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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2026

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MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3 data sheets.

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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. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

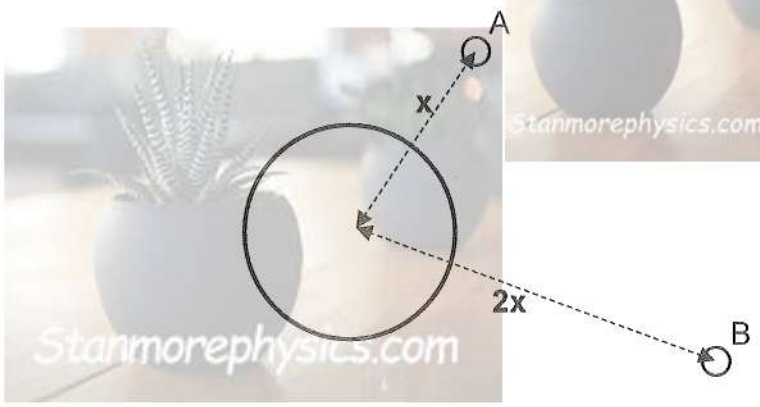
Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following pairs of relationships describes Newton's Second Law?

A	$a \propto F_{net}$	$a \propto m$
B	$a \propto F_{net}$	$a \propto \frac{1}{m}$
C	$F_{net} \propto \frac{1}{a}$	$F_{net} \propto m$
D	$F_{net} \propto \frac{1}{a}$	$a \propto \frac{1}{m}$

(2)

1.2 Two identical satellites, A and B, of equal mass orbit the Earth. The distances from satellites A and B to the centre of the Earth is **x** and **2x** metres respectively.



The ratio of the gravitational force exerted by the Earth on satellite A to the gravitational force exerted by the Earth on satellite B is …

A 1 : 2

B 2 : 1

C 4 : 1

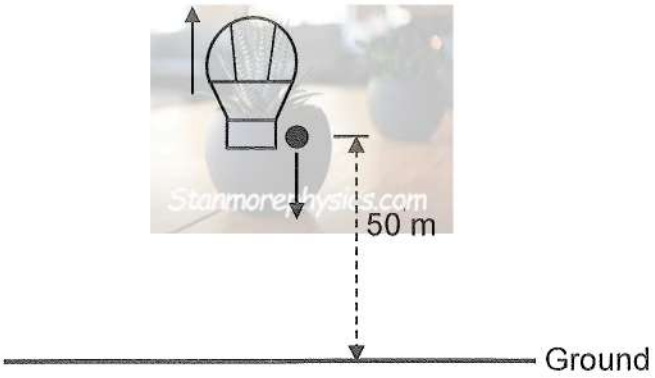
D 1 : 4

(2)

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1.3 A hot-air balloon, moving upwards at a constant velocity, is 50 m above the ground when a stone is dropped from the balloon. Ignore the effects of friction.



Consider the following statements:

(i) The initial velocity of the stone is zero relative to the ground.

(ii) The speed of the stone is always increasing after being dropped.

(iii) The maximum height reached by the stone above the ground is greater than 50 m.

Which of the statements above is/are CORRECT?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

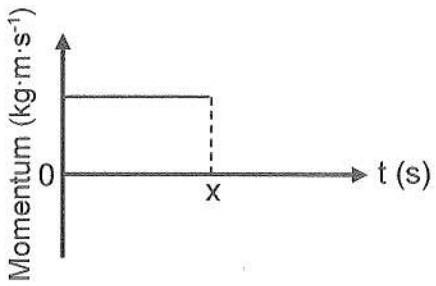
D (iii) only (2)

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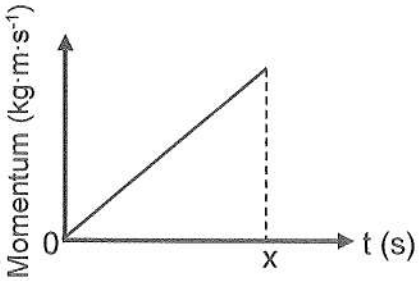
1.4 Which ONE of the following is a correct momentum versus time graph for a ball striking a racket for a total contact time of x seconds?

Assume that the force exerted on the ball by the racket is constant.

