Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2021

PHYSICAL SCIENCES P1 (EXEMPLAR)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 13 pages, including a 2-page data sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 10 questions.
2. Answer ALL the questions.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the questions correctly according to the numbering system used in this question paper.
6. You are advised to use the attached DATA SHEETS.
7. The formulae and substitutions must be shown in ALL calculations.
8. Give brief motivations, discussions, etc. where required.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Start EACH question on a NEW page.
11. All diagrams are not necessarily drawn according to scale.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Choose the answer and write down (A–D) next to the question numbers (1.1–1.10) in your ANSWER BOOK, for example 1.11 D.

1.1 Safety belts in cars are designed to reduce the extent of injuries to passengers during accidents. Which ONE of Newton's laws of motion best explains the tendency of a passenger's body to move forward during a head-on collision?

A Law of Universal gravitation

B First Law

C Second Law

D Third Law (2)

1.2 An object of mass **m** rests on a flat table. If the action force of the Earth on this object is **m**g, which ONE of the statements given below best describes the reaction force?

A The table pushing up on the object with force **m**g

B The object pushing down on the table with force **m**g

C The object pulling upward on the Earth with force **m**g

D The table pushing down on the floor with force **m**g (2)

1.3 A constant net force, **F**, acts on a box which moves along a frictionless horizontal surface. Which ONE of the following quantities remains constant while the net force **F** acts on the box?

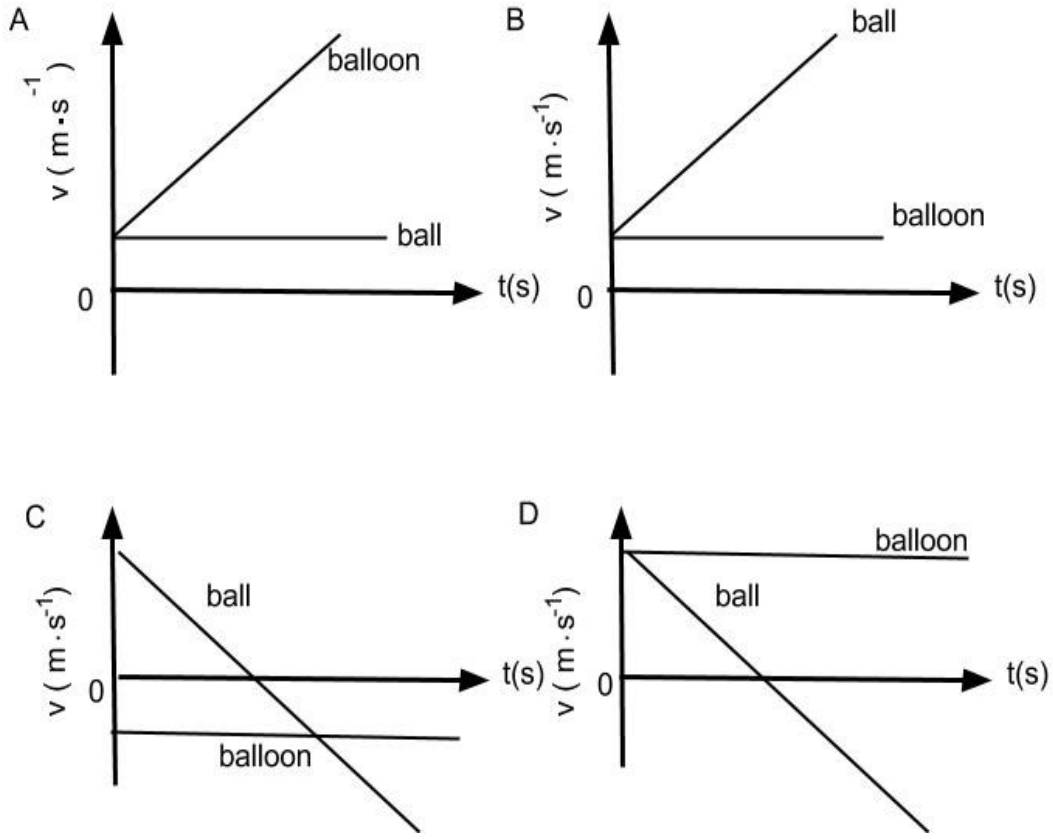
A Change in momentum

B Work done on the box

C Rate of change of velocity

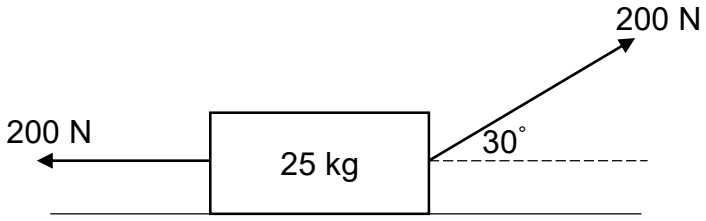
D Change in gravitational potential energy (2)

1.4 A ball is dropped from a hot air balloon that is moving upwards at a constant velocity. Take UPWARDS as the POSITIVE direction. The correct velocity versus time graph for the motion of the ball and the balloon is:



(2)

1.5 Two forces, each of magnitude 200 N, are simultaneously applied to a toolbox of mass 25 kg resting on a horizontal surface as shown in the diagram below. Ignore the effects of friction.



Work will be done by the net force on the toolbox because it will …

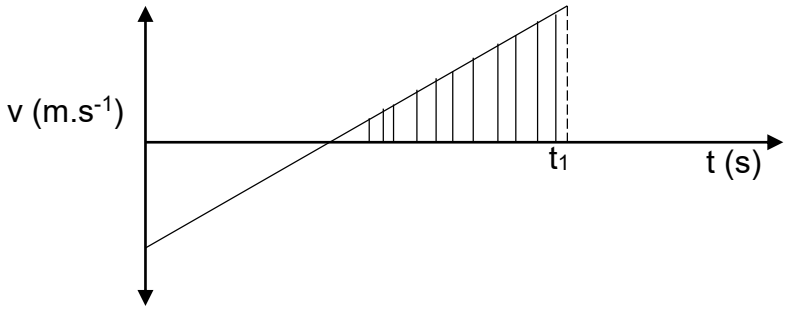
A accelerate to the left.

B accelerate to the right.

C be lifted off the surface.

