education

MPUMALANGA PROVINCE

REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2025

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MARKS: 150

TIME: 3 HOURS

This question paper consists of 20 pages including 3 data sheets

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INSTRUCTIONS AND INFORMATION

1. Write your name on the FOLIO PAPERS.
2. This question paper consists of ELEVEN questions. Answer ALL the questions on the FOLIO PAPERS.
3. Start EACH question on a NEW page on the FOLIO PAPERS.
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 may use appropriate mathematical instruments.
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. You are advised to use the attached DATA SHEETS.
12. 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 number (1.1 to 1.10) on the FOLIO PAPERS, e.g. 1.11 D.

1.1 Which ONE of the following forces always acts perpendicular to the surface on which a body is placed?

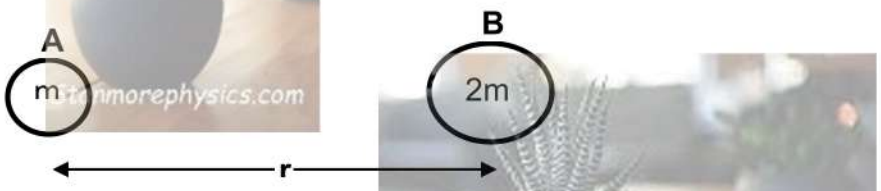
A Normal force

B Frictional force

C Gravitational force

D Tension force (2)

1.2 Two isolated bodies, **A** and **B**, having masses m and 2m respectively, are placed a distance r apart.



Consider the following statements regarding the gravitational force exerted by the bodies on each other.

i. The force exerted by **B** on body **A** is half that exerted by **A** on body **B**.

ii. The force exerted on the bodies is independant of the masses of the bodies.

iii. The force exerted on body **A** by **B** is equal but opposite to that exerted on body **B** by **A**.

iv. The forces will always be attractive.

Which of the statements above are TRUE?

A (i), (ii) and (iv) only

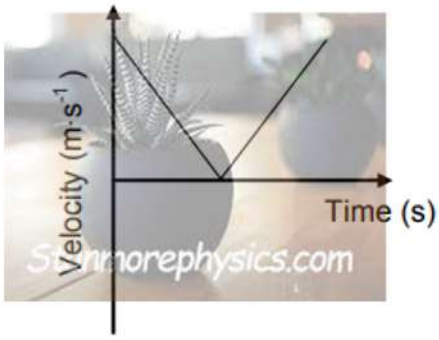
B (ii), (iii) and (iv) only

C (iii) and (iv) only

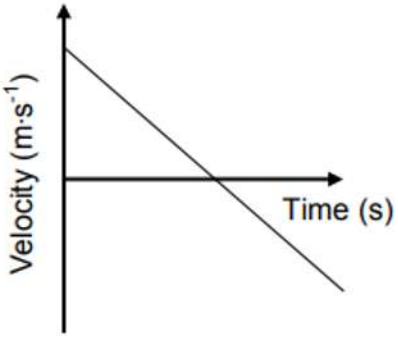
D (iv) only (2)

1.3 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following graphs best represent velocity-time graph of the stone?

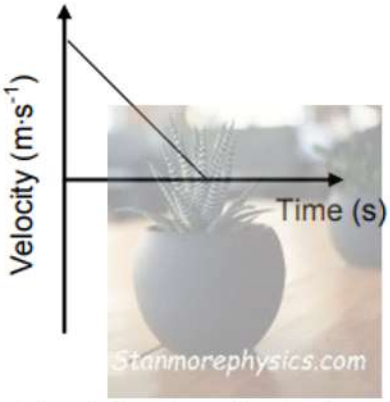
A



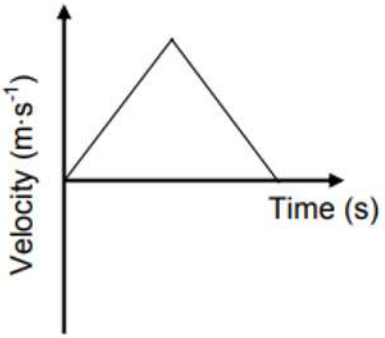
B



C



D



(2)

