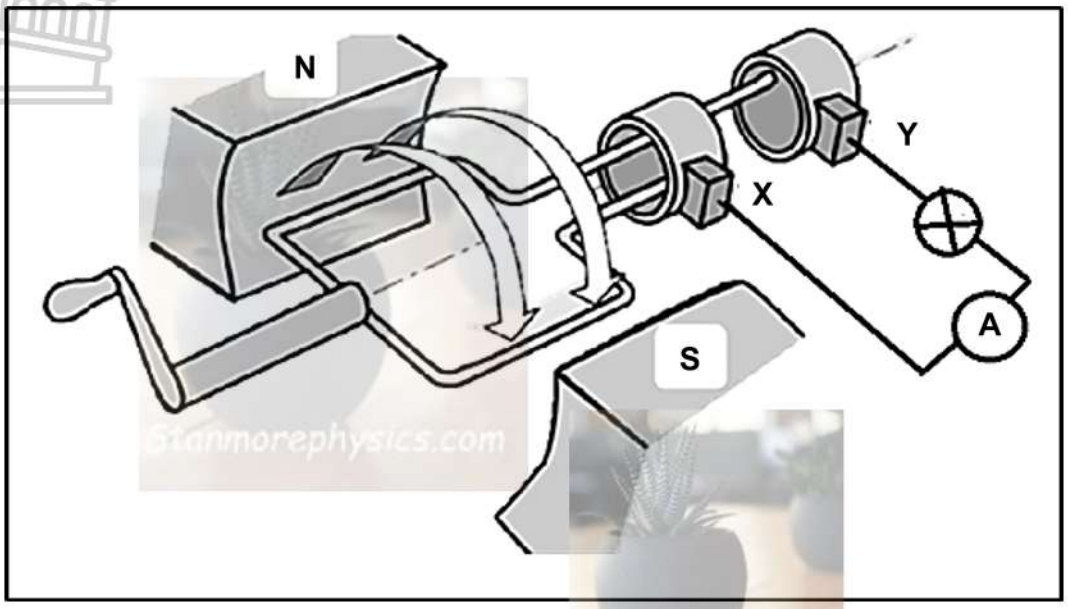
8.2.3 The emf of the battery (5)

8.3 Resistor **R** is replaced with resistor **M**, which has a smaller value than **R**. How will this change the power dissipated by the 20 Ω resistor? Choose from INCREASE, DECREASE or REMAIN THE SAME.

Explain the answer by referring to relevant formulae and principles. (4)
[17]

QUESTION 9 (Start on a new page.)

A group of Grade 12 learners is investigating two factors that affect the current induced in a generator. They build a hand-operated generator consisting of a handle connected to a coil and magnets, as shown in the diagram below.



The generator is connected to a sensitive ammeter and a light bulb with a power rating of 1,5 W. The table below shows the results of the learners' investigations:

INVESTIGATION	ROTATION OF COIL (Cycles per second)	DISTANCE BETWEEN THE MAGNETIC POLES (m)	MAXIMUM AMMETER READING (A)
1	6	0,2	0,21
	8	0,2	0,28
	10	0,2	0,35
2	10	0,2	0,35
	10	0,4	0,18
	10	0,6	0,12

9.1 Write down the energy conversion that takes place in this generator. (1)

9.2 When the handle is turned, the light bulb flickers, and the ammeter needle moves back and forth. Give a reason for this observation. (1)

9.3 In INVESTIGATION 1, the learners investigate the speed of the rotation of the handle on the induced current.

9.3.1 Write an investigative question for investigation 1. (2)

9.3.2 When the coil is in the position as shown in the diagram, will the current in the external circuit flow from **X** to **Y** or from **Y** to **X**? (1)