D remain at rest. (2)

1.6 While a helicopter is moving vertically upwards with constant velocity, a camera is dropped from it. The camera lands on the ground after t_1 seconds. The sketch graph below represents the velocity-time relationship of the camera's motion. **Downward direction is positive**.



The shaded area under the graph represents the:

A Total distance the camera has travelled

B Speed with which the camera strikes the ground below

C Maximum height of the camera above the ground

D Magnitude of the displacement of the camera (2)

1.7 The work done by the car's engine to increase its velocity from **0 to *v*** is *W*. What work should be done by the engine to increase its velocity from ***v* to 2*v*** ?

A *4W*

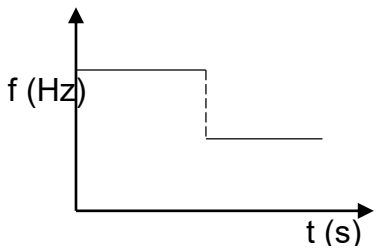
B *3W*

C *2W*

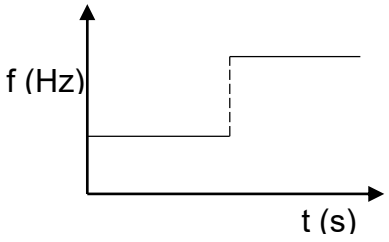
D *W* (2)

1.8 An ambulance moving at constant velocity, producing a sound, approaches a stationary listener, passes the listener and moves away. Which ONE of the following graphs best represents the change in observed frequency versus time?

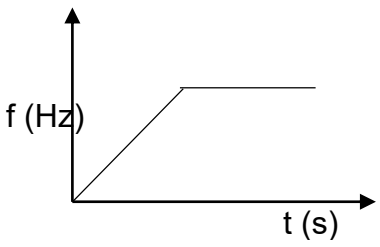
A



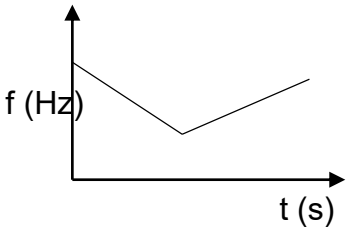
B



C



D



(2)

1.9 Two identical metal spheres, each carrying a charge **Q**, are at a distance **r** apart. Which ONE of the following pairs of changes, that are made simultaneously, will **DOUBLE** the electrostatic force that one charged sphere exerts on the other?

	DISTANCE BETWEEN CENTRES OF SPHERES	MAGNITUDE OF CHARGES
A	Decrease distance to $\frac{\mathbf{r}}{\sqrt{2}}$	Reduce the charges on both spheres to $\frac{\mathbf{Q}}{2}$
B	Decrease distance to $\frac{\mathbf{r}}{2}$	Double the charges on both spheres
C	Decrease distance to $\frac{\mathbf{r}}{\sqrt{2}}$	Double the charges on both spheres
D	Decrease distance to $\frac{\mathbf{r}}{2}$	Reduce the charge on one sphere to $\frac{\mathbf{Q}}{2}$

(2)

1.10 Two objects experience an INELASTIC collision in an isolated system. Which ONE of the following combinations regarding the total momentum and total kinetic energy is correct?

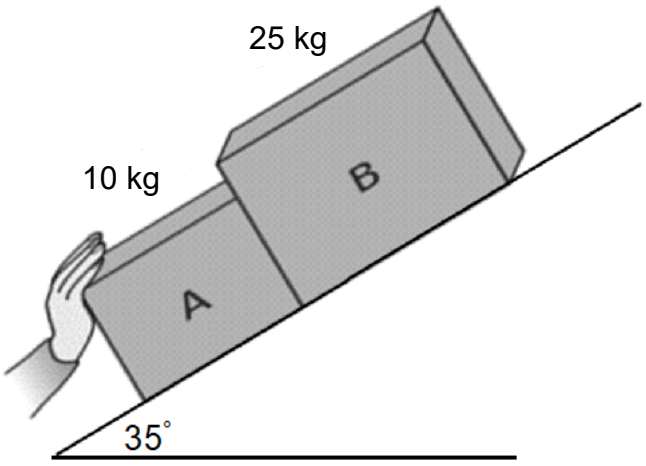
	Total momentum is …	Total kinetic energy is …
A	not conserved	conserved
B	conserved	not conserved
C	not conserved	not conserved
D	conserved	conserved

(2)

[20]

QUESTION 2 (Start on a NEW page.)

Two blocks, **A** and **B**, are placed on an inclined rough surface that makes an angle of 35° with the horizontal. Nceba is applying a force **F** on block **A** to push the system up the incline. Block **B** experiences a frictional force of 15 N.



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

2.2 Draw a labelled free-body diagram of all the forces acting on block **B**. (4)

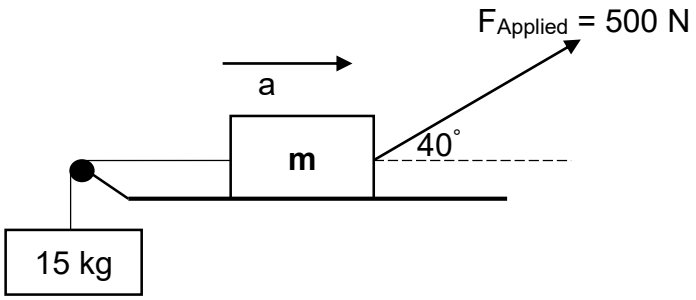
2.3 If the system accelerates at 1,5 $m.s^{-2}$ up the incline, calculate the force exerted by block **B** on block **A**. (6)

2.4 If block **A** experiences a frictional force of 4,5 N when the system was accelerating at 1,5 $m.s^{-2}$, calculate the magnitude of the force applied by Nceba. (4)

[16]

QUESTION 3 (Start on a NEW page.)

Two boxes of mass **m** and 15 kg, are connected by a light inextensible string passing over a frictionless pulley. A force of 500 N is applied, at an angle of 40° to the horizontal, on the box of mass **m** as shown in the diagram below. The box of mass **m** experiences a frictional force of 115 N and a normal force, F_N, of 623,3 N.



