basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of 11 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 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.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. 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 Inertia is the tendency of an object to …

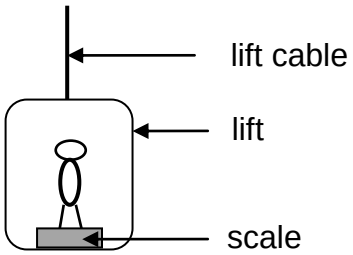
A maintain its mass.

B continue in a state of non-uniform motion.

C remain at rest or in the state of uniform motion.

D maintain its velocity when a non-zero net force is acting on it. (2)

1.2 A person stands on a bathroom scale that is fixed to the floor of a lift, as shown in the diagram below.



The reading on the scale is largest when the lift moves …

A upwards at a constant speed.

B downwards at a constant speed.

C upwards at a increasing speed.

D downwards at a increasing speed. (2)

1.3 An object is projected vertically upwards. Ignore air resistance.

As the object rises, its velocity …

A and acceleration are both directed upwards.

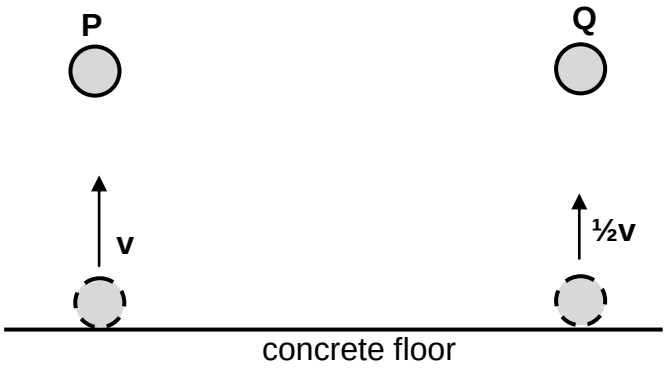
B and acceleration are both directed downwards.

C is directed upwards, but its acceleration is directed downwards.

D is directed downwards, but its acceleration is directed upwards. (2)

1.4 Ball **P** and ball **Q**, of the same mass, are dropped onto a concrete floor. Both balls hit the concrete floor at the same speed, **v**. Ball **P** rebounds with the same vertical speed, **v**, *but ball **Q** rebounds with speed* **½v**.

Refer to the diagram below. Ignore air resistance.



Which ONE of the following statements regarding the collision of EACH ball with the concrete floor is CORRECT?

A Kinetic energy is conserved for both balls **P** and **Q**.

B The change in momentum of ball **P** is greater than that of ball **Q**.

C The contact time with the floor is the same for both balls **P** and **Q**.

D Momentum is conserved for the collision of ball **P**, but not for that of ball **Q**. (2)

1.5 If the net work done on a moving object is POSITIVE, then we can conclude that the kinetic energy of the object …

A is zero.

B has increased.

C has decreased.

D has not changed. (2)

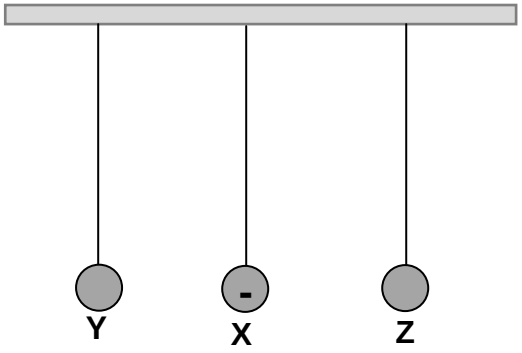
1.6 The spectrum produced by a moving asteroid, as observed from Earth, indicates that the light has shifted towards the blue end of the spectrum.

Which ONE of the following frequency combinations of the observed light and the distance between the asteroid and Earth is CORRECT?

	FREQUENCY OF OBSERVED LIGHT	**DISTANCE BETWEEN ASTEROID AND EARTH**
A	Increased	Decreases
B	Increased	Increases
C	Decreased	Decreases
D	Decreased	Increases

(2)

1.7 Three charged spheres **X**, **Y** and **Z**, supported by insulating threads of equal length, hang from a beam, as shown in the diagram below.
Sphere **X** is negatively charged.
Sphere **X** attracts sphere **Y**, but repels sphere **Z**.



Which ONE of the following conclusions is CORRECT?

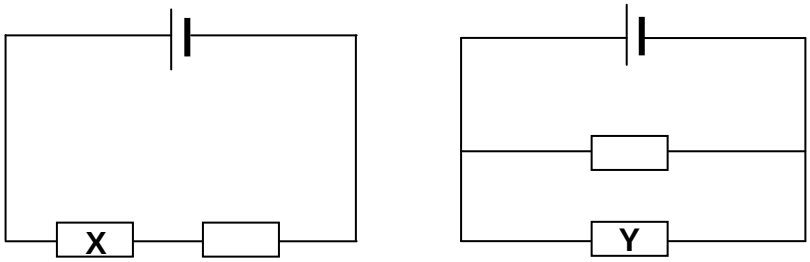
A Sphere **Y** is positively charged and sphere **Z** is negatively charged.

B Sphere **Y** is positively charged and sphere **Z** is positively charged.

C Sphere **Y** is negatively charged and sphere **Z** is negatively charged.

D Sphere **Y** is negatively charged and sphere **Z** is positively charged. (2)

1.8 In the circuit diagrams below, the cells and resistors are identical. The cells have negligible internal resistances.



The power dissipated in resistor **X** is **P**. The power dissipated in resistor **Y** is …

A ¼**P**.

B ½**P**.

C 2**P**.

D 4**P**. (2)

1.9 Which ONE of the following actions will NOT cause an **increase** in the induced emf in a coil if the coil is rotated in a uniform magnetic field?

A Rotating the coil faster

B Increasing the strength of the magnetic field

C Increasing the number of turns of the coil

D Replacing the coil with a coil of lower resistance (2)

1.10 A learner writes the following statements about the emission spectrum of light in a notebook:

(i) An emission spectrum is formed when certain frequencies of electromagnetic radiation pass through a cold gas.

(ii) The lines in the emission spectrum of an atom have the same frequency as the corresponding lines in the atom's absorption spectrum.

(iii) An emission spectrum is formed when the atom makes transitions from a high-energy state to a lower energy state.

Which ONE of the following combinations of the statements above is CORRECT?

A (i) only

B (ii) only

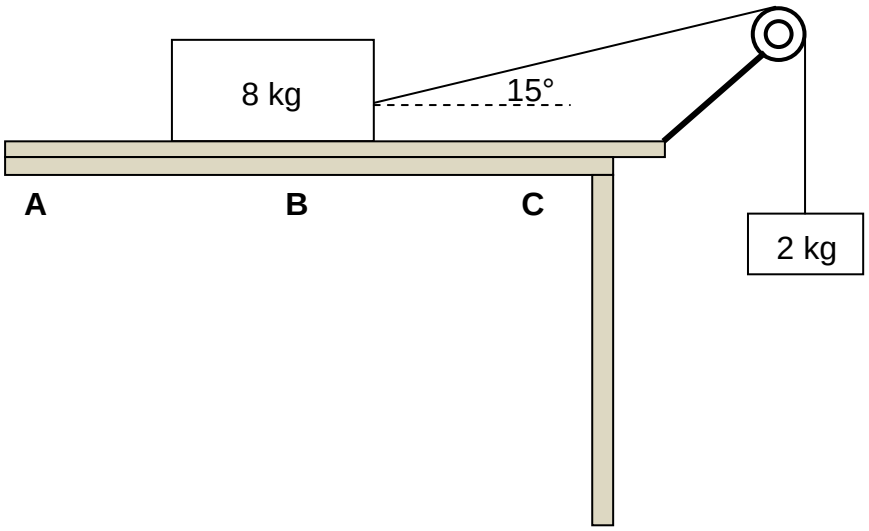
C (ii) and (iii) only

D (i) and (iii) only (2)

[20]

QUESTION 2 (Start on a new page.)

A block, of mass 8 kg, is placed on a rough horizontal surface. The 8 kg block, which is connected to a 2 kg block by means of a light inextensible string passing over a light frictionless pulley, starts sliding from point **A**, as shown below.



2.1 State Newton's Second Law in words. (2)

2.2 Draw a labelled free-body diagram for the 8 kg block. (4)

2.3 When the 8 kg block reaches point **B**, the angle between the string and the horizontal is 15° and the acceleration of the system is 1,32 $m \cdot s^{-2}$.

2.3.1 Give a reason why the system is NOT in equilibrium. (1)

2.3.2 Use the 2 kg mass to calculate the tension in the string. (3)

2.3.3 Calculate the kinetic frictional force between the 8 kg block and the horizontal surface. (4)

2.4 As the 8 kg block moves from **B** to **C**, the kinetic frictional force between the 8 kg block and the horizontal surface is not constant.

Give a reason for this statement. (1)

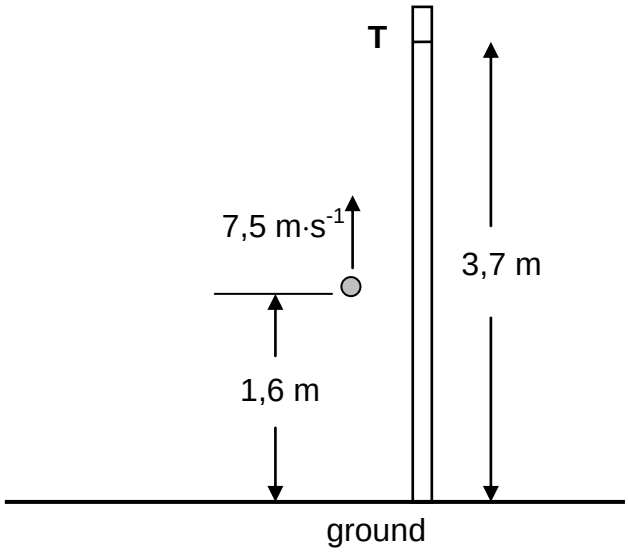
The horizontal surface on which the 8 kg block is moving, is replaced by another horizontal surface made from a different material.