9.4 In INVESTIGATION 2, the learners adjust the distance between the poles of the magnets.

9.4.1 Identify the dependent variable for this investigation. (1)

9.4.2 Name ONE variable that the learners must keep constant so that the investigation can be considered fair. (1)

9.4.3 Define the term *rms current.* (2)

9.4.4 Calculate the rms current that passes through the lightbulb when the magnetic poles are 0,6 m apart. (3)

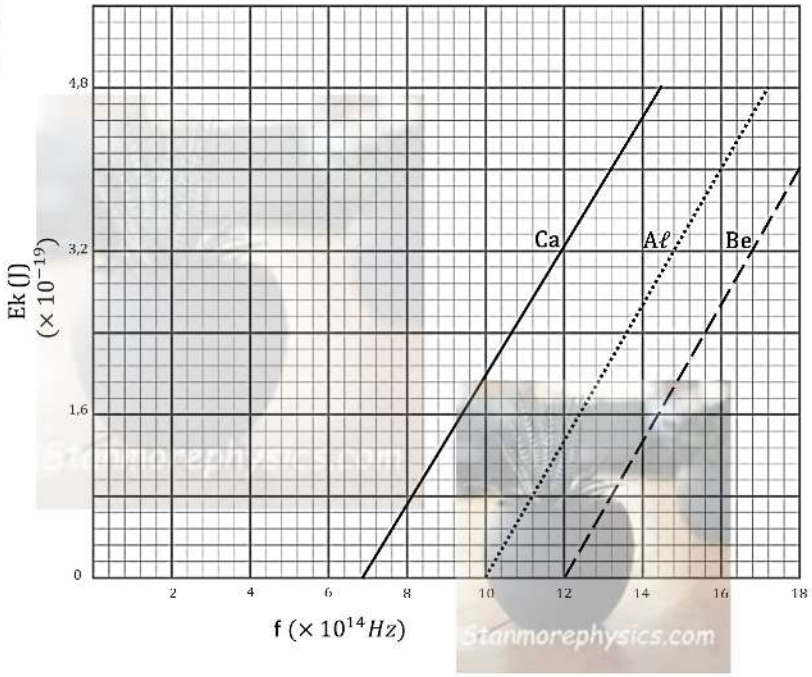
9.4.5 Calculate the resistance of the lightbulb when the magnetic poles are 0,6 m apart. (4)

9.5 The learners want to change their generator into a motor. Which component needs to be changed? (1)

[17]

QUESTION 10 (Start on a new page.)

When electromagnetic radiation shines on metals, electrons may be emitted. The maximum kinetic energy of the emitted electrons is plotted against radiation frequency for three metals, as indicated in the graph below:



10.1 What nature of electromagnetic radiation is illustrated by this phenomenon?

Answer only PARTICLE or WAVE. (1)

10.2 Define the term *threshold frequency*. (2)

10.3 Write down the threshold frequency of the metal beryllium (Be). (1)

10.4 Name the physical quantity represented by the gradient of the graph. (1)

10.5 Calculate the minimum energy that the incident light must have in order to emit electrons from the surface of calcium (Ca) metal. (3)

10.6 When electromagnetic radiation with a wavelength of 187 nm shines on one of the metals indicated in the graph, the maximum kinetic energy of the photoelectrons is found to be 4×10^{-19} J.

Use relevant calculations to identify the metal being irradiated. (5)

10.7 A frequency of 8×10^{14} Hz is shone onto aluminium metal. The intensity of the light is increased. What would the effect be on the release of electrons from the metal?

Write only INCREASE, DECREASE or NO EFFECT. Give a reason for the answer. (2)

[15]

TOTAL: 150

END

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 gravitasiekonstant*	G	$6,67 \times 10^{-11}$ $N \cdot m^2 \cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6$ m
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}$ kg
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·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

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max/maks)}$ or/*of* $E = W_o + K_{max/maks}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ or/*of* $K_{max/maks} = \frac{1}{2}mv^2_{max/maks}$	

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 = VIΔt 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*

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

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

VOORBEREIDENDE EKSAMEN

2026

MARKING GUIDELINES
NASIENRIGLYNE

10841

PHYSICAL SCIENCES: PHYSICS
FISIESE WETENSKAPPE: FISIKA

(PAPER/*VRAESTEL* 1)

15 pages/*bladsye*

QUESTION/*VRAAG* 1

1.1	C ✓✓	(2)
1.2	D ✓✓	(2)
1.3	C ✓✓	(2)
1.4	D ✓✓ (accept all other options as well) / *(aanvaar ander opsies ook)*	(2)
1.5	A ✓✓	(2)
1.6	B ✓✓	(2)
1.7	B ✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	D ✓✓	(2)

[20]

QUESTION/*VRAAG 2*

2.1

Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*
Net force must be mentioned/*Netto krag moet genoem word*

When a net force acts on an object, the object will accelerate in the direction of the force, and the acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

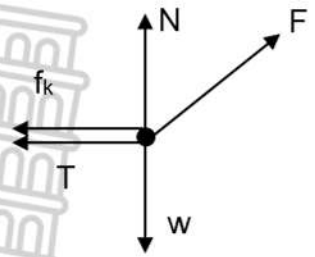
Wanneer 'n resulterende/netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag teen 'n versnelling direk eweredig aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*

The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force. (**2 or zero**)

Die netto (of resulterende) krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp in die rigting van die netto krag. (***2 of nul***) (2)

2.2



(5)