3.1 State Newton's Second Law of motion in words. (2)

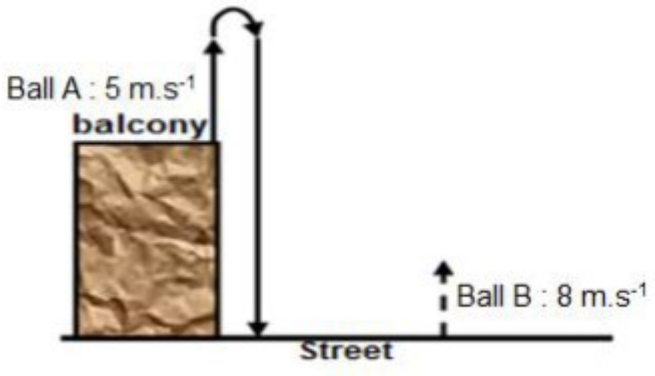
3.2 Calculate the value of **m** in the diagram above. (5)

3.3 Calculate the magnitude of the acceleration of the system as it moves towards the direction indicated on the diagram. (7)

[14]

QUESTION 4 (Start on a NEW page.)

Two balls **A** and **B**, are thrown simultaneously from different positions of the balcony overlooking the street. Ball **A** is thrown vertically upwards with a velocity of 5 m·s^{-1} from the top of a balcony and ball **B** is thrown vertically upwards with a velocity of 8 m.s^{-1} from the bottom of the balcony. Ignore effects of air resistance.



4.1 Define the term *projectile*. (2)

4.2 Calculate the magnitude of the displacement above the balcony of ball **A**. (3)

4.3 If the height of the balcony is 5 m, show by calculations whether or not ball **B** reached the maximum height reached by ball **A**. (5)

4.4 Calculate the speed at which ball **B** was moving when ball **A** reached its maximum height. (4)

4.5 At what time (in minutes) will the speed of the two balls be equal? (5)
[19]

QUESTION 5 (Start on a NEW page.)

A car of mass 1 140 kg, moving towards the east with a velocity of 30 $m.s^{-1}$, collides with an oncoming delivery van of mass 1 650 kg. After collision, the van continues moving towards its original direction at 12 $m.s^{-1}$ whilst the car moves at 10 $m.s^{-1}$. The system is isolated.

5.1 What is meant by *isolated system*? (2)

5.2 Determine the magnitude of the initial momentum of the car. (3)

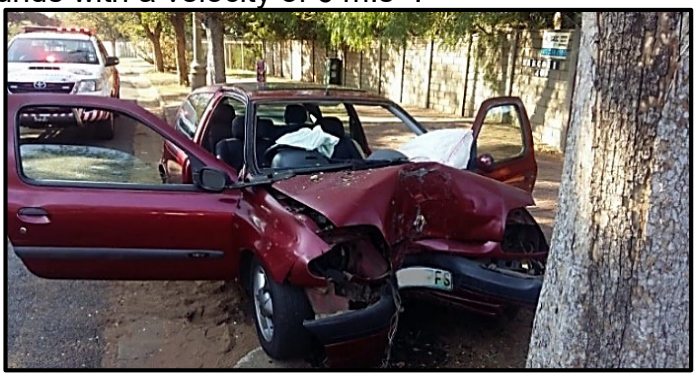
5.3 Calculate the velocity of the van before collision. (5)

5.4 Name and state the principle used to answer QUESTION 5.3. (3)

5.5 Calculate the change in momentum of the van. (3)
[16]

QUESTION 6 (Start on a NEW page.)

A car with a mass of 1 125 kg travelling at a constant velocity of 25 $m.s^{-1}$ collided with a tree and rebounds with a velocity of 6 $m.s^{-1}$.



The car was in contact with the tree for 3,5 s.

6.1 State Newton's Second Law of motion in terms of momentum in words. (2)

6.2 Calculate the total initial kinetic energy of the system. (4)

6.3 Calculate the impulse of the tree during the collision. (4)

6.4 Calculate the average force experienced by the car. (3)

6.5 Discuss by using the principles of physics, how the airbags of the car reduce the extent of injuries suffered by the driver. (2)

6.6 If the car did not rebound from the tree but the time interval remained 3,5 s, how will the magnitude of the force exerted on the car be influenced? Write only INCREASE, DECREASE or REMAIN THE SAME. Explain the answer. (4)

[19]

QUESTION 7 (Start on a NEW page.)

A research satellite has a mass of 3,4 x 10^3 kg. It orbits the Earth at a distance of 2,32 x 10^6 m from the centre of the Earth, which has a mass of 5,98 x 10^{24} kg.

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

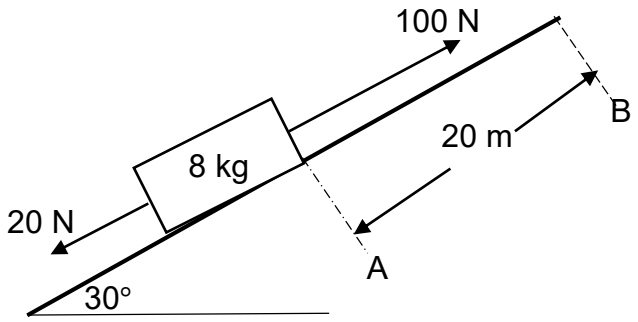
7.2 Name and state the law that is applicable to this situation. (3)

7.3 Another satellite of mass half that of the research satellite orbits at a distance half that of the research satellite from the centre of the Earth. Calculate the magnitude of the force of attraction between the Earth and this satellite. (3)

[10]

QUESTION 8 (Start on a NEW page.)

8.1 A crate of mass 8 kg was resting at point **A** on an inclined rough surface that makes an angle of 30° with the horizontal. Two forces $\mathbf{F_1}$ and $\mathbf{F_2}$, of 20 N and 100 N respectively, were simultaneously applied on the crate and it moved through a displacement of 20 m, as shown in the diagram below.



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

8.1.2 If the frictional force experienced by the crate is 8,5 N, calculate the net work done in moving the crate to point **B**. (4)

8.1.3 Use energy principles to calculate the velocity of the box as it passes point **B**. (4)

8.2 A race car with a mass of 1 500 kg can reach a speed of 26 m.s^{-1} from 0 m.s^{-1} in 4 s. Calculate the average power output of the car's engine. (5)

[15]

QUESTION 9 (Start on a NEW page.)