2.5 Will the kinetic frictional force, calculated in QUESTION 2.3.3 above, change? Choose from: YES or NO. Give a reason for the answer. (2)
[17]

QUESTION 3 (Start on a new page.)

In a competition, participants must attempt to throw a ball vertically upwards past point **T**, marked on a tall vertical pole. Point **T** is 3,7 m above the ground. Point **T** may, or may not, be the highest point during the motion of the ball.

One participant throws the ball vertically upwards at a velocity of 7,5 $m \cdot s^{-1}$ from a point that is 1,6 m above the ground, as shown in the diagram below. Ignore the effects of air resistance.



3.1 In which direction is the net force acting on the ball while it moves towards point **T**?
Choose from: UPWARDS or DOWNWARDS. Give a reason for the answer. (2)

3.2 Calculate the time taken by the ball to reach its highest point. (3)

3.3 Determine, by means of a calculation, whether the ball will pass point **T** or not. (6)

3.4 Draw a velocity-time graph for the motion of the ball from the instant it is thrown upwards until it reaches its highest point.

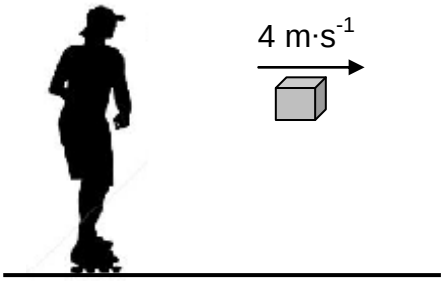
Indicate the following on the graph:

- The initial velocity and final velocity
- Time taken to reach the highest point (2)

[13]

QUESTION 4 (Start on a new page.)

Initially a girl on roller skates is at rest on a smooth horizontal pavement. The girl throws a parcel, of mass 8 kg, horizontally to the right at a speed of 4 $m \cdot s^{-1}$. Immediately after the parcel has been thrown, the girl-roller-skate combination moves at a speed of 0,6 $m \cdot s^{-1}$. Ignore the effects of friction and rotation.



4.1 Define the term *momentum* in words. (2)

4.2 Will the girl-roller-skate combination move TO THE RIGHT or TO THE LEFT after the parcel is thrown?
NAME the law in physics that can be used to explain your choice of direction. (2)

The total mass of the roller skates is 2 kg.

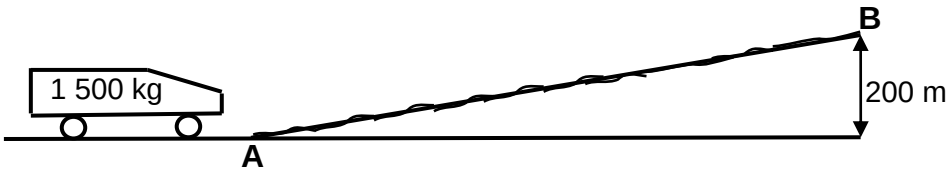
4.3 Calculate the mass of the girl. (5)

4.4 Calculate the magnitude of the impulse that the girl-roller-skate combination is experiencing while the parcel is being thrown. (3)

4.5 Without any further calculation, write down the change in momentum experienced by the parcel while it is being thrown. (2)
[14]

QUESTION 5 (Start on a new page.)

The diagram below, not drawn to scale, shows a vehicle with a mass of 1 500 kg starting from rest at point **A** at the bottom of a rough incline. Point **B** is 200 m vertically above the horizontal.



The total work done by force **F** that moves the vehicle from point **A** to point **B** in 90 s is $4{,}80 \times 10^6$ J.

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

5.2 Is force **F** a conservative force? Choose from: YES or NO. (1)

5.3 Calculate the average power generated by force **F**. (3)

The speed of the vehicle when it reaches point **B** is 25 $m \cdot s^{-1}$.

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

5.5 Use **energy principles** to calculate the total work done on the vehicle by the frictional forces. (5)
[13]

QUESTION 6 (Start on a new page.)

The alarm of a vehicle parked next to a straight horizontal road goes off, emitting sound with a wavelength of 0,34 m. A patrol car is moving at a constant speed on the same road. The driver of the patrol car hears a sound with a frequency of 50 Hz **lower than** the sound emitted by the alarm. Take the speed of sound in air as 340 $m \cdot s^{-1}$.

6.1 State the Doppler effect in words. (2)

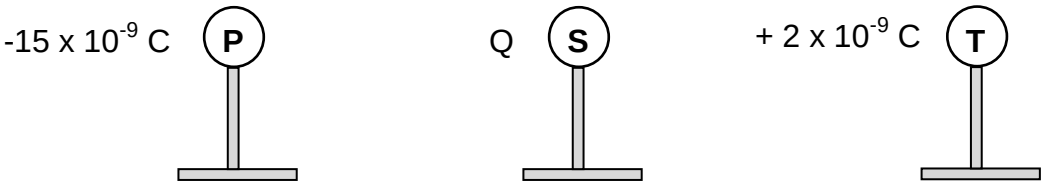
6.2 Is the patrol car driving TOWARDS or AWAY FROM the parked vehicle? Give a reason for the answer. (2)

6.3 Calculate the frequency of the sound emitted by the alarm. (3)

6.4 The patrol car moves a distance of *x* metres in 10 seconds. Calculate the distance *x*. (6)
[13]

QUESTION 7 (Start on a new page.)

Three small identical metal spheres, **P**, **S** and **T**, on insulated stands, are **initially neutral**. They are then charged to carry charges of -15 x 10^{-9} C, Q and +2 x 10^{-9} C respectively, as shown below.

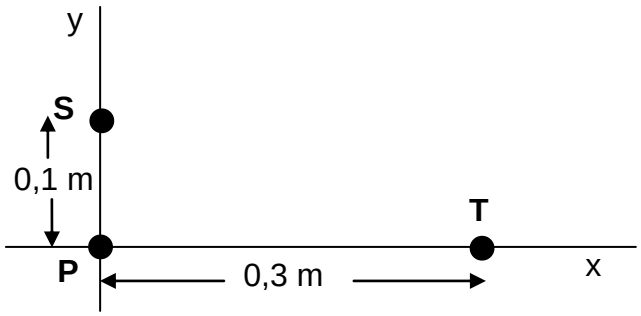


The charged spheres are brought together so that all three spheres touch each other at the same time, and are then separated. The charge on each sphere, after separation, is -3 x 10^{-9} C.

7.1 Determine the value of charge Q. (2)

7.2 Draw the electric field pattern associated with the charged spheres, **S** and **T**, **after they are separated** and returned to their original positions. (3)

The spheres, each with the **new charge** of -3 x 10^{-9} C, are now placed at points on the *x*-axis and the *y*-axis, as shown in the diagram below, with sphere **P** at the origin.



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

Calculate the magnitude of the:

7.4 Net electrostatic force acting on sphere **P** (5)

7.5 Net electric field at the origin due to charges **S** and **T** (3)

7.6 ONE of the charged spheres, **P** and **T**, experienced a very small increase in mass **after it was charged initially**.

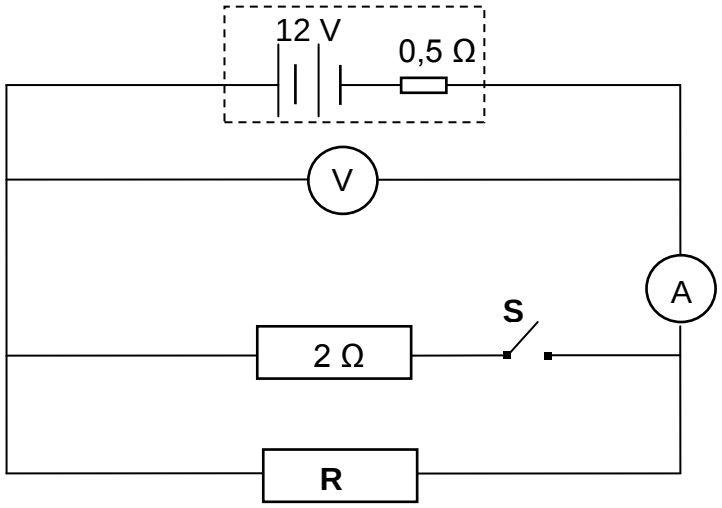
7.6.1 Which sphere, **P** or **T**, experienced this very small increase in mass? (1)

7.6.2 Calculate the increase in mass by the sphere in QUESTION 7.6.1. (3)

[19]

QUESTION 8 (Start on a new page.)

The battery in the circuit diagram below has an emf of 12 V and an internal resistance of 0,5 Ω. Resistor **R** has an unknown resistance.



8.1 What is the meaning of the following statement?

The emf of the battery is 12 V. (2)

The reading on the ammeter is 2 A when switch **S** is OPEN.

8.2 Calculate the:

8.2.1 Reading on the voltmeter (3)

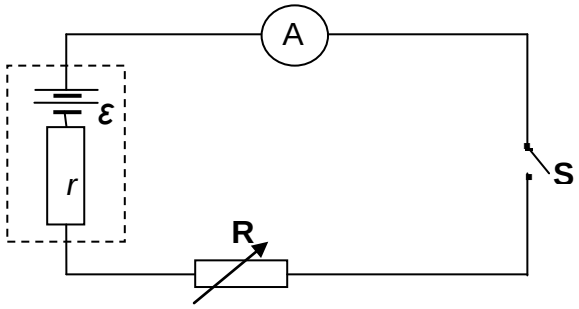
8.2.2 Resistance of resistor **R** (2)

Switch **S** is now CLOSED.