Accepted labels/*Aanvaarde benoemings:*	
w	F_g/F_w/mg/weight/gravitational force/*gewig*/*gravitasiekrag*
T	F_T/tension/F_{string}/*spanning*/F_{tou}
f_k	(kinetic) friction/F_f/*(kinetiese) wrywing*
N	F_N/Normal force/F_{normal}/$F_{normaal}$/*Normaalkrag*
F	Applied force/$F_{applied}$/*toegepaste krag*/$F_{toegepas}$

NOTES/*LET WEL:*

- Mark awarded for label and arrow./*Punt toegeken vir benoeming en pyltjie.*
- Do not penalise for length of arrows since drawing is not to scale./*Moenie vir die lengte van die pyltjies penaliseer nie aangesien die tekening nie volgens skaal is nie.*
- Any other additional force(s)./*Enige ander addisionele krag(te):* Max./*Maks.* 4/5
- If everything is correct, but no arrows./*Indien alles korrek is, maar geen pyltjies nie*: Max./*Maks.* 4/5
- If force(s) do not make contact with the dot./*Indien krag(te) nie met die kolletjie kontak maak nie*: Max./*Maks.* 4/5

2.3 On P/*Op P*:

$F_{net} = ma$ ✓

$T - f_k = ma$ ✓.....(1)

On Z/*Op Z*:

$F_{net} = ma$

$F_x - T - f_k = ma$ ✓.....(2)

Crates have same masses, thus (1) = (2)/*Kratte het dieselfde massa, dus (1) = (2)*

$T - f_k = F_x - T - f_k$

Identical frictional forces thus/*Identiese wrywingskragte, dus* $T = F_x - T$

$F_x = 2T$

$F\cos 60^0 = 2T$

$250\cos 60^0 = 2T$ ✓ (equating/*gelyk stel*)

$T = 62{,}5$ N ✓

If values are assumed then maximum 3/5.
Indien waardes aangeneem is dan maksimum 3/5

(5)

2.4 Larger than. ✓

- Force F is applied at an angle, which means the <u>normal force on crate Z will be smaller</u> than that on crate P.✓
- $f_k = \mu_k F_N$ and f_k is constant / Normal force (N) inversely proportional to μ_k as f_k is constant ✓

If calculation is shown, maximum 1/3 if no explanation in words.

Groter as

- *Krag F word teen 'n hoek toegepas, wat beteken dat die <u>normaalkrag op krat Z kleiner sal wees</u> as die op krag P.*
- *$f_k = \mu_k F_N$ en f_k is konstant / Normaalkrag (N) omgekeerd eweredig aan μ_k aangesien f_k konstant is*

Indien bewerking gedoen is, maksimum 1/3 indien geen verduideliking nie. (3)

[15]

QUESTION/*VRAAG* 3

3.1 An object which has been given an initial velocity and then it moves under the influence of the gravitational force only.✓✓ (2 or zero)

'n Voorwerp waaraan 'n beginsnelheid gegee is en wat dan slegs onder die invloed van die gravitasiekrag beweeg. (2 of nul) (2)

3.2.1

Down as positive/*Af as positief*	Up as positive/*Op as positief*
Ball K/*Bal K*:	Ball K/*Bal K*:
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓	$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
$\Delta y = (0)(1,2) + ½ (9,8)(1,2)^2$ ✓	$\Delta y = (0)(1,2) + ½ (–9,8)(1,2)^2$ ✓
$= 7,056$ m	$= –7,056$ m
Ball L/*Bal L*:	Ball L/*Bal L*:
$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$	$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$–(20–7,056)$ ✓$= v_i(1,2) + ½ (9,8)(1,2)^2$ ✓	$20 –(–7,056)$ ✓$= v_i(1,2) + ½ (–9,8)(1,2)^2$ ✓
$v_i = –16,667$ m·s^{-1}	$v_i = 16,67$ m·s^{-1} ✓
$v_i = 16,67$ m·s^{-1} ✓	
accept/*aanvaar* 16,667	

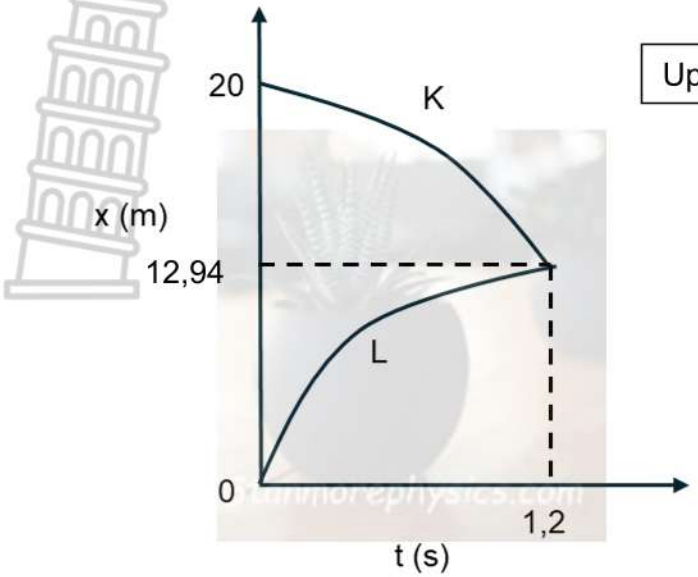
(5)