9.1 A hospital staff member moves away from an ambulance. The siren of the ambulance produces a sound of an unkown frequency. The staff member hears 0,85 times the frequency of the siren as he moves away from the ambulance. The speed of sound in the air is 340 $m.s^{-1}$.

9.1.1 Define *Doppler effect*. (2)

9.1.2 Calculate the velocity of the staff member as he moves away from the ambulance. (4)

9.1.3 Why is the frequency perceived by the listener moving away from the source lower than the actual frequency produced by the siren? (2)

9.1.4 If the staff member decided to get inside the ambulance, how would the frequency heard by the staff member compare, to that emitted by the ambulance?

Write only GREATER THAN, SMALLER THAN or EQUAL TO. (2)

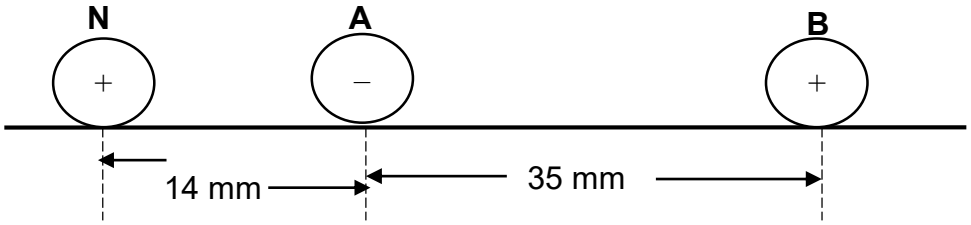
9.1.5 If the frequency of the source was 190 Hz, what will be the magnitude of the frequency registered by the staff member as he was moving away from the ambulance? (2)

9.2 Name TWO applications of the Doppler effect in Medical Science. (2)

[14]

QUESTION 10 (Start on a NEW page.)

The diagram below shows three point charges, **A** carrying a charge of -4 nC, **B** carrying a charge of +8 nC and **N** carrying a charge of +2 nC. These point charges are placed at distance apart from one another as shown in the diagram below.



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

10.2 Calculate the magnitude and direction of the net force around point charge **N** due to the presence of both point charges **A** and **B**. (5)

[7]

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•s^{-2}
Universal gravitational constant *Universelegravitasiekonstant*	G	6,67 x 10^{-11} N•m^2•kg^{-2}
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 m•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•m^2•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
Mass of earth *Massa op aarde*	M	5,98 x 10^{24} kg
Radius of earth *Radius van aarde*	R_E	6,38 x 10^3 km

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1 m_2}{d^2}$	$g = G\frac{M}{d^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = Fv$	

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$ or/ of $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{V}{d}$	$V = \frac{W}{q}$	$E = \frac{kQ}{r^2}$	$E = \frac{F}{q}$	$n = \frac{Q}{q_e}$

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 = VIΔt	W= $I^2R\Delta t$	W= $\frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$	P = VI	P = I^2R	$P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD 12*

JUNE/*JUNIE* 2021

PHYSICAL SCIENCES P1/*FISIESE WETENSKAPPE V1* MARKING GUIDELINE / *NASIENRIGLYN* (EXEMPLAR/*EKSEMPLAAR*)

MARKS/PUNTE: 150

This marking guideline consists of 14 pages./
Hierdie nasienriglyn bestaan uit 14 bladsye.

GENERAL GUIDELINES/*ALGEMENE RIGLYNE*

1. CALCULATIONS/*BEREKENINGE*

1.1 **Marks will be awarded for**: correct formula, correct substitution, correct answer with unit.
Punte sal toegeken word vir: *korrekte formule, korrekte substitusie, korrekte antwoord met eenheid.*

1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there are many relevant symbols and applicable substitutions.
Geen punte *sal toegeken word waar 'n* ***verkeerde of ontoepaslike formule gebruik*** *word nie, selfs al is daar relevante simbole en relevante substitusies.*

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.
Wanneer 'n fout gedurende ***substitusie in 'n korrekte formule*** *begaan word, sal 'n punt vir die korrekte formule en vir korrekte substitusies toegeken word, maar* ***geen verdere punte*** *sal toegeken word nie.*

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark.**
Indien ***geen formule*** *gegee is nie, maar* ***al die substitusies is korrek****,* ***verloor*** *die kandidaat* ***een punt****.*

1.5 **No penalisation** if **zero substitutions are omitted** in calculations where **correct formula**/**principle** is correctly given.
Geen penalisering *indien* ***nulwaardes nie getoon*** *word nie in berekeninge waar die* ***formule/beginsel korrek gegee is nie****.*

1.6 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and correct substitutions. The mark for the incorrect numerical answer is forfeited.
Wiskundige manipulasies en verandering van die onderwerp van toepaslike formules tel geen punte nie, maar indien 'n kandidaat met die korrekte formule begin en dan die onderwerp van die formule verkeerde verander, sal die punte vir die formule en korrekte substitusies toegeken word. Die punt vir die verkeerde numeriese antwoord word verbeur.

1.7 Marks are only awarded for a formula if a **calculation has been attempted**, i.e. substitutions have been made or a numerical answer given.
Punte word slegs vir 'n formule toegeken indien ***'n poging tot 'n berekening aangewend*** *is, d.w.s. substitusies is gedoen of 'n numeriese antwoord is gegee.*

1.8 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.
Punte kan slegs toegeken word vir substitusies wanneer waardes in formule ingestel word en nie vir waardes wat voor 'n berekening gelys is nie.

1.9 All calculations, when not specified in the question, must be done to a minimum of two decimal places.
Alle berekenings, wanneer nie in die vraag gespesifiseer word nie, moet tot 'n minimum van twee desimale plekke gedoen word.

1.10 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
Indien 'n finale antwoord van 'n berekening korrek is, sal volpunte nie outomaties toegeken word nie. Nasieners sal altyd verseker dat die korrekte/toepaslike formule gebruik word en dat bewerkings, insluitende substitusies korrek is.

1.11 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.
Vrae waar 'n reeks berekeninge gedoen moet word (bv. 'n stroombaan-diagramvraag) hoef nie noodwendig dieselfde volgorde te hê nie. VOLPUNTE sal toegeken word op voorwaarde dat dit 'n geldige oplossing vir die probleem is. Enige berekening wat egter nie die kandidaat nader aan die antwoord as die oorspronklike data bring nie, sal geen punte tel nie.