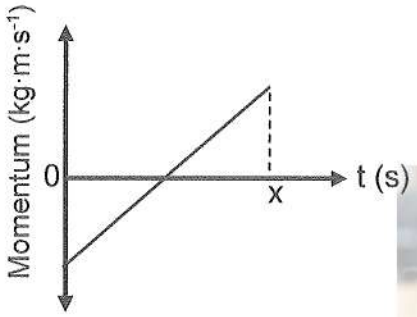
A



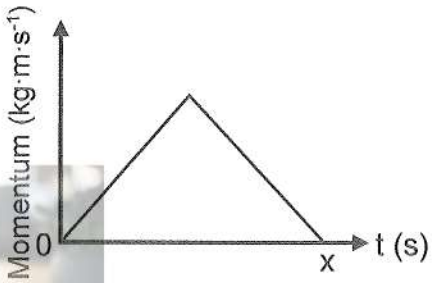
B



C

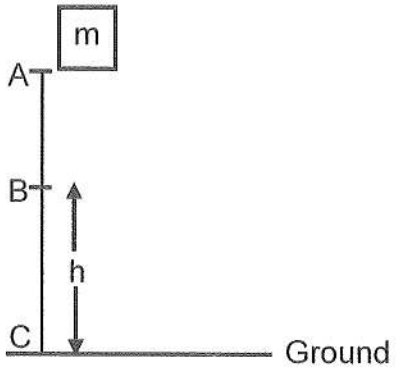


D



(2)

1.5 An object of mass m is dropped from point A. It passes point B, h metres above the ground, and strikes the ground at point C. See the diagram below. Ignore the effects of friction.



When the object is at point B, its kinetic energy is E.

Which ONE of the following expressions gives the kinetic energy of the object just before it strikes the ground at point C?

A E – mgh

B E + mgh

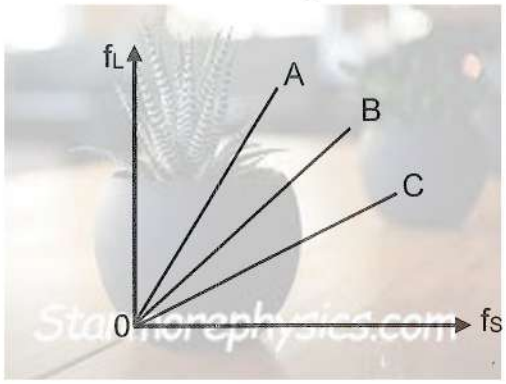
C E + 2mgh

D $E + \frac{1}{2}mgh$

(2)

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1.6 A source emits sound waves with different frequencies, f_S. The graph below shows the frequencies observed by a stationary listener, f_L, versus the frequencies of the sound emitted by the source.



Graph B is obtained when both the source and the listener are stationary. Graphs A and C are obtained when the source moves relative to the stationary listener.

Which ONE of the following statements is CORRECT?

A Graph A indicates that the source is moving away from the listener.

B Graph C indicates that the source is moving towards the listener.

C The gradient of graph A can be written as $\frac{v}{v - v_s}$

D The gradient of graph C can be written as $\frac{v}{v - v_s}$ (2)

1.7 A small test charge **q** is placed at point X, a certain distance from a fixed charge Q, as shown in the diagram below. The electric field at point X due to Q is **E**.



The charge on **q** is doubled. What will the electric field due to charge Q at point X now be?

A $\frac{1}{2}$**E**

B **E**

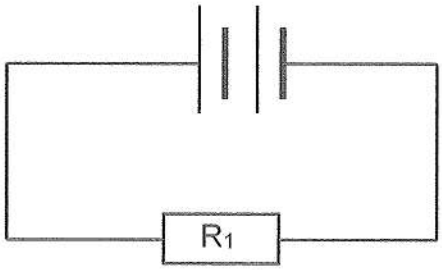
C 2**E**

D 4**E** (2)

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1.8 The battery and connecting wires in the circuit below have negligible resistance. The power dissipated by resistor R_1 is **P**.



A second, identical resistor R_2 is connected in series to R_1. What is the power now dissipated by R_1?

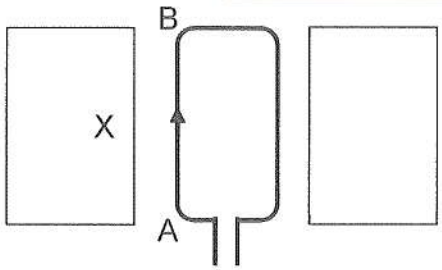
A $\frac{1}{4}$**P**

B $\frac{1}{2}$**P**

C 2**P**

D 4**P** (2)

1.9 The following simplified diagram of an electric motor shows a coil between two magnets. The current flows from A to B in the coil.