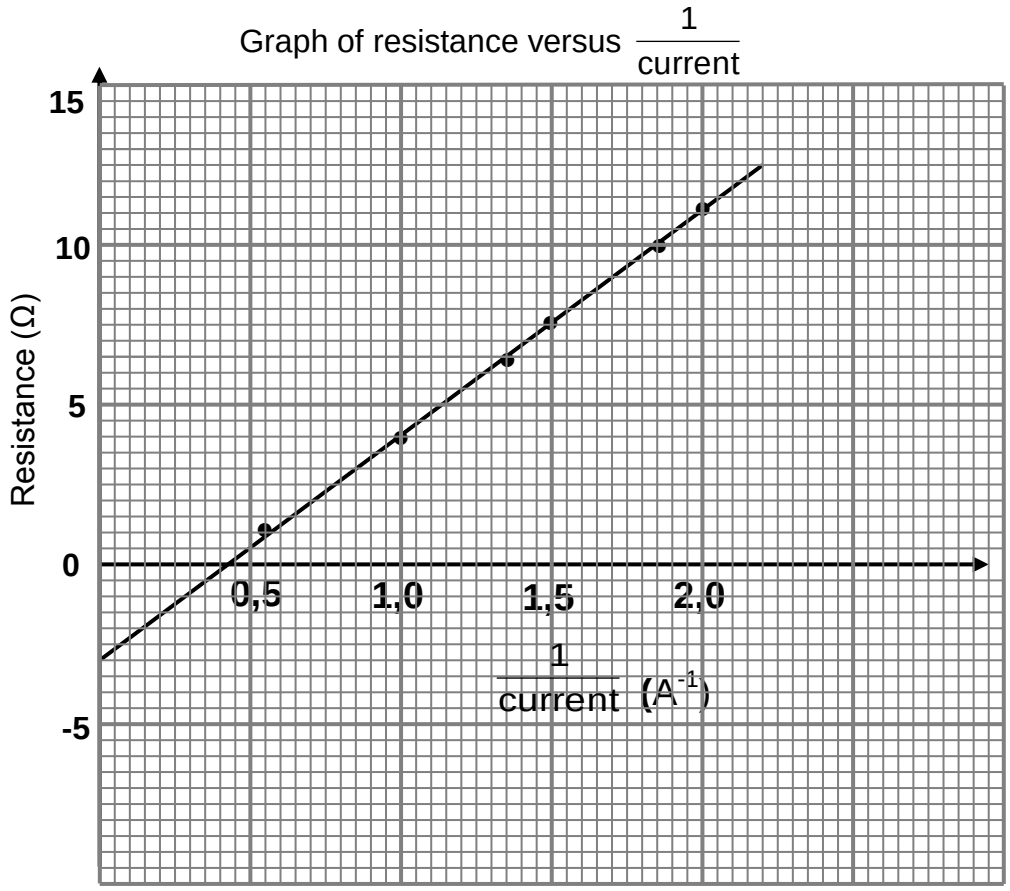
8.3 How does this change affect the reading on the voltmeter? Choose from: INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (4)
[11]

QUESTION 9 (Start on a new page.)

Learners perform an experiment to determine the emf (ε) and the internal resistance (*r)* of a battery using the circuit below.



The learners use their recorded readings of current and resistance, together with the equation $R = \frac{\varepsilon}{I} - r$, to obtain the graph below.



9.1 Which variable has to be kept constant in the experiment? (1)

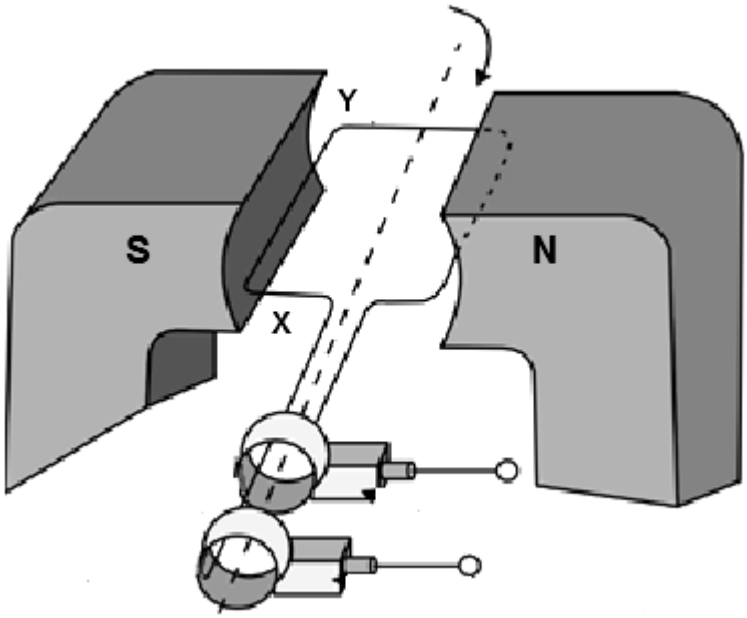
9.2 Refer to the **graph**.

9.2.1 Write down the value of the internal resistance of the cell. (2)

9.2.2 Calculate the emf of the battery. (3)
[6]

QUESTION 10 (Start on a new page.)

10.1 In the simplified AC generator below, the coil is rotated clockwise.



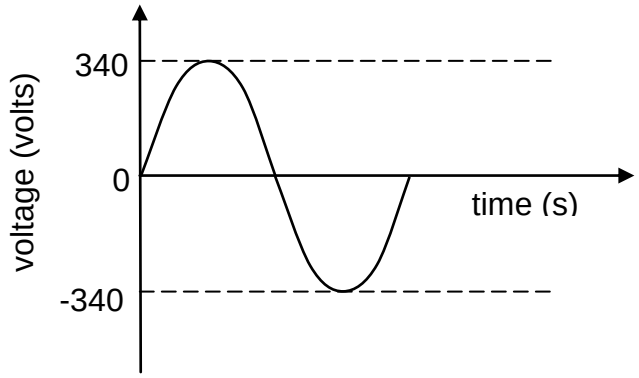
10.1.1 In which direction does the induced current flow in the coil?

Choose from: **X to Y** or **Y to X**. (1)

10.1.2 On which principle or law is the working of the generator based? (1)

10.1.3 State the energy conversion that takes place while the generator is in operation. (2)

10.2 The voltage output for an AC generator is shown below.



10.2.1 Write down the maximum (peak) output voltage of the generator. (1)

A stove is connected to the generator above, and delivers an average power of 1 600 W.

10.2.2 Calculate the rms voltage delivered to the stove. (3)

10.2.3 Calculate the resistance of the stove. (3)
[11]

QUESTION 11 (Start on a new page.)

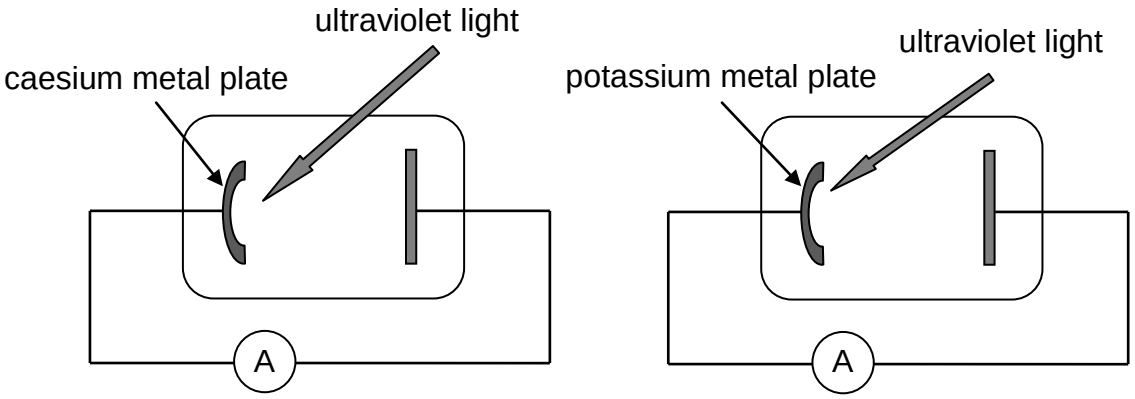
The threshold frequencies of caesium and potassium metals are given in the table below.

METAL	THRESHOLD FREQUENCY
Caesium	$5,07 \times 10^{14}$ Hz
Potassium	$5,55 \times 10^{14}$ Hz

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

11.2 Which ONE of the two metals in the table has the higher work function? Give a reason for the answer by referring to the information in the table. (2)

The simplified diagrams below show two circuits, **A** and **B**, containing photocells. The photocell in circuit **A** contains a caesium metal plate, while the photocell in circuit **B** contains a potassium metal plate.



Ultraviolet light with the same intensity and wavelength of $5,5 \times 10^{-7}$ m is incident on the metal plate in EACH of the photocells and the ammeter in circuit **A** registers a current.

11.3 By means of a calculation, determine whether the ammeter in circuit **B** will also register a current. (3)

11.4 Calculate the maximum kinetic energy of an ejected electron in circuit **A**. (5)

11.5 How will the maximum kinetic energy of the ejected electron, calculated in QUESTION 11.4, change when the intensity of the incident light increases?

Choose from: INCREASES, DECREASES or REMAINS THE SAME. (1)

[13]

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	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of 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	$6,63 \times 10^{-34}\ J{\cdot}s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2}$
Charge on electron *Lading op elektron*	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*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = \frac{hc}{\lambda}$
$E = W_0 + E_{k(max/maks)}$ or/*of* $E = W_0 + K_{max/maks}$ 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) = $I(R + r)$
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

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NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/*PUNTE*: 150

These marking guidelines consist of 29 pages.
Hierdie nasien riglyne bestaan uit 29 bladsye.