2. UNITS/*EENHEDE*

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.
*Kandidate sal slegs een keer gepenaliseer word vir die herhaaldelike gebruik van 'n verkeerde eenheid **in 'n vraag**.*

2.2 Units are only required in the final answer to a calculation.
Eenhede word slegs in die finale antwoord op 'n vraag verlang.

2.3 Marks are only awarded for an answer, and not for a unit *per se*. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:

- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

Punte sal slegs vir 'n antwoord en nie vir 'n eenheid per se toegeken word nie. Kandidate sal die punt vir die antwoord in die volgende gevalle verbeur:

- *Korrekte antwoord + verkeerde eenheid*
- *Verkeerde antwoord + korrekte eenheid*
- *Korrekte antwoord + geen eenheid*

2.4 SI units must be used except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this.
SI eenhede moet gebruik word, behalwe in sekere gevalle, bv. $V \cdot m^{-1}$ in plaas van $N \cdot C^{-1}$, en $cm \cdot s^{-1}$ of $km \cdot h^{-1}$ in plaas van $m \cdot s^{-1}$ waar die vraag dit regverdig.

3. GENERAL/*ALGEMEEN*

3.1 If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.
Indien een antwoord of berekening verlang word, maar twee word deur die kandidaat gegee, sal slegs die eerste een nagesien word, ongeag watter een korrek is. Indien twee antwoorde verlang word, sal slegs die eerste twee nagesien word, ens.

3.2 For marking purposes, alternative symbols (s, u, t etc) will also be accepted.
Vir nasiendoeleindes sal alternatiewe simbole (s, u, t ens) ook aanvaar word.

3.3 Separate compound units with a multiplication dot, no a full stop, for example, $m{\cdot}s^{-1}$.
For marking purposes, $m.s^{-1}$ and m/s will also be accepted.
Skei saamgestelde eenhede met 'n vermenigvuldigingspunt en nie met 'n punt nie, byvoorbeeld $m{\cdot}s^{-1}$. Vir nasiendoeleindes sal $m.s^{-1}$ en m/s ook aanvaar word.

4. POSITIVE MARKING/*POSITIEWE NASIEN*

Positive marking regarding calculations will be followed in the following cases:
Positiewe nasien met betrekking tot berekeninge sal in die volgende gevalle geld:

4.1 **Subquestion to subquestion**: When a certain variable is calculated in one subquestion (e.g. 3.1) and needs to be substituted in another (3.2 of 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent subquestions.
***Subvraag na subvraag**: Wanneer 'n sekere veranderlike in een subvraag (bv. 3.1) bereken word en dan in 'n ander vervang moet word (3.2 of 3.3), bv. indien die antwoord vir 3.1 verkeerd is en word korrek in 3.2 of 3.3 vervang, word **volpunte** vir die daaropvolgende subvraag toegeken.*

4.2 **A multistep question in a subquestion**: If the candidate has to calculate, for example, current in die first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.
***'n Vraag met veelvuldige stappe in 'n subvraag**: Indien 'n kandidaat bv. die stroom verkeerd bereken in 'n eerste stap as gevolg van 'n substitusiefout, verloor die kandidaat die punt vir die substitusie sowel as die finale antwoord.*

5. NEGATIVE MARKING/*NEGATIEWE NASIEN*

Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given in QUESTION 3.1, and 3.1 is incorrect, no marks can be awarded for QUESTION 3.2. However, if the answer for e.g. 3.1 is based on a calculation, the motivation for the incorrect answer could be considered.
'n Verkeerde antwoord, indien dit op 'n konsepsuele fout gebaseer is, kan normaalweg nie korrek gemotiveer word nie. Indien 'n kandidaat gevra word om in VRAAG 3.2 die antwoord op VRAAG 3.1 te motiveer en 3.1 is verkeerd, kan geen punte vir VRAAG 3.2 toegeken word nie. Indien die antwoord op bv. 3.1 egter op 'n berekening gebaseer is, kan die motivering vir die verkeerde antwoord in 3.2 oorweeg word.

QUESTION/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 C ✓✓ (2)

1.3 C ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 C ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

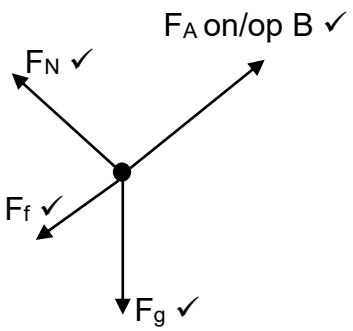
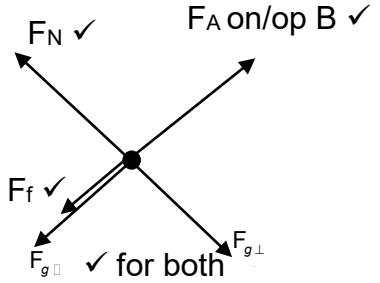
1.10 B ✓✓ (2)

[20]

QUESTION/*VRAAG* 2

2.1 When object **A** exerts a force on object **B**, ✓ object **B** simultaneously exerts an oppositely directed force of the same magnitude on object **A**. ✓
*Wanneer voorwerp **A** 'n krag op voorwerp **B** uitoefen, oefen voorwerp **B** 'n krag gelyk in grootte en in teenoorgestelde rigting op voorwerp **A** uit.* ✓ (2)

2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
	

(4)

2.3 Data:
M_B = 25 kg
f_B = 15 N
a = 1,5 m.s^{-2}
$F_{A\ on\ B}$ = ?
$F_{B\ on\ A}$ = ?

F_{net} = ma
$F_{A\ on\ B} + f_B + F_{g\parallel}$ = ma
$F_{A\ on\ B} + f_B + mgSin35^\circ$ = ma
✓ Any one/E*nige een*
$F_{A\ on\ B}$ + (- 15) + (- 25x9,8x0,574) ✓ = 25x1,5 ✓
$F_{A\ on\ B}$ – 155,63 = 37,50
$F_{A\ on\ B}$ = 193,13 N ✓
$F_{B\ on\ A}$ = - $F_{A\ on\ B}$
$F_{B\ on\ A}$ = - 193,13 N
$F_{B\ on\ A}$ = 193,13 N ✓ down the slope/ *teen die helling af* ✓ (6)