Which ONE of the following combinations is CORRECT for the polarity at X, the direction of the force experienced by section AB, and the energy conversion in the motor?

	POLARITY AT X	DIRECTION OF FORCE IN SECTION AB	ENERGY CONVERSION
A	South	Out of page	Mechanical to electrical
B	South	Into page	Electrical to mechanical
C	North	Out of page	Mechanical to electrical
D	North	Into page	Electrical to mechanical

(2)

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1.10 The work function of a metal is W_0. Photons, each with energy $E = \frac{1}{2}W_0$, are incident on the metal surface.

Which ONE of the following statements is CORRECT?

A When two photons strike an electron, the electron is not ejected.

B When two photons strike an electron, the electron is ejected with kinetic energy greater than zero.

C When one photon strikes an electron, the electron is ejected with zero kinetic energy.

D When two photons strike an electron, the electron is ejected with zero kinetic energy. (2)

[20]

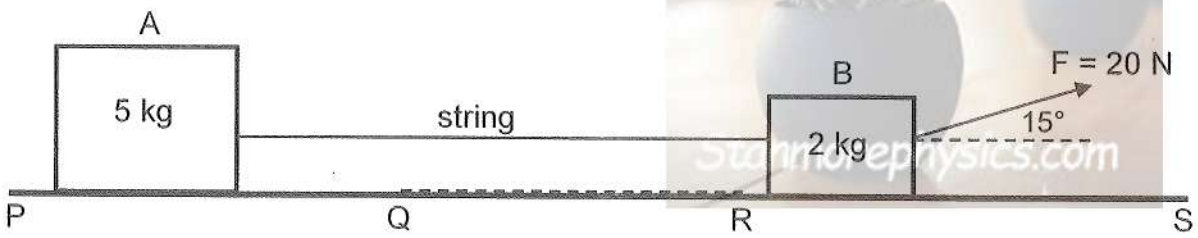


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QUESTION 2 (Start on a new page.)

A learner conducts an experiment to test the tension in a string. Block A of mass 5 kg is connected to block B of mass 2 kg by a light inextensible string. The blocks are initially at rest on a horizontal surface.

Sections PQ and RS of the surface are frictionless, while section QR is rough. When a force F of magnitude 20 N acts at an angle of 15° to the horizontal on block B, the blocks start to move.



2.1 Draw a labelled free-body diagram showing ALL the forces acting on block B as it moves. (4)

When block A moves over section QR, it experiences a constant frictional force of 11 N. The string will break immediately when the tension exceeds 16 N.

2.2 Define the term *frictional force*. (2)

2.3 Prove that the string will break as block A moves over section QR. (5)

2.4 Describe the motion of each block immediately after the string breaks by referring to their velocities. (2)
[13]

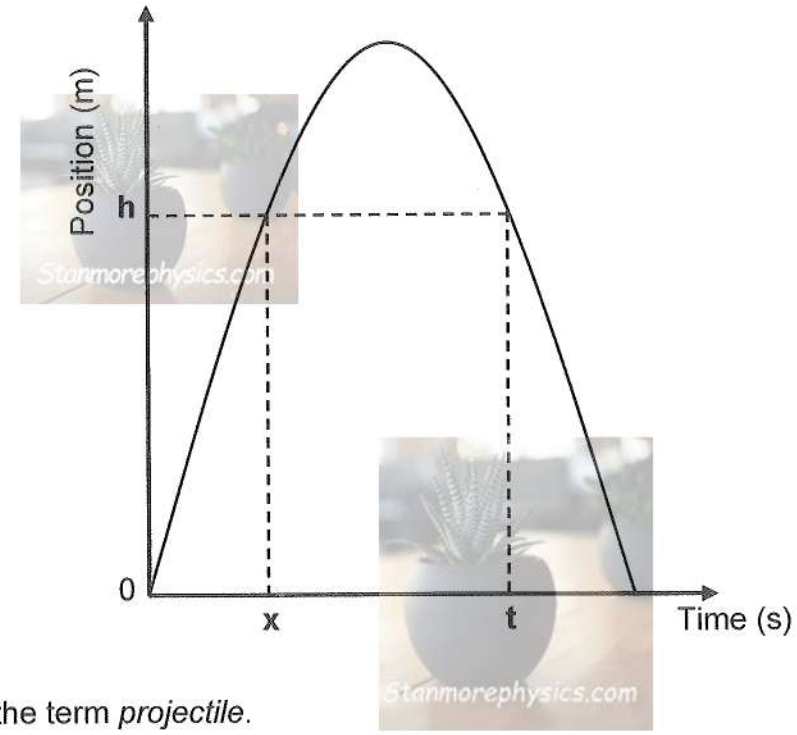
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QUESTION 3 (Start on a new page.)