3.2.2

Down as positive/*Af as positief*:	Up as positive/*Op as positief*:
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= 0^2 + 2(9,8)(20)$ ✓	$= 0^2 + 2(-9,8)(-20)$ ✓
v_f = <u>19,80 m·s^{-1} down/*af*</u> ✓	v_f = <u>19,80 m·s^{-1} down/*af*</u> ✓
accept/*aanvaar* 19,799 m·s^{-1} down/af	

(3)

3.3 Positive marking from Question 3.2.1/ *Positiewe nasien vanaf Vraag 3.2.1*



Up as positive/*Op as positief*

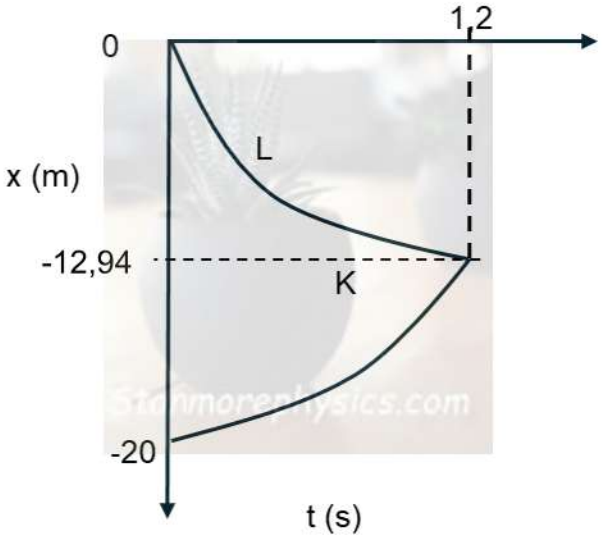
Marking criteria:
- ✓ curved line K starts at 20 m (or –20 m)
- ✓ curved line L starts from 0 m
- ✓ both lines stop at 12,94 m
- ✓ both lines stop at 1,2 s

If graphs are not labelled, max. 2/4
If ground not used as zero, max. ¾

Nasienkriteria:
- ✓*gekromde lyn K begin by 20 m (of –20 m))*
- ✓*gekromde lyn L begin by 0 m*
- ✓*Albei lyne stop by 12,94 m*
- ✓*Albei lyne stop by 1,2 s*

As grafieke nie benoem is nie, maks. 2/4
As die grond nie as nul gebruik word nie, maks. ¾

Accept/*Aanvaar*:



Down as positive/*Af as positief*

(4)
[14]

QUESTION/*VRAAG* 4

4.1 The product of an object's mass and its velocity.✓
Die produk van 'n voorwerp se massa en sy snelheid. (1)

4.2

OPTION 1/*OPSIE 1*

$E_k = ½ mv^2$

$260 = ½(130)v^2$ ✓ if this calculation is omitted: max. 4/5

$v = 2 \text{ m.s}^{-1}$ *as hierdie berekening weggelaat word: maks. 4/5*

$\sum p_i = \sum p_f$

$m_A v_i + m_B v_i = (m_A + m_B)v_f$ ✓ any one/*enige een*

$(130)(2) + (120)(2,5)$ ✓ $= (130 + 120)v_f$ ✓

$260 + 300 = 250v_f$

$v_f = 2,24 \text{ m} \cdot \text{s}^{-1}$ in the direction of the poles/towards the right ✓
in die rigting van die pale/na regs

OPTION 2/ *OPSIE 2*

$E_k = ½ mv^2$

$260 = ½(130)v^2$ ✓ if this calculation is omitted: max. 4/5

$v = 2 \text{ m.s}^{-1}$ *as hierdie berekening weggelaat word: maks. 4/5*

$\Delta p_A = -\Delta p_B$ ✓

$m_A (v_f - v_{iA}) = -m_B (v_f - v_{iB})$

$130 (v_f - 2)$ ✓$= -120 (v_f - 2,5)$ ✓

$v_f = 2,24 \text{ m} \cdot \text{s}^{-1}$ in the direction of the poles/towards the right ✓
in die rigting van die pale/na regs (5)

4.3 The sponge will:

- Increase the time it takes the rugby player to come to rest during the collision ✓
- If the **change in** momentum remains the same,✓
- The contact time will be inversely proportional to the net force ✓ experienced by the rugby player, according to $F_{net}\Delta t = \Delta p$ OR $F_{net} \alpha \frac{1}{\Delta t}$
- Therefore, a decrease in net force experienced will result in fewer injuries.✓