2.4 F_{net} = ma
$F_{Nceba} + F_{B\ on\ A} + f_A + F_{g\parallel}$ = ma
$F_{Nceba} + F_{B\ on\ A} + f_A + mgSin35^\circ$ = ma
✓ Any one/E*nige een*
F_{Nceba} + (- 193,13) + (- 4,5) + (- 10x9,8x0,574) ✓ = 10x1,5 ✓
F_{Nceba} – 253,88 = 15
F_{Nceba} = 268,88 N ✓ (4)
[16]

QUESTION/*VRAAG* 3

3.1 When a net/resultant force acts on an object of mass m, the object accelerates in the direction of the net force. ✓ The accelereation is directly proportional to the net force and inversely proportional to the mass. ✓
Wanneer 'n netto krag op 'n voorwerp inwerk, versnel die voorwerp in die rigting van die netto krag. ✓ Die versnelling is direk eweredig aan die netto krag en omgekeerd aan die massa van die voorwerp. ✓ (2)

3.2 $F_{net} = ma$
$F_g + F_N + F_Y = ma$
$F_g + F_N + F_a \sin 40^\circ = ma$
✓ Any one/E*nige een*

$F_g + (-623,3) + (-500\sin 40^\circ) = mx0$ ✓
$F_g - 623,3 - 321,39 = 0$
$F_g = 944,69$ N
$mg = 944,69$ ✓
$mx9,8 = 944,69$ ✓
$m = 96,40$ kg ✓ (5)

3.3 **<u>For 96,4 kg box / *vir 96,4 kg houer*</u>**

$F_{net} = ma$
$F_X + f_k + T = ma$
$F_a \cos 40^\circ + f + T = ma$
✓ Any one/E*nige een*

$500 \cos 40^\circ + (-115) + (-T)$ ✓ $= 96,4a$ ✓

$383,02 - 115 - T = 96,4a$
$268,02 - T = 96,4a$
$T = 268,02 - 96,4a$ ..... (1)

<u>For 15 kg box / *vir 15 kg houer*</u>

$F_{net} = ma$
$F_g + T = ma$
$mg + T = ma$
✓ Any one/E*nige een*

$-15x9,8 + T$✓ $= 15a$ ✓
$-147 + T = 15a$ (Substitute/*Stel in vir* T)

$-147 + (268,02 - 96,4a) = 15a$
$121,02 = 111,40a$
$a = 1,09$ m.s^{-2} ✓ (7)
[14]

QUESTION/*VRAAG* 4

4.1 It (projectile) is an object upon which the only force acting is the force of gravity. ✓✓
Dit (projektiel) is 'n voorwerp waarop die enigste krag wat daarop inwerk, die gravitasiekrag is. ✓✓

OR/OF

Projectile is an object that experiences only gravitational force. ✓✓
Projektiel is 'n voorwerp wat slegs die gravitasiekrag ondervind. ✓✓ (2)

4.2

OPTION 1 /*OPSIE 1*	
(upwards positive) ***(opwaarts positief)***	**(downwards positive)** ***(afwaarts positief)***
$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $0^2 = 5^2 + 2(-9,8)\Delta y$ ✓ $\Delta y = 1,28$ m ✓	$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $0^2 = (-5)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -1,28$ m $\Delta y = 1,28$ m, (upward) ✓
OPTION 2/*OPSIE 2*	
(upwards positive) ***(opwaarts positief)***	**(downwards positive)** ***(afwaarts positief)***
$v_f = v_i + g\Delta t$ $0 = (5) + (-9,8).\Delta t$ $\therefore \Delta t = 0,51$ s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $= (5)(0,51) + \frac{1}{2}(-9,8)(0,51)^2$ ✓ $\therefore \Delta y = 1,28$ m ✓	$v_f = v_i + g\Delta t$ $0 = (5) + (-9,8).\Delta t$ $\therefore \Delta t = 0,51$ s $\Delta y = v_i\Delta t + \frac{1}{2}g\Delta t^2$ ✓ $= (-5)(0,51) + \frac{1}{2}(9,8)(0,51)^2$ ✓ $\Delta y = -1,28$ m $\therefore \Delta y = 1,28$ m, (upwards) ✓

(3)

4.3 The maximum height reached by ball A (Δy_{max})
Die maksimum hoogte bereik deur bal A (Δy_{max}) = 1,28 + 5 = 6,28 m

Maximum height reached by ball B is given by:
Makisum hoogte bereik deur bal B is:

(upwards positive) ***(opwaarts positief)***	**(downwards positive)** ***(afwaarts positief)***
$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $0^2 = 8^2 + 2(-9,8)\Delta y$ ✓ $\Delta y_B = 3,27$ m ✓ Since $\Delta y_B < \Delta y_{max}$ ✓ OR 3,27 m < 6,28 m ∴ Ball B did not reach the maximum height. ✓ *∴ Bal B het nie die maksimum hoogte bereik nie.*	$v_f^2 = v_i^2 + 2g\Delta y$ ✓ $0^2 = (-8)^2 + 2(9,8)\Delta y$ ✓ $\Delta y = -3,27$ m $\Delta y_B = 3,27$ m, (upward) ✓ Since $\Delta y_B < \Delta y_{max}$ ✓ OR 3,27 m < 6,28 m ∴ Ball B did not reach the maximum height. ✓ *∴ Bal B het nie die maksimum hoogte bereik nie.*

(5)

4.4

(upwards positive) *(opwaarts positief)*	**(downwards positive)** *(afwaarts positief)*
$v_f = v_i + g\Delta t$ ✓ $0 = (5) + (-9,8).\Delta t$ ✓ $\therefore \Delta t = 0,51$ s $v_f = v_i + g\Delta t$ $= (8) + (-9,8).0,51$ ✓ $\therefore v_f = 3,00$ m.s^{-1} ✓	$v_f = v_i + g\Delta t$ ✓ $0 = (5) + (-9,8).\Delta t$ ✓ $\therefore \Delta t = 0,51$ s $v_f = v_i + g\Delta t$ $= (-8) + (9,8).0,51$ ✓ $v_f = -3,00$ m.s^{-1} $\therefore v_f = 3,00$ m.s^{-1} ✓