Ball A is projected vertically upwards from the ground with an initial velocity of 20 $m \cdot s^{-1}$. The ball is above a certain position **h** for 1,5 s of its motion. Ignore the effects of friction.

The position-time graph for the motion of the ball is shown below.



3.1 Define the term *projectile*. (2)

3.2 How does the velocity of the ball at **x** seconds compare to its velocity at **t** seconds? (2)

3.3 Using EQUATIONS OF MOTION ONLY, calculate:

3.3.1 The maximum height above the ground reached by the ball (3)

3.3.2 **h** (5)

3.3.3 **t** (3)

When ball A reaches position **h** at time **t** seconds, a second ball, ball B, is dropped from position **h**.

3.4 On the same set of axes, draw the velocity versus time graphs for EACH ball for its entire motion, until it strikes the ground.

Label the graphs A and B for balls A and B respectively.

Indicate the following on the graphs:

- The initial velocity for each ball
- The time at which ball B was dropped

(4)
[19]

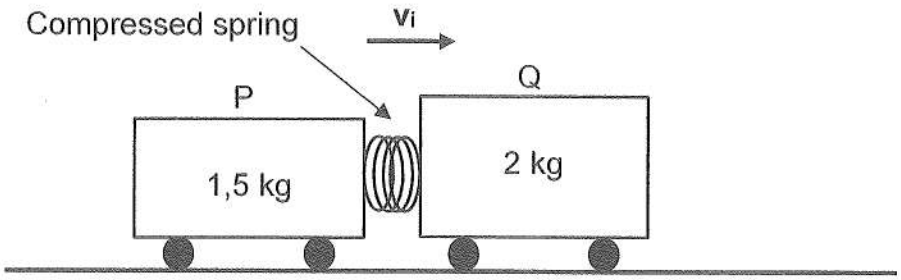
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QUESTION 4 (Start on a new page.)

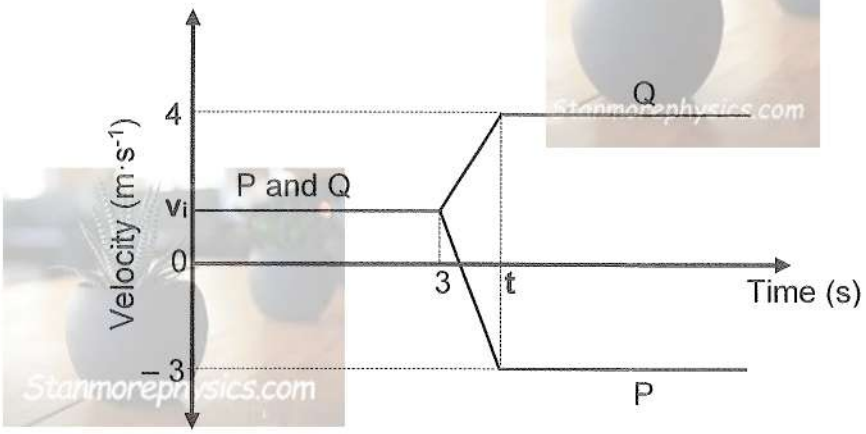
The length of a compressed spring is kept constant when it is between two trolleys P and Q, that are moving to the right with a constant speed v_i. The mass of trolley P is 1,5 kg and that of trolley Q is 2 kg.

The surface is horizontal and frictionless.



The trolleys move for 3 seconds, after which the spring expands to its natural length and falls to the ground at t seconds.

The velocity versus time graph below represents the motions of the trolleys.