1.4 Which ONE of the following physical quantities represents THE RATE OF CHANGE OF MOMENTUM of an object?

A Net force

B Kinetic energy

C Impulse

D Acceleration (2)

1.5 The speed of a bicycle increases from 2 m·s^{-1} to 8 m·s^{-1}. Its kinetic energy increases by a factor of …

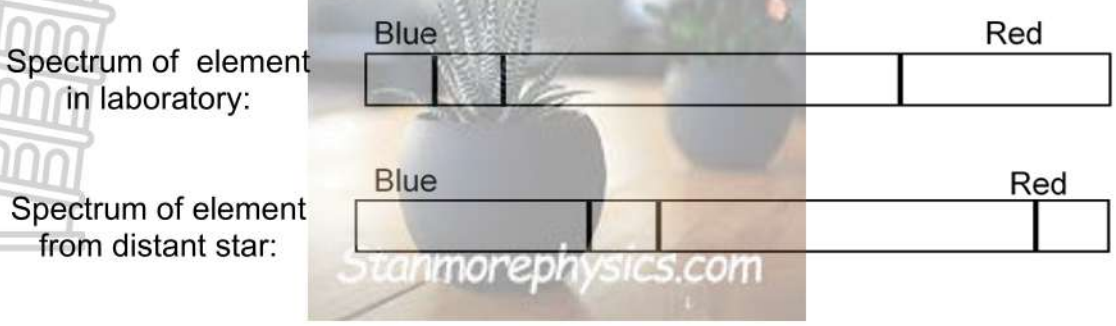
A 4

B 16

C 8

D 10 (2)

1.6 Astronomers obtained the following spectral lines of an element:



This observation confirms that the …

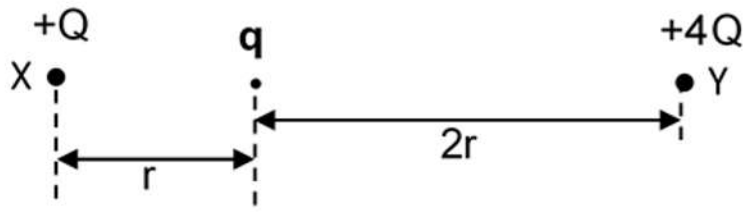
A star is moving towards the earth.

B star is moving away from the earth.

C universe is shrinking.

D star is undergoing no relative movement. (2)

1.7 Two positive charges, **+Q** and **+4Q**, are placed at point **X** and point **Y** respectively as shown in the diagram below. A POSITIVE small charge **q** is kept at rest between points **X** and **Y**.



When **q** is released, **q** will …

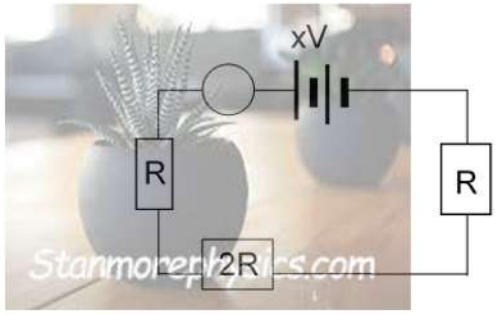
A move towards **X**.

B move towards **Y**.

C stay at rest.

D move vertically downwards. (2)

1.8 Consider the circuit diagram below with three resistors in series. The battery has an emf of **xV** with negligible internal resistance.



What is the voltmeter reading across the **2R** resistance?

A 2xV

B xV

C $\frac{x}{4}$V

D $\frac{x}{2}$V

(2)

1.9 A learner lists the following as factors that affect the magnitude of the current induced in an AC generator:

i. The strength of the magnetic field
ii. The speed of rotation of the coil
iii. The number of turns of the coil

Which ONE of the combinations below is CORRECT?