Die spons sal:

- *Die tyd wat dit vir die rugbyspeler neem om tydens die botsing tot stilstand te kom, vergroot*
- *As die **verandering in** momentum dieselfde bly,*
- *Sal die kontaktyd omgekeerd eweredig wees aan die netto krag wat die rugbyspeler ervaar, volgens $F_{net}\Delta t=\Delta p$ OF F_{net} α Δt*
- *Daarom sal 'n afname in netto krag wat ervaar word, tot minder beserings lei.* (4)

4.4 **POSITIVE MARKING FROM 4.2/*POSITIEWE NASIEN VANAF 4.2***

Player A/*Speler A*	Player B/ *Speler B*
$F_{net}\Delta t = m(v_f - v_i)$ ✓	$F_{net}\Delta t = m(v_f - v_i)$✓
$F_{net}(0,8)$✓ $= 130(2,24 - 2)$✓	$F_{net}(0,8)$✓ $= 120(2,24 - 2,5)$✓
$F_{net} = 39$ N ✓	$F_{net} = -39$ N
	Therefore/*Daarom* 39 N✓

(4)

[14]

QUESTION/*VRAAG* 5

5.1 The total mechanical energy in an isolated system remains constant.✓✓ (2 or 0)
OR
The sum of gravitational potential energy and kinetic energy in an isolated system remains constant.

Die totale meganiese energie in 'n geïsoleerde sisteem bly konstant. (2 of 0)
OF
Die som van gravitasie- potensiële energie en kinetiese energie in 'n geïsoleerde sisteem bly konstant. (2)

5.2 Gravitational force ✓ (gravity is not accepted) (maximum 2/3)
The work done by the force of gravity ✓ does not depend on the path taken. ✓

Gravitasiekrag (gravitasie word nie aanvaar nie) (maksimum 2/3)
Die arbeid verrig deur swaartekrag, hang nie af van die pad/roete wat gevolg word nie. (3)

5.3

$$(E_P + E_K)_A = (E_P + E_K)_B \quad \checkmark \text{ any one/}$$
$$(mgh + \tfrac{1}{2}mv^2)_A = (mgh + \tfrac{1}{2}mv^2)_B \quad \textit{enige een}$$
$$(1,5)(9.8)(0,6)\checkmark + 0 = (1,5)(9,8)(0,2) + E_{K(B)}\checkmark$$
$$8,82 + 0 = 2,94 + E_{K(B)}$$
$$E_{K(B)} = 5,88\ J$$

$$W_{nc} = \Delta E_P + \Delta E_K \quad \checkmark$$
$$= (mgh_D - mgh_B) + (\tfrac{1}{2}mv_D^2 - \tfrac{1}{2}mv_B^2)$$
$$= [(1,5)(9,8)(0,12) - (1,5)(9,8)(0,2)]\ \checkmark + [(\tfrac{1}{2}(1,5)0^2) - 5,88]\ \checkmark$$
$$= (-1,176) + (-5,88)$$
$$= -7,056\ J\ \checkmark$$

If the system approach is used and the 0,2 m not used anywhere, max 2/7
No penalisation if zero substitution is omitted. Marking rule number 5.1.5
Indien die sisteem benadering gebruik is en die 0,2 m nie gebruik is nie, maks 2/7
Geen penalisering indien nulle nie invervang word nie. Merkreël nommer 5.1.5 (7)
[12]

QUESTION/*VRAAG* 6

6.1

Marking criteria/*Nasienkriteria:*
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

The change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓

Die verandering in frekwensie (of toonhoogte) van die klank waargeneem deur 'n luisteraar, omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium waarin die klank voortgeplant word, het.

OR / OF

An (apparent) change in (observed/detected) frequency/pitch as a result of the relative motion between a (sound) source and an observer.

Die (skynbare) verandering in (waargenome) frekwensie/toonhoogte as gevolg van relatiewe beweging tussen die (klank)bron en die luisteraar. (2)

6.2 HIGH/*HOË* ✓ (1)

6.3 Towards ✓ Because $f_L > f_S$ ✓
Na die bron toe Omdat $f_L > f_S$ (2)

6.4 NOTE: If the frequency is not converted to Hz, marks for substitution not awarded and no mark for answer. Marking rule number 5.1.10.
NOTA: Indien die frekwensie nie omgeskakel word na Hz nie, verloor punte vir invervanging en geen punt Antwoord nie. Merkreël nommer 5.1.10

$$f_L = \frac{(v \pm v_S)}{(v \pm v_L)} f_S \quad ✓$$

$$40\ 232 = \frac{(343 + v)}{(343)} f_s \quad ✓$$

$40232(343 - v) = 343f$ .....(1)

$$f_L = \frac{(343 + v)}{(343)} (40\ 000) \quad ✓$$

$f(343) = 40\ 000(343 + v)$ .....(2)