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

4.2 Calculate the magnitude of v_i. (4)

4.3 How does the acceleration of trolley P compare to that of trolley Q while the spring is expanding? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (2)

Trolley Q experienced an average force of magnitude 10 N while the spring was expanding.

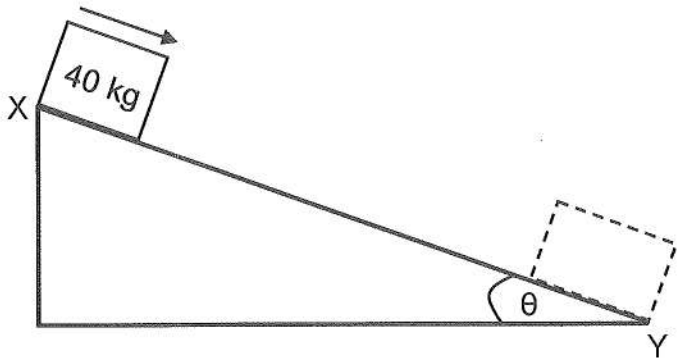
4.4 Calculate the value of t. (3)
[11]

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QUESTION 5 (Start on a new page.)

A block of mass 40 kg is released from rest at point X on a plane inclined at an angle θ to the horizontal.



When the block moves from point X to point Y, the bottom of the incline:

- It experiences a constant kinetic frictional force of 55 N
- Its gravitational potential energy changes by 2 500 J
- Its kinetic energy changes by 2 000 J

5.1 Define the term *non-conservative force*. (2)

5.2 Using ENERGY PRINCIPLES ONLY, calculate:

5.2.1 The distance from point X to point Y (4)

5.2.2 θ (4)

A block of mass 20 kg is now released from point X on the same surface. The coefficient of kinetic friction stays the same.

5.3 How will the net work done on the 20 kg block compare to the net work done on the 40 kg block when the blocks move from point X to point Y? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (2)
[12]

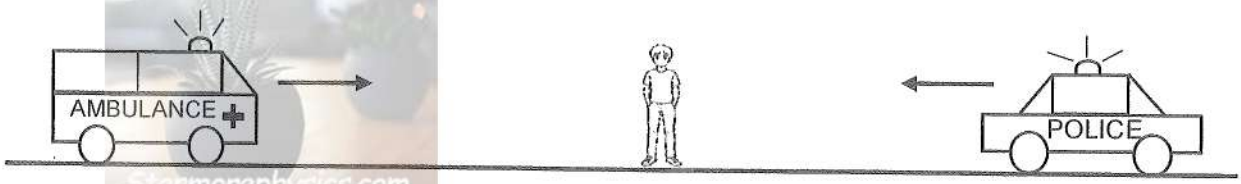
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QUESTION 6 (Start on a new page.)

6.1 An ambulance and a police car, both equipped with sirens, are moving with different, constant speeds towards an accident scene. The frequency of the soundwaves emitted by the sirens of both vehicles are not equal.

A listener, at the side of the road, observes that the frequencies of both sound waves are EQUAL.

Ignore any effects of wave interference.



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

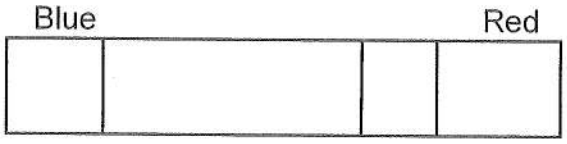
6.1.2 Draw the wave front diagram for the waves emitted from the ambulance, as observed by the listener both in front of and behind the ambulance. Use a dot to represent the ambulance. (2)

The ambulance moves at a speed **v** while the police car moves with a speed that is 5 $m \cdot s^{-1}$ faster than the ambulance.

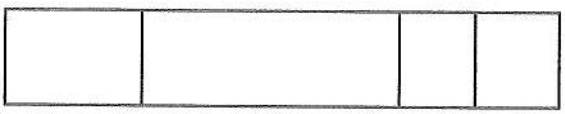
Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1.3 The ratio of the frequency of the sound from the police siren (f_P) to the frequency of the sound from the ambulance siren (f_A) is 0,984. Calculate **v**, the speed of the ambulance. (6)

6.2 The elements surrounding a star can be identified by their spectra. When the spectrum of an element surrounding a star is compared to the spectrum of the same element in a laboratory, the spectral lines are black and are shifted, as shown below.