QUESTION 1/*VRAAG 1*

1.1 C /D (2)

1.2 C (2)

1.3 C (2)

1.4 B (2)

1.5 B (2)

1.6 A (2)

1.7 A (2)

1.8 D (2)

1.9 D (2)

1.10 C (2)

[20]

QUESTION 2/*VRAAG 2*

2.1

When a (non-zero) resultant/net force acts on an object, the object will accelerate in the direction of the force with an acceleration that is directly proportional to the force and inversely proportional to the mass of the object. (2 or 0)
Wanneer 'n (nie-nul) resultante/netto krag op 'n voorwerp inwerk, sal die voorwerp in die rigting van die krag versnel teen 'n versnelling wat direk eweredig is aan die (netto) krag en omgekeerd eweredig aan die massa van die voorwerp.

OR/*OF*
The (non-zero) resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force. (2 or 0)
Die (nie-nul) netto krag wat op 'n voorwerp inwerk is gelyk aan die tempo van verandering van momentum.

ACCEPT/*AANVAAR*
Acceleration is directly proportional to the net force and inversely proportional to the mass of the object.
Versnelling direk eweredig is aan die netto krag en omgekeerd eweredig aan die massa van die voorwerp.

NOTE/*LET WEL*
If any of the underlined key words in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte sleutel woorde in die **korrekte konte**ks uitgelaat is, trek 1 punt af.*

(2)

2.2

Notes/*Aantekeninge*
- Mark is awarded for label and arrow
  Punt word toegeken vir byskrif en pyltjie
- Do not penalise for length of arrows
  Moenie vir die lengte van die pyltjies penaliseer nie.
- If T is not shown but $T_{\parallel}$ and $T\perp$ are shown, give 1 mark for both
  Indien T nie aangetoon is nie maat $T_{\parallel}$ en $T\perp$ is getoon. Ken 1 punt toe vir beide.
- If force(s) do not make contact with body/*Indien krag(te) nie met die voorwerp kontak maak nie:* Max/*Maks:* $\frac{3}{4}$
- Deduct 1 mark for any additional force /*Trek 1 punt af vir enige addisionele krag*

(4)

	Accept the following symbols /*Aanvaar die volgende simbole.*
N	F_N; Normal;Normal force /*Normaal; Normaalkrag*
f	F_f / f_k / frictional force/*wrywingskag*/kinetic frictional force/ *kinetiese wrywingskrag*
w	F_g; mg; Weight;$F_{Earth\ on\ block}$;Fw / G*ewig* ;Gravitational force / *Gravitasiekrag*/ 78,4 N
T	Tension/*Spanning*; F_T /F_A, F /16,96 N

2.3.1 The 2/8 kg block /system is accelerating/*Die 2/8 kg blok / sisteem is besig om te versnel*

OR/*OF*
The acceleration is not zero / a ≠ 0 ($m \cdot s^{-2}$) / a = 1,32 $m.s^{-2}$ / *Die versnelling is nie nul nie*

OR/*OF*
Velocity is /increasing/changing/not constant/*Snelheid neem toe/ verander/is nie konstant nie*

OR/*OF*
F_{net} is not equal to zero /F_{net} *is nie gelyk aan nul nie* / F_{net} ≠ 0 (N)

OR/*OF*
The acceleration is changing / *Die versnelling verander*

Accept/Aanvaar
An unbalanced force is acting on it / *'n Ongebalanseerde krag werk in op die liggaam* (1)

2.3.2 **For 2 kg/*Vir die 2 kg massa***

F_{net} = ma
mg -T= ma } ✓

1 mark for any
1 punt vir

(2)(9,8) – T = 2(1,32) ✓
T = 16,96 N ✓

F_{net} = ma
mg + T = ma
(2)(-9,8) + T = 2(-1,32) ✓
T = 16,96 N

(3)

2.3.3 **POSITIVE MARKING FROM 2.3.2/*POSITIEWE NASIEN VANAF 2.3.2***

F_{net} = ma
Tcos15º - f = ma } ✓

T_x = Tcos15º
= 16,96 cos15º
= 16,38 N (16,382 N)

16,382 – f = (8)(1,32) ✓
f = 5,82 N (to the left/*na links*) ✓

OR/*OF*

$F_{net} = ma$
$T\cos15^o + f = ma$ ✓

$T_x = T\cos15^o$
$= 16{,}96\cos15^o$
$= 16{,}38$ N (16,382 N)

$-16{,}382 + f = (8)(-1{,}32)$ ✓
f = 5,82 N (to the left/*na links*) ✓ (4)

2.4 **ANY ONE/*ENIGE EEN***
Normal force changes/decreases ✓/*Normaalkrag verander/neem af*
The angle (between string and horizontal) changes/increases. /*Die hoek (tussen die toutjie en die horisontaal) verander/neem toe*
The vertical component of the tension changes/increases/*Die vertikale komponent van die spanning verander / neem toe.* (1)

2.5 Yes✓/*Ja*
The frictional force (coefficient of friction) depends on the nature of the surfaces in contact. ✓
Die wrywingskrag (wrywingskoëffisiënt) is afhanklik van die aard van die oppervlaktes in kontak met mekaar.

ACCEPT/*AANVAAR*
The nature of the surface changes / μ_k changes
Die aard van die oppervlakte verander / μ_k *verander* (2)

[17]

QUESTION 3/*VRAAG 3*

3.1

Downwards/*Afwaarts* ✓

The only force acting on the object is the gravitational force/weight which acts downwards.✓/*Die enigste krag wat op die voorwerp inwerk is die gravitasiekrag/gewig wat afwaarts inwerk.*

ACCEPT/*AANVAAR*:
The only force acting is gravitational/weight.✓/*Die enigste krag wat inwerk is gravitasie/gewig*

OR/*OF*
Gravitational force/weight acts downwards.✓/*Gravitasiekrag/gewig werk afwaarts*

OR/*OF*
The ball is in free-fall / *Die bal in vry-val*

OR/OF
(Gravitational) acceleration is downwards/(*Gravitasionele) versnelling is afwaarts*

(2)

3.2

OPTION 1/*OPSIE 1*
Upward positive/*Opwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = 7,5 + (-9,8)\Delta t$ ✓
$\Delta t = 0,77$ s ✓

Downward positive/*Afwaarts positief*
$v_f = v_i + a\Delta t$ ✓
$0 = -7,5 + (9,8)\Delta t$ ✓
$\Delta t = 0,77$ s ✓

OPTION 2/*OPSIE 2*
Upward positive
Opwaarts positief
At highest point v_f is zero
By hoogste punt is v_f nul
$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (7,5)^2 + (2)(-9,8)\Delta y$
$\Delta y = 2,87$ (2,869) m

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$2,87 = \frac{7,5 + 0}{2}\ \Delta t$ ✓

$\Delta t = 0,77$ s✓

OPTION 2/OPSIE 2
Downward positive
Afwaarts positief
At highest point v_f is zero
By hoogste punt is v_f nul
$v_f^2 = v_i^2 + 2a\Delta y$
$0 = (-7,5)^2 + (2)(9,8)\Delta y$
$\Delta y = -2,87$ (-2,869) m

$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓
$-2,87 = \frac{-7,5 + 0}{2}\ \Delta t$ ✓

$\Delta t = 0,77$ s✓

OPTION 3/*OPSIE 3*	**OPTION 3/OPSIE 3**
Upward positive	**Downward positive**
Opwaarts positief	***Afwaarts positief***
$F_{net}\Delta t = m(v_f - v_i)$	$F_{net}\Delta t = m(v_f - v_i)$
$mg\Delta t = m(v_f - v_i)$	$mg\Delta t = m(v_f - v_i)$
$(-9,8)\Delta t = 0 - 7,5$	$(9,8)\Delta t = 0 - (-7,5)$
$\therefore \Delta t = 0,76531$ s (0,77 s)	$\therefore \Delta t = 0,76531$ s (0,77 s)

OPTION 4/*OPSIE 4*	**OPTION 4/*OPSIE 4***
Upward positive	**Downward positive**
Opwaarts positief	***Afwaarts positief***
(Top to Bottom / *Bo na onder*)	(Top to Bottom /*Bo na onder*)
$v_f = v_i + a\Delta t$	$v_f = v_i + \Delta t$
$-7,5 = 0 + (-9,8)\Delta t$	$7,5 = 0 + (9,8)\Delta t$
$\therefore \Delta t = 0,76531$ s (0,77 s)	$\therefore \Delta t = 0,76531$ s (0,77 s)

OPTION 5/*OPSIE 5*	**OPTION 5/*OPSIE 5***
Upward positive	**Downward positive**
Opwaarts positief	***Afwaarts positief***
(Top to Bottom/ *Bo na onder*)	(Top to Bottom / *Bo na onder*)
$v_f^2 = v_i^2 + 2a\Delta y$	$v_f^2 = v_i^2 + 2a\Delta y$
$(7,5)^2 = (0)^2 + 2(-9,8)\Delta y$	$(7,5)^2 = (0)^2 + 2(9,8)\Delta y$
$\Delta y = -2,87$ m	$\Delta y = 2,87$ m
$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$
$-2,87 = (0)\Delta t + \frac{1}{2} (-9,8)(\Delta t)^2$	$2,87 = (0)\Delta t + \frac{1}{2} (9,8)\Delta t^2$
$\Delta t = 0,765$ s	$\Delta t = 0,765$ s

(3)

NOTES for marking QUESTION 3.3 ***AANTEKENINGE vir merk van VRAAG 3.3***	
Formula mark/*Formule punt*	✓
Substitution mark /*Vervangingspunt*	✓✓
Mark for height/distance / *Punt vir hoogte/afstand*	✓
Mark for comparison/*Punt vir vergelyking*	✓
Mark for conclusion/*Punt vir gevolgtrekking*	✓

3.3

OPTION 1/*OPSIE 1*

Upward positive/*Opwaarts positief*

At highest point v_f is zero/*By hoogste punt is v_f nul*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

0✓ = $(7,5)^2 + (2)(-9,8)\Delta y$ ✓

$\Delta y = 2,87$ (2,869) m✓

This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**.✓

*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

Downward positive/*Afwaarts positief*

At highest point v_f is zero/*By hoogste punt is v_f nul*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

0✓ = $(-7,5)^2 + (2)(9,8)\Delta y$✓

$\Delta y = -2,87$ (-2,869) m✓

This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass the target. ✓

*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

OPTION 2/*OPSIE 2* (POSITIVE MARKING FROM 3.2)

Upward positive/*Opwaarts positief*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓

$\Delta y = (7,5)(0,77)$ ✓ + ½ $(-9,8)(0,77)^2$✓

$\Delta y = 2,87$ m (2,86 m)✓

This is higher than height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**. ✓

*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

Downward positive/*Afwaarts positief*

$\Delta y = v_i\Delta t + ½ a\Delta t^2$✓

$\Delta y = (-7,5)(0,77)$ ✓ + ½ $(9,8)(0,77)^2$✓

$\Delta y = -2,87$ m (2,869 m)✓

This is higher than the height needed to reach point **T** (2,1 m)✓therefore the ball will pass point **T**.