(4)

4.5 **(Upwards positive)**

For ball A/ *Vir bal A*

$v_f = v_i + g\Delta t$ ✓

$v_f = (5) + (-9,8).\Delta t$ ..... (1) ✓

For ball B/ *Vir bal B*

$v_f = v_i + g\Delta t$

$v_f = (8) + (-9,8).\Delta t$ ..... (2) ✓

Equating (1) and (2)/ *Stel (1) gelyk aan (2)*:
Since ball A will be moving downwards then/*Aangesien bal A afwaarts beweeg dat*:

$-(5 - 9,8.\Delta t) = 8 - 9,8.\Delta t$ ✓

$19,6.\Delta t = 13$

$\Delta t = 0,66$ s

$\Delta t = 0,011$min ✓ (5)

[19]

QUESTION/*VRAAG* 5

5.1 A system on which the net external forces acting is zero. ✓✓
Dit is 'n sisteem waarop die netto eksterne krag wat op die sisteem inwerk, nul is. ✓✓ (2)

5.2 **Let east be positive/*Laat oos positief wees***

$p = mv$ ✓

$= 1\ 140 \times 30$ ✓

$= 34\ 200$ kg.m.s^{-1}, (east/*oos*) ✓ (3)

5.3 $\Sigma p_i = \Sigma p_f$
$m_v v_{iv} + m_c v_{ic} = m_v v_{fv} + m_c v_{fc}$ ✓

$1\ 650\ v_{iv} + 1\ 140 \times 30$ ✓ $= 1\ 650 \times -12 + 1\ 140 \times 10$ ✓

$1\ 650\ v_{iv} = 11\ 400 - 34\ 200 - 19\ 800$

$v_{iv} = -25,82$

$v_{iv} = 25,82$ m.s^{-1} ✓, west ✓ (5)

5.4 Principle of conservation of linear momentum ✓
The total linear momentum of an isolated system remains constant (preserved). ✓✓
Beginsel van behoud van lineêre momentum. ✓
Die totale lineêre momentum in 'n geïsoleerde sisteem bly konstant (behoue). ✓✓ (3)

5.5 $\Delta p = m(v_f - v_i)$ ✓
$\Delta p = 1\ 650\ (-12 - (-25{,}82))$ ✓
$\Delta p = 22\ 803\ kg.m.s^{-1}$ ✓ (3)
[16]

QUESTION/*VRAAG* 6

6.1 The net/resultant force acting on an object is equal to the rate of change in momentum of the object. ✓✓
Die netto/resulterende krag wat op 'n voorwerp inwerk, is gelyk aan die tempo van verandering van momentum van die voorwerp. ✓✓ (2)

6.2 Total $E_{k\ Before} = E_{k\ tree} + E_{k\ car}$
$= \frac{1}{2} m v_{tree}^2 + \frac{1}{2} m v_{car}^2$ ✓ Any one/*Enige een*
$= \frac{1}{2} (m)(0^2)$ ✓ + $\frac{1}{2} (1\ 125)(25)^2$ ✓
$= 351\ 562{,}5$ J ✓ (4)

6.3 **Impulse of the tree/*Impuls van die boom*:**
Let original direction be positive/*Laat die oorspronklike rigting positief wees*
$F_{net}\Delta t$ (car) $= m(v_f - v_i)$ ✓
$= 1\ 125(-6 - 25)$ ✓
$= -\ 34\ 875$ N
$F_{net}\Delta t$ (car) = 34 875 N, backwards/*terugwaarts*
$F_{net}\Delta t$ (tree) = 34 875 N ✓, original direction of the car/ *oorspronklie rigting van die motor*. ✓ (4)

6.4 F_{net} (car) $= \frac{m(v_f - v_i)}{\Delta t}$ ✓
F_{net} (car) $= \frac{1\ 125(-6 - 25)}{3{,}5}$ ✓
F_{net} (car) = - 9 964 N
F_{net} (car) = 9 964 N, backwards/*terugwaarts* ✓ (3)

6.5 When the airbags deploy during collision, the contact time of the driver with the airbag increases. ✓ According to the equation $F_{net}\Delta t = \Delta p$, when contact time increases the net force experienced by the driver decreases. ✓ Then, the extent of injury is reduced.
Wanneer die lugsak gedurende die botsing ontplooi, sal die kontaktyd van die bestuurder met die lugsak verhoog. Volgens die vergelyking $F_{net}\Delta t = \Delta p$ *, wanneer die kontaktyd verhoog sal die netto krag wat deur die bestuurder ervaar word verlaag.* ✓ *Dus sal die omvang van die beserings verminder word.* (2)

6.6 Decrease ✓
The final velocity will now be zero. ✓ Then, according to the equation: $\Delta p = m(v_f - v_i)$, it follows that Δp will decrease. ✓ If Δp decreases then F_{net} decreases as they are directly proportional to each other. ✓
Verminder ✓
Die finale snelheid sal nou nul wees. ✓ *Volgens die vergelyking:* $\Delta p = m(v_f - v_i)$ *dit volg dat* Δp *sal verlaag.* ✓ *As* Δp *afneem dan sal* F_{net} *verlaag aangesien hulle direk eweredig is aanmekaar.* ✓ (4)
[19]

QUESTION/*VRAAG* 7

7.1 $F = \frac{Gm_1m_2}{r^2}$ ✓

$F = \frac{(6,67 \times 10^{-11})(3,4 \times 10^{3})(5,98 \times 10^{24})}{(2,32 \times 10^{6})^2}$ ✓ ✓

$= 251\ 959,05$

$= 2,52 \times 10^5$ N ✓ (4)

7.2 Newton's Law of Universal Gravitation ✓
Any two objects or particles in the universe attract each other with a force which is directly proportional to the product of their masses ✓ and inversely proportional to the square of the distance between their centres. ✓
Newton se Universele Gravitasiewet
Enige twee liggaam of deeltjie in die heelal trek mekaar aan met 'n krag wat direk eweredig aan die produk van hul massas ✓ *en omgekeerd eweredig aan die kwadraat van die afstand tussen hul middelpunte aan.* ✓ (3)