A (i) and (ii) only

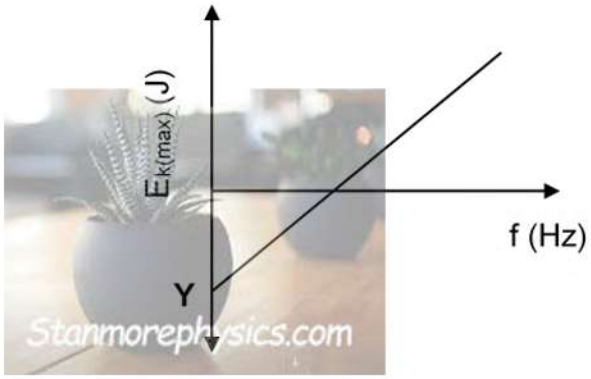
B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii)

(2)

1.10 In an investigation on the photo-electric effect the graph of maximum kinetic energy ($E_{k(max)}$) versus frequency (f) of incident light on a certain metal is obtained, as shown below.



The intercept (**Y**) and the gradient represent respectively the ...

A work function and threshold frequency.

B work function and Planck's constant.

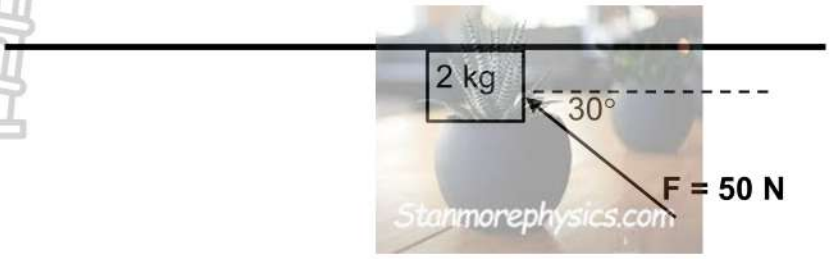
C threshold frequency and work function.

D threshold frequency and Planck's constant. (2)

[20]

QUESTION 2 (Start on a new page.)

A force of magnitude 50 N is acting at an angle of 30° on a 2 kg object to push the object against a rough horizontal ceiling as shown in the diagram below. The object accelerates to the LEFT at 20 $m \cdot s^{-2}$. Ignore air resistance.



The coefficient of kinetic friction between the object and the surface of the ceiling is UNKNOWN.

2.1 State Newton's second law of motion in words. (2)

2.2 Draw a labelled free-body diagram indicating all the forces acting on the object while in motion. (4)

2.3 Calculate the:

2.3.1 Magnitude of the normal force acting on the object (3)

2.3.2 Magnitude of the coefficient of kinetic friction (4)

2.4 The force is now acting at a smaller angle. What effect will this have on the following? Choose from INCREASES, DECREASES or REMAINS THE SAME.

2.4.1 Value calculated in QUESTION 2.3.2 (1)

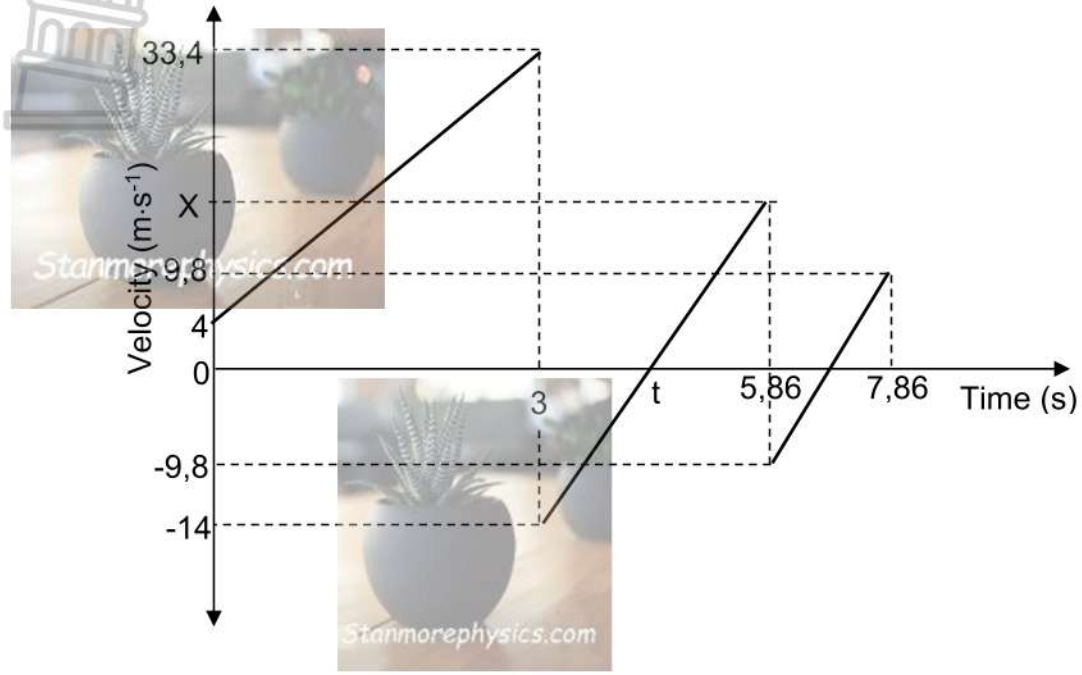
2.4.2 Kinetic frictional force acting on the object. Give a reason for the answer (2)