*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

OPTION 3/*OPSIE 3*

$(E_{mech})_{Top/Bo} = (E_{mech})_{Ground/Grond}$
$(E_P + E_K)_{Top} = (E_P + E_K)_{Bottom/Onder}$
$(mgh + ½ mv^2)_{Top/Bo} = (mgh + ½ mv^2)_{Bottom/Onder}$

1 mark for any
1 punt vir enige

(9,8)(h) + 0 ✓= $\underline{0 + (½)(7,5)^2}$ ✓
h = 2,87 m (2,869 m)✓

This is higher than height needed to pass the target (2,1 m)✓<u>therefore the ball will pass the target</u>.✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) verby te gaan dus sal die bal punt **T** verbygaan.*

OPTION 4/*OPSIE 4*

$W_{net} = \Delta E_K$
$mg\Delta x\cos\theta = ½ mv_f^2 - ½ mv_i^2$ ✓
$\underline{(9,8)\Delta x\cos 180^o}$✓ = $\underline{0 - ½(7,5)^2}$✓
Δx = 2,87 m (2,869 m)✓

This is higher than point height needed to pass point **T** (2,1 m)✓<u>therefore the ball will pass point **T**</u>. ✓
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) verby te gaan dus sal die bal punt **T** verbygaan.*

OPTION 5/*OPSIE 5*

Upward positive/*Opwaarts positief*

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. *By hoogste punt is v_f* nul
$v_f^2 = v_i^2 + 2a\Delta y$
0✓ = $[\underline{(7,5)^2 + (2)(-9,8)}(y_f - 1,6)]$✓
y_f = 4,47 (4,469) m✓

Yes
OR/*OF*
This point (4,47m) is higher than point **T** (or even the required height of 2,1 m) therefore the ball will pass point **T**.
Ja
*Dit is hoer as die hoogte benodig om punt **T** (2,1 m) te bereik dus sal die bal punt **T** verbygaan.*

Downward positive/*Afwaarts positief*

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. *By hoogste punt is v_f* nul
$v_f^2 = v_i^2 + 2a\Delta y$
0✓ = $[\underline{(-7,5)^2 + (2)(9,8)}\{y_f - (-1,6)\}]$ ✓
y_f = -4,47 (-4,469) m✓
height is/*hoogte is* 4,47 m.
This point (4,47 m) is higher than point **T**✓✓ (or even the required height of 2,1 m) <u>therefore the ball will pass point **T**</u>.
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt **T** verbygaan.*

OPTION 6/*OPSIE 6* (POSITIVE MARKING FROM 3.2)

Upward positive/*Opwaarts positief*

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$(y_f - 1,6) = (7,5)(0,77)$ ✓ $+ \frac{1}{2} (-9,8)(0,77)^2$ ✓
$y_f = 4,47$ m (4,469 m) ✓

This point (4,47m) is higher than point **T** ✓✓ (or even the required height of 2,1 m) therefore the ball will pass point **T**.
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt **T** verbygaan.*

Downward positive/*Afwaarts positief*

If the highest point is y_f then $\Delta y = (y_f - y_{1,6})$ At highest point v_f is zero
Indien die hoogste punt y_f is, dan is $\Delta y = (y_f - y_{1,6})$. By hoogste punt is v_f nul

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ ✓
$\{y_f - (-1,6)\} = (-7,5)(0,765)$ ✓ $+ \frac{1}{2} (9,8)(0,765)^2$ ✓
$y_f = -4,47$ m (-4,469 m) ✓

This point (4,47m) is higher than point T✓✓ (or even the required height of (2,1m) therefore the ball will pass point **T.**
*Hierdie punt (4,47 m) is hoer as punt **T** (of selfs die benodigde hoogte van 2,1 m) dus sal die bal punt **T** verbygaan.*

OPTION 7/*OPSIE 7* (POSITIVE MARKING FROM 3.2)

Upward positive/*Opwaarts positief*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \left(\frac{0 + 7,5}{2}\right)(0,77) \quad ✓✓$$
$$= 2,89 \text{ m} \quad ✓$$

This is higher than height needed to pass the target (2,1 m) ✓ therefore the ball will pass the target. ✓
Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.

OPTION 7/*OPSIE 7* (POSITIVE MARKING FROM 3.2

Downward positive/*Afwaarts positief*

$$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t \quad ✓$$
$$= \frac{0 - 7,5}{2} (0,77) \quad ✓✓$$
$$= -2,89 \text{ m} \quad ✓$$

Height /*Hoogte* is 2,89m
This is higher than height needed to pass the target (2,1 m) ✓ therefore the ball will pass the target. ✓
Dit is hoer as die hoogte benodig om die teiken verby te gaan (2,1 m) dus sal die bal die teiken verbygaan.

OPTION 8/*OPSIE 8*

Upward positive/*Opwaarts positief*

At highest point v_f is zero/*By hoogste punt is v_f nul*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

0✓ $= v_i^2 - (2)(9,8)(2,1)$ ✓

$v_i = 6,42\ m\cdot s^{-1}$ ✓

This is the actual velocity needed to reach the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will pass the target. ✓

Dit is die werklike snelheid benodig om die teiken te bereik

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

Downward positive/*Afwaarts positief*

At highest point v_f is zero

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

0✓ $= v_i^2 + (2)(9,8)(-2,1)$ ✓

$v_i = 6,42\ m\cdot s^{-1}$ ✓

This is the actual velocity needed to pass the target.

The given velocity is greater than the actual velocity needed. ✓

The ball will reach the target. ✓

Dit is die werklike snelheid benodig is om die teiken te verby te gaan.

Die gegewe snelheid is groter as die werklike snelheid benodig

Die bal sal die teiken verbygaan.

OPTION 9/*OPSIE 9*

$W_{nc} = \Delta E_p + \Delta E_k$

$0 = mgh_f - mgh_i + \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$

$0 = (9,8)h_f - (9,8)(1,6) + \frac{1}{2}(0)^2 - \frac{1}{2}(7,5)^2$

$0 = (9,8)h_f - 43,805$

$\therefore h_f = 4,47\ m$

$\therefore$ The ball will pass point **T**

*Die bal sal punt **T** verbygaan.*

OPTION 10/*OPSIE 10*

POSITIVE MARKING FROM 3.2 / POSITIEWE NASIEN VANAF 3.2

Upward positive/*Opwaarts positief*

Δt(max. height/*maks. hoogte*) = 0,77 s

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$2,1 = (7,5)\Delta t + \frac{1}{2} (-9,8)\Delta t^2$

$\therefore \Delta t = 0,36$ s

$\therefore \Delta t$ (max height/*maks.hoogte*, 0,77 s) > Δt (to pass point **T**/ om **T** *verby te gaan,* 0,36 s)

∴ The ball passed point **T**

*Die bal het punt **T** verbygegaan.*

Downward positive/*Afwaarts positief*

Δt (max height) = 0,77 s

$\Delta y = v_i\Delta t + \frac{1}{2} a \Delta t^2$

$2,1 = (7,5)\Delta t + \frac{1}{2} (-9,8)\Delta t^2$

$\therefore \Delta t = 0,36$ s

$\therefore \Delta t$ (max height, 0,77 s) > Δt (to reach point T, 0,36 s)

∴ The ball passed point **T**

*Die bal het punt **T** verbygegaan*

OPTION 11/*OPSIE 11*

Upward positive/*Opwaarts positief*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$(3,7 - 1,6) = 7,5\ \Delta t + \frac{1}{2} (-9,8)\ \Delta t^2$

$\Delta t = 0,375$ s

The time to pass point **T** is less than time to reach maximum height . Ball will pass point **T**.

*Die tyd om punt **T** verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt **T** verbygaan*

Downward positive/*Afwaarts positief*

$\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$

$(3,7 - 1,6) = -7,5\ \Delta t + \frac{1}{2} (9,8)\ \Delta t^2$

$\Delta t = 0,375$ s

The time to reach point **T** is less than time to reach maximum height . Ball will pass point **T**.