SPECTRUM 1
Spectrum of element in a laboratory



SPECTRUM 2
Spectrum of element surrounding a star

6.2.1 Name the type of line spectra referred to above. (1)

6.2.2 Name the type of shift observed in Spectrum 2. (1)

6.2.3 Is the star moving TOWARDS or AWAY FROM the Earth? (1)

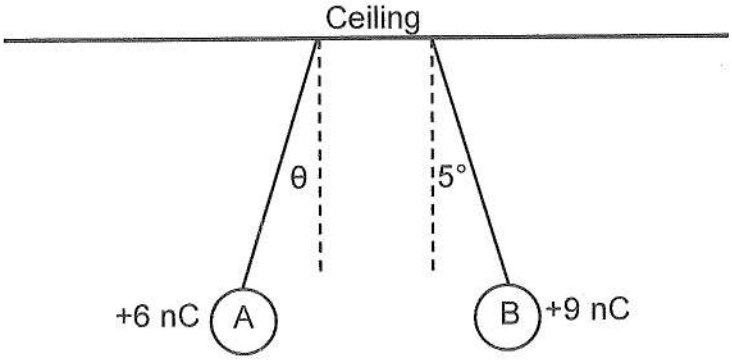
[13]

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QUESTION 7 (Start on a new page.)

Two small identical spheres A and B carry charges of +6 nC and +9 nC respectively. The spheres are of equal mass and are suspended from a ceiling by light insulated strings. The strings are of equal length. The spheres come to rest at angles indicated in the diagram.

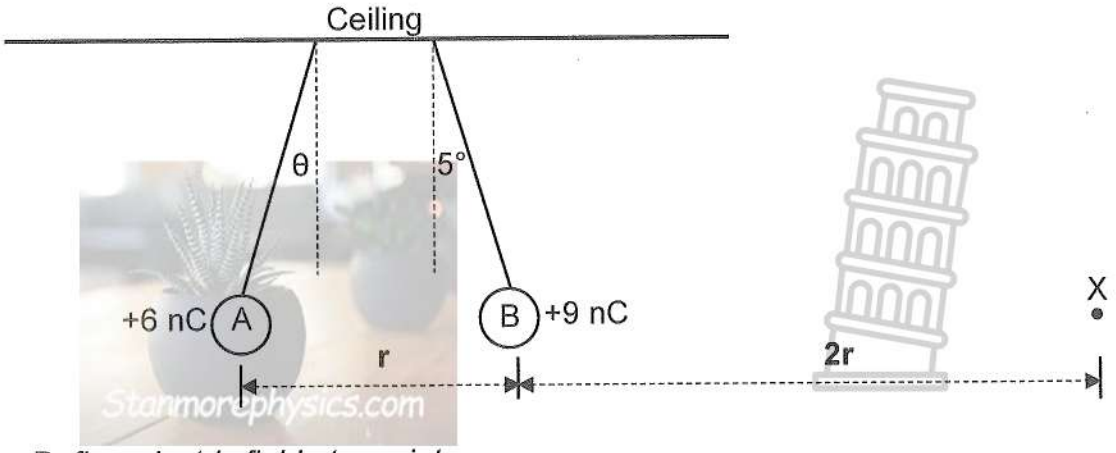


7.1 State *Coulomb's law* in words. (2)

7.2 Draw a labelled vector triangle to show ALL the forces acting on sphere B. Indicate the size of at least TWO angles in the triangle. (3)

7.3 Is the angle θ GREATER THAN 5°, LESS THAN 5° or EQUAL TO 5°? Give a reason for the answer. (2)

The distance between spheres A and B is **r** metres. X is a point on the line joining the centres of the spheres and is **2r** metres to the right of sphere B, as shown in the diagram below.