[16]

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QUESTION 3 (Start on a new page.)

The graph below represents the motion of a 500 g ball thrown vertically downwards from a certain height above the ground and bounces on the ground a number of times. Ignore the effects of friction.



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

Use the graph to answer the questions that follow.

3.2 Write down the:

3.2.1 Name of the physical quantity represented by the gradient of this graph (1)

3.2.2 Number of times the object reached the maximum height (1)

3.2.3 Magnitude of the velocity at which the object reaches the ground during the second bounce (1)

3.3 Calculate the height above the ground from where the object was thrown. (3)

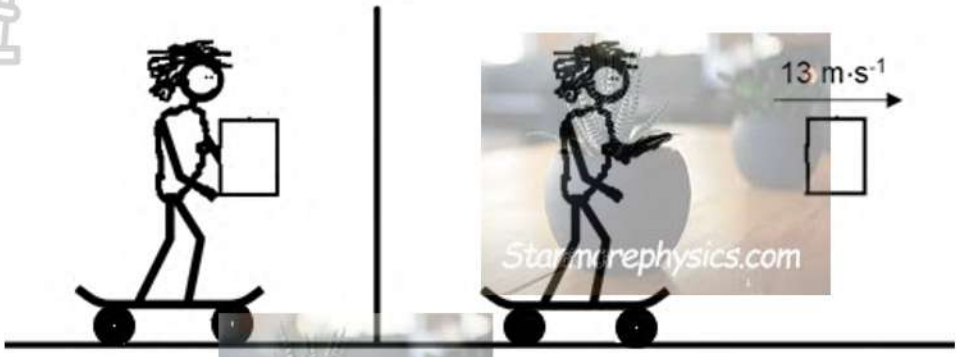
3.4 WITHOUT USING THE EQUATIONS OF MOTION, Calculate the:

3.4.1 Numerical value of time **t** on the graph. (3)

3.4.2 Maximum height reached by the ball after the first bounce (3)
[14]

QUESTION 4 (Start on a new page.)

A learner of mass 60 kg is standing on a stationary skateboard of mass 5 kg while holding a school bag of mass, **m**. After some time, the learner throws the school bag horizontally at a constant velocity of 13 m·s^{-1} to the right as shown in the diagram below.
Ignore the effect of wheel rotation.



Immediately after throwing the school bag, the combined learner-skateboard system has a CHANGE IN MOMENTUM of 6,5 kg·m·s^{-1} to the LEFT. Assume that the system is isolated.

4.1 Explain what is meant by the term *isolated system*. (1)

4.2 Calculate the:

4.2.1 Velocity of the learner-skateboard system immediately after throwing the school bag (3)

4.2.2 Mass **m** of the school bag (4)

Modern cars are equipped with safety features, which play an important role in saving the lives of passengers.