*Die tyd om punt **T** verby te gaan, is minder as tyd om maksimum hoogte te bereik.. Bal sal punt **T** verbygaan*

OPTION 12/*OPSIE 12*

Upward positive/*Opwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = (7,5)^2 + 2(-9,8)(2,1)$

$v_f = 3,88\ m\cdot s^{-1}$

Velocity at **T** is 3,88 $m\cdot s^{-1}$ therefore the ball still moving towards its maximum height

*Snelheid by **T** is 3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte*

Downward positive/*Afwaarts positief*

$v_f^2 = v_i^2 + 2a\Delta y$

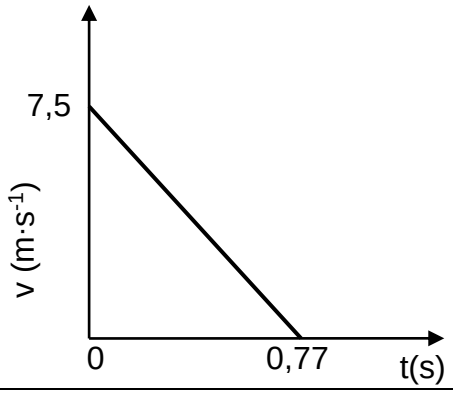
$v_f^2 = (-7,5)^2 + 2(9,8)(-2,1)$

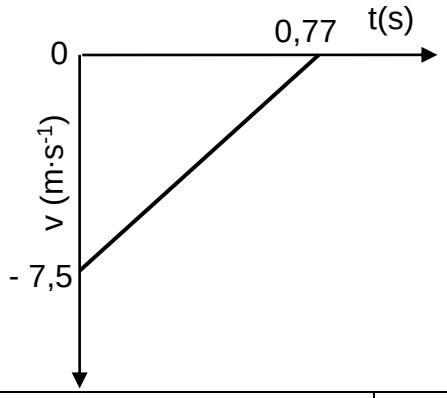
$v_f = -3,88\ m\cdot s^{-1}$

Velocity at **T** is -3,88 $m\cdot s^{-1}$ therefore the ball is still moving towards its maximum height

*Snelheid by **T** is -3,88 $\cdot m\cdot s^{-1}$ dus beweeg die bal steeds opwaarts na maksimum hoogte* (6)

3.4 **POSITIVE MARKING FROM 3.2 / *POSITIEWE NASIEN VANAF 3.2***





Notes/*Notas*:	
Initial velocity and time for final velocity shown *Beginsnelheid en tyd vir finale snelheid aangedui.*	✓
Correct straight line (including orientation) drawn *Korrekte reguitlyn (insluitend oriëntasie) geteken.*	✓

(2)
[13]

QUESTION 4/*VRAAG 4*

4.1 Momentum is the product of the mass of an object and its velocity
Momentum is die produk van die massa van 'n voorwerp en sy snelheid.
[NOTE/LET WEL: 2 or/of 0] (2)

4.2 To the left/*Na links*
Newton's third law/*Newton se derde wet*

ACCEPT/*AANVAAR*:
Principle of conservation of linear momentum / law of action-reaction
Beginsel van behoud van lineêre momentum/wet van aksie-reaksie
Newton's third law **and** Newton's second law/*Newton se derde wet **en** Newton se tweede wet* (2)

NOTE: For QUESTION 4.3 and 4.4 motion to the right has been taken as positive. Candidates may use the opposite direction.
LET WEL: Vir VRAAG 4.3 en 4.4 word beweging na regs as positief geneem. Kandidate mag die teenoorgestelde rigting gebruik.

4.3

OPTION 1/*OPSIE 1*

$\sum p_i = \sum p_f$

$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$

mass of girl is m / *massa van meisie is m*

$\{(m + 2)(0)\} + \{8(0)\} = \{(m + 2)(-0,6)\} + (8)(4)$

$m = 51,33$ kg

Allocate mark if 0 is substituted on left hand side/*Ken punt toe indien 0 aan linkerkant vervang is.*

N**OTE**: Penalise only once for the incorrect sign of the 0,6.
LET WEL: *Penaliseer slegs eenmaal die die inkorrekte teken van 0,6*

OPTION 2/*OPSIE 2*

$\sum p_i = \sum p_f$

$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$

$0 = m_1v_{1f} + m_2v_{2f}$

$0 = (8)(4) + m_2(-0,6)$

$\therefore m_2 = 53,33$ kg

$\therefore m_{girl} = 53,33 - 2$

$\therefore m_{girl} = 51,33$ kg

OPTION 3/*OPSIE 3*

$\Delta p_{girl} = -\Delta p_{parcel}$

$m(v_f - v_i) = -m(v_f - v_i)$

$(m + 2)(-0,6 - 0) = -8(4 - 0)$

$m = 51,33$ kg (5)

4.4

POSITIVE MARKING FROM *4.3*/*POSITIEWE NASIEN VANAF 4.3*

Impulse = $\Delta p = m(v_f - v_i)$

$= \underline{(51,33 + 2)(-0,6 - 0)}$

$= -32$ N·s / kg·m·s^{-1}

Magnitude of impulse/*Grootte van die impuls* is 32 N·s /32 kg·m·s^{-1}

OR/*OF*

Impulse = $\Delta p_{parcel/pakket} = m(v_f - v_i)$

$\Delta p = (8)(4 - 0) = 32$ kg m·s^{-1}

$\therefore \Delta p_{girl/meisie} = 32$ kg m·s^{-1} (3)

4.5

POSITIVE MARKING FROM 4.4 /*POSITIEWE NASIEN VANAF 4.4*

32 kg·m·s^{-1} / N·s to the right/opposite direction /*na regs /teenoorgestelde rigting* (2)

[14]

QUESTION 5/*VRAAG 5*

5.1 A force is non-conservative if the work it does on an object which is moving between two points depends on the path taken.
'n Krag is nie-konserwatief indien die arbeid wat dit verrig op 'n voorwerp wat tussen twee punte beweeg van die pad afhang.
OR/*OF*
A force is non-conservative if the work it does on an object depends on the path taken.
'n Krag is nie-konserwatief indien die arbeid wat dit verrig afhang van die pad wat dit neem.

OR/*OF*
A force is non-conservative if the work it does in moving an object around a closed path is non-zero
'n Krag is nie-konserwatief indien die arbeid wat dit verrig om 'n voorwerp op 'n geslote pad te beweeg nie-nul is. (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If the word work is omitted 0 marks
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien die woord arbeid uitgelaat is 0 punte.*

5.2 No/*Nee* ✓ (1)

5.3

OPTION 1/ *OPSIE 1*

$P = \frac{W}{\Delta t}$ ✓

$= \frac{4{,}8\times10^{6}}{(90)}$ ✓

$= 53\,333{,}33$ W

$= 5{,}33 \times 10^{4}$ W (53,33 kW) ✓

OPTION 2/*OPSIE 2*

$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

$= \left(\frac{0 + 25}{2}\right)(90)$

$= 1\,125$ m

$W_F = F\Delta x\cos\theta$

$4{,}80 \times 10^{6} = F(1\,125)\cos0^{o}$

$F = 4\,266{,}667$ N

$P_{ave} = Fv_{ave}$

$= (4\,266{,}667)(12{,}5)$

$= 53\,333,33$ W (3)

5.4 The net/total work done on an object is equal to the change in the object's kinetic energy✓✓
Die netto/totale arbeid verrig op 'n voorwerp is gelyk aan die verandering in die voorwerp se kinetiese energie.
OR/*OF*
The work done on an object by a net force ✓is equal to the change in the object's kinetic energy. ✓
Die arbeid verrig op 'n voorwerp deur 'n netto krag is gelyk aan die verandering in die voorwerp se kinetiese energie. (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

5.5

OPTION 1/*OPSIE 1*

$W_{net} = \Delta K$✓
$W_w + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$
$mg\Delta x\cos\theta + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$
$(1\ 500)(9,8)200\cos180^o$✓ + $W_f + 4,8 \times 10^6$ ✓= $½ (1\ 500)(25^2 – 0)$ ✓
$-2\ 940\ 000 + W_f + 4,8 \times 10^6 = 468\ 750$
$W_f = -1\ 391\ 250$ J
$= -1,39 \times 10^6$ J✓

OR/OF

$W_{net} = \Delta K$✓
$W_w + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$
$-\Delta Ep + W_f + W_F = ½ mv_f^2 - ½ mv_i^2$
$-(1\ 500)(9,8)(200 – 0)$✓ + $W_f + 4,8 \times 10^6$ ✓= $½ (1\ 500)(25^2 – 0)$ ✓
$-2\ 940\ 000 + W_f + 4,8 \times 10^6 = 468\ 750$
$W_f = -1\ 391\ 250$ J
$= -1,39 \times 10^6$ J ✓ (5)

NOTE/*LET WEL*
0 can be omitted in above substitutions.
0 kan in bogenoemde vervangings weggelaat word.

OPTION 2/*OPSIE 2*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$
$W_{nc} = ½ mv_f^2 + mgh_f - ½ mv_i^2 - mgh_i$

1 mark for any of these/
1 punt vir enige van hierdie

$W_f + W_F = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$W_f + 4,8 \times 10^6$ ✓ $= [½ (1\ 500)(25)^2 + -0]$ ✓ $+ [(1\ 500)(9,8)(200) - 0]$ ✓
$W_f = - 1,39 \times 10^6$ J $(-1,40 \times 10^6$J $)$ ✓

OR/*OF*

$W_{nc} = \Delta K + \Delta U$
$W_{nc} = ½ mv_f^2 - ½ mv_i^2 + mgh_f - mgh_i$
$= ½ m (v_f^2 - v_i^2) + mg(h_f - h_i)$
$W_{nc} = ½ mv_f^2 + mgh_f - ½ mv_i^2 - mgh_i$

1 mark for any of these/
1 punt vir enige van hierdie

$W_f + 4,8 \times 10^6$ ✓ $= [½ (1500)(25)^2$ + $(1500)(9,8)(200)] - [0 + 0]$
$W_f = - 4,8 \times 10^6 + 3,4 \times 10^6$
$= - 1,39 \times 10^6$ J $(-1,40 \times 10^6$J $)$ ✓ (5)

ACCEPT THE FOLLOWING FOR: /*AANVAAR DIE VOLGENDE VIR* : $(3/5)$

POSITIVE MARKING FROM 5.3/*POSITIEWE NASIEN VANAF 5.3*

$v_f = v_i + a\Delta t$
$25 = 0 + a(90)$
$a = 0,277…$ m s^{-2}

$F_{net} = ma$
$= (1\ 500)(0,2777…) = 416,66…$ N

$F + (w_{||}) + (-f_k) = 416,666…$
$4\ 266,6667 – 1\ 500(9,8)\sin\theta - f_k = 416,666…$
$f_k = 1\ 236,6667$ N

$W_f = f_k \Delta x \cos\theta$
$= (1\ 236,6667)(1\ 125)(\cos 180°)$
$= - 1\ 391\ 250$ J (5)

[13]

QUESTION 6/*VRAAG 6*

6.1 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) (golflengte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar verskillende snelhede relatief tot die medium van klank voortplanting het.