(1) = (2)

$40232(343 - v) = 40\ 000(343 + v)$

$v = 0{,}992\ m \cdot s^{-1}$ ✓ (4)

6.5 AWAY ✓

- The emission spectral lines of the gas in the distant star has shifted towards the red end of the spectrum✓/Diagram 2 shows red shift
- Red light spectrum has lower frequency / longer wavelength ✓
  Lower frequency indicates that star is moving away.

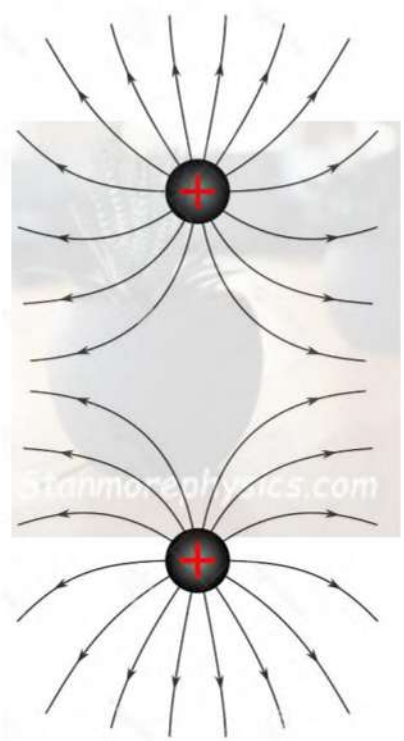
WEG VAN ✓

- *Die emissiespektrumlyne van die gas in die ver afgeleë ster het na die rooi kant van die spektrum verskuif/Diagram 2 wys rooiverskuiwing*
- *Rooi ligspektrum het laer frekwensie / langer golflengte*
  Laer frekwensie dui aan dat die ster besig is om weg te beweeg (3)

6.6 The universe is expanding/*Die heelal brei uit*.✓ (1)
[13]

QUESTION/*VRAAG* 7

7.1



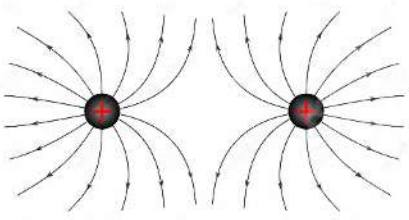
MARKING GUIDELINES:

- ✓ Shape (field lines spread out evenly)
- ✓ Magnitude (equal number of field lines on X and Y)
- ✓ Direction (arrows pointing away from both charges)

NASIENRIGLYNE:

- ✓ *Vorm (veldlyne eweredig versprei)*
- ✓ *Grootte (ewe veel veldlyne om X en Y)*
- ✓ *Rigting (pyltjies wys weg van albei ladings)*

Accept if sketched this way/ *aanvaar indien so om geteken*



(3)

7.2 **Marking criteria/*Nasienkriteria:***
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*
If mass is mentioned, zero.
Indien massa genoem word, nul.

The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓

Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van die ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. (2)

7.3 $F_{net} = 0$ N ✓ OR zero/*OF nul* (1)

7.4 $F_{net} = F_{XY} - F_g = 0$

$F_{XY} = \frac{kQ_1Q_2}{r^2}$ ✓

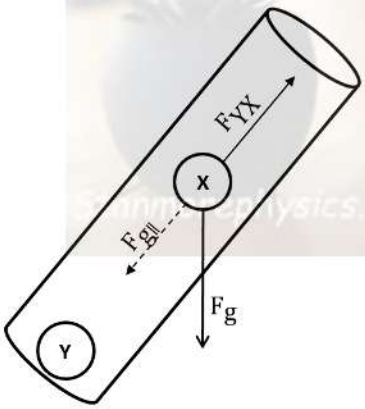
$mg = F_{XY}$

$(5 \times 10^{-6})(9,8)$✓ $= \frac{(9 \times 10^9)(x)(x)}{(50 \times 10^{-3})^2}$ ✓

$x = 3,689 \times 10^{-9}$

$\therefore Q_X = Q_Y = 3,69 \times 10^{-9}$ C ✓ (4)

7.5



INCREASE✓
Sphere Y remains fixed at the bottom of the tube, so when the tube is tilted:
✓ Magnitude of F_{YX} remains the same
✓ Only $F_{g\parallel}$ opposes F_{YX} and $F_{g\parallel} < F_{YX}$
OR
Only $F_{g\parallel}$ opposes F_{YX} and $F_{g\parallel} < F_g$
OR
Only $F_{g\parallel}$ opposes F_{YX} and $F_{net} \neq 0\ N$