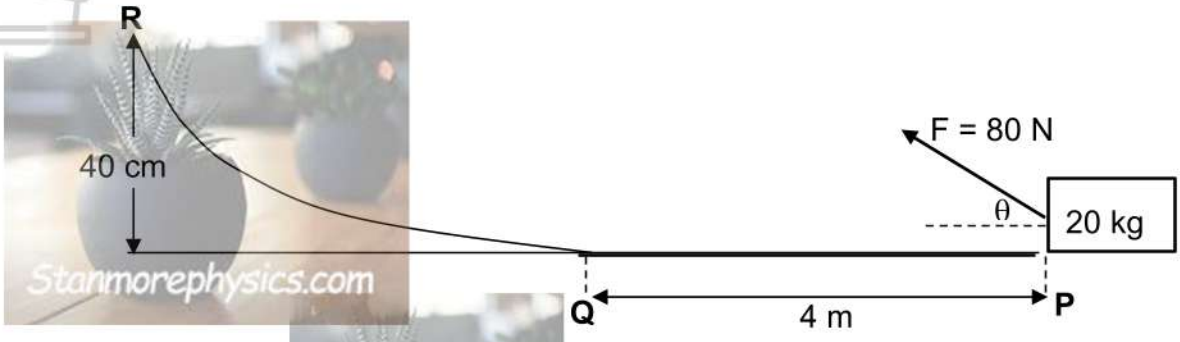
4.3 Name any ONE of the safety features modern cars are equipped with. (1)

4.4 Explain using a relevant physics principle, how the safety features help in reducing the number of fatalities during accidents. (2)

[11]

QUESTION 5 (Start on a new page.)

A force of 80 N pulls a 20 kg object at an unknown angle θ along the 4 m horizontal rough surface from rest at point **P** to point **Q** while experiencing a constant frictional force of 45 N. When the object reaches point **Q**, the force is removed and the object continues to move up a curved frictionless surface to a stop at point **R** at the height of 40 cm above the horizontal surface as shown in the diagram below. Ignore the effect of air resistance.



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

5.2 Is the mechanical energy of the object CONSERVED or NOT CONSERVED while the object is moving from point **P** to point **Q** along the horizontal surface?
Give a reason for the answer. (2)

5.3 Calculate the:

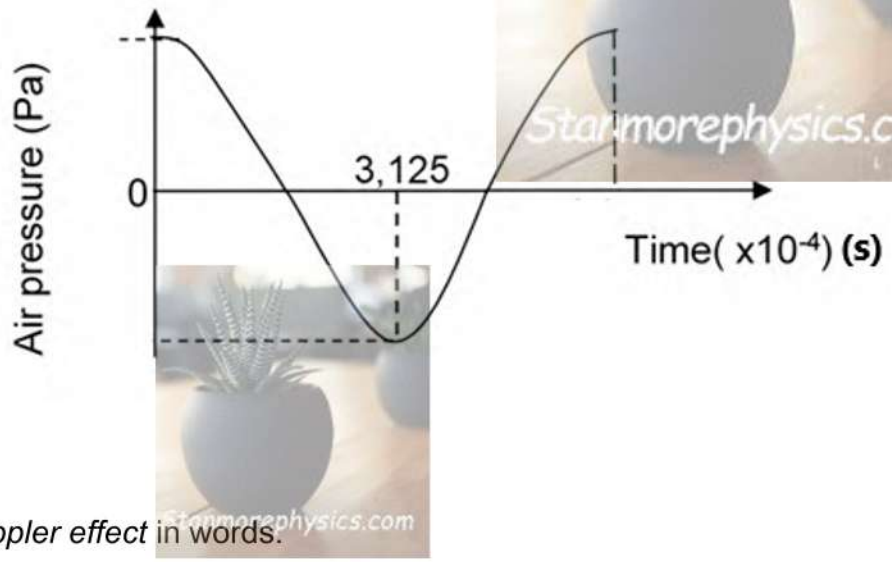
5.3.1 Magnitude of the angle θ, shown in the diagram above, using energy principles ONLY (5)

5.3.2 Power delivered by force **F** if the time taken for the object to move from point **P** to point **Q** is 2,86 seconds (3)

[12]

QUESTION 6 (Start on a new page.)

The siren of an ambulance emits sound waves of frequency 1 836 Hz while the ambulance is moving at a constant speed on a straight road. A learner standing next to the road with a detector observes the change in pitch of the sound waves.
The graph of air pressure versus time below was obtained from the detected sound waves by the detector. Take the speed of sound in air as 340 $m \cdot s^{-1}$.