7.4 Define *electric field at a point*. (2)

7.5 Write down the direction of the net electric field at point X. Choose LEFT or RIGHT. (1)

7.6 The magnitude of the net electric field at point X is $1,05 \times 10^4 \text{ N·C}^{-1}$. Calculate **r**. (6)

[16]

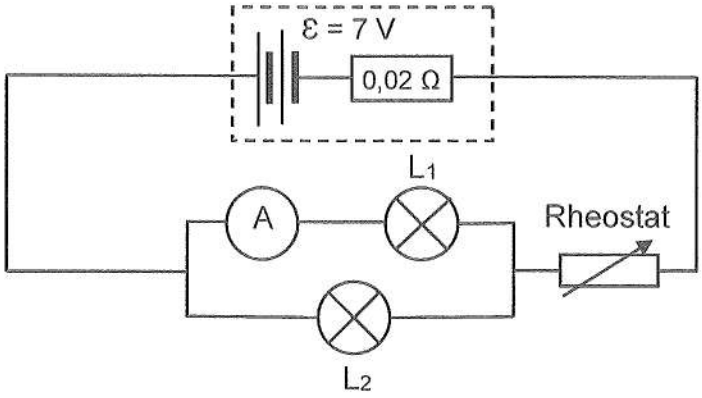
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QUESTION 8 (Start on a new page.)

8.1 Two identical light bulbs L_1 and L_2 are connected to a rheostat (variable resistor) and a battery, as shown in CIRCUIT 1 below. The battery has an emf of 7 V and an internal resistance of 0,02 Ω. The connecting wires and the ammeter have negligible resistance.

CIRCUIT 1



The equivalent resistance of the parallel combination is 0,72 Ω. The rheostat is set so that the power dissipated by each bulb is 25 W.

Calculate the:

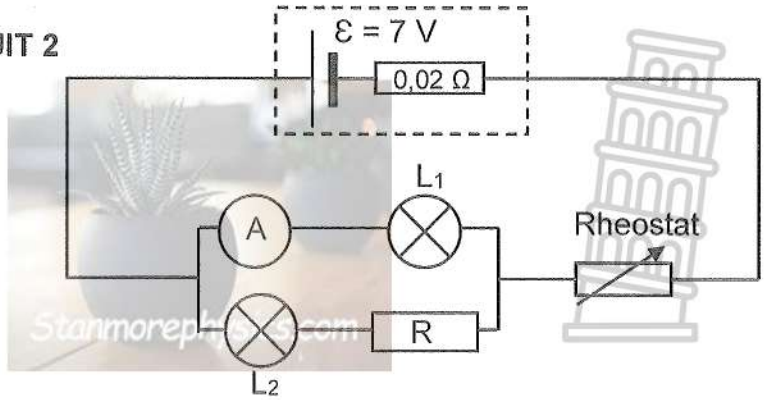
8.1.1 Resistance of L_1 (2)

8.1.2 Reading on the ammeter (3)

8.1.3 Resistance at which the rheostat is set (5)

A resistor, R, of unknown resistance is now connected in series to bulb L_2, as shown in CIRCUIT 2 below. The resistance of the rheostat remains unchanged. Both bulbs continue to glow.

CIRCUIT 2



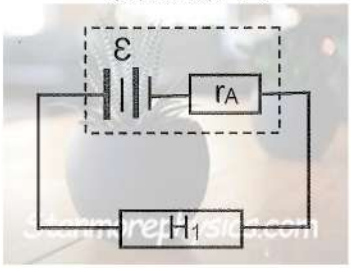
8.1.4 Will the ammeter reading in CIRCUIT 2 be GREATER THAN, LESS THAN or EQUAL TO the ammeter reading in CIRCUIT 1? Explain the answer. (6)

8.1.5 Will bulb L_1 in CIRCUIT 2 now glow BRIGHTER THAN, DIMMER THAN or THE SAME AS in CIRCUIT 1? (1)

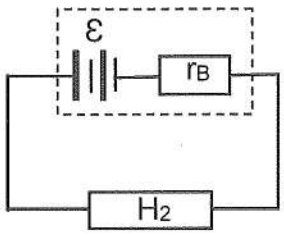
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8.2 Battery A and battery B, connected in circuits A and B respectively, have the same emf. The internal resistance of battery A (r_A) is greater than the internal resistance of battery B (r_B). Both batteries are connected to identical heaters H_1 and H_2.