7.3 $F_1 = \frac{Gm_1m_2}{r^2} = F$

$F_2 = \frac{Gm_1\frac{m_2}{2}}{\left(\frac{r}{2}\right)^2}$ ✓

$F_2 = \frac{\frac{Gm_1m_2}{2}}{\frac{r^2}{4}}$ ✓

$F_2 = 2\frac{Gm_1m_2}{r^2} = 2F$

$F_2 = 2(2,52 \times 10^5\ N)$

$F_2 = 5,04 \times 10^5$ N ✓ (3)
[10]

QUESTION/*VRAAG* 8

8.1 8.1.1 The net work done on an object is equal ✓ to the change in the kinetic energy of the object. ✓
Die netto arbeid deur 'n voorwerp verrig is gelyk ✓ aan die verandering in kinetiese energie van die voorwerp. ✓

OR /*OF*

The amount of work done by a net force ✓ on an object is equal to the change in the object's kinetic energy. ✓
Die arbeid verrig deur 'n netto krag ✓ is gelyk aan die verandering in kinetiese energie van die voorwerp. ✓ (2)

8.1.2

OPTION 1/*OPSIE 1*

$W_{net} = W_{F1} + W_{F2} + W_{//} + W_f$ ✓
$= F_1\Delta x\text{Cos}180^\circ + F_2\Delta x\text{Cos}0^\circ + mg\text{Sin}30^\circ\Delta x\text{Cos}180^\circ + f\Delta x\text{Cos}180^\circ$
$= \underline{(20)(20)(-1) + (100)(20)(1)}$ ✓ + $\underline{(8)(9,8)(0,5)(20)(-1) + (8,5)(20)(-1)}$ ✓
$= -400 + 2000 - 784 - 170$
$= 646$ J ✓

OPTION 2/*OPSIE 2*

$F_{net} = F_2 + F_1 + F_{g//} + f$
$= F_2 + F_1 + mg\text{Sin}30^\circ + f$
$= 100 + (-20) + \{-(8)(9,8)(0,5)\} + (-8,5)$
$= 32,3$ N
$W_{net} = F_{net}\Delta x\text{Cos}\theta$ ✓
$= F_{net}\,\Delta x\text{Cos}0^\circ$
$= (32,3)$ ✓ $(20)(1)$ ✓
$= 646$ J ✓ (4)

8.1.3 $W_{net} = \Delta E_k$
$W_{net} = E_{kf} - E_{ki}$
$W_{net} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
✓ Any one/*Enige een*

646 ✓ $= \frac{1}{2}(8)v_f^2 - \frac{1}{2}(8)(0)$ ✓

$v_f^2 = \frac{(2)(646)}{8}$
$= 161,5$
$v_f = 12,71\ m.s^{-1}$ ✓ (4)

8.2 $\Delta E_k = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ ✓

$= \frac{1}{2}(1\,500)(26)^2 - \frac{1}{2}(1\,500)(0)^2$ ✓

$= 507\,000$ J

$P = \frac{\Delta E_k}{\Delta t}$ ✓

$= \frac{507\,000}{4}$ ✓

$= 126\,750$ W

$= 126{,}75$ kW ✓ (5)

[15]

QUESTION/*VRAAG* 9

9.1 9.1.1 It is the apparent **change in frequency** (or pitch/wavelength) of the sound detected by a listener because the sound source and the listener have **different velocities** relative to the medium of sound propagation. ✓✓

*Dit is die **verandering in frekwensie** (toonhoogte/golflengte) van die klank waargeneem deur 'n luisteraar omdat die klankbron en die luisteraar **verskillende snelhede** relatief tot die medium waarin die klank voortgeplant word, het.* ✓✓

OR/*OF*

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

*Dit is **oënskynlike verandering in frekwensie** (toonhoogte/golflengte) **wat waargeneem word** as gevolg van die relatiewe beweging tussen die bron en waarnemer.* ✓✓ (2)

9.1.2 $f_L = \frac{v \pm v_L}{v \pm v_S} f_S$

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

✓ Any one/*Enige een*

$0{,}85x$ ✓$= \frac{340 - v_L}{340}(x)$ ✓

$289x = (340 - v_L)(x)$

$289 = 340 - v_L$

$v_L = 51$ m.s^{-1} ✓ (4)

9.1.3 When the listener moves away from the source the sound waves that reach him have <u>longer wavelength</u> ✓ and a sound with a lower pitch is registered because of a <u>lower frequency</u>. ✓

As die luisteraar van die bron af wegbeweeg, het die klankgolwe wat hom bereik <u>langer golflengte</u> en 'n klank met 'n laer toonhoogte geregistreer weens 'n <u>laer frekwensie</u>. ✓✓ (2)

9.1.4 It would be the same ✓✓
Dit sal dieselfde bly ✓✓ (2)

9.1.5 $F_L = 0,85f_S$
$= 0,85 \times 190$ ✓
$= 161,5$ Hz ✓ (2)

9.2 To measure the velocity of blood flowing through blood vessels. ✓
To scan a fetus/foetus. ✓
Om die snelheid van bloed wat deur are vloei, te meet. ✓
Om 'n fetus te skandeer. ✓ (2)
[14]

QUESTION/*VRAAG* 10

10.1 The magnitude of the electrostatic force exerted by one point charge (Q) on another point charge (Q) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓
Die grootte van die elektrostatiese krag wat een puntlading (Q_1) op 'n ander puntlading (Q_2) uitoefen, is direk eweredig aan die produk van ladings en omgekeerd eweredig aan die kwadraat van die afstand (r) tussen hulle. ✓✓ (2)

10.2 **East is positive/*Oos is positief***

$$F_{AN} = \frac{kQ_AQ_N}{r^2} \checkmark$$
$$= \frac{(9x10^9)(4x10^{-9})(2x10^{-9})}{(0,014)^2} \checkmark$$
$= 0,0005$ N, East/*Oos*

$$F_{BN} = \frac{kQ_BQ_N}{r^2}$$
$$= \frac{(9x10^9)(8x10^{-9})(2x10^{-9})}{(0,049)^2} \checkmark$$
$= 0,00006$ N, West/*Wes*,

$F_{net} = F_{AN} + F_{BN}$
$= 0,0005 - 0,00006$ ✓
$= 0,00044$ N, East/Right */ Oos/regs* ✓ (5)
[7]

TOTAL/*TOTAAL*: 150