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

6.2 Calculate the:

6.2.1 Frequency of the sound waves detected by the detector (2)

6.2.2 Wavelength of the sound waves emitted by the siren (3)

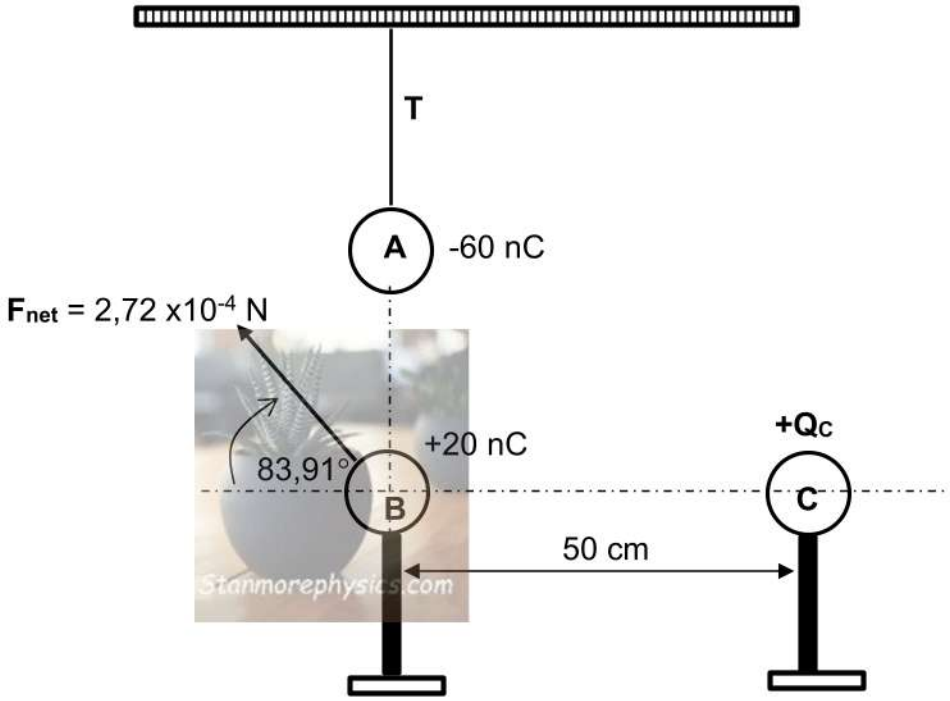
6.2.3 Speed at which the ambulance is moving (5)

6.3 What is the frequency of the sound waves detected by the driver of the ambulance? Choose from GREATER THAN, EQUAL TO or LESS THAN 1 836 Hz?
Give a reason for the answer. (2)

6.4 State ONE application of Doppler effect in medical industry. (1)
[15]

QUESTION 7 (Start on a new page.)

A small metal sphere, **A**, with charge, -60 nC and a mass of 0,02 kg, is suspended by an inextensible light string with negligible mass. Another TWO small positively charged spheres **B** and **C**, each on an insulated stand, with charges +20 nC and **+Q_C** are brought closer to sphere **A** as shown in the diagram below. Ignore air resistance.



The NET ELECTROSTATIC FORCE acting on sphere **B** due to the presence of sphere **A** and **C** is 2,72 x10^{-4} N; 83,91° above the negative x-axis as shown in the diagram above.

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

7.2 Draw the free body diagram indicating all the forces acting on sphere **A**. (3)

7.3 Calculate the:

7.3.1 Magnitude of the tension **T** in the string (3)

7.3.2 Magnitude of the charge on sphere **C** (3)

7.4 In which direction will the NET ELECTROSTATIC FORCE on sphere **B** be experienced, if sphere **C** is removed?
Choose from TO THE RIGHT, UPWARDS or DOWNWARDS. (1)