OR/*OF*

An (apparent) change in observed/detected frequency (pitch), as a result of the relative motion between a source and an observer (listener).
'n (Skynbare) verandering in waargenome frekwensie (toonhoogte),(golflengte) as gevolg van die relatiewe beweging tussen die bron en 'n waarnemer/luisteraar (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
Indien enige van die onderstreepte sleutel woorde/frases in die korrekte konteks uitgelaat is, trek 1 punt af.

6.2 Away from/*Weg vanaf*
Observed frequency lower/*Waargenome frekwensie is laer* (2)

6.3
$v = f\lambda$
$340 = f\,(0{,}34)$
$f = 1\,000$ Hz (3)

6.4 **POSITIVE MARKING FROM 6.3/*POSITIEWE NASIEN VANAF 6.3***

$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ **OR/*OF*** $f_L = \frac{v - v_L}{v} f_s$

$950 = \left(\frac{340 - v_L}{340 + 0}\right) 1\,000$

$v_L = 17\ m \cdot s^{-1}$

distance/*afstand* $x = v\Delta t$
$= (17)(10)$
$= 170$ m

OR/*OF*

$f_L = \frac{v - v_L}{v} f_s$

$950 = \left(\frac{340 - {}^{17}/_{10}}{340 + 0}\right)(1000)$

distance/*afstand* $x = 170$ m

ACCEPT/*AANVAAR*

$v_L = \Delta f\lambda$ ✓

$= (50)(0,34)$ ✓✓

$= 17\ m\cdot s^{-1}$

distance/*afstand* $x = v\Delta t$

$= (17)(10)$ ✓

$= 170\ m$ ✓ (6)

[13]

QUESTION 7/*VRAAG 7*

7.1

$$Q_{net/netto} = \frac{Q_1 + Q_2 + Q_3}{3}$$

$$-3 \times 10^{-9} = \frac{-15\times10^{-9} + Q + 2\times10^{-9}}{3}$$ ✓

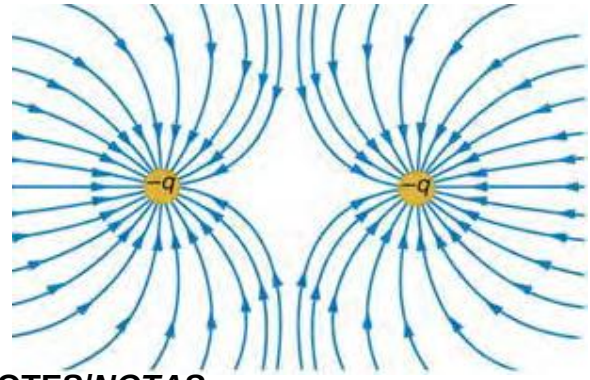
$Q = +4 \times 10^{-9}\ C$✓

NOTE/*LET WEL*

✓ for addition of the three correct charges

✓ correct answer (2)

7.2



NOTES/*NOTAS*

Correct shape /*Korrekte vorm* ✓

Correct direction/*Korrekte rigting* ✓

Lines must not cross and must touch spheres ✓

Lyne moet nie kruis nie en moet die sfere raak (3)

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

Die grootte van die elektrostatiese krag uitgeoefen deur een puntlading (Q_1) op 'n ander puntlading (Q_2) <u>is direk eweredig aan die produk van die (groottes) van die ladings en omgekeerde eweredig aam die kwadraat van die afstand (r) tussen hulle.</u> (2)

NOTE/*LET WEL*

If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark. If masses used (0/2)

*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af. Indien massas gebruik word, (0/2)*

7.4

OPTION 1/*OPSIE 1*

$F = \frac{kQ_1Q_2}{r^2}$

$F_{SP} = \frac{(9\times10^9)(3\times10^{-9})(3\times10^{-9})}{(0,1)^2}$

$= 8,1 \times 10^{-6}$ N downwards/*afwaarts*

$F_{TP} = \frac{(9\times10^9)(3\times10^{-9})(3\times10^{-9})}{(0,3)^2}$

$= 9 \times 10^{-7}$ N left/*links* ($0,9 \times 10^{-6}$ N to the left/*na links*

$F_{net}^2 = (F_{SP})^2 + (F_{TP})^2$

$F_{net} = \sqrt{(F_{SP})^2 + (F_{TP})^2}$ for either

$F_{net} = \sqrt{(8,1\times10^{-6})^2 + (0,9\times10^{-6})^2}$

$F_{net} = 8,15 \times 10^{-6}$ N

OPTION 2/*OPSIE 2*

$E_s = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(3\times10^{-9})}{(0,1)^2}$

$= 2\,700$ N.C^{-1}

$E_T = \frac{kQ}{r^2}$ both substitutions
beide vervangings

$= \frac{(9\times10^9)(3\times10^{-9})}{(0,3)^2}$

$= 300$ N.C^{-1}

$E_{net} = \sqrt{E_S^2 + E_T^2}$

$= \sqrt{(2700)^2 + (30)^2}$

$= 2\,716,62$ N.C^{-1}

$F = Eq$

$= (2\,716,62)(3 \times 10^{-9})$

$= 8,15 \times 10^{-6}$ N (5)

7.5

POSITIVE MARKING FROM 7.4 / *POSITIEWE NASIEN VANAF 7.4*

OPTION 1/*OPSIE 1*

$E = \frac{F}{q}$ ✓

$= \frac{8,15\times10^{-6}}{3\times10^{-9}}$ ✓

$= 2,72 \times 10^3$ N.C^{-1} ✓ (3)

OPTION 2/*OPSIE 2*

$E_S = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,1)^2}$

$= 2\ 700\ N.C^{-1}$

$E_T = \frac{kQ}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})}{(0,3)^2}$

$= 300\ N.C^{-1}$

$E_{net} = \sqrt{E_S^2 + E_T^2}$

$= \sqrt{(2700)^2 + (30)^2}$

$= 2\ 716,62\ N.C^{-1}$

NOTE/*LET WEL*
Mark Allocation/*Puntetoekenning*
correct formula/*korrekte formula*
both subsitutions/*beide vervangings*
correct answer/*korrekte antwoord*
If calculation done in 7.4 award full marks for answer written here. / *Indien berekening in 7.4 gedoen is, moet volle punte vir die antwoord wat hier geskryf is, toegeken word.*

7.6.1 Sphere/*Sfeer* P or/*of* T✓ (1)

7.6.2 **SPHERE P/*SFEER P***

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-15\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 9,38 \times 10^{10}$

mass gained/*massa gewin* = $n_e m_e$

m gained /*gewin*= $(9,38 \times 10^{10})(9,11 \times 10^{-31})$

$= 8,55 \times 10^{-20}$ kg ✓

SPHERE T/*SFEER T*

$n_e = \frac{Q}{q_e}$ or/*of* $n_e = \frac{Q}{e}$

$= \frac{-5\times10^{-9}}{-1,6\times10^{-19}}$ ✓ $= 3,125 \times 10^{10}$

mass gained/*massa gewin* = $n_e m_e$

m gained /*gewin*= $(3,125 \times 10^{10})(9,11 \times 10^{-31})$

$= 2,85 \times 10^{-20}$ kg ✓ (3)

[19]

QUESTION 8/*VRAAG 8*

8.1 The battery supplies 12 J per coulomb/12 J per unit charge.
Die battery verskaf 12 J per coulomb lading

OR /*OF*
The potential difference of the battery in an open circuit is 12 V.
Die potensiaal verskil van die battery in 'n oop stroombaan is 12 V

OR/*OF*
The battery does 12 J of work per coulomb of charge.
Die battery verrig 12 J arbeid per coulomb lading

OR/*OF*
Maximum work done by the battery per unit charge is 12 J
Maksimum arbeid verrig deur die battery per eenheidslading is 12 J

OR/*OF*
Maximum energy supplied by the battery per unit charge is 12 J
Maksimum energie verskaf deur die battery per eenheidslading is 12 J

OR/*OF*
The battery supplies 12 J of energy per coulomb/ 12 J of energy per unit charge
Die battery verskaf 12 J energie per coulomb/12 J energie per eenheidslading

OR/*OF*
The greatest potential difference that can be generated by a battery is 12V
Die grootste potensiaalveskil wat deur 'n battery gelewer word, is 12 V

OR/*OF*
The total energy transferred by a battery to a unit electric charge is 12 J
Die totale energie oorgedra deur die battery aan 'n eenheid elektriese lading is 12 J

OR/*OF*
The total amount of electric energy supplied by the battery per coulomb/per unit charge is 12 J
Die totale hoeveelheid elektriese energie verskaf deur die battery per coulomb/per eenheid lading is 12 J (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af*

8.2.1 **OPTION 1/*OPSIE 1***

$V_{lost/verlore} = I\,r$
$= (2)\,(0,5)$
$= 1\ V$

$V_{ext/eks} = Emf/emk - V_{lost/verlore}$
$= (12 - 1)$
$= 11\ V$

OPTION 2/*OPSIE 2*
$\varepsilon = I(R + r)$
$12 = V_{ext/eks} + (2)(0,5)$
$V_{ext/eks} = 11\ V$

OPTION 3/*OPSIE 3*
$\varepsilon = I(R + r)$
$12 = 2(R + 0,5)$
$R = 5,5\ \Omega$
$V = IR$
$= 2(5,5)$
$= 11\ V$ (3)