CIRCUIT A



CIRCUIT B



The current is allowed to flow for a while. Assume that the resistance of each heater stays the same. How does the temperature of:

8.2.1 Battery A compare to that of battery B? (1)

8.2.2 Heater H_1 compare to that of heater H_2? Explain the answer WITHOUT A CALCULATION. (3)
[21]

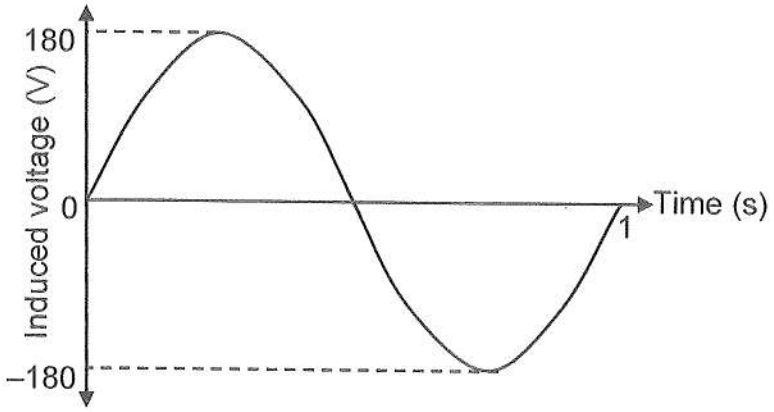
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QUESTION 9 (Start on a new page.)

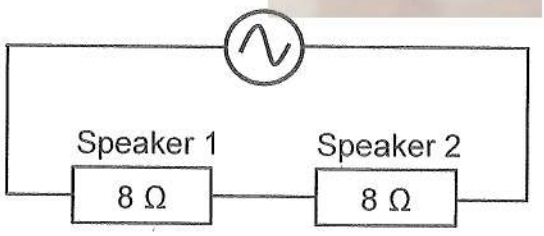
9.1 Name the principle on which a generator works. (1)

The induced voltage versus time graph for one cycle of a generator is shown below.



9.2 Calculate the rms voltage induced by this generator. (3)

The generator above is connected to two identical speakers, as shown in the circuit diagram below. Each speaker has a resistance of 8 Ω and provides a maximum sound output when a current of 11 A passes through it.



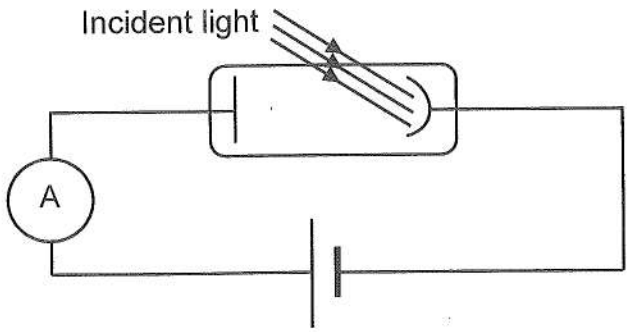
9.3 Will this generator be able to supply enough power to obtain a maximum sound output from each speaker? Choose from YES or NO. Explain the answer AND give a relevant calculation. (5)

9.4 Redraw the graph above in your ANSWER BOOK. The speed of the rotation of the coil is now doubled. On the same set of axes, draw the graph of induced voltage versus time that will now be obtained for 1 second. Indicate the value of the maximum induced voltage on your graph. (3)
[12]

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QUESTION 10 (Start on a new page.)

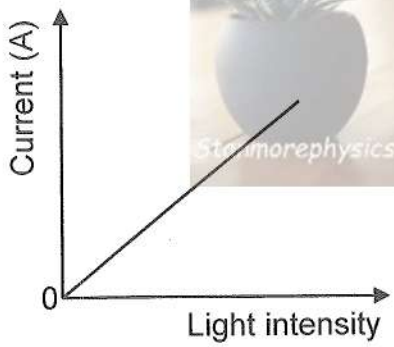
Light of a single wavelength of 390 nm is shone on the cathode of a photoelectric cell, as shown in the circuit diagram below. The ammeter registers a current.



10.1 Define the term *photoelectric effect*. (2)

10.2 What does the photoelectric effect conclude about the nature of light? (1)

An experiment is conducted to determine the relationship between the intensity of the incident light and the current in the circuit. The results obtained are shown in the graph below.



10.3 Write down an investigative question for this experiment. (2)

10.4 How would the gradient of the graph be affected if the:

10.4.1 Frequency of the incident light is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

10.4.2 Cathode was replaced by a metal that has a lower work function? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

The work function of the cathode is $3,78 \times 10^{-19}$ J.

10.5 Calculate the magnitude of the maximum speed of the photoelectrons. (5)
[13]

TOTAL: 150

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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	3,0 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	1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg

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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* $\Delta K = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ 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* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max)}$ or/*of* $E = W_0 + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

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