TOENEEM✓
Sfeer Y bly vas aan die onderkant van die buis, sodat wanneer die buis gekantel is:
✓ *Die grootte van F_{YX} sal dieselfde bly*
✓ *Slegs $F_{g\parallel}$ werk teen F_{YX} en $F_{g\parallel} < F_{YX}$*
OF
Slegs $F_{g\parallel}$ werk teen F_{YX} en $F_{g\parallel} < F_g$
OF
Slegs $F_{g\parallel}$ werk teen F_{YX} en $F_{net} \neq 0\ N$ (3)

[13]

QUESTION/*VRAAG 8*

8.1 The maximum energy provided by a battery per unit charge passing through it ✓✓ (2 or zero)
Die maksimum energie wat 'n battery lewer per eenheidslading wat daardeur vloei (2 of nul) (2)

8.2.1 Marking criteria: /*Nasienriglyne:*
- ✓ Current of 0,2 A in branch
- ✓ Substitution for calculating reading on A1
- ✓ Correct answer

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$V_{20\Omega}$ = IR = (0,3)(20) = 6 V $R = \frac{V}{I}$ $30 = \frac{6}{I}$ ✓ I = 0,2 A Reading on/*lesing op* A_1 = 0,3 + 0,2 ✓ = 0,5 A ✓	Resistance/*weerstand*: 20:30 = 2:3 Current/*stroom*: 3:2 0,3:0,2 ✓ Reading on/*lesing op* A_1 = 0,3 + 0,2 ✓ = 0,5 A ✓
OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
Resistance/*weerstand*: 20:30 = 2:3 $\frac{3}{5}$✓ xI_T = 0,3A✓ I_T = 0,5 A✓	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ $\frac{1}{R_p} = \frac{1}{20} + \frac{1}{30}$ R_p = 12 Ω $R = \frac{V}{I}$ $20 = \frac{V}{0,3}$ ✓ V = 6 V $R = \frac{V}{I}$ $12 = \frac{6}{I}$ ✓ I = 0,5 A ✓

(3)

8.2.2 **Positive marking from QUESTION 8.2.1/*Positiewe nasien vanaf VRAAG 8.2.1***
$R = \frac{V}{I}$✓
$R = \frac{2,25}{0,5}$✓
R = 4,5 Ω✓
(3)

8.2.3 **Positive marking from QUESTION 8.2.1 and 8.2.2**
Positiewe nasien vanaf VRAAG 8.2.1 en 8.2.2

OPTION 1/ *OPSIE 1*

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{20} + \frac{1}{30}$ ✓

$R_p = 12\ \Omega$

$R_T = R_p + R_s = 12 + 4,5$ ✓ $= 16,5\ \Omega$

$\varepsilon = I(R+r)$ ✓

$= (0,5)(16,5 + 1,5)$ ✓

$= 9\ V$ ✓

ACCEPT/ *AANVAAR*

$R_p = \frac{R_1 R_2}{R_1 + R_2}$

OPTION 2/ *OPSIE 2*

$\varepsilon = V_{ex} + V_i$ ✓

$= (6$ ✓ $+ 2,25)$ ✓ $+ (0,5)(1,5)$ ✓

$= 9\ V$ ✓

(5)

8.3 Increase.✓

Total resistance of circuit will decrease ✓ and total current will increase. ✓
Larger current in each of the branches will mean more power as $P \alpha I^2$ ✓ if resistance of 20 Ω remains constant.

Verhoog.

Totale weerstand van die stroombaan sal afneem en totale stroom sal toeneem.
Groter stroom in elk van die takke beteken meer drywing omdat $P \alpha I^2$ as weerstand van 20 Ω konstant bly. (4)

[17]

QUESTION/*VRAAG* 9

9.1 Mechanical energy (converts) to electrical energy.✓
Meganiese energie (skakel om) in elektriese energie. (1)

9.2 Alternating current is generated. ✓
OR
The current continuously changes direction in the outer circuit.

Wisselstroom word opgewek.
OF
Die stroom verander voortdurend van rigting in die buitenste stroombaan. (1)

9.3.1 How would an <u>increase in (rotational) speed</u> affect the (induced) <u>current</u>? ✓✓
OR
How would an <u>increased (rotational) frequency</u> affect the (induced) <u>current</u>?