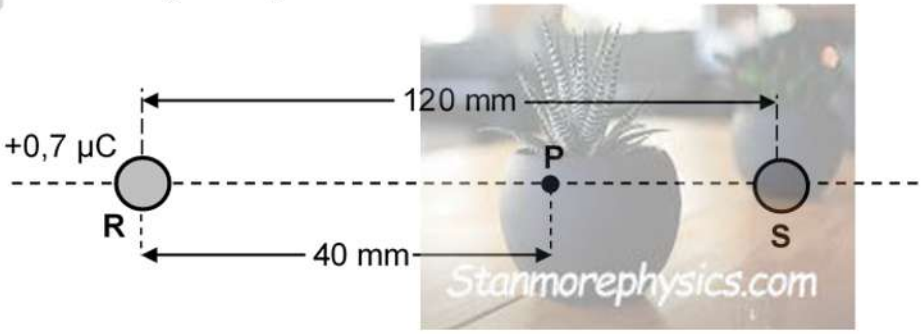
[12]

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QUESTION 8 (Start on a new page.)

Two small charged spheres **R** and **S** are placed 120 mm apart in a vacuum as shown in the diagram below. Sphere **S** has 7,5 x10^{12} electrons in excess and sphere **R** has a charge of +0,7 µC.

Point **P** is 40 mm to the right of sphere **R**.



8.1 Define the term *electric field at a point.* (2)

8.2 Draw a diagram that shows the net electric field pattern around the two spheres. (3)

8.3 Calculate the:

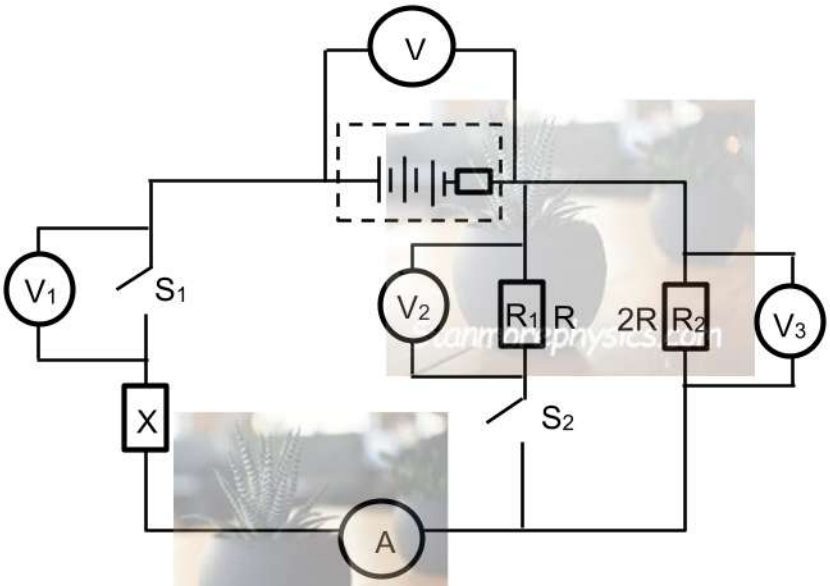
8.3.1 Charge on sphere **S** (3)

8.3.2 Net electric field at point **P** (5)

[13]

QUESTION 9 (Start on a new page.)

In the circuit diagram below the battery has an internal resistance of 0,5 Ω and the EMF OF EACH CELL is 1,5 V. Both switches S_1 and S_2 are open.



9.1 State Ohm's law in words (2)

9.2 With both switches S_1 and S_2 open, what is the reading on:

9.2.1 V (1)

9.2.2 V_1 (1)

9.2.3 V_3 (1)

Both switches S_1 and S_2 are now closed and the equivalent resistance of the resistors connected in parallel is equal to 1 Ω and the reading on A is 1,8 A.