8.2.2 **POSITIVE MARKING FROM 8.2.1/*POSITIEWE NASIEN VANAF 8.2.1***

OPTION 1/*OPSIE 1*
$R = \frac{V}{I}$
$= \frac{11}{2}$
$= 5,5\ \Omega$

OPTION 2/*OPSIE 2*
0,5:R
1:11
$R = 5,5\ \Omega$

OPTION 3/*OPSIE 3*
$\frac{1}{0,5} = \frac{11}{R}$
$R = 5,5\ \Omega$

OPTION 4/*OPSIE 4*
$V_{total} = IR_{total}$
$12 = (2)R_{total}$
$R_{total} = 6\ \Omega$
$R = 6 - 0,5$
$= 5,5\ \Omega$

OPTION 5/*OPSIE 5*
$\varepsilon = I(R + r)$
$12 = 2(R + 0,5)$
$R = 5,5\ \Omega$ (2)

8.3 Decreases /*Neem af*
Total resistance decreases /*Totale weerstand neem af*
Current increases/*Stroom neem toe*
"Lost volts" increases, (emf the same)/*"Verlore volts" neem toe, (emk dieselfde)*
External potential difference decreases/*eksterne potensiaal verskil neem af*

OR/*OF*
Decreases /*Neem af*
Total resistance decreases /*Totale weerstand neem af*
Current increases/*Stroom neem toe*
$\varepsilon = V_{ext/eks} + Ir$
Ir increases/*Ir neem toe*
ε is constant/*is konstant*
$\therefore V_{ext/eks}$ decreases/*neem af* (4)
[11]

QUESTION 9/*VRAAG 9*

9.1 Temperature/*Temperatuur* (1)

9.2.1 *r* = 3 Ω or/*of* 1,5 Ω

Accept *for one mark only*: /*Aanvaar vir slegs een punt*
r = -3 Ω or/of -1,5 Ω (2)

9.2.2 ε = slope (gradient) of the graph/*helling(gradiënt)van die grafiek*

$\varepsilon = \frac{7,5-(-3)}{1,5-0}$

= 7 V

Accept any correct values from the graph
Aanvaar enige korrekte waardes vanaf die grafiek

OR/*OF*
POSITIVE MARKING FROM 9.2.1 / *POSITIEWE NASIEN VANAF 9.2.1*

$R = \frac{\varepsilon}{I} - r$

$7,5 = 1,5\varepsilon - 3$

ε = 7 V

Accept any correct values on the line from the graph
Aanvaar enige korrekte waardes op die lyn vanaf die grafiek

OR/OF
ε = I(R + r)
= 0,5(11 + 3)
ε = 7 V (3)
[6]

QUESTION 10/*VRAAG 10*

10.1.1 Y to/*na* X (1)

10.1.2 Faraday's Law Electromagnetic Induction
Faraday se wet van Elektromagnetiese Induksie

OR/OF
Electromagnetic induction/Faraday's Law
Elektromagnetiese induksie/Faraday se wet (1)

10.1.3 Mechanical (kinetic) energy to electrical energy
Meganiese (kinetiese) energie na elektriese energie (2)

10.2.1 340 V (1)

Accept / Aanvaar
-340 V

10.2.2

POSITIVE MARKING FROM 10.2.1/*POSITIEWE NASIEN VANAF 10.2.1*

$$V_{rms/wgk} = \frac{V_{max/maks}}{\sqrt{2}}$$

$$= \frac{340}{\sqrt{2}}$$

$V_{rms/wgk}$ = 240,42 V (3)

10.2.3

POSITIVE MARKING FROM 10.2.2 / *POSITIEWE NASIEN VANAF 10.2.3*

<u>OPTION 1/*OPSIE 1*</u>

$$P_{ave/gemid} = \frac{V^2_{rms/wgk}}{R}$$

$$1\,600 = \frac{(240{,}42)^2}{R}$$

$$R = 36{,}13\ \Omega\ (36{,}126\ \Omega)$$

OR/*OF*
R = 36,12 Ω (36,124 Ω)

<u>OPTION 2/ *OPSIE 2*</u>

$$P_{ave/gemid} = \frac{V^2_{rms/wgk}}{R} = \frac{\frac{V^2_{max/maks}}{2}}{R} = \frac{V^2_{max/maks}}{2R}$$

$$1\,600 = \frac{(340)^2}{2R}$$

$$R = 36{,}13\ \Omega\ (36{,}125\ \Omega)$$

OPTION 3/*OPSIE 3*

$P_{ave/gemid} = V_{rms/wgk} I_{rms/wgk}$

$1600 = (240,416)\ I_{rms/wgk}$

$I_{rms/wgk} = 6,66$ A

$R = \frac{V_{rms}}{I_{rms}}$

$= \frac{240,416}{6,66}$

$= 36,1\ \Omega\ (36,09\ \Omega)$

(Do not penalise if rms is omitted in $R = \frac{V_{rms}}{I_{rms}}$ / *Moenie penaliseer indien wgk uitgelaat is nie.)*

OPTION 4/*OPSIE 4*

$P_{ave/gemid} = \frac{V_{max/maks} I_{max/maks}}{2}$

$1600 = \frac{340 I_{max/maks}}{2}$

$I_{max/maks} = 9,412$ A

$R = \frac{V_{max}}{I_{max}}$

$= \frac{340}{9,412}$

$= 36,12\ \Omega$

(Do not penalise if max is omitted in $R = \frac{V_{max}}{I_{max}}$ / *Moenie penaliseer indien maks uitgelaat*

(3)
[11]

QUESTION 11/*VRAAG 11*

11.1 Work function of a metal is the minimum energy needed to eject an electron from the metal surface ✓
Arbeidsfunksie van 'n metaal is die minimum energie benodig om 'n elektron uit die oppervlakte van 'n metaal vry te stel. (2)

NOTE/*LET WEL*
If any of the underlined key words/phrases in the **correct context** is omitted deduct 1 mark.
*Indien enige van die onderstreepte sleutel woorde/frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

11.2 Potassium / *Kalium* / K

f_o for potassium is greater than f_o for caesium
f_o vir kalium is groter as f_o vir sesium

OR/*OF*
Work function is directly proportional to threshold frequency
Arbeidsfunksie is direk eweredig aan die drumpel frekwensie

ACCEPT/*AANVAAR*
$W_o = hf_o$
$W_o \ \alpha \ f_o$ (2)

11.3 **OPTION 1/*OPSIE 1***

$c = f\lambda$

$3 \times 10^8 = f(5,5 \times 10^{-7})$

$f = 5,45 \times 10^{14}$ Hz

$f_{uv} < f_{o\ of\ K(potassium)}$

∴ Ammeter in circuit **B** will not show a reading
∴ *Ammeter in stroombaan B sal nie 'n lesing toon nie.*

OPTION 2/*OPSIE 2*

$E = \frac{hc}{\lambda} = \frac{(6{,}63\times10^{-34})(3\times10^{8})}{5{,}5\times10^{-7}}$

$= 3{,}6164 \times 10^{-19}$ J

$W_o = hf_o = (6{,}63 \times 10^{-34})(5{,}55 \times 10^{14}) = 3{,}68 \times 10^{-19}$ J

$W_o > E$ or/*of* $hf_o > hf$

∴The ammeter will not register a current /*ammeter sal nie lesing registreer*

Mark allocation / *Puntetoekening*

both correct formulae/*beide korrekte formules*: $E = \frac{hc}{\lambda}$ and $W_o = hf_o$

both substitutions/*beide vervangings*: $\frac{(6{,}63\times10^{-34})(3\times10^{8})}{5{,}5\times10^{-7}}$ and/*en* $(6{,}63 \times 10^{-34})(5{,}55 \times 10^{14})$

correct conclusion

OPTION 3/*OPSIE 3*

$c = f_o\lambda_o$

$3 \times 10^8 = (5{,}55 \times 10^{14})\lambda$

$\lambda_o = 5{,}41 \times 10^{-7}$ m

λ_o (threshold wavelength) < λ (incident wavelength)
λ_o *(drumpelgolflengte)* < *λ (invallende golflengte)*

∴ the ammeter will not register a current / *ammeter sal nie lesing registreer* (3)

11.4 **OPTION 1/*OPSIE 1***

$E = W_0 + E_{k(max)}$

$hf = hf_o + \frac{1}{2}mv^2_{max}$

$h\frac{c}{\lambda} = h\frac{c}{\lambda_0} + E_{K(max)}$

.

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.
***LET WEL**: Indien Ek van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord*

$\frac{(6{,}63\times10^{-34})(3\times10^{8})}{5{,}5\times10^{-7}} = (6{,}63 \times 10^{-34})(5{,}07 \times 10^{14}) + E_{k(max)}$

$E_K = 2{,}55 \times 10^{-20}$ J (Range/*Gebied*: $2{,}52 \times 10^{-20} – 2{,}6 \times 10^{-20}$ J)

OPTION 2/*OPSIE 2*

POSITIVE MARKING FROM 11.3/POSITIEWE NASIEN VANAF 11.3

$E = W_0 + E_{k(max)}$

$hf = hf_o + \frac{1}{2}mv_{max}^2$ ✓

$h\frac{c}{\lambda} = h\frac{c}{\lambda_0} + E_{K(max)}$

NOTE: If E_K of the incorrect photocell is calculated, candidate forfeit the mark for the final answer.
***LET WEL**: Indien Ek van verkeerde fotosel bereken is, verbeur kandidaat die punt vir finale antwoord*

$(6,63 \times 10^{-34})(5,45 \times 10^{14})$ ✓✓ $= \underline{(6,63 \times 10^{-34})(5,07 \times 10^{14}) + E_{k(max)}}$ ✓

$E_K = 2,52 \times 10^{-20}$ J ✓ (Range/*Gebied*: $2,52 \times 10^{-20} – 2,6 \times 10^{-20}$ J) (5)

11.5 Remains the same/*Bly dieselfde* ✓ (1)

[13]

TOTAL/*TOTAAL*: 150

ADDENDUM

QUESTION 7.2

Accept the following electric field diagram which would be formed if the effect of the third charge is considered.
Aanvaar die volgende elektrieseveld diagram wat gevorm sal word indien die effek van die derde lading in ag geneem is.