If yes or no answer – deduct one mark. Max ½
Indien ja of nee Antwoord – trek een punt af. Maksimum ½

Hoe sou 'n <u>toename in (rotasie) spoed</u> die (geïnduseerde) <u>stroom beïnvloed</u>?
OF
Hoe sou 'n <u>verhoogde (rotasie-) frekwensie</u> die (geïnduseerde) <u>stroom beïnvloed</u>? (2)

9.3.2 Y to/*na* X ✓ (1)

9.4.1 (Induced) current/*(Geïnduseerde) stroom* ✓ (1)

9.4.2
- Rotational speed/frequency✓
- Area/Size of coil
- Number of windings on coil
(ANY ONE FOR ONE MARK) do not accept strength of magnet.

- *Rotasiespoed/frekwensie*✓
- *Oppervlakte/Grootte van die spoel*
- *Aantal windings op die spoel*
(ENIGE EEN VIR EEN PUNT) moenie sterkte van magneet aanvaar nie. (1)

9.4.3 **Marking criteria/*Nasienkriteria:***
If any of the underlined key words/phrases in the correct context is omitted deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

(The rms current is) the <u>alternating current</u> (AC) which dissipates/produces the <u>same amount of energy</u> as an <u>equivalent direct current</u> (DC). ✓✓

NOTE: If potential difference is mentioned, then 0/2
If definition starts with DC, then 0/2

Die wgk-stroom is die wisselstroom (WS) wat dieselfde hoeveelheid energie verbruik/oordra as 'n ekwivalente gelykstroom (GS)

***LET WEL:** as potensiaalverskil genoem word, dan 0/2*
Indien definisie met GS begin, dan 0/2 (2)

9.4.4 $I_{rms/wgk}=\frac{I_{max}}{\sqrt{2}}$ ✓ subscripts have to be there/ *onderskrifte moet daar wees*

$I_{rms/wgk}=\frac{0,12}{\sqrt{2}}$ ✓

$I_{rms/wgk}$=0,0848 A ✓

Accept/A*anvaar* 0,08 A and 0,085 A (3)

9.4.5 Positive marking from QUESTION 9.4.4/*Positiewe nasien vanaf VRAAG 9.4.4*
NOTE: Recalculate using previous answer.
NOTA: Herbereken met vorige antwoord.

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*
$P_{ave} = I_{rms}^2R$ ✓	$P_{ave} = V_{rms/wgk}I_{rms/wgk}$
1,5 ✓ $= (0,0848)^2R$ ✓	(1,5) ✓ $= V_{rms/wgk}(0,0848)$
$R = 208,59\ \Omega$ ✓	$V_{rms/wgk} = 17,687$ V $R = \frac{V}{I}$ ✓ $= \frac{17,687}{0,0848}$ ✓ $= 208,59\ \Omega$ ✓
	Range/*Gebied*: 207 – 234,38

(4)

9.5 Place/add a power source in the external circuit ✓
Plaas/voeg 'n kragbron in die eksterne stroombaan by (1)
[17]

QUESTION/*VRAAG 10*

10.1 Particle/*Deeltjie* ✓ (1)

10.2 The minimum frequency of light needed to emit electrons from a certain metal surface. ✓✓ (2 or 0)
Die minimum frekwensie lig benodig om elektrone uit 'n sekere metaaloppervlak vry te stel (2)

10.3 12×10^{14} (Hz) ✓ (Read from graph/*Lees van grafiek af*) (1)

10.4 Planck's constant/*Planck se konstante* ✓ (1)

10.5 $E = W_0 + E_{K(max)}$ ✓

$E = (6,63 \times 10^{-34})(6,8 \times 10^{14})$ ✓ + 0

$E = 4,508 \times 10^{-19}$ J ✓ (accept 4,51 x 10^{-19} J) (3)

10.6 $E = W_0 + E_{K(max)}$
$\frac{hc}{\lambda} = hf_0 + \frac{1}{2}mv_{max}^2$
✓ any one/*enige een*

$\frac{(6,63\times10^{-34})(3\times10^8)}{(187\times10^{-9})}$ ✓ $= (6,63 \times 10^{-34})f_0 + (4 \times 10^{-19})$ ✓

$f_0 = 10 \times 10^{14}$ Hz ✓

∴ Metal/*metaal* is ALUMINIUM (Aℓ) ✓ (5)

10.7 No effect. ✓
The frequency is still smaller than the threshold frequency ✓ and will not emit any electrons.
OR
The photons do not have enough energy to release an electron.
OR
Increase in intensity does not change frequency.

Geen effek nie.
Die frekwensie is steeds kleiner as die drumpelfrekwensie en sal geen elektrone vrystel nie.
OF
Die fotone het nie genoeg energie om 'n elektron vry te stel nie.
OF
Toename in intensiteit sal nie frekwensie verander nie. (2)

[15]

TOTAL/*TOTAAL:* 150