9.3 Calculate the:

9.3.1 Reading on V_2 (3)

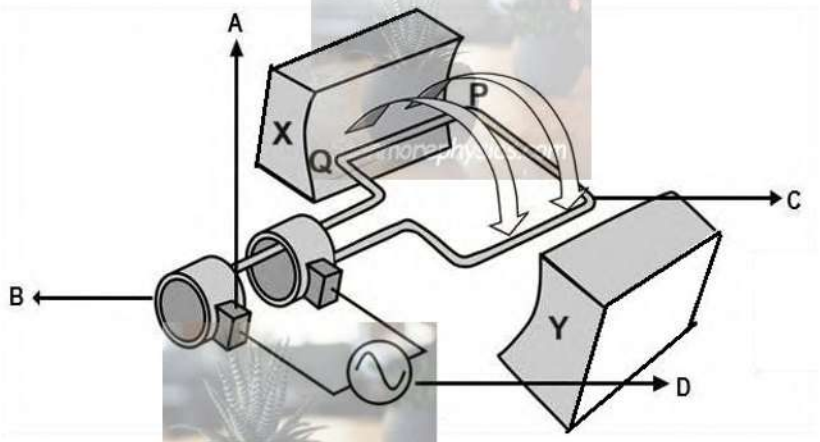
9.3.2 Resistance of resistor R_2 (3)

9.4 Switch S_2 is now open while switch S_1 is closed. What effect will this change have on the power dissipated through resistor **X**? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

[14]

QUESTION 10 (Start on a new page.)

The diagram below shows a simplified diagram of an electric machine. Study the diagram below and answer the questions that follow. When the coil is in the indicated position, the current inside the coil flows from **P** to **Q**.



10.1 What type of electric machine, (MOTOR or GENERATOR), is represented by the diagram above? Give a reason for the answer. (2)

10.2 Write down the:

10.2.1 NAME of the principle under which this machine operates (1)

10.2.2 NAME and FUNCTION of component labelled **D** (2)

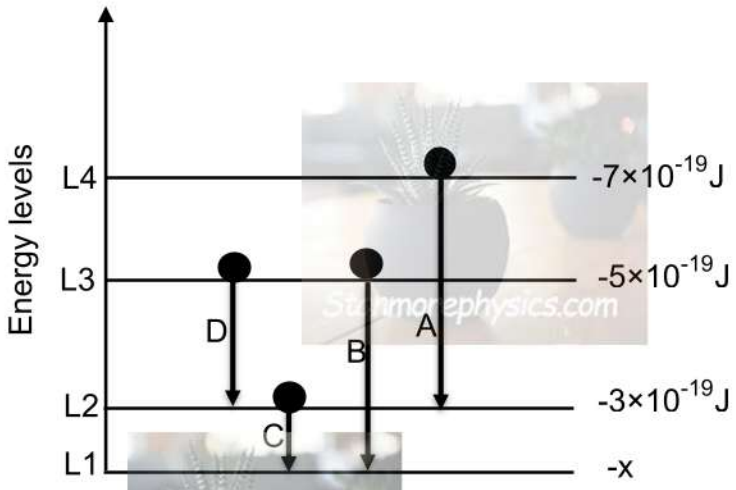
10.2.3 Polarity of the magnets labelled **X** and **Y** (1)

10.3 A maximum voltage of 311 V is used to dissipate an electrical energy of 9 672,1 J through a 50 Ω resistor appliance connected to an AC generator. Calculate the time taken to produce the 9 672,1 J of electrical energy. (4)

[10]

QUESTION 11 (Start on a new page.)

The diagram below represents electron transitions (**A** – **D**) within energy levels. The light produced during each transition is incident on metal **Q** with a work function of 1 x10^{-19} J.



Transition **C** produces light with a frequency of 3, 0166 x 10^{14} Hz.

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

11.2 What type of spectrum will be observed when electrons make such transitions? (1)

11.3 Calculate the:

11.3.1 Speed of the photoelectrons when the light from transition **A** is incident of the surface of metal **Q** (4)

11.3.2 Value of **x** on the diagram. (3)

11.4 How does EACH of the following affect the maximum kinetic energy of the photoelectrons? Choose from INCREASES, DECREASES or REMAINS THE SAME.

11.4.1 Intensity of the light decreases (1)

11.4.2 Wavelength of the incident light decreases. Give a reason for the answer (2)

[13]

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 gravitasiekonstant*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
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*	en	1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of the Earth *Massa van die Aarde*	M	5,98 x 10^{24} kg
Radius of the Earth *Radius van die Aarde*	R_E	6,38 x 10^6 m

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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* $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ 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*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/of $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ 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)
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

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ALTERNATING CURRENT/*WISSELSTROOM*

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

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NATIONAL SENIOR CERTIFICATE
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